بەڕێوەبەرایەتی توێژینەوەی کشتوکاڵی سلێمانی

توێژینەوە بڵاوکراوەکان لە گۆڤارە زانستیەکان

٢٠١٤-٢٠٢٢

وەزارەتی کشتوکاڵ و سەرچاوەکانی ئاو
بەڕێوەبەرایەتی گشتی توێژینەوەو ڕێنمایی کشتوکاڵی
بەرێوەبەرایەتی توێژینەوەی کشتوکاڵی سلێمانی

توێژینەوە بڵاوکراوەکان لــــە گۆڤارە زانستی یەکان

٢٠١٤-٢٠٢٢

کۆکردنەوەو ئامادەکردن و ڕێکخستنی

کاروان فتاح معرووف
هەردی عبداللە محمود
شاناز عارف کویخا

هەیکەلی ئیداری (بەڕێوەبەرایەتی توێژینەوەی کشتوکاڵی سلێمانی)

بەڕێوەبەر

- هۆبەی کارگێـــــڕی و خۆیــەتی
- هۆبـــــــەی ژمێریـــــــاری
- هۆبەی پلان دانان و بەدواداچوون و کەشناسی
- هۆبەی توێژینەوەی بەروبوومی کێڵگەیی
- هۆبەی توێژینەوەی پاراستنی رووەک
- هۆبەی توێژینەوەی باخداری و دارستان و پاوان
- هۆبەی توێژینەوەی سامـــــانی ئــاژەڵ
- هۆبەی توێژینەوەی سەرچاوەکانی ئاوو بەنداوەکان
- هۆبەی ئامێــــرەکان
- هۆبەی یاســاو مولکـــداری
- هۆبــەی کـــۆگـــــا
- هۆبــەی ووربـــــــــــــینـی
- هۆبەی توێژینەوەی پشکنینی خاک و تاقیگەکان
- هۆبــــەی پیس بـــوونی ئـــاو
- وێستگەکانی توێژینەوە لە قەزاو ناحیەکان
  - * وێستگەی توێژینەوەی کشتوکاڵی چەمچەماڵ- بانی مقان
  - * وێستگەی توێژینەوەی کشتوکاڵی زرگوێز
  - * وێستگەی توێژینەوەی کشتوکاڵی بی بی جەک- بازیان
  - * وێستگەی توێژینەوەی کشتوکاڵی موان – سید صادق
  - * وێستگەی توێژینەوەی کشتوکاڵی گردجان –رانیە

ژمارەی فەرمانبەران بەپێی بڕوانامەو ڕەگەز تا بەرواری 2022/4/22

ز	بڕوانامە	ڕەگەز		کـــــۆ
		نێر	مێ	
1-	دکتۆرا	0	0	0
2-	ماستەر	14	6	20
3-	دبلۆمی باڵا	1	0	1
4-	بکالریۆس	40	43	83
5-	دبلۆم	18	14	32
6-	ئامادەیی	2	2	4
7-	ئامەدەیی پیشەیەکان	22	15	37
8-	ناوەندی	7	0	7
9-	سەرەتایی	29	6	35
10-	خوێندنی خێرا	0	0	0
11	بێ بڕوانامە	27	9	36
	کۆی گشتی	**160**	**95**	**255**

(ئامانجەکانی بەڕێوەبەرایەتی توێژینەوەی کشتوکاڵی)

- دروســـت کردنـــی جـــۆری بـــاش لە دانەوێڵەکـــان و بەرهەمە کێڵگەیەکـــان لە ڕێـــگەی پــــــرۆژەی (تربیە النبـات) بـۆ کـۆکردنەوەی زیـاتر لە سیفەتێکی پەسەند لە جۆرێکی دروست کراو بە مەرجێک جێگەی ڕەزامەندی جوتیاران و بەکار هێنەران بێت .
- دەست نیشان کردنی کاتی گونجاو بۆ چاندن و کۆکردنەوەو دەرمان رشا ندن لە کات و ڕێژەی پێویست .
- دەسـت نیشـان کردنـی گونجـاو تـرین ی تەرز بـۆ مەبەسـتی بەرهەڵسـتی کردنـی دەردە کشـتوکاڵیەکالیە جیاوازەکـان وە هەڵبژاردنـی گونجـاو تـرین تەرز بـۆ بەرەنگـاربونەوەی ووشکە ساڵی و گۆرانکاری ژینگەیی نوێ کە هاتۆتە ناوچەکەمان
- بەکارهینانی کود بەشێوەیەکی زانسـتیانە بە پـێ ی پێویسـت لەسـەر ئەنجامی شـیکاری خاک , هەوڵدان بۆ بەکارهێنانی کودی ئۆرگانی و کودی زیندوو لەبەر ئەوەی ئەم جۆرە کودانە دوورن لە مەترسی پیسبوونی ژینگەیی و کوالیتی کشتوکاڵی بەرزدەکەنەوە .

- گرنگی دان به ڕیگەی نویٚ بۆ ئاودان و ئاودانی تەواو کاری .
- کیومالٚکردنی مێروو و دەردە کشتوکالٚیەکان وە کۆکردنەوەو دراسەکردنی سوڕی ژیانیان, ڕێکخستن و هەلٚگرتنیان لە مۆزەخانەدا...
- دروست کردنی باخی دایکانە بۆ چەندین جۆر لە (مێو , زەیتون , میوە ,هەنار ,هەرمیٚ ,توو,شاتوو) .
- چاندنی بەروبووم بە سیستمی نویٚ و بیٚ کێلاٚن .
- بەرەنگاربونەوەی نەخۆشی و دەردە کشتوکالٚیەکان بە ڕێگەیIPM .
- بەرهەمهێنانی سەوزەگرنگەکان بەبەردەوامی ساڵ دووركەوتنەوە لە هاوردەکردن کە پێداویستی ڕۆژانەی هاوڵاتیانن.
- بەرهەمهێنانی خواردنی تەندروست و دوور لە پاشماوە قڕکەرە کیمیایی یەکان و سمادی زۆر لە پێکهاتەکەیاندا...
- بەکارهێنانی تەکنەلۆجیای نویٚ لە چاندن و دروێنەکردن و هەلٚگرتنی بەرهەمی کشتوکالٚی ...
- بەبازاڕ کردنی بەپیشەسازی کردنی بەرهەم لەڕێگەی بەرهەمهێنان و دروستکردنی تەرزی نویٚ لە سەوزەو میوەکان کە بۆ پیشەسازی لەقوتونان گونجاو بێت...
- بەرهەمهێنانی تەرزی نویٚ لەگەنم کە بۆ پیشەسازی کردنی ئارد و ساوەرو معکرۆنی و قەرەخەرمان گونجاو بێت...
- دروستکردنی کێلگەی داخراوی سامانی ئاژەلٚ و پەرەپێدانی بەشێوەی زانستی و دوورکەوتنەوە لە لەوەڕگای کراوە...
- پەرەپێدانی بواری هەنگ و پەلەوەری خۆمای و ماسی..

مێژووی بەرێوەبەرایەتی تویژینەوەی کشتوکاڵی سلێمانی

بەرێوەبەرایەتی توێژینەوەی کشتوکاڵی سلێمانی لە پێشدالە ساڵەکانی (1957) بە بەشی زیانبەخشەکان کەسەر بە مەزرەعەی کۆنی بەکرەجۆ بووە دامەزراوە . دواتر بوو بە (وێستگەی توێژینەوەی پاراستنی کشتوکاڵی – بەکرەجۆ) کە سە بە (بەرێوەبەرایەتی گشتی پاراستنی کشتوکاڵ) بوو لە بغداد لە سالی (1983) مەڵبەندی توێژینەوەی کشتوکاڵی سلێمانی دروست بوو , وە (بەشی خاک) ی ناوبراوی خرایە سەر کە ئەم مەڵبەندە سەر بە (الهيئةالعامة للبحوث الزراعية والتطبيقية) لە بەغداد – ابوغریب بوو , دواتر لە هەموو پارێزگانی عیراقدا مەڵبەندی توێژینەوەی کرایەوە بەڵام لە ساڵی (1987) کەم کرانەوە بۆ (3) مەڵبەندی سەرەکی لە (موصل , ابوغریب , بەکرەجۆ)لەساڵی (2007) دا مەڵبەندی توێژینەوەی کشتوکاڵی ناوەکەی گۆردرا بە بەرێوەبەرایەتی توێژینەوەی کشتوکاڵی سلێمانی , ئەم بەرێوەبەرایەتیە لە (6) هۆبەی هونەری پێک دێت و لەگەڵ (5) وێستگەی توێژینەوە کە دابەش بووە بەسەر ناوچە جیا جیاکانی پارێزگای سلێمانی کە هاوکارن لەگەڵ هۆبە هونەریەکاندا بۆ ئەنجام دانی کاروو چالاکی یەکانیان ..

بەڕێوەبەرایەتی توێژینەوەی کشتوکاڵی سلیمانی

توێژینەوە بڵاو کراوەکان لە 2022-2014

نـــــــــــــــاوەڕۆک

هۆبەی توێژینەوەی سامانی ئاژەڵی

Comparative study of chemical composition and microbial loads of chicken eggs from Kurdish local chicken and retail markets in Iraqi Kurdistan Region

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Abstract:
The aim of the study was to compare the chemical composition particularly protein content, minerals and some heavy metals and the level of microbial contaminations between Kurdish local chicken eggs and commercially available in retail markets in Kurdistan. Total protein in white egg, minerals (Fe, Mg, Cu, and Ca), heavy metals (Pb, Cd, and Co), and microbiological quality were assessed. The results show that depending on egg type it is possible to use such nutrient claims as "high protein". The examined eggs samples comply the permissible limits for trace elements in table eggs. The findings indicate that the concentrations level of heavy metals in eggs are set within the standard limits and considered as safe for human consumption. In add ion, microbial loads off examples were tested for aerobic plate count which shows that 46.6% of examined entire contents of egg samples (Barn, Erbil, Domestic, Iran and Turkey) fulfilled with the standards and a total bacterial count within the permissible count (2.5×10^4/g) except one sample from barn of the coli form count was confirmed *E. coli*, and one sample from barn was positive for salmonel.

Introduction:

People in Kurdistan consume caged hen which imported from different neighbor? Countries such as Turkey and Iran and local Eggs which produced in Erbil city in Kurdistan. Some people are considering the Domestic Kurdish local chicken eggs to be superior to eggs from caged hens**.** Eggs are an outstanding source of micro and Macro nutrients, including all essential amino acids, fats, water-soluble vitamins, minerals, lecithin and unsaturated fats [1, 2]. In terms of daily diet, eggs (fresh eggs) are the most important and nutritious food item, and it's moreover included in many food products serving different functions [3].Hen eggs quality (in terms of nutrition) are effected by many factors, some of the hen a grand breed, the nutrient density and composition of hen feed along with rearing system[4]. Since eggs represent an essential. Portion of humans' diet (children in particular) and due to the elevated pollution in the glob l Environment with Trace elements, led to an increased investigation in terms of metal Contamination of eggs included food-stuffs [5]. Iron (Fe) and Copper (Cu) are some of the Indispensable required trace elements for Humans, however, at high concentrations all Metal elements are toxic [6 and 7]. Arsenic (As), Lead (Pb) and Cadmium (Cd) are heavy Metals that accumulate over time and toxic When laid, eggs are mostly found to be sterile(90%), but it's possible for the eggs to be Contaminated on the outer shell surface and Internally [8].Eggs is a good source of nutrients needed for growth of pathogenic and spoilage Microorganisms. Egg spoilage depends on.

temperature, handling, storage, and Availability of nutrients in eggs [9]. Bacteria and fungi are micro-organisms that can contaminate eggs and elevate the hazards of causing spoilage and food borne diseases since the egg defense mechanism can be evaded by these micro-organisms and then penetrating in to the egg. Food poisoning caused by the Salmonella serotypes (most frequently Salmonella Enteritis is, Salmonella, and Salmonella typhimurium) which are the mostly prevalent pathogen of eggs that are Found inside the eggs shell [10]. Another source of egg contamination with pathogen is by the ovarian infection either prior to laying or afterward due to the microorganism entry in to the egg (in which elevated temperature and humidity are regarded as auxiliary conditions for the infection) causing spoilage and economical damage or create hazards in terms of public health[11].In Kurdistan, it's vital to perform an analysis for the eggs in terms of microbial, nutritional Composition due to elevated eggs consumes in the region. Eggs quality is associated by the users in terms of yolk color and freshness. Additionally, the consumers in Kurdistan regard local chicken eggs as superior when compared to eggs from caged hens.Therefore,this study was aimed to identify and address the residual concentration levels of iron, cobalt, copper and lead in eggs of domestic local hen and commercially imported eggs, and to compare the nutritional composition particularly protein content and microbial contaminations

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Materials And Methods:

Sample collection:

The commercial and domestic Kurdish local egg samples were collected randomly from various retail markets in Kurdistan. The samples were analyzed at the laboratories of College of Agricultural Engineering Sciences, University of Sulaimani.

Table (1): Source of egg samples:

Sample code	Farming	Type of eggs in the market
1-	**Barn eggs (control)**	**Farmer – Barn eggs**
2-	**Caged chicken eggs from (Erbil)**	**Eggs in boxes**

3-	**Kurdish local chicken eggs (Domestic)**	**Free range**
4-	**Caged chicken eggs from (Iran)**	**Eggs in boxes**
5-	**Caged chicken eggs from (Turkey)**	**Eggs in boxes**

Protein Determination in Eggs according to the Kjeldahl Method:

The protein content in eggs is important and essential parameter to determine in order to ensure the quality and safety of food. The nitrogen content in eggs sample was estimated by Kjeldahl's method [12]. Approx. 1.2 g of the homogenized sample was weighed indirectly into a sample tube. A portion of 20 mol sulfuric acid and 2 Kjeldahl tablets were added and the digestion was performed. After digestion the ammonia of the sample was. Injected to OES-ICP Perkin Elmer2100 for determine [13].

Microbial examination of eggs:
Ten-fold serial Decimal dilutions were Aseptically prepared from the rinse solutions, as well as from the homogenous egg contents using 0.1% sterile peptone water. The egg was prepared for evacuation of its content according to the method described in A.P.H.A. egg was washed with warm water, the egg was drained and immersed in70%Alcohol for 10 min, then flamed after it has-been removed from alcohol. A hole was made the blunt end of the egg by using sterile Scalpel. The contents of each group (sample)were removed aseptically and received into a sterile mixer until the sample becomes homogenous [14].Twenty-five ml of the egg was placed in a sterile stomacher bag to which 225ml of buffered peptone water was added. The sample was homogenized in the stomacher for one minute to obtain a homogeneous primary sample. Decimal serial distilled into a boric acid solution by steam Distillation and titrated with sulfuric acid.

Preparation of egg samples for determine mineral and heavy metals :

Egg samples were washed with de-ionized Water, the egg yolk and white were mixed in a200ml beaker. A portion (5-10gm) of mixed sample was accurately weighed into 100-ml beaker and 5-10ml 65% and concentrated HNO3was added and covered with watch glass. After 30 min the beaker was placed on hot. plate up to 140°C until the complete decomposition of sample was achieved and the total volume was reduced to nearly 3-5ml.the digested sample was cooled and filtered into a 50ml calibrated flask, the solution was injected to OES-ICP Perkin Elmer 2100 for determine [13] . TCC and TABC [16]. Colonies were measured as colony-forming units (CFU) per mol sing number of bacteria/mol = Number of colonies on the plate*reciprocal of the dilution of the sample (17). TCC and TABC [16]. Colonies were measured as colony-forming units (CFU) per mL using number of bacteria/mL = Number of colonies on the plate*reciprocal of the dilution of the sample (17).

Examination for Salmonella:
Aseptically weigh 25g of egg content into a sterile 500 ml screw cap jar, add 225 ml pepton water , and mix well by swirling, Loosen cap 1/2 turn and incubate for 24 hrs at37°C. After incubation, transferred 1 ml of the culture to 10 ml of tetrathionate broth, and incubated at 37°C for 24 hrs. A loopful of tetrathionate broth culture were streaked on to three selective agar media

dilutions of the primary sample for egg content were set up using test tubes containing 9ml of the diluentof 0.1% peptone water. Serial dilutions of therinsate were pour plated on plate count agar All the media was prepared following the manufacturer instruction and sterilized by autoclaving at 121°C for 20 min [15].

Total aerobic bacterial and coli form count:

Total viable count of all the egg content Samples were determined by standard plate count method using nutrient agar by the pour plate technique and Mac Conkey agar medium in duplicates for total aerobic bacterial counts (TABC) and total coli form count (TCC), respectively. The plates were then incubated at37°C for (24-48) h and plates with colonies from 30 to 300 were used for determining egg samples. Maximum value of protein was recorded in eggs from caged hens in Erbil12.867% and minimum value was recorded in eggs from caged hens in Turkey 10.3% which was less than of the protein in barn eggs. 13.023%, Kurdish local chicken eggs12.237%, Erbil 12.867% and Iran 12%. This difference might be referring to hens feed and balanced dietary protein levels [19].

of Salmonella-Shigella agar (SS agar) salmonella on ss agar appear colorless colonies, production of H 2 Sturn the center of colony to black , and then
incubated at 37°C for 24 hrs, after incubation ,the plate were examined for typical colony, and suspected Salmonella colonies were subculture to a selective Mac Conkey agar plate and non-selective Nutrient agar plate and incubated at 37°C for 24 hrs for more confirmation conducted to microscopic examination [18].

Statistical analysis:

The data were statistical analysis according to the method of analysis of variance as a general test. Factorial experiment with three replications was used by (XLSAT) program ver. 7.5.2 and conducted using Complex Randomized Design (CRD). All possible comparisons among the means were carried out by using (Dunkin) test at the signify cant level of 0.05 after they show their significant in the general test.

Results and discussion:

Protein contents:

Table 2 shows the results of protein percentage of eggs from different egg samples shows that protein content is vary among samples of eggs between 10.30 - 13.02%.Therewas a significant differences in caged chicken eggs from Turkey compared to other

Table (2): The percentage of protein content in different type of eggs

Egg samples	Protein %
Barn eggs (control)	13.023_{a}
Caged chicken eggs from (Erbil)	12.867_{a}

Kurdish local chicken eggs (Domestic)	12.237a
Caged chicken eggs from (Iran)	12.000a
Caged chicken eggs from (Turkey)	10.300b
N=3, (p<0.05)	

Minerals:

The results showed that disparity in metals concentrations in eggs among the samples. The concentration of heavy metals in eggs are presented in (Table3).In general, Iron (Fe) appear relatively high concentration in egg Content which ranged between 1.56 to 3.84ppm, the highest iron content was observed in Kurdish local chicken eggs which was3.840ppm and the lowest was in caged chicken eggs from Turkey 1.560ppm.Magnesium (Mg) ranged between 12.53 in Kurdish local chicken eggs to 18.48 ppm in caged chicken eggs from Erbil. There was no significant difference in Copper (Cu) and Calcium (Ca) among the egg samples, which Cu ranged between 0.069 to 0.092 ppm, and Ca ranged between 15.12 to 20.75 ppm. These Results didn't differ significantly from levels of minerals were determined in eggs by another Investigators [20]. In the absence of dietary in formations about the hens, the variation in egg miner las may refers to the dietary system, Hen age, hen strain and farming methods. The fore, we cannot identify reasons that Contributed to these variation precisely [21].In table (4), Cobalt (Co) have been the lowest concentration ranged 0.005 to 0.006 ppm. The level of Cadmium (Cd) concentration ranged from 0.006 to 0.034 ppm. The concentration of Pb level ranged between 0.053 to 0.112ppm. It has been reported that free-range System hens produced eggs richest in Micronutrients (K, Na, Ca, Mg, Zn, Se, Mn and Fe), as it allows hens to supplement the irdietary ration [22]. It is in partial agreement with our results. Content of lead and cad miumin all egg samples were below the detection level, therefore, it can be concluded that all egg samples were free of heavy metals .However; a study in Egypt has established equally noticeable contamination with Pb and Cd in both free range eggs and caged hens' eggs [23].

Table (3): Minerals in different type of eggs (ppm)

Egg samples	Means			
	Fe	Mg	Cu	Ca
Barn eggs (control)	1.950b	13.880b	0.087a	19.810a
Caged chicken eggs from (Erbil)	1.930b	18.480a	0.085a	20.750a

Kurdish local chicken eggs (Domesctic)	3.840a	12.530b	0.081a	19.250a
Caged chicken eggs from (Iran)	1.870b	14.020b	0.069a	19.200a
Caged chicken eggs from (Turkey)	1.560b	14.300b	0.092a	15.120a

N=3, ($p<0.05$)

Table (4): The concentration of heavy metals in different type of eggs (ppm)

Egg samples	Means		
	Co	Cd	Pb
Barn eggs (control)	0.005_a	0.008_b	0.104_b
Caged chicken eggs from (Erbil)	0.005_a	0.034_a	0.053_e
Kurdish local chicken eggs (Domesctic)	0.005_a	$0.007_{b,c}$	0.112_a
Caged chicken eggs from (Iran)	0.006_a	0.008_b	0.074_c
Caged chicken eggs from (Turkey)	0.005_a	0.006_c	0.059_d

N=3, ($p<0.05$)

Microbial contamination in eggs:

According to the results reported in Table (5),the highest values of total bacteria counts was in Barn 3× 10^4, the lowest value was in Turkey, the high results may be due to bad handling of eggs during storage with high temperature specially in summer months and under humid conditions. In addition, the results for total coli form counts were positive in three treatment (Barn, Domestic, Iran) with mean value 3×10^2, 8×10^2, 2×10^2 (cfu/ml)(Table 6), only one sample from barn of the coli form count was confirmed *E. coli*, and only one sample from barn was positive for salmonella test. The high counts of coli forms may be due to bad sanitary conditions and/or delay in eggs collection from nests which were contaminated with fecal matters. Tested samples for aerobic plate count showed that 46.6 % of the total examined samples of entire egg contents of Barn, Turkey, Iran, local, and Erbil eggs content fulfilled with Egyptian standards with a total bacterial count. Storage, dirty nesting materials, cloths, hands of poultry workers, dust, and the environment, weather conditions, transporting and marketing [27]. This resulting in eventual penetration of the shell. Entrance of microorganisms into egg content may beeither by penetration or with drawl through pores of the shells [28].

within the permissible count (2.5× 104/g) Stated by the (Egyptian Organization for Standardization and Quality Control, [24] of egg. The mean total viable count for the egg content lower than the accepted $10x10^5$gm/cfu as recommended by the International Commission on the Microbiological Specification for Food ICMSF [25]. Microbial load of less than 2 log cfu packaged egg is considered an excellent commercial standard [26] .The absence of standard structures and drainage system in the market and the relatively high humidity could have contributed to the high microbial growth. It was also found out that most retailers do not store eggs in refrigerators, thus the eggs are exposed to weather conditions, resulting in their contamination. The isolated microbes could cause severe health problems like, diarrhea, nausea and abdominal pain, since they are pathogenic. Microorganisms can be found inside egg content; may be due to the fact that the egg emerges from the hens body through the same passageway feces is excreted And fecal contamination through the pores on the shell after they are laid. After deposition, eggs may. Also come in to contact with environmental bacteria which hmay due to temperature, soil, length of study evaluates chemical composition and microbial loads of table eggs at retail markets from major and Kurdish local chicken in Iraqi Kurdistan. Toxic heavy metals can Have serious adverse impacts on human health .For this reason, the present investigation is mainly focused on the evaluation of Pb, Cd, Co, and Cu in egg samples, collected from the City of Kurdistan. According to the results, the concentration of essential trace metals was not found higher within

Table (5): The total bacterial count in different type of eggs (cfu/ml)

Egg samples	Mean of total coliform counts (cfu/ml)
Barn eggs (control)	$3\times 10_2$,
Caged chicken eggs from (Erbil)	1.0×10
Kurdish local chicken eggs (Domesctic)	$8\times 10_2$
Caged chicken eggs from (Iran)	$2\times 10_2$
Caged chicken eggs from (Turkey)	1.0×10

Conclusion:

The permissible limit. The results of microbial contents in eggs retails can be attributed to unhygienic Conditions in the markets and poor handlings. Therefore, it is recommended to establish and enforce quality control and inspection regulations of table eggs to provide safe and Good Quality eggs for consumption. Also, retailers can store their eggs under good Hygienic conditions in refrigerators.

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مقارنة بعض المكوونات الغذائية للبيض والمحتويات الميكروبية بين الدجاج المحلي الكردي والدجاج التجاري المتوفر في إقليم كردستان العراق

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2,3 , قسم علوم الاغذيةوالسيطرة النوعية , كليةعلوم الهندسةالزراعية, جامعة السليمانية مديرةالبحوث الزراعية السليمانية, وزارة الزراعةوالرى

المستخلس:-

كان الهدف من الدراسة هى هى المقارةالقيمة الغذائية و خاصة محتوى الروتين والمعادن , ثم بعض المعادن الثقيلة والتقيم المايكروبى بين بيض الدجاج المحلى الكردى والاقفاصالمتوفر تجارى فى كردستان. تم تحليل متوسط عينة مكونة من خمسين بيضة من كل نوع فى مختبر كلية الهندسة الزراعية قسم علوم الاغذية و السيطرةالنوعية بجامعة السليمانية. ت؟هر النائج أنه اعتماد على نوع البيض كانت جميع عينات البيض أمنه من الناحية المكروبيولوجية ولا تحتوى على معادن يقيلة . تتوافق عينات البيض المفحوصة من الحدود المموح بها للعناصر النزرة فى بيض المائدة , وتشير النتائج الى مستوى تركيزات المعادن فى البيض أسواق مدينة كوردستان وضعه ضمن الحدودالمعارية وتعتر أمنة للاستهلاک البشرى . أظهر عدد الصفائح الهوائية أن (46.6%) من المحتويات الكاملةالتى تم فحصها من محتوى البيض فى قفض, ديک رومى , أيران , محلى , وبيض هولر تم استفئها مع المعايير مع العدد الاجمالى للبكتريا ضمن العدد المسموح به

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ESTIMATING THE CONCENTRATIONS OF SOME HEAVY ELEMENTS IN THE MEAT OF MALE KURDISH SHEEP FOR MEAT IN SOME AREAS OF SULAYMANIYAH GOVERNORATE

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ABSTRACT : This study was carried out in order to find out the level of sheep's meat, liver and kidney contamination by heavy metals such as: copper, lead, zinc, cadmium and cobalt in different areas of al Sulaimanyah Governorate in comparison within ternational allowed levels. For the above purpose; three samples of (meat, liver and kidney) were taken in three different districts of al Sulaimanyah Governorate were covered: Said Sadiq, Dokan district and Sulaimanyah city center. The samples were collected during October and November 2020. The triple interference (factors) has affected significantly, the amount ofcopper in the different sheep tissues; so the amount was varied with the difference of tissue, the place and the time of taking the sample. The highest level of copper in Liver's tissue was recorded in Dokan district during November, while the lowest level of copper in the meat tissue was recorded in Said Sadiq district during November. The triple interference for the study factors, also affected the level of Zinc in different sheep tissue were the amount varied by tissue difference, place and the time of sample taking. Highest level of Zinc was recorded in kidneys tissue, in Sulaimanyah city Centre during October, while less amount of Zinc was recorded in liver's tissue in Said Sadiq during October. The triple interference within the study's factor, significantly affected the amount of cadmium. The amounts were varied by difference of tissue, place and time of taking the samples. Highest-level of cadmium was recorded in the meat tissue, at Sulaimanyah city Centre during October, while less amount of Cadmium was recorded in liver's tissue, Said Sadiq district during October. The triple interference did not affect significantly the amount of Lead and Cobalt in different sheep's tissue.

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INTRODUCTION

Red meat plays an essential role in human diet these days. It provides an important source of micro and macro Nutrients. Consumers also, desire meat because of its organoleptic properties and nutritional value (Confabs and Leroy, 2019). Food is considered contaminated if it contains pathogens or is interacted with chemical or Radioactive materials. This causes food poisoning and accelerates the appearance of signs of corruption on it, and thus makes it unfit for human consumption (Samarqand Voutsa, 2002). Heavy metals refer to any metallic element that has a relatively high density and is toxic even at a low concentration (Durable *et al*, 2007).With 5G/cm3 or higher density, the heavy metals are dangerous because they tend to bio accumulate (this means any increase in their concentration in a living being with time compared to its concentration in Environment). Minerals accumulate in living beings at anytime they are eaten and stored faster, meaning that they Are not destroyed in the body (INL, 2008). Heavy metals contamination from meat and other eatable tissues is major food safety and human health concern, because these metals, even with a low proportion, will cause hazard On the consumer's health. Forage could be one source of metals to reach animal's body (WHO, 2001).A number of studies showed; meat contaminating by heavy metals in farms, especially contamination with lead and cadmium with levels above known standards, and this will cause negative effects on human health as a result the of cumulative affect inside human's body. For that; it's farmers and meat industries responsibility to work on reducing contamination with these metals (Hoha *et al*, 2014). Several studies were conducted at the world and Iraq's level to study the level of heavy metals in the meat

Of farm animals like cows, sheep, goat, poultry and fish. The studies covered different governorates like; Kirkuk(Al Pirkdhri, 2018), Salahuddin (Ibrahim, 2013), Baghdad(Al Qabbani) and Dyala (Al-Zuhairi *et al*, 2015).
Countries around the world have paid great attention to the study of food contamination, as it is directly related to many dangerous diseases that afflict humans, when exposed to environmental pollutants, whether through air, water or food, so all countries are keen to free food from These pollutants or have a low content of pollutants through environmental research and studies and the issuance of the necessary legislation to ensure the provision of safe food for individuals. The present study aimed to study the level of contamination of meat, liver and kidney of sheep with heavy metals such as lead, cadmium, copper, zinc and cobalt in different locations in Sulaimanyah Governorate and identifying areas that show higher levels of heavy metal contamination

MATERIALS AND METHODS

Source of meat

On muscles, liver and kidneys of the male species. All animals were Local Iraqi species, the animals were breeding in pasture, are from three is tricts of Sulaimanyah locations, which included Dokan, Said Sadiq and Sulaimanyah city Center. The study was carried out during October and Conducted to measure the ratio of heavy elements.

Determination of heavy elements

The heavy metals concentration was determined by method as described by Ropme (1983).

Statistical analysis

The complete random design (CRD) was applied tostudy the effect of meat type, season of the year andlocation in different traits. According to the mathematical model below, the differences between the averages werecompared with the Duncan Multidimensional Test. Xlstat(2004) was used in statistical analysis.

Y_{ijklm} = m + A_i + B_j + C_k + CD (kl)+ABC (ijk)+e_{ijkm}

Where,

Y_{ijkm}: View values for each attribute.m: General averageEffect of meat type (muscles, liver and kidney)) Ai:B_j : Effect of month (October and November)Effect of location (Dokan, Said Sadiq andSulaimanyah city center): CkABC (ijk): Effect of interaction between meat, seasonand location.e_{ijkm}: random error which distributes a normaldistribution with a mean of zero and a variation of S2e.

RESULTS AND DISCUSSION

Copper contamination

Copper is found naturally in all plants and animals, although it is an essential element for all known organisms, Including humans and other animals. Even at low levels, when ingested in large quantities or proportions, it

November.

Collection of samples

The samples were collected from Sheep aged 7-9months. Meat samples (muscles liver and kidney) were used in three replicates were randomly selected from three locations of Sulaimanyah locations, which include Dokan, Sayd Sadiq and Sulaimanyah city center, the thigh muscle was meat muscle samples which used for our Study, while the Internal organs samples consisted of liver and kidneys. After the slaughter of animals, the samples were left until samples were taken from animals studied from the thigh muscle in all carcasses area and samples were then put in polyethylene bags and then placed in special Packages and boxes Refrigerated for this purpose until it reaches the laboratory. The meat and kidney samples were cut into medium pieces by a knife and then encased by a thermocouple machine. A sieve was used with adiameter of 0.45. These models were then placed inpolythene bags and then placed in special plastic container Prepared for this presentation and numbered. The samples of the liver were cut into pieces and then placed in plastic Bags and then in plastic containers for this purpose. After that, all samples were placed in frozen temperature (-18°C) until chemical tests were conducted and tests were

can be toxic (ATSDER, 2004). It is evident from the results of Table 1 that the triple interference between the study factors had a significant effect on the amount of copper

In the different tissues of the sheep under study, as the quantities differed when the tissue, location and time of sample was taken. The highest amount of copper was recorded in liver tissue, in Dokan region in November, and it was (9,050 ppm), while the lowest amount of copperas recorded in meat tissue, in the Sayed Sadiq area in November, and it was (4,000 ppm). The type of tissue did not have a significant effect on the amount of copperas the amount of copper did not differ from the amount of copper in the meat, liver and kidney. Differences were recorded as: The highest percentage was recorded in liver tissue, and it was (5.833 ppm), while the lowest amount of copper was recorded in the kidney tissue, and it was (5.183 ppm). The results did not match with the findings of Ibrahim (2013). Regarding the concentration

Table 1: The percentage of copper contamination in samples taken from sheep in three different sites in Sulaimanyah during October and November

Sample types	Region	Month		
		October	November	
Meat	Dokan	6.600 ±0.500 ab	6.150 ±0.550 ab	6.375 ±0.330 ab
	Sayd-Sadiq	6.650 ±0.150 ab	4.000 ±0.350 b	5.550 ±0.654 ab
	Center-Sulaiman yah	5.200 ±0.400 b	4.450 ± 1.100 b	4.600 ±0.590 b
	Average	6.150 ±0.345 a	4.867 ±0.530 a	5.508 ±0.358 a
Liver	Dokan	5.850 ±0.250 ab	9.050 ±2.950	7.450 ±1.521 a
	Sayd-Sadiq	4.950 ±0.150 b	4.700 ±1.600 b a	4.825 ±0.660 b

	Center-Sulaiman yah	5.550 ±0.250 b	4.900 ±0.400 b	5.225 ±0.269 ab
	Average	5.450 ±0.195 a	6.217 ±1.251 a	5.833 ±0.615 a
Kidneys	Dokan	6.150 ±0.050 ab	6.500 ±0.500 ab	6.325 ±0.229 ab
	Sayd-Sadiq	4.800 ±0.800 b	4.600 ±1.400 b	4.700 ±0.661 b
	Center-Sulaiman yah	4.750 ±0.550 b	4.300 ±0.200 b	4.525 ±0.272 b
	Average	5.233 ±0.384 a	5.133 ±0.583 a	5.183 ±0.333 a

The averages bearing similar letters (within cells of similar color) are not significantly different (P> 0.05 between them)

of the copper element, in thigh meat, as it recorded is higher level than the kidney and liver, and it was (7.27parts per million) in the thigh meat and in the kidney (7.25ppm) and in the liver (6.48 ppm). It also did not match with the results of El-Kabbani (2015), where the level of copper concentration in sheep's liver was higher than its meat, as it was recorded (46.189 and5.80 parts permillion), respectively. As for the effect of the area difference on the amount of copper, we noted that there is a significant difference in the amount of copper between the different areas of our study: Liver tissue,meat, and kidneys were at highest copper level in the Dokan region (7,450, 6,375 and 6,325 ppm), respectively. The lowest amount of copper, was recorded in the meat and kidney tissue of sheep from the Sulaimanyah district and liver from Sayed Sadiq area, where it was (4,600, 4,525 and 4,825 ppm), respectively. Becker *et al* (2011)indicated that the high concentration of the element in some sites and its decrease in other sites may be due to contamination of those sites with industrial and human Sources and the lack of its presence in other sites. These results are in agreement with Okayed and Ugwu (2010)when they studied the level of heavy metal contamination in goat meat in different locations in Nigeria. Also, Al-Ajwadi (2011) indicated that the study area had asignificant effect (p <0.05) on the copper concentration.

The results are consistent with the nindings of Ibrahim(2013), who found significant differences in copperconcentration between three regions. The copperconcentration was highest in Baiji (4.92 ppm) while it , and the highest copper concentration washing Baiji. The results are close to what Al-Qabbaniconfirmed (2015) in the presence of a significant effect(p≤0.05) for the site in the concentration of the copper element, as it recorded a high level in Dora City (22.01parts per million) compared to Sadr City (2.48 parts per million).The months of the study did not significantly affect the amount of copper in the various tissues of sheep, but mathematical differences were foundaccording to the Month of taking the samples, as the amount of copper in the meat tissue in October was higher than in November, when it was (6.150 and 4.867 ppm) on, respectively. While in liver tissue the highest amount was in the month ofNovember and the lowest in the month of October, and it was (6.217. and 5.450 ppm), respectively, but the kidneytissues, the amount in October was higher than inNovember, when it was (5.233 and 5.133 ppm), respectively. The concentrations obtained from theseresults are within the internationally permissible limits (5-7 ppm) as stated in FAO / WHO (2010). These resultswere in agreement with Nwude *et al* (2010), whoindicated that copper levels increase in ruminants' bodies in rainy seasons, which may be due to the abundance ofplants on which animals feed, which may be contaminated with these elements due to the presence of commonsources of pollution with this mineral, which is what Liphadzi *et al* (2003) have shown that the sources ofcopper pollution are power stations, metal smelting,furnaces, and agricultural systems that use pesticides orto the ability of plants to absorb copper more easily, which was in Tikrit and Samarra (1.69 and 1.63 ppm),

may be due to the ease with which copper is absorbedby the plants. Contaminated animal feed and raising livestock near a polluted environment are the main causeresponsible for heavy metal contamination of meat (Miranda *et al*, 2005). Bazargani-Gilani *et al* (2016)conducted a study on copper pollution in Iran. In the liverand kidneys of cattle and sheep, the concentration of lead in all samples was above thepermissible limit, as it was revealed that the highest level of copper (126.14 ppm) was in the livers of sheep. While our current study recorded rates of copper very low compared to the internationally accepted limits. Our results approximate those of Morshdy *et al* (2018), who studied the amount of copper in 120 muscle flesh samples Kidney and liversamples from camels, cattle, buffaloes and sheep were randomly generated from Zagazig, Sharkia, Egypt, where the copper concentrations ranged between 0.10-8.82 mg / kg. The results are similar to the findings of Al-Bayrakhadi (2018), in his study of the amount of copper in the meat and organs of the sheep's body in threeregions of Kirkuk, where the amount of copper ranged between 0.917 to 25.574 ppm and significant differenceswere found between regions, seasons and body parts ofthe animals under study. The quantities of copper in our study also approximate the quantities recorded by El-Ghareeb *et al* (2019), where 120 muscle meat, liver and kidney samples of camels and sheep were collected fromslaughterhouses in recorded in kidney tissue, which was (4.208 ppm), whilethe lowest amount of lead was recorded in meat tissues,which was (3.725 ppm). The effect of the difference in the area on the amount of lead, we notice that there is asignificant difference in the amount of lead between thestudy areas, in the kidney tissue. The highest amount of lead was in sheep in the Sulaimanyah Center area: theliver in Sayed Sadiq and the meat in the Sulaimanyahcenter, where it was (4,900, 4,600 and 4,600 ppm),respectively. The lowest amount of lead, it was recorded in the meat tissue of Sayed Sadiq, the liver in the animalsof the Sulaimanyah district and the kidneys in the animals of the Dokan area, where it was (3,300, 3,700 and 3,750ppm), respectively. Time of taking samples (the monthsof the year under study) did not significantly affect the amount of lead in the various tissues of sheep, but therewere mathematical differences according to the monthof taking samples, as the amount of lead in the meat tissue in October was higher than in November, when it was(3,750). And 3.700 ppm) respectively, while in liver tissuethe highest amount was in the month of October and the lowest in the month of November, and it was (4.083 and4.067 ppm), respectively. The levels of lead recorded inour current study, exceeded the acceptable limits indicated by the WHO (2007), as it determined the acceptablepercentage in food between 1.5-1.7 ppm. It is higher thanthe percentage indicated by the global permissiblepercentages according to the provisions of FAO-WHO(2010) and also exceeded the percentage referred to byHameeda (2000) as it showed that the permissible level in meat for lead is 1.00 parts per million, and higher thanthe limits indicated by the European Federation'sregulations limits for the permissible limits of lead in meat and offal of agricultural animals slaughtered forconsumption at maximum concentrations

Al-Ahsa center in Saudi Arabia. The copper content ranged from 0.06 to 5.02 mg / kg in edible tissues from Camels and from 0.11 to 3.35 mg/kg in sheepsamples. Mean concentrations of copper in camel and sheep livers were 1.66 and 1.74 mg/kg, respectively.

Lead contamination

Live stocks near hazardous waste sites may be exposed to lead and chemicals containing lead through: breathing in air, drinking water, eating foods, orswallowing dust or dirt containing lead (ATSDAR, 2007).

It is evident from the results of Table 2 that the triple interference between the study factors did notsignificantly affect the amount of lead in the varioustissues of the sheep under study, but the quantities differedmathematically according to the tissue, location and time of sample taking. The highest amount of lead wasrecorded in kidney tissue, in the Sulaimanyah district in October, when it was (4,950 parts per million), while thelowest amount of lead was recorded in meat tissue, in the Sayed Sadiq area in October, and it was (2,900 ppm).The type of tissue did not have a significant effect on the amount of lead, as the amount of lead did notdiffer in the meat, liver and kidneys, but amountdifferences were recorded. The highest percentage was are 0.10 and0.50 mg/kg, respectively (EFSA, 2009). There is a strong relationship between the concentration of lead in soil and its accumulation and it's piling in plant parts and animaltissues raised in these contaminated environments (Mateo *et al*, 2007). This can be supported by other sources whoindicated that the concentration of the element of leadexceeded the permissible limits, as its concentration inthe waters of the Lower Zab River reached between (2.39-2.34 micrograms/liter), respectively, while theconcentration of the element in water taken from wells,reached (2.61 micrograms/liter) (Al-Shawani 2009).

The increase in population density in recent timesand the presence of oil installations in populated areas,has led to an increase in lead concentrations and this is what Ibraheem (2013) referred to in his study in threeareas of Salah al-Din Governorate Tikrit, Samarra and

Table 2 : The percentage of lead contamination in samples taken from sheep in three different sites in Sulaimanyah during October and November

Sample types	Region	Month		
		October	November	
Meat	Dokan	4.200 ± 1.100 a	3.550± 0.45 a	3.875 ±0.520 a
	Sayd-Sadiq	2.900 ± 1.100 a	3.700 ± 0.90 a	3.300 ±0.624 a
	Center-Sulaiman yah	4.150± 0.950 a	3.850± 0.750 a	4.000± 0.502 a
	Average	3.750 ± 0.542 a	3.700± 0.329 a	3.725 ± 0.302 a
Liver	Dokan	3.850 ± 0.750 a	4.000± 1.300 a	3.925 ± 0.614 a

	Sayd-Sadiq	4.800± 0.000 a	4.400± 0.400 a	4.600 ± 0.200 a
	Center-Sulaiman yah	3.600 ± 0.200 a	3.800± 1.00 a	3.700 ± 0.420 a
	Average	4.083 ± 0.306 a	4.067 ± 0.45 a	4.075 ± 0.259 a
Kidneys	Dokan	3.950± 0.150 a	3.550± 0.050 a	0.132±3.750 a
	Sayd-Sadiq	4.200 ± 0.100 a	3.700 ± 1.40 a	3.950 ± 0.591 a
	Center-Sulaiman yah	4.950± 0.150 a	4.900 ± 0.20 a	4.925 ± 0.103 a
	Average	4.367 ± 0.199 a	4.050± 0.454 a	4.208 ± 0.241 a

The averages bearing similar letters (within cells of similar color) are not significantly different (P> 0.05 between them).

Baiji, as an increase in the percentage of lead wasrecorded in densely populated areas.
The results of our study are in linewith the results of
the study of Sathyamoorthy *et al* (2016), which estimatedthe amount of lead in sheep meat in India, and the
concentration of lead in the meat was above the
international permissible limit. Theresults of our currentstudy are higher than the results recorded by Sadullah,(2013) in his study on sheep in Duhok regions, as he
indicated a high level of lead in Duhok region from therest of the study areas. The lowest level was recorded inBarda rash area: (0.159, 0.204 ppm) during spring seasonand the reason was attributed to the crowding and the
large number of factories in the region. The results ofthe study do not coincide with what El-Qabbani pointedout (2015), which indicated that the concentration of theelement lead was different according to the regions,
seasons and type of meat, as it was in the area of the AlDora area higher than Al Sadir area in all animals and
for all seasons and times. The results of our study showedless amount compared and the concentration was (34.77parts per million). Lead in Al-Dora area and the lowest
concentration (6.68 parts per million) in Sadr City. Healso indicated that the concentration of lead in sheep liver
was higher than muscle meat, as it was recorded (57.09parts per million), while muscle meat was recorded (16.39parts per million). While our current study, did not reveal
differences between tissue types in the percentage oflead. The results of our study do not coincide with the
results of Al-Bayrakhadi (2018), who to season, region and tissue type, but the percentagesrecorded in our study are close to the results of the abovestudy, where lead levels ranged between 0.244 -5.607ppm. The results of our study are higher than the results
of the Morshdy *et al* (2018) study on lead levels in musclemeat and kidneys and liver samples from camels, cattle,
buffaloes and sheep randomly from the city of Zagazig,Sharkia, Egypt and the highest concentration of lead insheep's muscles was recorded as it was 0.49 mg/kg. Our
current results are less than the results of the study ofEl-Ghareeb *et al* (2019) that was conducted in the citycenter of Al-Ahsa in Saudi Arabia on the meat of muscles,
liver and kidneys of camels Cattle, buffaloes and lambwere randomly from the city of Zagazig, Sharkia, Egypt.The highest concentration of lead was recorded in sheep's
muscles, where it was 0.49 mg/kg. And our current resultsare less than the results of the study of El-Ghareeb *et al*(2019) that was conducted in the city center of Al-Ahsa
in Saudi Arabia on muscle meat, liver and kidneys forCamels and sheep from slaughterhouses, and the highestpercentage of lead in sheep livers was 10.81 micrograms/ kg.

Zinc contamination

Zinc is involved in many physiological functions:including marrow production, bone formation, and brainfunctions, and also participates in the formation and
division of cells. On the other hand, it helps in the growthand development of the fetus, and is an essential factorfor sexual maturity and wound healing, blood clotting,thyroid function, and good vision continuity (Salako *et al*,

indicated that thereare significant differences in lead percentages according

2016). High amounts of zinc can cause intestinal distressand toxicity, and prolonged exposure may lead to decreased plasma concentrations, anemia, pancreaticdamage, and insufficient absorption of copper from food,which may lead to the occurrence of cancer (Shukla *etal*, 2010). It is evident from the resultsof Table 3 that thetriple interference between study factors had a significant effect on the amount of zinc in the various tissues of thesheep under study, as the quantities differed accordingto, location and time of sample was taken.The highest amount of zinc was recorded in kidneytissue, Sulaimanyah district in October, when it was(20,250 parts per million), while the lowest amount ofzinc was recorded in liver tissue, Sayed Sadiq area in October and it was (9,800 ppm). The effect of tissuetype recorded a significant difference in the amount of zinc between the liver and the kidneys only, as the amountof zinc in the meat did not differ with the liver and the kidneys, but mathematical differences were recorded. Itwas recorded in liver tissue and it was (13.042 ppm).
Morshdy *et al* (2018). Collected samples of muscle meat,kidneys and liver samples, randomly, from camels, cattle,buffaloes and lamb from the city of Zagazig al Sharkia,Egypt, showed concentrations of zinc ranged between 3.25-8.39 mg/kg, while for the study of El-Ghareeb *et al*(2019) were samples collected from the muscles, liver and kidneys of camels and sheep from slaughterhousesin Al-Ahsa Center in Saudi Arabia, zinc was recorded in the tissues in descending order, which were examined inthe following order, liver, kidneys, muscles. We studiedthe effect of difference in areas of study on the amountof zinc, we noticed that there is a significant differencein the the kidney tissues, the quantity was higher in the monthof October than in November. (17.733 & 15.633 ppm),respectively. The results of our current study are lessthan the permissible limit internationally as the internationally permitted ratio is (50 ppm) (Hameeda, 2000;Abou-Arab, 2001). The industrialized and densely populated areas have higher concentrations of heavymetals in the animal’s organs and apparatus are higherthan in rural and low populated areas. It was found thatzinc concentrations were at a high level in the liver andtissues of the animal in most livestock’s is higher thanGlobally permissible limits. The concentration of zinc in the meat and liver of cattle is increased due to consumptionof contaminated plants grown in soils contaminated also with this ingredient (Santhi *et al*, 2008). The results areconsistent with what Ibraheem (2013) indicated in thehigh concentration of zinc in Tikrit, which is a densely populated area than the rest of the study places, as thehighest concentration reached (55.39 parts per million), while the lowest concentration level was in Baiji, whereit was recorded (43.79 parts per million). However, theresults of our study contradict him in that the percentage of zinc concentration in thigh meat is higher than the liverand kidneys, as the thigh muscle meat recorded thehighest concentration (60.30 ppm) and the liver the lowest concentration (33.37 ppm). The value of zinc in this studyis less than the study of zinc levels in fresh meat in cattle,sheep, chickens and camels in Algeria, as it was 23.51parts per million (camel meat in the northern region) and147.82 parts per million (lamb meat in the southern region)and none of the samples exceeded the recommended limits (Badis *et al*, 2014). The results of this study agreewith the findings of El-Kabbani (2015) in the presence of a significant effect ($p \leq 0.05$) for the site on the level ofzinc concentration and a high level of concentration(583.08 parts per million) was

amount of zinc between the study areas, in kidneytissue and meat, the highest amount of zinc was in sheep meat in the Sulaimanyah district, and in liver tissue thehighest amount was in sheep in the Dokan region, where it was (19,525, 17,825 & 13.975 ppm), respectively, butThe minimum amount of zinc was recorded in the liver tissue of sheep from the Sulaimanyah district, the kidneysf sheep from the Sayed Sadiq area, and the meat ofsheep from the Dukan region, where they were (12,150,12,250 and 13,100 ppm), respectively. The time ofsampling (the months of the study) did not significantlyaffect the amount of zinc in the various tissues of sheep,but mathematical differences were found according tothe month of taking the samples. The amount of zinc inthe meat tissue in October was higher than in November,when it was (15,467 and 15). 050 ppm,respectively, whilein liver tissue the highest quantity was in the month ofNovember and the lowest in the monthof October and it was (14,600 and 11,483 ppm), respectively. Looking at observed in the Dora areawith a significant difference ($p \leq 0.05$) Compared to Sadr City, which scored (390.09 ppm) and for all areas of thestudy, with regard to the type ofmeat, the liver scored the highest results and the zinc concentration was (392.13ppm) and thigh meat the concentration was (103.47 ppm).

The results of our study were less than the results of astudy conducted in Egypt (Beni Suef), where zinc levels were in sheep muscle meat (43.84 ppm), liver (38.06ppm), and kidneys (22.9 ppm) (Khalafalla *et al*, 2015).The results of the current study are less than the results found by Bazargani-Gilani *et al* (2016). To assess zinclevels in the liver and kidneys of cattle, sheep, and goatsin the mining region of western Iran and the highest level of zinc (105.19 ppm) was found in the liver of sheep.The results of the study are consistent with the results of

Table 3 : The percentage of zinc contamination in samples taken from sheep in three different sites in Sulaimanyah during two months

Sample types	Region	Month		
		October	November	
Meat	Dokan	14.300 ±2.000 abcde	11.900 ±2.40 cde	13.100 ±1.451 c
	Sayd-Sadiq	1.200±16.000 abcde	13.700 ±3.90 abcde	14.850 ±1.793 bc
	Center-Sulaiman yah	16.100 ±3.900 abcde	19.550 ±0.550 ab	17.825 ±1.891 ab
	Average	15.467 ±1.230 a	15.050 ±0.896 a	15.258 ±1.075 ab
Liver	Dokan	10.700 ±1.300 cde	17.250 ±1.050 abc	13.975 ±2.010 bc

	Sayd-Sadiq	9.800 ±0.300 e	16.200 ±0.10 abcde	13.000 ±1.852 c
	Center-Sulaiman yah	13.950 ±0.850 abcde	10.350 ±0.850 de	12.150 ±1.149 c
	Average	11.483 ±1.670 b	14.600 ±1.884 ab	13.042 ±0.922 b
Kidneys	Dokan	19.650 ±0.350 ab	16.900 ±0.400 abcd	18.275 ±0.823 ab
	Sayd-Sadiq	13.300 ±2.800 bcde	11.200 ±2.900 cde	12.250 ±1.754 c
	Center-Sulaiman yah	20.250±2.050 a	18.800 ±1.300 ab	19.525 ±1.076 a
	Average	17.733 ±1.402 a	15.633 ±1.664 a	16.683 ±1.168 a

The averages bearing similar letters (within cells of similar color) are not significantly different (P> 0.05 between them)

the study of Al-Bayrakhadi (2018), in terms of theexistence of triple interference effects of factors of meattype, location and seasons on zincmetal concentration ineach of the thigh meat, liver and kidney samples in sheepin three locations in Kirkuk governorate (Daquq, KirkukCenter and Dibis). During the winter and summer seasons, the zinc concentration in thecollege at the KirkukCenter site in the summer season recorded the highestconcentration, with a significant difference (P≤0.05) from the rest of the study sites, as it was recorded (133.441parts per million), while the amount recorded for thigh meat in Dibs area (17.695 ppm).

Cadmium contamination

Cadmium is dangerous, whether by inhalation oringestion, and can cause acute and chronic poisoning, and it is a highly toxic mineral that can disrupt a numberof biological systems,usually in doses much lower thanmost toxic minerals. Cadmium is found along the food chain and eventually accumulates in the body. Whenconsuming contaminated food, cadmium is present intobacco smoke, which contributes to an increased risk tohuman health (Nordberg *et al*, 2007). It is evident fromthe results shown in Table 4, that the triple interferencebetween the study factors had a significant effect on theamount of cadmium in thevarious tissues of the sheepunderstudy, as the quantities differeddepending on thetissue, location and time of sample was taken.The highest amount of cadmiumwas recorded in meat tissue, Sulaimanyah district in (1.000 ppm). These results are in line with what Al-Bayrakhadi (2018) mentioned in his study on cadmiumcontamination in sheep meat in Kirkuk, where the studyshowed that there is a significant effect of theinteraction between the factors type of meat, location and season inthe concentration of cadmium. Significant differenceswere recorded in the level of cadmium concentration inthe liver during the season of summer in Kirkuk region, as it recorded the highest level ofconcentration (5.620parts per million). While inside college area, the winterseason was recorded in the area of Dibis, the lowestlevel of cadmium concentration (2.040 parts per million).The type of tissue did not have a significant effect on theamount of cadmium, as the amount of cadmium did notdiffer in the meat, liver and kidneys, but mathematicaldifferences were recorded. Liver, and was (1.467 ppm).As for the effect of the area difference on the amount ofcadmium, we note that there was no significant differencein the amount of cadmium between the study areas, but there were mathematical differences. In meat tissue, thehighest amount of cadmium was in sheep in the Sulaimanyah district, kidney tissue in sheep in theSulaimanyah district, and college in sheep in Sayed Sadiqarea, where it was (2.050, 2.000 and 1.550 ppm),respectively. As for the lowest amount of cadmium, it was recorded in the meat tissue of sheep from the Dokanregion, the liver in sheep from the Sulaimanyah Center,and the kidneys of sheep From the Sayed Sadiq area,where it was (1,200, 1,350 and 1,700 ppm), respectively.

The time of the sampling (the months of the study) didnot significantly affect the amount of cadmium in thevarious tissues of sheep, but mathematical differences

October, when it was (2,450 ppm), while the lowest amount of cadmium was recorded in liver tissue, Sayed Sadiq district in October and it was

Table 4 : The percentage of cadmium contamination in samples taken from sheep in three different sites in Sulaimanyah during October and November.

Sample types	Region	Month		
		October	November	
Meat	Dokan	1.400 ±0.200 ab	1.000 ±0.100 b	1.200 ±0.147 a
	Sayd-Sadiq	1.500 ±0.300 ab	1.550 ±0.250 ab	1.525 ±0.160 a
	Center-Sulaiman yah	2.450 ±0.650 a	1.650 ±0.450 ab	2.050 ±0.397 a
	Average	1.783 ±0.286 a	1.400 ±0.186 a	1.592 ±0.173 a
Liver	Dokan	1.050 ±0.050 ab	1.950 ±0.750 ab	1.500 ±0.402 a
	Sayd-Sadiq	1.000 ±0.200 b	2.100 ±1.000 ab	1.550 ±0.524 a
	Center-Sulaiman yah	1.300 ±0.300 ab	1.400 ±0.100 ab	1.350 ±0.132 a
	Average	1.117 ±0.111 a	1.817 ±0.351 a	1.467 ±0.205 a
Kidneys	Dokan	1.950 ±0.150 ab	1.550 ±0.150 ab	1.750 ±0.144 a
	Sayd-Sadiq	1.750 ±0.050 ab	1.450 ±0.350 ab	1.600 ±0.168 a
	Center-Sulaiman yah	1.700 ±0.200 ab	2.300 ±0.600 ab	2.000 ±0.311 a
	Average	1.800 ±0.082 a	1.767 ±0.250 a	1.783 ±0.125 a

The averages bearing similar letters (within cells of similar color) are not significantly different (P> 0.05 between them

were found according to the month oftaking samples, inthe texture of meat, the amount of cadmium in the meattissue in October was higher than in November, where itwas (1.783 and 1,400 ppm) respectively, while in liver tissue the highest arithmetic quantity was in Novemberand the lowest in October, and it was (1,817 and 1,117 ppm), respectively.Regarding the tissues taken from college area, the quantity in the month of October was mathematicallyhigher than in November, as it was (1.800 and 1.767 ppm),respectively. All the results obtained in our current study were higher than the allowed international levels. the limits from different sources, as well as the use of primitiveand unexamined methods when using chemical fertilizersand various pesticides, which causes an increase in the percentage of pollution with the element (Madad, 2016).In which the large number of factories and petrochemical factories there is an increase in soil pollution. It was foundthat the percentage of cadmium in the cities adjacent toSulaimanyah reached (3.55 parts per million) (Al-Jumaily, 2009). The reason may be due to the increase inpopulation density and the discovery of oil fields in additionto the establishment of new cement factories inSulaimanyah governorate that may lead to increased cadmium pollution, and this is what many studies haveindicated, including Muhammad that are permissible internationally By the EuropeanUnion, cadmium is (0.050, 0.50 and 1.0 ppm) in meat, liver and kidneys of livestock respectively (EC, 2001;EFSA, 2009) and also the permissible concentration ofcadmium is (0.050 ppm) according to FAO/WHO (2010).

Industrial areas and airports and the frequent movement of dust and high air currents lead to the highlevel of accumulation of heavy metals, especially (cadmium), above normal levels, especially in plants thatgrow on the side of the main roads and this helps thetransmission of this element to the animal through thesepolluted weeds and then its transmission through the chain.Nutritional materials are added to animal tissues (Atayese *et al*, 2008) and this element and its compounds dissolvequickly and easily in water, especially rainwater, and then cause soil and water pollution, after which plants andanimals (Rogowska *et al*, 2008).The population expansion in recent times has led toan increase in pollution levels, to varying degrees and (2003) that wasconducted in Kirkuk about the role of these facilities inincreasing pollution with this metal. The results of our current study are higher than the results of Al-Jaff *et al*(2013) study to find out thepercentage of cadmium insheep livers and chickens imported from abroad and foundin the shops and markets of Sulaimanyah, The highest concentration of cadmium was in sheep liver (0.130 ppm).

The results of the study do not coincide with the resultsof the Ibraheem (2013), where it was found that thecadmium percentage varies according to the season, as it was found in the summer season its highest level in the winter season in all areas of the study where it was (0.47and 0.27 ppm), respectively. Our study with this study onthe presence of the site effect, the city of Tikrit recordedthe highest results (35 ppm), Samarra and Baiji (0.37 ppm)for each of them, and these results also differ with theIbraheem study regarding the type of meat, as their study

found a lower level of cadmium in theliver in winter thanin summer in both Tikrit and Baiji.The results of our study are less than the results foundby El-Kabbani (2015), where thecadmium was high andsignificantly in the chest area when compared to the area of the cycle and for all types of meatand seasons. Also,it was noted that the concentration of the cadmium element in the liver of sheep washigher than the musclesin the winter season, as it reached (24.48 ppm) while muscle meat (2.76 ppm). The results of the current studyare close to those of Bazargani-Gilani et al. (2016) which was conducted to assess the levels of cadmium in theliver and kidneys of cattle, sheep and goats in the mining and summer seasons. The percentage of cobalt was lessthan the results of the study of Al-Birkhadri, where itwas recorded. Liver in the central region of Kirkuk inthe summer season had the highest concentration (5.031parts per million), while thigh meat at the siteof Dibis in the winter season recorded the lowest concentration(1.081 parts per million).

The type of tissue did not have a significant effecton the amount of cobalt, as the amount of cobalt did notdiffer in the meat, liver and kidneys, but mathematical differences were recorded. Meat, and was (0.264 ppm).The results of the study do not coincide with what wasindicated by the results of the study by Akan *et al* (2010),which concluded that the concentration of cobalt in theliver and kidneys of goats in Nigeria was higher thantheir muscles. Our results in this region of western Iran and the highest concentration ofcadmium in sheep, where it reached in the kidneys of sheep (1.93 ppm). The results of the current study arehigher than the results of the Morshdy et al. (2018) study,which was conducted on samples of muscle meat,kidneys, and liver samples from randomly generated camels, cattle, buffaloes and lamb rom Zagazig, SharkiaEgypt and the cadmium concentration was between 0.03-0.11 mg/kg. The results of our studyare similar to theresults of the study of El-Ghareeb *et al* (2019). The cadmium concentrations in liver,kidneys and muscleswere 1.79, 1.18 and 0.44 micrograms/kg, respectively,for sheep slaughtered at Al-Ahsa Center in Saudi Arabia.

Cobalt contamination

The body needs cobalt in small quantities and itspresence is important to the body. Nevertheless, it isconsidered a secondary mineral, it is included in thesynthesis of vitamin B12 and contributes to the breakdown of carbohydrates, proteins and it enters into the synthesisof amino acids and creates DNA molecules and supports the immune system and the nervous system in their work,as well as responsible for monitoring the work of cellsand the growth and development of globules Red blood(Alkhalaf *et al*, 2010; Al-Jaafari, 2010). It is evident fromthe results of Table 5 that the triple interference betweenthe study factors did not significantly affect the amountof cobalt in the various tissues of the sheep under study,but the quantities differed mathematically according tothe tissue, location and time of taking the sample. Thehighest amount of cobalt was recorded in kidney tissue,Dokan area, in October, when it was (0.425 ppm), whilethe lowest amount of cobalt was recorded in meat tissue,Sayed Sadiq area in November, and it was (0.150 ppm).The results of the study do not study converge withwhat Brzostowski and Falandysz (2011) referred to in his study to find out levels of heavy elements in the muscletissue, liver and kidneys of red deer in Poland, as theaverage concentration of cobalt was (0.017, 0.18 and0.089 ppm dry weight), respectively.However, the effect of the area difference on theamount of cobalt, we noted that there was no significant difference in the amount of cobalt between the studyareas, but there were mathematicaldifferences. In kidney,meat and liver tissues.The highest amount of cobalt was in the sheep ofthe Dokan region, as it was (0.380, 0.330 and 0.330 ppm),respectively. As for the lowest amount of cobalt, it wasrecorded in the meat and kidney tissue ofsheep from the Sulaimanyah district and the liver tissue of the sheep inthe Sayed Sadiq area, where it was (0.225, 0.303 and0.245 ppm), respectively. The time of taking samples (themonths of the year under study) did not significantly affect the amount of cobalt in the various tissues of sheep, butthere were mathematical differences according to themonth of taking the samples, as the amount of cobalt inthe meat tissue in October was higher than in November,when it was (0.305) and (0.223 ppm), respectively. Whilein liver tissue the highest quantity was in the month ofNovember and the lowest in the month of October and itwas (0.315 and 0.242 parts per million), respectively. The kidney tissue, the quantity was in the month of Octoberhigher than in November, as it was (0.338 and 0.325 partsper million), respectively. The percentages recorded inthe current study are higher than the global permissiblelimit (0.1 ppm) (ATSDR, 2013). It is also higher than thepercentages mentioned by Hameeda (2000),whichindicated that theglobal permissible natural percentageis (0.1 parts per million).

match with the results ofthe study of Al-Birkhdari (2018), which found that thereis an effect of the interaction of the factors type of meat,location and season on the concentration of cobalt in goatsin three sites in Kirkukgovernorate during the winter

Table 5 : The percentage of cobalt contamination in samples taken from sheep in three different sites in Sulaimanyah during October and

November.

Sample types	Region	Month		
		October	November	
Meat	Dokan	300 ±0.000 a	0.360 ±0.140 a	0.330 ±0.060 a
	Sayd-Sadiq	0.325 ±0.025 a	0.150 ±0.050 a	0.238 ±0.055 a
	Center-Sulaiman yah	0290 ±0.190 a	0.160 ±0.040 a	0.225 ±0.088 a
	Average	0.305 ±0.050 a	0.223 ±0.062 a	0.264 ±0.039 a
Liver	Dokan	0.360 ±0.140 a	0.300 ±0.000	0.330 ±0.060 a
	Sayd-Sadiq	0.150 ±0.050a	0.340 ±0.160 a	0.245 ±0.088 a
	Center-Sulaiman yah	0.215 ±0.115 a	0.305 ±0.055 a	0.260 ±0.058 a
	Average	0.242 ±0.033 a	0.315 ±0.059 a	0.278 ±0.038 a
Kidneys	Dokan	0.425 ±0.025 a	0.335 ±0.035a	0.380 ±0.031 a
	Sayd-Sadiq	0.275 ±0.055 a	0.350 ±0.150a	0.313 ±0.069 a
	Center-Sulaiman yah	0.315 ±0.015 a	0.290 ±0.120a	0.303 ±0.050 a
	Average	0.338 ±0.044 a	0.325 ±0.052a	0.332 ±0.029 a

The averages bearing similar letters (within cells of similar color) are not significantly different (P> 0.05 between them).

Contaminated plants may be the cause of an increasein the concentration of mineralelements, especially cobalt,and their accumulation in the hair and nails of animals(Duruibe *et al*, 2007). Contamination of meat with heavy metals, even at low concentrations, which results fromindustrial systems and mineral wastes is one of the main causes of the deterioration of human and animal healthdue to the danger and toxicity of these minerals (Swarup *et al*, 2006). The reason may be attributed to the presenceof cobalt in the hair and nail tissues and the skin of animalsin addition to its presence in leafy plants that may beexposed to drought in the summer season (EFSA, 2009;Zhuang *et al*, 2009). The results of the study approximate with Derayah El-Kabbani, as it was found that the resultsdiffer according to the site, he indicated that theconcentration of the cobalt element recorded a differencebetween the sites. As the concentration of cobalt in thecourse area was higher than the chest area in all studyanimals and for all seasons and dates, as the highestconcentration appeared (9.19 parts per million) for cobalt,and the level of cobalt was recorded at the lowest level, it reached (8.88 parts per million). As for the type ofmeat, the concentration of cobalt in sheep’s liver washigher than muscle in winter, reaching (16.66 ppm), whilemuscle meat was recorded (4.08 ppm).

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Impact of using sunflower seed meal in male broiler diets on performance traits and carcass characteristics

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Abstract
This study was conducted to determine the impact of using three levels of sunflower seed meal (SFSM) (0%, 10%, and 20%) to evaluate the growth performance, carcass traits in 270 male broiler (Ross 308), reared for 42 days distributed in a completely randomized design, with (3) treatments five replicates with (18) chicks per each for 42 days. T1: Control treatment (Basal diet containing zero SFSM), T2: Basal diet containing 10% SFSM and T3: Basal diet containing 20% SFSM. The inclusion of various levels of sunflower seed meal was observed alter the productive performance of the birds. The inclusion of 20 % sunflower seed meal (SFSM) had significant differences ($p \leq 0.05$) in overall body weight (LBW), body weight gain (BWG), while %10 SFSM had a significant impact on feed intake (FI), feed conversion ratio (FCR). The inclusion of sunflower seed meal from10 %, 20% had effect on carcass characteristic cut yield of broilers. They were slaughter weight, carcass weight, dressing percentage, breast, joint wings, and legs. Slaughter weight, carcass weight, breast weight, leg weight, wing weight, were influenced by high level of (SFSM) which had a significant effect ($p \leq 0.05$) between treatments. This study was concluded that male broiler performance traits carcass characteristics improved by inclusion high level of (SFSM).
Key words: sunflower seed meal, broiler, performance, carcass characteristics

المستخلص

أجريت هذه الدراسة لتحديد تأثير استخدام ثلاثة مستويات من كسبة بذور زهرة الشمس (SFSM))0، ٪ 10 ٪ و 20 ٪)لتقييم الأداء الانتاجي وصفات الذبيحة، استخدم 270 من ذكور افراخ فروج اللحم (Rose 308) ، تمت تربيتها لمدة 42 يومًا موزعة في تصميم عشوائي كامل ، مع) 3 (معاملات،و خمسة مكررات لكل معاملة و) 18 (فرخة لكل مكرر . تضمنتالمعاملات : T1 : (معاملة المقارنة)العليقة الاساسية بدون اضافة : T2 . SFSM العليقة الاساسية باضافة % 10من SFSM والعليقة الاساسية باضافة . SFSM % 20 لوحظ أن اضافة مستويات مختلفة من كسبة بذور دوار الشمس يغير الأداءالإنتاجي للطيور .كان لإدراج 20 ٪ من كسبة بذور زهرة الشمس (SFSM) قد ادت الى اختلافات معنوية (p≤0.05) فيالوزن الكلي للجسم (LBW) ، والزيادة الوزنية للجسم (BWG) ، وكمية العلف المستهلك (FI) ، وكفاءة تحويل العلف (FCR)مقارنة مع المعاملات الأخرى .ان اضافة كسبة بذور زهرة الشمس من 10 ٪ و 20 ٪ كان له تأثير على صفات الذبيحة للطيور .تأثر وزن الذبيحة، وزن الصدر ووزن الفخذ، ووزن الاجنحة بارتفاع مستوى (SFSM) الذي كان له تأثير معنوي (p≤0.05)بين المعاملات .خلصت هذه الدراسة إلى أن صفات الأداء الانتاجي لذكور دجاجفروج اللحم قد تحسنت باضافةكسبة زهر الشمس. الكلمات المفتاحية :كسبة بذور زهرة الشمس، ذكور دجاج فروج اللحم، الأداء النتاجي، صفات الذبيحة.

Introduction

Sunflower seed meal (Helianthus annuus) is a by-product of sunflower meal, the oil extraction industry for human consumption. Poultry feed prices are consistently increasing because of dependence on imported soybean meal. Hence, it is essential to find sustainable alternative protein sources. Sunflowers are thought to be one of the first plants cultivated in the Americas, and (*Helianthus Annuus*) was developed in North America by Indian tribes and first commercialized in Russia (Ditta and King, 2017). It is used as an alternative source of protein in broiler diets it is economically important due to a very large quantity of source of protein. The chemical composition of Sunflower seed meal is comparable with soybean meal; it is higher than those in cottonseed or rapeseed meals. Sunflower seed meal decorticated contains 45.4% crude protein 2,320 Kcal/kg. Metabolizable energy (Council, 1994). Even it has a low level of lysine content of 1.70 % but it is well balanced with its amino acid composition. The synthetic lysine can be supplemented in the diet to complete the nutrient requirement of broilers (Sangsoponjit *et al.*, 2017). It is essential to improve the efficiency of conversion of proteins from feed to meat. The only apparent disadvantage of this feedstuff is that it contains relatively high level of fiber and low level of metabolizable energy and lysine compared to soybean meal Amino acids are the building blocks of proteins. As lysine is the first limiting amino acid in sunflower meal, the growth of chicks substantially depends on its concentration in broiler diets. The strong lysine deficiency in sunflower meal must be balanced by L-lysine HCl to obtain satisfactory performance (Lević *et al*., 2005).

Broiler production in certain countries often suffers from an inadequate supply of local high-quality protein. Increased production of sunflower seeds (*Helianthus annuus L.*) for oil can provide more meal that can provide protein and offset the need for soybean meal, which is often unavailable due to cost (Ditta and King, 2017). Presently, due to adaptive capabilities in various climatic soil conditions, sunflower seeds are grown worldwide. (The non-availability of SBM at economical prices supports a need to search for alternate protein sources in least cost formulations for poultry in certain countries (Laudadio *et al.,* 2014)and (Rama Rao *et al.,* 2006). However, investigators reported that SFSM can replace up to two thirds of the soybean meal protein in the starter finisher diets of broilers. Addition of L-lysine HCl allows more flexibility
in feed formulation, allowing high inclusion rates of sunflower meal. The amino acid digestibility are reported to be 86%, 88% and 89% respectively for sunflower meal with 32%, 35%, and 37% crude protein. Similarly, protein digestibility is higher in high protein sunflower meal (Rama Rao *et al*., 2005). Another characteristic of SFSM is that it does not have anti-nutritional factors such as those found in soybean, cottonseed and rapeseed meals. Enzyme supplementation to SFSM-based diets in different types of poultry species need further study. The ingredient can successfully be included in layer, broiler and waterfowl diets to replace 50-100% of soybean meal, depending on the type of diet and the nature of the other ingredients (Senkoylu and Dale, 1999).

Materials and Methods

Husbandry, experimental design diets

This experiment was carried out at the poultry farm of Animal Science Department/ College of Agricultural Engineering Sciences/ University of Sulaimani. Two hundred and seventy male chicks (Ross 308) were used to evaluate their performance with three levels of sunflower seed meal (0, 10 and 20). The two first weeks was for adapting the chicks

together. At 14th days the male chicks were distributed in (3) treatments each treatment has (5) replications with (18 chicks) per each pen. From the second week to the end of the experiment the experimental diets were presented, feed and water were given (*ad libitum)*. The birds had free access to feed and water at all time. The chicks were fed two different levels of protein diet as grower from 15-28 days old was (%21 crude protein) and (3100 kcal/kg), from 28-42 days old was (%20 crude protein) and (3070kcal/kg) for the control (3150 Kcal/kg) for the other treatments.
T1: Control treatment (Basal diet containing zero SFSM).
T2: Basal diet containing 10% SFSM.
T3: Basal diet containing 20% SFSM.

Ingredient's composition of the grower and finisher diets and its analysis are shown in tables 1:

Table (1): Composition of the grower diet (15-28) days of age

Ingredients	Sunflower Seed Meal		
	0	10%	20%
Sunflower Seed Meal	0	50	100
Corn	462	408	339
Soybean Meal (%46)	304	278	280
Wheat	200	200	200
Wheat bran	0	30	50
Premix*	25	25	25
Soybean Oil	0	0	0
Mono-Calcium	5	5	5
Toxin Binder	4	4	4

L-Lysine (%)	1.35	1.35	1.35
Methionine (%)	1.65	1.65	1.65
Calcium (%)	1	1	1
Av. phosphorus (%)	0.45	0.45	0.45
Methionine + cystine (%)	1	1	1
Calculated Analysis			
Crude protein	21	21	21
Metabolizable energy kcal/kg	3100	3100	3100

Table (2): Ingredients Composition of the finisher (29-42) days of age

Ingredients	Sunflower Seed Meal		
	0	10%	20%
Sunflower Seed Meal	0	100	200
Corn	431	357	246
Soybean Meal (%46)	288	225	203
Wheat	250	250	250
Wheat bran	0	0	60
Premix*	25	25	25
Soybean Oil	0	0	0
Mono-Calcium	0	0	0
Toxin Binder	4	4	4
L-Lysine (%)	0	10	10
Methionine (%)	1.3	1.3	1.3
Calcium (%)	0.6	0.6	0.6
Av. phosphorus (%)	0.9	0.9	0.9
Methionine + cystine (%)	0.95	0.95	0.95
Calculated Analysis			
Crude protein	20	20	20
Metabolizable energy kcal/kg	3070	3150	3150

Performance Traits Measured

The following parameters (performance traits) were evaluated: live body weight, body weight gain, feed intake, and feed conversion ratio and carcass traits. The birds were weighed individually and feed consumption recorded at weekly intervals.

Statistical analysis The data from this experiment were analyzed according to analysis of variance (ANOVA) using the General Linear Model (GLM) within the statistical program Complete Randomized Design (CRD) procedures of XLSTAT. (Addinsoft, version.5.03, 2016) in one-way ANOVA, its significance was verified at the level of 5% using Duncan's multiple range test program (Duncan,1954) to determine the effect of different treatments.

Results and discussions

Table (3) shows the live body weight (LBW) at different age periods in each treatment. The highest LBW in the 15 days of age was in T3 which was (445.85g), the lowest was in T1(control) which was (416.80g). There were significant differences ($p \leq 0.05$) between T1 and T3, no significant differences ($p > 0.05$) were obtained between T1 and T2. Also, in the second age period (21days) the T2 was the highest weight (837.60g), the lowest was T1 (control) which was (810.400g). There were no significant differences (p>0.05) between the treatments in live body weight in 21, 35 and 42 days except 28 days of age. There were significant differences (p≤0.05) between T1, T2 andT3 and the highest LBW was in T3 (1389.80g). In 35 days of the highest LBW was T3 which was (2109.80g) and the lowest one was T1 (control) which was (1986.200). At the last period (42days) age T1 (control) was obtained the lowest LBW was (2665.400g) while T3 gained the highest LBW (2775.20g). Live body weight was significantly affected by addition of SFM during periods which is in treatments.

Table (3): Impact of using sunflower seed meal in broiler diet on live body weight (g) in different ages

Treatments	**Age (days)**				
	15	21	28	35	42
T1	416.80_{b} ± 10.27	810.40_{a} ± 11.52	1340.60_{b} ± 20.80	1986.20_{a} ± 26.82	2665.40_{a} ± 20.23
T2	432.80_{ab} ± 7.36	837.60_{a} ± 22.10	1273.40_{b} ± 27.30	1995.20_{a} ± 63.29	2688.20_{a} ± 78.90
T3	445.85_{a} ± 2.53	828.00_{a} ± 10.27	1389.80_{a} ± 20.25	2109.80_{a} ± 45.68	2775.20_{a} ± 20.50

Values (means ± SEM) in rows with different superscripts differ significantly (p≤0.05)

Similar sult recorded by (Kocher *et al*., 2000) growth rate of birds fed the SFM diets was significantly affected (*P* < 0.001). These results are in in contrast with (Salih and Taha, 1989) that in study indicated that the rate of live weight gain, were insignificantly affected by the level of SSM in the diet. However, the main effect of A-V fat on weight gain was significant (P<.01). Chicks fed diets containing 6% A-V fat 10 or 20% SFM gained more weight than did those fed 10 or 20% SFSM diets containing no A-V fat (Zatari and Sell, 1990). Musharaf, (1991) in study indicated that increasing the sunflower seed meal level to 250 g kg- i supplemented with lysine and methionine, supported growth equal to or better than the control diet.

Results in table (4) show the effect of the diet on the BWG in different treatments and different age periods, there were no significant difference (p>0.05) between treatments in different periods of ages. Chickens in T1 have got the highest BWG in age period (15-21) days which was (393.600 g) and the lowest one was T3 which was (349.800 g). In period (22-28 days), highest BWG was in T3 which was (577.400g) according to the other treatments and the lowest one was T2 were gained (448.200g). In age period (29-35 days) the highest BWG was T2 which was (721g) and T1(control) was the lowest BWG which was (637.40g)

Table (4): Impact of using sunflower seed meal in broiler diet on live body weight gain (g) in different age periods.

Treatments	**Age periods (days)**				
	(15-21)	**(22-28)**	**(29-35)**	**(36-42)**	**Overall**

T1	393.60a ± 12.47	529.40a ± 14.32	637.40a ± 12.49	679.20a ± 31.24	2248.60a ± 27.12
T2	392.20a ± 14.65	448.20b ± 15.60	721.00a ± 37.22	693.00a ± 39.48	2255.40a ± 74.81
T3	349.80a ± 17.11	577.40a ± 28.40	719.00a ± 40.81	665.40a ±56.76	2329.35a ± 21.22

alues (means ± SEM) in rows with different superscripts not differ significantly (p≤0.05)

Also, in the last age period and overall there were no significant differences (p>0.05) between treatments.in (36-42) days the highest BWG obtained by T2 (693g) while in overall T3 gained (2329.35g) which was the highest. (Nassiri Moghaddam *et al*., 2012) in study observed that BWG responded quadratically (P<0.01) with increasing levels of dietary SFM. Since the performance of the broiler chicks receiving the highest BWG which have highest level of SFM This finding con- firm that in the present study, the magnitude of response in weight gain to higher levels of sunflower seed meal was significantly greater (Musharaf, 1991). Pelleting diet

Table (5): Impact of using sunflower seed meal in broiler diet on feed intake (g) in different age periods.

Treatments	**Age periods (days)**				
	(15-21)	**(22-28)**	**(29-35)**	**(36-42)**	**Overall FI**
T1	454.20a ± 8.13	675.80a ± 19.46	1077.20a ± 29.49	1091.80a ± 48.18	3299.00a ± 65.87
T2	437.40a ± 13.19	603.80a ±41.34	1097.60a ± 81.97	1193.80a ± 117.83	3332.60a ± 178.15
T3	415.40a ± 15.35	631.40a ± 53.26	1057.80a ± 28.15	1156.20a ± 25.10	3260.80a ± 92.32

a Values (means ± SEM) in rows with different superscripts not differ significantly (p≤0.05)

The effects of using SFSM supplement and soybean oil to the diets on feed conversion ratio (FCR) are shown in table (6). The results did not indicate significant differences (p>0.05) between periods (15-21), (22-28), (29-35), (36-42) and overall. The maximum FCR in age period (15-21 days) was in T3 (1.204) and the minimum one in T2 (1.120). While in age period
(22-28 days) birds in T2 recorded the highest (1.344) FCR T3 recorded the lowest (1.123). In age period (29-35days) the maximum mean was T1 (control) (1.693) and the minimum mean was T3 (1.485). In age period (36-42) days the highest FCR was in T3 (1.778) and lowest FCR was in T1 (control) which was (1.617). While in overall T2 obtained (1.478) which was the highest FCR and (T3) gained lowest FCR (1.400). Similar observations have been obtained by (Salih and Taha, 1989) FCR were not significantly affected by the levels of inclusion rates of SSM. (Musharaf, 1991) recorded at 15 and 20% of the diet, feed conversion ratio was equal to the control (soya bean meal). In experiment (Nassiri Moghaddam *et al*., 2012) observed , the effects of various levels of SFM (0, 70, 140, and 210 g/kg) on chick performance and FCR were improved (P < 0.05) when up to 140 g of SFM was used.

Table (6): Impact of using sunflower seed meal in broiler diet on feed conversion ratio (g feed intake/g live body weight) in different age periods.

Treatments	Age periods (days)				
	(15-21)	(22-28)	(29-35)	(36-42)	Overall FI
T1	454.20ab ± 8.13	675.80a ± 19.46	1077.20a ± 29.49	1091.80a ± 48.18	3299.00a ± 65.87
T2	437.40ab ± 13.19	603.80a ± 41.34	1097.60a ± 81.97	1193.80a ± 117.83	3332.60a ± 178.15
T3	415.40bc ± 15.35	631.40a ± 53.26	1057.80a ± 28.15	1156.20a ± 25.10	3260.80a ± 92.32

Values (means ± SEM) in rows with different superscripts not differ significantly (p≤0.05)

According to the data in table (7), some carcass traits were influenced by dietary treatments. According to slaughter weight There were no significant differences (p>0.05) between treatments T1 and (T2, T3), Slaughter weight in T3 gained the highest weight it was (2230g) while T2 gained the lowest slaughter weight which was (2800g). There were no significant differences (p>0.05) between treatments in carcass weight T3 obtained the highest which was (2230g) the lowest carcass weight was T2which was (2141g). Breast weight, leg weight and wing showed that there were no significant differences (p>0.05) between treatments T1(control) was gained the highest breast weight (853.1g) while T2 was (838.5g). Maximum leg weight obtained by T3 (657.7g) minimum leg weight was in T2 (616.2).

While in wing weight the highest was T3 (248.8g) and T2 was gained the lowest (231.5g). In dressing percentage there was no significant differences between treatments, T2 gained the highest dressing percentage (76.298) and lowest dressing percentage was T3 which was (75.378a). dressing percentage were not significantly affected by the levels of inclusion rates of SFSM (Salih and Taha, 1989). The differences in the weights of the various carcass parts reflected the differences in the final weight consequently, in the carcass weight: if calculated as a percentage of carcass weight, no significant differences were found between groups for any of the carcass slices (Zollitsch *et al.*, 1997)

Table (7): Impact of using sunflower seed meal in broiler diet on Carcass traits (g).

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Treatments	Slaughter weight	Carcass weight	Breast weight	Leg weight	Wing weight	Dressing percentage
T1	2898a ± 65.15	2200a ± 57.19	853.10a ± 26.44	624.6a ± 20.25	237.30a ± 7.12	75.88a ± 0.67
T2	2800a ± 78.88	2141a ± 87.03	838.50a ± 37.78	616.20a ± 21.89	231.50a ± 7.29	76.30a ± 1.50
T3	2958a ± 70.20	2230a ± 58.82	843.10a ± 27.23	657.70a ± 20.29	248.80a ± 5.72	75.38a ± 0.73

a Values (means ± SEM) in rows with different superscripts not differ significantly (p≤0.05)

Fascina *et al.*, 2009) indicated that there were no significant differences in various characteristics of the subjective quality traits of breast meat.(Araujo *et al*., 2013) observed that carcass results are a consequence of the decrease in weight gain and function of the increase of SFSM in the diet. These results differ from those by (Oliveira *et al.*, 2003) and (Tavernari *et al.*, 2009), who did not verify any influence on carcass parameters up to the levels of 25.0% and30.0% inclusion SFSM, respectively.

Conclusion

The inclusion of sunflower seed meal (SFSM) in the diets at level of 0 %, 10 % and 20 %. Using %20 of SFSM in diet had significant impact on the productive performance traits of broilers in terms of live body weight, body weight gain also on carcass weight and slaughter weight as well. while feed intake, feed conversion ratio and resulted in the best dressing percentage Influenced by including %10 of SFSM.

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Agroecosystem Management Practices on some Cucumber Plant Parameters using Integrated Fertilization under Green House

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Abstract: This study was conducted in Tainal watershed, Bazian City, west of Sulaimaniyah, north of Iraq (35º57'31''N, 45º 17'98''E), the soil fertility was analyzed before the application of kinds of soil biofertilizer like dry yeast *Saccharomyces cerevisiae* with two concentrations ($5g^{-L,}$ 10 g^{-L}) of dry yeast. Biofertilizers, organic matter like humic acid and chemical fertilizer for more comparison and water as a control. Results using dry yeast (10 g^{-L}) have significant differences in ($P \leq 0.05$) on the vegetable parameters, plant height, leaf area, yield, the number of harvest day and the weight of root system. Also the humic acid and biofertilizers have a significant effect ($P \leq 0.05$). The yeast (10 g/L) have significant differences on ($P \leq 0.05$) on yield (1.3 ton/ha) comparing with control of 48.73 kg/5 m^2, and the total leaf area of 1.5 m^2 comparing with the control 1.16 m^2. The experiment was performed as factorial with randomized completely block design (R.C.B.D) on Cucumber plant type of (SAIF F1) with three replicates; each unit from the 18 unite (plot) contained 18 cucumber plant. The data were analyzed by using XLSTAT program statistically analyst.

Keywords: Agroecosystem Management, Cucumber, Non-Chemical Fertilizer, Soil fertility.

Introduction

During the last century, people who live on watersheds in any ecosystem faced many challenges which mitigating the effects of all of the changes that adversely affect human welfare and the functioning of natural ecosystems; the use of modern agricultural technologies raising yield has become an effective substitute for land expansion (Wilde, 2013). These issues have increased public awareness of soil Ecology and the significance of maintaining soil health in the agroecosystem (Wang & McSorley 2005).

Being intensively cultivated with high yielding crops needs to be carried executed (Vollrath, 2011). Soil testing is usually followed by collecting composite soil samples in the fields without geographic reference. The results of such soil testing are not useful for site-specific recommendations and subsequent monitoring soil obtainable nutrients status of using GPS will help in formulating site-specific balanced fertilizer recommendation and to understand the status of soil fertility spatially and temporally (Patil *et al*., 2012). The beneficial effects of using natural improve on soil fertility have been repeatedly shown yet; there are no procedures for their management (Bauer & Black, 1994). Many of organic materials functions with respect to soil fertility are known. Organic or biological compounds influence nutrient availability (i) by nutrients added, (ii) through mineralization-immobilization patterns, (iii) as an energy source for microbial activities, (iv) as precursors to soil organic matter (SOM), and (v) by reducing P sorption of the soil. The challenge is to merge organics of differing quality with inorganic fertilizers to optimize nutrient availability to plants (Palm *et al*., 1997). Results of research made on organic and synthetic fertility amendments influence soil microbial, physical and chemical properties of the yields were higher on farms with sort of organic production regardless of soil amendment type (Bonanomi *et al*., 2014). Alternative fertility amendments enhanced beneficial soil microorganisms decreased pathogen populations, increased soil organic matter, total carbon, and cation exchange capacity (CEC), and lowered bulk density thus improving soil quality (Bulluck *et al*., 2002). Cucumber is a popular cultivated plant in the gourd family Cucurbitaceae. Over 4000 years ago, the cucumber was spread beyond Indian borders, moved through Ancient Greece, Rome, Europe, New World, China, and eventually becoming fourth most widely cultivated vegetable in the globe (Siful, 2008). This journey was filled with golden periods when they were viewed as integral parts of many culture's cuisines, and sometimes they were dealt with as bringers of disease. In 2010, worldwide cucumber production was 57.5 million tons; the majority of the world's production and export being located in China (40.7 million tons). Cucumber (*Cucumis sativus* L.) is an important vegetable crop in our region especially in Sulaimaniyah province which has almost 3000 greenhouses; and %50 of them are cultivating with cucumber. Bacterial fertilizers of the preparation of living bacteria are applied to improve soil and increase the yield, the culture of nodule bacteria (*Rhizobium* spp.) have long been used extensively for this purpose and no controversy exists over their usefulness (Maurya *et al*., 2015).

Material and Methods

Site of Experiment

A-Bazian located in Kurdistan region Northeast of Iraq, 20 km. southwest of Sulaimaniyah province, 35N latitude, and 45 E longitude, big and important agricultural city that contain at least 4000 greenhouses, sea surface level reach it (837m-847m) also located in Basarah Basin (Fig. 1) that located in high folded zone, it has a wide plain with slightly slope topography called Bazian Plain. It contains six Watersheds and 14 Micro-catchments (Barzinji, 2013).

B-Stream flow: Basrah Basin has many springs, kameezes. Basrah Basin has a perennial mainstream, which consists of the combination of two great streams which are Tilie stream and Chami Tainal stream (Barzinji, 2013).

Climate

In winter, Bazian climate is cold and rainfall getting to the freezing point at the end of January and February, in middle and end of December snowfall be the higher and rainfall quantities reach it 800 mm- 1000 mm /year. In summer climate is hot and dry getting to 45^oc, in September wind is faster compared to other months also in June wind is faster but not like in September as shown in Table (1).

Soil

The experiment was carried out in normal greenhouses in Bazian city which located in 35°57'31''N, 45°17'98''E, and all agricultural practices were done in an organic way without using any chemical or pollute sources starting from plowing; the plow and all materials were sterilized by absolute ethanol (C_2H_5OH, 35%) as observed in (Table 2).

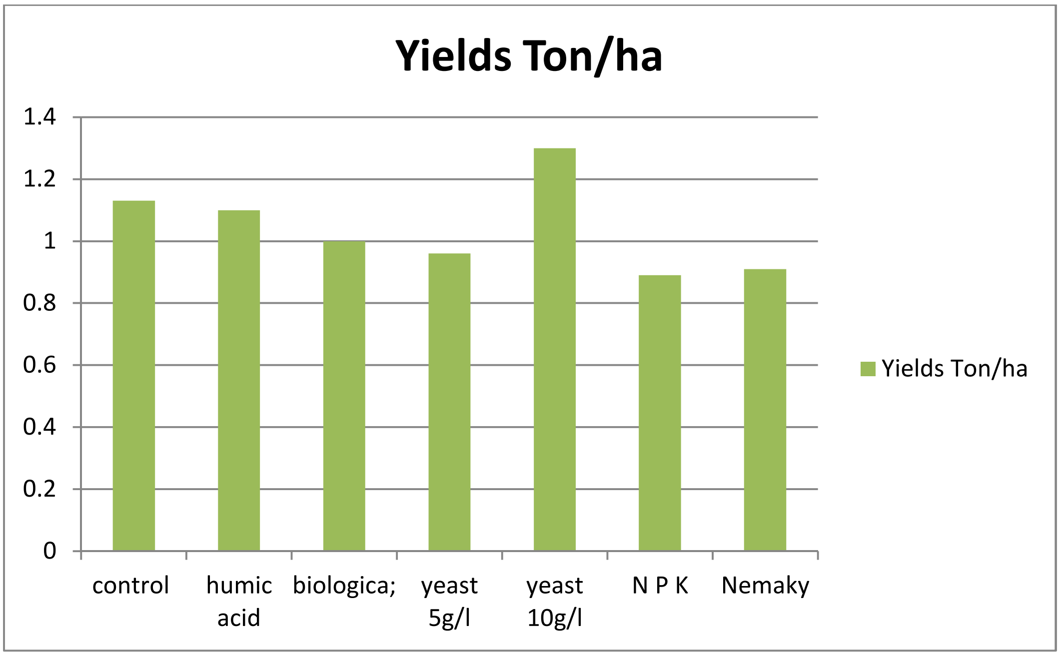

Fig. (1): Effect of treatments on cucumber yield (kg/m^2) between April-August 2016.

Table (1): Average of climate data for Bazian city, 2016.

Months	Temperature (°C)			Precipitation (rain) mm.	Humidity (%)	Sun (hours)	Pressure (Mb)	Wind speed (M / hr.)
	Max.	Min.	Mean					
Feb 2016	15	4	11	69.5	59	73	1021.1	6.5
Mar 2016	17	6	15	175.4	147	106.3	1015.1	10.5
Apr 2016	24	10	20	73.9	38	136	1013.1	9.4
May 2016	30	17	25	19.9	23	146	1010.5	11.4
Jun 2016	37	21	31	3.8	16	149.8	1007.4	12.3
Jul 2016	42.1	25	34.5	0	13	155	1002.8	11.6
Aug 2016	42	24	36	0	22	154.8	1006	10.1

Treatments and experimental design.

X.L.STAT program used for statistical analysis. Type of research design was R.C.B.D.. Numbers of treatments = 7, Numbers of replications = 3, Distance of treatments (sow line) = 5 m, Width of terraces or plot (unite experiments) = 1 m , High of the terraces 30cm., Area of plot = 5 m^2, Distance between each plots= in the same line = 1 m, Numbers of sow lines in each treatments 2 line zigzag way. Distance between each two plant=40 cm. Numbers of guard line = 2. Numbers of plant in each plot = 18 cucumbers plant. Numbers of plants selected for parameters and data's = 10. Distance between each feed line 40 cm. Table (3) explains the procedure used for soil analyses.

Table (2): Soil analysis for soil samples before the research.

Analysis element	Before
Soil texture	Clay loam
E.C./ ds. m.	0.28
pH	7.76
N%	0.14
Available P (ppm)	15.18
Soluoble K+ (mg/l)	0.1
Soluble Na+ (mg/l)	0.17
Soluble Ca+ (mg/l)	1.9
Soluble Mg+ (mg/l)	3.6
Cl^- mg/l	0.4
O.M. %*	2.06
$CaCo_3$ %	27
HCO_3 mg/l	1.7
CO^{-3} mg/l	0.3

*** O.M.: Organic matter.**

Methods: Distribution of treatment.

1- Control (T1).

2- Humic acid (T2).

Adding 1mm/plant to the soil before planting (7-10 days).

Adding 1mm/plant to the soil after planting (15 days).

Adding 1mm/plant to the soil during flowering.

Adding 1mm/plant to the soil before planting (7-10 days).

Adding 1mm/plant to the soil at first fruiting.

Adding 1mm/plant to the soil after one, two and three months.

3-Infoxgen a Biological fertilizer Austrian origin (T3): According to the recommendation on the box.

With planting when watering concentration (25 g \ l of water).

After the planting (20 days) in the same concentration.

After the First harvest directly concentration (30 g \ l of water).

Table (3): Procedures for soil analysis.

Analysis type	Procedure
Soil Texture	Bouyoucos (1936)
E.C.	Richards (1954)
pH	McLean (1982)
N%	Kjeldahl
Available P	Olsen *et al*. (1954)
K, Na, Ca, Mg, Cl	Richards (1954)
O.M. %*	Walkley & Black (1934)
$CaCo_3$ %	FAO (1976)
HCO_3 CO_3	Richards (1954)

*** O.M.: Organic matter.**

A month after the first harvest concentration (30 g \ l of water).

Two months after first harvest concentration (30 g \ l of water).

4-Fungus (*Saccharomyces cerevisiae*) of bread yeast (Commercial dry yeast) added to the soil with two concentrations:

5 g \ l of water (T4).

10 g \ l of water (T5).

5- Chemical fertilizer (NPK) 20:20:20 (T6).

Adding 1.5gm/plant to the soil before planting by (10) days, and in the middle of the season and before the seasons end in one month.

6-Vegetable extracts (Nemakey) (T7) add ($1mm\backslash m^2$) to the soil before planting, with first fruiting and after one month.

Results and Discussion

The results of table (4) and Fig. (2) indicated that the highest significant was in cucumber yield (1.3 ton/ha) when using of 10g/plant yeast; the reason of the increasing of yield because of yeast which contains a growth regulator like oxiness, gabbiness, carbohydrate and other important elements for growing (Joshi, *et al*., 2009). Using humic acid gave a significant effect on yield (1.1 ton/ha), because of humic ability to soil solution and increase the plant's uptake for elements.

Day to harvesting made significant difference on the treatments of yeast (10g/plant yeast); Albrecht *et al.* (1997) reported that might be due to induces nutrient minerals absorption through improvement of soil pH. Bown & Rovira (1991) and Sarhan (2008) indicated the yeast ability to increase the production of stimulants for plant growth, especially Gibberellins, Auxins and Cytokinins which act to improve the plant cell division and its growth results showed when they increase of yeast extract up to (10 $g^{-L)}$ improved the vegetative growth characters as expressed as plant length, stems and leaves number/plant, leaf area/plant, fresh and dry weights of the whole plant. Biofertilizer treatment affected significantly by decreasing the number of days needed to harvest (Larkin, 2008).

Table (4): Effect of fertilizers on some parameters.

Treat.	Yields Ton/ha	Day to Harvesting	Leaf area Cm^2	The weight of the shoot system kg	The weight of the root system, kg	TSS
Treat.1	1.13 c	62 b	1.16 c	3.45b	1.35b	3b
Treat.2	1.10 b	56 a	1.46 b	4.55a	2ab	7b
Treat.3	1b	59 b	1.4 b	3.88a	1.82ab	6b
Treat.4	0.96 c	61.3b	1.21c	3.75 a	1.74 ab	7b
Treat.5	1.30 a	50 a	1.5a	4.6 a	2.39 a	8.3a
Treat.6	0.89 c	61 b	1.1c	3.35 b	1.5b	6b
Treat. 7	0.91 c	62b	1.2c	3.4 b	1.55b	6b

Means with different letters are significantly different according to Duncan's multiple ranges test at P≤0.0.

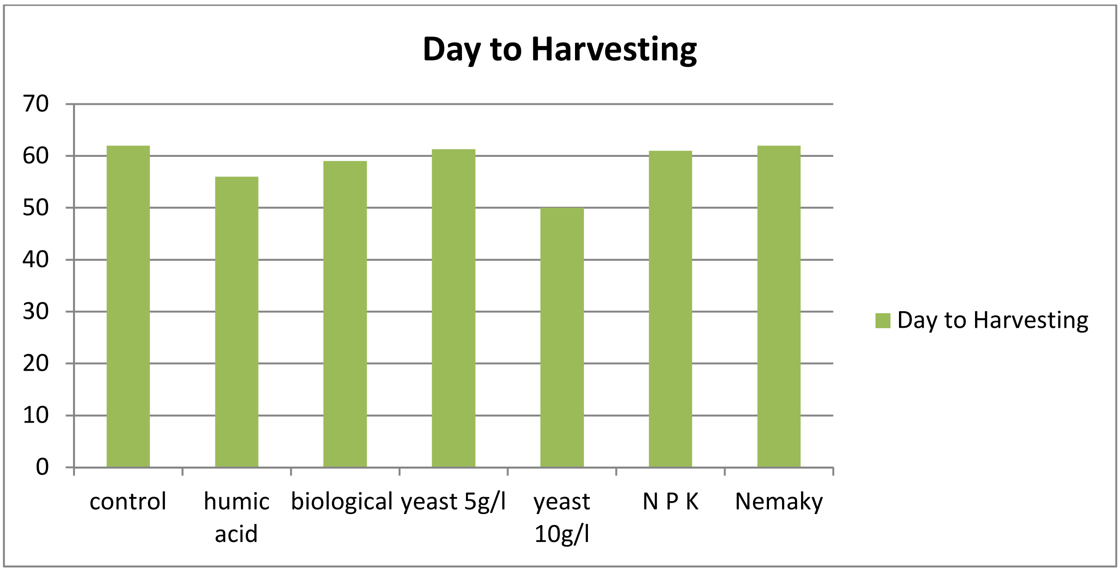

Fig. (2): Effect of treatments on cucumber yield (kg/m^2) between April-August 2016.

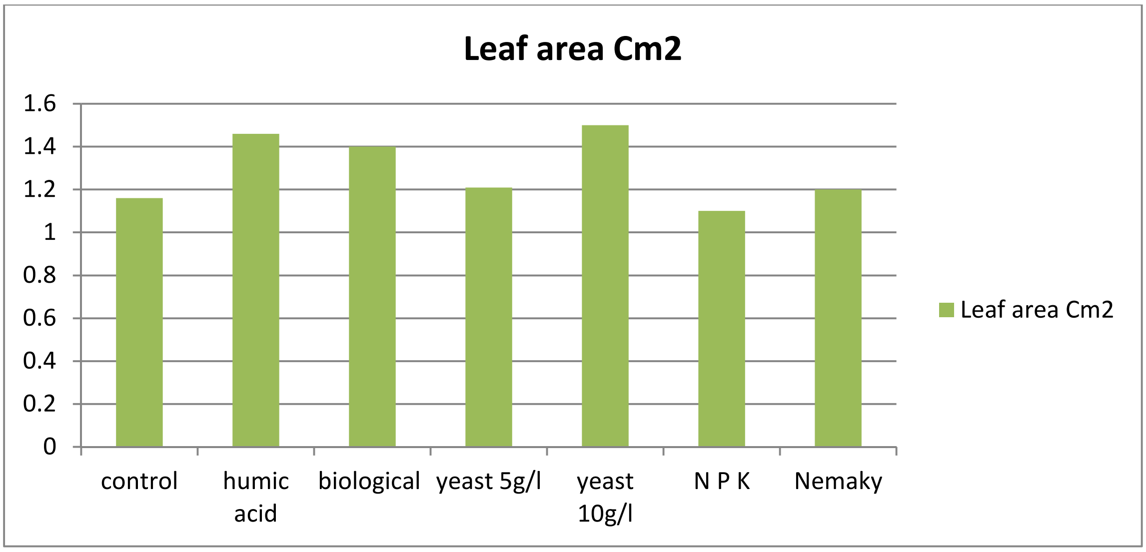

Fig. (3): Effects of treatments on cucumber yield (kg/m^2) between April-August 2016.

The yeast application (10 g^{-L}) and humic acid (1ml. /plant) gave the highest significant leaf area (1.5cm^2) and (1.4cm^2) as shown in Fig. (3). Abdel-Monnem (2015) reported applying bread yeast near the plants roots with concentration of (4 and 8 g) lead to a significant increase in the leaf area compared with the control.

The significant effect of biofertilizers (25g./l.) may be due to the fact that biofertilizers which have a positive effect on chemical composition in leaves by providing doses of nutrient to the plants and in some cases to provide plants with some promoting growth regulators (Abd El-Monem, *et al*., 2008). In addition, biofertilizers increase microorganisms living in the soil and these microorganisms work on the organic matter in the soil to convert organic N to mineral N (Lampkin, 1990).

Biofertilizers play a fundamental role in converting P and K fixed form to be ready soluble for plant nutrition and making the uptake of nutrients by plants easier. These results are in conformity with the findings of Supanjani, *et al*. (2006). Kaya *et al*. (2009) and Khan *et al*. (2012) showed that application of biofertilizers (N-fixing bacteria, P-dissolving microorganisms, and K-solubilizing bacteria) increased chemical constituents of sweet pepper leaves.

Conclusions

Agroecosystem practices that increase the capacity of the ecosystem in the ways that contribute to reduce needs for surplus additions that should be emphasized in conjunction with breeding for cultivars and their associated microorganisms (Drinkwater, 2009); the role of using natural fertilizer (resources) to maintain fertility of soils and have a healthy agroecosystem throw soil fertility management can have many effects on plant quality (Wander *et al*., 1994).

We found evidence to suggest that natural fertilizer practices can influence the relative resistance of agricultural crops to insect pests generally. Increased N levels in plant tissue were found to decrease pest resistance (Phelan *et al*., 1995).

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Biological Control of Root-Knot Nematode (*Meloidogyne javanica*) by Using Commercial Dry Yeast on Eggplant *Solanum melongena* in Halabja Province, Iraq

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Abstract: The fungal biocontrol agent using dry yeast was evaluated for its potential to control the root-knot nematode (*Meloidogyne javanica*) on eggplant *Solanum melongena*. In open field, soil samples were taken from a depth of 30 cm under soil surface for nematode analysis and the results showed that the soil was epidemic with root-knot nematodes, therefore, a plan was applied to use four concentrations of dry yeast (3, 6, 9 and 12 g/l) comparing with control which used only water. These treatments were applied in a factorial R.C.B.D. design on eggplant (Jawaher F1) with triplication. Statistical analysis was done by XLSTAT program. Water quantities were controlled by an irrometers and kept around field capacity. Root galling and larvae were measured by sieve method and the results showed that nematode activity in concentrations of 9 and 12 g/l had been inhibited by decreased number of second stage juveniles from 879 to 411 and from 879 to 274 juveniles/kg, respectively with significant differences ($P \leq 0.05$). Also, a significant results increasing was obtained in fresh weigh of shoot system (2050 g), fresh weigh of root system (845 g), plant height (102 cm) and yield (97 ton/hectare) when nematode used in concentration of 12 g/l.

Keywords: Biological control, Eggplant, *Meloidogyne javanica*, Yeast, Plant-parasitic nematode

Introduction

Using nematicides to decrease the activities of plant-parasitic nematodes is an expensive way and may cause a high environmental risk to non-target organisms and applicators (Thomason, 1987). So, there was a need to develop alternative control measures to manage plant-parasitic nematode under field conditions (Jansen et al., 2002; Karajeh, 2013). The use of natural and safe agents may promote growth of crops and induce their resistance to many diseases. *Saccharomyces cerevisiae* in dry yeast is considered as a promising yeast fungus

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for promoting plant growth of different crops (Shalaby & El-Nady, 2008). In the last decades, it became an effective alternative to chemical fertilizers safely used for human, animal and environment (Omran, 2000). According to ITIS (2020), *Saccharomyces cerevisiae* Hansen, 1883 belongs to the family Saccharomycetaceae, order Saccharomycetales, class Saccharomycetes, phylum Ascomycota, and kingdom Fungi of the domain Eukarya. Table 1 demonstrates the elements and the contents of the dry yeast.

Table 1: Elements and contents of the dry yeast.

Compound	mg/g	Compound	mg/g
Carbohydrates	82	Magnesium	2
Total Nitrogen	90	Phosphate	1-13
Nitrogen humid acid	40	Potassium	30
Magnesium	2	Sodium	56
Cupper	0.05	Zinc	0.05
Calcium	0.1	Cobalt	0.005
Iron	0.05		

This effective role due to its content of cytokinins and tryptophan (a precursor of indole acetic acid), the yeast suggested playing a beneficial role in cell division and enlargement and on vegetative plant growth and fruit yield (Nassar et al., 2005).

El-Tarabily (2004) found out that *Rhizoctonia solani* infection of sugar beet plants was suppressed by yeasts. Yeast were tested for biological control of post-harvest diseases of fruits and vegetables (Punja, 1997; Zheng et al., 2003) as well as against molds of stored grains (Petersson et al., 1999) and to control powdery mildews (Urquhart & Punja, 1997). Use of yeast fungi as biocontrol agents of soil-borne plant pathogens and plant growth promoters has been recently investigated (El-Tarabily & Sivasithamparam, 2006; Azzam et al., 2012).

The yeast fungus (*S. cerevisiae*) reduced infection of the nematode *Meloidogyne incognita* on Egyptian henbane and increased its growth (Youssef & Soliman, 1997). Yeast also is considered as a natural growth stimulator because of its richness in nucleic acid proteins, carbohydrates, vitamins, lipids and different minerals as well as its improvement of phosphorus and manganese uptake by the plant roots (Mekki & Ahmed, 2005).

Infective juveniles of nematodes are capable of finding their host in response to chemical stimuli from the insects. The bacteria multiply within the body cavity of the infected host insect and cause rapid death of the insect. The nematodes feed on the bacteria within the insect cadaver and reproduce several times before emerging to find new insect hosts. That the nematode and the bacterium cannot survive independently of one another which plays a part in the decision to exempt this microbial pesticide (Nickle & Welch, 1985).

Overcoming nematode environmental sensitivity appears to be the most critical factor restricting wide use of insect-pathogenic nematodes as nonchemical insecticides. Nematode effectiveness will be greatest where moisture and temperature conditions can be optimized for example in greenhouses suppression of soil-inhabiting insects has been most consistent when nematodes have been applied as a drench to potted plants and containerized nursery stock (Bedding & Miller, 1981) under conditions where insects and nematodes are confined when the soil surface is moist and shaded from sunlight and where competition with other organisms is minimized. Nematodes remain effective in conjunction with most insecticides such as pyrethrins and methoxychlor and with rotenone and diatomaceous earth (Petersson et al., 1999). However, some organophosphates and insecticides such as phenamiphos, carbofuran and oxamyl, adversely affect nematode development and reproduction (Hara & Kaya, 1982) and this incompatibility must be considered when using nematodes in an integrated pest management program.

In the present research, we try to give an understanding about the importunity of protecting plant and soil biologically by using commercial dry yeast to control the negative activation of root-knot nematodes.

Material and Methods

The study included five treatments each with three replicates; T1 = control used only water, T2 = dry yeast 3 g/l, T3 = dry yeast 6 g/l, T4 = dry yeast 9 g/l and T5 = dry yeast 12 g/l.

These treatments were applied as shown below.

T1 = Using of only water for irrigation and spring.

T2 = Spray the transplants with 3 g/l yeast after 15 days of transplanting.
Spray the plants with 3 g/l yeast after flowering.
Spray the plants with 3 g/l yeast after flower setting.
Spray the plants with 3 g/l yeast after first harvesting.

T3 = Spray the transplants with 6 g/l yeast after 15 days of transplanting.
Spray the plants with 6 g/l yeast after flowering.
Spray the plants with 6 g/l yeast after flower setting.
Spray the plants with 6 g/l yeast after first harvesting.

T4 = Spray the transplants with 9 g/l yeast after 15 days of transplanting.
Spray the plants with 9 g/l yeast after flowering.
Spray the plants with 9 g/l yeast after flower setting.
Spray the plants with 9 g/l yeast after first harvesting.

T5 = Spray the transplants with 12 g/l yeast after 15 days of transplanting.
Spray the plants with 12 g/l yeast after flowering.
Spray the plants with 12 g/l yeast after flower setting.
Spray the plants with 12 g/l yeast after first harvesting.

For chemical and physical soil properties, analyzing soil samples was undertaking from the research location. The results of the physico-chemical properties of the soil are presented in Table 2. The analyses of the organic matter were performed according to Schnitzer & Khan (1978). Total nitrogen of the soil was determined by the Kjeldahl method (Kjeldahl, 1883). Phosphorus was measured according to Olsen et al. (1954). Extractable Calcium, Potassium, Magnesium and Sodium were measured according to Thomas (1982).

Table 2: Soil analysis before treatments.

Soil texture	Organic matter (ppm)	pH	E.C. (ds/m)	N (ppm)	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Na (ppm)	Cl (ppm)
Clay loam	1295	7.0	0.39	821	12.3	2.1	9.3	19.4	2.3	7.9

Study Area

Halabja province (Figure 1) is located at 35°12′N 46°00′E in Kurdistan region, Iraq, 90 km east of Sulaimaniyah province and 714 km northeast of Baghdad province. With an elevation of 900 m, this area is considered as one of the most fertile areas in whole Iraq.

Figure 1: Map of the study location in Halabja province.

Field Distribution of Treatments

- Type of the research design (R.C.B.D.), numbers of treatments = 5
- Statistical analysis was done by XLSTAT program.
- Duncan's multiple ranges test at 0.05 was used for comparison among treatments

- Numbers of replications = 3, distance of treatments (sow line) = 6 m.
- Width of terraces = 0.6 m, high of the terraces = 0.3 m.
- Area of plot = 11 m^2, numbers of sow lines for each treatments = 3 lines
- Numbers of guard lines = 2, numbers of plants in each plot = 30 plants.
- Numbers of plants selected for parameters and data's = 9 plants.
- Eggplant varieties (Jawaher F1), Treatments Field distributions
- Nematode larvae were isolated and counted from soil as indicated in Table 3.

Table 3: Procedure of nematode analysis.

No.	Materials	Procedure and Source
1	20-mesh sieve (833 µm aperture)	Howard Ferris, Departments of Entomology and Nematology, University of California (from Zuckerman et al., 1981)
2	200-mesh sieve (74 µm aperture)	
3	325-mesh sieve (43 µm aperture)	
4	Coarse sieve (1 cm aperture)	
5	Two stainless steel bowls or plastic buckets	
6	250 ml beaker, 600 ml beaker	
7	Coarse spray wash bottle or tube attached to faucet	

Results and Discussion

The observed larval density of soil in treatments T1, T2, T3, T4 and T5 was recorded before the initiation of the experiment at soil depth of 25-30 cm (Table 4). Such density is higher than the recommended density for cucumber (200-250 larva/1 kg soil). The soil was contaminated with the nematode *M. javanica*.

Table 4: Soil analysis for nematode larvae of *Meloidogyne javanica* before cultivation.

Treatments	Population of nematode before treatments/kg soil
T1 Control	730
T2 3 g/l yeast	844
T3 6 g/l yeast	905
T4 9 g/l yeast	879
T5 12 g/l yeast	781

The results showed a significant effect in the numbers of juveniles that decreased from 1320 in control treatment to 274 when using 12 g/l dry yeast and 411 in 9 g/l dry yeast after 75 days from transplanting (Table 5). This result was returned to the fungus *S. cerevisiae* in the commercial yeast which made some changes in the roots antagonistic to root-knot nematodes because high level of humic acid and sugars in the plant roots increasing the resisting plant for nematodes (Karajeh, 2013). Also, the two humic acid serine and phenylalanine work as nematodes inhibitors and improve the adsorption capability of roots and produce some lignin's and phenols as suggested by Attyia & Youssry (2001).

Table 5: Effect of dry yeast to control number of nematode juveniles biologically.

Treatments	No. of nematodes before transplanting/kg	No. of juveniles/kg soil after 30 days from transplanting	No. of juveniles/kg soil after 75 days from transplanting
Control	730^{b}	890^{d}	1320^{d}
3 g/l yeast	844^{a}	712^{b}	623^{c}
6 g/l yeast	905^{a}	774^{bc}	577^{c}
9 g/l yeast	879^{a}	605^{b}	411^{b}
12 g/l yeast	781^{b}	453^{a}	274^{a}

Means with different letters are significantly different according to Duncan's multiple ranges test at $P \leq 0.05$.

Table 6 showed significant effects on numbers of galls that decreased from 38 galls/plant roots when using 12 g/l to 5 galls/plant roots after 75 days and 5 galls/plant roots when using 9 g/l after 75 days. The negative effect of yeasts on *M. javanica* might be due to the ability of the yeast fungus to convert carbohydrates to ethyl alcohol and CO_2 that are toxic to nematodes (Hashem & Abo-Elyousr, 2011). Commercial product, containing cells of *S. cerevisiae*, at the rate of 5 g/plant significantly affected J2s of *M. incognita* in soil and root galling in squash and increased yield of the plant under field conditions (Noweer & Hasabo, 2005).

Field application of *S. cerevisiae* progressed tomato and crop growth and increased nematode resistance to tomato authenticity by increasing their total phenolic root content in a manner similar to the externally applied hydrogen peroxide (Karajeh, 2014).

Table 6: Effect of different concentrations of dry yeast on the number of galls.

Treatments	No. of galls/plant roots before transplanting	No. of galls/plant roots after 30 days from transplanting	No. of galls/plant roots after 75 days from transplanting
Control	14^{a}	26^{d}	38^{c}
3 g/l yeast	15^{a}	12^{c}	10^{b}
6 g/l yeast	16^{b}	9^{b}	$6a^{b}$
9 g/l yeast	15^{a}	10^{b}	5^{ab}
12 g/l yeast	18^{a}	12^{a}	5^{a}

Means with different letters are significantly different according to Duncan's multiple ranges test at $P \leq 0.05$.

Increasing in eggplant growth and yield of *S. cerevisiae* that treated plants may be due to the indirect effect of the yeast on the nematode infection besides the yeast direct role in promoting plant growth and development (Akhtar & Alam, 1990). Also, this investigation showed that the growth enhancing effect of yeast application might be due to the yeast that produced cytokinins which are responsible for increasing the production and accumulation of soluble metabolites. Alam et al. (1977) reported that mechanism of dry yeast as biocontrol activity may involve competition for nutrients, site exclusion parasitism and induced resistance or make physical and chemical soil properties unsuitable for plant pathogens.

Table 7 showed a significant effect on fresh weight of shoot system which increased from 710 g when using 12 g/l to 2050 g and to 1670 g when using 9 g/l. Also, this table indicated that using commercial dry yeasts (9 and 12 g/l) was more effective than using yeasts 3 and 6 g/l in reducing *M. javanica* infection on fresh weight of root system of eggplant and their final population in field soil phytotoxicity accompanied to human when using dry yeast up to 736 and 845 g, respectively compared to control treatment which was 300 g.

Using of dry yeast had significant effect on plants as higher rises compared to control were recognized in the treatments 9 and 12 g/l in the lengths of the plants which reached 89 and 102 cm, compared to the control which was 60 cm (Table 7). This table also showed that using yeast with concentrations of 9 and 12 g/l has significant effect on mild root system weights (736 and 845 g, respectively). Yield reached 86 and 97 ton/hectare respectively, compared to control treatment which was 70 ton/hectare. Such positive effects on the root plant resistance against the plant parasitic nematodes led to improve root health and weight gain (Hashem et al., 2008). Originality the vegetative growth parameters of *Azadirachta indica* (plant height, stem and root and fresh and dry weights) were significantly affected by all foliar uses with yeast extract at 5, 10 and 15 g. (Taha et al., 2016). The effect of promoting yeast extract can be attributed to its effect on metabolism, biological activity, photosynthetic pigments and enzyme activity that in turn promotes vegetative growth (El-Sherbeny et al., 2007).

Table 7: Effect of dry yeast on shoot and root systems weight, plant height and yield of eggplant.

Treatments	Fresh weight of shoot system (g)	Fresh weight of root system (g)	Plant height (cm)	Yield (ton/hectare)
Control	710^{e}	300^{e}	60^{d}	70^{c}
3 g/l yeast	850^{d}	390^{d}	64^{cd}	74^{c}
6 g/l yeast	1120^{c}	575^{c}	74^{c}	78^{bc}
9 g/l yeast	1670^{b}	736^{b}	89^{b}	86^{b}
12 g/l yeast	2050^{a}	845^{a}	102^{a}	97^{a}

Means with different letters are significantly different according to Duncan's multiple ranges test at $P \leq 0.05$.

Conclusion

Application of the yeast *S. cerevisiae* was used as a treatment to affect population of the nematode *M. javanica* and root gall formation on eggplant through its effects on nematode infection and reproduction and also through inducing plant resistance and enhancing fruit production of eggplant under field conditions.

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Control of Root-Knot Nematode of Eggplant and its Effect on Plant Growth and Yield under Plastic House Condition

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Abstract: *Root – knot nematode (Meloidogyneincognita) is the dangerous disease caused significant effects on eggplant growth and yield. This study was conducted at Bazian, Sulaimani Governorate, Kurdistan Region, Iraq to estimate the population densities and their control, using different methods and with effects on vegetative growth and floral characteristics of the eggplants. An experiment was laid down in a simple randomized complete block design (RCBD) including 9 treatments with three replicates. The results showed that the reproduction factor (RF) of the nematodes in the Nemakey 0.75 ml $m^{-2}$and Charge (Humic acid %15) treatments were 0.00 and 0.50 respectively. Reduction of the juveniles 2 were 100.0 and 81.9%, respectively, so they are considered to be the two best treatments for decreasing the population densities of the nematodes. The highest plant height was 118.7cm recorded in the Nemakey 0.75 ml m^{-2} treatment, while the Charge gave the largest no. of Leaves/plant (712.7), in the same treatment, the highest amount of chlorophyll was 48.67 mg g^{-1}, with the shoot weight/plant (3350 g). However, there were no effects of the all of the treatments on the percentage of leaf dry matter. The largest root length was recorded for the Nemakey 0.75 ml m^{-2} (50.33 cm) and the root weight was 1066.7g for the Nemakey 1 ml m^{-2}.There were no significant effects of any of the treatments on the total flowers/plant and few effects were observed on the aborted and setting flower/plant, also no. of the days needed for flowering. Charge obtained the highest no. of fruit /plant and the % of Brix of the fruits, while the Nemakey 2 ml m^{-2} had significant effects on fruit weight (g), yield (kg/plant).The percentage of increased yield (102.58 , 10.60 and 48.04) respectively, compared with the control.*

Keywords: *Root-knot nematode, Meloidogyne, Nemakey, Rugby, Charge, Eggplant growth and yield.*

1. INTRODUCTION

Eggplant (*Solanum melongena* L.) is one of the important cultivated vegetable crops in the world. According to the FAO in 2012, 90% of the eggplant production comes from five countries, including China, India, Iran, Eygpt, and Turkey. The cultivated areas exceed more than 1,600,000 ha., the total yields equal 43,573,139 tons yearly. Iraq (Kurdistan region included) produces 460,000 tons annually preempt the seventh rank of the world eggplant production (FAOSTAT. 2012).

Eggplants attack several pests and diseases like; damping-off and root rots, soft rots, plant viruses and nematodes. The most important diseases in Kurdistan region, Iraq, particularly in Sulaimani are root-knot nematodes (Sulaiman *et al*., 2016).

Root-knot nematode (RKN) disease comes first among the diseases and pests infecting eggplants in Kurdistan and Iraq (Stephen *et al*., 2003 and Zwain, 2014). *Meloidogyne* is regarded to be the most important genus affecting many plant species (Abu-Gharbiah, 2010), and the losses caused by it exceeded 50% and estimated to be 100 billion dollars annually. Four species of *Meloidogyne* are wide-spread in the world, which are *M. javanica, M. incognita, M. hapla* and *M. arenaria* (Menjivar *et al*., 2012).

Several methods have been applied to control RKN, e.g. chemicals, organic compounds, plant extracts, resistant varieties, and biological control (Sikora and Fernandez, 2005). Chemicals, for their easiness in using their giving relative quick results by the farmers are wider and more applied by them to control RKNs and other plant pathogens (Brand *et al*., 2010).

In Sulaimani province, there was no real investigation about controlling RKN. Therefore this study comes to investigate the actual causal agent(s) and using alternatives - with chemicals - are so useful and beneficial for vegetable crops, consumers and their farmers themselves and in order to maintain agro-ecosystem clean and far away from pollutants. Nemakey (Turkish plant extract mixture product) and some organic compounds, like Humic acid 15% are excellent methods and alternatives in this regard for solving this problem which the farmers suffered from, especially in protected farming for a long time.

2. Materials and Methods

An experiment was conducted in a plastic house in Bazian, Sulaimani Province in Bibijak located at 32 Km west of Sulaimani province during the 2013-2014 season. RCBD with three replicates was used, each included 9 plots (0.8 x 4 m) in which nine treatments were distributed, distances among blocks and plots were 2 and 1 m successively. Plastic pipes were used for the purpose of trickle irrigation. Several samples each one kg weight were taken throughout the field for physical and chemical analysis (Table 1). In order to calculate number of nematodes and some other parameters. One kg soil sample was taken from each plot, and then transferred to the research laboratory in the Department of Horticulture, Faculty of Agricultural Sciences, University of Sulaimani. After mixing the soil samples thoroughly, 100g from each was taken (as subsample) for the purpose of mentioned before.

Table1. *Some physical and chemical properties of the plastic house soil prior to planting in 2013 at Bazian Experimental Station/ Sulaimani Agricultural Research Center.*

Soil texture	E.C./ ds. m.	pH	Total N %	Available P (ppm)	Soluble K^+ (meq/L)	Soluble Na^+ (meq/L)	Soluble Ca^+ (meq/L)	Soluble Mg^+ (meq/L)	CL (mg/L)	O.M %	$CaCO_3$ %	HCO3 (meq/L)	CO^{-3}
Clay loam	0.30	7.3	0.1	16.5	0.13	0.19	1.3	2.8	0.3	1.2	27	1.73	0.31

Seeds of eggplant (cv. Jawaher-F1) were sown in a nursery close to the plastic house, after the seeds germinating and reaching the physiological ages (4-5 truly leaves), seedlings transferred carefully to their permanent places in the plastic house at a rate of 8 seedling/plot (experimental unit) to one side, with 80 cm between the seedlings interval. All necessary agricultural processes were carried out for all the treatments. The treatments included:

T_1: Rugby 1 ml m^{-2} ,T_2: Rugby 1.6 ml m^{-2} ,T_3: Rugby 2 ml m^{-2} ,T_4: Nemakey 0.75 ml m^{-2} ,T_5: Nemakey 1 ml m^{-2} ,T_6: Nemakey 1.5 ml m^{-2} ,T_7: Formalin 1% ,T_8: Control (water spray only) and T_9: Charge, 1.5 ml m^{-2} .

(Note: 1-Formalin1% (Formaldehyde 37.8% diluted to 1%); 2- Nemakey® [(Turkish natural organic nematicide, Merkez Anadolu Kimya, Turkey-Organic matter 25%, N=4%, K2O= 5%, pH: 8-10)]; 3- Rugby® 100 ME (Cadufos), FMC, Philadelphia, Pennsylvania, USA], 4-Charge® (an organic fertilizer; consists of high P+Humic acid 15%, Thailand), all these materials have been purchased from local markets.) Formalin application was carried out two weeks before the seedlings transferring to avoid its detrimental effect, while other treatments were done only a day before planting. All the treatments were applied ones, except for Charge applied thrice.

Diagnosis of the nematode (s): For diagnosing of the root-knot nematode, perineal patterns procedure have been used (Hartman and Sasser,1985), for this purpose root-knot nematode females were collected from the diseased plants in the plastic house at Bazian Experimental Station / Sulaimani Agricultural Research Center.

The parameters have been taken:

-Nematodes parameters:

1-Population densities (Number of Juveniles2 / 100 g soil) using modified Baermann Funnel technique (Whitehead and Hemming, 1965 from Whitehead, 1998).

2- Reproduction factor (Rf) = final population of the nematodes (Pf) / initial population of the nematodes (Pi), the data have been obtained were used for giving the host status rating with the quantitative method (Rf $\geq$ 1 means that the plant good host for the nematode, Rf = 1 is poor host and Rf $\leq$ 0.1 means non-host according to the standards were pointed out by Sasser *et al.*, 1984**.**

-*Reduction of the number of nematodes (Juveniles 2)* **=** No. of J2 of control – No. of J2 in the treatment

(After10 and 30 days from the applying the treatments /No. of J2 in control x 100 (Youssef and Lashein, 2013).

-Plant growth parameters:

A. Vegetative and root growth characteristics:

1- Plant height (cm), 2- Number of leaves/plants, 3- Chlorophyll (mg/g of a leaf) using Minolta chlorophyll meter model SPAD-502 plus, Japan, 4- Shoot weight (g/plant), 5- % of leaf dry matters, 6- Root length (cm) and 7- Root weight (g/plant).

B. Flowering characteristics

1- Number of total flowers/plant, 2- Number of aborted flower/plant, 3- % of setting flowers, and 4- Days needed for flowering (after planting).

C. Yield characteristics

1- Number of fruits/plant, 2- Fruit weight (g), 3- Brix (%) using Digital refractometer 660K, Brix/RI check out, Reichert Company, Japan, and 4- Yield (kg/plant)

Data analysis

The experiment has been carried out using complete randomized block design (RCBD) with three replicates and means compared according to the Duncan's multiple range test ($p \leq 0.05$). XLSTAT computer programming has been used for data analysis.

3. RESULTS

Fig.1 shows the effect of different treatments on the population densities and on the reproduction factor (RF). Hence, it shows the clear and significant effects of natural (Mixture of some plant extracts) the nematicide "Nemakey" and Charge (the organic fertilizer). The RF of nematodes in the Nemakey 0.75 ml m^{-2} and Charge were 0.00 (Fig.1C) and 0.50 and the reduction of the number of juveniles 2 were 100.0 and 81.9%, respectively (Fig 1B), after 30 days of applying treatments, thus indicated that the positive and significant decreasing in the fecundity and the reproduction of the root-knot nematodes (RKNs) has occurred. Since when the Rf equals one or less than one, this means that the ability for reproduction of the RKNs were decreased.

Results in Table 2 show the effect of different treatments on vegetative and root growth. It has been found that average of plant height increased (48.7 cm) in the case of using Nemakey 0.75 ml m^{-2} treatment, while these parameters were increased in the number of leaves/plant (712.7), average of chlorophyll content (48.07 mg) and the shoot weight (3350 g) were increased when Charge was used. On the other hand, Nemakey 1.5 ml m^{-2} treatment affected on the percentage of leaf dry matter (22.83) in contrast the highest average of root length was 50.83 cm in the Nemakey 0.75 ml m^{-2} treatment. Furthermore Nemakey 1 ml m^{-2}treatment lead to remarkable increasing of root weight (1066.7 g).

It has been found that there were no significant differences among the treatments in the number of flowers/plant characteristics, although this was more (137.39) in the case of Charge, if compared with the other treatments and control. The number of aborted flower/plant was significantly less in the Nemakey 0.75 ml m^{-2} and Charge; 16.67 and 18.67 respectively, compared with control treatment (45.70), and vice versa the percentage of the setting flowers in the two above mentioned were much greater; 86.93 and 86.79% respectively, compared with the other treatments and control. The number of days needed for flowering in Charge was 142, this was the least needed days compared to the treatments and control (Table 3).

It was observed from Table 4that Charge had impact on the increasing the number of fruits and the Brix (%) were 118.67 and 4.80 respectively, while the Nemakey 1.5 ml^{-2} treatment increased the fruit weight/plant, the total yield of the fruits/plant and the percentage of the increased yield (102.58 g, 10.60 kg and 48.04%) respectively.

4. DISCUSSIONS

The results of this experiment revealed that adding of organic fertilizers (Charge) to the soil amended the soil with natural plant products, this lead to increasing in plant growth and yield (Fig.1 and Tables 2,3) of eggplants and suppressing the number of nematode populations (Fig. 1A).

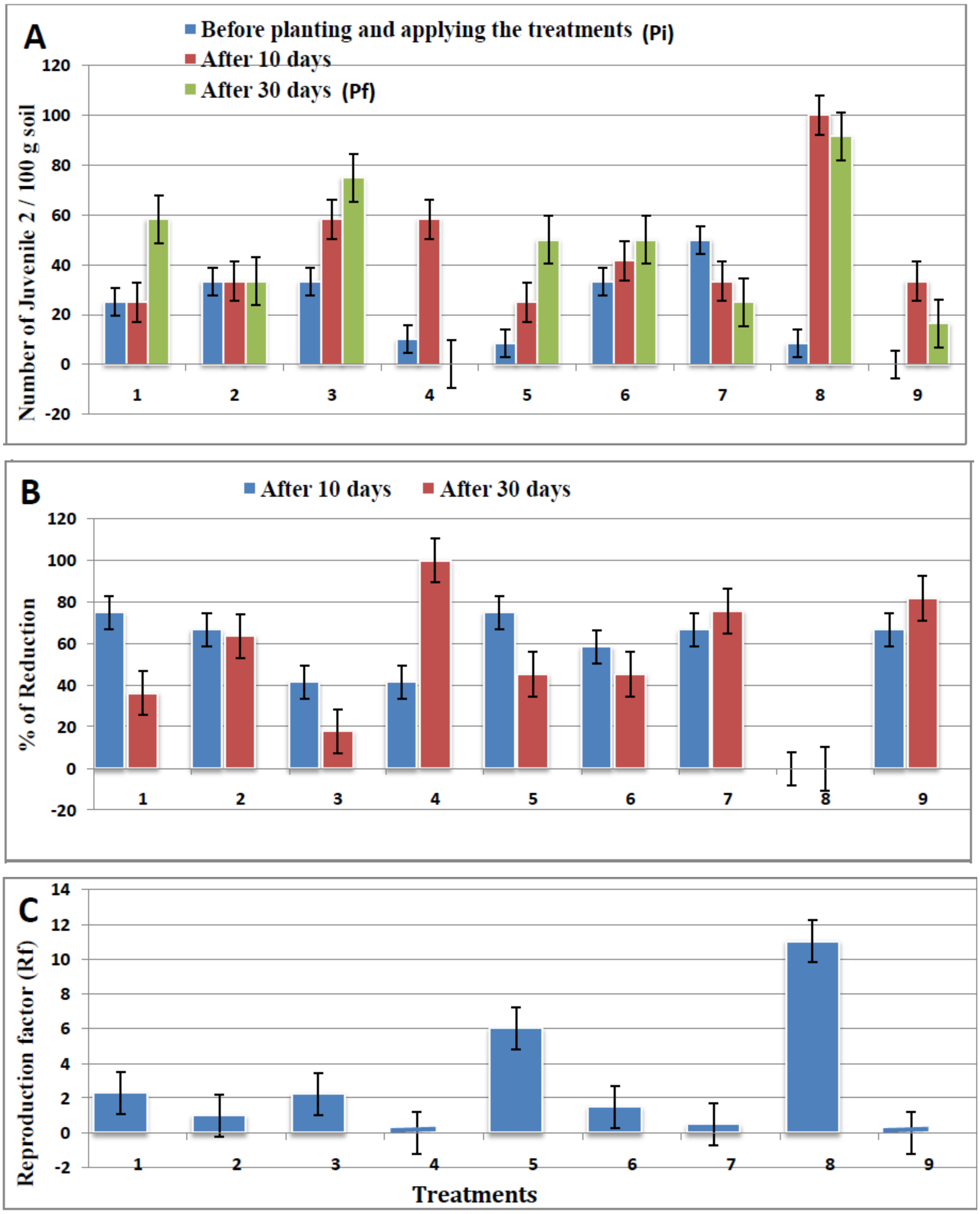

Fig 1. *Effect of different treatments {T1, T2 and T3, are Rugby® 100 ME at 1, 1.6 and 2 ml m*$^{-2}$*; T4, T5 and T6 are Nemakey® 0.75, 1and 1.5 ml m*$^{-2}$*; T7 is Formalin 1%; T8 is control (water only); and T9, Charge®; 1.5 ml m*$^{-2}$*} on:* ***A****; Nematode (Meloidogyne incognita)population densities (Juvenile 2),* ***B*** *% of reduction of the number of the nematode, and* ***C****; Reproduction factor (Rf) = Final population density of the nematodes (Pf) / Initial population density (Pi), the bars are the standard errors ($P \leq 0.05$).*

Results obtained from the Fig. 1 and Tables 2-4 indicate that the organic nematicide (Nemakey) and organic matter (Charge) showed significantly and good effect on reducing *Meloidogyne* populations in the soil furthermore without any detrimental effect on the beneficial nematode populations (as we observed under light microscope during the root-knot nematode (RKN) counting, in sometimes the number of the beneficial nematodes populations in the tested soil samples reached to more than five times more than the harmful nematodes (RKN). Morales *et al*., 2011 pointed to the similar result in their investigations. From Table (1) it appeared that the soil was weak in organic matter (OM) and organic nitrogen (ON) and other chemical elements (OM and ON were (1.2 and 0.1) % respectively and available P was 16.5 ppm, soluble K^+ was 0.13). The Nemakey treatment because of its content of organic matter and organic nitrogen and good amount of potassium, caused to supplement the plant complete essential micro and macro elements, which inhances the plants to strengthing themselves and suppressing the root-knot nematodes attacking (Zewain, 2014).

Table 2. *Effects of different treatments for controlling root- knot nematode, Meloidogyne incognita on some vegetative and root growth characteristics of egg plants (cv. Jawaher-F1).*

Treatments*	Plant height (cm)**	Nº of leaves / plant	Chlorophyll mg/100g fresh weight	Shoot weight (g / plant)	% of Leaf dry matter	Root length (cm)	Root weight (g)
T1	108.3 a	258.7 bc	39.47 bc	1116.7 b	19.65 a	33.00 bc	393.3 b
T2	102.7 a	282.0 bc	39.27 bc	1150.0 b	20.71 a	27.67 c	370.0 b
T3	104.0 a	221.0 c	38.80 c	866.7 b	21.35 a	34.67 a-c	451.0 b
T4	118.7 a	630.0 a	38.50 c	2583.3 a	19.12 a	50.33 a	566.7 b
T5	117.7 a	687.3 a	39.73 bc	2833.3 a	21.17 a	38.33 a-c	1066.7 a
T6	117.0 a	618.7 a	40.53 b	3033.3 a	22.83 a	47.67 ab	630.0 b
T7	110.7 a	431.3 b	36.57 d	1456.7 a	19.31 a	28.33 c	478.3 b
T8	94.7 a	191.0 c	35.13 e	700.0 b	21.99 a	25.33 c	486.7 b
T9	115.7 a	712.7 a	48.67 a	3350.0 a	20.25 a	41.00 a-c	681.7 b

** T1, T2 and T3 are Rugby® 100 ME at 1, 1.6 and 2 ml m^{-2} respectively, T4, T5 and T6 are Nemakey® 0.75, 1 and 1.5 ml m^{-2} respectively, T7 is Formalin 1%, T8 is control (water only), and T9, Charge; 1.5 ml m^{-2} applied thrice during the growing season.*

***Each number is the mean of three replications. Values in column followed by the same letter are not significantly different (P ≤ 0.05) according to Duncan´s Multiple Range Test.*

Table 3. *Effect of different treatments for controlling root knot nematode, Meloidogyne incognita on some flowering characteristics of eggplants (cv. Jawaher-F1).*

Treatments*	Nº of Total flower / plant**	Nº of aborted flowers / plant	% of setting flowers	Days needed for flowering (after planting)
T1	119.34 a	20.67 ab	82.78 ab	159.33 c
T2	136.22 a	42.89 ab	68.46 ab	161.00 d
T3	126.00 a	32.67 ab	74.57 ab	160.67 d
T4	124.67 a	16.67 a	86.93 a	155.00 b
T5	122.00 a	23.34 ab	78.47 ab	155.00 b
T6	119.34 a	25.56 ab	78.20 ab	142.00 a
T7	128.89 a	23.34 ab	80.94 ab	161.00 d
T8	124.45 a	45.70 b	63.54 b	160.00 cd
T9	137.34 a	18.67 a	86.79 a	142.00 a

** T1, T2 and T3 are Rugby® 100 ME at 1, 1.6 and 2 ml m-2 respectively, T4, T5 and T6 are Nemakey® 0.75, 1 and 1.5 ml m-2 respectively, T7 is Formalin 1%, T8 is control (water only), and T9, Charge; 1.5 ml m-2 applied thrice during the growing season.*

***Each number is the mean of three replications. Values in column followed by the same letter are not significantly different (P ≤ 0.05) according to Duncan´s Multiple Range Test.*

Table 4. *Effect of different treatments for controlling root knot nematode, Meloidogyne incognita on some yield characteristics of eggplants (cv. Jawaher-F1).*

Treatments*	Nº of fruit / plant**	Fruit weight (g)	Brix (%)	Yield Kg / plant	% of the increased yield
T1	98.67 ab	87.69 a	4.47 b	8.60 cd	16.77
T2	93.33 ab	89.93 a	4.47 b	8.30 cd	15.92
T3	93.33 ab	84.79 a	4.43 b	7.90 de	10.33
T4	108.00 a	83.33 a	4.50 b	9.00 bc	25.69
T5	98.67 ab	98.89 a	4.47 b	9.70 ab	35.47
T6	103.33 ab	102.58 a	4.83 b	10.60 a	48.04
T7	96.00 ab	84.46 a	4.47 b	8.10 cd	13.12
T8	78.67 b	92.80 a	4.23 b	7.16 e	-
T9	118.67 a	81.74 a	4.80 a	9.70 ab	35.47

** T1, T2 and T3 are Rugby® 100 ME at 1, 1.6 and 2 ml m-2 respectively, T4, T5 and T6 are Nemakey® 0.75, 1 and 1.5 ml m-2 respectively, T7 is Formalin 1%, T8 is control (water only), and T9, Charge; 1.5 ml m-2 applied thrice during the growing season.*

***Each number is the mean of three replications. Values in column followed by the same letter are not significantly different (P ≤ 0.05) according to Duncan´s Multiple Range Test.*

The chemonematicides (Rugby) also relatively have been reducing the number of RKN, but however causes inadmissible and toxicity effects on the plant growth status (Al-Agidi and Al-Mashhadaani, 2013). Charge, although it improves the eggplant growth and physiological status (Sulaiman *et al*., 2016), it also induces the plant, creating the so-called secondary metabolites (Phytoalexins), which triggers the plants more resistance to the root-knot nematode infection. Oka and Pivonia, 2002 stated that organic fertilizers contain formulations releasing this form of nitrogen in the soil that can suppress nematode populations. Worthily applying the organic fertilizers to the farmer's soils conserving and promoting soil aggregation and impeding the nematode juveniles movement (Melba and Onweremadu, 2009).

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Different Soil Improvers Enhance Cucumber Productivity by Suppressing Root-Knot Nematodes (Meloidogyne javanica L.)

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Different Soil Improvers Enhance Cucumber Productivity by Suppressing Root-Knot Nematodes (*Meloidogyne javanica* L.)

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Abstract: Root-knot nematodes (RKNs) severely infest cucumber crop; however, limited is known about the effect of different soil improvers on RKNs suppression and subsequent improvement in cucumber productivity. Therefore, the current study was conducted to infer the role of different soil improvers (i.e., humic acid, commercial dry yeast, rhizobium and Nemakey) in suppressing RKNs and improving cucumber productivity. The soil improvers were applied at the time of sowing and data relating to growth (leaf area, chlorophyll contents, root and shoot biomass), yield related traits (fruit width and length, number of aborted flowers, days to harvest and yield) and number of egg sacs and nematode larvae in soil were recorded. All soil improvers suppressed the number of egg sacs and larvae compared to control treatment, and the highest suppression was recorded with Nemakey compared to the rest of the soil improvers. Similarly, growth and yield related traits were improved by all soil improvers compared with the control treatment and the highest improvement was noted with Nemakey. It is concluded that Nemakey can effectively be used to suppress RKNs and improve cucumber productivity in nematode contaminated soils. Moreover, the efficacy of Nemakey should be tested for other crops.
Keywords: Nemakey, root-knot nematodes, cucumber, growth, productivity

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1. Introduction

Cucumber, (*Cucumis sativus* L.) is the most important cucurbitaceous crop grown around the world (Asadi et al., 2018; Zhang et al., 2018). Several biotic and abiotic factors adversely affect the productivity of cucumber (Anwar et al., 2018; Wei et al., 2015). The biotic factors include the diseases caused by fungi, bacteria, viruses and nematodes. The root-knot nematodes (*Meloidogyne* spp.) are the most prevalent cause of yield losses in cucumber (Abu-Gharbieh et al., 2005; Karajeh, 2013).

The root-knot nematodes (RKNs) infest several crops globally (Ntidi et al., 2016; Shigueoka et al., 2016), including vegetable crops (Naz et al., 2016; Podesta et al., 2016; Zhou et al., 2016). Over 100 species of *Meloidogyne* have been described from different parts of the world (Karssen and Moens, 2006); however, only four species (*M. incognita*, *M. javanica*, *M. arenaria* and *M. hapla*) are responsible for economic losses and 95% infestations globally. The global distribution of these species is as follows: *M. incognita* 47%, *M. javanica* 40%, *M. arenaria* 7% and *M. hapla* 6% (Sasser, 1980). These RKNs adversely affect uptake of nutrients and water, and translocation of photosynthates and minerals (Williamson and Hussey, 1996) resulting in altered root: shoot ratio (Anwar and Van Gundy, 1989), which has a negative effect on the yield (Orr and Robinson, 1984).

The management of RKNs is more difficult than that other pests as they mostly inhabit the soil and usually attack the underground parts of the plants (Stirling, 2018). Although nematicides are effective,

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easy to apply and show rapid effects; however, they are withdrawn from the market in some developed countries because of their concerns about public health and environmental safety (Schneider et al., 2003). Besides, nematicides' use to control RKNs is an expensive measure and may have high environmental risk to air, water, non-target organisms and the applicators. Moreover, excessive and continuous use of pesticides to control different pests and diseases resulted in public awareness against their environmental and health impacts. Thus, there is a need to develop alternative control measures to manage plant-parasitic nematode under field conditions.

The main approaches of alternative control are: (1) genetic modification of the biocontrol agent towards gaining disease suppression mechanisms efficient against as many as pathogens (2) environmental manipulation favoring the biological control agent, while suppressing the competitive microflora and (3) developing a mixture of strains with enhanced bio control activity (Helmberger et al., 2018; Janisiewicz, 1988; Learmount et al., 2016; Warnock et al., 2017). Developing a mixture of strains of biological control agents is the most easy and quickest way of alternative control. Several strategies can be considered for obtaining the biocontrol mixtures such as mixing different organisms with various plant colonization mechanisms to control targeted pathogens mixtures or mixtures of antagonists show an optimum performance at various temperature, pH, and moisture conditions for plant colonization.

The search for novel and environment-friendly alternatives to manage RKNs has therefore become increasingly important. Extensive investigations have been conducted over the last twenty years to assess the potential of different biocontrol agents to manage RKNs. However, the biological control agents suffer narrowness of their target pathogens compared to commercial pesticides (Janisiewicz, 1996) and inconsistent performance (Wilson and Backman, 1998). Nonetheless, research efforts have found that nematophgous bacteria are widely distributed, possess diverse modes of action and have broad host ranges (Tian et al., 2007).

Biological control of different plant diseases was focused primarily using bacteria or filamentous fungi (Whipps, 2001). Therefore, application of yeast as biocontrol agents acts as a new method against different pathogens. Potential use of yeasts as biocontrol agents of soil-borne fungal plant pathogens and as plant growth promoters were recently investigated by El- Tarabily et al. (2006). Wide variety of yeasts has been used extensively for the biological control of post-harvest diseases of fruits and vegetables (Punja, 1997; He et al., 2003). Yeasts belonging to the genera *Rhodotorula*, *Crytococcus* and *Saccharomyces* are common components of the soil rhizosphere (Sampedro et al., 2004); thus, can be used for the control of RKNs.

Different organic materials are traditionally used to improve soil fertility and structure. Moreover, these materials are known to control RKNs (Houx et al., 2014). Different pests, including RKNs are being managed by different organic materials, such as animal and green manures and compost in the recent years (Rudolph and DeVetter, 2015; Forge et al., 2016). However, these materials have merely been tested for improving cucumber productivity and suppressing RKNs.

Therefore, the current study was designed to test the efficacy of different organic soil improvers for RKNs suppression and yield improvement of cucumber. It was hypothesized that different soil improvers will suppress the egg sacs and nematode larvae in the soil. Similarly, the soil improvers will improve the growth and yield due to suppressed activities of RKNs. The results of the study will help to find a sustainable management option for RNKs in cucumber.

2. Materials and Methods

2.1. Experimental Site Description

The current study was conducted in the plastic house of Bazian Research Station, Agricultural Research Directorate, Sulaimaniyah, Iraq (54.0745 latitude, 31.3635 longitude and 847 m above sea level).

Table 1. Physicochemical properties of the soil used in the study

Soil Property	Value
Texture	Clay loam
PH	7.3
E.C. (ds/m.)	0.28
N (ppm)	1000
P (ppm)	14.2
K (ppm)	2.34
Ca (ppm)	22
Mg (ppm)	33.6
Na (ppm)	2.3
Cl (ppm)	10.65
$CaCO_3$ (ppm)	270000
HCO_3^- (ppm)	103.7

The soil of the greenhouse was contaminated with *Meloidogyne javanica* nematode. The density of nematodes was recorded before the initiation of the experiment at three different soil depths, i.e., 0-10, 11-20 and 21-30 cm. Nematode larvae were isolated and counted from greenhouse soil by Baermann funnel. The observed larval density was 80, 121, and 93 larva/250 g of soil in 0-10, 11-20 and 21-30 cm soil depth, respectively. The observed nematode larval density was higher than the recommended density for cucumber (50 larva/250 g soil). Moreover, soil sample was collected and analyzed for physical and chemical properties. The physico-chemical properties of the soil are presented in (Table 1).

2.2. Experimental Treatments

Four different soil improvers, i.e., humic acid, commercial dry yeast that contain *Saccharomyces cerevisiae* fungi, rhizobium bacteria and vegetable extract called Nemakey were used in the study along with a control treatment for comparison. Distilled water was used in the control treatment of the study. Humic acid (2 ml plant $^{-1}$) was applied to the soil 10 days before sowing. Commercial dry yeast (*Saccharomyces cerevisiae*) was incorporated to the soil (5 g m^{-2}) at three different stages, i.e., 10 days before sowing, during mid-season and at the end of the season. Rhizobium bacteria was incorporated by planting bean seeds 15 days before the sowing of cucumber and bean plants where harvested at flowering stage from the stem near the soil and removed. Nemakey is plant extract used for strengthening the crops against pathogens in addition to their organic substitutes for nitrogen and potassium. It also helps plants to absorb nutrients. Nemakey was applied to the soil before sowing (1 ml m^{-2}), during first fruiting and in the middle of season.

2.3. Experiment Setup and Design

The experiment was conducted in greenhouse. The seedbed was prepared, and different soil improvers were added to soil as per treatment explained above. The row × row and plant × plant distance was kept 50 and 40 cm, respectively. The experiment was laid out according to completely randomized design with four replications. The crop was kept free from weeds by manual weeding.

2.4. Observations

Data related to growth, allometric traits, yield and quality was recorded. Plant height of ten randomly selected plants from each experimental unit was measured at maturity with the help of measuring tape and averaged. Leaf area was measured at 30 days after sowing with the help of leaf area meter (DT Area meter, Model MK2, Delta T Devices, Cambridge, UK). Fruit length and width of ten randomly selected fruits was measured and averaged to record fruit length and width. Biomass production was recorded at maturity. Five randomly selected plants were harvested, weighed fresh, dried in an oven at 65 ± 5 °C until constant weight and then dry weight was recorded. The total chlorophyll content of fresh leaves was estimated following the method suggested by Barnes et al. (1992). Total chlorophyll was calculated according to the following formula;

$$\text{Total chlorophyll (mg } g^{-1}) = (20.2 \times A_{645}) + (8.02 \times A_{663}) \times \frac{V}{1000 \times W}$$

where, A = absorbance at specific wavelength; V = final volume of chlorophyll extract and W = fresh weight of sample.

Number of egg sacs were computed from three different locations in each experimental unit 30 days after sowing and averaged. Similarly, number of nematode larvae were counted 60 DAS from three different locations and averaged. The number of root nodes were computed from ten randomly selected plants in each experimental unit and averaged. Number of aborted flowers from five randomly selected plants were counted at maturity and averaged. Total yield harvested during the season was computed and averaged.

2.5. Statistical Analysis

The collected data was tested for normality by Shapiro-Wilk normality test. The variables having non-normal distribution were transformed by Arcsine transformation. Fischer's Analysis of Variance (ANOVA) technique was used to test the significance in data. Least significant difference test at 99% probability was used to separate treatments' means where ANOVA indicated significance. Finally, correlation was tested among all measured variables.

Table 2. Analysis of variance of different soil improvers for different yield and quality parameters of cucumber

Parameters	Sum of squares	Mean squares	F Value	P Value
Chlorophyll Contents	19.93	4.98	14.58	0.0004*
Fruit Width	2.20	0.55	22.34	0.0001*
Fruit Length	39.35	9.84	25.44	0.0001*
Number of Larvae	299534.40	74883.60	746.35	0.0001*
Number of Egg Sacs	165.33	41.33	68.89	0.0001*
Number of Aborted Flowers	22.27	5.57	30.48	0.0001*
Number of Days to Harvest	197.60	49.40	6.56	0.0074*
Number of Root Nodes	374.27	93.57	73.87	0.0001*
Peel Thickness	1060.00	265.00	9.91	0.0017*
Total Leaf Area	0.44	0.11	50.83	0.0001*
Total Soluble Solids	7.62	1.90	34.86	0.0001*
Shoot Biomass	3.91	0.98	273.00	0.0001*
Root Biomass	1.08	0.27	140.32	0.0001*
Yield	206.87	51.72	17.70	0.0002*

*=significant at $p \leq 0.01$

3. Results

Different soil improvers significantly influenced all measured variables during the experiment (Table 2). The highest and the lowest leaf area was recorded for Nemakey and control treatments (Table 3). The longest fruits were harvested from Nemakey and Rhizobium treatments, whereas humic acid produced shortest fruits. Rhizobium and humic acid observed the highest fruit width, whereas the lowest fruit width was recorded for commercial dry yeast. The highest and the lowest root biomass was recorded for Nemakey and Rhizobium treatments, respectively. Similarly, Nemakey and commercial dry yeast observed the highest and the lowest shoot biomass, respectively. The highest chlorophyll contents were noted for Nemakey, whereas Rhizobium and commercial dry yeast had the lowest chlorophyll contents during the study (Table 3).

The highest number of egg sacs and larvae were recorded in the control treatment, whereas Nemakey observed the lowest number of egg sacs and larvae (Table 4). Similarly, the highest number of root nodes were noted for Nemakey, whereas the lowest number of root nodes were recorded for control. The highest number of aborted flowers were recorded for control, humic acid and Rhizobium, whereas commercial dry yeast observed the lowest number of aborted flowers. The lowest number of days to reach harvest stage were observed for Nemakey, whereas rest of the treatments taken same number of days to reach harvest. The highest and the lowest yield was recorded for Nemakey and control treatments, respectively (Table 4).

Different growth, allometric and yield related traits exhibited significant positive/negative correlations with each other (Table 5). Chlorophyll contents had negative correlation with number of days to reach harvest, whereas had positive correlation with root biomass, shot biomass and yield. Fruit width was positively correlated with number of aborted flowers. Similarly, fruit length was positively correlated with total leaf area. The number of nematode larvae were positively correlated with the number of egg sacs, days to harvest and root nodes, whereas had negative correlation with total leaf area, root biomass and yield.

Table 3. Effect of different soil improvers on growth, allometric and biochemical traits of cucumber

Treatments	Total Leaf Area (cm^2 $plant^{-1}$)	Root Biomass (g $plant^{-1}$)	Shoot Biomass (g $plant^{-1}$)	Chlorophyll Contents (mg g^{-1})	Fruit Length (cm)	Fruit Width (cm)
Control	1.34 c	2.55 d	4.68 b	41.70 b	15.03 b	3.83 ab
Humic acid	1.23 d	2.78 c	4.75 b	41.55 b	13.33 c	4.03 a
Commercial dry yeast	1.49 b	2.88 b	4.45 c	40.47 c	15.73 b	3.00 c
Rhizobium	1.46 b	2.41 e	4.43 c	39.80 c	17.07 a	4.03 a
Nemakey	1.74 a	3.19 a	5.82 a	43.17 a	18.00 a	3.67 b

Table 4. Effect of different soil improvers on number of egg sacs, number of larvae of Meloidogyne *javanica*, number of root nodes, number of aborted flowers, number of days to harvest and yield of cucumber

Treatments	Number of Egg Sacs of nematode	Number of Larvae of nematode	Number of Root nodes	Number of Aborted Flowers	Number of days to Harvest	Yield ($kg/5m^2$)
Control	12.33 a	446.67 a	3.33 d	8.50 a	62.33 a	50.40 c
Humic acid	7.00 b	156.67 c	6.33 c	9.27 a	61.33 a	55.48 b
Commercial dry yeast	4.67 c	108.67 d	6.00 c	5.80 c	59.67 a	49.37 c
Rhizobium	7.00 b	278.67 b	11.67 b	8.70 a	64.33 a	51.25 c
Nemakey	2.33 d	48.67 e	17.33 a	7.50 b	53.67 b	59.32 a

The number of egg sacs were positively correlated with days to harvest and rot nodes, whereas negatively correlated with total leaf area, root and shoot biomass. Yield was positively correlated with chlorophyll contents, root and shoot biomass, whereas had negative correlation with nematode larvae, days to harvest and root nodes (Table 5).

4. Discussion

The application or manipulation of nematode antagonistic microbes is one area being investigated to find out the alternative to nematicides (Meyer, 2003; Qureshi et al., 2011). Fungi are known to possess a huge diversity of metabolic pathways and they provide several large classes of commercial compounds, including many antibiotics used in medicines. Several compounds with nematicide activity have also been reported from fungi (Li et al., 2007). However, no major commercial product based on these natural fungal compounds has been developed yet (Li et al., 2007). Secondary metabolites from fungi associated with rhizosphere and rhizoplane of crop plants offer an exciting area of research for the discovery of potential nematicide compounds.

The results indicated that different soil improvers suppressed the number of egg sacs and larvae. The suppression in nematode larvae resulted in improvement of growth and yield related traits. However, huge differences were noted among the soil improvers for RKNs suppression and yield improvement. The possible reason of these differences is different nature of the organic soil improvers used in the current study. Several earlier studies have also reported significant differences among soil improvers for suppressing nematode activity (Tejada, 2009; Tabarantab et al., 2011). The results of the current study also contradict with several earlier studies where addition of organic compounds increased the number of nematode larvae in soil. The increase in the activity of nematodes in these studies was related to improvement in root surface area and biomass with the addition of organic manures. These improvements in root biomass and surface area provided more feeding sites for nematodes (Li et al., 2010; Roth et al., 2015; Wang et al., 2006).

Table 5. Correlation among different growth parameters and yield attributes of cucumber

	Chlorophyll Contents	Fruit Width	Fruit Length	Nematode Larvae	Number of Egg Sacs	Number of Aborted Flowers	Days to Harvest	Number of Root Nodes	Total Leaf Area	Shoot Biomass	Root Biomass	Yield
Chlorophyll Contents	**1.00**											
Fruit Width	0.05	**1.00**										
Fruit Length	0.10	-0.11	**1.00**									
Nematode Larvae	-0.28	0.40	-0.25	**1.00**								
Number of Egg Sacs	-0.20	0.36	-0.51	**0.94**	**1.00**							
Number of Aborted Flowers	0.06	**0.89**	-0.33	0.44	0.50	**1.00**						
Days to Harvest	**-0.57**	0.29	-0.34	**0.62**	**0.57**	0.41	**1.00**					
Root Nodes	-0.33	0.36	-0.18	**0.98**	**0.90**	0.38	**0.62**	**1.00**				
Total Leaf Area	0.28	-0.32	**0.88**	**-0.52**	**-0.70**	-0.51	**-0.67**	-0.45	**1.00**			
Shoot Biomass	**0.85**	0.05	0.46	-0.49	**-0.52**	-0.04	**-0.75**	-0.50	**0.65**	**1.00**		
Root Biomass	**0.68**	-0.41	0.27	**-0.81**	**-0.74**	-0.48	**-0.82**	**-0.80**	**0.59**	**0.79**	**1.00**	
Yield	**0.74**	0.32	0.26	**-0.55**	-0.49	0.27	**-0.60**	**-0.58**	0.40	**0.83**	**0.64**	**1.00**

The figures in bold represent significant positive/negative correlation with respective variable(s)

Leaf yellowing, reduced plant height and biomass, decreased chlorophyll contents and low yield are the significant negative effects exerted by RKNs to different crops (Bora and Neog, 2006; Haider et al., 2003; Vovlas et al., 2008; Azam et al., 2011).

The RKNs feed on giant cells which ceases root growth and stops tips to swell, ultimately resulting in reduced root and shoot length (Siddiqui et al., 2014). Although, different soil improvers tended to improve the root and shoot biomass, severe reduction was noted in control treatment of the study. The decreased root and shoot biomass resulted in less nutrient uptake, eventually resulting in stunting and smaller plants. Several studies have reported the stunting of plants by different RKNs species (Ogbuji and Okarfor, 1984; Enopka et al., 1996; Haider et al., 2003; Khan et al., 2006).

Application of humic acid improved the growth and productivity of cucumber in the current study. Antioxidants such as α-tocopherol, α-carotene, superoxide dismutases, and ascorbic acid are improved by the application of humic acid (Sun et al., 2004). These antioxidants may play a role in the regulation of plant development and flowering, which ultimately improve the yield (Ziadi et al., 2001).

The highest chlorophyll contents were recorded with yeast during the study. This increase in photosynthetic pigments' formation could be attributed to the role of yeast cytokinins delaying the aging of leaves by reducing the degradation of chlorophyll and enhancing the protein and RNA synthesis (Shalaby et al., 2008). Antagonistic activity of the ascomycetous yeast strain *Pichia anomala* against *Fusarium spp.* contaminated barley grains was also reported by (Laitila et al., 2007).

Although yield was improved and nematode larvae were lowered by different soil improvers, Nemakey, a commercial organic fertilizer exhibited the highest RKNs suppression and yield improvement. Namakey is composed of plant extracts and oils. Root development is promoted by Nemakey which ensures the formation of healthy root hairs (Ismail et al., 2017). Improved root structure helped the plant to uptake more nutrients, which ultimately improved plant growth and yield. However, the actual mechanism of nematode suppression needs to be explored for Nemakey.

4. Conclusion

The yield improvement and suppression of RKNs indicates the potential of different soil improvers, especially Nemakey for controlling RKNs in cucumber and yield improvement. Nemakey can be efficiently utilized in RKNs contaminated soils for higher cucumber productivity. However, actual mechanism behind RKNs suppression with Nemakey needs to be thoroughly tested. Moreover, the potential for Nemakey for other vegetable crops should also be explored in future studies.

List of Abbreviations: RKNs: Root-knot nematodes, RNA: Ribonucleic acid, ANOVA: Analysis of variance

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Author's Contribution: A. Sürücü designed the experiments and contributed materials and reagents. N.M. Abdulrahman, A.M.A. Mahmud, F.R. Ahmed and J.H. Saeed conducted the experiments and collected data. S. Farooq analyzed the data and wrote the initial draft of the manuscript. All authors read and approved the final draft of the manuscript. A. Sürücü supervised the study.

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EFFECT OF DIFFERENT IRRIGATION SYSTEMS ON IRRIGATION WATER USE EFFICIENCY, GROWTH AND YIELD OF POTATO UNDER BAZIAN CLAY LOAM SOIL CONDITION

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ABSTRACT

A field experiment was conducted at Bazian Agricultural Research Center, Sulaimani governorate in clay loam soil to investigate the effect of different irrigation systems (Furrow "F", Sprinkler "S", Drip "D", and Sub-surface drip irrigation system "SD" with three different depths (10cm-SD_{10},25cm-SD_{25}, and 40cm-SD_{40}) on irrigation water use efficiency, growth and yield of potato (SYLVANA c.v). Results showed that the total amount of water delivered from the source was significantly smaller for (SD_{25}) and (SD_{40}). Maximum water used by potato root and the higher application efficiency were observed by (SD_{25}). There are no significant differences between (SD_{25}) and (SD_{40}) in irrigation water use efficiency IWUE, while the both systems were superior significantly on the other irrigation systems in this trait.

(SD_{25}) recorded the highest value and significantly dominated on other irrigation systems in many growth characteristics of potato. As well as this irrigation system (SD_{25}) was significantly increased potato yield and the percentages of yield increase were 35.5% and 27.6% compared to (F) and (S) respectively. There were no significant differences between (SD_{25}) and (D) in the average of tuber weight, while both treatments were superior significantly on the other irrigation systems. No significant different recorded between (S) and (F) for all growth and yield characteristics. Generally (SD_{25}) gave better results in water use and potato production.

***KEYWORDS**:* Irrigation System, Subsurface-drip, Water use, Potato growth, Yield

INTRODUCTION

Development of irrigated agriculture depends not only on sufficient water available, but also on the suitable irrigation system selection. Selecting an appropriate irrigation method has an effect on economic return through maximizing crop yield while minimizing the irrigation water used. Seckler et al. (Seckler, Amarasingle, Molden, Silva, & Barker, 1998.) Concluded that by developing irrigation processes 50% of the water demand increase can be covered by 2025. There are many well-known irrigation systems, such as border strip, furrow, sprinkler, drip and subsurface drip irrigation system. With increasing water demand sprinkler and drip irrigation methods are play a great role in improving irrigation. In recent years the application of drip irrigation in Iraq has grown up due to installation cost decrease (Badr, Abou Hussein, Al-Tohamy, & Gruda, 2010).

Subsurface drip irrigation system SD is one of the modern irrigation techniques used around the world. In subsurface drip irrigation system irrigation water is applied directly to the root zone, reducing losses due to surface runoff and evaporation. There is also no losses due to deep percolation while a small part of soil will be wetted. Nowadays, due to continues water resource decreases, subsurface drip irrigation required evaluation in order to improve water use efficiency. Installing drip laterals at deeper depth results in the reduction of soil evaporation, in contrast the deep percolations will increase. In sandy loam soils, downward movement of water occurs considerably because gravity force is larger than capillary force. Therefore, it is recommended to place drip laterals at a depth of (10 cm) for potato crop to reduce water losses due to deep percolation (Kumari, 2012).

Subsurface drip predominated surface drip irrigation significantly for potato yield in fields with sandy soil (Ati, Iyada, & Najim, 2012) and maximum average yield was recorded with subsurface lateral drip installed at 15 cm depth compared to 30 and zero cm depths. (Neelam &

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T.B.S., 2006). According to (Bozkurt and Mansuroğlu) the highest lettuce yield was obtained from drip laterals placed at 10 cm depth over zero and 20 cm drip line depth (Bozkurt & Mansuroğlu, 2011) . Onder et al. (Onder, Caliska, Onder, & Caliskan, 2005) concluded that in early potato productions under Mediterranean conditions the subsurface drip did not show considerable preferences on surface drip irrigation, however subsurface drip irrigation method was more expensive and difficult to replace. Ati et al (Ati, Iyada, & Najim, 2012) studied the effect of different irrigation methods and potassium fertilizers on the yield of potato and from the results both furrow and drip irrigation methods didn't have significant effects on tuber yield.

Potato is considered as a major food crop in many countries. It has a shallow root zone with most of its root system lying in the upper 40 cm zone of soil, also the root may extend to (1m) of soil depth. (Ati, Iyada, & Najim, 2012). Potatoes have a lower toleration for water scarcity than most other crops. When the applied irrigation water equaled to the exact water required depending on soil water tension measurement, potato plants had a higher quality/quantity product than if they were under/over irrigated. (Kang, Wang, Liu, & Yuan, 2004)..

The effects of irrigation methods have been widely studied for potato (Kumar, Asrey, Mandal, & Singh, 2009) (Onder, Caliska, Onder, & Caliskan, 2005), (Camp, 1998). In Kurdistan-Iraq, insufficient information about the irrigation water use efficiency and potato yield is available. The application of pressurized irrigation systems in Kurdistan-Iraq is limited. Subsurface drip irrigation system as a special case of drip irrigation system also had not got interest. The vast majority of Iraqi potatoes are furrow irrigated (USAID Iraq). New strategies are required to promote water saving and irrigation system improvement. Moreover under conditions of continuous decreasing of water sources, techniques based on best irrigation method and higher potato yields seem to be reasonably appropriate.

The objective of this study was to assess and compare the effects of different irrigation systems (furrow irrigation, sprinkler irrigation, drip irrigation and subsurface drip irrigation with different depth of drip line placement) on irrigation water use efficiency (IWUE), growth and yield characteristics of potato under Bazian and clay loam soil condition.

MATERIALS AND METHODS

A field experiment was conducted at Bazian Agricultural Research Center during (March to July 2014) located about (20 km) south west of Sulaimani governorate- Kurdistan - Iraq, with latitude (45˚ 07' 54"), longitude (35˚ 36' 31") and an altitude of (842m) above sea level, to evaluate the effect of different irrigation systems from both engineering and agronomic viewpoints. Soil samples were taken from the depth of (0-30 cm) at the location and analyzed in Directorate of Agricultural Research Center, Bakrajo. Some basic soil physical and chemical properties are given in Table (1).The experiment location characterized by Mediterian climate (Al-Ansari, 2013), the meteorological data during the growing season were collected and summarized in (Table 2).

Table(1):- Some physical and chemical properties of the experiment soil

Soil texture	E.C. $ds.m^{-1}$	PH	N%	Available P Ppm	Soluble K^+ $meq.l^{-1}$	Soluble Na^+ $meq.l^{-1}$	Soluble Ca^+ $meq.l^{-1}$	Soluble Mg^+ $meq.l^{-1}$	Cl $meq.l^{-1}$	O.M. %	$CaCO_3$ %	HCO_3 $meq.l^{-1}$	CO_3 $meq.l^{-1}$
Clay loam	0.28	7.7	0.14	15.18	0.10	0.17	1.9	3.6	0.4	2.06	27.1	1.7	0.3

Table(2): Some meteorological data of the experiment location during the study period

Month	Average Temperature (˚C)	Average relative humidity (%)	Average wind speed ($Km.\ h^{-1}$)	Average sunshine duration (h)	Rainfall (mm)
March	13.65	55.3	1.78	5.6	24.4
April	17.94	50.5	1.31	7.9	19.2
May	25.90	26.3	1.45	8.9	3.3
June	27.90	20.9	1.65	11.8	1.4

July	31.76	11.2	1.96	12.2	0

Water used for irrigation was taken from a local well. The irrigation water was tested and the results (Table 3) showed that its quality was within the acceptable limits.

Table (3): Irrigation water test results

E.C. ($ds.m^{-1}$)	PH	SolubleK$^+$ ($meq.l^{-1}$)	SolubleNa$^+$($meq.l^{-1}$)	Soluble Ca^+($meq.l^{-1}$)	SolubleMg$^+$($meq.l^{-1}$)	HCO_3 ($meq.l^{-1}$)	CO_3 ($meq.l^{-1}$)
0.4	7.2	0.012	0.12	3	1.2	4.5	0.7

The field was plowed twice across each other and the experimental plots were prepared manually. Each plot measured 8.10 m^2 (3.00 * 2.70 m) and contained 30 plants spaced (0.90 * 0.30 m), plots were separated 2 m from each other. The potato cultivar used was SYLVANA, originating from the Netherlands. The tubers were planted manually, at a depth of 15 cm on March 3, 2014, and harvested on July 1, 2014. Standard agricultural practices such as fertilization, weeding, disease and pest control were carried out uniformly during the growing season for all treatments. All plots received basic application of 260 $kg.ha^{-1}$ Urea (46% N), 160 $kg.ha^{-1}$ Di-ammonium Phosphate (18% N and 46% P_2O_5) and 180 $kg.ha^{-1}$ Potassium Sulfate (50% K and 17% S). Before the potatoes emerge, the same amount of water with the same frequency were applied to all of the treatment plots in order to guarantee a uniform germination (Wang, et al., 2011).Irrigation done depending on available water holding capacity using Tensiometers installed at (30) cm soil depth and used to monitor soil moisture content. All irrigations scheduled to be start when the moisture content drops below (50%) of available water holding capacity.

The experiment consisted of (6) treatments:

(F): Traditional furrow irrigation system, irrigation done by traditional surface irrigation method which is considered as control treatment.

(D): Drip irrigation system, the drip line was placed in the experimental plot on the soil surface. The lateral pipes were 20 mm in diameter. The drippers were twin wall, 30 cm dripper spacing, and (6 ℓ. h^{-1}) flow rate.

(SD_{10}), (SD_{25}) and (SD_{40}): these treatments are consisted of drip irrigation system with drip lines buried to depths of (10, 25, and 40 cm) respectively, this method is symbolized as (SD) for irrigation type and (SD_{10}, SD_{25}, and SD_{40}) referring to lateral line depths of (10, 25, and 40 cm) respectively.

(S): Solid set sprinkler irrigation method with one lateral line. The sprinkler spacing was about %40 of wetted diameter. The sprinkler used was characterized as (H-RB20, Nozzle 2.4 mm, operation head 2.5 bar, application rate 20 mm. h^{-1}). Sprinkler are set on riser of (70) cm height.

Experimental design was Randomized Complete Block Design (RCBD) with three replications. Data were analyzed by a computer program (XLSTAT Pro 7.5.3. 2005) and the comparisons among means were carried out by Duncan's Multiple Range test at $P \leq 0.05$ (Al-Rawi & Khalafulla, 1980). Each replication consisted of six experimental units and treatments were arranged randomly.

Measurements have been made in two aspects, engineering and agronomic. The following measurements for engineering aspect were done (delivered water from the source, total evaporation, deep percolation, water used by crop root, application efficiency and irrigation water use efficiency).

The field application efficiency was calculated by dividing water depth that is consumed by a crop relative to the depth of applied water (Bekele & Tilahun, 2006).

$$E_a = \frac{Water\ depth\ used\ by\ crop\ root\ (cm)}{Water\ depth\ applied\ in\ the\ field\ (cm)} * 100 \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Irrigation water use efficiency (IWUE) was calculated by dividing the yield obtained per unit of irrigation by total water applied, The IWUE was calculated from the following equation: (Ati, Iyada, & Najim, 2012):

$$\text{IWUE} = \left(\frac{\text{Total yield (kg)}}{\text{Total water applied } (m^3)}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

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For agronomic analysis; the following parameters were recorded from five plants and the means were recorded: root length (cm), plant height (cm), Stem diameter (mm), number of leaves per plant, leaf area (cm^2), leaf Chlorophyll content ($mg.\ g^{-1}$ fresh weight), number of tubers per plant, tuber weight (g), yield ($g\ plant^{-1}$).

RESULTS AND DISCUSSION

Effect of different irrigation systems on different water use measurements of potato are given in (Table 4) and (Figure 1). The experiment resulted in significant ($P \leq 0.05$) difference in all irrigation systems on all measured parameters. The total amounts of water delivered from the source during the growing season were significantly higher for furrow (F) and sprinkler irrigation systems (S) with values of (2100 and 1850 liter) respectively, while the lowest amount was measured by (SD_{40}) and equaled (1010 liter) which was not differed significantly with (SD_{25}).Water losses due to evaporation was large for furrow (F) and sprinkler irrigation systems (S), since the furrow irrigation system has no potential to save irrigation water by reducing wetted soil surface and sprinkler drops are exposed to sunlight and wind. Moreover adding small amount of water prevented deep percolation except in furrow irrigation due to large amount of irrigation water added (Trautmann & Porter , 2012). Number of irrigations for the total growth season were maximum for furrow (F) and sprinkler systems (S) and minimum Drip irrigation systems. There were no significant differences between the irrigation systems (Drip "D", Sub-surface drips "SDs" and Sprinkler "S") in the depth of water used by potato roots while all of them superior significantly on the furrow system. There are not significant differences between all drip (D) and subsurface drip irrigation systems (SDs) in the application efficiency, while they were superior significantly on the furrow (F) and sprinkler irrigation systems (S) in this trait. The higher application efficiency was observed by (SD_{25}) which was equal to 88% and the lowest value gave by furrow system (F) which was equal to 52%. The subsurface drip irrigation system (SD_{25}) resulted in the highest value of IWUE (12.387 $kg.\ m^{-3}$) which was superior significantly over furrow, drip and sprinkler irrigation systems, whereas the percentage of increase was (161, 55.5 and 115.5%) respectively. A sample of IWUE calculation is given in the following (Furrow method given as an example):

$$\text{Total yield per plot (kg/plot)} = \text{Average yield per plant} * \text{Number of plants per plot}$$

$$\text{Average yield per plant} = 375.1\,\frac{\text{gm}}{\text{plant}} \text{ from Table (6)}$$

$$\text{Average yield per plant} = 0.3751\,\frac{\text{kg}}{\text{plant}}$$

$$\text{Total number of plants per plot} = 30 \text{ plants/plot}$$

$$\text{Total yield per plot (kg/plot)} = 0.3751 * 30 = 11.253 \text{ kg/plot}$$

$$\text{Total water applied} = 2100 \text{ Liter, from Table (4),}$$

$$\text{Total water applied} = 2.1\ m^3$$

$$\text{IWUE} = \left(\frac{\text{Total yield (kg)}}{\text{Total water applied } (m^3)}\right)$$

$$\text{IWUE} = \left(\frac{11.253\text{(kg)}}{2.1\ (m^3)}\right) = 5.36\ kg/m^3$$

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Table(4):- Different water used measurements for different irrigation systems

Irrigation systems	Delivered water from the source (ℓ)	Total Evaporation (cm)	Deep percolation (cm)	Number of Irrigations	Water used by crop root (cm)	Application efficiency (%)	IWUE $kg.m^{-3}$	IWUE Increase of SD_{25}%
F	2100 a	25.1	4.8	12	40 b	52 c	5.363 d	161
D	1480 b	0	0	10	49.1 a	60 a	9.123 bc	55.5
SD_{10}	1350 bc	0	0	11	47.4 a	74 a	9.213 b	52
SD_{25}	1100 cd	0	0	9	49.3 a	88 a	14.007 a	0
SD_{40}	1010 d	0	0	9	48.2 a	87 a	12.387 a	13.8
S	1850 a	15.3	0	12	46 a	66 b	6.50 cd	115.5

Means with different letters are significantly different according to Duncan's multiple ranges test at P≤0.05

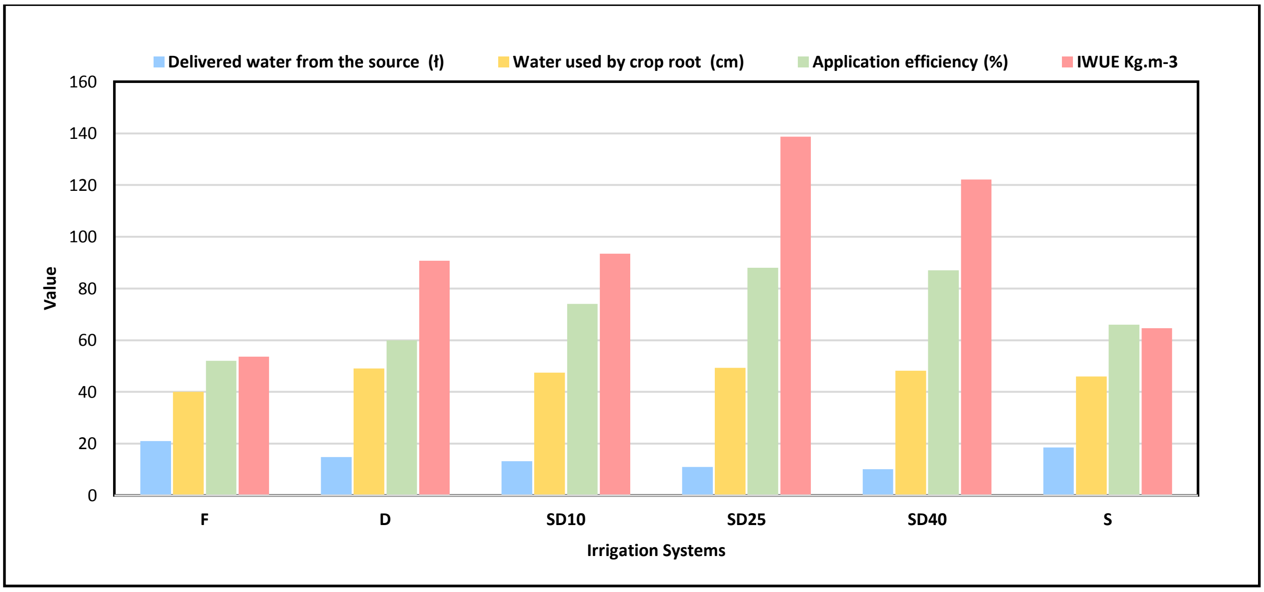

Fig. (1): Comparing parameters for different irrigation systems-For the purpose of clarifying; Delivered water from the source was divided by (100) and IWUE was multiplied by (10)

Comparing the results of agronomic characteristics, Table (5) shows that there were differences among different irrigation systems for potato plant growth. Subsurface drip irrigation system (SD_{25}) was superior significantly over furrow system (F) in root length, plant height, stem diameter and number of leaves per plant by (33.9, 31.7, 60.4 and 25.2%) respectively. while, mean of leaf area was not affected significantly by different irrigation systems. Drip irrigation system (D) gave the highest value of total chlorophyll content in leaves (44.87 $mg.g^{-1}$) and dominates significantly over furrow (F) and sprinkler irrigation systems (S) by (20.7 and 19.7%) respectively. Sprinkler irrigation system (S) was not different significantly from the furrow system (F) with regard to in all growth characteristics.

Table (5):- Effect of different irrigation systems on potato growth (SYLVANA c.v)

Irrigation Systems	Root length (cm)	Plant height (cm)	Stem diameter (mm)	No. of leaves $plant^{-1}$	Leaf area (cm^2)	Leaf chlorophyll content (mg g^{-1})
F	50.10 b	79.10 c	10.10 c	145.2 c	54.37 a	37.17 b
D	63.20 ab	91.77 b	14.20 ab	168.2 b	52.60 a	44.87 a
SD_{10}	54.30 b	84.20 bc	10.30 c	159.3 b	51.13 a	39.91 ab
SD_{25}	67.10 a	104.20 a	16.20 a	181.8 a	57.60 a	39.21 ab
SD_{40}	53.20 b	85.10 bc	11.10 bc	171.0 ab	53.33 a	40.33 ab
S	51.20 b	80.20 c	10.10 c	138.8 c	49.07 a	37.47 b

Means with different letters are significantly different according to Duncan's multiple ranges test at P≤0.05

Table (6) represented the influence of different irrigation methods on yield parameters of potato. The data revealed that subsurface drip irrigation system (SD_{25}) was significantly increased potato yield if compared to all other irrigation methods, whereas the percentages of yield increase were 35.5% and 27.6% compared to furrow (F) and sprinkler irrigation systems (S) respectively. The ability of (SD_{25}) to improve tubers yield could be attributed to the better performance under subsurface drip that can maintain a favorable soil water status in the root zone, which in turn helped the plants to utilize moisture as well as nutrients more efficiently from the limited wetted area. Moreover an advantage of burring the lateral drip lines at 25 cm is that the lateral depth is sufficient to avoid damage from tillage or other equipment but shallow enough to wet the root zone without wetting the soil surface (Abou Lila T.S. et al, 2013) .

Subsurface drip irrigation (SD_{25}) has led to increase the mean of tubers weight (101.6 g), due to the role played by this irrigation system to improving the root and vegetative growth of plants (root length, plant height, stem diameter, number of leaves, leaf chlorophyll content and leaf area of the plant) which are leads to increases ability of the plant to form tubers more larger sizes and then increasing the plant yield. Sprinkler irrigation system (S) was used to record the largest number of tuber per plant (6.1) which it is not differ significantly with other irrigation systems except drip irrigation (D). Also, sprinkler irrigation method (S) was not different significantly from the furrow system (F) in all yield traits.

Table(6): -Effect of different irrigation systems on potato yield (SYLVANA c.v)

Irrigation Systems	Yield (g $plant^{-1}$)	Tubers weight (g)	No. of tubers $plant^{-1}$
F	375.10 c	66.97 b	5.7 ab
D	447.30 b	99.40 a	4.5 b
SD_{10}	412.50 bc	73.60 b	5.6 ab
SD_{25}	508.40 a	101.60 a	5.0 ab
SD_{40}	411.40 bc	77.60 b	5.3 ab
S	398.40 c	66.40 b	6.1 a

Means with different letters are significantly different according to Duncan's multiple ranges test at P≤0.05

Depending on the results and discussions of this field study, it can be concluded that the (SD_{25}) method offers considerable advantage for both yield and IWUE of potato. It seems to optimize the use of water in potato production under situations of water shortage then could be recommended for irrigation of potato crop under the Mediterranean climate of Kurdistan-Iraq with the possibility to reduce supply of limited water availability.

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Effect of Some Agroecosystems Management Applications on Plant Flowering and Root-Knot Nematodes Activates Using Some Soil Improvements in Greenhouses

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Abstract: The present work implementation was achieved in Tainal watershed, Bazian city, west of Sulaimaniyah, north of Iraq. A total of 30% of greenhouse soils were infected with root-knot nematodes and most of these soils were not fertile. In location N35.750, E45.354, the research, in epidemic soil with nematodes, was done by making an analysis for water quality and soil fertility as well as nematode infections before any application. Four types of soil improvements (biological improvement like dry yeast *Saccharomyces cerevisiae* with two concentrations, biofertilizers, organic matter like humic acid and extract for plant and fungi residue called Nemakey) were used. These treatments were applied in a factorial R.C.B.D. design on cucumber plant (SAIF F1) with triplication. Each unit contained 18 cucumber plants. Statistical analysis was done by XLSTAT program. The results showed that using dry yeast (10 g/ l) had significant differences ($P \leq 0.05$) on the abortive flowers, number of nematode larvae and egg masses, galls and total suspended solids (TSS). Biofertilizers exerted significant differences ($P \leq 0.05$) on the nematode activity in all stages (larvae, egg mass and galls). Humic acid resulted in significant differences ($P \leq 0.05$) on the flower setting.

Keywords: Agroecosystems management, Soil improvements, Non-chemical fertilizers, Root-knot nematode, Cucumber flowering.

Introduction

Use of yeasts as bio-fertilizers in agriculture has received considerable attention because of their bioactivity and safety for human and the environment. The application of the yeasts significantly ($P<0.05$) increased the photosynthetic pigments, soluble sugars, sucrose and total soluble proteins of sugar beet (Agami et al., 2012). Taha et al. (2016) showed that spraying neem plants with yeast extract at 15% significantly increased growth parameters (plants height and both fresh and dry weights of both stem and root) and enhanced total chlorophyll, phosphorus, potassium and total soluble sugars content. Using the concentration of 5% of dry yeast extracts gave the highest values.

Altering cultural management practices such as crop rotation may be an effective method to suppress insect and disease pressure while maintaining yields. Modern agriculture favors shorter crop rotations for ease of management and perceived higher profits. However, this practice allows polyphagia's pests to sustain populations between ideal hosts (Cassman et al., 2011). On longer term, more diverse crop rotations have long been effectively used to prevent pests. Rotations that include fewer favorable hosts can interrupt resource requisites in time and/ or space, such as position sites or highly nutritious food sources, which may limit the success of insect populations as well as reduce virus incidence. Soils under longer crop rotations have also been shown to suppress soil-borne pathogens, including fungi and nematodes (Abawi & Widmer 2000). Successful management of a plant virus and its vector may require a broad approach with multiple changes in cultural practices, such as crop

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rotation and nutrient management (Sasser, 1972). Bagheri et al. (2017) showed that interactions observed in the synthetic must, were upheld in the natural must fermentations, suggesting the broad applicability of the observed ecosystem dynamics. Importantly, the presence of indigenous yeast populations did not appear to affect the broad interaction patterns between the consortium species.

Results of a research made an organic and synthetic fertility amendments influence soil microbial, physical and chemical properties the yields being higher on farms with sort of organic production, regardless of soil amendment type (Bulluck et al., 2002). Alternative fertility amendments, enhanced beneficial soil microorganisms, decreased pathogen populations, increased soil organic matter, total carbon and cation exchange capacity (CEC) and lowered bulk density thus improving soil quality (Barker et al., 2000; Agamy et al., 2013).

Many soils of greenhouses in different places in Bazian area suffered from infections with root-knot nematodes. Cucumber is highly susceptible to *Meloidogyne* spp. and considerable plant damaged and yield loss occurs worldwide. For instance, root-knot nematode is the most economically important cucumber disease in north of Iraq. Nematodes are wormlike invertebrate animals found in marine, freshwater and terrestrial habitats depending on the species. Nematodes might feed on a variety of organisms, including plants, other nematodes and their eggs, fungi, protozoans, bacteria and insect larvae (Freckman & Caswell, 1985).

Bacterial fertilizers are preparation of living bacteria which are applied to improve soil (Bowman, & Sayler, 1996). So, the theoretical idea of the present study depends on the interrelationship between plant, water and soil, which are the natural resources that human use positively or negatively to maintain soil fertility from exhaustion and inhibit nematode activity. This research depends on using some applications of agroecosystem management to protect the triangle natural resources (soil, water and plants).

Materials and Methods

Bazian city is located in northeast of Iraq, 20 km. southwest of Sulaimaniyah governorate, 35N latitude and 45E longitude. It is a big and important agriculture area which contains at least 4000 greenhouses. It is located at a level which reaches 837-847 m above sea surface level. Table (1) shows the climate data for Bazian station.

Table 1: Average climate data for Bazian city for the period from February till July 2016.

Months	Temperature (ºC)			Rain precipitation (mm.)	Wind speed (M/ hr.)	Humidity (%)	Sun hours	Pressure (Mb)
	Max.	Min.	Avg.					
Feb.	15	4	11	69.5	6.5	59	73	1021.1
Mar.	17	6	15	175.4	10.5	47	106.3	1015.1
April	24	10	20	73.9	9.4	38	136	1013.1
May	30	17	25	19.9	11.4	23	146	1010.5
June	37	21	31	3.8	12.3	16	149.8	1007.4
July	42.1	25	34.5	0	11.6	13	155	1002.8

Table 2: Soil analysis for soil samples before the research.

Analysis Element	Soil texture	E.C. ds. m.	pH	N%	Available P (ppm)	K^+ (meq/ l)	Na^+ (meq/ l)	Ca^+ (meq/ l)	Mg^+ (meq/ l)	Cl meq /l	o.m %	$CaCO_3$ %	HCO_3 meq/ l	CO^{-3}
Before	Clay loam	0.28	7.76	0.14	15.18	0.10	0.17	1.9	3.6	0.4	2.06	27	1.7	0.3

Research properties in the greenhouses

Research design R.C.B.D., no. of treatments 7, no. of replications 3, distance of treatments 5 m, width of terraces 1 m, area of plot 5 m^2, distance between plots 1 m, no. of sow lines in treatments 2 in a zigzag way, distance between two plants 40 cm, no. of guard line 2, numbers of plants in each plot 18 cucumbers plants, no. of plants selected for parameters and data 10, distance between each feed line 40 cm, cucumber variety SAIF F1, excel program used statistical analysis X.L.STAT.

Methods

1. Control which uses only water (T1).
2. Use of compost component of humic acid (T2):
- Addition to the soil an amount of 1 mm/ plant before planting for 7 days.
- Addition to the soil an amount of 1 mm/ plant by fertigation.
- Addition to the soil an amount of 1 mm/ plant after planting for 15 days.
- Addition to the soil an amount of 1 mm/ plant during the flowering.
- Addition to the soil an amount of 1 mm/ plant at the first fruit.
- Addition to the soil an amount of 1 mm/ plant after a month.
- Addition to the soil an amount of 1 mm/ plant after two months of production.
- Addition to the soil an amount of 1 mm/ plant after three months of production.
3. Biological fertilizer (infoxgen) (T3): Addition to the soil was in following stages:
- With planting when watering by addition of 25 g/ l water (1.38 g/ plant).
- After the planting (for 20 days) in the same concentration (1.38 g/ plant).
- Directly after the first harvest in a concentration of 30 g/ l water (1.66 g/ plant).
- A month after the first harvest in a concentration of 30 g/ l water (1.66 g/ plant).
- Two months after first harvest in a concentration of 30 g/ l water (1.66 g/ plant).
4. Yeast (*Saccharomyces cerevisiae*) of yeast bread (Commercial dry yeast):
- Addition to the soil with a concentrations of 5 g/ l (277.77 mg/ plant) as T4.
- Addition to the soil with a concentrations of 10 g/ l (555.55 mg/ plant) as T5.
- In the first stage was before planting by 7 days, in the second stage in the middle of the season and the third stage before the end of the season in one month.

A- N.P.K. addition of the chemical fertilizer (20: 20: 20) after transplanting with one week, starting with 1 g/ plant each week until the harvest. After that, it was applied as 1.5 g/ plant (T6).

B- Nemakey vegetable extracts (T7) was used at a rate of 1 mm/ m^2 one week before planting and after the first setting in the same rate as well as in the middle of the harvest.

Water supply and controlling amounts of irrigations

As water is one of the most precious natural resource components and agroecosystem elements, it must be kept from any losses. In the present research, the analysis of water of a well, which was good for irrigation, is demonstrated in table (3).

Table 3: Analysis for water used in irrigation.

E.C. ds.m.	pH	Soluble K+ (meq/ l)	Soluble Na+ (meq/ l)	Soluble Ca+ (meq/ l)	Soluble Mg+ (meq/ l)
0.4	7.2	0.012	0.12	3	1.2

The analysis showed that the electrical conductivity (total concentration of salts dissolved in irrigation water) is suitable for irrigation. The value of the soluble sodium percentage (SSP) was 2.77%, which is less than the critical value specified by the US Salinity Research Laboratory. The value of sodium adsorption ratio (SAR) and values of the Ca, Mg and Na of irrigation water (0.0272) is very suitable as the US Salinity Research Laboratory. Extended to water salinity, the residual sodium carbonate (RSC) was 1 meq/ l and is within the allowable limits. Either Magnesium ratio (28.57%) is very suitable because it is less than the 50% allowed, Calcium in the value of irrigation water was 3 meq/ l and is within the permissible (less than 10 meq/ l). To control the amounts of water which was used to irrigate the plants, tensionmeters (irrometers) were applied by using a 16 mm dripper pip for the sub lateral lines that feed the plants with 6 l/ hr. water with a distance of 40 cm between each dripper.

Soil sample taking for nematode analysis

Sampling was followed in the end of August after the summer season which is the best time for nematode samples from 20-25 cm by using clean and sterilize shovel. Sampling of Root-Plant Sample was followed for analysis. Root samples from the effected plants in greenhouses were cut. The wet weight was taken for these samples.

Table 4: Procedure of nematodes analysis.

No.	Materials	Procedure and Source
1	20-mesh sieve (833 µm aperture)	Howard Ferris, Departments of Entomology and Nematology, University of California Zuckerman et al. (1981)
2	200-mesh sieve (74 µm aperture)	
3	325-mesh sieve (43 µm aperture)	
4	Coarse sieve (1 cm aperture)	
5	Two stainless steel bowls or plastic buckets	
6	250 ml beaker, 600 ml beaker	
7	Coarse spray wash bottle or tube attached to faucet	

Results and Discussion

Table (5) shows that using humic acid (1 mm/ plant), bioferitlizer (25 g/ l water) and yeast (10 g/ l) exerted a significant difference effect on flowering operation and chlorophyll ratio. Also, using yeast (10 g/ l) had a significant difference effect on numbers of aborted flowers. Biological fertilizer achieved a significant difference effect on numbers of setting flowers.

In the present study, the yeast *S. cerevisiae* had a role as bioferitlizer. Yeast, as fertilizer, increased the nitrogen and phosphorus content of roots and shoots of cucumber. Yeast addition to the soil also increased the root-to-shoot ratio and induced species-specific morphological changes which included increased tillering in sugarcane and greater shoot biomass in tomato plant (Lonhienne et al., 2014). Adding yeast as a soil amendment increased the nitrogen (N) and phosphorus (P) contents. Yeast addition to soil also increased the root-to-shoot ratio. These findings support the notion that brewers "yeasts" are a cost-effective bioferitlizer which improve not only plant nutrition, but also plant vigor during the early growth phase (Lonhienne et al., 2014).

Table 5: Effect of soil amendments on flowering operation and chlorophyll ratio.

Treatment	Chlorophyll ratio	No. aborted flowers	No. of setting flowers	No. of total flowers
Control	38^{b}	7^{b}	17^{c}	24^{a}
Humic acid (1 mm/ plant)	40.33^{a}	4^{b}	15^{d}	23^{a}
Bioferitlizer (25 g/ l water)	41^{a}	6^{bc}	29^{a}	27^{a}
Yeast (5 g/ l)	38.6^{b}	4^{bc}	23^{b}	27^{a}
Yeast (10 g/ l)	41.3^{a}	1^{a}	21^{bc}	22^{a}
NPK (1 g/ plant)	37.6^{b}	7^{bc}	21^{bc}	28^{a}
Nemakey (1 mm/ m^2)	38.3^{b}	8^{c}	20^{bc}	26^{a}

Means with different letters are significantly different according to Duncan's multiple ranges test at P≤0.05.

Number of nematode larvae in soil, egg masses and number of galls were significantly different among treatments as shown in table (6).

Table 6: Effect of fertilizer on nematodes.

Treatments	No. larvae/ 250 g soil	No. egg masses/ plant	No. galls/ plant
Control	430^{d}	12^{b}	18^{d}
Humic acid (1 mm/ plant)	48^{a}	3^{a}	3^{a}
Bioferitlizer (25 g/ l water)	$94a^{b}$	4^{a}	4^{ab}
Yeast (5 g/ l)	105^{ab}	6^{a}	6^{ab}
Yeast (10 g/ l)	70^{a}	3^{a}	3^{a}
NPK (1g/ plant)	278^{c}	6^{a}	11^{b}
Nemakey (1 mm/ m^2)	156^{b}	7^{b}	8^{c}

Means with different letters are significantly different according to Duncan's multiple ranges at P≤0.05.

S. cerevisiae caused significant differences in numbers of nematode larvae, similar to the nematicides, when applied as a rhizosphere soil. Different yeast strains are promising bio-control agents for different crops root knot nematode infection, which reduced nematode reproduction and increased plant growth parameters. The yeast was more affective at 10 g/ l. Furthermore, the application of *S. cerevisiae* resulted in improving yields and increasing fruit yield (Hussain & Khalaf, 2007; Karajeh, 2013). Karam et al. (2012) used dry yeast as bioferitlizer. There was a high degree of inconsistency in plant growth response and tissue nutrient contents of treated plants.

The environmental pollution, costliness of synthetic pesticides and chemical control will no longer hold future in sustainable agricultural production, thus, justifying attempts by previous workers to develop non-chemical alternative control technologies using organic substances (Adegbite & Adesiyan, 2005; Renčo et al., 2007; Atungwu & Kehinde, 2008). Addition and maintenance of organic matter, spatially the active fraction, will improve the physical, chemical and biological properties of soil against specific pathogens and their resultant disease. Total soil nematodes and plant parasitic nematodes are spatially affected by organic matter (Widmer et al., 2002) and might be due to the fact that bread yeast induces nutrient minerals absorption through improvement of soil pH to acidity (Pawter et al., 1985).

The significant effect of biofertilizers may be due to the fact that they have a positive effect on chemical composition in leaves in any agroecosystems by providing nutrients to the plants and in some cases to provide plants with some promoting growth regulators. In addition, biofertilizers increase microorganisms living in the soil and these microorganisms work on the organic matter in the soil to convert organic N to mineral N (Lampkin, 1990; Bargaz et al., 2018).

Figures 1 and 2 show that the treatment with the yeast reduces number of nematode larvae and number of galls/ root.

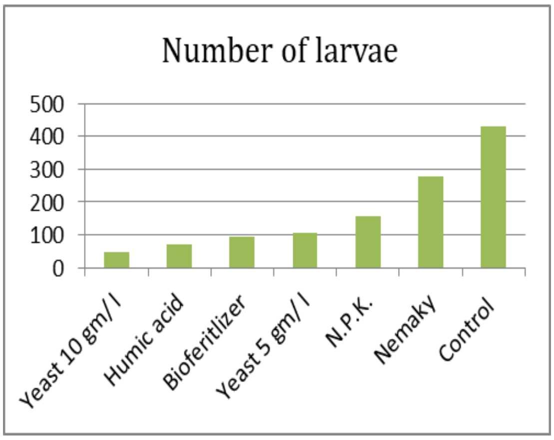

Figure 1: Effect of soil amendments on number of larvae.

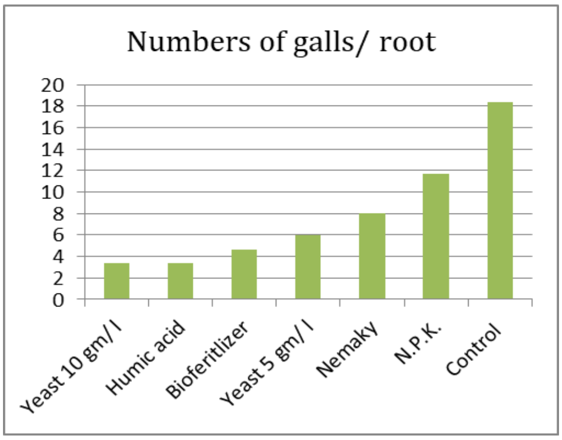

Figure 2: Effect of soil amendments on numbers of galls/ root.

The mechanism of yeast bio-control activity may involve competition for nutrients site exclusion parasitism and induced resistance and/ or make physical and chemical soil properties changes clear (Noweer & Hasabo 2005). The yeast *S. cerevisiae* as well as the nematicides Ethoprophos when applied as a rhizospheric soil drench treatment led to an obvious reduction of root galling caused by the nematode *Meloidogyne javanica* and resulted in reducing the nematode reproduction ability on cucumber (Karajeh, 2013). Noweer & Hasabo (2005) found that the effect of yeast on *M. incognita* might be due to the activity of *S. cerevisiae* to convert carbohydrates to ethyl alcohol and CO_2 toxic to nematodes. Increase in number and weight of fruits in treatments is partially due to the effect of the tested materials on the nematode; besides its role in plant nutrition as suggested by Akhtar & Alam (1990).

The treatments of yeast increased number of egg masses/ root and decrease the T.S.S. as observed in figures 3 and 4, respectively. The process that occurred in dry yeast produces CO_2 in high quantity, a factor that may increase photosynthesis and consequently plant growth. The high content of dry yeast from vitamin B5 and minerals might play a considerable role in orientation and translocation of metabolites from leaves into the productive organs (Mohamed et al., 1999). The application of *S. cerevisiae* could suppress population of *M. javanica* and root gall formation on cucumber through its effects on nematode infection and reproduction and through inducing plant resistance and enhancing fruit production of cucumber (Agami et al., 2012).

The treatments of yeast increased number of egg masses/ root and decrease the T.S.S. as observed in figures 3 and 4, respectively.

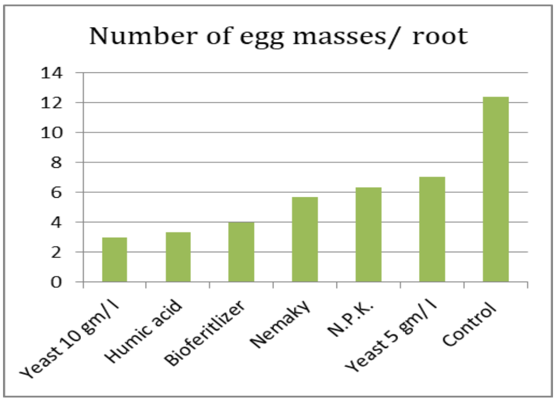

Figure 3: Effect of soil amendments on number of egg masses/ root.

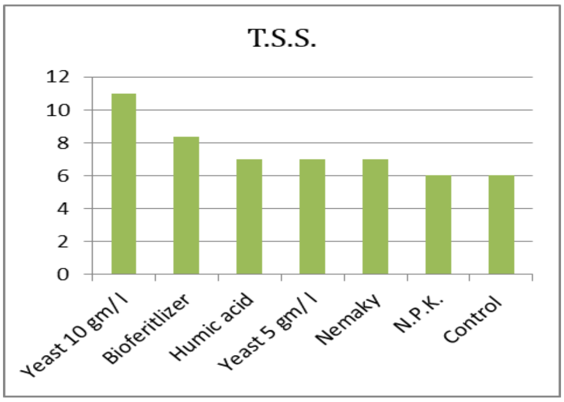

Figure 4: Effect of soil amendments on total soluble sugars.

High content of total phenolic compounds in cucumber roots treated with *S. cerevisiae* gave the ability to resistance and soil application of the yeast enhanced cucumber plant and root fresh and dry weight and fruit yield. Yeasts were able to enhance growth and increase tissue nutrient contents of marigold (Azzam et al., 2012). The pronounced increase in cucumber growth and fruit yield of *S. cerevisiae* treated plants may be due to the indirect effect of the yeast on the nematode infection; besides the yeast direct role in promoting plant growth and development (Akhtar & Alam, 1990). The application of the yeast *S. cerevisiae* could suppress population of *M. javanica* and root gall formation on cucumber through its effects on nematode infection and reproduction and through inducing plant resistance and enhancing fruit production of cucumber (Agami et al., 2012). Organically-amended soil may change the physical properties of soil, which in turn may adversely affect the nematode behavior, such as hatching, movement and survival. The biofertilizers further improve soil fertility through nitrogen fixation, thus supplement additional nitrogen, which might be detrimental to the population of nematodes. Phosphates are known to reduce soil pH, which has an adverse effect on nematode multiplication (Pant et al., 1983). The dry yeast solution treatment (6 g/ l) increased T.S.S. (Hussain & Khalaf, 2007). Taha et al. (2016) reported that most of dry yeast extracts treatments caused significant increase in total soluble sugars. Total soluble sugars of the present investigation are generally in agreement with those reported by some investigators (Abd El-Naby, 1998; Abd-El-Fattah & Sorial, 2000; El-Mansi et al., 2000; Shiboob, 2000). Figures 5 and 6 demonstrate the significant effect of the yeast on chlorophyll in leaf (mg/ wet plant weight) and reducing the abortive flowers/ 5 m^2.

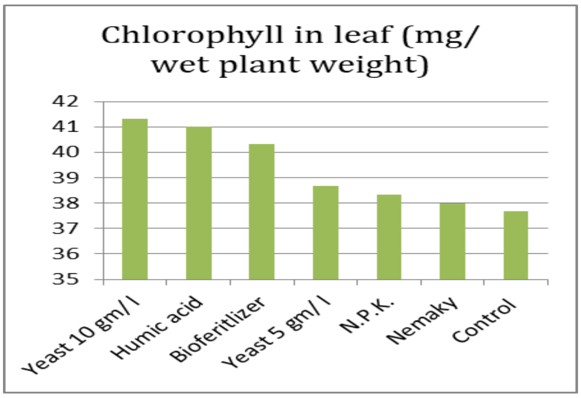

Figure 5: Effect of soil amendments on chlorophyll in leaf.

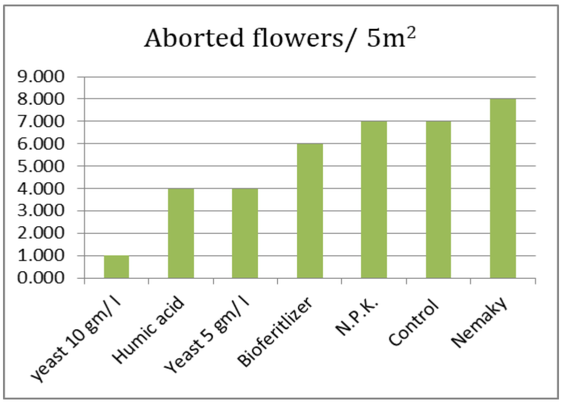

Figure 6: Effect of soil amendments on aborted flowers.

From figure 6, a significant difference with using yeast (10 g/ l concentration) on chlorophyll ratio in leaf is due to its influence on the nutritional signal transduction producing growth regulators and suppressing pathogen (Amer, 2004; El-Tohamy & El-Greadly, 2007). Sarhan et al. (2011) found that using yeast extract and humic acid gave a significant result on amounts of chlorophyll in eggplant by increasing the total chlorophyll amounts in the plant. Abbasniayzare et al. (2012) found that the biofertilizers have a significant effect on flowering in comparing with the control. Mady (2009) discovered through his escapement on faba bean that using dry yeast as a biological fertilizer has a significant difference on the total flower. Ali et al. (2014) found that the yeast had a positive effect on *Geranium* plant in characteristics of flowering growth (numbers and widths).

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تأثير موعد الزراعة وتغطية التربة بالبلاستيك الاسود في النمو الزهري والحاصل لهجين الباذنجان (JAWAHER-F1) داخل البيوت البلاستيكية

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الخلاصة

اجري البحث في البيت البلاستيكي التابع لمديرية البحوث الزراعية في بكره جو / السليمانية خلال الموسم الزراعي 2012 بهدف دراسة تأثير ثلاث مواعيد لزراعة البذور وهي (1/15 و 2/15 و 2012/3/15) وتغطية التربة بالبلاستيك الاسود والتداخل بينهما في النمو الزهري والحاصل لهجين الباذنجان (JAWAHER-F1). أظهرت النتائج ان الموعد الاول للزراعة لم تختلف معنوياً مع الموعد الثاني في صفات معدل عدد الازهار الكلية والازهار المجهضة لكل نبات ونسبة الأزهار العاقدة وكذلك بعض صفات الحاصل ومنها الحاصل الكلي ومعدل وزن الثمرة الواحدة، ولكن تفوقا معنوياً على الموعد الثالث في كثير من الصفات المدروسة. ان معاملة تغطية التربة بالبلاستيك الاسود تميزت بتحسين جميع الصفات المدروسة الخاصة بالنمو الزهري والحاصل الكلي والحاصل المبكر ومعدل عدد الثمار للنبات الواحد . ان الموعدين الاول والثاني للزراعة وتداخلهما مع تغطية التربة بالبلاستيك لم تختلفا معنوياً فيما بينهما ولكن تفوقا وأعطيا أعلى قيمة في كثير من الصفات المدروسة قياساً بالمعاملات التوافقية الاخرى.

الكلمات المفتاحية: باذنجان و موعد الزراعة و تغطية التربة و النمو الزهري و الحاصل.

المقدمة

يعد الباذنجان Eggplant أحد محاصيل الخضر التابعة للعائلة الباذنجانية Solanaceae، واسمه العلمي (*Solanum melongena* L.). يعتقد بأن هذا المحصول قد نشأ أولاً في المناطق الحارة في كل من الهند والصين اذ ينمو فيهما برياً (حسن، 2001). وهوأحد الخضراوات واسعة الانتشار في الكثير من بقاع العالم وعلى وجه الخصوص في المناطق الاستوائية وشبه الاستوائية ومناطق حوض البحر الابيض المتوسط، كما انه يعد أحد الخضر الصيفية المهمة في العراق اذ ان الباذنجان يتمتع بأهمية غذائية واقتصادية كما انه يعد نباتاً طبياً في العديد من دول العالم، اذ يستخدم كدواء لعلاج كل من داء السكري والتهاب القصبات والربو وحالات الأسهال الشديد (Daunay وآخرون، 2000)، ويستخدم أيضاً في خفض نسبة الكوليسترول في الدم (Nisha وآخرون، 2009 و Daunay وآخرون، 2000).

يعد موعد الزراعة من العوامل المحددة لانتاج ونجاح المحصول أو أخفاقه، ويتحدد موعد الزراعة المناسب بدرجات الحرارة السائدة والرطوبة النسبية وطول فترة الاضاءة وشدة الاشعاع وغير ذلك من العوامل في موقع الزراعة .ان أفضل درجة الحرارة لمحصول الباذنجان داخل البيوت المحمية هي 25-30°م في الأيام المشمسة ومابين 20-22°م في الأيام الغائمة، أما درجة الحرارة ليلاً فيجب أن لا تقل عن 16°مفي الجو الغائم نهاراً وعن 20°م في الجو المشمس، وان لا تقل الرطوبة النسبية داخل البيت عن 60-70% (بوراس وآخرون، 1999)، الا ان ارتفاع درجة حرارة البيت في النهار الى 37-40°م وانخفاض الرطوبة النسبية عن الحدود المشار اليها وخاصة في مرحلة التزهير التي تنتج غالباً عن شدة السطوع الشمسي تزيد من تعرض النبات لتساقط الازهار نتيجة لإحتراق المتوك في الأزهار، ونقص نسبة إنبات حبوب اللقاح وضعف نمو الأنابيب اللقاحية (Sanwal وآخرون، 1997). كما أشار مهدي وآخرون، (2009) عن سعدالدين، (2000) ان موعد الزراعة يحدد المدة الزمنية التي يستغرقها النبات في الوصول الى مرحلة معينة من النمو وهذا له أهمية زراعية كبيرة. لذا من الضروري وضع برنامج لتحديد موعد

الزراعة لكل منطقة حسب الظروف المناخية السائدة لتلك المنطقة، وذلك لأن نتائج موقع جغرافي أو بيئي معين لايمكن تعميمها على المواقع البيئية الاخرى.

تعد تغطية التربة Soil Mulching من التقانات المستعملة على نطاق واسع من قبل المزارعين ولاسيماً في الدول المتقدمة زراعياً فهي فضلاً عن كونها طبقة واقية تحمي التربة من عوامل البيئة

تاريخ تسلم البحث 2014/12/15 وقبوله 2015/4/28

المختلفة، اذ تعمل على تحسين ظروف التربة وتجهيز المواد العضوية لها، وتهيئة بيئة جيدة لنمو المجموع الجذري للنبات، وتؤدي الى امكانية رفع درجة حرارة التربة الى عمق 15 سم (Gordon وآخرون، 2008 و Tarara، 2000). كما تعمل التغطية على تقليل التباين في درجات الحرارة بين الليل والنهار وحفظ رطوبة التربة وتقليل تبخر الماء من سطح التربة، ومنع تكوين القشرة الصلبة(Soil crust) على سطح التربة (محمد والريس، 1982). كذلك تسهم التغطية في تقليل تكاليف الانتاج والمكافحة (Lamont، 1993) بالاضافة الى خفض الاستهلاك المائي. أشارShrivastava وآخرون، (1994) ان التغطية بالبلاستيك الاسود تعمل على توفير 95% من تكاليف مكافحة الادغال وزيادة محصول الطماطة بنسبة 53% مع توفير 44% من مياه الري مقارنة بمعاملة المقارنة. وأشار Pessarakli وDris، (2004) و Farghali، (1994) ان استعمال أغطية التربة البلاستيكية السوداء أو البيضاء أدى الى زيادة المحصول المبكر والمحصول الكلي للباذنجان، مع زيادة في النمو الخضري للنباتات. كما وجد بلدية، (2009) في دراسته ان معاملة تغطية التربة بالبلاستيك الاسود تعمل على زيادة كفاءة عملية الري بالتنقيط وتحد من تملح التربة وتعمل على تنظيم درجة حرارة التربة وبالتالي تؤدي الى التبكير في الإنتاج والحاصل الكلي للباذنجان بمعدل 41.4%.

نظراً لأهمية موعد الزراعةوالدور الايجابي لعملية تغطية التربة بالبلاستيك، وبسبب ندرة الدراسات والابحاث المنشورة على هذين العاملين وخصوصاً على محصول الباذنجان في محافظة السليمانية، وضعت فكرة هذا البحث لدراسة تأثير ثلاث مواعيد للزراعة وتغطية التربة بالبلاستيك الاسود والتداخل بينهما في بعض صفات النمو الزهري والحاصل لهجين الباذنجان (JAWAHER-F1).

مواد وطرائق البحث

نفذت التجربة في بيت بلاستيكي مساحته 450 م^2 (50م × 9م) التابع لحقول مديرية البحوث الزراعية في السليمانية للفترة من 15-01-2012 الى 18-12-2012. تم تنظيف البيت البلاستيكي من الادغال ومن بقايا نباتات الموسم السابق، ثم حرثت الارض بالمحراث القلاب حرثاً عميقاً وبعدها تم تنعيم وتسوية التربة باستعمال آلة الروتيفيتر. تم ترك مسافة 60 سم على جانبي البيت البلاستيكي ثم قسمت المسافة المتبقية الى 5 مساطب عرض كل منها 1 م والمسافة بين مسطبة واخرى 70 سم ثم وزعت الوحدات التجريبية على المساطب طول كل منها 4 م والمسافة بين وحدة واخرى 1 م. واضيف السماد الكيمياوي DAP الى المساطب بمعدل 200 كغم/هكتار. وأخيراً تم نصب أنابيب الري بالتنقيط من نوع GR (أنبوبتين لكل مسطبة والمسافة بين المنقطات كانت 40 سم) وهكذا أصبح البيت مهيئ للزراعة، بعد ذلك تم اخذ عينات عشوائية من تربة الحقل واجريت بعض التحاليل عليها في مختبرات قسم التربة والمياه / مديرية البحوث الزراعية في السليمانية، ويبين جدول (1) نتائج هذه التحاليل. كما يبين الجدول (2) المعدلات الشهرية لدرجات الحرارة العظمى والصغرى والرطوبة النسبية من زراعة البذور الى نهاية الموسم داخل وخارج البيت البلاستيكي.

تضمنت التجربة المعاملات التالية :

المعاملة الاولى: مواعيد الزراعة للبذور ويرمز بـ (A):

أ- الموعد الاول A1: 2012/01/15

ب- الموعد الثاني A2: 2012/02/15

ج- الموعد الثالث A3: 2012/03/15

المعاملة الثانية: التغطية ويرمز بـ (B):

أ- معاملة المقارنة (بدون تغطية) B1

ب- تغطية التربة بالبلاستيك الأسود (استخدمت طبقة واحدة من البولي أثلين، سمكه 80 مايكرون) B2

تم زراعة بذور هجين الباذنجان JAWAHER -F1 حسب المواعيد المقررة المشار اليها مسبقاً داخل نفق بلاستيكي مرتفع ومدفأ في صواني فلينية خاصة بإنتاج الشتلات تحتوي على 80 خلية ملئت بالبيتموس فقط، وبعد وصول الشتلات الى عمر فسيولوجي مناسب (4-5 أوراق حقيقية) اختيرت الشتلات القوية والمتجانسة بالحجم، وتم نقلها الى الوحدات التجريبية في البيت البلاستيكي وذلك بعد مرور 70 و 66 و 53 يوماً من زراعة البذور، حيث زرعت الشتلات على جهتي المسطبة بشكل متبادل مع ترك 80 سم بين شتلة واخرى وهكذا بلغ عدد الشتلات في الوحدة التجريبية الواحدة 10 شتلات (خمس شتلات على كل جانب من جانبي الوحدة التجريبية). وبعد مرور أسبوع من زراعة الشتلات أجريت عملية الترقيع للشتلات حسب الحاجة .

وقد اجريت كافة عمليات الخدمة الزراعية بعد الشتل حسب الطرق المتبعة داخل البيوت البلاستيكية وبشكل متماثل لجميع المعاملات، اذ تم تربية النباتات على ساقين رئيسيين وعلى شكل حرف (Y). وتم ري النباتات حسب الحاجة واستخدم نظام التبريد بالرذاذ بهدف تلطيف جو البيت وزيادة الرطوبة النسبية في أوقات الجفاف وخاصة عند الظهيرة. وتم مكافحة النباتات من الاصابات الحشرية والمرضية بمجرد ظهور علاماتها الاولية وبالطرق المناسبة في حينها.

نفذت التجربة العاملية وفق تصميم القطاعات العشوائية الكاملة (RCBD–Factorial) وبثلاثة مكررات ، ووزعت المعاملات عشوائياً ضمن كل مكرر، وتمت مقارنة المتوسطات حسب إختبار دنكن متعدد الحدود على مستوى إحتمال 5%. واستعمل البرنامج الحاسوبي XLSTAT في التحليل الاحصائي للبيانات.

الصفات المدروسة: تم تحديد 6 نباتات عشوائياً من كل وحدة تجريبية وتم حساب معدل الصفات التالية عليها:

1- عدد الأزهار المجهضة / نبات: تم حساب معدل عدد الأزهار المجهضة للنباتات الستة المختارةفي كل وحدة تجريبية من بداية التزهير والى نهاية الموسم وذلك من خلال عَد الأزهار التي لم تعقد ثماراً ومن ثم تم حساب المعدل.

2- عدد الأزهار الكلية / نبات: تم حسابها وذلك بأخذ متوسط عدد الأزهار المجهضة والأزهار العاقدة في النباتات الستة في كل وحدة تجريبية .

3- نسبة الأزهار العاقدة (%): تم حسابها حسب المعادلة التالية:

نسبة الأزهار العاقدة (%) = [معدل عددالأزهار العاقدة (معدل عدد الثمار) / معدل عدد الأزهار المتكونة على النبات الواحد] × 100.

4- عدد الايام اللازمة لتزهير 50% من النباتات: تم حسابه بتحديد عدد الايام اللازمة من زراعة البذور ولحين تزهير نصف عدد النباتات المختارة في كل وحدة تجريبية (3 نباتات).

5- حاصل النبات الواحد (كغم): تم جمع الحاصل خلال الفترة من (2012/06/07) إلى (2012/12/18) وبلغ عدد الجنيات 30 و 29 و 27 جنية حسب المواعيد الزراعية. تم حساب الوزن الكلي للثمار الناتجة من النباتات الستة في الوحدة التجريبية الواحدة ومن ثم أخذ متوسط حاصل النبات الواحد بالكيلوغرام.

6- الحاصل المبكر (كغم/نبات): أعتبرت الجنيات السبعة الاولى من كل وحدة تجريبية كحاصل مبكر.

7- معدل عدد الثمار/نبات: تم حساب معدل عدد الثمار لكل نبات من النباتات الستة ولجميع الوحدات التجريبية وذلك من بداية موسم الجني وحتى نهايته.

8- معدل وزن الثمرة (غم): تم حساب متوسط وزن الثمرة الواحدة وذلك بتقسيم الوزن الكلي لثمار النباتات الستة المختارة في كل وحدة تجريبية على عدد الثمار الكلي لنفس النباتات.
9- معدل عدد البذور/ثمرة: تم اخذ ثمرة واحدة بوزن 200 غم تقريبا في كل وحدة تجريبية ولعشر مرات من جني الحاصل وقطعت طولياً الى 8 مقاطع وحسبت اعداد البذور فيها ثم استخرج معدلها.

جدول (1): بعض الصفات الكيمياوية والفيزياوية لتربة البيت البلاستيكي قبل الزراعة

الصفات	Sand $gm.kg^{-1}$	Silt $gm.kg^{-1}$	Clay $gm.kg^{-1}$	Texture	pH	EC $ds.m^{-1}$	O.M $gm.kg^{-1}$	Total N $mg.kg^{-1}$	Available P $mg.kg^{-1}$	Soluble K $mg.kg^{-1}$	$CaCO_3$ $gm.kg^{-1}$
القيمة	151.3	485.1	363.6	SCL	7.1	0.52	7.5	1.2	2.4	98.3	225

جدول (2): المعدلات الشهرية لدرجات الحرارة العظمى والصغرى والرطوبة النسبية من زراعة البذور إلى نهاية الموسم داخل وخارج البيت البلاستيكي

التأريخ	داخل البيت البلاستيكي				خارج البيت البلاستيكي			
	درجة الحرارة ($م^0$)		الرطوبة النسبية %R.H		درجة الحرارة ($م^0$)		الرطوبة النسبية %R.H	
	العظمى	الصغرى	العظمى	الصغرى	العظمى	الصغرى	العظمى	الصغرى
كانون الثاني	19.7	15.1	82.4	61.5	8.5	3.4	84.7	54.5
شباط	24.4	16.8	79.3	50.8	14.1	6.2	80.8	48.2
آذار	28.6	17.5	77.2	44.8	18.2	8.7	74.8	26.1
نيسان	27.2	12.0	90.7	37.2	25.3	9.4	72.6	20.5
مايس	31.1	18.1	72.9	34.7	29.1	15.4	68.3	20.1
حزيران	40.5	23.5	37.2	18.3	37.3	20.6	30.2	8.0
تموز	45.3	26.7	30.4	13.8	41.6	24.5	26.4	6.9
آب	45.9	27.9	32.5	14.2	41.9	24.4	27.9	9.0
أيلول	41.1	21.3	37.3	16.0	37.7	18.5	35.2	10.8
تشرين الأول	33.4	17.5	63.9	20.6	29.6	14.0	37.7	13.5
تشرين الثاني	24.9	12.0	87.1	60.1	21.5	9.9	83.6	40.9
كانون الأول	16.8	7.4	96.1	62.3	13.5	3.2	72.0	34.3

النتائج والمناقشة

أولاً: تأثير موعد الزراعة وتغطية التربة بالبلاستيك الاسود والتداخل بينهما في بعض صفات النمو الزهري:

يلاحظ من الجدول (3) تفوق كل من الموعدين الاول (1/15) والثاني (2/15) معنوياً على الموعد الثالث (3/15) في صفات عدد الازهار المتكونة والمجهضة ونسبة الازهار العاقدة في النبات الواحد في حين لم يظهر أي اختلاف معنوي بينهما في الصفات أعلاه، فقد أدى الموعد الاول الى زيادة عدد الازهار الكلية بنسبة 34.1% وتقليل عدد الازهار المجهضة بنسبة 34% وزيادة نسبة الازهار العاقدة بمقدار

15.3% قياساً بالموعد الثالث وكذلك الحال بالنسبة للموعد الثاني الذي تفوق معنويا على الموعد الثالث في الصفات أعلاه بنسبة 31.8 و 28.3 و 13.7% على التوالي، وقد يعزى السبب الى الدرجات الحرارة والرطوبة النسبية الملائمة داخل البيت في فترة تزهير موعدي الاول والثاني (شهر مايس) مقارنة بفترة تزهير الموعد الثالث (شهر حزيران) كما موضح في الجدول (2)، إذ أشار بوراس وآخرون، (1999) ان أفضل درجة حرارة لمحصول الباذنجان داخل البيوت المحمية هي 25-30°م في الأيام المشمسة ومابين 20-22°م في الأيام الغائمة، ورطوبة نسبية لاتقل عن 60-70%، الا ان ارتفاع درجة الحرارة وانخفاض الرطوبة النسبية عن الحدود المشار اليها وخاصة في مرحلة التزهير يؤدي الى تشكل كمية كبيرة من الأزهار غير كاملة التكوين وغير قادرة على الاخصاب والعقد وهذا مايتسبب في سقوطها . كما يلاحظ أيضاً تفوق معنوي للموعد الثالث في تقليل عدد الايام اللازمة لتزهير نصف النباتات قياساً بالموعدين الاول والثاني وربما يعود السبب الى الدرجات الحرارة العالية نسبياً في فترة النمو الخضري لشتلات هذا الموعد (شهر مايس) نسبة الى الموعدين الآخرين (شهر نيسان). حيث عبرتا النمو الخضري وكانتا في موعد التزهير.

وأشار نفس الجدول الى أن معاملة تغطية التربة بالبلاستيك الاسود زادت معنوياً من عدد الازهار المتكونة على النبات الواحد بنسبة 11.1% وقللت عدد الازهار المجهضة بنسبة 17.4% وزادت من نسبة الازهار العاقدة بفرق 5.8% وكان عدد الأيام اللازمة لتزهير 50% من النباتات في معاملة التغطية أقل بـ 12 يوم من معاملة المقارنة (بدون تغطية التربة). وربما يعزى سبب تفوق معاملة تغطية التربة بالبلاستيك إلى دورها في تحسين بعض الخواص الكيمياوية والفيزياوية والحيوية للتربة، إذ تساعد على رفع درجة حرارة التربة والمحافظة على رطوبتها ومنع تصلب سطحها وتحسين تهويتها، وهذه العوامل مجتمعة قد تزيد من النشاط البيولوجي للكائنات الحية الدقيقة الموجودة في التربة مثل الـ (Actinomycetes) والـ(Nitrosomonas) والـ(Nitrobacter) التي تقوم بتحويل المواد العضوية الى النترات (NO_3^{-1}) وهي الصورة النايتروجينية الصالحة للامتصاص من قبل النبات (Hankin وآخرون، 1982). اضافة الى دورها في زيادة جاهزية الكثير من العناصر الغذائية وتشجيع نمو الجذور وزيادة قدرتها على امتصاص الماءوالعناصر الغذائية، كما يزداد أيضاً معدل استخدام النايتروجين في تكوين البروتينات التي تعمل على تسريع عملية النمو. وهذه العوامل مهمة جداً للتبكير في التزهير وزيادة عدد الازهار ورفع نسبة عقدها (Wien وآخرون، 1993).

أما فيما يتعلق بالتداخل فنلاحظ من الجدول أن أفضل معاملتين هما الزراعة في الموعد الاول والثاني (1/15 و 2/15) مع تغطية التربة بالبلاستيك (A1B2 و A2B2) إذ أدتا الى زيادة عدد الازهار المتكونة (124 و 122 زهرة/نبات) وتقليل عدد الأزهار المجهضة (16 و 17 زهرة مجهضة / نبات) وزيادة نسبة الأزهار العاقدة (87.10% و 86.07%) على التوالي بدون حدوث فروقات معنوية بينهما في حين أدت الزراعة في الموعد الثالث (3/15) مع تغطية التربة بالبلاستيك (A3B2) الى تقليل عدد الايام اللازمة للتزهير 50%من النباتات إذ بلغت 82 يوم وبفرق معنوي عن المعاملات التوافقية الاخرى.

جدول (3): تأثير موعد الزراعة وتغطية التربة بالبلاستيك الاسود والتداخل بينهما في صفات النمو الزهري

موعد الزراعة	التغطية	عدد الازهار /نبات	عدد الازهار المجهضة /نبات	نسبة الازهار العاقدة (%)	عدد الايام اللازمة لتزهير 50% من النباتات
1/15		118.00 a	17.5 a	85.17 a	121.0 c
2/15		116.00 a	19.0 a	83.62 a	102.5 b
3/15		88.00 b	26.5 b	69.89 b	88.5 a

	بدون تغطية التربة (المقارنة)	101.67 b	23 b	77.38 b	110.0 b
	تغطية التربة بالبلاستيك الاسود	113.00 a	19 a	83.19 a	98.0 a
1/15	بدون تغطية التربة (المقارنة)B1	112.00. b	19 a	83.04 ab	127.0 d
(A1)	تغطية التربة بالبلاستيك الاسود B2	124.00 a	16 a	87.10 a	115.0 c
2/15	بدون تغطية التربة (المقارنة)B1	110.00 b	21 ab	80.91 b	108.0 c
(A2)	تغطية التربة بالبلاستيك الاسود B2	122.00 a	17 a	86.07 a	97.0 b
3/15	بدون تغطية التربة (المقارنة) B1	83.00 d	29 c	65.06 d	95.0 b
(A3)	تغطية التربة بالبلاستيك الاسودB2	93.00 c	24 b	74.19 c	82.0 a

المتوسطات في العمود الواحد ذات الاحرف غير المتشابهة تختلف معنوياً حسب اختبار دنكن عند مستوى إحتمال 5%.

ثانياَ: تأثير موعد الزراعة وتغطية التربة بالبلاستيك الاسود والتداخل بينهما في بعض صفات الحاصل:

يظهر من الجدول (4) ان الزراعة في المواعيد الثلاثة قد أدت الى حدوث اختلافات معنوية في صفات الحاصل بإستثناء معدل وزن الثمرة التي لم تظهر فيها أي اختلافات معنوية، وقد أدى الموعد الأول (1/15) الى حدوث زيادة معنوية في صفات كل من حاصل النبات الواحد والحاصل المبكر ومعدل عدد الثمار للنبات الواحد بنسبة 63.8 و 236.8 و 63.4% على التوالي قياساً بالموعد الثالث (3/15) أما نسبة الزيادة في الموعد الثاني (2/15) لنفس الصفات مقارنة بالموعد الثالث فقد كانت 60 و174.6 و 57.7% على التوالي. وقد يعود السبب الى العوامل المناخية وخاصة درجات الحرارة والرطوبة النسبية في موعدي الاول والثاني للزراعة إذ كانت أكثر مناسبة في مراحلبداية التزهير وعقد الثمار مقارنة بالموعد الثالث، وتسبب ذلك تشجيع عملية التزهير وتقليل ظاهرة الاجهاض (Abortion) ورفع نسبة عقد الازهار(الجدول 3) وبالتالي أدت الى زيادة عدد الثمار وكمية الحاصل المبكر والحاصل الكلي للنبات الواحد. وأشار العديد من الباحثين الى ان كلا من صفتي معدل عدد الثمار للنبات ومعدل وزن الثمرة الواحدة لهما اهمية كبرى في التحقق عن مستوى الاداء الحقلي لأي نبات مثمر وذلك لكونهما من المكونات الرئيسية للحاصل الكلي في وحدة المساحة أو للنبات الواحد، وهذه تعطي فكرة واضحة عن القدرة الانتاجية للنبات، وفي ظروف هذه التجربة قد ترجع زيادة كمية الحاصل الى زيادة عدد الثمار وليست الى أوزانها.

أدت الزراعة في المواعيد المبكرة الى تقليل معدل عدد البذور في الثمار اذ ان الموعد الاول قلله بنسبة 10.6 و 28.1% مقارنة بالموعد الثاني والثالث، كما ان الموعد الثاني تفوق على الموعد الثالث في تقليل هذه الصفة بنسبة 19.49%.

جدول (4): تأثير موعد الزراعة في صفات الحاصل

موعد الزراعة	حاصل النبات الوحد (كغم)	الحاصل المبكر (كغم / نبات)	عدد الثمار / نبات	وزن الثمرة الواحدة (غم)	عدد البذور / ثمرة
1/15	14.467 a	5.507 a	100.5 a	144.1 a	168.0 a
2/15	14.125 a	4.490 b	97.0 b	145.8 a	188.0 b
3/15	8.830 b	1.635 c	61.5 c	145.2 a	233.5 c

المتوسطات في العمود الواحد ذات الاحرف غير المتشابهة تختلف معنوياً حسب اختبار دنكن عند مستوى إحتمال 5%.

يوضح الجدول (5) ان معاملة تغطية التربة بالبلاستيك الاسود أدت الى زيادة معنوية في صفات حاصل النبات الواحد، الحاصل المبكر ومعدل عدد الثمار للنبات الواحد بنسب 20 و 25 و 19.5% على التوالي قياساَ بمعاملة المقارنة (بدون تغطية التربة). ولم يتأثر صفتي معدل وزن الثمرة الواحدة ومعدل عدد البذور معنوياً بالمعاملة. ويعزى سبب ذلك الى ان هذه التقنية قد أدت الى التبكير في الإزهار ورفع نسبة الازهار العاقدة وخفض عدد الازهار المجهضة للنبات الواحد (الجدول 3). إذ أشار كثير من الدراسات ومنها Read، (2007) بان التغطية قد تؤثر على رفع حرارة التربة إذ لا تقل أهميتها عن حرارة الهواء في تأثيره على سرعة العمليات الفسيولوجية والحيوية وبالتالي الانتاج. أو ربما يعود السبب الى ان عملية تغطية التربة تعمل على خزن غاز ثاني أوكسيد الكربون الذي يتمركز قرب المناطق السفلى للنباتات من خلال

الثقوب التي تخرج منها النباتات مما أدى الى زيادة كفاءة عملية البناء الضوئي وتراكم الكربوهيدرات مما شجع النباتات على التزهير بصورة مبكرة وسرعة تطور ونمو ثمارها وزيادة حاصلها (الدوغجي وآخرون، 2008 وعلي، 2001).

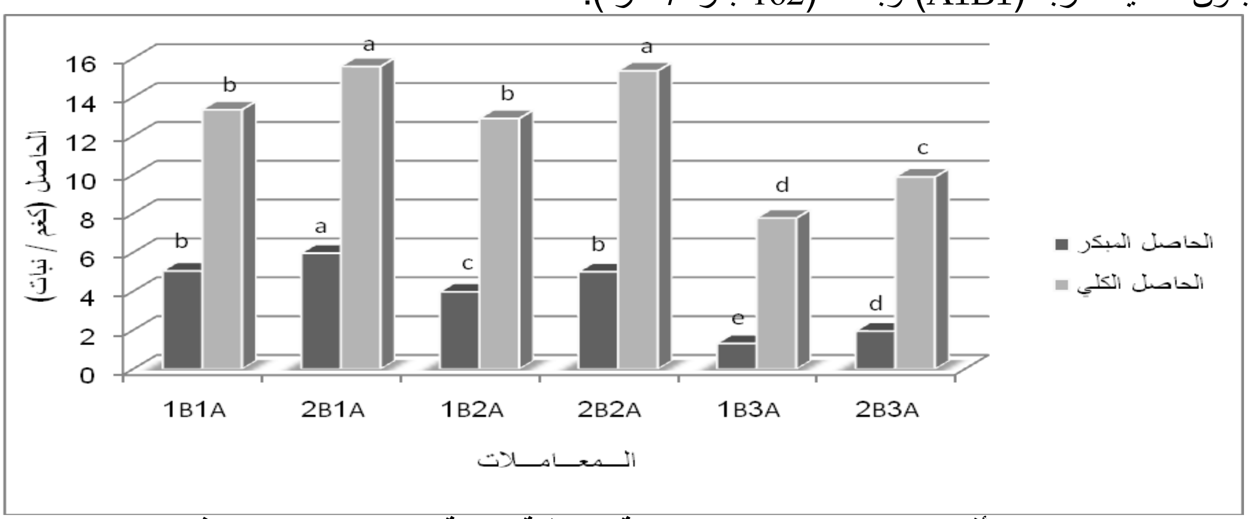
جدول (5): تأثير تغطية التربة بالبلاستيك الاسود في صفات الحاصل

التغطية	حاصل النبات الوحد (كغم)	الحاصل المبكر (كغم / نبات)	عدد الثمار / نبات	وزن الثمرة الواحدة (غم)	عدد البذور / ثمرة
بدون تغطية التربة (المقارنة)	11.341 b	3.446 b	78.67 b	145.3 a	202.67 a
تغطية التربة بالبلاستيك الاسود	13.607 a	4.309 a	94.0 a	144.8 a	190.33 a

المتوسطات في العمود الواحد ذات الاحرف غير المتشابهة تختلف معنوياً حسب اختبار دنكن عند مستوى إحتمال 5%.

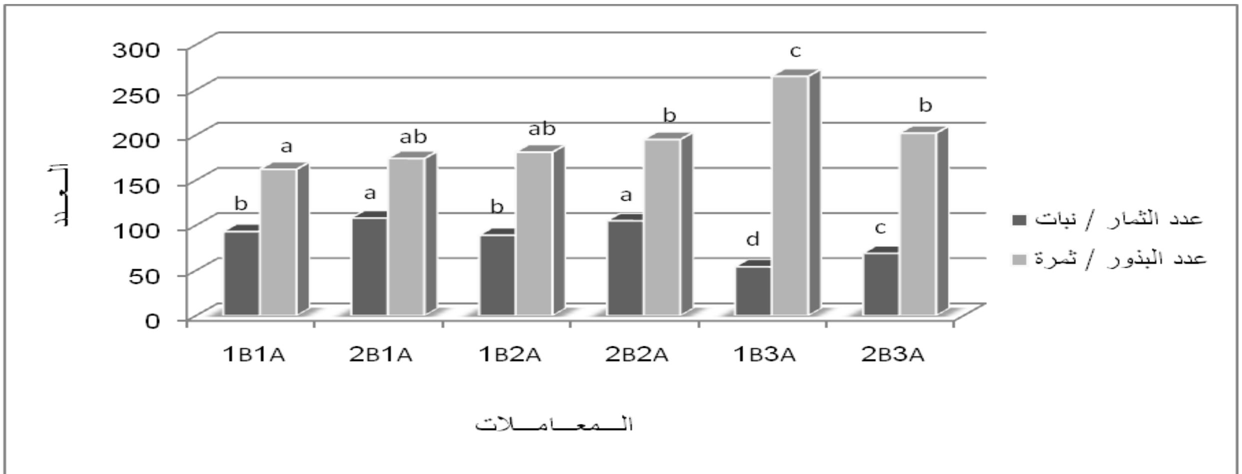
أما بالنسبة لتأثير التداخل بين العاملين ، فان النتائج الواردة في الشكل (1) تشير الى ان التداخلات قد أثرت معنوياً في صفتي حاصل النبات الواحد والحاصل المبكر، اذ أعطت معاملة التداخل بين الزراعة في الموعد الاول (1/15) مع تغطية التربة بالبلاستيك الاسود (A1B2) أعلى قيمة لهتين الصفتين وبلغت (15.580 و 5.976 كغم/نبات) على التوالي، في حين لم توجد فروقات معنوية بين هذه المعاملة ومعاملة تداخل الزراعة في الموعد الثاني مع تغطية التربة بالبلاستيك (A2B2) في صفة الحاصل الكلي.

كما يلاحظ من الشكل (2) ان أعلى معدل لصفة عدد الثمار في النبات الواحد قد نتج عن الزراعة في الموعدين الاول (1/15) والثاني (2/15) وتداخلهما مع تغطية التربة بالبلاستيك (A1B2 و A2B2) اذ لم تختلفا معنوياً فيما بينهما ولكنهما تفوقا على جميع المعاملات التوافقية الاخرى وأعطيا (108 و 105 ثمرة / نبات) على التوالي، بينما أقل عدد من الثمار لكل نبات (54 ثمرة / نبات) وأعلى عدد من البذور في الثمرة الواحدة (265 بذرة / ثمرة) ناتجة من معاملة الموعد الثالث بدون تغطية التربة (A3B1). اما أقل عدد من البذور في الثمرة الواحدة فكانت ناتج من المعاملة التوافقية المكونة من الزراعة في الموعد الاول (1/15) بدون تغطية التربة (A1B1) وبلغت (162 بذرة / ثمرة).



الشكل (1): تأثير التداخل بين موعد الزراعة وتغطية التربة بالبلاستيك الاسود في صفتي حاصل النبات الواحد والحاصل المبكر (كغم / نبات)

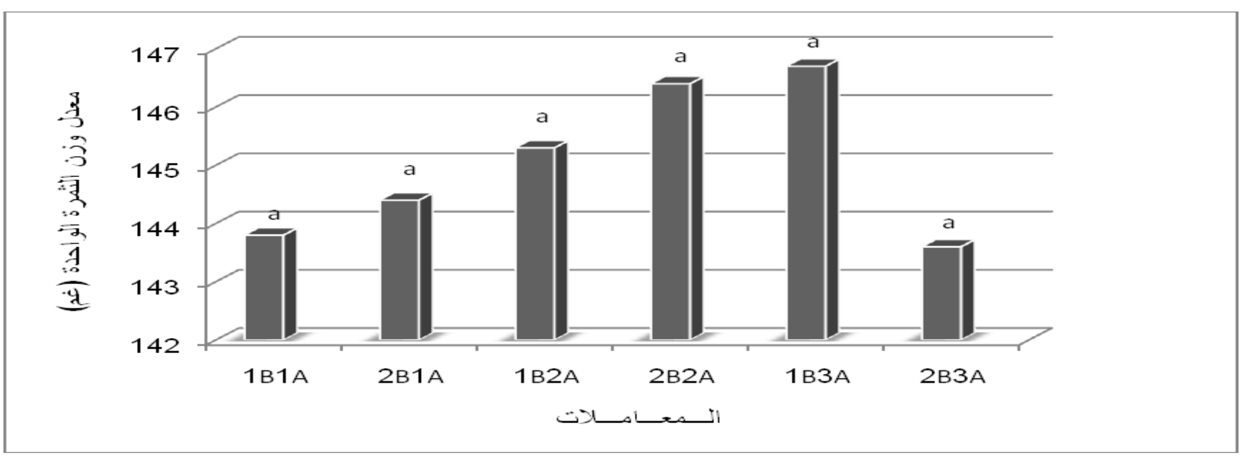
الاختلاف في الاحرف يدل على وجود فروقات معنوية بين المتوسطات حسب اختبار دنكن عند مستوى احتمال 5%.



الشكل (2): تأثير التداخل بين موعد الزراعة وتغطية التربة بالبلاستيك الاسود في صفتي عددالثمار / نبات وعددالبذور / ثمرة

الاختلاف في الاحرف يدل على وجود فروقات معنوية بين المتوسطات حسب اختبار دنكن عند مستوى احتمال 5%.

ان النتائج المبينة في الشكل (3) يشير الى عدم وجود فروقات جوهرية من الناحية الاحصائية بين المعاملات التداخلية في صفة معدل وزن الثمرة الواحدة.



الشكل (3): تأثير التداخل بين موعد الزراعة وتغطية التربة بالبلاستيك الاسود في صفة معدل وزن الثمرة الواحدة (غم)

الاختلاف في الاحرف يدل على وجود فروقات معنوية بين المتوسطات حسب اختبار دنكن عند مستوى احتمال 5%.

يستنتج من هذه الدراسة ان الزراعة في الموعد الاول والثاني (1/15 و 2/15) مع تغطية التربة بالبلاستيك الأسود تعد مناسبة جداً لزراعة الباذنجان داخل البيوت المحمية في محافظة السليمانية ويفضل الموعد الثاني بسبب قلة تكاليف خدمة الشتلات وامكانية المحافظة عليها من موجات البرد والصقيع.

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Effect of sowing dates and black plastic mulching on flowering growth and yield of Eggplants (JAWAHER- F1 cv.) in plastic houses

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Abstract

The experiment was carried out in plastic houses in the Directorate of Agricultural Research, Bakrajo, Sulaymaniyah during 2012 growing season in order to study the effect of three seed sowing dates (January 15, February 15 and March 15) and black plastic mulching in addition to their interactions on flowering growth as well as yield of eggplant (JAWAHER-F1 cv.). The results indicated that the firstsowing date was not different significantly from the second date with regard to the total number of flowers and aborted flowers per plant, proportion of the setting fruits as well as some yield characteristics such as total yield per plant and average weight of one fruit. However, the two sowing dates were superior significantly to the third date with respect to many studied characteristics. Black plastic mulching resulted in the improvement of the whole studied flowering traits as well as total and early yields and number of the fruits per plant. The first and second sowing dates and their interactions with black plastic mulching were not different significantly, while they were superior giving the maximum values in the majority of studied characteristics.

Key words: Eggplant , Sowing date , Soil mulching , Flowering growth , Yield.

Impact of Some Soil Organic Improvements on Soil Fertility and Plant Growth on Cucumber Plant (*Cucumis sativus*) under Greenhouse Condition in Sulaimaniyah Governorate

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ABSTRACT

For this goal, four types of soil improvements were used (Industrial biological fertilizer, such as dry yeast (*Saccharomyces cerevisiae)* in three concentrations (3, 6, 9 g^{-L}), Biofertilisers with one concentration, organic matter, such as humic acid and folic acid with one concentrations as well as control. These seven applications were administered to Cucumber plant in an R.C.B.D. design with three different replications

The outcomes show that when use the results show that using dry yeast (6 g^{-L}) has a significant difference in ($P_{0.05}$) on the soil PH that decreased to 6.8 as well as Nitrogen contain 4.8%; available phosphorus 40.5ppm; potassium 2.9ppm. Humic acid has a statistically significant ($P_{0.05}$) influence on EC, P, O.M., Biofertilisers have a statistically significant effect ($P_{0.05}$) on Ca (22.04ppm) soluble ,Folic acid made a significant ($P_{0.05}$) effect on soils E.C. (0.73ds^{-m}), A comparison between effects of the treatments on cucumber yield and number of days until harvesting, green group system, root group system, and TSS (total soluble solid) it become clear that Yeast 3g^{-L} give the significant difference ($P_{0.05}$), treatments Humic acid, Biofertilisers, Yeast 3g^{-L} give a significant difference ($P_{0.05}$) on green group system and root group system.

Keywords: Soil Fertility, Organic Fertilizer, soil improvements, Cucumber yield.

تأثير بعض المحسنات العضوية في خصوبة التربة ونمو نبات

الخيار *Cucumis sativus* في ظروف الصوبة البلاستيكية في محافظة السليمانية

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- **تاريخ استلام البحث 2022/2/28 وقبوله 2022/3/30**

الخلاصة

تم استخدام أربعة أنواع من محسنات التربة غيرالكيميائية لايجاد تأثيرها على نمو النبات و خصوبة التربة : مركب بايلوجي مثل الخميرة الجافة (*Saccharomyces cerevisiae*)بثلاث جرعات (3 ، 6 ، 9 جم\لتر) ، سماد حيوي بتركيز واحد ، المواد العضوية (humic acid, Folic acid)بتركيز واحد بالاضافة الى الشاهد،

تم تطبيق هذه التطبيقات السبعة على نباتات الخيار حسب تصميم .R.C.B.D وأظهرت النتائج أن استخدام الخميرة الجافة (6 جم) له فرق معنوي في ($P_{0.05}$) على حموضة التربة والذي انخفض إلى 6.8 وكذلك محتوى النيتروجين البالغ 4.8% ، والفوسفور المتاح 40.5 جزء في المليون ، والبوتاسيوم 2.9 جزء في المليون.

حامض الهيوملك كان له تاثيرا معنويا عند المستوى ($P_{0.05}$) على التوصيل الكهربائي لمحلول التربة و كذلك على جاهزية الفسفور والمادة العضوية، السماد الحيوي كان له تأثيرا معنويا عند المستوى ($P_{0.05}$) على تركيز الكالسيوم البالغ 22.04 جزء في المليون ، Folic acid كان له تأثيرا معنويا عند المستوى ($P_{0.05}$) على قدرة التوصيل الكهربائي للتربة والذي بلغ (0.73 ds/m) ، عند مقارنة تأثيرات المعاملات على محصول الخيار وعدد الأيام حتى الحصاد ونظام المجموع الخضري ونظام المجموع الجذري وإجمالي المواد الصلبة القابلة للذوبان نجد أن الخميرة بتركيز(3غم\لتر) أحدث فرقًا معنويًا ($P_{0.05}$) كما أحدث مع الهيومك أسيد والسماد الحيوي، ومعاملة الخميرة (3غم\لتر) نتج عنها فرقًا معنويًا (($P_{0.05}$) في نظام المجموع الخضري ونظام المجموع الجذري.

الكلمات المفتاحية: خصوبة التربة، السماد العضوي، السماد الحيوي، محسنات التربة، الخيار

INTRODUCTION

In recent decades, chemical fertilizers have grown increasingly popular across the world, concentrating on the soil as a dead container for plant roots rather than a dynamic ecosystem in which the crop is just one among hundreds or thousands of interacting species, it is now recognized that there is a steady reduction in production in dense monoculture areas that get high chemical fertilizer treatments alone. Even in irrigated paddy fields, there is a reduction. Ferris et al. (1).

Greenhouse gases like as nitrous oxide and ammonia are emitted as a result of nitrogen fertilizer usage Ammonia, in addition to producing nitrogen, may also raise soil acidity. Excess nitrogen fertilizer use causes insect issues by boosting the natality rate, lifespan, and pests' overall fitness Organic farming does not give enough nutrition on its own., according to experience in tropical Asian nations, and organic fertilizers must be combined with a chemical fertilizer basal dressing. Ingham et al., (2); Zallar & Koepke, (3).

Although soil fertility is acknowledged as a major barrier to agricultural productivity in developing nations, fertilizer use is dropping in Sub-Saharan Africa.

For soil fertility management, smallholder farmers still rely primarily on livestock waste. Data from a sample of 3,330 geo-referenced farm families in Central and Western Kenya were used to investigate the drivers of soil fertility management techniques, including both the use of cow dung and inorganic fertilizer. Sarhan et al., (4).

Cropping strategies for maize, rice, and wheat will determine whether the global dilemma of supplying rising food demand while simultaneously protecting the environment is solved or not. In large-scale particularly in poor nations, small-scale systems, the trade-offs for the optimum produce and environmental preservation is to ensure synchronization between Without a surplus or deficit, nitrogen supply and crop demand are balanced. Despite advances in fundamental biology and ecology. Shiboob, (5). controlling the fate of nitrogen in cropping systems is becoming increasingly difficult, and while biochemistry and genetics can help, The scientific challenge is not to be taken lightly.

Controlling nitrogen destiny in cropping systems that need to maintain production increases on the world's finite amount of arable farmland is getting increasingly difficult, therefore the scientific problem's complexity should not be underestimated. Cassman et al., (6).

According to Juan et al., (7) applying organic fertilizer had a considerable impact on carbon and nitrogen microbes, with carbon microbes changing from (96.4) to (500.1) mg^{-kg} and nitrogen microbes changing from (35.89) to (101.8) mg^{-kg} Some soil microbial characteristics and soil enzyme activities were significantly different from other treatments that did not employ organic fertilizer while also raising the soil total nitrogen and total phosphor ratios.

Soil organic matter is crucial for biological processes. And chemical activities in the soil, in addition changes in soil organic matter have a big influence on soil nitrogen turnover because microbial immobilization requires available Carbon. Soils with greater organic matter may be able to immobilize more nitrogen and reduce nitrogen loss to the environment. Otherwise, when available Carbon is exhausted, there will be a faster turnover of nitrogen and losses. Soil Carbon turnover can be influenced by changes in nitrogen supply. Gliessman, S.R., (8).
Wu et al., (9). Reported the application of Bioferitlizer, which included three species of nitrogen-fixer (*Azotobacter chroococcum*), Phosphorus solubilizer (*Bacillus megaterium*), and third apply potassium solubilizer (*Bacillus mucilaginous*), on soil Features significantly boosted the development of Z. Mays. When Bioferitlizer was employed, the maximum biomass and seedling height were reached. According to this greenhouse study, Bioferitlizer in half the quantity Application showed equivalent Treatments with organic or chemical fertilizers have different impacts.

Fertilizer combination of nitrogen-fixing bacteria and phosphorus-solubilizing bacteria generated the highest soil organic matter (1.28 %). The majority of nitrogen delivered by chemical fertilizers was leached out of reach of plants; whereas, due to its gradual release and effective consumption by plants, an integrated fertilizer resulted in an increase in nitrogen concentration in soil. The integrated fertilizing method, according to the findings of this study, is more successful in dry farming than other fertilizing systems. Sanchez et al., (10)

Shafeek et al., (11). Reported Plant wastes and natural-raw wastes, depending on their physical and chemical characteristics, are organic and mineral components that are widely diffused and innocuous. High dispersion, which is represented by system particles of colloidal substances spread in diverse settings, determines the specificity of physical condition. Differences in extremely low equilibrium insolubility and chemical composition influence the distinctiveness of physical states. As an example, consider the following circumstance. Carbohydrates, proteins, lipids, and other organic material, as well as a variety of chemical compounds, are abundant in organic wastes. Organic wastes have a high concentration of carbohydrates, proteins, lipids, and other organic material, as well as a range of chemical compounds. Organic wastes have a high percentage of carbohydrates, proteins, lipids, and other organic compounds, whereas phosphorus gypsum has a high concentration of sulfur and calcium.

Teak seedlings' growth and nitrogen absorption shown to be aided by humic acid. Plant height, monthly growth rates, and total dry matter yield all increased considerably. above the controls in the two soils at the three Humic Acid treatment doses. The addition of HA to the two soils increased their productivity. Seedling absorption of Nitrogen, Phosphorus, Potassium, Magnesium, Calcium, Zinc, Iron, while lowering Manganese uptake. An investigation was conducted out. To investigate the influence of various fertilizers and farming techniques. Lonhienne et al., (12).

Table 1: Elements and contains of dry yeast to each gram.

Elements	Mg^{-g}	component	Mg^{-g}	Elements	Mg^{-g}
Cupper	0.05	Carbohydrate	82	Magnesium	2
Calcium	0.1	Total Nitrogen	90	Phosphate	1-13
Iron	0.05	Nitrogen Humid acid	40	Potassium	30
Zinc	0.05	Magnesium	2	Sodium	56

Yeast extracts enriched culture medium caused morphological abnormalities, according to Abraham et al., (13) This might be due to the plantlets' stress response to the yeast extract's elicitor, which created an accumulation of secondary metabolites. The fact that the overall phenolic Curcuma mangga plantlets' content increased shows that yeast extract can cause methyl jasmonate to develop, resulting in higher phenolic content. If yeast extract is applied to the growth media, total phenolic content and total phenolic content increased. The production of phenolic was unaffected by increasing the concentration of yeast extract.

However, adding yeast extract to the culture medium did not enhance overall phenolic content. as a phenolic elicitor. Yeast extract was shown to have no effect on the biosynthetic process of plants. It did, however, cause the creation methyl jasmonate and endogenous jasmonic acid, both of which have an impact on secondary metabolite production. shikawa et al., (14).

MATERIAL AND METHODS

Table 2: Before the experiment, soil samples were analyzed and the results were as below.

Analysis element	**Soil texture**	**E.C. / dS/m**	**PH**	**N %**	**Available P (ppm)**	**Soluble K^+ (ppm)**	**Soluble Na^+ (ppm)**	**Soluble Ca^+ (ppm)**	**Soluble Mg^+ (ppm)**	**Cl (ppm)**	**O.M %**	**$CaCo_3$ %**	**HCO_3 (ppm)**	**CO^{-3} (ppm)**
Before	Clay loam	0.24	7.20	0.19	17.54	8.2	7.3	54.1	35.2	24.8	2.9	19	67.1	12

Irrigate the Experiment

Depending on these evaluations below for the water used to irrigate the research have no side effect on the plant growth?

Table 3: results analysis for water use it in irrigation

E.C. / ds/m	**PH**	**Soluble K+ (ppm)**	**Soluble Na+ (ppm)**	**Soluble Ca+ (ppm)**	**Soluble Mg+ (ppm)**	**HCO3 (ppm)**	**CO^{-3} (ppm)**
0.5	6.8	0.58	3.21	40.08	20.6	237.9	33

The results of the table are in accordance with the recommendations of the US Salinity Research Laboratory, and this water source is valid for agricultural uses, Senthurpandiane t al., (15).

Table 4: Soil analysis procedures

analyses kind	proceedings
Soil Texture	Bouyoucos,(16); FAW, (17)
E.C.	Olsen and Sommers, (18)
PH	McLean, (19)
N%	Kjeldahl, (20)
Available P	Richards, (21)
Soluble K	Richards, (21)
Soluble Na	Richards, (21)
Soluble Ca	Richards, (21)
Soluble Mg	Richards, (21)
Cl	Richards, (21)
O.M. %	Walkley & Black, (22)
$CaCO_3$ %	Nelson, (23)
HCO_3	Chapman, & Pratt, (24)
CO_3	Chapman, & Pratt, (24)

Experiment Design in the Greenhouse.

- This Experiment applied in greenhouses with a total area 450m^2, each terraces have 6 m^2 area, width terraces (unite experiments) = 90cm, the terraces are 25cm high. In the same line, the distance between each plot is 90cm. The number of sow lines in each treatment is two lines. Each plant has a distance of 30 cm between it and the next plant. Treatment distance (sow line) = 3 m, total number of plant= 16 plant, in each treatment 8 Plants chosen for parameters and data.

For statistical analysis, the X.L. STAT program was employed. Design of the research (R.C.B.D)
- (SAIFE F1) is the most Cucumber (*Cucumis sativus*) Variety used.

- 7 Treatment applied with three applications.

Treatments in the Experiment

T1- Control that only requires water.

T2- Use of humic acid (%35 humic acid) as a compost component.

- 2mm humic acid / Plant added to the soil before planting b (7-10 days).

- When irrigated, 2 mm humic acid /plant are added to the soil with the water.

- 2mm humic acid /plant were added to the soil after planting with (three weeks).

- 2mm humic acid / plant added after flowering.

- 2mm humic acid / plant added to the soil when the first fruits appear.

- 2mm humic acid / plant added to the soil after a five week of harvesting.

- 6week after harvesting 2mm humic acid /Plan added.

- After 10 weeks of harvesting, 2mm humic acid / plant add to the soil.

T3- Biological fertilizer: Apply in three stages to the soil.

- With sowing, add the fertilizer with concentration (15g /liter of water).

- In the same concentration after sowing by (3 week).

- Direct concentration after the first harvest (25g/ liter of water).

- Same Concentration after four week from first harvest.

- After six weeks after the initial harvest, the concentration remains the same.

T4- Added Fungus, using the (Commercial dry yeast of bread) to be a source for (*Saccharomyces cerevisiae*), that add it to the soil with three concentrations, (3g/ liter of water).

T5- Add another amount (6g/ liter of water) of Commercial dry yeast of bread.

T6- another amount adds it (9g/ liter of water) of Commercial dry yeast of bread.

T7- Folic acid (18 % folic acid), use in one concentration (3mm/ plant).

RESULTS AND DISCUSSISON

Table 5: Effect OF Fertilizer Treatments on Soil Fertility

Treatment	Texture of Soil	Electrical Conductivity ds/m	PH	O.M (%)	Nitrogen %	available Phosphorus ppm	Potassium ppm	Calcium ppm
Before sowing	Clay loam	0.8	7.2	1.8	2.5	11.3	1.4	32.06
Biofertilisers	Clay loam	1.2 b	7.4 b	1.8 b	3.0 c	22.7 c	1.95 b	22.04 a
Control	Clay loam	0.85 a	7.5 c	0.4 f	1.8 e	0.8 e	1.17 b	14.02 a
Folic acid	Clay loam	0.73 a	7.2 d	0.5 e	3.2 d	2.1d	1.09 b	20.04 a
Humic acid	Clay loam	0.8 a	7.3 d	2.6 a	4.2 b	38.4a	2.34 b	26.05 a
Yeast 3g^{-L}	Clay loam	1.61 b	7.1 b	0.6 d	3.4 d	14.3 d	1.36 b	18.03 a
Yeast 6 g^{-L}	Clay loam	2.51 d	6.8 a	2.5 a	4.8 a	40.5a	2.93 a	28.05 a
Yeast 9 g^{-L}	Clay loam	2.82 d	7.4 b	0.9 c	3.7cd	30.4b	3.5 a	16.03 a

Duncan's multiple ranges test shows that means with different letters are substantially different at P0.05.

The characteristics of the chosen fertilizers utilized in this study varied depending on the kind of fertilizer (Table 5). Kato et al., (25). The electrical conductivity (EC) of extract Yeast 6g^{-L} was much greater than the other fertilizers (Table 5), which may be related to the fact that the dry yeast decomposes quickly.

According to our findings, the pH of the soil after harvest declined in all treatments, but increased with the administration of control. The drop the addition of a high organic Folic acid to the soil can be connected to a change in PH. Increased microbial activity and reduced inorganic fertilizer input result in complete breakdown of organic materials. could be attributed to the lowering of pH of plots with high organic fertilizer application, whereas organic matter degradation is completed as a result of enhanced microorganism limited inorganic fertilizer use and actions could be attributed Plots with less organic fertilizer application have a lower pH, Agbede, (26)

Table 5 demonstrates that using and yeast $6g^{-L}$ for the plants resulted in a considerable shift in soil pH when compared to the baseline soil pH, the significant number of fungal and plant residues may have contributed to this finding. Other researchers have shown similar results. Materrechera and Mkhabela, (27).

The soil pH, available P, and available K levels were all considerably raised by yeast $6g^{-L}$ treatment. (Table 5) shows that applying Folic acid and Yeast 9 g^{-L} did not lead to a substantial change as compared to the pH of the soil baseline soil pH. (7.2). the significant amount of bases used with the composts may have contributed to this result. Other researchers have shown similar results .Whalen et al., (28).

The activity of acidic and alkaline soils phosphates was modulated use various fertilizers applications. Dick, (29). That adding organic materials to the soil increased the activity of acid phosphates. We detected Acid phosphate activity did not differ significantly between the control and the experimental groups. And folic acid treatments when comparing the phosphates activity of the Yeast $3g^{-L}$ and folic acid treatments to that of the yeast $6g^{-L}$ plots. The highest activity of acid phosphates was seen in soils treated with yeast $6g^{-L}$ and humic acid. Sudduth et al.,(30).

At the same time, the properties of soil humus are reliant on and unique from various soil types. The principal component of soil humus, humic acids, determines its features and, as a result, its role in the natural environment. The amount of humic acids contained in humus, as well as their properties, are known to be altered by the fertilization method utilized. Gonet and Dębska, (31).

The pre-planting soil research (Table 5) demonstrates inadequate soil fertility, requiring fertilizer application to recover nutrients lost during to increase yields, harvest crops and add nutrients.Ayuba and Olatunji, (32). The quantity of total nitrogen in the soil before planting (2.5 ppm) is less than the recommended level (4.8 ppm).

With the use of Yeast 6 g^{-L} and humic acid fertilizer, the total nitrogen status of the soil improved the input of nitrogen to the soil led to a significant increase in nitrogen levels in the soil, resulting in enhanced microbial activity as a result of higher nutrient concentrations. of various fertilizers Adeniyan and Ojeniyi, (33).

Shalaby and El-Ramady, (34) reported that the absence of fertilizer application and nitrogen uptake by component crops may be to blame for the overall N depletion reported in the control.

We utilized dry yeast $6g^{-L}$ and organic fertilizer in our study to increase organic materials in the soil, which was consistently low in areas that did not get any fertilizer. The lack of fertilizer is to blame, because it sped up the breakdown of organic substances according to Taha et al.,(35) soil's organic matter content may be maintained by integrating agricultural wastes and mulching.

Soil amendments using organic and inorganic fertilizers it has been observed that organic matter accounts for up to 90% of the cations exchange capacity of mineral soil surface layers. Stevenson, (36).

Similarly, the amount of accessible P in control treatment dropped, which might be due to nutrient absorption by elements plants and/or component fixation, which normally happens when the soil pH is lower, Brady and Weil, (37). The use of yeast $6g^{-L}$ fertilizer resulted in a greater accumulation of accessible P. The interchangeable bases followed a similar pattern. The rise in viable Phosphoresce is most likely because organic matter releases nutrients into the soil fertilizer treatment. When it comes to plant factors like crop yields, the results obtained at the extract dry yeast 6 g^{-L} and humic acid fertilizer utilized in the study are shown, the increases in soil pH levels that have been seen. Hussain and Khalaf, (38).

Cucumber yield components rose when yeast extract application was raised from 3 g^{-L} to 6 g^{-L} some studies have seen comparable favorable responses of cucumber to humic acid fertilizer application. Also observed a large linear rise in cucumber production in response to nitrogen, Found a strong response of cucumber to fertilizer treatment in the humid rainforest zone in their study using straight nitrogen and potassium fertilizers, concluding that nitrogen alone was particularly successful in improving cucumber production with application. Carpenter et al., (39)

Our investigation also revealed that diverse fertilization treatments had a substantial influence on soil accessible nutrient concentrations, with the exception of Exchangeable Ca^{+2}, which had no effect statically and had no meaningful effect. The nutrients applied by fertilizers were greater than the nutrients absorbed by the vegetables, according to these findings; comparable findings were reported by others. Ayoola, (40).

Another explanation for the quick buildup of nutrients in the soil is that minimal leaching occurs under greenhouse conditions. Chen et al., (41). Exchangeable Ca rose by nearly 21% in plots treated with organic fertilizer after cropping, but decreased in all other plots. The yeast extract, humic acid, and Biofertilisers treatments produce larger levels of Ca than the other treatments. This might be due to the development of a high-solubility Ca & P complex.

Table 6: Impact of soil amendment's on some plants growth properties

Treatments	Yields Ton ha^{-1}	Day to Harvest	Leaf area meter(cm^2)	Green group Weight (kg.)	Root group Weight (kg.)	TSS
Control	8.45 b	69 a	39 b	6.5 a	2.3 ab	5.5 b
Humic acid	7.78 b	72 b	38 b	5.9 a	2.8 ab	6.7 b
Biofertilisers	7.33 c	74 b	32 c	5.9 a	2.7 ab	5.1b
Yeast 3g-L	9.80 a	63 a	45 a	6.8 a	3.3 a	7.9 a
Yeast 6 g-L	7.03 c	71 b	31 c	5.5 b	2.5 b	5.3 b
Yeast 9 g-L	7.13 c	78 b	32 c	5.7 b	2.5 b	5.8 b

Duncan's multiple ranges test shows that means with different letters are substantially different at P0.05 **TSS**= total soluble solids.

The most significant cucumber production was around 39.2 Ton ha^{-1} for yeast-treated (Yeast 3g^{-L}) plants (table 6) and yeast treatment (Yeast 3g^{-L}) generated the highest significant (6.8kg) fresh weight. Muwaffaq, (42).

According to Ezz El-Din & Hendawy, (43), utilizing dry yeast at a concentration of (4g^{-L}) boosted borage plant development metrics and exhibited significant variations in the mean fresh weight of aerial parts when comparison to the control plot.

When comparison to control, humic acid produced a rise in shot characteristics. Furthermore, as comparison to plot controls, splashed plants by dry yeast concentrations of (3 and 6 g^{-L}) resulted in Plant height and total chlorophyll levels differed in a beneficial way. Sarhan et al.,(44).

The acquired increases in the previously described features might be attributable to the fact that carbon dioxide levels are rising in the soil air caused a drop in soil pH that make interaction with waters soil, which produced carbonic acid, as shown by the equation below. Zaki, (45)

Carbonic acid causes certain soil phosphate compounds to dissolve, Phosphorus levels should be increased compounds in the soil solution. Furthermore, Reducing the soil PH rise the accessibility of nutritive elements for crops uptake. Proteins, growth factors found in yeast. Abdou, (46).

Thanaa et al., (47). Reported that organic matter effecting on soil microorganisms varies depending on soil type, organic matter supply, and decomposition state, although most soil organism populations increase

According to Guidi et al., (48). Humic acid treatment has a variety of effects on the soil chemical characteristics, and adding Organic matter has the potential to produce a probable increase in available nutrients, including an increase in organic carbon.

Furthermore organic matter alters the amount of accessible nitrogen in the soil; nitrogen availability is determined by the organic source's C/N ratio. The overall biological activities in soil are affected differently by various sources of organic materials. Wood & Edwards, (49)

CONCLUSION

Given the economic limits imposed on production-oriented agricultural systems, nutritional requirements in agriculture will be difficult to meet. Because nutrients are crucial in agro ecosystems, conscious control of fundamental ecosystem processes can help prevent environmental losses. Under this concept, the objective of survey fertility would be to balance nutrient budgets as much as feasible while maintaining these reservoirs.

Management of a healthy agro ecosystem employing organic soil fertility methods can also supply secondary element supplies from time to time. Traditional farming practices, which rely mostly on artificial supplies of N, P, and K, are deficient aside from nutritional concentrations.

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Influence of climate changes (Winds, vapour pressure) on Sulaimaniyah Governorate, stricture and sustainable Agro ecosystem.

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Abstract

Since the beginning of 1985, the importance of recording and documenting meteorological information, especially the subject of research (wind speed, vapour pressure) has become very important Sulaimaniyah (north of Iraq) over 34 government-sponsored wind speed and vapour pressure as well as the other climate parameters like Rain, heat, Relative Humidity and Sun Shine gauge sites have operated on Sulaimaniyah.

The few wind speed recorders show a high level of speed that never have been seen in these 34years, in January and February 2017 the wind speed get 8 and 9m.sec^{-1} but in months 4,5,6 ,9 lower speed recorded in Sulaimaniyah (0.1m.sec^{-1}). However, as an average in the 1985 and 1992 we got the highest rate 3.1and 2.2m.sec^{-1} in the other hand in 1991 we record the lower rate 1m.sec^{-1} The average changes throw the 34years it 0.04 and.

The main target for this study is to estimate the available data, then use the accepted data to create a 34-year database

Changes in wind speed and in vapor pressure systems are likely to have a particularly strong impact on arid and semi-arid ecosystems and may reflect historical regime changes there for from the climatology data the vapour pressure increased clearly throw these years.

Results from a decade of climate change data’s that winds and vapor pressure are seasonality, timing, variability, and magnitude are all involved and these may be altered in future climates.

Keywords: Climate Change, Winds speed, Vapour pressure, Sustainable Agro ecosystem.

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Introduction

The city of Sulaimaniyah is located in the northeastern part of Iraq. It is characterized by the general nature of its surface. It is mountainous and is surrounded by valleys and some small plains. The city is located on the western slopes of the Azmur Mountains and at an elevation of 850 m above sea level and between latitudes 30º 44' and 20º 46' east and latitude 35º 850' and 30º 36' north. The city is surrounded by several mountain ranges from north-west to south-east.

Sulaimaniyah is furnished on sloping land with a slope of 3.5%. The northern end of the city is 885 meters above sea level, while the southern end is 800 meters above sea level. There are several plateaus on the southern and western sides of the city, which are usually not noticed on the topographic map, and also on the map. Sulaimaniyah as well as the rest of the cities in the Kurdistan Region of Iraq enjoys a mild summer because of the rise from the level of sea level and this is different from what it is in the rest of Iraqi cities. Winter is particularly cold during the night with snow falling sometimes.

An important challenge that faces current land management practices is to raise food production and soil conservation to meet expecting direction in food production while look after flexibly to climate change (1). To improve crop yields and reduce greenhouse gas emissions under future climate change scenarios (2). 'Sustainable agroecosystems could relive the climate change effect on bridging our current knowledge gaps and recognize the contribution of sustainable agricultural practices as a way forward to reduce the global footprint of carbon and nitrogen(7). It will suitable and beneficial for the researcher's concerned interested in mitigating the influence of climate change on any ecosystem and to get the information that need to get such a target(8) Wind is primary to transport precipitation, critical for all types of plantation in ecosystems (4).

In this article we will try to find answers for some questions like: -

To study the respond of climate change what procedures could be taken?

For better understanding the effectively reply to climate changes there will a requirements for a new technology and advanced research.

The climate change influence's on ecosystems elements as well as individual kinds are Have caused serious difficulties on the natural resources managing. Lander and Guard (10) conservation of ecosystems in the past has been largely dependent on the supposing of a stable climate and has focused on the protection of existing individual species as long the conservation of species populations meanwhile conserved areas (11). Gardiner *et al.* (6) Types of harms because of wind speed in any ecosystem are classified from little to no death, for example the microscopic harm of breakdown of total leaf, breaking branch, tree leveling.

As climate change forces species to migrate to more suitable climates, ecosystems will be disassembled and reassembled in new locations, often outside the bounds of protection, and with new casts of characters. Some species will be lost, while other species will appear in new locations where they may become invasive and add to the pressures on existing species (12).

Factors of Wind speed can conceder as an important disorder dynamics and ecological factors in ecosystems (5).

To understand how climate change impacts on individual species in a hand and entire ecosystems in the other hand there will be a need to do a research, Climatic transport of elements or newly gathering ecosystems can continue to supply the ecosystem services Which may be dependent on civil societies (13). Factors of Wind speed impact on air temperature, moisture relative evaporation, and transpiration and snow distribution in an ecosystem (9 and 17).

Researches in research social science are important for soils, natural resources, and conservation experts Administration of risk adaptation guidance to face the constantly changing climate (14). Moreover, a little is known about the social agreed for new advanced approaches to species conservation and land protection.

Social acceptance of the screening approach to protect species that may develop where the functions of the ecosystem are affected by climate changes and changes in species previous experience with conservation management (16). There is also a need for combined estimate and decision support tools to help managers and the public understand and agree on the reasonable provisions that will result (15).

Changes in agro ecosystem structure from wind can be classified as follows: (A) Initial injures: that occurs by few hours or days after wind disorder is direct, people and properties may be damaged (B) secondary injures: recorded over a days, weeks, months and years after disorders Consecutive and caused by various harmful factors involved in the process (C) High damage documented for many years or decades after disorders It is mainly seen in social and economic relations. Changes in the structure of the agricultural ecosystem returned to wind disturbances reflecting the different interactions between the wind speeds. Site features like soil, water content in tree species instillation, hedges of tree (6).

Graphic and map is one of the most effective ways of representing natural phenomena’s, including humans like climate elements on ecosystem in general especially if supported by charts and graphs designed on the basis of science technology and acceptable to serve. This research came to emphasize the study of climate and its characteristics to identify these characteristics by graphics and maps using application of GIS (3). Water vapour is a gas and its pressure contribute to the total atmospheric pressure. The amount of water in the air is related directly to the partial pressure exerted by the water vapour in the air and is therefore a direct measure of the air water content. When air is enclosed above an evaporating water surface, equilibrium is reached between the water molecules escaping and returning to the water reservoir. At that moment, the air is said to be saturated since it cannot store any extra water molecules. The corresponding pressure is called the saturation vapour pressure (e° (T)). The number of water molecules that can be stored in the air depends on the temperature (T). The higher the air temperature, the higher the storage capacity, the higher its saturation vapour pressure. Pure water vapor is said to be saturated when it can exist in stable thermodynamic equilibrium with a plan surface of pure water or ice, at the interface, the water vapor has the same temperature and pressure as the condensed phase, water vapor over super cooled (below 0^0C)water is, strictly speaking not in stable equilibrium but rather metastable equilibrium. The pressure witch pure water has in state of saturation, called (saturation pressure) is a function of temperature only.

Material and Methods:

A-Source of Data:

For equipment standardization reasons and calibration, data reliability, only data from directory of metrology and earthquake of Sulaimaniyah were used these governorate directories provide the climate data for 34yers.

B- Evaluation of Database:

Several methods and tools were used to assess the quality of rain data. In cooperation with the Directorate of meteorology in the province of Sulaimaniyah this study used the longest, most winds and vapor pressure records (Fig.1)

To establish baseline relationships, Plant types, patterns and soil permeability characteristics were used to assess relative humidity and drought in order to determine wind speed. Two years, 1992 and 2016, it has large gaps in wind data, and there is a great need to rebuild databases for these years.

Fig. 1, yearly average wind speed (m.sec^{-1})

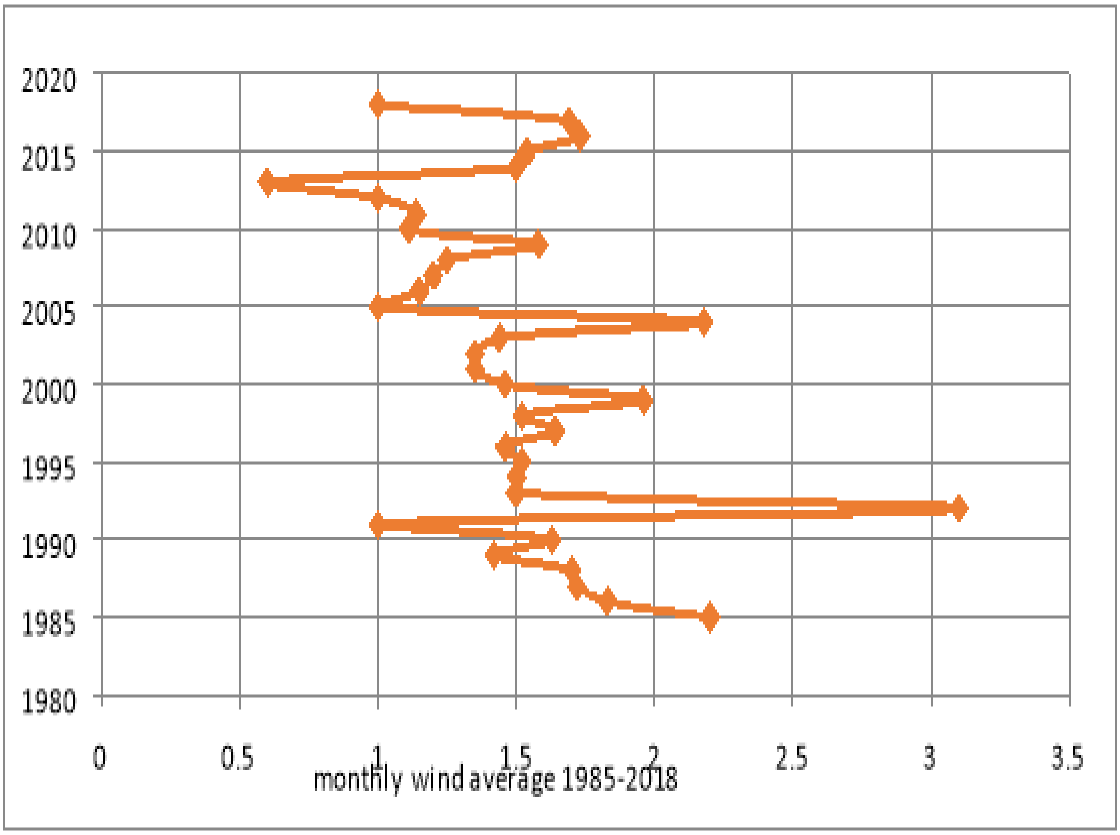
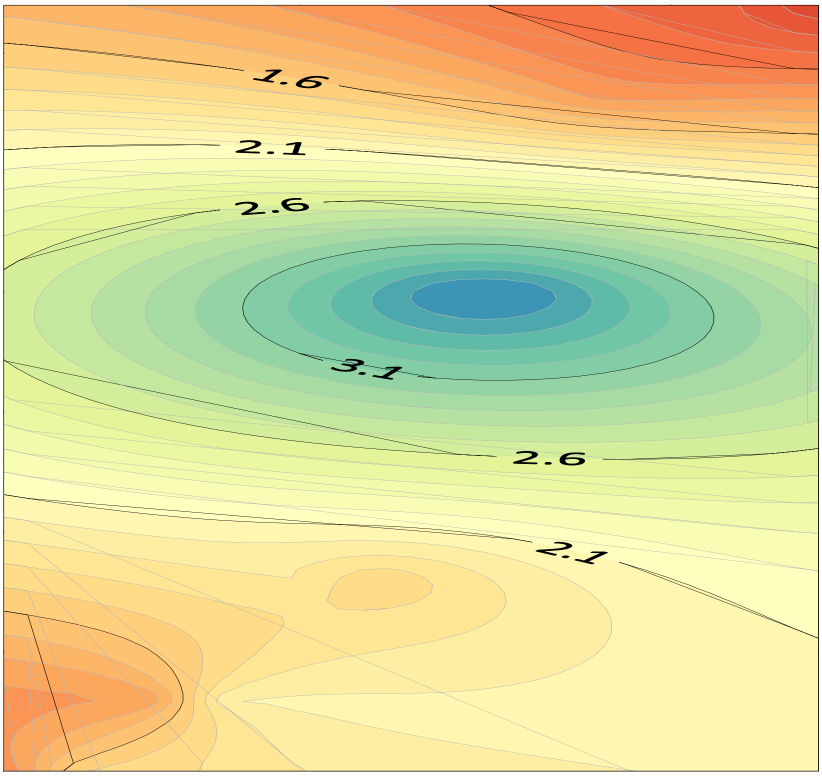


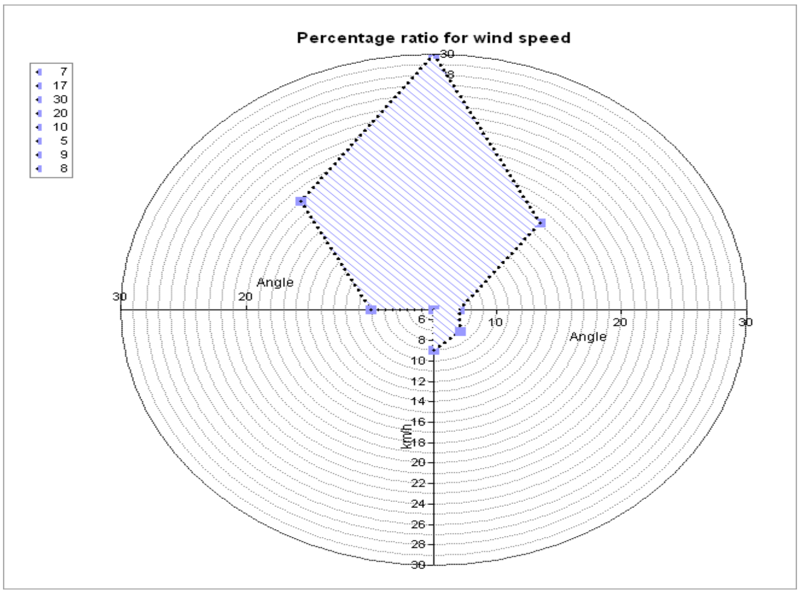
Fig. 2, yearly (1985-2018) wind speed (m.sec^{-1}) just for month of February



D-analysis:

Annual data were drawn for each year, from (fig. 4) in 2017 we have the highest and lowest speed wind the highest (m.sec^{-1}) were in February and the lowest were April, may, Jun, august, and September. Also, in 1992 we have a high degree speed in October (7m.sec^{-1}) (Fig. 3) wind rose show the main wind direction from north east mostly with speed get to 30(m.sec^{1})

Fig. 3, wind rose for Sulaimaniyah wind direction.

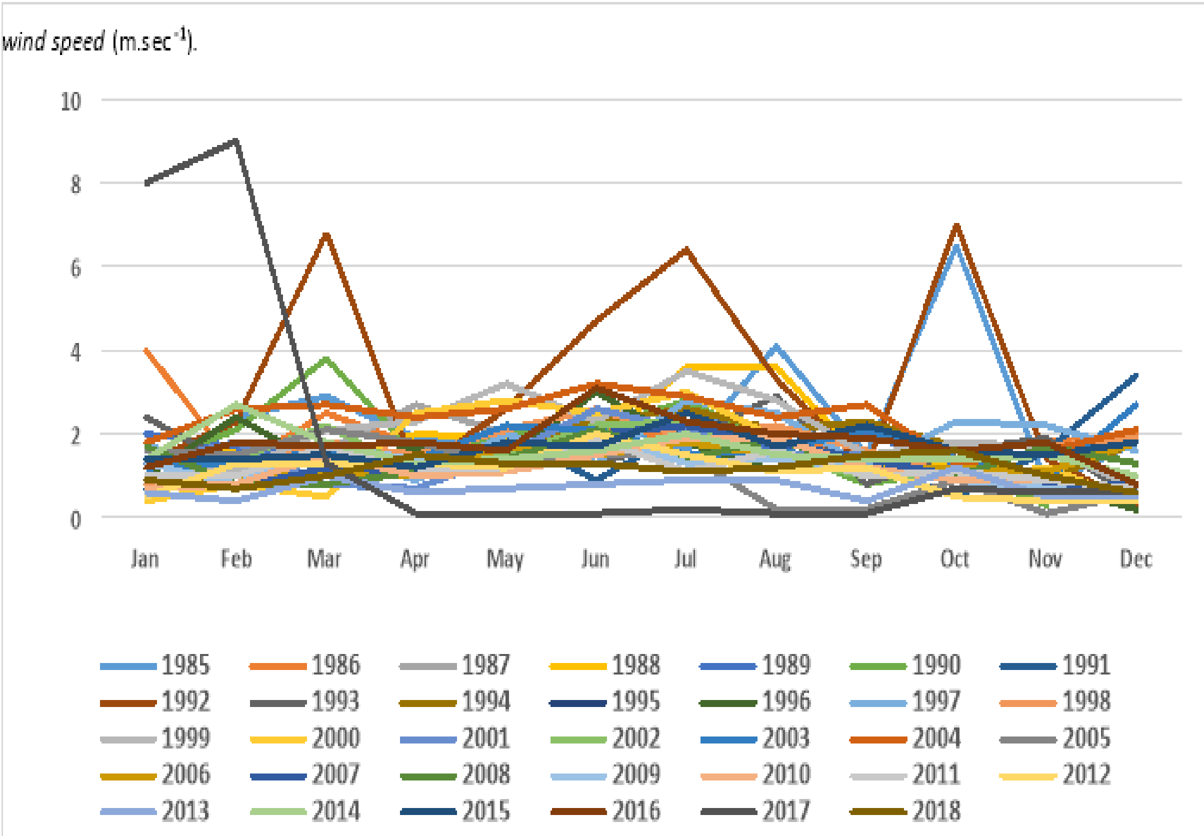


Results and Discussion: -

Two basic databases were developed for this study. The databases were produced by using the Microsoft excel database program as well matlab and Surfer. The first is a 34-year database of the yearly wind speed. An example of this database appears in Figure 1. The second is a 34-year database consisting of annual data for a given month such as February (Fig. 2).

Vapor pressure and winds both and together are most important climate factor even they are so different but to gather have a series effect on the earth since winds is a result to the horizontal and vertical differences in vapor pressure causing distribute the pressure. Vapor pressure is forcing that effect on a unite or it is air weight upper any area.

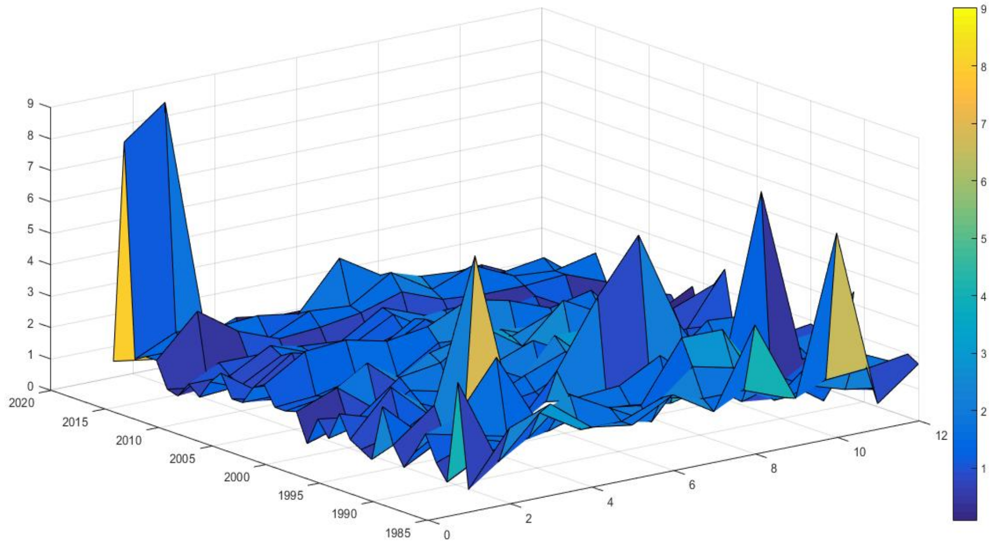
Fig. 4, annual wind speed (m.sec^{-1}) data from 1985 – 2018



In 2013 we Sulaimaniyah climate live the lowest year in wind speed (0.6m/sec.).

Also, in 1991(1 m/sec.) we a have calm year. As more and more information about wind distribution was revealed, a reanalysis by MATLAB program each map was made to adjust the annual wind speed distribution. This process was carried out through our investigation, the analyzes were very similar. Differences were discussed and resolved in a single consensus analysis. The mean annual wind speed map was developed by selecting 34year base data on Sulaimaniyah that included all of the wind speed. These34years data are shown in (Figure 4). From (Fig. 2) The 34, 1-year values for each year the mean was then calculated to derive a 34-year value

Fig. 5, annul wind speed data for 34year and 12monthes



The resulting, accurate analysis was produced 34-year annual wind (Figs. 5). The results are somewhat preliminary since only we focused on the data's present and analyzes were completed in this study. More complete monthly and seasonally analysis will be conducted in the follow-up study and we will focus also on winds speed influence on Sulaimaniyah ecosystem. So, wind movement horizontally or (table 1) show that averages winds speed getting higher in study area in Sulaimaniyah starting from January (1.4 m.sec^{-1}) until august in the summer, in the summer winds get the highest speed averages (2 m.sec^{-1}) in July.

The averages winds speed it is higher in summer comparing with winter and that return to low vapor pressure in the summer.

The study area effected each season by some kind of winds moved from different direction but the winds direction are eastern north, these winds effected on the on the air temperature and decreased that make winter colder

The winds that came from west some time brings dusts to study area that increased in late spring and summer in the other hand decreased in winter.

Table1, annual averages monthly, yearly winds speed (m.sec^{-1}) from1985-2018

MON	AVR	MON	AVR
January	1.4	July	2
February	1.58	August	1.7
march	1.64	September	1.29
April	1.33	October	1.42
May	1.63	November	1.15
June	1.93	December	1

February's 2017 Sulaimaniyah ecosystem affected by the highest wind speed 6($m.sec^{-1}$) from (fig. 6) the vapor pressure getting higher starting from 1985 (7.5MPa) until 2018 (10.33 MPa) in 2015, 2018 and 2016 in levels (10.4, 10.3 and 10 MPa) we record the highest vapor pressure. This increasing is of the vapor pressure could return to the the different Weather styles can have significant impacts on air pressure, the density of cold air is more than the hot air, because the character's that form hot air have a greater speed and are far apart from the cold air. Ambient air pressure depends on temperature changes. The most obvious change in air pressure occurs twice a day with the rise and fall of the sun. Midnight is the time when the lowest pressure is recorded for air pressure, while the middle of the day is the time when the highest air pressure.

Fig. 6, vapour pressure (MPa) monthly and yearly average, 1985 -2018

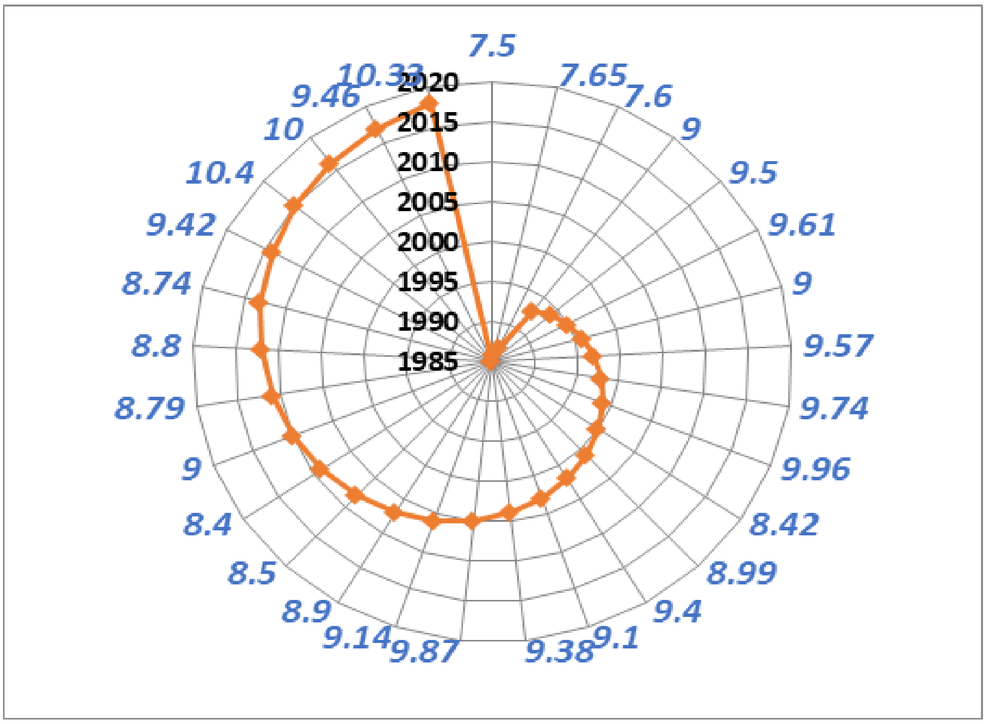
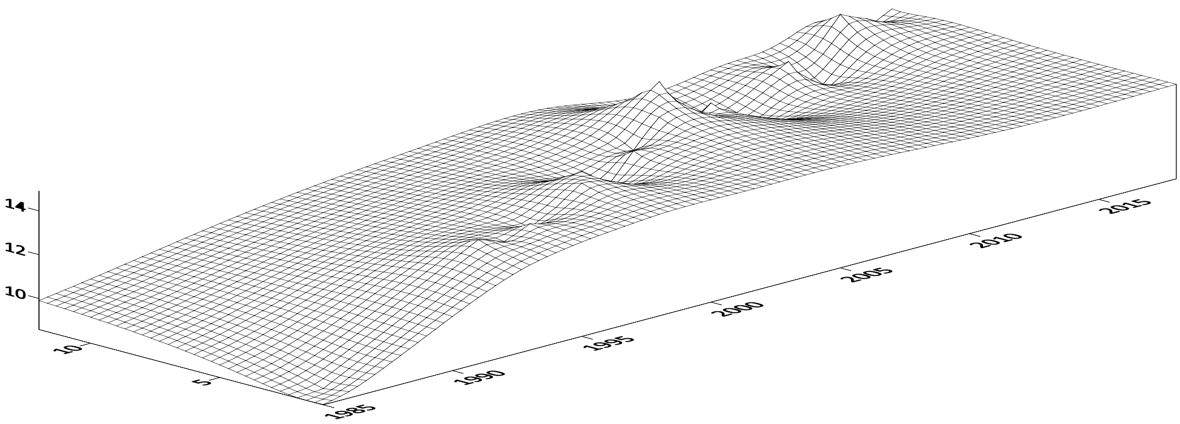
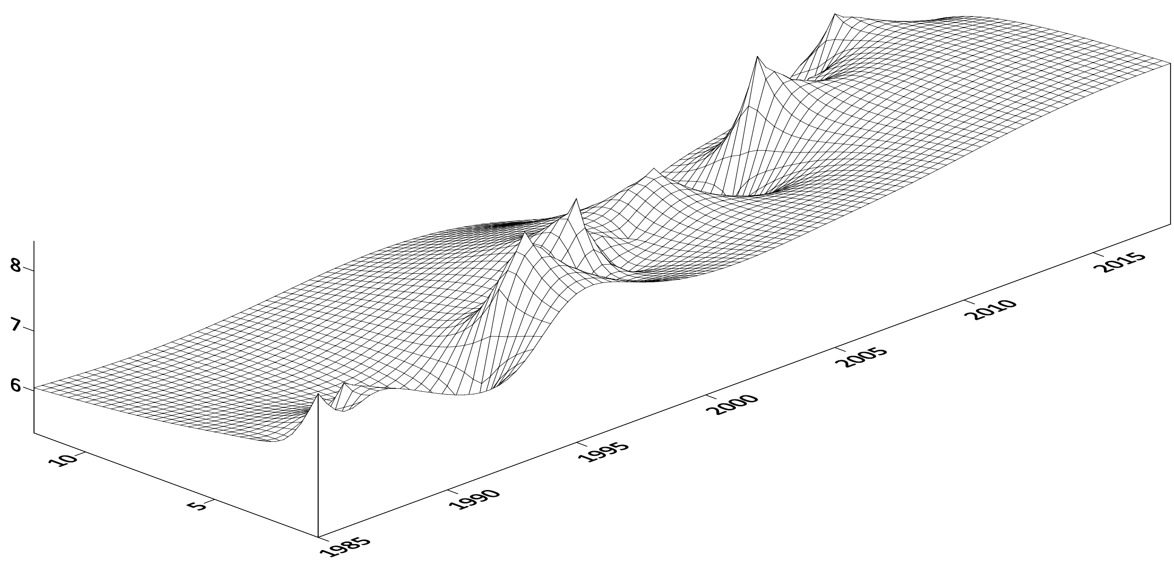


Fig. 7, vapor pressure (MPa) yearly average for July (1985 – 2018)



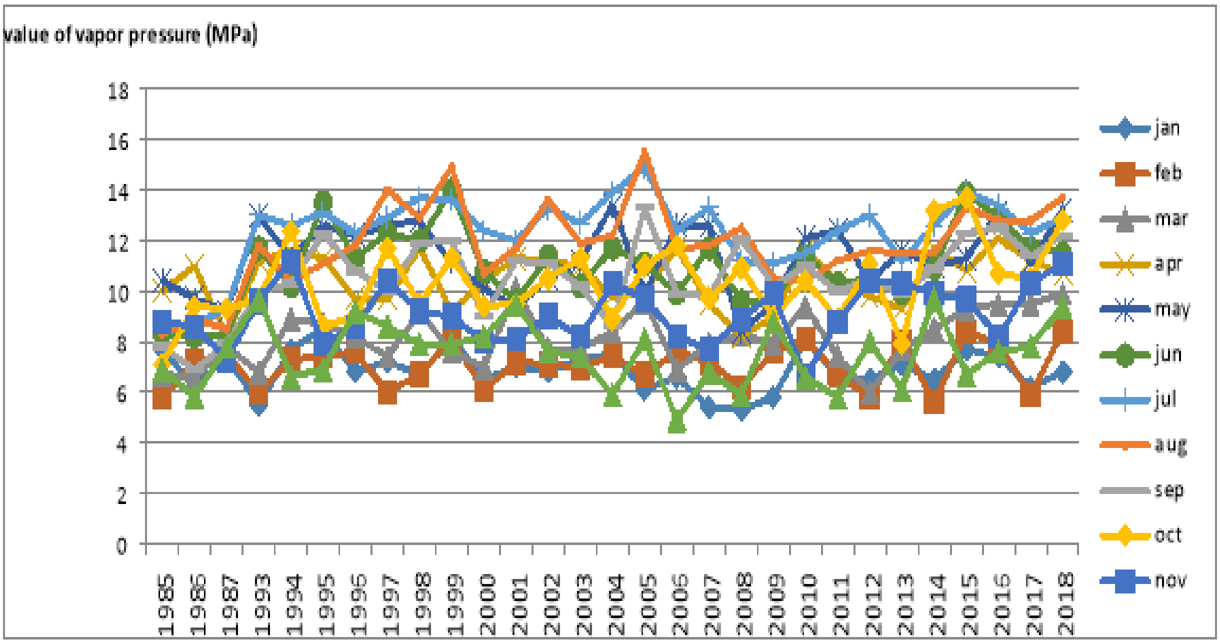
From (Fig. 7and Fig. 8) in July have the highest ratios of vapor pressure comparing to the other month, in this month 2004 we have the highest record (14.9 MPa).

Fig. 8, vapor pressure (MPa) yearly average for January (1985 – 2018)



In the other hand and from (fig 8, fig 9) we record the lowest ratios of vapor pressure, in January 2008 we record the lowest level of vapor pressure (5.3 MPa). So recording a significant changes starting from 1985 until 2018 in vapors values by increasing these values year to year that's advance about the heating get higher in our reign.

Fig. 9, monthly average for vapor pressure from 1985-2018



Conclusion

Wind and vapour pressure are important pillar in ecological factors that influencing on development, growth and reproduction of growing in ecosystems. Wind factors are one of the harmful agents that cause a composite interaction. So the Interactions between agro ecosystem and wind need to understand the basics for mitigation of the negative affect associated with wind disturbances on plantation in worldwide. There wasn't a direct affect measuring to decrease the associate risk. Early treatment and removal of wind or infected plantation may reduce or eliminate the epidemic locally. Integrated plantation protection been an effective pillar in the agro ecosystem in the conditions of global change. Wind disturbances show that integrated plantation protection against heavy winds in agro ecosystems in Sulaimaniyah need more scientific studying and researches.

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Influence of heavy rainfall in 2018-2019 and submerging on some soil properties greenhouse's in Bazian plain, Sulaymaniyah Governorate

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Abstract

In rain season 2018-2019 Sulaymaniyah governorate has been precluded to rainfall precipitation with very high quantities that never has been recorded since 1985 that impact on some soil properties taking samples from 80 greenhouses in (Tainal watershed, Bazian plain, Sulaymaniyah Governorate). Since in some of these greenhouse waters flood get 1.5m high and others distorted and kinds of residues has been collected in others greenhouses as well as effects of water submerging on these greenhouses soils. Taking soil samples from greenhouses from all locations that effected hardly and making analysis for some properties' as a parameters and the results showed that the soil solution electrical conductivity (EC) decreased significantly ($P<0.05$) in (Location1, Location2, Location6) ($1.65 dsm^{-1}$,$0.35 dsm^{-1}$, $0.25 dsm^{-1}$) respectively. the pH of soils decreased as the results showed (Location1, Location2, Location3) (8.06, 8.31, 7.8) respectively but not significantly, soil aggregate differences had effected significantly and changed in different locations because of removal of the sand part, silt decreased from (% 17.25) in control Location to (5.6 in Location2, 4.1in Location7) but didn't get to the limit that could change the soil texture. Submergence soils caused decreasing significantly ($P<0.05$) in phosphorus concentration in (Location1, Location7) (17ppm, 12ppm) respectively. The Concentration of nitrate in soil solution decreased significantly ($P<0.05$) (Location1, Location7) (2.5mg kg-1, 14mg kg-1) respectively under the submerged condition at field capacity causing an increase in the concentration of potassium (0.743 in Location3 and 4.358 in Location4) in some locations. Sodium increased in most of the locations significantly ($P<0.05$) (L1, L3, L5, L7) ($0.378 m\ mol^{-1}$, $0.434 m.mol^{-1}$, $0.443 m.mol^{-1}$, $0.643\ m.mol^{-1}$) respectively otherwise, magnesium and calcium decreased in the soil solution. From the investigation some farmer record that in the study area vegetables grew better after the submerging soils.

Keywords: flooding, submerges, soil properties, nutrient concentration, ions leaching,

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Introduction

Bazian plain is one of the most important agricultural area in Sulaymaniyah Governorate because of the big numbers of greenhouses project there are as well as the forests and kinds of agricultural activates, therefore, we select an area contain 80 greenhouse for our study.

Heavy rainfalls especially with high intensity proceedings are important factors to encourage the process of soil erosion especially in lands have some slop (19). There are an interaction relationship between rainfall and the form of the earth surface effects on the visible features of an area of land especially in terms of heavy soil erosion(3)

precipitation impacts on the different levels of soil moisture and the hydrological processes like runoff in the soil surface and the infiltration of water in the deep levels and this is important for the elements cycle in the nature, precipitation especially with heavy intensity have an effect on the elements cycles process(1).

Flooding or flooding of dry soils in water causes a series of physical, chemical and biological processes that severely affect soil quality as a means of plant growth(13). The nature, pattern, and extent of the processes depend on the physical and chemical properties of the soil and on duration of submergence (13). Draining and drying a flooded soil reverse most of those changes. A unique characteristic of submerged soil, which affects shifts in nitrogen, is the depletion of oxygen (O_2) in most of the root zone (20). When the soil is submerged with water, the amount of oxygen in the soil is greatly reduced due to the propagation of oxygen. The water is about 10,000 times less than it diffuses into the air (4). Due to this dramatic reduction in gas exchange between air and soil after immersion, the source of O_2 can meet the demand of aerobic organisms. Within hours of soaking, optional microorganisms predominate. After a few hours to days, anaerobic microorganisms accumulate esoteric layers. Optional and anaerobic organisms use oxidized soil substrates as electronic receptors for respiration, thereby reducing soil components in a sequence predicted by thermo dynamics (8). The water column covering the submerged soil contains dissolved O_2 oxide, which usually moves a small distance into the soil before it runs out. Submerged soils are thus distinguished, based on the penetration of O_2, into an aerobic (oxidized) and anaerobic (reduced) surface layer (11).

The thickness of this oxidized surface layer of soil is determined by the net effect of the O_2 supply of covered water and the rate of O_2 consumption in the soil. The high CO_2 consumption in the soil results in a thin layer of oxidized soil about 1 mm thick. Low O_2 consumption results in a thicker oxidation layer.

For this purpose the present research amid to study the effect of rainfall on some greenhouses soil properties immediately after the end of rain season.

Studying the impact of submerges on some physicals and chemicals soil properties of the soil that was flooded.

Materials and Methods

Bazian plain located between longitude 35º.49ˈ. 00ˈˈ N and latitude 45º.25ˈ. 00ˈˈ E. 28km west of Sulaymaniyah city center an on elevation of approximately 950 meters above sea level, after season 2018-2019 rainfall flooding water submerged in most of Bazian plain in some places reached 150cm. select 7 locations (L1=Zeika, L2=Gawani, L3= shwankara, L4= karaitaza, L5= Warmizyar, L6= Mahmudia, L7= Latifawa), area soil samples were taking in three replicate from seven deferent locations from deep25cm during April and May of 2019. Particle size distribution was determined by dry sieving and moisture and for micro-fractions by pipette method(10).Using XLSTAT program for statically analysis. Figure 1 showed the locations that effected by raining hardly and submerging except the control location that did not hit like the other locations.

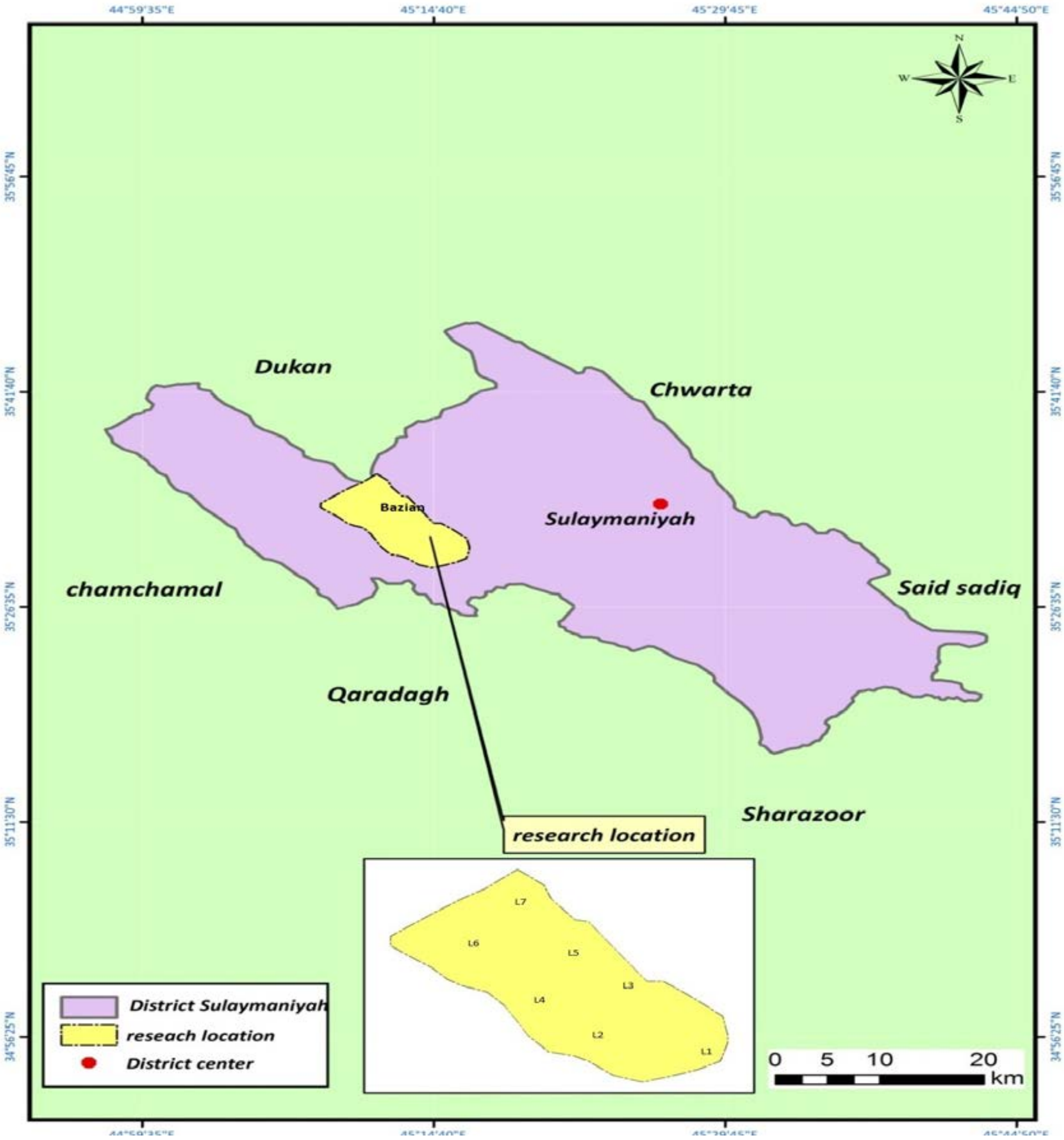

Figure 1 research locations by author using application of ArcGIS (10.2).

The Electrical conductivity for the soil was measured: water (1: 2.5) suspended after leaving the suspension settles overnight according to Richard(21).

The pH soil was determined on the suspension above after stirring. To measure pH ($CaC1_2$) the 0.01 M suspension was made with respect to $CaCl_2$ and stirred. The pH ($CaCl_2$) was measured two hours after suspension according to McLean(16).

Organic matter was determined by modifying the soil quantity method containing 30-100 mg of humus, 25 ml 0.25 MK2Cr207 and 40 ml conc. H_2SO_4 is placed in a 400 ml vial. The mixture was stored for 1.5 hours on a hot water bath, and allowed to cool for 30 minutes. 175 ml of water were added. After standing overnight, the caloric solution and measurement were measured compared to the criteria (red filter, 620-645 nm), according to Schnitzer and Khan (22).

The Total nitrogen of the soil was determined by the Kildahl method using tecator equipment. A 1-3 g sample of air-dry soil was weighed in a digestion tube containing 8 g of K_2SO_4 and 1 g of $CuSO_4$. Hit. H_2So_4 (20 ml) was added. The mixture was maintained at about 420°C (for 1-2 hours) until clear. 50 ml of water was added to the cryogenic extract, and alkaline with sodium hydroxide and distilled nitrogen was synthesized to 4% boric acid and titrated using 0.01M HC1 using bromocresol greenmethyl red as an indicator according to Chen and Dittert(7).

Phosphorus extract with 0.5 M $NaHCO_3$, pH 8.5thevolumetric soil: the extraction ratio was 1:20 and shaking time 1 hr. (27r.p.m.) Phosphorus color metrically measured with an ammonium moly ascorbic acid reagent according to Olsen *et. al*. (18)

Potassium, sodium, calcium and magnesium were extracted from the soil with 1 m CH_3COONH_4, pH 7.0 (6). The soil was volumetric: ant extract ratio 1: 10 and vibration (end on end) time 1 hour (27 noons). Hit. HC1 and La were added to the extract to make the extract 0.2 M with respect to HC1 and contains 0.25% La. Cations were determined using an atomic absorption spectrometry (Techtron AA-4 or Varian Techtron 1200) using an acetylene flame for air, magnesium and propane air for K and Na.

Extractable Ca, K, Mg, and Na were measured by atomic absorption of 1 mol/L NH^4OAC extracted of fresh soil, Total exchangeable bases were calculated as the sum of the concentration of Ca, K, Mg, and Na. exchangeable acidity was determined with the barium chloride – trie –ethanolamine method according to Thomas(24).

The effect of the flood on soil texture was detected by analyzing changes in soil molecular composition and soil texture type along the high gradient. The relationship between changes in soil texture and soil nutrients was discussed. All data were analyzed using XLSTAT software.

Results and Discussion

Description for the area after submerged waters get difference’s high starting from 30cm to 150cm left a lot of residues brings kinds of insects and worms like nematodes in some places in addition to less weed competition. Seeds of many kinds of weed species not germinate or their germination rate were decreased when they are submerged.

Saturation of soil following submergence causes kind of swelling of soil aggregates causing increasing in aggregate size and changing in many of soils properties (Table 1).

Starting from January of 2019 a heavy quantity's of rains precipitated on Sulaimaniyah that get 1235mm and this was the highest level since year1985(Figure 2).

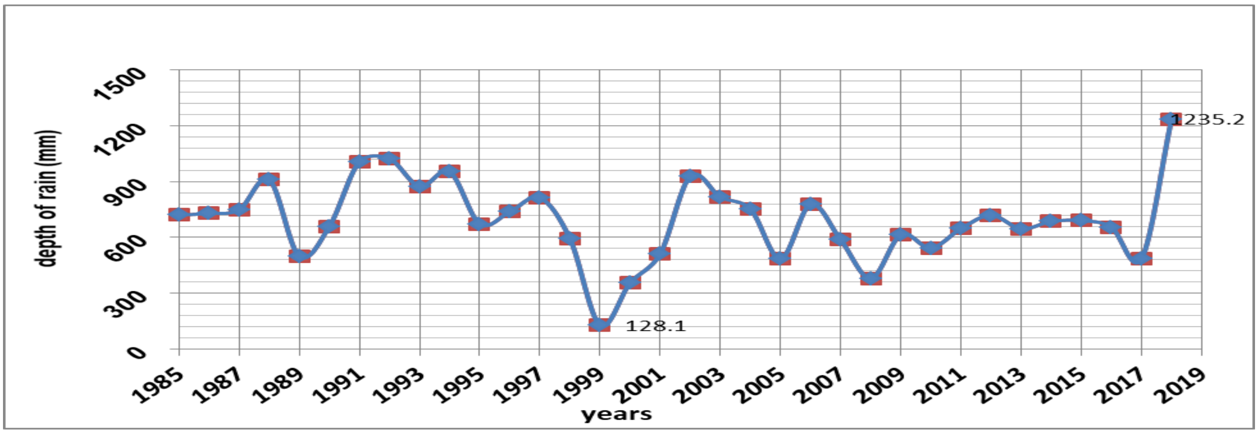

Figure 2 Annual rainfalls for 33years (1985-2019).

Source; directorate of Meteorology and earthquakes in Sulaymaniyah

Table 1 some soils properties effected after submerges in seven locations

Locations	EC ds.m^{-1}25c	PH	Sand	Silt	Clay	Class of Texture
L_1 (control)	1.65^a	8.06	17.25^a	39.49^b	43.26^b	Silt
L_2	0.35^d	8.31	5.68^c	50.79^d	43.53^b	Silt
L_3	0.9^b	7.8	6.75^c	32.47^a	60.78^d	Clay
L_4	0.68^c	8.08	14.71^a	44.58^c	40.71^a	Silt
L_5	0.38^d	7.8	6.08^c	50.44^e	43.48^b	Silt
L_6	0.25^d	7.87	6.34^c	50.98^d	42.68^b	Silt
L_7	0.39^d	7.89	4.15^c	47.81^d	48.04^c	Silt

Different letters in the columns indicate significant differences ($P < 0.05$).

(L1=Zeika, L2=Gawani, L3= shwankara, L4= karaitaza, L5= Warmizyar, L6= Mahmudia, L7= Latifawa)

Effects of flooding on chemical and physical properties

Comparison of locations indicated that the electrical conductivity (EC) of the soil solution changed differently in the soil of the site studied immediately after the growth of the flood. At location 5, the EC of the soil solution was significantly lower than the other soil solution (Table 1).

The specific chemical and physical properties of these soils are listed in Table 1. Important data in Table 1 indicate that the soil studied did not have a wide range in the initial pH (7.8-8.3)

The soil texture type in this area is Salty clay except in L_3 there wasn't a significant change in soil texture composition because

Of the wide range need it to make a change in soil texture, in L_3 the silt percentage Decreased to 32.47 % we suggest that return to the Flood water flow effect (14).

As well as the sand percentage decreased significantly from 17.25% to lower percentage like in locations (L_2 5.68 and L_7 4.15).

Flooding resulted a significant change in soil percentages of clay, silt, and sand (Table 1) compared with the non-flood it. When soils are submerged under water the suite of cation and anions held in the exchange complex are released in solution(10)

Nitrogen takes place in soils basically as compound organic essence, ammonia, molecular nitrogen, nitrite and nitrate. The transformations of nitrogen are micro-biological inter-conversions adjusted in the Soil by the chemically and physically environment(5).

Nitrogen mineralization was not higher in the soils studied in this survey rather than aerobic conditions, the lower Nitrogen mineralization in the submerged soil return to higher Nitrogen loss(10)

Table 2, Chemical properties effected after submerges soil in seven locations

Soil No.	Total N (mg kg^{-1})	Available P (mg kg^{-1})	Soluble ions K^+ (mmol L^{-1})	Soluble ions Na^{++} (mmol L^{-1})	Soluble ions Ca^{++} (mmol L^{-1})	Soluble ions Mg^{++} (mmol L^{-1})
L_1(control)	2.5 ^{a}	17 ^{a}	0.351 ^{b}	0.378 ^{b}	5.5^a	3.5 ^{a}
L_2	1.7 ^{c}	15 ^{a}	0.233 ^{b}	4.565 ^{b}	2.75 ^{b}	1 ^{b}
L_3	1.6 ^{c}	11 ^{b}	0.743 ^{a}	0.434 ^{b}	3.25^b	0.75 ^{b}
L_4	1.8 ^{b}	16 ^{a}	4.358 ^{b}	1.043 ^{a}	1 ^{c}	1 ^{b}
L_5	1.9 ^{b}	15 ^{a}	0.097 ^{c}	0.443 ^{b}	2.25 ^{b}	0.5 ^{b}
L_6	2.0 ^{b}	16 ^{a}	0.115 ^{c}	0.243 ^{c}	2 ^{b}	0.9 ^{b}
L_7	1.4 ^{b}	12 ^{b}	0.220 ^{b}	0.643 ^{b}	1.35 ^{c}	0.65 ^{b}

Different letters in the columns indicate significant differences ($P < 0.05$).

(L1=Zeika, L2=Gawani, L3= shwankara, L4= karaitaza, L5= Warmizyar, L6= Mahmudia, L7= Latifawa)

When soils are submerged; the main transformations are accumulation of ammonia, nitrogen fixation and leaching losses of nitrogen. The series of operations had an important possibility on the nutrition in the greenhouses (8).

In aerated soils ammonium is the in organic form and all of the nitrogen reactions that follow the composition of organic matter proceed towards the production of Nitrate Thus organic form of nitrogen undergoes mineralization to Ammonium oxidation of Ammonium to Nitrite and oxidation of Nitrite to Nitrate In aerobic soils, (23).

Nitrogen in organic form throws mineralization and ammonification result NH^{3+} throws microbial oxidation resulted NO^{2-} throws microbial oxidation NO^{3-}

In the other hand anaerobic soils the obscurity of Oxygen inhibits the activity of the Nitrosamines micro-organisms that oxidizes Ammonium and therefore, nitrogen mineralization stops at the Ammonium form (23)

In submerged soil:-

Nitrogen in organic form throws mineralization result NH^{4+} Comparison between soils studied in this survey and the control was not significantly differences the absorption of phosphorus by throwing roots led to the depletion of phosphate ions in the root system (25). This initial decreasing in available phosphorus could return to the increasing in PH or the decreased solubility of phosphorus associated with calcium(12).

Soil submergence impacts on the available phosphorus in a way that Phosphorus is notimplicated in oxidation-reduction reactions in redox potential range encountered in submerged soils, but because of its reactivity with a number of redox elements its behavior is significantly affected by flooding (11).

When an aerobic soil is submerged the concentration of available phosphorus initially decreased and thereafter declines with the period of submergence. However, the magnitude of initial increase and decrease in the later period of submergence depends on the soil properties(26)

There is an initial increasing in soluble Potassium after submergence is closely related like it is shown in Table (2) and that could return to the effect of flooding on leaching some ions like iron or manganese and It is then replaced by potassium ions.

There were evident from vegetative growth and plant production follow up support that plants in this study area can absorb the total absorbed Potassium from the non-exchangeable form under submergence than that of non-submergence soils therefor submergence soil could increase the exchangeable potassium content in these soils(15)

Calcium content was lower in locations 4, 7 and higher in control location 1. Other differences location 2, 5, and 6 was not found to be significant, Sodium ratios value was lower in the study locations 1, 3, 5, 6, and 7 and higher in location 2 Magnesium content was lower in vegetation location 2, 3, 4, 5, 6, and 7 and higher in location 1 these differences in the impact of submerge on these elements could be a result of leaching

Conclusions:

The main conclusion of this work was to study the impacts of the submerges waters that caused because of the heavy rainfall in season 2018-2019 and the results showed many change recorded in the soil physical and chemical properties such as calcium and magnesium that decreased Cleary so in these conditions farmers should be more attention to made some analysis for soils.

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INFLUENCE OF TEMPERATURES RISE OVER 48-YEARS ON SULAYMANIYAH AGROECOSYSTEM STRUCTURE AND NEMATODES DISTRIBUTION USING GIS APPLICATION

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ABSTRACT: From a studied to collect data for temperature degrees during 1973 until 2019 there is clear evidence that show climate change is happening in our region. The collected data showed that the average annual temperature rate has raised by almost 1.3°C, the average of warmest year for this period was recorded in 2010 and it was 21.55°C. In 2016, average temperature degree was high 20.3°C as the global worm rising the lowest temperature in this period was 16.2°C recorded in 1992. Since 1973 until 1985 the average temperature was 18.39°C and since 1986 until 1998 the average temperature raised to 18.79°C, then since 1999 until 2010 the average temperature raised again to 19.93°C but in period 2011 to 2018 the average temperature raised to 20.09°C. The difference between warmest monthly average temperatures and the coldest month of the year or annual range in 1988 was the highest and valued 31.9°C while in year 1973 was the lowest (19.6°C) but the rate for the period 1973 to 2018 was 27.9°C. The *absolute* annual temperature range or differences between the maximum absolute temperature and the minimum absolute temperature during a year was obvious like in 1973 was the highest (53°C) and in 1987 was the lowest (35°C). Diurnal temperature variation or the daily difference between the maximum and minimum temperatures was limited in winter months almost recorded 6 - 9°C, but in summer months the ranges is bigger almost reported 15 - 18°C. Over these years specially from (2008 -2019) soils that affected with plant pathogenic nematodes increased dramatically in the study area witch was within 10 km^2 because of rising temperatures degrees and need to use greenhouses instead of open field cultivation, these greenhouses numbers influencing on agroecosystem structure for a long terms. From this investigation, and to control plant pathogenic nematodes in the infested greenhouses, farmers used kinds of chemical pesticides that cause damages to the soils and the yields as well as changing agroecosystem structure. Agroecosystem structure for the study area has been changed relatively because of increasing the numbers of greenhouses that got almost 7000 greenhouse causing imbalance in agroecosystem by using a huge amount of water (125 m^3/greenhouse).

Key words: Climate changes, rising temperature, agroecosystem stricture, Plant-Parasitic Nematode

INTRODUCTION

Among the many global exchange factors that contribute to non-linear responses to ecosystems and sudden shifts, climate change in particular is likely to push ecosystems across borders. Experiments have shown that climate change can lead to changes in the ecosystem. Transformations caused by warming in species composition in grassland are widely observed (**Yang *et al.*, 2011**). Warming above 1.5°C is expected to significantly increase the likelihood of reaching critical turning points for ice sheets in Greenland and Antarctica (**Climate Analyzes, 2017**) as Greenland's ice sheet faces an irreversible drop of about 1.6°C to warming (**Hare *et al.*, 2016**). While there are some uncertainties regarding the turning points, it is clear that

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limiting the rise of temperatures to less than 1.5°C will lead to a rise in the sea level to less than one meter and that rising temperatures above this level threatens to raise the sea level to several meters over the coming centuries. An increase in shrubs and grass-like plants can reduce the competitive performance of other plant species and thus change the competitive hierarchy within society (**Niu and Wan, 2008**). Net primary productivity. Ecosystem state shifts can significantly affect ecosystem functions, including changes in net primary productivity, water and food recycling, regional climate regulation, and food interactions (**Zavaleta, 2006**).

Recent research in agricultural ecosystems indicates that winter climate changes may lead to lower soil levels C and isolation of the C ecosystem (**Senthilkumar *et al.,* 2009**). Global warming can have adverse effects on plant growth.

From a long-term viewpoint, however, warming temperatures in the atmosphere will drive major crop production sites. Water shortages caused by global warming will be the biggest problem for crop production (**Nakicenovic *et al.,* 2000**). Plants mainly depend on sufficient fresh water, and agricultural water accounts for 70% of water use worldwide. As temperatures rise, evaporation increases water sources and precipitation decreases, arid regions will become more ruined. Generally speaking, entire crop production will be affected by global warming, leading to food shortages worldwide (**Singh and Sontakke, 2002**).

Photosynthesis is one of the most physiological processes sensitive to stress when hyperthermia. Reproductive development is more sensitive than the vegetative development of high temperatures, and temperature sensitivity varies between crops (**Singh *et al.,* 2001**).

The components of the agroecosystem are highly sensitive to changes in climate, especially to severe weather events, low soil moisture, temperature changes and an increase in carbon dioxide in the atmosphere. It will also affect groundwater replenishment patterns and epidemic transpiration rates (**Allen *et al.,* 1994**).

Results reported that climate change scenarios without the physiological effects of CO_2 cause a decrease in the estimated production. Greenhouse gases such as CO_2, CH_4, and N_2O are directly related to agriculture (**Aggarwal, 2000**).

The global warming potential (GWP) of CH_4 is twenty times and the potential for nitrous dioxide is 300 times that of carbon dioxide, while the physiological effects of CO_2 mitigate the negative effects (**Warrick, 1988**).

Cure and Acock (1986) reported that, controlling environment of cultivation has enriched the information about temperatures degree that effected increasing or decreasing on the agroecosystem practices. The impact of temperature degrees is more complicate with lower production.

Increasing temperatures and interacting with changes in water systems and water management that affect crop productivity and sustainability in ecosystems. Likewise, changes that interact constructively should take into account negative events, especially torrential rains, with direct consequences such as the loss of irrigated areas or agricultural land, due to the high or frequent floods and droughts. Changes in the water system will affect the water availability of plants and will affect yields, increase their density and parasitoid levels with nematodes, due to the positive effects on the plant's entire biomass (**Wessolek and Asseng, 2006**).

Increasing temperatures are expected to enhance plant growth, providing a greater food source for nematode but also increasing the whole ecosystem. Temperatures also effect on some plants stages like rapid of germination, flowering of plants (**Goudriaan and Zadoks, 1995**).

Higher CO_2 levels lowered the numbers of bacterial feeders, increasing fungal feeders and predators in forest (**Neher *et al.,* 2004**). Air pollutants effect on nematodes through changes in the physiology of the host plant. Synergistic interactions between ozone or SO_2 and *Meloidogyne incognita* were observed on tomato, as higher levels of foliar damage were found on nematode infested plants (**Khan and Khan, 1997**). Nematodes reaction to rising CO_2 levels is complex, depending on trophic groups: no effect was reported on nematodes from grassland soil (**Freckman *et al.*, 1991**), but numbers decreased in cotton rhizosphere (**Runion *et al.*, 1994**).

Objectives of the study

The objectives of the present study aims to determine the general trend of temperature and study the effect of the change in temperature rise on increasing infection of root-knot nematodes (*Meloidogyne* spp.) in Sulaimaniyah Governorate, Iraq.

MATERIALS AND METHODS

The study used the inductive and inferential method in treating climate data,by studying, analyzing, and categorizing the monthly averages of temperature, and deriving the results,the study used the descriptive approach in describing the rise in temperature, determining the factors that cause it, and describing the environmental effects resulting from it. The study also used a number of statistical methods to collecting data's in excel sheet to get the average annual temperature, the absolute annual temperature range, diurnal temperature variation.

The study area was in Sulaimaniyah Governorate. City of Sulaimaniyah is located in the northeastern part of Iraq. It characterized by the general nature of its surface. It is mountainous and is surrounded by valleys and some small plains. The city is located on the western slopes of the Azmur Mountains that located between longitude 35^{o}.49'. 00" N. and latitude 45^{o}.25'.00" E. The city is surrounded by several mountain ranges from north-west to south-east.Sulaimaniyah is providing on sloping land 3.5%. The northern end of the city is 885m above sea level and southern end is 800m. above sea level.

Based on climate classifications carried out by researchers and specialists in this field the climate of the city can be considered as a temperate climate or (the Mediterranean climate of the mountain) and its most important climatic characteristics are:

- The annual average temperature is 18.74°C.
- As for the wind and as shown in the wind rose of the city, the prevailing winds are (North-East and usually very fast). Rainfall mainly in winter and spring, while there is no rain in the summer, more annual Rainfall recorded in 2018, reaching 1273.80 mm. The average daily amount of solar radiation reaching the Sulaimaniyah station is 989.4 kcal/cm^2/day. It is possible to say that there is moderation in the solar radiation in the general northern region in general and Sulaimaniyah in particular due to the high clouds and relative humidity. Daily vertical radiation rate that reaches the northern region equivalent to 5-6 kWh /m^2 and 6-6.5 kWh /m^2 for the central and southern region.
- The average daily brightness of the sun below in February (4.7) hours/day and the maximum in July (12.6) hour / day, the annual rate of this period is (8.33) hours/day, less than the total rate of energy saving (the period of sunshine) 8.8 hours per day.

The biological assessment of the city of Sulaimaniyah illustrates the following:

- In terms of rainfall, it is noted that high rates of rainfall fall annually, as the annual rate of 1273.8 mm.

Survey of root-knot nematode infection was made in the greenhouses in an area contain at least 4000 greenhouses. Studying types of vegetables that planted in these greenhouses.

RESULTS AND DISCUSSION

Understanding How Temperatures Increased by 1.5°C

Fig. 1 shows the changes in annual averages temperatures and the increase of disorder in climatic patterns, year of 2010 was the highest year in average annual temperature of 48 years since 1973-2019 on recorded with increase get 1.5°C and 1999 was high also with difference's increase getten average of 1.5°C if making a trendline throw these years the heat increased from 18°C to 19.5°C almost. From Table 1 the overlap between temperature rise and effect of that on agriculture and type of plant cultivate has become crucial to understanding the role that region warming plays in contributing to agriculture and mitigating its effects (**Gaasland, 2003**). Increasing or decreasing Sulaimaniyah air temperatures impact on plant distribution and

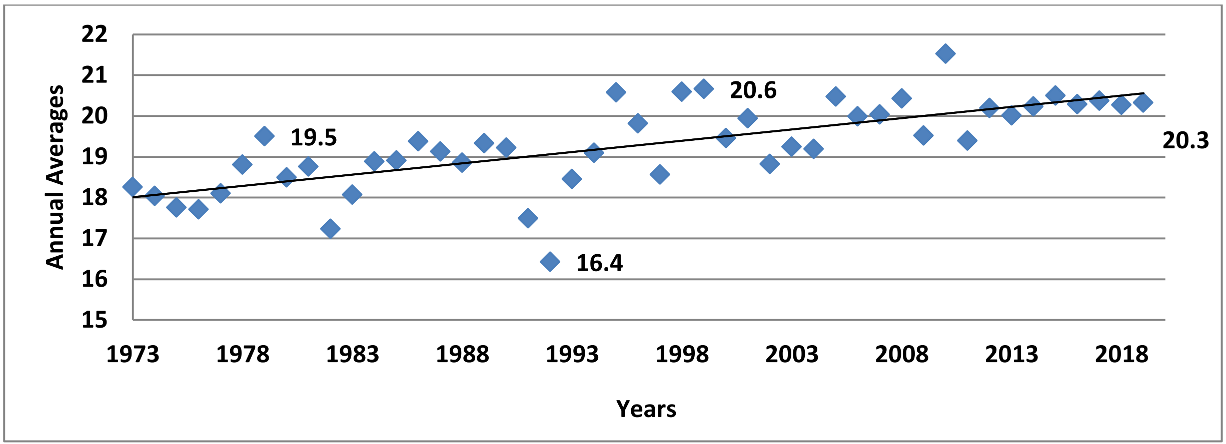

Fig. 1. Average annual temperatures degree (°C) during 48 years (1973-2019)

__Source__: Directorate of Meteorology and earthquakes in Sulaimaniyah, Iraq

productionas well as management drought conditions (**Battisti and Naylor, 2009**). Warming also could make changing in the resistance of vegetable's to specific diseases or by increasing disease of living organisms by mutation caused by environmental stress (**Gregory *et al.*, 2009**).

In Sulaimaniyah region the absolute temperature have a clear range between the maximum and minimum degree (Fig. 2). Data's recorded in years like 1972, 1975, 1981, 1987, 1988, 1998, 1999, 2008, 2010, 2018 shows differences between the maximum absolute temperature and the minimum absolute temperature during the year that affect agriculture by changing the length of the growing season, and crop distribution (**Chakravarty and Mallick, 2003**).

Maximum and Minimum Temperature Directions

Average of minimum and maximum temperature both have their own significance effects in the growth and development of plants during life cycle. The highest maximum temperature year are found in 1987 (Figs. 3 and 4) while the lowest temperature year were in 2019. During these 48 years the maximum temperature increased by an average of 1.5°C. This a clear evidence of strong changing climate in our region by increasing temperature in a way ecosystems have responded to these changes.

Crop production suffers in our regions where changes in temperature will further stress the already limited productive (**Müller, 2009**).

Because of the temperatures getting higher also grow seasons have become unstable that's leads to droughts condition which affect the quality of yields (**Howden *et al.*, 2007**).

Annual Averages for March Month as an Individual Months

March month is an impotent for agriculture in our region, so it considerate in the coldest months and the most worm as well as founding the trendline for all months during 1973 – 2019 the coldest March month were 3.95, 4.3 and 4.7°C, respectively in years 1992, 1987 and 2019, warmest March months degree were 21.95, 21.35 and 19.45°C in years 2008, 2018 and 1997. The general trendline for March annual average temperature degree for past 48 years was increasing in a way that clearly shows how temperatures rise in our region, environment like that will effect on quality and quantity of agricultural productivity, changing in quantity of water that use in irrigation or other cultivation process (**Wolfe *et al.*, 2008**).

Trendline for the records in Fig. 3 shows how worm in March month increase about 1.5°C and that increase of effecting by pests and disease as well other stress sucrose on the yield that decreased by about 30% (**Souza *et al.*, 2008**) as well as the morphology of transplanting such as size, color, mild water stress have effected clearly because of the increase in temperature in this month (**Inman-Bamber *et al.*, 2009**).

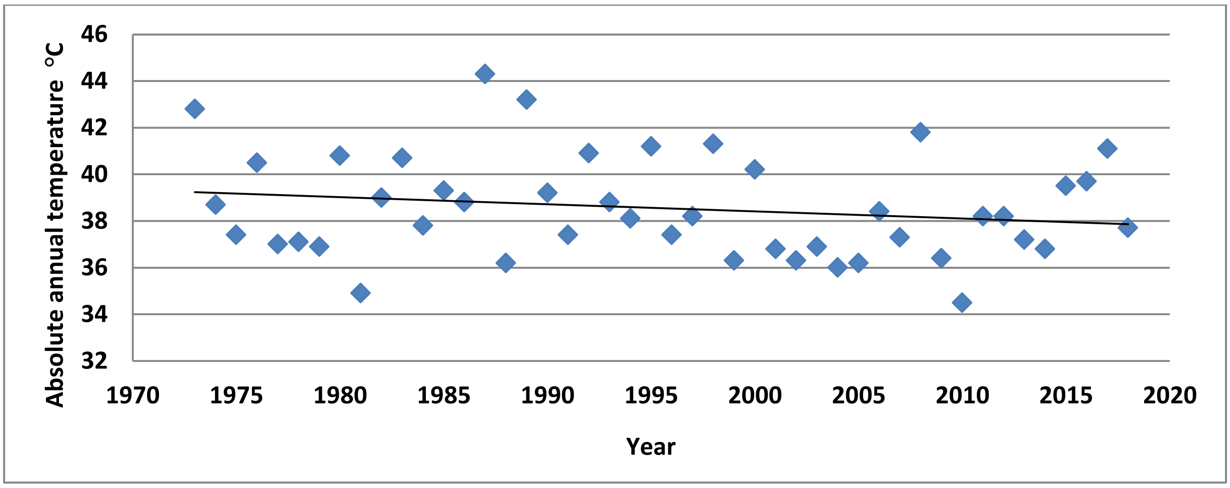

Fig. 2. Absolute annual temperatures degree (°C) during 48 years (1973-2019)

Source: Directorate of Meteorology and earthquakes in Sulaimaniyah, Iraq

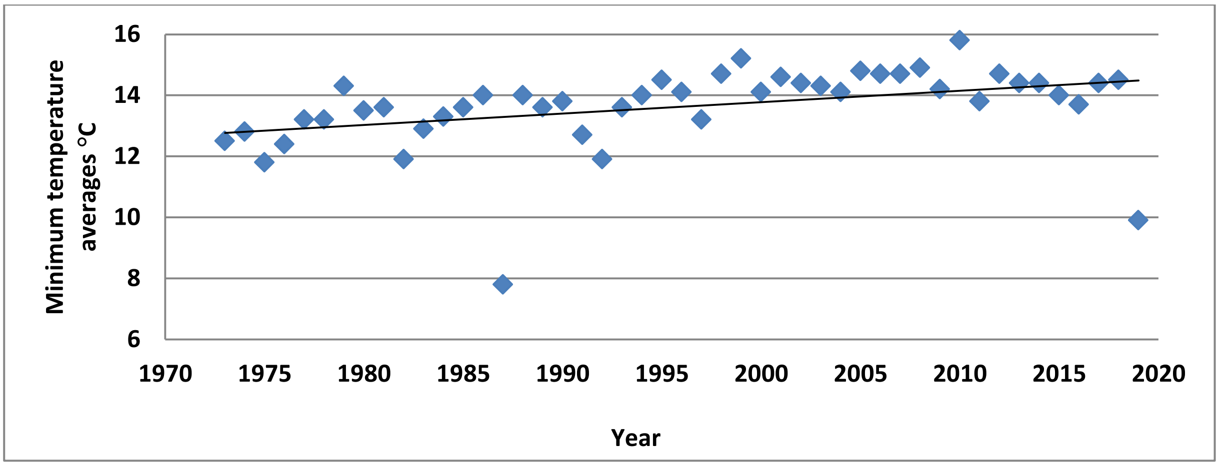

Fig. 3. Annual minimum temperatures degree (°C) during 48 years (1973-2019)

Source: Directorate of Meteorology and earthquakes in Sulaimaniyah, Iraq

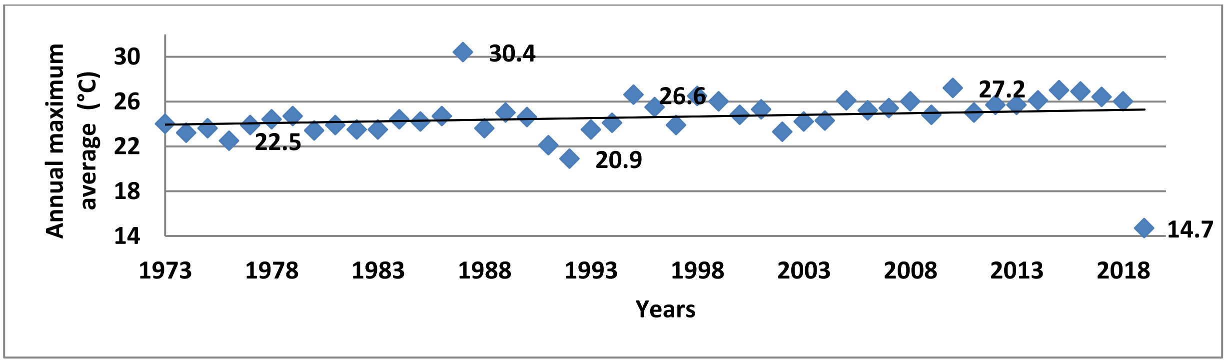

Fig. 4. Annual maximum temperatures degree (°C) during 48 years (1973-2019)

Source: Directorate of Meteorology and earthquakes in Sulaimaniyah, Iraq.

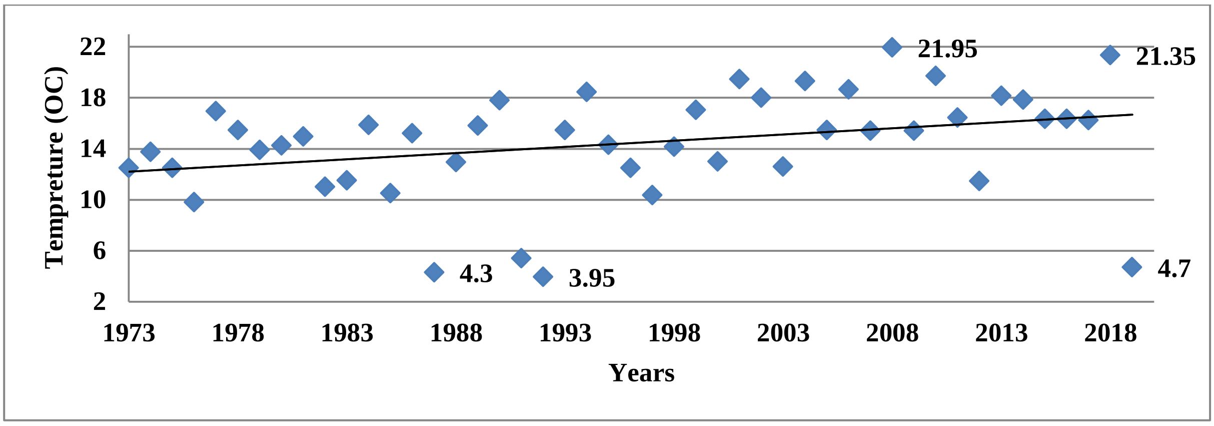

Fig. 5. The annual averages for March month during (1973 – 2019)

Source: Directorate of Meteorology and earthquakes in Sulaimaniyah, Iraq.

Annual Averages for August Month as a Heating Month in the Season

Trendline in Fig. 6 for heating degrees recorded for August months since 1973 until 2019 shows increasing in the temperatures from 31.5°C average to 33.8°C average. Continuing in rise temperature cause drought in the ecosystem as well the huge range between day night temperature that reach (20°C) and decreasing air humidity lead to dry air and wide speared drought because of narrowing the vegetation cover areas (**Chitwood, 2002**).

Temperatures and soil temperature as a results affects many nematode activities such as egg hatching, nematode distribution, and their ability to survive It also affects the plant host and thus the nematode, nematode to remain in an active state, a thin membrane of water must be available to cover it, and a sufficient amount of oxygen to breathe. These two requirements are usually met in most agricultural soils at a humidity level of 40-60% of the field capacity. The fluctuation of soil moisture due to irrigation water is one of the main factors affecting nematode density in the soil (**Sikora and Fernandez, 2005**).

Survey of some Important Cultivation Locations in Sulaimaniyah Agroecosystem

Site description

This area is a wide plain with slightly slope topography called Bazian Plain. It's contain 6 Watersheds and 14 micro-catchments (**Barzinji, 2013**).

In 24 locations (villages), select some greenhouses cultivated with vegetables (Cucumber, Tomato, and Pepper) to take soil samples (25 cm depth) for nematodes analysis.

Nematode egg masses were isolated and counted from soil as indicated in Table 1.

After 2007, excessive use of greenhouses increased with the relative increase in temperature rates, which led to an increase greenhouses gain heat during the day with the solar radiation entering these greenhouse and turn into thermal energy when in contact with plants and soil. This huge areas of using plastic greenhouses contributed to increased the air temperature throw emersion's gases especially CO_2 causing the spread of types of diseases, insects and plant parasite like nematodes (**Varshney *et al.*, 2011**).

The results of this study show that type of crop plays a major role in increasing nematodes distribution, the cucumbers and tomato plant roots are more affected by root-knot nematodes compering to other vegetables (Table 2).

Also, the nematodes in the pepper infested soils responses to the changes of hydrologic cycle as a result to the changing climate, rising temperature degrees when these worms are transported from drought soils to the wet soil in the greenhouses that being irrigated regularly (**Hoeksema *et al.*, 2000**).

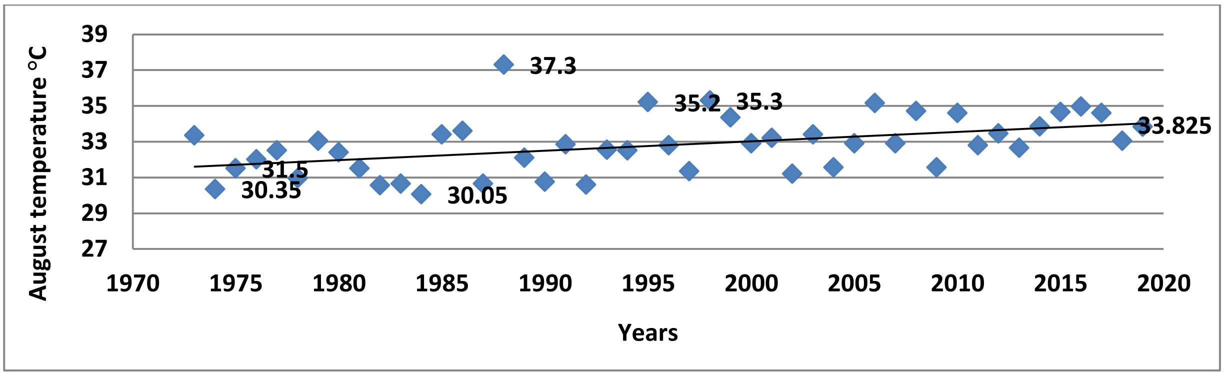

Fig. 6. The annual averages for August month during (1973 – 2019)

<u>**Source**</u>: Directorate of Meteorology and earthquakes in Sulaimaniyah, Iraq.

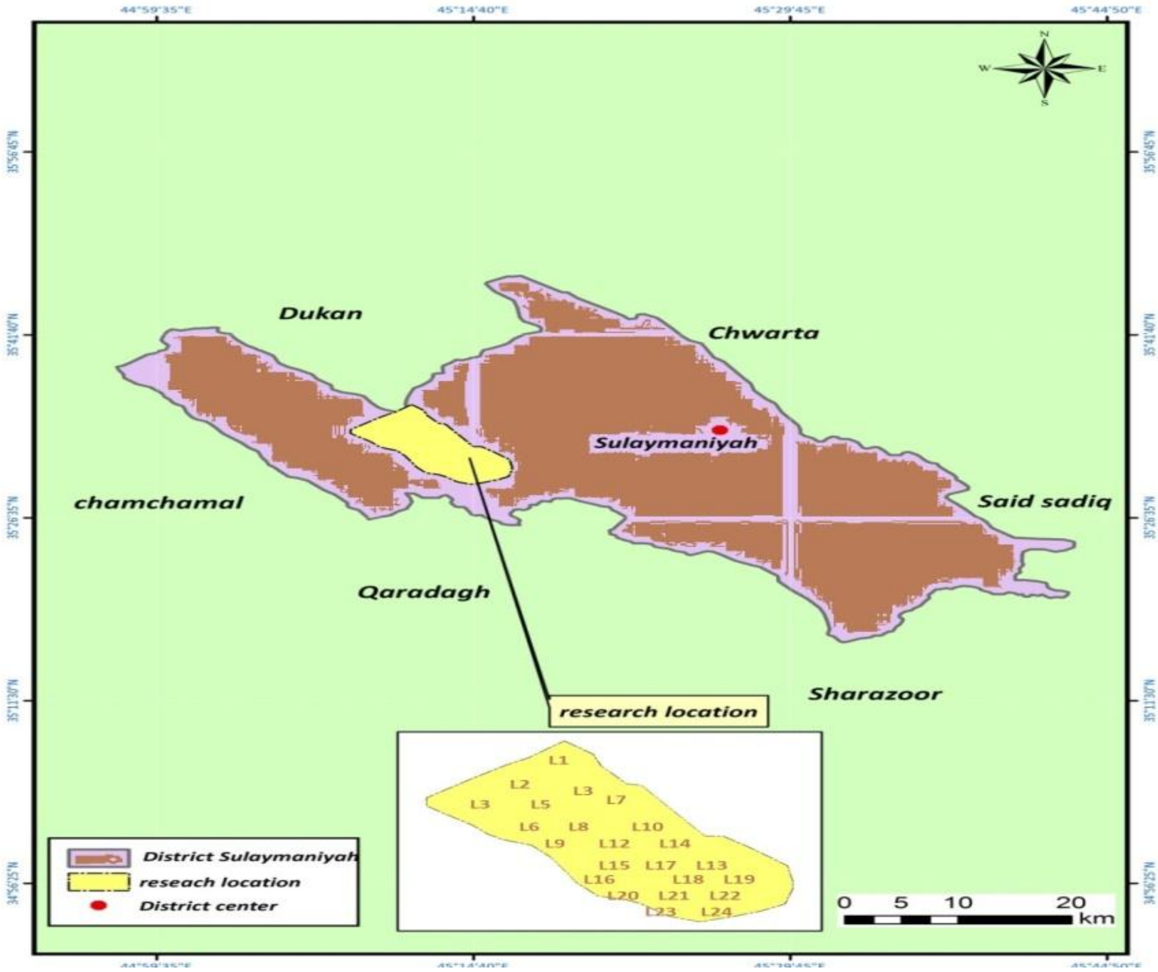

Fig. 7. Villages coordinate for survey locations in Sulaimaniyah Governorate

Study area using application of GIS (ArcGIS 10.1 program)

Table 1: Nematode analytical

No.	Tools and materials	Reference
1	20-mesh sieve (833 µm aperture)	
2	200-mesh sieve (74 µm aperture)	Howard Ferris, Departments
3	325-mesh sieve (43 µm aperture)	of Entomology and
4	Coarse sieve (1 cm aperture)	Nematology,
5	Two stainless steel bowls or plastic buckets	University of California
6	250 ml beaker, 600 ml beaker	(from **Zuckerman** ***et al.*****,**
7	Coarse spray wash bottle or tube attached to faucet	**1981**)

Soil samples taken from these locations from depth 25-30 cm.

Table 2. Survey for root-knot nematodes (*Meloidagyne* spp.) in some locations of Sulaymaniya Governorate

Loc.	Village name	Latitude (N)	Longitude (E)	Crop	Description	No. of egg masses/root system
L_1	Bagajani	35.573129	45.179865	Cucumber	Not infected	0
L_2	Mewk	35.574642	45.170733	Cucumber	Infected	16
L_3	Bagajani	35.562523	45.153836	Cucumber	Infected	23
L_4	Koyik	35.563983	45.170733	Pepper	Non infected	0
L_5	Kani big	35.563227	45.175807	Cucumber	Infected	24
L_6	Shuwankara	35.564188	45.192795	Cucumber	Infected	20
L_7	Tuiawlia	35.559212	45.190636	Tomato	Not infected	0
L_8	Qushqaya	35.557166	45.193336	Tomato	Infected	31
L_9	Ali Bzaw	35.555679	45.180524	Pepper	Non infected	0
L_{10}	Ali Bzaw	35.554676	45.176405	Cucumber	Infected	27
L_{11}	Penjsharnma	35.540696	45.191150	Tomato	Infected	30
L_{12}	Kani Shaya	35.538872	45.217801	Cucumber	Infected	39
L_{13}	Kani Shaya	35.529785	45.204436	Cucumber	Infected	19
L_{14}	H. Sarchawa	35.525898	45.208930	Pepper	Not infected	0
L_{15}	H. Sarchawa	35.531651	45.195435	Cucumber	Not infected	0
L_{16}	Mahmudia	35.524027	45.198905	Tomato	Infected	13
L_{17}	Ziyeka	35.524583	45.221645	Cucumber	Not infected	0
L_{18}	Ziyeka	35.518852	45.222030	Cucumber	Infected	17
L_{19}	Warmizyar	35.515835	45.237502	Cucumber	Infected	21
L_{20}	Warmizyar	35.517955	45.235790	Tomato	Infected	18
L_{21}	Gawani	35.500416	45.254908	Cucumber	Not infected	0
L_{22}	Gawani	35.501443	45.254239	Cucumber	Infected	28
L_{23}	Gawani	35.508113	45.254239	Cucumber	Not infected	0
L_{24}	Latifawa	35.492244	45.231547	Cucumber	Infected	25

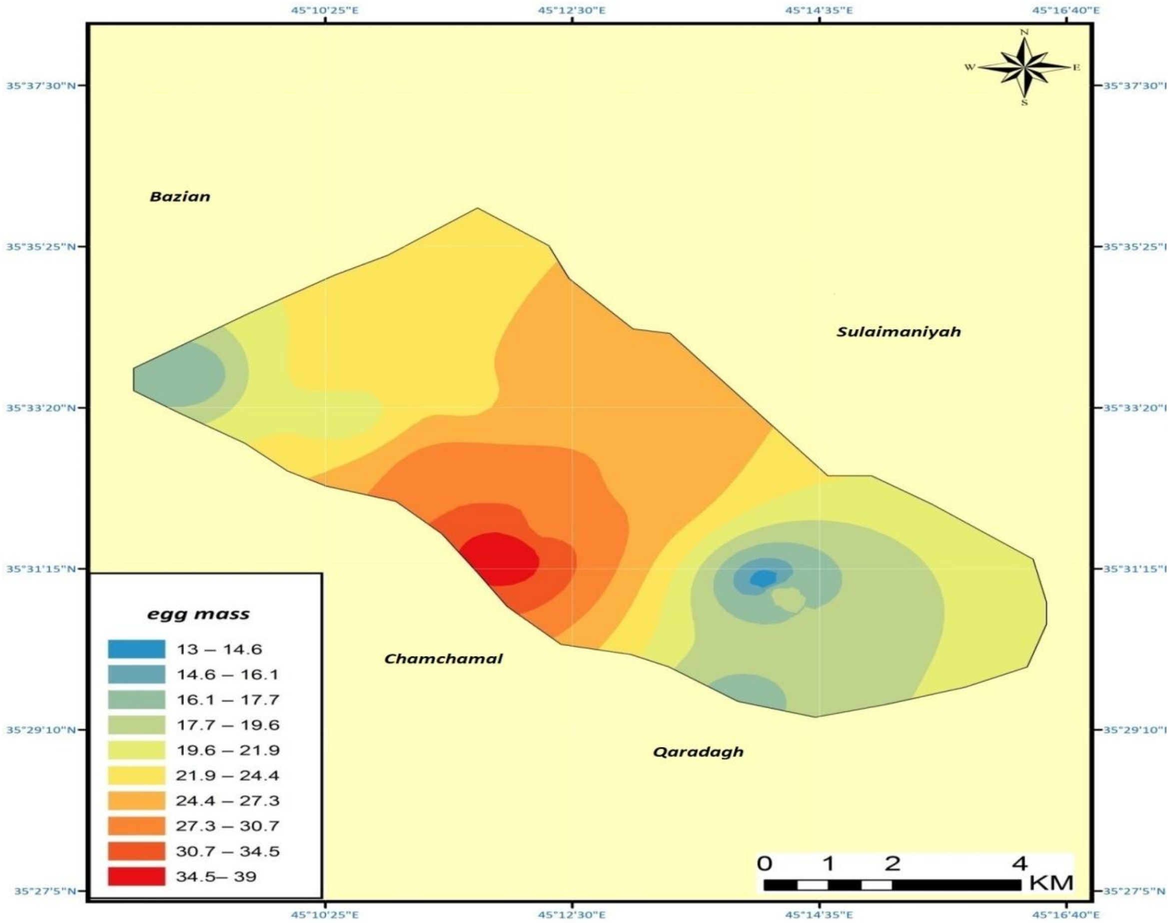

Fig. 8. Survey for nematodes egg masses distribution in Sulaimaniyah, Bazian plane

Gis map explain the distribution of egg masses in the study area (ArcGIS 10.1 program).

However, increasing heat in the plant environment cause increasing in the plants physiological activates such as heat that absorbed and the amount of heat that lost energy then the plant is heated and increase the permeability of membranes and leakage of dissolved substances from cells thus root surface become more vulnerable to the nematodes (**Chakraborty *et al.*, 2000**).

Temperatures rise and changes in cultivation environment when interacted with some human activity such as using land that affecting on crops productivity and sustainability in the study area ecosystems (**Fuhrer, 2003**).

Other impacts of climate change, such as the occurrence of floods, contributed to the increased prevalence nematodes like what happened in 2019 (**Akram *et al.*, 2020**), which led to the spread of many diseases and pests in particular nematodes (**Kardol *et al.*, 2010**).

Conclusion

A changing about 1 or 1.5°C in temperature can impact on agricultural ecosystem in Sulaimaniyah region. Agricultural crops will be more exposed to the temperature stresses caused by extreme climatic events. Warming and rising warm degree enhances the distribution of nematode. Moreover, due to increasing temperature, from our investigation many wild species of plants become extinct for example (Anchusa and Digitalis), increasing temperature degree relate to the increasing in CO_2levels having negative physiological impacts photorespiration on plant.

So Sulaimaniyah city it is comfort from heating side for humans and the assessment of areas above the level of thermal comfort to warm and warm, the temperature during the year is as follows: 45% of year it is cold.30% it is comfort for humans.15% fell warm.10% it is hot.

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تأثير الارتفاع في درجات الحرارة على مدى 48 عاما على هيكلية النظام البيئي الزراعي و توزيع النيماتودا في السليمانية باستخدام تطبيق نظم المعلومات الجغرافية

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1- مديرية الأبحاث الزراعية في السليمانية – إقليم كوردستان – العراق

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من دراسة أجريت لجمع البيانات الخاصة بدرجات الحرارة خلال الفترة من عام 1973 حتى عام 2019، يتضح لنا بالدليل أن هناك تغيرات مناخية تحدث في منطقتنا، تشير البيانات إلى أن متوسط درجة الحرارة السنوية قد ارتفع بنحو 1.3 درجة مئوية، وقد تم تسجيل متوسط السنة الأكثر دفئًا خلال هذه الفترة في عام 2010 وكان 21.55 ^{o}م، في عام 2016 كان متوسط درجة الحرارة مرتفعًا والذي وصل إلى 20.3^{o}م مع ارتفاع درجة الحرارة العالمية. وقد سجلت أدنى درجة حرارة في هذه الفترة 16.2 ^{o}م في عام 1992، منذ عام 1973 حتى عام 1985 كان متوسط درجة الحرارة 18.39 ^{o}م ومنذ 1986 حتى 1998 ارتفع متوسط درجة الحرارة إلى 18.79 ^{o}م ثم منذ 1999 حتى 2010 ارتفع متوسط درجة الحرارة مرة أخرى إلى 19.93 ^{o}م ولكن في الفترة 2011 إلى 2018 ارتفع متوسط درجة الحرارة إلى 20.09 ^{o}م، كان الفرق في متوسط درجة الحرارة بين أكثر الشهور سخونة وبرودة في السنة والذي يعرف بالنطاق السنوي لدرجة الحرارة في عام 1988 هو الأعلى 31.9 ^{o}مبينما كان في عام 1973 أدنى مستوى 19.6^{o}م ولكن المعدل للفترة من 1973 إلى 2018 كان 27.9 ^{o}م، كانت مدى درجة الحرارة السنوية المطلقة أو الفروق بين درجة الحرارة القصوى المطلقة ودرجة الحرارة الدنيا المطلقة خلال عام واضحًا كما في عام 1973 كان الأعلى 53 ^{o}م وفي عام 1987 كان الأدنى 35^{o}م، كان الاختلاف في درجات الحرارة اليومية أو الفرق اليومي بين درجات الحرارة القصوى والدنيا محدودًا في أشهر الشتاء تقريبًا 6-9 درجة مئوية ولكن في أشهر الصيف تكون النطاقات أكبر تقريبًا 15 - 18 درجة مئوية، على مدى هذه السنوات خاصة في الفترة من 2008-2019 توسعت مساحات الأراضي التي تأثرت بالنيماتودا المتطفلة على النبات بشكل كبير حسب دراسة اجريت على مساحة 10 كيلومترات مربعة و ذلك بسبب ارتفاع درجات الحرارة والحاجة إلى استخدام البيوت البلاستيكية بدلاً من الزراعة في الحقول المفتوحة، ومن خلال هذه الدراسة اتضح ان المزارعون للسيطرة على الديدان الخيطية التي تصيب للنباتات في البيوت المحمية المتضررة يستخدمون أنواعًا من المبيدات النيماتودية التي تسبب أضرارًا للتربة والانتاج بالإضافة إلى تغيير النظام البيئي الزراعي، حدث تغيرفي بنية النظام البيئي الزراعي لمنطقة الدراسة نسبيًا بسبب زيادة أعداد الصوب الزراعية التي وصلت الى ما يقرب من 7000 صوبة زجاجية مما تسبب في اختلال توازن النظام البيئي مثل استخدام كمية كبيرة من المياه في الري 125م^{3}/ صوبة.

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Mapping a Survey for Soil Fertility in Tainal Watershed (Bazian plane) Sulaimaniyah Ecosystem Using Application of GIS

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Abstract

Soil fertility parameters (nitrogen, phosphorus, potassium, calcium, magnesium, sodium, chloride, calcium carbonate, organic matter) were determined in soil samples that taking from deep 0 – 30cm. In greenhouses sowed with different vegetable cucumber, tomato, pepper, eggplant) in 24 villages of Tainal watersheds (Bazian city-As Sulaimaniyah). In the present study, a new technology of ArcGIS 10.1 was used for mapping. The results obtained from a survey area had 12 km^2 (N 35.5731; E 45.1798) for soil fertility. Results show that farmers did not fertile soil based on soil analysis except some farmers in Bagajani sites (N 0.22%, P 92.6 ppm, K 0.038 mEq^{-L}, O.M 2.85%, EC.0.23 $dS.m^{-1}$).In the same area (N: 35.750, E:45.354), soil in villages (Shuwankara, Zyeka , Gawani) have the heights ratio in nitrogen comparing to others (0.0380% , 0.325%) . According to the results, all the greenhouses soil samples are low in fertility and need to add appropriate fertilizers. All the soils in other villages' have the same problem accept one site they were using organic matter before sowing by two months. The study revealed that 82% of the samples were under critical threshold value for soil fertility.

Keywords: Soil fertility survey, GIS, Bazian, plant nutrient elements.

Introduction:

According to Ulrike *et al.*, (22). Food production should increase by 40% by 2025, in order to meet the needs of a population that is rising at a rate of 33%. Intense cropping, inconsistent fertilizer use, and unreliable and low-quality irrigation water are all necessary elements of the region for meeting these food production targets for wealthy people, all of which have resulted in less productive soils. However, no particular spatial information on the status of micro and macronutrients in the so-called "food desert" exists at this time.
Although soil fertility is a significant limitation to agricultural production in developing countries, GIS-derived variables are included in the household decision model. Their use also allows for the prediction of geographical uptake based on parameter estimates.

Akhter *et al.*, (2) create detailed maps of the region's soil fertility and link the state of fertility to agricultural practices. According to Omamo *et al.*, (15). A geographic information system (GIS) is a critical tool for integrating various types of spatial data to derive useful information, such as agro-climatic zone, land use, and soil management.

It must be carried out to be aggressively planted with high-producing crops, according to Staal *et al.,* (18). Composite soil samples are often obtained in the fields after soil testing with no geographic reference. Further monitoring of soil accessible nutrients status using GPS will aid in developing site-specific balanced fertilizer recommendations and understanding the state of soil fertility regionally and temporally, and such soil testing findings are not acceptable for site-specific recommendations (16). Exchange capacity: Soil fertility is linked to (exchange capacity), or the ratio of colloidal particles, particularly humic compounds, that make up the adsorption compound. Plants' mineral nutrition improves as their exchange capacity is increased. Provides a favourable environment for plant root development (6, 1 and 13) Fertility. The mineral cation proportion in the soil: The cations required for plant nutrition must be accessible in a balanced manner in the soil. Organic matter: Because it enhances the physical and chemical characteristics of the soil, the quantity of organic matter in the soil plays an important role in soil fertility (9). Soil Structure: The ability of roots to penetrate the soil in search of water and minerals that nourish the plant is dependent on soil structure. The texture of the soil: It's the soil's mechanical structure, or the total of the basic constituents that make up the soil, such as clay, silt, fine sand, coarse sand, and occasionally gravel. Depth of the soil: The higher the depth of the soil, the bigger the area over which the roots may grow, allowing plants to receive more nutrients. The depth of the soil can occasionally compensate for nitrogen deficiency (11). Soil Structure: The ability of roots to penetrate the soil in search of water and minerals that will nourish the plant is dependent on soil structure. The texture of the soil It's the soil's mechanical structure, or the total of the basic constituents that make up the soil, such as clay, silt, fine sand, coarse sand, and gravel. Depth of soil the deeper the soil, the larger the area over which the roots may grow, increasing numerous of nutrients received by the plants. The depth of the soil can compensate for nitrogen deficiency in some cases (20).

Material and Method

Bazian is a large and important area located in Kurdistan, northeast of Iraq, 20 kilometers southwest of Sulaimaniyah governorate, 35N latitude and 45 E longitudes, with at least 4000 greenhouses. The sea surface level reaches it (837m – 847m). Also, in the BASARA Basin, which is in the high folded zone, is the Bazian Plain, which is a large plain with a slightly sloped surface. It has six watersheds and fourteen micro-catchments'- Streamflow: Basara Basin has many sprinkameezezes. Basara Basin has pa erenniamainstream, which consists of the combination of two great streams which are The ilia stream and the Chami Tainal stream (4).

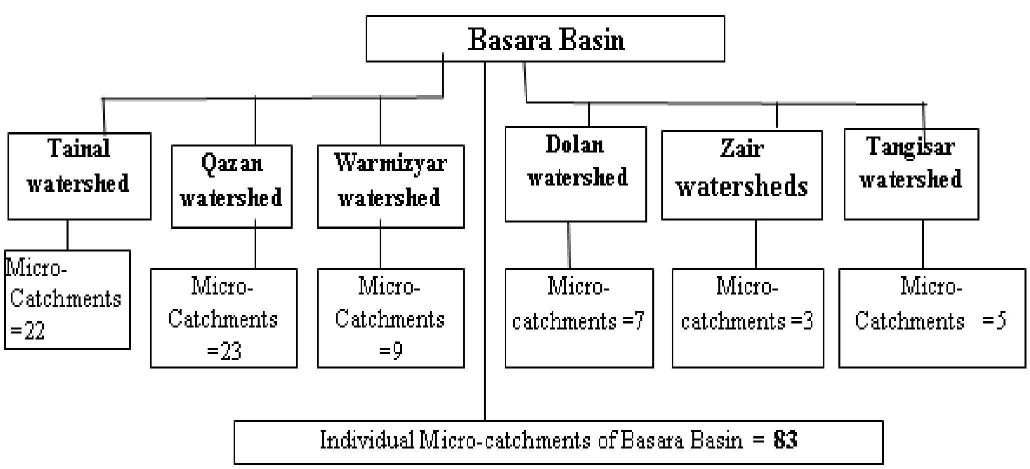

Fig. 1, Basara Basin

Village name	E.C. ds.m	PH	N $meq.l^{-1}$	Available P $meq.l^{-1}$	Soluble K^+ $meq.l^{-1}$	Soluble Na^+ $meq.l^{-1}$	Soluble Ca^{+2} $meq.l^{-1}$	soluble Mg^{+2} $meq.l^{-1}$	Cl^- $meq.l^{-1}$	$CaCo_3$ $meq.l^{-1}$	HCO_3 $meq.l^{-1}$
Bagajani	0.59	7.57	750	0.13	0.38	0.13	2.35	2.75	0.41	2840	3.7
Mewk	0.70	7.65	321	0.07	0.065	0.11	0.97	1.35	0.265	2000	1.64
Bagajani	0.235	7.64	785	0.95	0.038	0.77	5	6.6	1.55	1800	1.8
Koyik	0.23	7.50	339	0.07	0.011	0.075	1.15	1.65	0.37	1460	1.7
Kani big	0.235	8.45	785	0.12	0.011	0.22	3	1.95	0.55	1380	1.8
Shuwankara	0.41	7.40	1357	0.11	0.015	0.23	3.2	1.35	0.38	1500	3.2
Tui awlia	0.38	7.30	642	0.15	0.022	0.2	2.8	1.45	0.35	980	0.8
Qushqaya	0.29	8.20	303	0.08	0.018	0.053	1.4	0.9	0.18	1500	1.8
Ali Bzaw	0.45	7.45	410	0.09	0.027	0.145	1.45	0.85	0.375	1620	2.95
Ali Bzaw	0.29	7.70	535	0.04	0.055	0.19	1.1	1.35	0.25	1480	1.35
Kani Penjsharnma	0.42	8.45	714	0.26	0.042	0.12	1.25	0.6	0.55	1260	1.7
Kani Shaya	0.34	7.85	1035	0.08	0.032	0.079	3.35	1.7	0.315	1160	1.25
Kani Shaya	0.43	8.15	339	0.075	0.032	0.07	1.4	1	0.25	960	0.9
Halay Sarchawa	0.36	7.15	785	0.11	0.038	0.13	1.5	1.7	0.35	1080	0.7
Halay Sarchawa	0.45	7.40	392	0.06	0.0175	0.775	1.8	1.25	0.15	1260	0.5
Mahmudia	0.37	8.6	410	0.08	0.019	0.16	1.7	1.65	0.29	960	0.8
Ziyeka	0.36	7.05	428	0.12	0.038	0.11	2.7	1.85	0.19	1620	2.45
Ziyeka	0.30	7.42	1160	0.14	0.032	0.18	2.55	2.1	0.35	1080	0.6
Warmizyar	0.44	8.15	785	0.11	0.04	0.086	2.85	3.4	0.45	1340	2.6
Warmizyar	0.049	7.95	892	0.12	0.04	0.14	3.15	3.8	0.42	1440	1.4
Gawani	0.35	7.70	250	0.08	0.0125	0.115	0.745	1.2	0.325	1600	1.5
Gawani	0.255	6.80	1160	0.21	0.018	0.28	4.1	2.6	0.51	1340	0.94
Gawani	0.445	7.75	500	0.14	0.016	0.088	2.65	1.45	0.44	1400	1.2
Latif awa	0.47	8.05	1107	0.14	0.027	0.11	3.2	2.1	0.32	880	0.6
Warmizyar	0.44	8.15	785	0.12	0.04	0.086	2.85	3.4	0.45	1340	2.6
Warmizyar	0.049	7.95	892	0.13	0.04	0.14	3.15	3.8	0.42	1440	1.4
Gawani	0.35	7.70	250	0.08	0.0125	0.115	0.745	1.2	0.325	1600	1.5
Gawani	0.445	7.75	500	0.14	0.016	0.088	2.65	1.45	0.44	1400	1.2
Latif awa	0.47	8.05	1107	0.12	0.027	0.11	3.2	2.1	0.32	880	0.6

Table1. Soil analysis for the samples that taken from the study area

Using GIS applications to produce GIS maps to show the distributions soils fertility in the area, this area contains many villages, we took the samples from 24 villages that contain at least 2000 greenhouse in 10km2 area, Soil Samples taken from deep 20 – 30cm for fertility analysis.

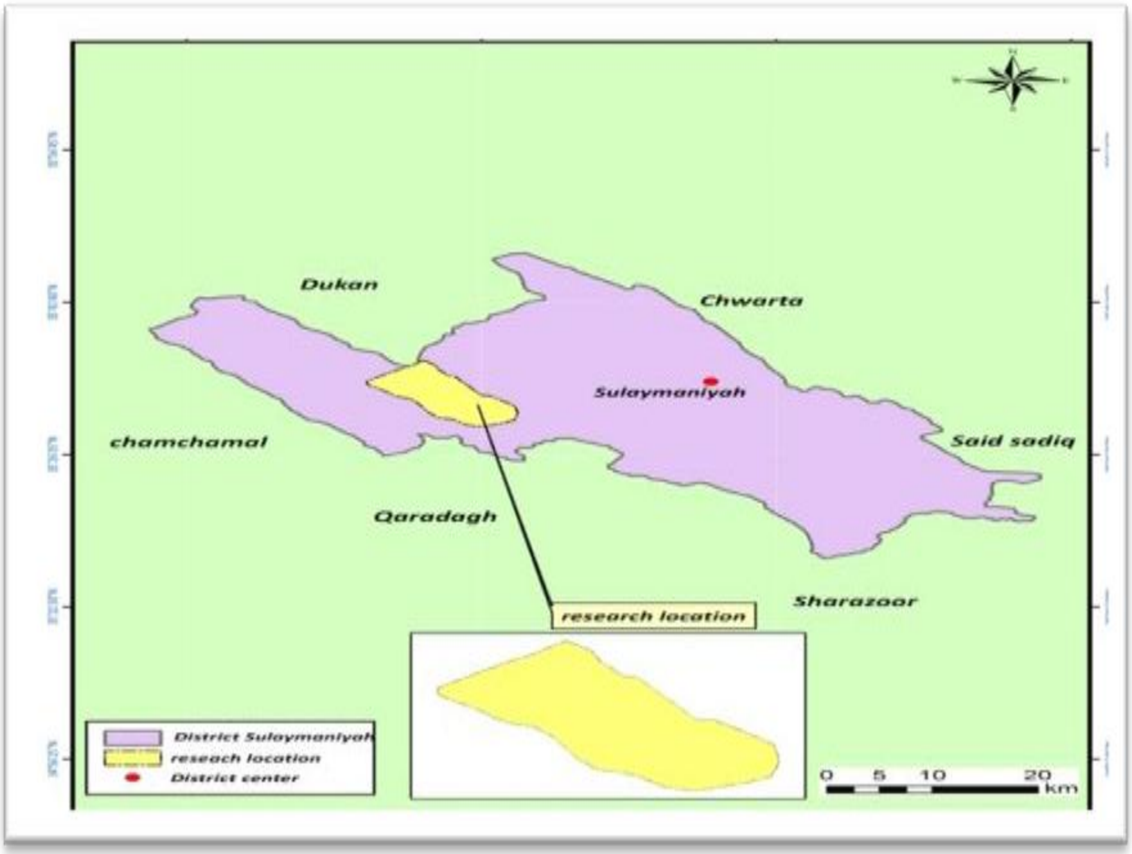

Fig. 2, Location of the survey depending on table 3, and ArcGIS 10.1

Table 2. Plant analysis procedures

Analysis kind	Procedure	Source
N%	Kjeldahl	Soil and plant analysis (Laboratory index) by John Ryan George Stephen international Center for agriculture Research in the dry areas. And Abdul Rashid National Center for Agriculture research Islamabad, Pakistan
Available P	Olsen and Sommers, 1982	
Soluble k	Richards, 1954	
Soluble Na	Richards, 1954	
Soluble Ca	Richards, 1954	
Soluble Mg	Richards, 1954	
CL	Richards, 19544	
O.M. %	Walkley, 1974; FAW, 1974	
$CaCo_3$ %	FAW, 1974	
HCO_3	Richards, 1954	
CO3	Richards, 1954	

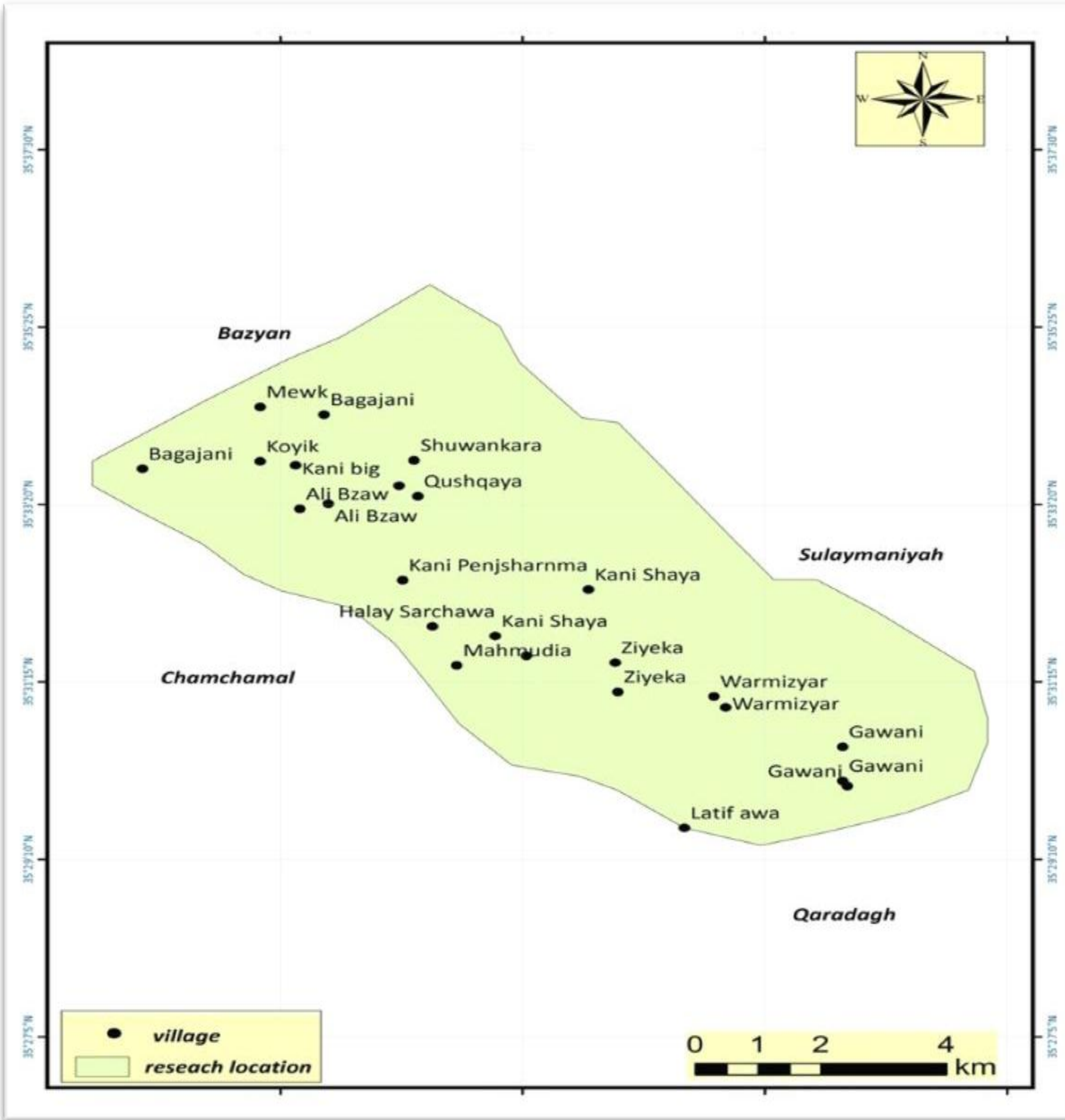

Fig. 3, Villages coordinate in Tainal watershed depending on table 3, and ArcGIS 10.1program

Results and Discussions

Making Gis map for parameters that selected before to explain the distribution in the villages

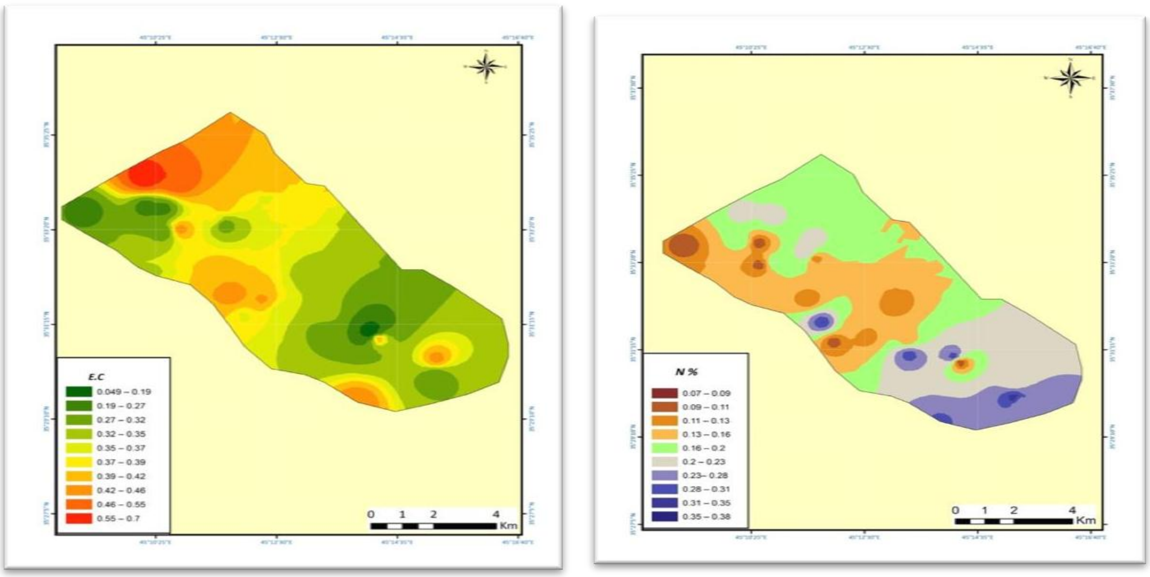

Fig. 4, Depend on Table 3, ArcGIS 10.1 Survey for soil fertility showed A Spatial Distribution of A: EC, B: N% for the study area

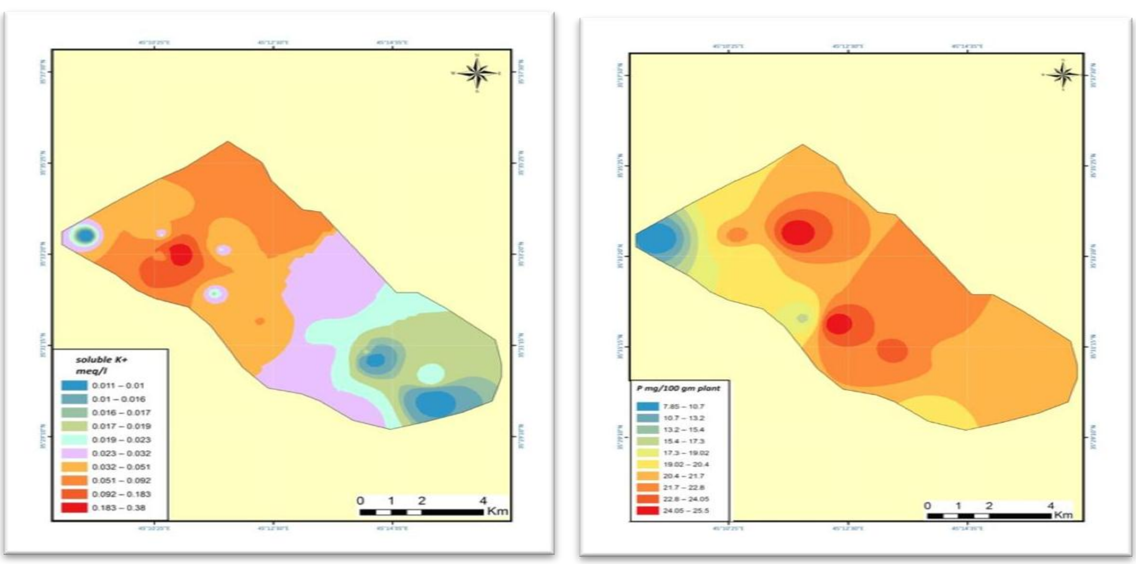

Fig. 5, Depend on Table 3, ArcGIS 10.1 Survey for soil fertility showed A Spatial distribution of A: K, B: available (p) for the study area

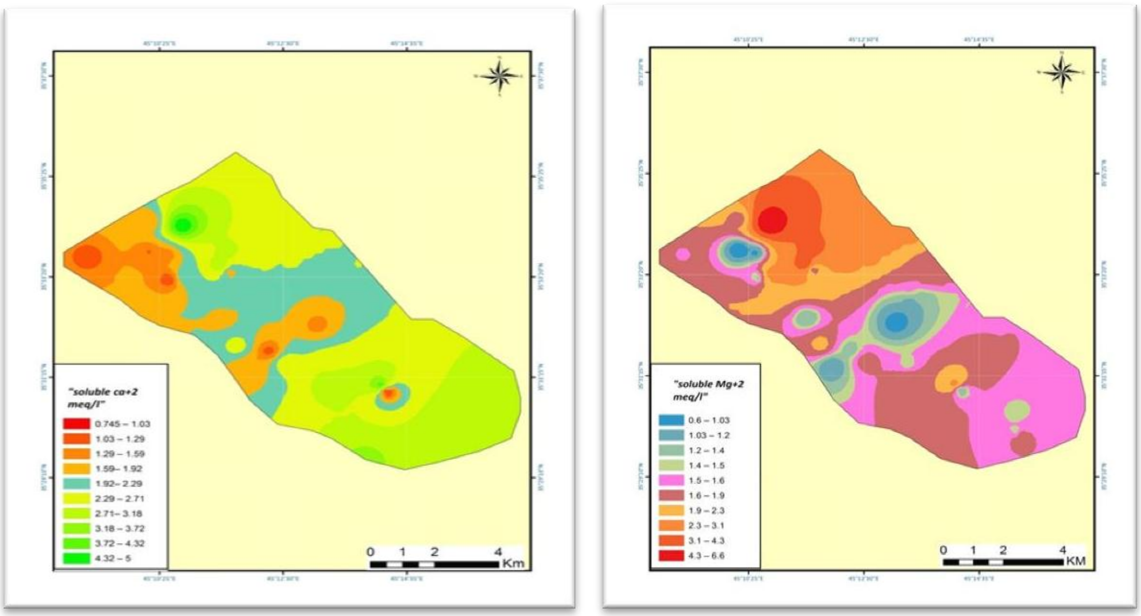

Fig. 6, Depend on Table 3, ArcGIS 10.1 Survey for soil fertility showed A Spatial distribution of A: Ca, B: Mg for the study area

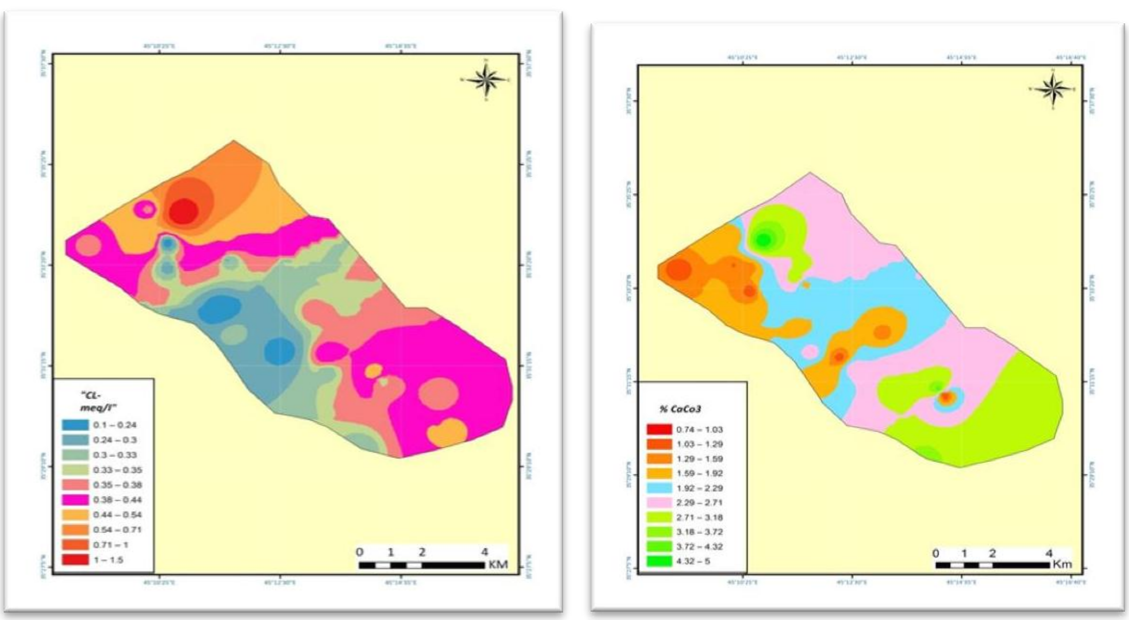

Fig. 7, Depend on Table 3, ArcGIS 10.1 Survey for soil fertility showed A Spatial distribution of A: Cl , B: CaCo3 for the study area

Improvement of plant health is the ultimate goal of ecosystem management. Even if adding organic matter to soil may not prevent soil pests, it can increase crop yields, which is the primary goal for a farmer (10).

From Fig. 4, A and Table 3 there is a difference between the 24 sits that we study (Mewk 0.70 and Bagajani 0.59, Latif awa 0.47, Haley Sarchawa 0.45 $ds.m^{-1}$) E.C. was high that return to using a high quantity of chemical fertilizer as reported from. Aimrun *et al*. (3).
Farmers in this area use green manure and organic fertilizer on a regular basis, and when these rich nutrients break down, salts and ions in the soil's liquid phase rise. Such changes have an impact on soil EC, which is influenced by a variety of soil fertility properties, including pH, P, K, Mg, Ca, OM, CEC, and the concentrations of other soluble salts (17).

EC-soil property interactions are easily identified because the amplitude of the reactions governing soil EC levels is complicated and dynamic. It's crucial to look into the changes in EC in soils treated with various wastes; EC is defined by Bronson *et al.*, (5). As the total amount of salts and ions in the soil solution, whose levels are influenced by the kind, content, and amount of waste that is delivered to the soil?

EC could be used as a supplement to other soil fertility indicators. In this location, soil EC varies, although it had altered (from 0.23 to 0.7 $ds.m^{-1}$) as a result of the addition of organic matter, primarily when the soil was incubated with chicken and animal manures and other compost. The soil EC values found in this investigation, regardless of the extent of the soil electrical conductivity change, were below the range considered safe for plant growth, according to Sudduth *et al*., (21).

Our farmers depend on three sources of Nitrogen; mineralization of organic microbial decomposition of animal and plant residues in the soil gives mineral nitrogen, nitrate and ammonium, forms of nitrogen that plants can absorb from the solution of soil. Soil organic matter also is an essential source for N.

Biological fixation of atmospheric N2 This N supply is unavailable to plants unless it is catalytically converted to mineral N (NH^{+4}) by extremely specific bacteria, therefore plants in greenhouses do not receive it directly.

Some farmers employ crop residues that aren't removed from the greenhouse at harvest, leading to disease carryover, root exudates, and more crop residues. The reasons why N fertilizer application boosted soil organic matter were the following (7).

From Fig. 4, B and Table3 (Shwankara 0.38, Ziyka 0.32, Gawani 0.32, Kani shaya 0.29 %) the law ratio of N in most of the area return to the lowest of adding compare with taking from soils Bonner and Varner (19) reported this return to not use a scientific program depending on soil analysis, generally, most of the soils in this area is under the moderate range (< 0.2 %)

Because of using plant and animal residue and chemical and organic fertilizer so our farmers have a good source for Phosphorus, ratios in soils in these areas were in higher in (Bagajani 92.64 $mg.kg^{-1}$, Kani penjsharma 25.9, Gawani 21) this high quantity in the soil as in Table 3

$H2PO^{-4}$ and HPO^{-4} are two types of soluble P, with the proportions varying depending on the ph. They are in equal quantities at pH 7.2. The ratio of $H2PO^{-4}$ to HPO^{-4} is 10:1 at pH 6.2, and 1:10 at pH 8.2. Philippe et al., (19).

(Fig. 5, A Table 3) In (Kani Shaya and Qushqaya) Phosphorus ratio was the highs (25.5mg, 25.3mg) these ratios are low compared to plant needs as, Lenaldo *et al*., (12) reported.

Potassium is the "universal cation" like they say in the biological systems, in all pH levels have no toxic, even at soil and plant levels, farmers like to use K in their crops they depend on chemical fertilizer at first to supply them with K and also an organic source.

(Fig. 5, A Table3) In (Mewk 0.065, Ali Bzaw 0.055, Kani Penjsharnma 0.042 $m.eq.l^{-1}$) we have the high value of K, but it is a low value for K in the soil in this area depending on Najera et al., (21).

(Fig. 6 and Table 3) farmers in this area use Ca not widely, in (Bagajani 5.0 meq/l. and Gawani 4.1, Latif awa $3.3m.eq.l^{-1}$) these are the highs in this area but Najera *et al*. (14) said soil should content in medium average ($4.1\text{-}8mol.kg^{-1}$) but in the other places the Ca ratio is lower so the need to use some calcium source as a fertilizer.

When we visited other greenhouses, we noticed yellow fractures between the veins and around the leaf edges instead of Mg deficiency. Purple, brown, and red are among the other colors that show. The older leaves are the first to suffer, and some of them die as a result of their lack of treatment.

Farmers must understand the need to apply a yearly mulch of compost as a long-term solution. This will conserve moisture while also providing enough magnesium to the soil to keep the plants healthy.

After heavy irrigation, high $CaCO_3$ causes rhizospheric alkalinity and nutrient imbalance, resulting in reduced root growth and poor plant development. Soil farmers in (Upper Bagajani 14.2%, Mewk 10%, Lower Bagajani 9%, Ziyeka 8.1 percent, Ali Bzaw 8.1 percent) (Fig.7, B Table 3) have the highest it ratio in this area. The major component of limestone, calcium carbonate, is frequently utilized to reduce soil acidity and provide calcium (Ca) for plant nourishment. The term "lime" can apply to a variety of things, but it most commonly refers to pulverized limestone in agricultural applications.

The occurrence of excessive CaCO3 (15-40%), according to FAO (8) is not a significant issue in our reign soils, though it is close in some spots. However, in a greenhouse, the temperature will rise in the summer, causing evaporation from the top and replacement from the water table below. When groundwater is taken up, it frequently contains considerable volumes of dissolved CaCO3, which is deposited inside the soil-body upon evaporation, resulting in a buildup of this substance.

Conclusions

Although the concept of sustainability has gained widespread acceptance, the dominant healthy agricultural philosophy views high yields and decreased environmental consequences as incompatible.

Given the economic limits imposed on production-oriented farming systems, nutritional requirements in agriculture will be difficult to meet. Because nutrients are crucial in agro ecosystems, conscious control of fundamental ecosystem processes can help to prevent environmental losses. Under this concept, the goal of survey fertility would be to balance nutrient budgets as much as feasible while maintaining these reservoirs.

Breeding for cultivars and their associated microbes that do not require surplus additions of soluble nutrients should be stressed in conjunction with agroecosystem activities that expand the ecosystem's capacity in ways that lead to reduced needs for surplus additions. Understanding the need to employ natural fertilizer (resources) to keep soils fertile and sustain a healthy agroecosystem Soil fertility management can have a variety of consequences on plant quality, which can alter the abundance of nematodes or other insects as well as the extent of herbivore damage. The distribution of mineral supplements in crop plants has the potential to affect the growth, survival, and reproduction of insects that feed on these plants.

Agroecosystem management based on organic soil fertility methods can offer secondary element supplies from time to time, resulting in a healthy agroecosystem. Traditional farming techniques, which rely primarily on artificial supplies of N, P, and K, are deficient. In addition to nutrient concentrations, optimal fertilization, which offers a balanced balance of components, can boost insect resistance.

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Mapping of Plant-Parasitic Nematode using GIS Technology in Tainal Watershed, Sulaimaniyah Province, Iraq

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Abstract The present experiment was conducted to evaluate soil samples which had been taken from depths ranging from 0-30 cm in greenhouses planted with different vegetables such as cucumbers, tomatoes, peppers and eggplants in 24 agricultural sites in 19 villages. GIS application was used to make maps showing the results of a field survey that was conducted. The experiment was conducted for an area of 12 km^2 in the Tainal Plain, west of Sulaimaniyah Province. Nearly 30% of the soil of the greenhouses were heavily infected. Plant analysis showed that the characteristics of ash, fat and moisture were significantly affected as a result of infection with nematodes. The spread of root-knot nematode juveniles in the villages of Al-Mahmoudia, Kani Pengsharma and Kani Shaya was 706, 695 and 622 per 250 g of soil. In tissues of the studied plants, the highest nitrogen content was 68.2 mg in Ziyeka, 60.4 mg in Gawani and 59.7 mg in Ali Bzaw. Phosphorus concentrations were highest in Kani Shaya, Shwankara and Ziyeka (25.5, 25.3 and 23.1 mg, respectively). Warmizyar had 91.8 mg of potassium, Kani Shaya had 78.6 mg and Kani Big had 71.6 mg. The calcium concentrations in Ziyeka, Gawani and Mewk were 54.5, 48.4 and 47.7 mg, respectively.

Keywords: Root-knot nematode, *Meloidogyne incognita*, Plant analysis ArcGIS map, GIS coordinates

Introduction

In the past few years, *Meloidogyne javanica*, a root-knot nematode, had infected at least 3000 greenhouses in Iraq's Bazian Plain, Sulaimaniyah Province. Root-knot disease was caused by several species of the genus *Meloidogyne*. It was a parasitic nematode that makes its home in the roots of affected plants. There are around 98 known species within this genus (Jones et al., 2013). *Meloidogyne* species can survive in both hot regions and short winters throughout the planet. The root-knot nematode was one of the most damaging families of parasitic nematodes (Gill & McSorley, 2011). These nematodes are pests of nearly all major crops. Furthermore, *Meloidogyne* species are responsible for around 5% of worldwide crop yield loss each year (Karajeh, 2008). Farmers and other plant producers have long referred to it as "the nematode" illness (Mankau, 1980), because of the significant production decrease and visible root-galling signs caused by these pests. Depending on the species, nematodes are wormlike invertebrate creatures that can be found in marine, freshwater or terrestrial environments. Plants, other nematodes

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and their eggs, fungi, protozoans, bacteria, tardigrades and insect larvae are all possible food sources for nematodes (Freckman & Caswell, 1985).

Giné et al. (2014) showed the effects of *M. incognita* and *M. javanica* on cucumber, the maximum multiplication rate and equilibrium density of root-knot nematodes on cucumber and yield losses, and the relationships between relative leaf chlorophyll content and relative cucumber dry top weight biomass in response to increasing nematode densities.

GIS is an effective tool for analyzing, comprehending and projecting huge and complex data sets on crop output, productivity, land use, socioeconomic aspects and a range of agro climatic and environmental data (Seif-Ennasr et al., 2020). Several attempts have been made to employ anti-fungus to control the root-knot nematodes. Following soil preparation before planting with peat, tomato root irritation caused by *M. javanica* was greatly decreased (Sharon et al., 2007). The use of bran from *Bacillus* 251 as a bio-control agent of *M. incognita* on tomatoes, as detailed by Kiewnick & Sikora (2006), resulted in a significant reduction in egg production.

The drop in recent decades appears to be due to pathogenic agents as well as seasonal fluctuations. Plant diseases lowered worldwide output by more than 20% on average each year; nevertheless, isolated areas may suffer losses of 50% to 100% owing to one or more pests (Dhaliwal & Koul, 2007). Plant-parasitic nematodes are critical biological constraints in almost all types of agricultural plants all over the world, and they cause considerable losses in chilli production (Moon et al., 2010).

Any change in the biological components of ecological setup causes environmental deterioration. Many nematicides have been deregistered, resulting in pollution of the biosphere, highlighting the need for innovative techniques to combat nematodes and, as a result, improve agricultural yield. Farmyard manures, composts and botanical residues are all widely utilized in diverse crops as organic sources of nutrients. The best available option in integrated nutrient management programs is the complementary use of biofertilizers and organic manures in appropriate combinations with chemical fertilizers. This increases output, reduces fertilizer input costs, enhances the effectiveness of additional fertilizers and improves soil health at the same time (El-Sherif et al., 2007).

The aim of this research was to utilize a GIS to characterize soil types, soil texture and pH in relation to nematode incidence, significance and dispersion.

Material and Methods

Soil Sample Taking for Nematode Analysis

Nematode samples were taken from 20-25 cm depth throughout the summer season, cleaned and sanitized the shovel after each use, then the samples were placed in bags for analysis by using the sieving method.

Root-Plant Sample Taking for Analysis

1. Samples of roots were collected from diseased plants in greenhouses. Plants with infected roots were cut down. The fresh weight of these samples was calculated.
2. ArcGIS 10.1 application (WGS 1984_UTM_Zone_38N) with project coordinates system was used to create maps.

Table 1: Procedure of nematodes analysis.

No.	Materials	Source of procedure
1	20-mesh sieve (833 µm aperture)	Zuckerman et al. (1981)
2	200-mesh sieve (74 µm aperture)	
3	325-mesh sieve (43 µm aperture)	
4	Coarse sieve (1 cm aperture)	
5	Two stainless steel bowls or plastic buckets	
6	250 ml beaker	
7	600 ml beaker	
8	Coarse spray wash bottle or tube attached to faucet	

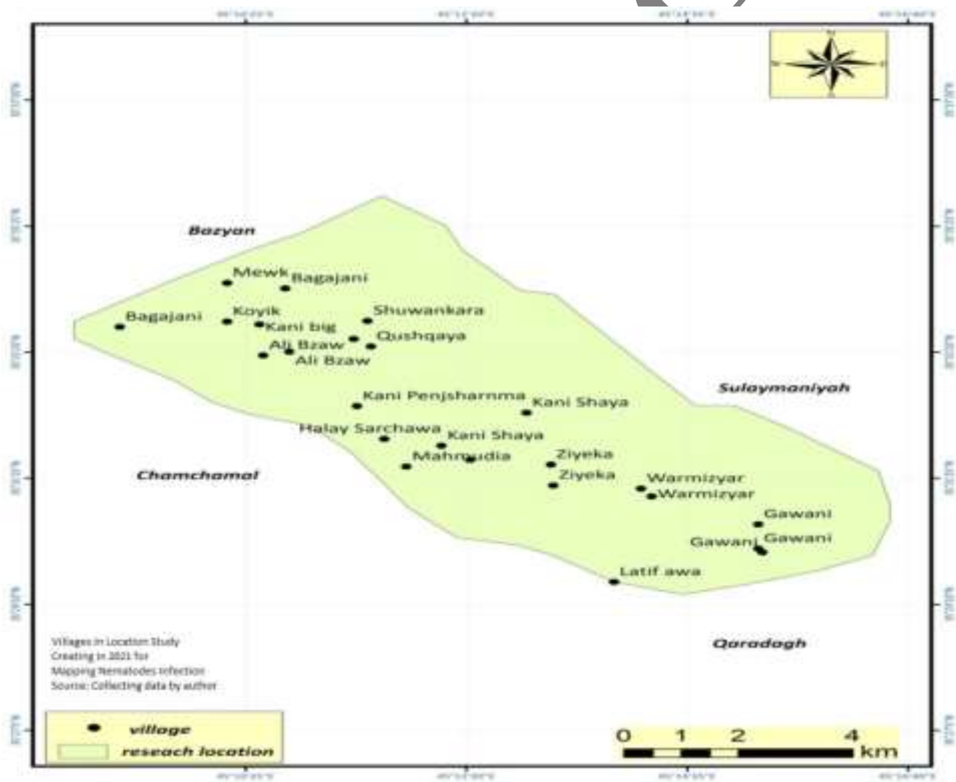

Figure 1: Villages covered in the present study.

Table 2: GIS coordinates for locations in Tainal Watershed.

Locations no.	Village name	Latitude	Longitude
L1	Bagajani 1	N 35.57	E 45.17
L2	Mewk	N 35.57	E 45.17
L3	Bagajani 2	N 35.56	E 45.15
L4	Koyik	N 35.56	E 45.17
L5	Kani Big	N 35.56	E 45.17
L6	Shuwankara	N 35.56	E 45.19
L7	Tui Awlia	N 35.55	E 45.19
L8	Qushqaya	N 35.55	E 45.19
L9	Ali Bzaw 1	N 35.55	E 45.18
L10	Ali Bzaw 2	N 35.55	E 45.17
L11	Kani Penjsharnma	N 35.54	E 45.19
L12	Kani Shaya 1	N 35.53	E 45.21
L13	Kani Shaya 2	N 35.52	E 45.20
L14	Halay Sarchawa 1	N 35.52	E 45.20
L15	Halay Sarchawa 2	N 35.53	E 45.19
L16	Mahmudia	N 35.52	E 45.22
L17	Ziyeka 1	N 35.52	E 45.22
L18	Ziyeka 2	N 35.52	E 45.23
L19	Warmizyar 1	N 35.51	E 45.23
L20	Warmizyar 2	N 35.51	E 45.25
L21	Gawani 1	N 35.50	E 45.25
L22	Gawani 2	N 35.50	E 45.25
L23	Gawani 3	N 35.50	E 45.23
L24	Latif Awa	N 35.49	E 45.23

Results and Discussion

The study area was one of the most important agricultural areas in the province, not because it contains huge numbers of greenhouses, but also because it contains vast areas of farms and forests, in addition to inhabited villagers who depend directly for their livelihood on agriculture. So, the present investigation was done in some villages that were randomly chosen as they were infected with nematodes (Upper Warmizyar 1, Lower Warmizyar 2, Mahmudia, Ali Bzaw 2, Penjsharnma, Kani Shaya 1, Kani Shaya 2, Qushqaya, Kani Large, Bagajani 2, Latif Awa and the others that are not infected) are shown in Table 3 (Upper Warmizyar 1, Lower Warmizyar 2, Mahmudia and Ali Bzaw 1).

Table 3: GIS coordinates for villages affected or not with nematodes in Tainal Watershed.

Location	Village name	Latitude	Longitude	Crops	Description
L 1	Warmizyar 1	35.51	45.23	Tomato	affected
L 2	Warmizyar 2	35.51	45.25	Cucumber	affected
L 3	Mahmudia	35.52	45.19	Tomato	affected
L 4	Ali Bzaw 2	35.55	45.17	Cucumber	affected
L 5	Penjsharnma	35.54	45.19	Tomato	affected
L 6	Kani Shaya 1	35.53	45.21	Cucumber	affected
L 7	Kani Shaya 2	35.52	45.20	Cucumber	affected
L 8	Qushqaya	35.55	45.19	Tomato	affected
L 9	Kani Big	35.56	45.17	Cucumber	affected
L 10	Bagajani 2	35.56	45.15	Cucumber	affected
L 11	Latif Awa	35.49	45.23	Cucumber	affected
L 12	Gawani 1	35.50	45.25	Cucumber	non affected
L 13	Gawani 2	35.50	45.25	Cucumber	non affected
L 14	Gawani 3	35.50	45.23	Cucumber	non affected
L 15	Ziyeka 1	35.52	45.22	Cucumber	non affected
L 16	Ziyeka 2	35.51	45.23	Cucumber	non affected
L 17	Halay Sarchawa 1	35.52	45.20	Pepper	non affected
L 18	Halay Sarchawa 2	35.53	45.19	Cucumber	non affected
L 19	Ali Bzaw 1	35.55	45.18	Pepper	non affected
L 20	Shuwankara	35.56	45.19	Cucumber	non affected
L 21	Tui Awlia	35.55	45.19	Tomato	non affected
L 22	Koyik	35.56	45.17	Pepper	non affected
L 23	Mewk	35.57	45.17	Cucumber	non affected
L 24	Bagajani 1	35.57	45.17	Cucumber	non affected

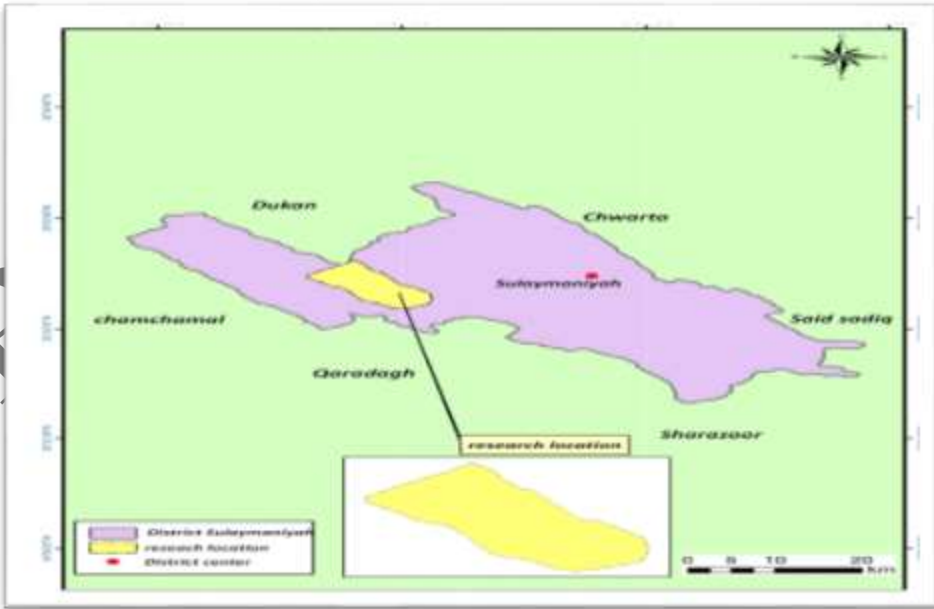

Figure 2: Locations area in Sulaimaniyah Province, north Iraq.

Table 4: Plant analysis for some greenhouses infested and non-infested with nematodes.

Village name	BRIX (%)	Chlorophyll (mg/g)	N (mg)	P (mg)	K (mg)	Ca (mg)	Mg (mg)	Protein (mg)
Mewk	8	28	56.8[a]	19.7[b]	61.3[c]	47.7	10.5	0.47
Bagajani 2	12.6	29.2	22.4[d]	7.85[d]	29.3[d]	23.5	4.7	0.38
Kani Big	7.6	25.35	33.6[c]	22.6[b]	71.6[b]	16.1	8.25	0.45
Shuwankara	11	41	51.4[b]	25.5[a]	141[a]	15	13.15	0.62
Ali Bzaw 1	11.5	41	59.7[b]	19.6[b]	59.9[c]	40.5	9.4	0.57
Ali Bzaw 2	6.1	19.4	20.0[d]	18.4[c]	69.7[b]	9.55	7.2	0.365
Kani Shaya 1 Shaya	8.35	21.44	31.3[c]	25.3[a]	78.6[b]	14.45	7.95	0.65
Halay Sarchawa 1	14	41	57.6[b]	16.9[c]	58.1[c]	44	11.15	0.61
Ziyeka 2	9.5	38	68.2[a]	23.1[a]	69.8[b]	54.5	11.5	0.66
Warmizyar 2	7.8	22.3	37.0 [c]	21.6[b]	91.8[b]	17.15	7.8	0.58
Gawani	10	38.5	60.4[a]	21.6[b]	66.7[b]	48.4	10.75	0.52
Latif Awa	6.9	19.1	30.5[c]	18.9[d]	73.2[b]	14.3	63	0.51

* Means with different letters are significantly different according to Duncan's multiple range tests at P≤0.05.

** In each greenhouse, 10 plants were selected for plots.

Table 5: Survey in Tainal Watershed, plant and nematodes analysis.

Village name	Fat (g)	Ash (g)	Moisture	Carbohydrates (g)	Larvae	Egg mass	Galls
Mewk	0.11	0.46[b]	77.2[b]	2.05	-	-	-
Bagajani 2	0.095	0.03[d]	91.9[a]	2.15	458[d]	16	20
Kani Big	0.1	0.35[c]	64.5[c]	1.55	515[c]	23	16
Shuwankara	0.12	0.51[a]	89.3[a]	3.4	-	-	-
Qushqaya	+	+	+	-	615[b]	24	38
Ali Bzaw 1	0.12	0.51[a]	73.3[b]	2.2	-	-	-
Ali Bzaw 2	0.09	0.22[d]	82.5[a]	2.3	588[b]	20	30
Penjsharn	+	+	+	-	695[a]	31	36
Kani Shaya 1	+	+	+	-	622[b]	27	36
Kani Shaya 2	0.08	0.32[c]	77.5[b]	2.05	568[c]	30	38
Halay Sarchawa	0.13	0.63[a]	92.6[a]	3.95	-	-	-
Mahmudia	+	+	+	-	706[a]	39	45
Ziyeka 1	0.16	0.51[b]	81.3[b]	2.8	-	-	-
Warmizyar 1	+	+	+	-	487[d]	19	26
Warmizyar 2	0.085	0.38[c]	77.4[b]	2.3	290[e]	13	19
Gawani 3	0.10	0.58[a]	86.5[a]	3.7	-	-	-
Latif Awa	0.075	0.35[c]	65.5[c]	1.35	425[d]	17	21

*Different letters show significant difference according to Duncan's multiple range at P≤0.0.

** In each greenhouse, 10 plants were selected for plots.

\+ Means no reading as plants were not affected with nematodes, so, they didn't reach this stage.

\- Means on reading as plants were affected with nematodes.

In soils infected with nematodes, some parameters, such as total nitrogen, available phosphorus and potassium, caused a limeted decrease in the ratios of these parameters (Ruess, 1995). However, their generic richness was decreased, and community structure was altered by increasing the abundance of inhibiting and non-direct effects on the environment were seen (Table 4).

Table 5 showed that soils epidemics with nematodes significantly affect differences negatively on some plant properties directly (fats, ash and moisture) causing many changes like death of young branches and the continuation of death, and nematode occurs in the complexity of the roots so that the absorption of water with the increase of loss of transpiration and evaporation leaves and branches (Li et al., 2010).

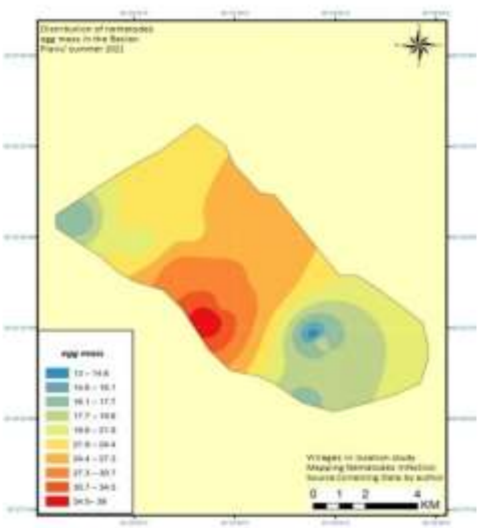

Figure 3: Depending on Table 4. Survey for distribution of egg mass of nematode by ArcGIS 10.1 program.

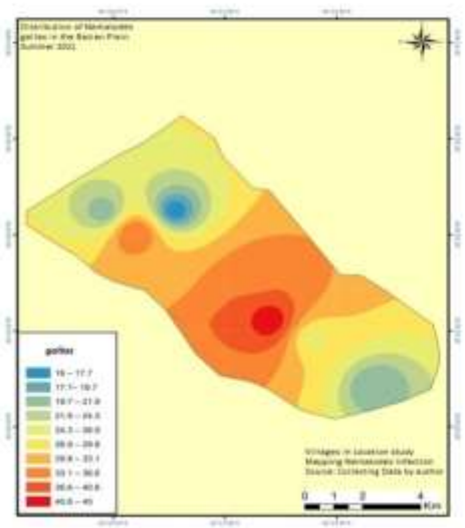

Figure 4: Depending on Table 4. Survey for distribution of galls of nematodes by ArcGIS 10.1 program.

The spread of root-knot nematode larvae in Mahmudia, Kani Penjsharnma and Kani Shaya with populations in 706, 695 and 622/ 250 g soil were the highest in these areas (Figures 3 & 4). After the present investigation in this matter for many years, farmers in this site did not use the scientific or right ways to control or prevent the spread of this nematode. The reason of speared of this nematode is due to use the plow without sterilization for other farms (Goswami & Singh, 2004).

Meloidogyne species were common in vegetable world where they parasitize vascular root tissues and induce their familiar root galls (Abawi & Widmer, 2000; Davies et al., 2003; Anwar & Mckenry 2010). *M. javanica* is the common nematode in this region. Nematode root galling causes obstruction of root systems and its presence is often been associated with increased incidence and severity of *Fusarium* wilts of several field crops (Martin et al., 1994).

In this survey, only *M. javanica* was currently considered to be economically damaging cucumber and tomato. *M. javanica* was the commonly species pest on cucumber in Tainal Watershed. It is likely that the root-knot second-stage juveniles recovered were based as *M. javanica* on the continuous cucumber production (Gebremikael et al., 2016). This indicates that improved frequency of irrigation can alleviate some plant stress in this damaged area. Although nematode populations may be higher in this area, the example illustrates that a different set of factors (soil and management factors) can influence the pattern of nematode incidence and plant damage within a field (Baird et al., 1996).

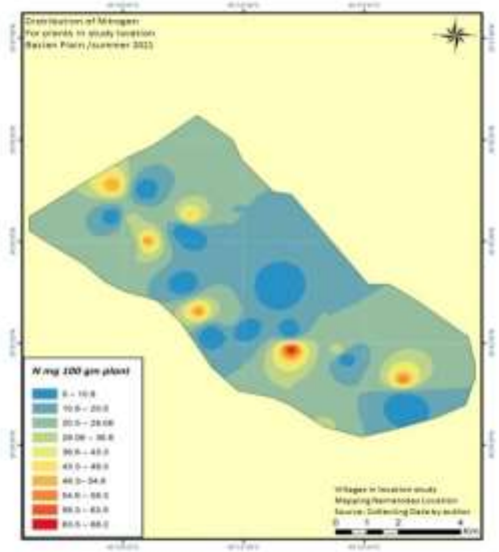

Figure 5: Depending on Table 4. Distribution of nitrogen for plants in study location by ArcGIS 10.1.

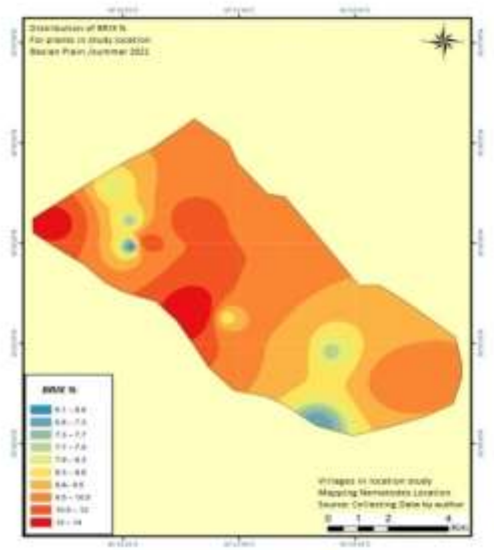

Figure 6: Depending on Table 4. Distribution of BRIX % for plants in study location by ArcGIS 10.1.

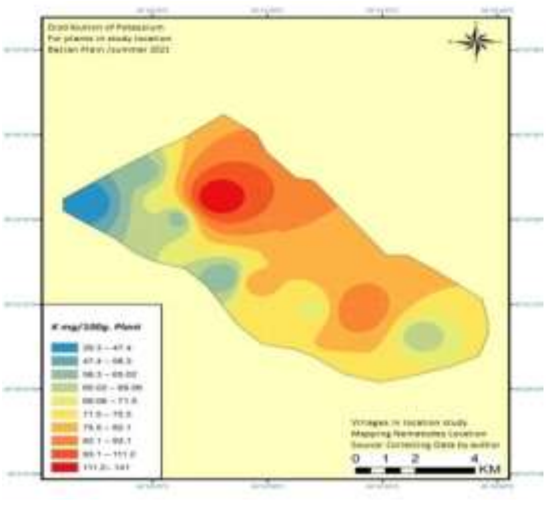

Figure 7: Depending on Table 4. Distribution of Potassium for plants in study location by ArcGIS 10.1.

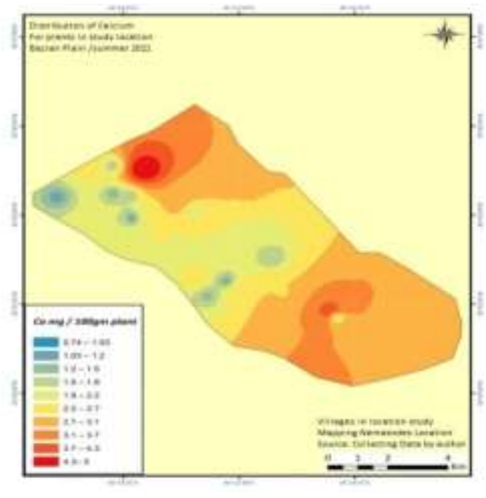

Figure 8: Depending on Table 4. Distribution of calcium for plants in study location by ArcGIS 10.1.

The importance of Ca levels in the cytoplasm have a role as signaling mechanisms for environmental stress. Ca pumps are directed out of the cytoplasm, either to vacuoles, where it may be precipitated as calcium oxalate, or across the plasma, the function of the majority of plant Ca was structural, in the cell walls of shoots and roots so farmers need to know these basics on calcium (Wright & Rowland, 2008).

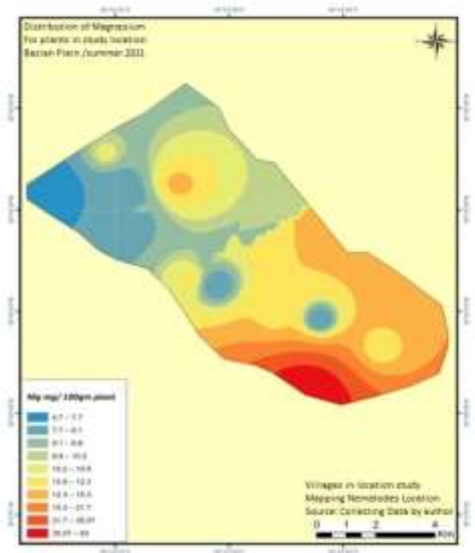

Figure 9: Depending on Table 4. Distribution of magnesium for plants in study location by ArcGIS 10.1.

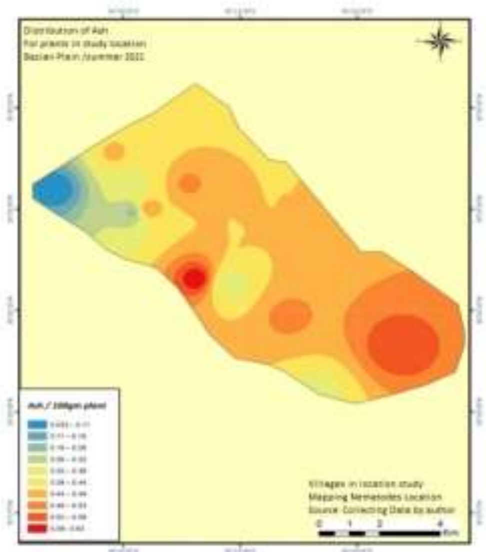

Figure 10: Depending on Table 4. Distribution of ash for plants in study location by ArcGIS 10.1.

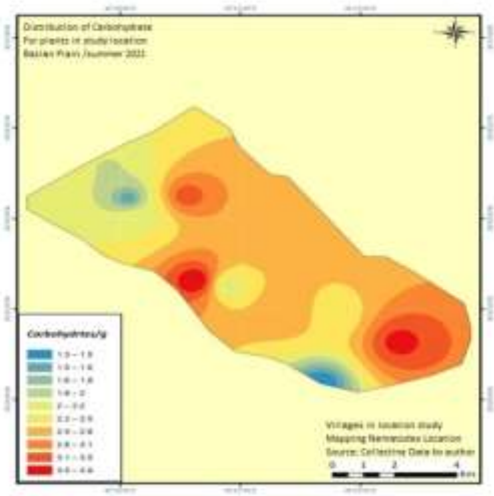

Figure 11: Depending on Table 4. Distribution of carbohydrates for plants in study location by ArcGIS 10.1.

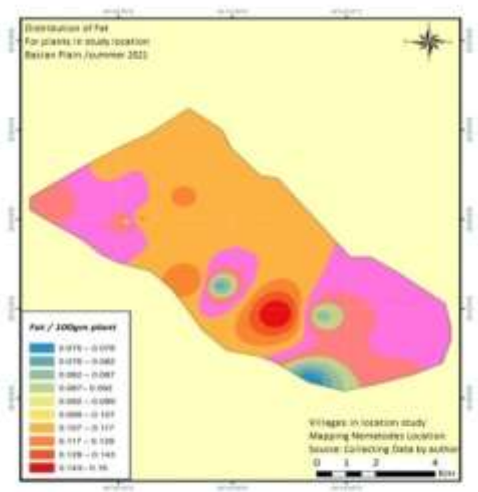

Figure 12: Depending on Table 4. Distribution of fat for plants in study location by ArcGIS 10.1.

Plant ratio of magnesium was higher (13.15) in Shuwankara and Ziyeka (11.5) as in Figure 9. So, these were very low ratios as compared with those of Oliveira et al. (2010). As with the nutrient problems, plant parasitic nematodes affecting on the vegetables will make a series of problems facing the farmers, therefore, they help to pass this (Hue et al., 2005).

Chloride (Cl) is the most recent addition to the list of essential elements. Although chloride was classified as a micronutrient, leaf chlorophyll is a direct indicator of nitrogen status and growth rate of the plant (Table 4). The highest amount of chlorophyll in collected samples was 41 mg/g in Ali Bzaw, Shuwankara and Sarchawa. This agrees with nitrogen ratio in some plants (Liu et al., 2007). In order to limit oxidative damage under stress, plants have developed a series of detoxification systems that break down the highly toxic reactive oxygen species, catalyses and peroxidases. Peroxidase comprises one important class of pathogenesis related proteins implicated in "defense responses" in which an important role is to catalyze the formation of phenolic radicals at the expense of H_2O_2 (Gaspar et al., 1991).

Phenolic compounds in plants played a vital role in their defense system, particularly redox response and free radical scavenging. Furthermore, accumulation of phenols at the site of infection was characteristic in plant defense response, caused rapid cell death and prevents penetration of pathogens (Isah, 2019). Increase in phenolic compounds due to nematode infection had been reported in several studies (Nagesh & Reddy, 2004; Liu et al., 2007). Chlorophyll is an important bimolecular which led to photosynthesis and allows plants to absorb energy from light (Mandal & Dutta, 2020). Nematode infection reduces chlorophyll content and ultimately the carbohydrate supply to the nodule resulting lower nitrogen fixation (Figure 11). The ratio of ash (Table 5) is low, as the highest ratio were in Sarchawa and Gawani (0.63 and 0.58 g, respectively) and these are lower than 1% as reported by Füzesi et al. (2015).

The ratio of BRIX (Table 4) in villages of Bagajani and Ali Bzaw 1 (12.6% and 11.5%, respectively) were the highest. From Figure 5, plants in each villages (Halay Sarchawa 3.95 g, Gawani 3.7 g and Shuwankara 3.4 g) have the highest weight of carbohydrates that return to plants produce a high diversity of natural products with a prominent function in the protection against predators and pathogens (Jones, 1976). These mechanisms include pre-existing physical and chemical barriers, as well as inducible defense response in the form of induction of defense-related enzymes that become activated upon pathogens. In parasitic nematodes, they are particularly crucial for digestion of host tissues and evasion of host immune responses (Thakur et al., 2014). Pathogen infection and various abiotic stresses lead to overproduction of reactive oxygen species such as superoxide anion, singlet oxygen and hydrogen peroxide which are produced continuously as byproducts of various metabolic pathways, and are highly reactive and toxic. They produce oxidative stress by damaging proteins, lipids and carbohydrates (Sreedhar et al., 2013). Halay Sarchawa, Bagajani 2 and Shuwankara had the highest moisture levels (92.6%, 91.9% and 89.3%, respectively) according to Table 5. In comparison with the cucumber's usual water content of 96%, these moderate ratios are quite low (Guelinckx et al., 2016).

In conclusion, farmers are using chemical nematicides which temporarily effect most nematicides, but nematode populations are never completely eliminated with a single nematicide application. Since nematode eggs are resistant to nematicides treatments, it is important that nematicides be applied after egg hatching.

Acknowledgements

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A Study on Precipitation Change and its Impact on Wheat Cultivation in Sulaimaniyah Region, Iraq

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Abstract: Using a production function method and district-level data from 1941 to 2020, this study examines the influence of climate change on wheat cropped area in Sulaimaniyah. The data for these time periods provide evidence of an ncrease in mean rainfall. Since the quantity of rain that fell on Sulaimaniyah during the 79-year research period is averaged out, it comes to 679 mm, which is a good rate for fulfilling agricultural irrigation demands in this location, especially when an essential crop like wheat requires about 450 mm for adequate output. Only nine years, out of the 79 years analyzed, had less than 450 mm of rain, while the rest had more than 450 mm. During the research period, variations in rainfall quantities had an impact on the farmed areas. Season 2019-2020 cultivated about 39250 hectares in Sulaimaniyah Region, with precipitation of 746 mm, while the season before that was one of the wettest, with 1317 mm rain. For the rainy years, which allow greater areas for cultivation, the visual distribution of cultivated areas across the study years reveals a semi-organized pattern. Seasons 2006-2007, 2007-2008 and 2008-2009 were three of the driest seasons, with agricultural areas reduced to bare minimums despite acceptable rainfall levels, although those years were not drought years, since a drought year is defined as a year with less than 300 mm of rain.

Keywords: Climate change, Rainfall, cultivating area, Wheat cultivation

Introduction

One of the most critical elements influencing the overall impact of climate change will be changes in precipitation. Although precipitation is more difficult to forecast than temperature, scientists can make certain predictions with confidence about the future (Schlenker & Roberts, 2008; Dell et al., 2014). Warmer air can contain more moisture, and global water vapor increases by 7% for every degree Celsius of warming. It's less obvious how this will translate into changes in global precipitation, although overall precipitation volume is anticipated to rise by 1-2% for each degree of warming (Feng et al., 2013). There is evidence that regions that are currently wet are more likely to grow wetter, but details regarding how much moisture and the consequences will be at the local scale are difficult to predict. The subtropical dry lands are expected to get drier and move towards the poles. Winters

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are anticipated to be wet over much of Europe, while summers in central and southern Europe will be dryer. (Hundecha & Bardossy, 2005; Fisher et al., 2012).

Changes in weather patterns that make it harder to anticipate precipitation, while many climate models agree on future warming on a global scale, there is less consensus at a technical level when it comes to predict how these changes will impact weather and hence precipitation (Ward et al., 1993). In warmer climates, heavy precipitation is expected to increase, resulting in fewer, but more severe occurrences. This might result in prolonged droughts and a higher danger of floods (Okpara, 2006). So far, any impact of climate change on regional precipitation has been indistinguishable from natural fluctuations. However, a signal began to develop in some specific situations.

According to a new research, man-made climate change increased the likelihood of disastrous floods in England and Wales in the fall of 2000 and Germany in 2021. Increases in severe rainfall throughout the winter may begin to emerge in the UK in the 1920s of twentieth century, according to current thinking (Mearns et al., 2001). According to global warming data, the average global temperature has risen by roughly 1.5 °C since the Industrial Revolution began. According to a separate research, the tendency is increasing, with average temperatures rising by 0.2 °C per decade as global temperatures rise and precipitation patterns shift locally (Tamiotti et al., 2009).

According to the Global Discussion Forum of the United Nations Framework Convention on Climate Change (UNFCCC), rising global temperatures are anticipated to enhance agricultural productivity in temperate zones while reducing yields in tropical regions. Climate change is described by the United Nations Environment Program (UNEP) as severe weather events that have negative consequences for agriculture, water resources, human health, plant cover, soil, ozone layer depletion and carbon dioxide doubling in the ecological environment (Ofori-Boateng, 2014). Climate change has an impact on all natural and human systems, and it may jeopardize human progress as well as social, political and economic existence. Most droughts in arid and semi-arid regions are linked to a late beginning of the rainy season and an early cessation of rainfall, resulting in a significant reduction in the length of the rainy season (Stern, 2008).

Rainfall as a Critical Variable in Climate Change

Agro-meteorology is the study of the impact of numerous meteorological conditions on agriculture (Salami et al., 2010). Climate variables have a direct influence on agricultural productivity and are used as a basis for agricultural production forecasts. Changes in air temperature and precipitation fluctuations can be used to track climate change. Due to disruptions in the socio-economic system caused by drought or floods, climate change has piqued public attention, particularly in connection to the unpredictability of precipitation over time. On the social and economic side, the impact of climate change is expressed in the amount of surface water in the valley and the volume of groundwater recharge (Ajayi, 1998). Climate fluctuation has a limited influence on power supply (for heating, cooling, irrigation and lighting), coastal cattle husbandry and agriculture, the presence of some disease vectors (valley fever), flood water devastation and tourist and business curtailment (Sivakumar, 1992).

The findings revealed that the frequency of distinct rainfall events, as well as related seasonal and yearly rainfall, in the Kurdistan Region/ Iraq is geographically and seasonally heterogeneous, with the highest rainfall in the northeast and decreasing rainfall in the south. Unsurprisingly, it was discovered through seasonal research that there was a favorable association between agricultural productivity and rainfall in the region. This connection indicates rain-fed agriculture's dominance in the region (Al-Quraishi et al., 2021).

All humid events in Central Europe rose throughout the second half of the twentieth century (1946-1999), despite limited geographical coherence in the trend and evidence of too high changes in extremes relative to the yearly average (KleinTank & Können, 2003). The annual precipitation fraction index rose in the station where the quantity of yearly precipitation increased, leading to particularly wet days with disproportionately significant swings in precipitation extremes (Giannini et al., 2003). There is no obvious reaction to extremes in places with lower annual rainfall. Maximum precipitation patterns in Europe during the last century (1901-2000) indicated regional variations in seasonality (Mottet et al., 2006).

Ahmad et al. (2017) conducted an experiment in Kurdistan Region/ Iraq on the effect of drought on some wheat cultivars and found that wheat yield decreased significantly with the effect of drought and a decrease in rainfall, especially in critical months. Germination percentages of all cultivars used in this experiment were greater in the control treatment and began to decline with increasing amount of water stress.

Opoku-Ankomah & Amisigo (1998) used a time series spectral analysis to determine the importance of weekly, monthly and yearly rainfall in agriculture, water and environmental projects. The most notable feature of precipitation in Central and Western Europe is a considerable rise in winter precipitation, both in terms of average intensity and in the occurrence of quite intense occurrences. There is no indication that summer precipitation indices have changed much (Bozzola et al., 2012).

Osborn et al. (2000) identified a tendency towards wetter circumstances in winter and drier conditions in summer for the United Kingdom, based on a comprehensive data network over the second half of the twentieth century. Intensive heavy rainfall in the winter and transitional seasons grew severe in magnitude and frequency in Western Germany over the same time period. Unlike in the winter, however, the summer tendency in severe rainfall is less dramatic. Climate variability may impact the availability of ground and surface water resources in the long run (Chebil & Frija, 2016). To establish the nature of this restriction, more study is required. Precipitation, an important component of the hydrological cycle, has a high value, both spatially and temporally (between annual and inter annual) and the change in high precipitation has been analyzed, in part, for each of the individual European countries and stations, and to a lesser extent, for Europe as a whole, based on these indicators. (Ghosh et al., 2009).

Changes in precipitation can be regarded as a reaction to external influences or feedback mechanisms in the climate system (Finan et al., 2002). Rainfall is the most significant meteorological element that controls agriculture since it provides the water required for the soil and plant atmosphere systems to function. Precipitation fluctuates greatly, although other time and spatial factors are quite conservative. Precipitation is defined by a numerous asymmetric cycle of abnormalities of various magnitude; these findings corroborate prior findings (Hulme et al., 2001).

Naylor et al. (2007) stated that the findings of rainfall studies in any location can aid decision-makers in the management of water, agricultural, environmental, and other water-related initiatives. While precipitation variability is a prominent characteristic of the climate, the region's average annual precipitation has significantly decreased since 1969.

Due to the intense and severe years of drought that affected Iraq, which resulted in decreased agricultural land areas, large losses in the area of vegetation in Kurdistan Region/ Iraq were noted from 2000 to 2008. The severe drought periods that affected Iraq, particularly the Kurdistan Region/ Iraq in 2000 and 2008, among other variables, as well as a considerable reduction in rainfall averages, are mostly to blame for this loss (Gaznayee et al., 2022).

Methodology

The mathematical programming technique is used in this work for two reasons. Extensive assessment of economic studies on climate and agriculture is the first reason (Olayide et al., 2016). Using economically estimated fixed-effects dashboard data models, the most notable pair of traditional issues with models based on cross-section data, such as inconsistent and unobservable estimates of climate-related variables, may be minimized. This needs at least two years of observations and data collection, and is based on a single year of original data from farmers.

The other reason is that mathematical optimization provides for a more detailed depiction of the physical limitations that actual farmers confront when selecting what to plant and when to plant it. Because various rainfall schedules specify a distinct set of limitations experienced by farmers, accurate characterization of these constraints is critical to the present study (Rodrigues et al., 2012). Because the present unit of observation and the relevant data are at the farmer level, the crop and farmer-specific production functions may be parameterized without resorting to maximum entropy approaches to disaggregate production characteristics from coarser to finer particular scales, such as the farmer level (Obioha, 2008). The hydrological component employs a mass-balance model to estimate the monthly, seasonal and annual water available for irrigation to farmers in the watershed (Nicholson et al., 2012). The physical restrictions on water and rainfall utilized in the economic component were determined using this information. Following that, these two components are progressively coupled to allow for the assessment of the impacts of changes in rainfall and the volume of stored water in tiny reservoirs on agricultural revenue at various model time resolutions (Mills, 2007).

Location Study

Sulaimaniyah is a province in northern Iraq. It is distinguished by the overall appearance of its surface. It is hilly, with valleys and tiny plains surrounding it. The city (35°33′26″N 45°26′08″E) is situated at an elevation of 850 meters above sea level. From north to south, the city is bordered by many mountain ranges. Sulaimaniyah is built on a 3.5% sloping piece of ground. The city's northern end rises to 885 meters above sea level, while the southern end rises to 800 meters. The city's climate may be classified as temperate, or the Mediterranean climate of the mountain, based on climate classifications conducted by researchers and professionals in this field. It's most important climatic features included the average annual temperature of 18.74 °C, the predominant winds (locally known as rashaba, which in Kurdish language means strong winds) are northeast and usually very fast and the rainy season is primarily in the winter and spring, with little rain in the summer. In 2018, more annual rain was reported; totaling 1273.80 mm. solar radiations hitting the Sulaimaniyah station on a daily basis averages 989.4 kcal/cm^2/day. Due to the heavy clouds and relative humidity, it is reasonable to state that solar radiation is moderated in the northern area in general and in Sulaimaniyah in particular. Daily vertical radiation rate of 5-6 kWh/m^2 in the northern area, and 6-6.5 kWh/m^2 in the middle and southern regions. Wheat is the most significant crop in the study region, accounting for more than half of the total land area (Mazid, 2015).

Result and Discussion

Figure 1 depicts the time spans from 1945 to 1951, then 1952 to 1957, 1959 to 1962, and so on through 2019. The line rises and falls in a semi-regular pattern during all of these times. During the 79-year research period, there were at least 21 rises and falls. It did not exceed the periods when rainfall dropped for four seasons in a row, such as the years 1948 to 1951. When the amount of rain that fell on Sulaimaniyah Rgion over the study period, is averaged out, it comes to 679 mm, which is an excellent rate for meeting agricultural irrigation needs in this region, especially when an important crop like wheat requires approximately 450 mm for adequate production. Table 1 displays the yearly rainfall trend. Based on the results of research and studies conducted at stations affiliated with the Agricultural Research Department in Sulaimaniyah Province, the amounts of rainfall were classified into three main divisions according to the needs of the irrigated wheat plant, which were estimated to be around 400 mm. (Dell et al., 2014).

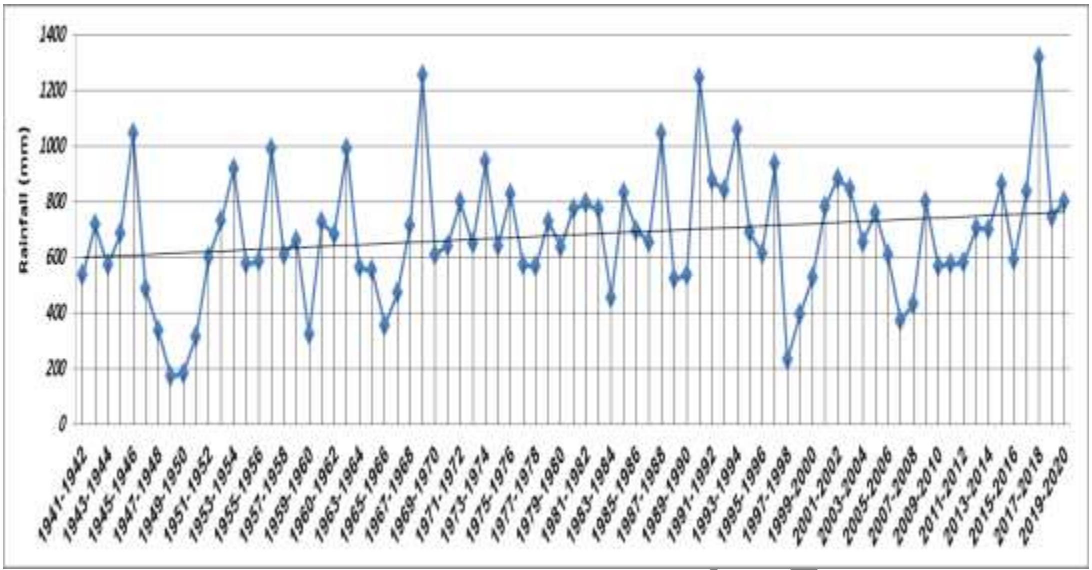

Figure 1: Data of rainfall for Sulaimaniyah Region based on the compositing of 79 annual analyses from the newly developed 1941 to 2019. Source: Directorate of Meteorology and Earthquakes in Sulaimaniyah, Iraq.

There were only nine seasons in which the amounts of rain were less than the critical limit or the first division, which was calculated at less than 400 mm, which is a small fraction compared to the 78 years in the research period. In terms of the second class of rain quantities, it was a fair quantity, estimated at more than 450 mm, with 21 seasons in which the amount of rain was between 400 and 650 mm. The plant gets its needs from the amount of rain water at these percentages. The number of seasons covered in the third group grew to 41, with heavy years defined as those with more than 650 mm of rain. As a results for data's in table 1, it is clear that if the wheat crop depends in its growth and production on the amounts of rain, then the percentage of rain is good and is considered good to give the best production in the event of a good distribution of this rain (Tošić & Unkašević, 2005; Aggarwal, 2008).

As indicated in Table 2, total rainfall in eight decades has grown. Of course, this increase is dispersed across the years of these decades in various years and months, but it appears that the rates of rainfall have increased with time (Lobell et al., 2011).

Because the bulk of seeds, planted in November, the germination of these seeds is dependent on the amount of rain. November is one of the most significant months for the culture of wheat.

Table 1: The state of rain during the period from 1941 to 2019.

Rainfall state	Years	Number of years	Rainfall amounts
Low	1948-1949, 1949-1950, 1998-1999 1950-1951, 1959-1960, 1947-1948 1965-1966, 2007-2008, 1999-2000	9	Lower than 400 mm
Moderate	2008-2009, 1983-1984, 1966-1967 1946-1947, 1988-1989, 2000-2001 1941-1942, 1989-1990, 1964-1965 1963-1964, 1977-1978, 2010-2011 1943-1944, 1976-1977, 2011-2012 1954-1955, 2012-2013, 1955-1956 2016-2017, 1951-1952, 2006-2007 1957-1958, 1969-1970, 1996-1997 1979-1980, 1974-1975, 1970-1971 1972-1973	29	400-650 mm
High	2004-2005, 1986-1987, 1958-1959 1961-1962, 1944-1945, 1995-1996 1985-1986, 2014-2015, 2013-2014 1967-1968, 1942-1943, 1960-1961 1978-1979, 1952-1953, 2019-2020 2005-2006, 1982-1983, 1980-1981 2001-2002, 1981-1982, 1971-1972 2009-2010, 1975-1976, 1984-1985 2017-2018, 1993-1994, 2003-2004 2015-2016, 1992-1993, 2002-2003 1953-1954, 1997-1998, 1973-1974 1962-1963, 1956-1957, 1987-1988 1945-1946, 1994-1995, 1991-1992 1968-1969, 2018-2019.	41	More than 650 mm

Source: Directorate of Meteorology and Earthquakes in Sulaymaniyah, Iraq.

Table 2: Changes in rainfall amounts for specific months over decades since 1941.

Years (1941-2020)	Rainfall amount	Rainfall amount for November*		Rainfall amount for March*		Rainfall amount for April*	
		Mm	%	mm	%	Mm	%
Decade 1 (1941-1950)	5031.6	528.9	10.51	901.1	17.9	543.6	10.80
Decade 2 (1951-1960)	6701.6	829.5	12.37	1262	18.83	1136.3	16.95
Decade 3 (1961-1970)	6819.7	634.0	9.29	914	13.4	1394.9	20.45
Decade 4 (1971-1980)	7123.1	536.9	7.53	1455.8	20.43	872.1	12.24
Decade 5 (1981-1990)	6894.6	1086.9	15.76	1008.2	14.62	725.7	10.52
Decade 6 (1991-2000)	6873.5	1012.5	17.64	1105.0	16.07	916.4	13.33
Decade 7 (2001-2010)	6647.7	578.8	8.7	797.6	11.99	1030.8	15.50
Decade 8 (2011-2019)	7474.0	982.3	13.14	1267.2	16.95	628.9	8.41

Source: directorate of Meteorology and Earthquakes in Sulaimaniyah, Iraq.
* Since November, March and April are critical months for wheat growth.

Table 3 shows that the quantity of rain varied by season and decade over the research period, but in general, most of the seasons had good quantities of rain until the seeds germinated, which surpassed the 10% of November rainfall. This month is important for the growth of wheat plants since the absence of ground moisture during this phase leads to a loss of fertilization and seed storage, therefore plants should not be thirsty during this phase.

The ovary progressively comes up to maturity in this month, as well as a process of pollination and fertilization in wheat flowers. The most essential activities that occur in this month are the transfer of nutrients, water and organic elements, necessary for growth, from stems and leaves to grains. A pollination and fertilization procedures are also carried out throughout April. After pollination and fertilization in the wheat flower, starch storage occurs in the grains, and the weight of the grains rises linearly throughout this month depending on rainfall quantities, temperature, organic matter and nutrients, and then progressively follows the stage of grain maturity (Moberg & Jones, 2005).

Table 3: Effect of long term of rainfall on changing sowing wheat date.

Decades (1941-2020)	Sowing in September	Sowing in October	Sowing in November	Sowing in December	Sowing in January
Decade 1 (1941-1950)	Non	3 Seasons	6 Seasons	Non	1 Season
Decade 2 (1951-1960)	Non	1 Season	5 Seasons	4 Seasons	Non
Decade 3 (1961-1970)	Non	Non	5 Seasons	4 Seasons	1 Season
Decade 4 (1971-1980)	Non	1 Season	4 Seasons	5 Seasons	Non
Decade 5 (1981-1990)	Non	2 Seasons	7 Seasons	1 Season	Non
Decade 6 (1991-2000)	Non	3 Seasons	7 Seasons	Non	Non
Decade 7 (2001-2010)	Non	3 Seasons	4 Seasons	3 Seasons	Non
Decade 8 (2011-2019)	Non	4 Seasons	5 Seasons	Non	Non

Sources: Directorate of Meteorology and Earthquakes in Sulaimaniyah, Iraq and General Directorate for Agriculture in Sulaimaniyah, Iraq.

Climate change, particularly changes in the critical and important months for the germination of crops, particularly the crop under study, has had an impact on the field study conducted and the information received that the dates of planting the wheat crop have changed as the dates of rainfall have changed.

Table 3 shows that the planting season has shifted between October and November in the recent decade. They used to plant their crops in October at the start of the decade, but as rainy season dates changed, farmers had to wait planting until November to ensure that the seeds of their crops germinated, as this month became more guarantees for planting and seed germination (Dai et al., 2004).

Table 4 shows the steady rise in temperature rates as in the months under investigation, which is clearly seen, especially in the crucial and essential months for wheat cultivation, such as October and November. The average temperatures for October and November in the 1940s were 25 and 16.7, respectively. In following study period, average temperatures reached 28.9 and 20.3, respectively in the first decade of this century. Although this rise in temperatures was accompanied by a rise in the rates of rain, the dates of the fall of these rains were not in the interest of some field crops, especially the crop under study.

According to Figure 2, differences in rainfall amounts had an effect on the cultivated areas during the study period. The largest cultivation areas reordered were in season 2019-2020, which cultivated nearly 157 000 dunam (also spelled as donum) in Sulaimaniyah Region. In this season, the precipitation was 746 mm, but the season before that was one of the wettest, with 1317 mm rain (Parry et al., 2004).

Table 4: Relationship between rainfall and temperatures.

Decades (1941-2020)	Rainfall Average	Average Temp. in Sep.	Average Temp. in Oct.	Average Temp. in Nov.	Average Temp. in Dec.	Average Temp. in Jan.
Decade 1 (1941-1950)	503.16	32.6	25.0	16.76	10.75	7.25
Decade 2 (1951-1960)	670.16	33.4	26.10	17.07	10.95	7.3
Decade 3 (1961-1970)	681.97	34.9	26.70	17.8	11.32	7.5
Decade 4 (1971-1980)	712.31	35.03	27.25	18.42	11.63	7.77
Decade 5 (1981-1990)	689.46	35.62	27.78	18.57	12.41	8.4
Decade 6 (1991-2000)	687.35	36.2	28.5	19.2	13.35	9.0
Decade 7 (2001-2010)	664.77	36.5	28.6	19.8	12.5	10.4
Decade 8 (2011-2020)	830.44	34.76	28.9	20.3	13.17	10.6

Sources: Directorate of Meteorology and Earthquakes in Sulaimaniyah, Iraq and General Directorate for Agriculture in Sulaimaniyah, Iraq.

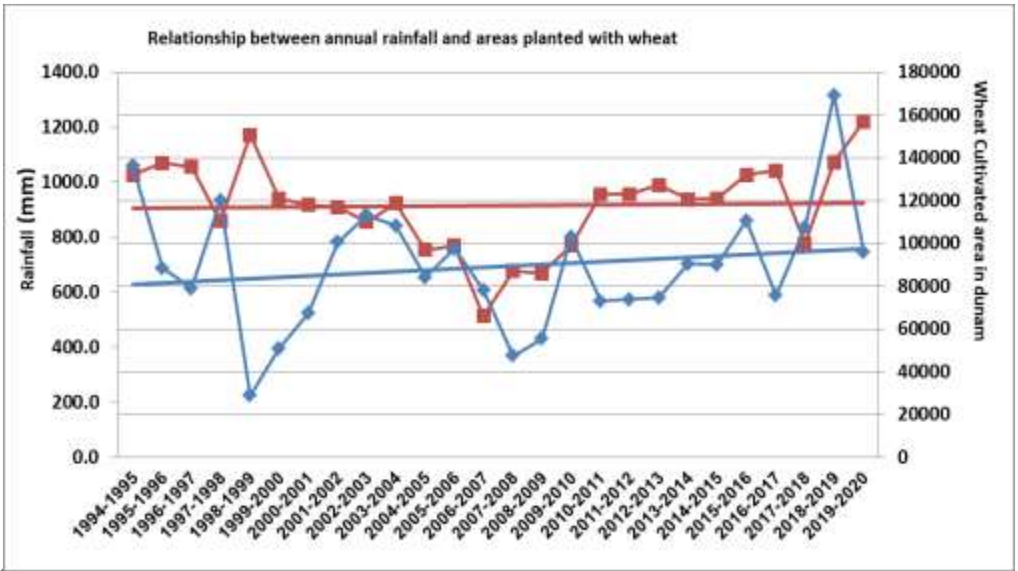

Figure 2: Relationship between the areas cultivated with wheat (in dunam which is 2500 m^2) and the amount of rain in Sulaimaniyah. Sources: General Directorate for Agriculture in Sulaimaniyah, Iraq and Directorate of Meteorology and Earthquakes in Sulaimaniyah, Iraq.

The graphic distribution of cultivated areas over the study years (Figure 2), shows a semi-organized pattern for the wet years, which provided larger areas for cultivation, such as the seasons1994-1995, 1997-1998, 2001-2002, 2002-2003, 2003-2004, 2004-2005, 2005-2006, 2006-2007, 2007-2008, 2008-2009, 2009-2010, 2015-2016, 2017-2018 and 2018-2019 which were one of the very dry seasons in which farmed lands were reduced to the bare minimums, despite the fact that rainfall levels were within permissible standards, and those years were not drought years, since a drought year is defined as a year with less than 300 mm of rain.

When comparing the cultivated areas in successive years from 1994 to 2020 (Figure 3), one can see that there is a change in the cultivated areas, particularly during 1994, 2006 and 2019. As a result, the quantities of wheat produced will change annually, affecting the output and economic return for farmers. When looking at the cultivated areas from 1997-98, when about 934 dunam were planted, it is clear that there has been a reduction in the cultivated lands, peaking in 2006-2007. After the 2006-2007 seasons, wheat planting areas increased until they reached their greatest level in 2016 season, when they reached around 870 dunam. When drawing a trend line for these data in the graph, one can notice that the areas planted with wheat in the years under consideration have been rather stable (Singh et al., 2013).

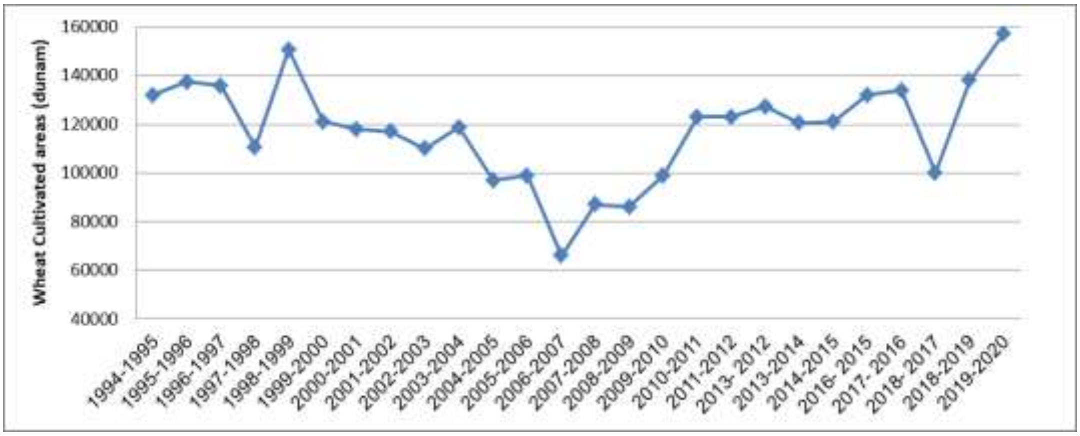

Figure 3: Impact of rainfall amounts changes on cultivated area in Sulaimaniyah Region (One dunam= 2500 m^2). Sources: General Directorate for Agriculture in Sulaimaniyah, Iraq and Directorate of Meteorology and Earthquakes in Sulaimaniyah, Iraq.

The adoption of most regions is one of the causes for output fluctuations from year to year. The impact of cultivated wheat on rainfall quantities and dispersion, in addition to other variables, such as the development of rust infections, epidemic in a number of wet years before maturity, during the planting season (Zolina et al., 2005).

Because of the dramatic variations in rain amounts and distribution, as well as the dramatic increase and fall in temperatures, officials may be compelled to re-examine some of the fundamentals of wheat production, such as selecting better planting dates in response to climatic changes. Researching and developing long-term solutions, at the very least, to the impact of climate change on agriculture in general, including meetings between scientists, government officials and incorporating farmers through a series of interconnected workshops are needed. The work of specialized committees between the Ministry of Agriculture and meteorologists is needed to create simulation programs for the next 30 years and to find sports models. The Aqua Crop program has shown to be crucial in determining how people may be impacted by climate change in the near future. Every year that goes by, without the program being implemented, is an irreversible loss in terms of studying the consequences of climate change on agriculture and developing more effective policies.

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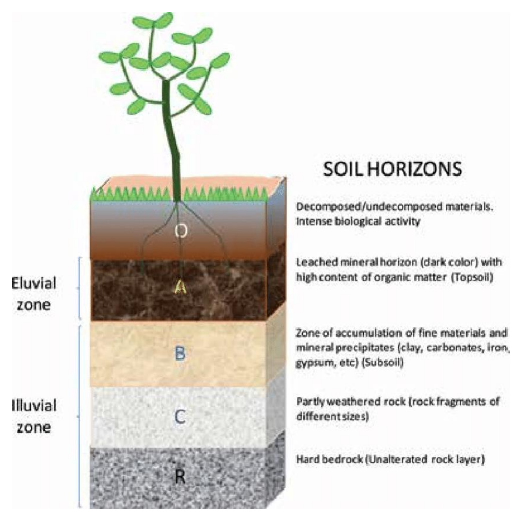

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گۆڤاری زانکۆی سلێمانی بەشی A

Effect of Soil Application of Zinc Fertilizer on Growth and Yield of Wheat at Bakrajow and Kanypanka locations in Sulaimani Governorate.

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Abstract:

This study was conducted during growing season of 2010 - 2011, to study the effect of four levels of Zinc as Zn- EDTA (0, 20, 40, 60 kg Zn ha^{-1}) on growth traits and yield of wheat variety *ovanto* at two different agricultural locations (Bakrajow and Kanypanka) using Randomized Complete Block Design (R.C.B.D.) with three replicates. The results showed that the increase in rates of Zn causes an increase in grain yield, grain zinc content and zinc uptake by plant, from both of locations. However the results showed that the relative yield was decreased with increasing of zinc application rate from both of locations.

Key words: Zinc fertilizer and Wheat Production, Zinc uptake, grain yield

1. Introduction:

Zinc is one of the essential micro nutrient for plants, animals and human [1]. Zn is needed by plants in small amount but the critical concentrations or if the available amount is not adequate, the plants and/ or animals will suffer from physiological stress brought about by the dysfunction of several enzyme systems and other metabolic functions in which zinc plays apart [2], He reported that the zinc which is available to plants is that present in the soil solution or is adsorbed in a labile form. The soil factors affecting the availability of zinc to plants are those which control the amount of zinc in the soil solution and its sorption-desorption from/ into the soil solution. These factors include: the total zinc content, pH, organic matter content, calcium carbonate content, redox conditions, microbial activity in the rhizosphere, soil moisture status, concentration of other elements, concentration of macro-nutrients, especially phosphorus and climatic condition.

Higher plants absorb Zn as divalent cations (Zn^{2+}) which acts either as a metal component of enzymes or as a functional structural, or a regulatory cofactor of a large number of enzymes [3], [4].On the other hand zinc deficiency is a global nutritional constraint for plant growth, particularly in calcareous soils of arid and semi arid regions [5]. One of the most important micronutrient deficiencies is attributed to zinc deficiency that is worldwide problem in human nutrition.

Wheat as one of the most critical nutrient sources for human and animals which plays an important role in production of food combinations worldwide. Among necessary elements for growth and development, zinc has been considered as one of fundamental elements for natural growth of wheat and other crops [6]. Soils with low organic material content and pH above 7 have potentially high zinc deficiency and in such a situation the problem is easily fixable using insoluble zinc granular fertilizers [7].

The objective of the present investigation is to study the effect of zinc application on growth and yield of wheat in calcareous soil.

2. Materials and Methods:

To consider effects of Zinc fertilizer application (to soil) on growth and yield of wheat in calcareous soil, the experiment was conducted at two different locations, the first one at Bakrajow Agricultural Research farm (743 masl 35^{o}32^{-}37.7$^{"}$ N 45^{o}20^{-}53.9$^{"}$E) and the second one at Kanypanka Agricultural Research farm (580 masl 35^{o}22^{-}37$^{"}$ N 45^{o}20^{-}33$^{"}$ E) under rain-fed condition during winter growing season of 2010-2011. To study the effect of four levels of Zinc as Zn-EDTA 15% Zn (T_1=0, T_2= 20, T_3=40 and T_4= 60 kg Zn ha^{-1}) were added to the soil in deep of 25 cm at a sowing time . The field experiment was set as Randomized Complete Block Design (R.C.B.D) with three replicates. The means were compared statistically according to Duncan multiple ranges using 0.05 as significant level, and the plot area was 6 m^2. On 27 and 29 December 2010 the plots were sown with seeding rate 140 kg ha^{-1} by direct seeding of wheat variety *Ovanto* at Bakrajow and Kanypanka locations. 200 kg ha^{-1} nitrogen fertilizer was added and splitted to two equal doses which were applied at the seeding time and after 20 days of germination. 200 kg P_2O_5 ha^{-1} as triple super phosphate TSP and 150 kg K_2O as KCl were applied at the seeding time. The plants from Kanypanka location were harvested on 19th/June/2011, while at Bakrajow location the harvest was conducted on 21st/ June/2011. Soil samples were taken from all experimental units at (0 to 30 cm) depth, then air dried thoroughly mixed, ground passed through a 2 mm sieve, and stored in plastic bottles prior to analysis. Some physical and chemical properties of the soils are given in (Table 1). Electrical conductivity (EC) and pH were measured for the soil saturation extract with EC-meter, model (WTW 82362 Weilheim, Germany) and a pH-meter, model (Microprocessor pH meter, Hanna pH 211) respectively. Organic matter was determined by dichromate oxidation (Walkley and Black method) as described by [8]. The total calcium carbonate equivalent was determined by a rapid titration method [9].Cation Exchange Capacity (CEC) was determined by saturation with 1*M* NH_4OAc at pH 8.1[10].Soluble HCO_3^-, Cl^- and Ca^{2+} + Mg^{2+} titration methods [11].Na^+ and K^+ were determined by using (Flame Photometer). $SO_4^{2-}$was indirectly determined from combined Ca and Mg by titration with (0.02*M*) EDTA di-sodium salt according to [12]. Available P was determined by [13]. The particle size was determined according to international pipette method as described by [14].

Biological parameters were calculated according to [15], [16]. As follow:

Relative yield = (yield of control / yield of fertilized treatment) x100……….....… (1)

Response %=[(fertilized yield – control yield) / fertilized yield] x 100……………… (2)

Table. 1: Some physical and chemical properties of soil used in field experiments.

Properties		Location	
		Bakrajow	Kanypanka
Particle Size Distribution(PSD) g kg^{-1}	Sand	115.4	234.0
	Silt	523.6	572.0
	Clay	361.0	196.0

Textural Class		SiCL	SiL
pH		7.90	7.60
EC_e dS m^{-1} at 25°C		0.40	2.60
Soluble ions mmolc L^{-1}	Ca^{2+}	1.70	12.00
	Mg^{2+}	0.31	4.60
	Na^{+}	0.48	4.20
	K^{+}	0.19	6.10
	HCO_3^{-}	2.95	3.20
	Cl^{-}	0.21	16.10
	SO_4^{2-}	0.81	20.10
Cation Exchange capacity $cmol_c$ kg^{-1}		29.76	22.10
Available Zn mg kg^{-1}		0.565	1.563
Organic matter. g kg^{-1}		17.60	22.03
Available Phosphorous mg kg^{-1}		6.50	9.00
$CaCO_3$ equivalent g kg^{-1}	Total	328.00	225.00

3. Results and Discussion:

Number of tillers per hill:

The highest number of tillers per hill(4.66) was recorded from T_2 while the lowest value (4.00) was obtained from T_4 for Bakrajow location but for Kanypanka location the highest numbers of tillers per hill (4.76) was recorded from T_2 while the lowest (4.32) was obtained from T_4. The effects of all treatments on numbers of tillers per hill were identical to each other (Table 2).

Plant height:

The highest plant height (78.33 cm) was observed in T_1 but the lowest plant height (74.66 cm) in T_4 for Bakrajow location, while for Kanypanka location the highest plant height (78.16 cm) was observed from T_3 and the lowest plant height (77.16) was recorded from T_1. The plant heights were found identical to each other for both Bakrajow and Kanypanka location (Table 2).

Weight of 1000 grains:

The maximum weight of 1000 grains (53.86 g) was obtained from T_3 treatment and the minimum value (52.26g) was found from T_2 treatment at Bakrajow location, while in Kanypanka location the maximum weight of 1000 grains(48.26g) was obtained from T_4 treatment and minimum value(46.53g) was found from T_2 treatment (Table (2). From the above results it has been observed that the application of Zn fertilizer has not a significant effect on number of tillers per hill, plant height and the weight of 1000 grains in both locations because the soil is calcareous soil and contain an excess of Ca^{2+} ions. These Ca^{2+} ions undergo reactions with the applied zinc and make it unavailable for plant uptake these results were agree with finding bye [17].

Grain yield:

The grain yield was generally higher in Kanypanka location than Bakrajow location. The highest grain yield was found from T_4 (871.68 kg ha^{-1}) and the lowest was found from T_1 (733.35 kg ha^{-1}) at Bakrajow location, while the highest grain yield was found from T_4 (1208.36 kg ha^{-1}) and the lowest was found from T_1 (1025.02 kg ha^{-1}) at Kanypanka location Table(3).

Table. 2: Effect of Zn application on number of tillers per hill, plant height and weight of 1000 grains.

Locations	Zn application (kg ha^{-1})	No. of tiller per hill	Plant height (cm)	Weight of 1000 grain (g)
Bakrajow	0	4.33a	78.33a	53.20a
	20	4.66a	77.33a	52.26a
	40	4.33a	76.33a	53.86a
	60	4.00a	74.66a	53.73a
Kanypanka	0	4.43a	77.16a	48.00a
	20	4.76a	77.50a	46.53a
	40	4.62a	78.16a	47.86a
	60	4.32a	77.25a	48.26a

Values in the same column of each location followed by the same letter are not different significantly $p<0.05$

Concentration of Zn in grain and Zn uptake:

The results showed that the Zn content in grain were nearly similar in both locations. The Zn concentration in grain increased with increasing Zn application. So, the highest Zn value was found from the highest Zn application, but the highest Zn content in grain was in plants grown at Kanypanka inspite of Zn application the value (1.70 mg kg^{-1}) was much higher in T_4 at Kanypanka location than T_4 at Bakrajow location which was (0.718 mg kg^{-1}). This was very evident in the Zn uptake by the crop (Table 3).The results showed that the Zn uptake by grain was increase with increasing of Zn application at both locations. So, the highest Zn uptake by grain was in grain plants grown at Kanypanka location. The value (2054.21 mg ha^{-1}) was much higher in T_4 at Kanypanka location than T_4 at Bakrajow location which was (625.86 mg ha^{-1}) (Table3).The reasons of low zinc uptake from both of locations maybe due to fixation of zinc by available calcium ion.

Locations	Zn application (kg ha^{-1})	Grain yield (kg ha^{-1})	Grain Zn concentration (mg kg^{-1})	Grain Zn uptake (mg ha^{-1})	Relative yield (control/fertilized)x 100	Response %
Bakrajow	0	733.35a	0.453a	332.20a	…………….	………..
	20	755.02a	0.596a	450.00a	97.13	2.87
	40	855.02a	0.675a	577.14a	85.76	14.23
	60	871.68a	0.718a	625.86a	84.13	15.86
Kanypanka	0	1025.02a	0.435b	445.88b	……….	………
	20	1125.02a	0.455ab	511.88ab	91.11	8.88
	40	1156.7a	0.574ab	663.95ab	88.86	11.38
	60	1208.36a	1.700a	2054.21a	84.48	15.17

Table.3: Effect of Zn application on grain yield, grain Zn concentration , Zn uptake by grain, Relative yield and (Response %)

Values in the same column of each location followed by the same letter are not different significantly $p<0.05$

Effect of Zn fertilizer level on (Response %) and Relative yield:

Result in (Table 3) showed that the relative yield was decreased from 97.13 to 84.13 % for Bakrajow location and from 91.11 to 84.48% for Kanypanka location. While the response percentage for grain yield as it is opposite in trade with relative yield affected by Zn fertilizer level and soil type, the range of response percentage increased with increasing Zn fertilizer level from 2.87 to 15.86% for Bakrajow location and from 8.88 to 15.17% for Kanypanka location.

The response of wheat to Zn fertilization:

The results in Fig. 1. Refer to the significant effect of Zn fertilizer on grain yield of wheat plant in Bakrajow and Kanypanka locations in Sulaimani governorate. These results showed that increasing Zn fertilizer application from 20 to 60 kg Zn ha^{-1} as Zn-EDTA increased significantly the grain yield of wheat from 733.4 to 817.7 kg ha^{-1} for Bakrajow location and from 1025.02 to 1208.36 kg ha^{-1}for Kanypanka location comparing with control treatment.

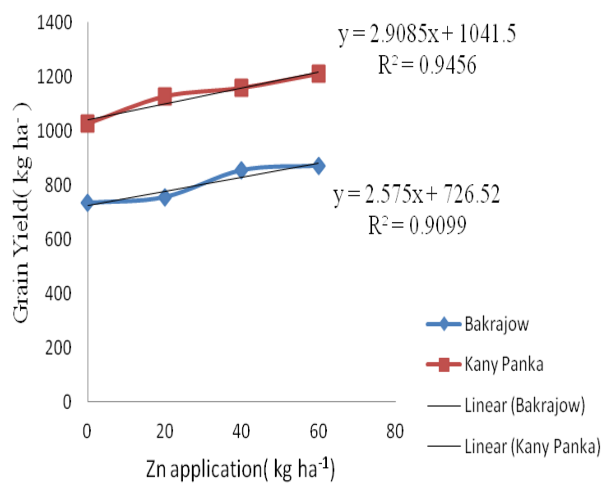

Fig.(1) effect of Zn application on grain yield of wheat.

IV. Conclusions:

According to results obtained from present study, it can be concluded that the increasing in Zn application lead to increase in grain yield and Zn uptake by plant. But the relative yield was decreased with increasing Zn application

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Kinetics of copper release in some calcareous soils from Sulaimani governorate, Iraqi Kurdistan Region.

ABSTRACT

This study was conducted to estimate copper release kinetic in five calcareous soils includes (Sharazor, Qaradagh, Bazian, Mawat, and Surdash) at the Sulaimani governorate, Iraqi Kurdistan – region. The highest amount of Cu release during 48 hours was least in soil Qaradagh (0.75mg kg $^{-1}$). While Soil Mawat exhibited the highest release (2.272mg kg^{-1}). The value of diffusion rate constant (kp) from parabolic diffusion varied from 0.123 to 0.321 with a mean of (0.221). The initial Cu release constant (αs) and Cu release rate coefficient (βs) from simple Elovich model, ranged from 0.42 to 1.164 with a mean of 0.6856, and from 2.197 to 5.952 with a mean of 3.6918. While the values of the rate constant (a and b) from the power function model with the mean were (0.249 and 0.605) respectively varied widely with the five soil. The parabolic diffusion was the best-fitted model used to describe Cu release process very well in the studied soils.

INTRODUCTION

Copper, like other micronutrients, is essential for plants, animals, and microorganisms, but it is toxic when its concentration more than the allowable level (Baker, 1990). Copper is adsorbed on manganese and iron oxides, organic matter and the surface of clay minerals in the soil; it is also precipitated as hydroxides, sulfide and carbonate copper (McBride,1981; Baker, 1990). Generally, the amount of total copper content in Sulaimani governorate soils is typically sufficient but its soluble form in soil solution is very low due to high pH, low organic matter, and high calcium carbonate content in calcareous soils; therefore, the bioavailability of Cu is usually low in these soils, copper deficiencies can overcome by the addition of Cu fertilisers (Rate, and Sheikh – Abdulla, 2017). DTPA combines with free Cu ions in solution, forming soluble complexes, as a result the free copper ion activity in the solution decreases. Thus, Cu ions release from the surface of soil particles in order to compensate the free Cu ions in solution (Lindsay, and Norvell, 1978). The desorption of Cu from exchangeable sites and release of Cu from organic matter, crystalline mineral, and other metastable compounds to the solution, thus this process control the mobility of soil Cu, this leads to the relative contribution of copper availability for plants (Singh et al., 1994). Reyhanitabar and Karimian, (2008) showed that simple Elovich and two constant-rates were the best models for the explanation of Cu release of calcareous soils of central Iran. Data on the kinetics of Cu release in some calcareous soil

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in Sulaimani governorate in the Kurdistan region of Iraq are limited. Thus, the aims of the current research started to:
- estimate the release kinetic of Cu from studied soils.
- determine the fitness of various models for the description of the kinetics of Cu release from studied soils.

MATERIALS AND METHODS

Soil samples were taken from the depth (0-30) cm in five calcareous soil include (Sharazor, Qaradagh, Bazian, Mawat, and Surdash) at Sulaimani governorate, Iraqi Kurdistan region. The study area lies between (longitudes 35°15′ 27″ N; and latitudes 45 07′ 37″ E) as shown in (fig.1). All the five soils classified as (Argixerolls, Rendolls, Pelloxererts, Rendolls, and Argixerolls) according to the Soil Survey Staff, (2004). The soil samples air-dried, crushed, and passed through a 2-mm sieve before soil analysis and release studies. Some basic physicochemical properties of the studied soil including particle size distribution, pH, EC, organic matter %, calcium carbonate %, and CEC determined according to the methods of soil analysis as described by (Page et al. 1982; Rayan J. et al. 2001), available concentration of Cu in studied soil as defined in DTPA method (Lindsay and Norvell, 1978).

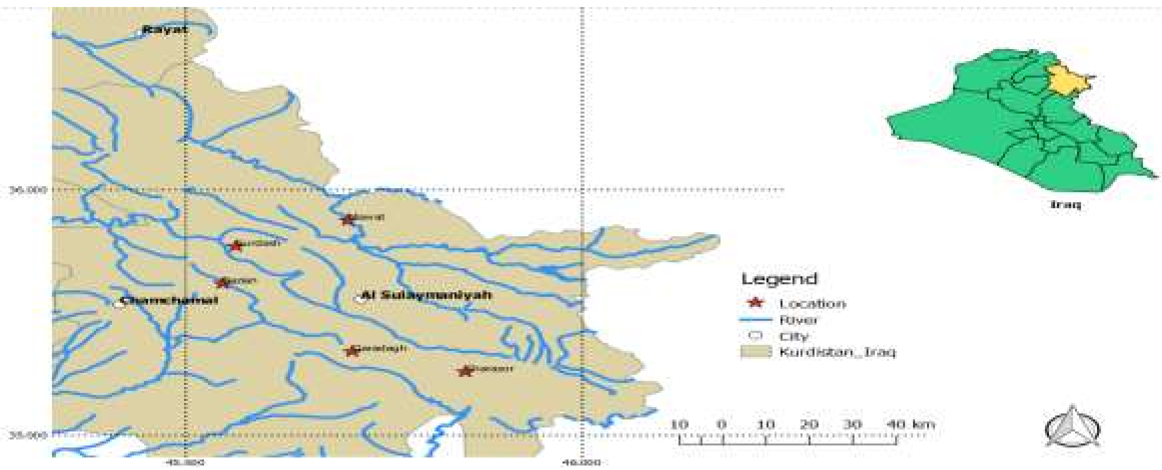

Fig. 1. The location of the studied area

Kinetic study procedure:

Release kinetics were studied using DTPA extracting solution (0.005*M* diethylene triamine pentaacetic acid, 0.1 *M* triethanolamine, and 0.01*M* $CaCl_2$) at pH=7.3; (Lindsay and Norvell 1978) as an extractant as follows: 50g oven-dried soil in duplicate were extracted with 100 ml of DTPA extracting solution with ratio (m/v of 1:2) at 25˚C ±1 in a constant temperature shaker, for periods of 0.5, 1, 2, 4, 6, 8, 24,48 hours. Added five drops of toluene to prevent microbial activity. For each shaking period, the soil suspension immediately filtered through Whatman paper No.42, then the concentration of Cu determined in a solution using Inductively Coupled Plasma – Optical Emission Spectrometry (ICP-OES). Eight models were used to describe the copper release in the studied soil including Zero order, First order, Second Order, Third Order, Simple Elovich, Parabolic diffusion, Power function, and Hyperbolic (Martin and Sparks, 1983;
Havlin et al., 1985) (Table 1). The model that gave the highest value of determination coefficient (R^2) and the minimum value of root mean square error (RMSE), and Akaike information criterion (AIC) considered as the best model. The value of determination coefficient, root mean square error, and Akaike information criterion calculated according to the following equations:
The determination coefficient (R^2) = $\sum (q_{meas} - q_{aepred})^2 / \sum (q_{meas} - q_{aepred})^{2+} (q_{meas} - q_{pred})^2$
Root mean square error (RMSE) = $\{\sum (q_{meas} - q_{pred})^2 / n - 2\}^{1/2}$ where q_{meas} and q_{pred} ,

q_{aepred} represent the measured, predicted, and average predicted Cu released, and n is the number of measurements. Akaike information criterion(AIC) generally calculated with the software.The basic formula of AIC = AIC = 2K− 2(ln L) (Mirzaei et al. 2017).
Where K indicates the number of parameters and L indicates a probability of the data given a model (likelihood).

Table 1. Kinetic models used in the studied soils.

Models	Equations	Parameters
Zero order	$q_t^* = q_0^* - k_0 t$	k_0 , zero-order rate constant (mg Cu kg $^{-1}$ h^{-1})
First Order	$\ln q_t = \ln q_0 - k_1 t$	k_1 , first-order rate constant (h $^{-1}$)
Second order	$1/ q_t = 1/ q_0 + k_2 t$	k_2, second-order rate constant [(mg Cu kg $^{-1}$) $^{-1}$]
Third order	$1/ q_t^2 = 1/ q_0^2 - k_3 t$	k_3 , third-order rate constant[(mg Cu kg $^{-1}$) $^{-2}$ h $^{-2}$]
Simple Elovich	$q_t = 1/\beta s \ln (\alpha s \beta s) + 1/\beta s \ln t$	αs , initial Cu desorption rate constant (mg Cu kg $^{-1}$ h^{-1}) and βs , Cu desorption rate constant [(mg Cu kg $^{-1}$) $^{-1}$]
Parabolic diffusion	$q_t = q_0 - k_p t^{1/2}$	kp, diffusion rate constant [(mg Cu kg $^{-1}$) $^{-0.5}$]
Power function	lnqt = ln a + b lnt	a, initial Cu desorptiorate constant [(mg Cu kg $^{-1}$(h $^{-1}$)^b] and b , desorption rate coefficient
Hyperbolic	$q_t / t = (q_0 / t ½) t$	t ½ semi decomposition time

*q_t is the amount of soil Cu released by DTPA (mg Cu kg $^{-1}$) after the time (h) of extraction, and q_0 , initial Cu concentration at time = 0

STATISTICAL ANALYSIS

Statistical operations performed using the statistical software addinosoft (2016). XLSTAT statistical and data analysis solution. Boston, USA.

RESULTS AND DISCUSSION

Physicochemical properties of the soil

Some chemical and physical properties of the soils presented in (table 2) showed that the soils vary in their texture from silty clay to loam, with a range of organic matter, and total calcium carbonate content, from 90 to 25, and 25 to 430 g kg $^{-1}$ respectively. Most of the soil had a neutral reaction (7.48 to 7.90). EC of the soil varied from 0.40 to 0.90 dS m^{-1}. The extractable Cu by DTPA varied from 0.12 to 0.51mg kg $^{-1}$, whereas the CEC values ranged from 26.93 to 41.57 cmolc kg $^{-1}$. The texture classes of the studied soils ranging from (loam to Silty clay) which it means that the texture of these soils ranged from fine to moderately textured soils, and the soils were slight to moderately alkaline due to the value of the studied soils ranged between (7.48 – 7.9). Electrical conductivity (EC) of the soil samples ranged between (0. 4 - 0.9 dS m^{-1}), this shows that the soil studied are non-saline and this might be due to relatively higher precipitation and variation of these locations in terms of topography. All soil considered as calcareous soil due to calcium carbonate content was between (25 – 430 gm kg^{-1}).

Table (2) Some chemical and physical properties in the studied soils.

Soil No.	pH	EC (dS m $^{-1}$)	T.CaCO$_3$ (g kg $^{-1}$)	O.M g kg $^{-1}$	Sand	Silt	Clay	Textural class	DTPA Cu mg kg $^{-1}$	CEC cmolc kg $^{-1}$
					g kg $^{-1}$					
Sharazor	7.49	0.60	180	25	37.20	475.10	487.70	Silty clay	0.51	41.15
Qaradagh	7.65	0.70	25	17	383.50	370.30	246.20	loam	0.47	26.93
Bazian	7.78	0.60	100	15	55.80	430.50	513.70	Silty clay	0.20	41.57
Mawat	7.48	0.9	25	16	161.90	434.20	403.90	Silty clay	0.38	39.42
Surdash	7.90	0.40	430	9.00	91.60	490.40	418.00	Silty clay	0.12	36.39

The pattern of Cu release

The amount of Cu released as a function of time from (0.5 to 48 hours) with DTPA extracting solution in the studied soil shown in (fig.2). The pattern of copper release models generally characterized by an initial rapid reaction, then the reaction started with a constant slowdown and it arrived at equilibrium at 48 hours. Our results are convenient with the findings of Motlagh, (2012) who stated that Cu release copper patterns from 14 calcareous agricultural soil of northern Iran generally characterized by an initial rapid reaction, the release rate started much slower. Lehmann and Harter (1984) measured the chelate-promoted kinetics of Cu release from soil to evaluate the bond formation strength and referred to the two-stage desorption kinetics to high bonding sites of low and high energy. They determined that there was a transmission of Cu from low-energy sites to higher energy sites with the increase in residence time. Yu and Klarup (1994) ascribed the slow-release stage of Cu to diffusion or slow dissolution of minerals. They concluded that surface coverings, oxides may dissolve slowly in the solution, possibly leaves further of the Cu available to extraction. The highest amount of Cu release for 48 hours was the least in soil Qaradagh (0.75mg kg $^{-1}$). While soil Mawat exhibited the highest release (2.272mg kg^{-1}). It may be due to CEC, pH and clay content, as noted soil Qaradagh had the lowest content of clay and CEC. The order of the amount of copper released into the soil was as follows: Mawat > Bazian > Sharazoor > Surdash > Qaradagh. Patterns of Cu release are governed primarily by soil characteristics. Our results are consonant with the findings of Motlagh,(2012) who showed that CEC and clay content are considered the most active factors that control the release of copper in calcareous soil from northern Iran. Likewise, McBride, (1989) stated that the metals sorption behavior in the soil varies from one soil to another which is influenced by soil characteristics such as CEC, clay contents, pH, and OM.

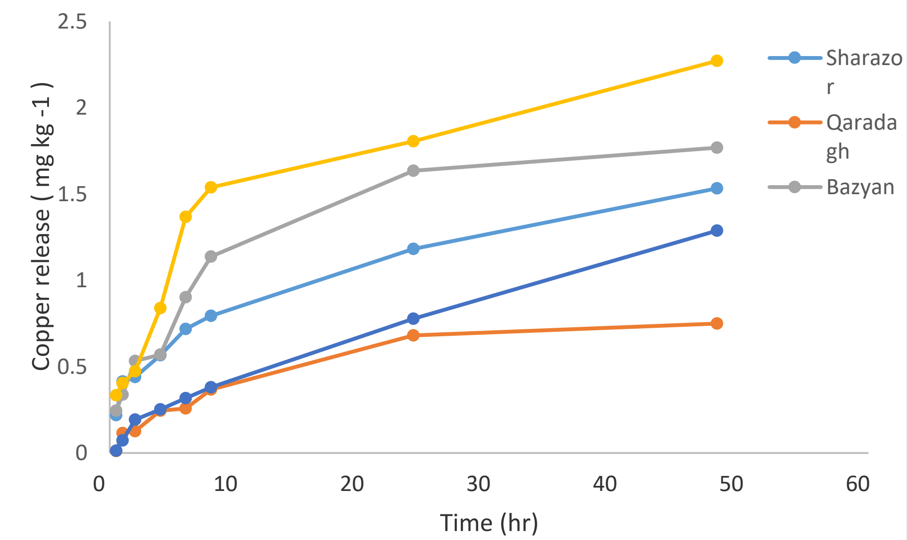

Fig. 2 Cu release by DTPA as a function of time .

Fitting the Cu release data to mathematical kinetic models

Eight kinetic models applied on Copper releases which include zero-order, first-order, second-order, third-order, simple Elovich, parabolic diffusion, power function, and hyperbolic used to describe Cu release in the studied soils by DTPA extracting solution from 0.5 to 48 hours. The goodness of fit as determined by the mean and the range of comparison of determination coefficients (R^2), root mean square error (RMSE), and Akaike information criterion (AIC) of the models calculated and presented in (tables 3and 4).The highest values of determination coefficient (R^2, 0.949), the lowest values of root mean square error (RMSE, 0.117), and Akaike information criterion (AIC, -36.496) meant that the parabolic diffusion was the best-fitted model used to describe Cu release process very well (table 3, and 4). This is consistent with results obtained by Wambu et al.,(2009) who reported that the parabolic diffusion equation fitted copper recoveries with R^2 = 0.96 that studied as a batch basis in H_2SO_4 and $CaCl_2$. Similar results were obtained by Ghasemi-Fasaei et al., (2007), who indicated that the power function, simple Elovich, and parabolic diffusion in Fars province in southern Iran, were the best-fitted models. On the other hand, Reyhanitabar and Karimian, (2008); Ghasemi-Fasaei et al. (2006) who showed that the best models for the description of Cu-desorption were two constant-rates and simple Elovich of calcareous soil from central Iran. The results of the comparison listed in (table 3, and 4) also showed that the values of R^2. RMSE, and AIC for simple Elovich, power function, and zero-order were smaller than parabolic diffusion models could also be used to describe Cu release kinetics. On the other hand, according to R^2, RMSE, and those models poorly described AIC values of first order, and hyperbolic kinetic models, the kinetic of Cu release in the studied soils; whereas, for the second-order, and third-order models due to lower value of R^2, and higher values of, RMSE, and AIC the results were not so favourable. Therefore, in this study, the second-order and third-order models were not convenient for describing Cu release in the studied soil

Table3. The determination coefficient (R^2) and root mean square error (RMSE), and the Akaike information criterion (AIC) of various kinetic models used to describe the copper release in the studied soils.

Eqauation	Sharazor			Qaradagh			Bazian			Mawat			Surdash		
	RMSE	AIC	R^2	RMSE	AIC	R^2	RMSE	AIC	R^2	RMSE	AIC	R^2	RMSE	AIC	R^2
Zero order	0.149	-28.793	0.9	0.116	-32.756	0.839	0.291	-18.061	0.783	0.394	-13.213	0.746	0.072	-40.382	0.975
First order	0.381	-13.754	0.678	1.137	3.757	0.412	0.489	-9.733	0.604	0.530	-8.465	0.563	1.103	3.264	0.510
Second order	1.050	2.487	0.397	34.632	58.415	0.108	1.045	2.404	0.396	0.825	-1.387	0.409	28.520	55.308	0.123
Third order	6.485	31.610	0.216	3658.398	132.975	0.077	5.371	28.595	0.251	2.989	19.218	0.309	2530.362	127.076	0.081
Simple Elovich	0.115	-32.885	0.940	0.075	-39.748	0.933	0.148	-28.848	0.944	0.194	-24.540	0.938	0.174	-26.246	0.855
Parabolic diffusion	0.056	- 44.542	0.986	0.061	-42.945	0.955	0.171	-26.551	0.925	0.258	-19.980	0.891	0.043	-48.464	0.991
Power function	0.110	-33.642	0.973	0.629	-5.717	0.820	0.147	-28.967	0.964	0.213	-23.008	0.929	0.504	-9.271	0.898
Hyperbolic	0.128	-31.143	0.425	0.028	-55.251	0.305	0.119	-32.399	0.469	0.162	-27.468	0.431	0.022	-59.072	0.296

The variable ranges and means of R^2, RMSE, and AIC for the studied soils, and eight kinetic models presented in (table 4), the average of R^2, RMSE, and AIC for all the five soil ranked as follows: Parabolic diffusion > simple Elovich > power function > zero-order > first-order > hyperbolic > second-order > third order.

Table 4. Mean and range of determination coefficient (R^2), root mean square error (RMSE), and Akaike information criterion (AIC) of different kinetic models for Cu release by DTPA in the five soils.

Equation	RMSE		AIC		R^2	
	Range	Mean	Range	Mean	Range	Mean
Zero order	0.072 - 0.394	0.204	- 40.382 - (-13.213)	-26.641	0.746 - 0.975	0.848
First order	0.381 - 1.137	0.728	-13.754 - (3.757)	- 4.980	0.412 - 0.678	0.553
Second order	0.825 - 34.632	13.214	-1.387 - (58.415)	23.445	0.108 - 0.409	0.286
Third order	2.989 - 3658	1240.721	19.218 - (132.975)	67.895	0.077 - 0.309	0.187
Simple Elovich	0.075 - 0.194	0.141	-39.784 - (-24.54)	- 30.461	0.855 - 0.944	0.922
Parabolic diffusion	0.043 - 0.258	0.117	-48.464 – (-19.98)	-36.496	0.891 - 0.991	0.949
Power Function	0.11 - 0.629	0.320	-33.642 - (- 5.717)	-20.121	0.82 - 0.973	0.917
Hyperbolic	0.022 - 0.162	0.092	-59.072 - (-27.468)	- 41.066	0.296 - 0.469	0.385

Kinetic Parameters

The values of the rate constants for parabolic diffusion, simple Elovich and power function models shown in (table 5). In parabolic diffusion model, kp constant represents the diffusion rate constant is regarded as the measurement of the relative rate of Cu release in the five soils, the value of kp ranged between 0.123 and 0.321 with a mean of (0.221). The highest value of diffusion rate constant recorded in Mawat soil and the lowest value attributed to Qaradagh soil. The lower value in the Qaradagh soil attributed to its lower clay content, and cation exchange capacity, this was consistent with statistical analysis. Our results are in agreement with results reported by Motlagh, (2012) who reported that the kp constant of the parabolic diffusion equation has a significant relationship with CEC at P = 0.01. In simple Elovich model, (αs) and (βs) constants

clarify the initial Cu release constant and Cu release rate coefficient, respectively (Boostani et al., 2016). In this study, (αs) varies from 0.42 to 1.164 with a mean of 0.6856, and (βs)from 2.197 to 5.952 with a mean of 3.6918. While (a) ranged between 0.055 and 0.444 with a mean of 0.2498 and, (b) ranges from 0.398 to 0.898 with a mean of 0.6056. The magnitude of the parameters, for the simple Elovich equation (αs and βs),

widely different for the five soils (table 5). Our results showed that according to the (αs) constant for the simple Elovich model, the highest magnitude of initial copper released was recorded in Mawat soil and the lowest value attributed to Qaradagh soil, this confirmed by statistical analysis. The value of (αs) constant for the simple Elovich equation relates significantly with some soil properties such as CEC, and soil pH. Our results are in agreement with (Ghasemi-Fasaei et al. (2007) who stated that the values of initial Cu release constant (αs) and Cu release rate coefficient (βs) were (0.73, and 2.76) respectively for the soil of southern Iran. The value of αs, βs is calculated for 30 minutes and the values shown in (table 5). The values of (αs, βs, t) for all the five soil more than one. Our results are in agreements with Dalal, (1985) who stated that simple Elovich equation derived from the Elovich equation with the hypothesis of (αs, βs, t) >1.

Havlin and Westfall (1985); Jalali and Zarabi, (2006) classified both (a) and (b) as rate constants. To better understand the meaning of the constants (a) and (b) can be obtained

by relating the constants to the rate of nutrient release instead of cumulative release (Allen et al.,1996). The smaller the value of b, the more quickly the release rate decay.

The values of the rate constant (a and b) with the mean are (0.249 and 0.605) from the power function equation widely different from the five soil (table 5). Similar results were reported by

Ghasemi-Fasaei et al., (2006) who reported that means for a and b values were 0.24 and 0.282, respectively for copper release of highly calcareous soils from southern Iran release by DTPA in the studied soils.

Table 5. Values of the rate constants for the kinetics models that best described Cu

Soils	Parabolic diffusion	Simple Elovich			Power function		
	kp (mg Cu kg^{-1} $)^{-0.5}$	αs (mg Cu kg^{-1} h^{-1})	βs (mg Cu $kg^{-1})^{-1}$)	αs βs t*	a	b (mg Cu $kg^{-1}(h^{-1})^{b}$	ab
Sharazor	0.203	0.852	3.650	93.294	0.339	0.398	0.135
Qaradagh	0.123	0.240	5.952	42.854	0.055	0.808	0.044
Bazian	0.261	0.898	2.739	73.789	0.356	0.459	0.163
Mawat	0.321	1.164	2.197	76.719	0.444	0.465	0.206
Surdash	0.198	0.274	3.921	32.231	0.055	0.898	0.049
Min	0.123	0.24	2.197	32.231	0.055	0.398	0.044
Max	0.321	1.164	5.952	93.294	0.444	0.898	0.206
Mean	0.221	0.6856	3.6918	63.7774	0.249	0.605	0.119

* calculated for t = 30 min

The values of (ab)were calculated and listed for the studied soil in (table 5). Mawat soil had the highest value of (ab) constant equal to (0.206) soil and the lowest value attributed to Qaradagh soil about (0.044). This is confirmed by statistical analysis. This may be due to more content of clay and CEC in soil Mawat as compared to Qaradagh soil. Our results are consistent with the result of Ghasemi-Fasaei et al., (2007), who reported that CEC in soils with a high-level pf carbonate soils likely to control the initial soil copper desorption rate.

CONCLUSIONS

The results of this study showed that the kinetics of Cu release using DTPA extracting solution in some calcareous soil from (0.5 to 48 hours) was rapid at the beginning then the reaction started with a constant slowdown and it arrived at equilibrium at 48 hours.

Parabolic diffusion was the best model based on the highest value of R^2, and the lowest value of RMSE, and AIC for the description of Cu release from some calcareous soil of Sulaimani governorate, Iraqi Kurdistan Region. The values of (kp), (αs, βs), and (a,b) for the parabolic diffusion, simple Elovich and power function models correlated with some soil characteristics like clay content and CEC in the studied soils.

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حركيات تحرر النحاس من بعض الترب الكلسية في محافظة السليمانية بإقليم كردستان العراق

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المستخلص

أجريت هذه الدراسة لتقدير حركيات تحرر النحاس من خمسة أنواع الترب الكلسية تشمل (شهرزور ، قرداغ ، بازيان ، ماوت، وسرداش) في محافظة السليمانية – إقليم كوردستان العراق. كانت أكبر كمية من تحرر النحاس خلال 48 ساعة هي الأقل في تربة قرداغ (0.75 ملغم لكل كجم $^{-1}$)، في حين أظهرت تربة ماوت أعلى تحرر (2.272 ملغم لكل كجم $^{-1}$) . تراوحت قيمة ثابت معدل الانتشار (kp) من الانتشار المكافئ من 0.123 إلى 0.321 بمتوسط (0.221). تراوح ثابت تحرر النحاس الأولي (αs) ومعامل معدل تحرر النحاس (βs) من نموذج Elovich البسيط ، من 0.42 إلى 1.164 بمتوسط 0.6856 ، ومن 2.197 إلى 5.952 بمتوسط 3.6918. في حين كانت قيم ثابت المعدل (أ و ب) من نموذج دالة القدرة مع الوسط (0.249 و 0.605) على التوالي على نطاق واسع مع التربة الخمسة. كان انتشار مكافئ أفضل نموذج مناسب تستخدم لوصف عملية تحرر النحاس بشكل جيد للغاية في التربة المدروسة.

الكلمات المفتاحية: النحاس ، تحرر النحاس ، معامل التحديد ، الحركية .

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Effect of some micronutrient application rates on yield and yield components of wheat in calcareous soil of the Iraqi Kurdistan Region

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Abstract

Wheat is the main essential cereal grain crop for food in the world. Management of nutrient is an important factor to increase its productivity. To evaluate the role of micronutrients in improving wheat yield, two field experiments were conducted by application of Zn, Cu, and Fe to the soil in individually and combined forms the source of micronutrients are $ZnSO_4$, $CuSO_4$ and Fe-EDDHA (Ethylenediamine Di-2-Hydroxyphenyl Acetate Ferric) 6% Fe. The number of treatments was thirteen treatments, and the experimental design is Randomized Complete Block Design (RCBD) with three replicates. Results showed that the application of Zn, Cu, and Fe in individually or combined forms were, not affected on the yield and yield components of wheat crop, except for plant height (cm), tillers per plant, 1000-grain weight (g) and harvest index from Bakrajow location While from Kanypanka location plant height (cm) and grain per spike were affected significantly.

Introduction

Wheat (*Triticum aestivum* L) is one of the most important crops among all cereals consumed by the people in a different form for human nutrition in the world and has been cultivated in calcareous soil in the arid and semi-arid region as well as in Kurdistan Region of Iraq. Besides this, it is necessary to livestock and industrial uses also. Micronutrients have prominent effects on dry matter, grain yield and straw yield in wheat[1]. El-Foult, 1983 [2] reported that the availability of micronutrients such as Fe, and Zn is much affected by pH and $CaCO_3$ content and soil texture usually micronutrient-deficiency problems are bound in the calcareous soil of arid and semi-arid regions. Micronutrients play a vital role in development and growth of plants and occupy a major essentiality in increasing crop yields [3]. Deficiency of micronutrients is extensive in most of the Asian countries due to the calcareous nature of the soils, high pH, low organic matter, salt stress, continuous drought, high bicarbonate content in irrigation water, an imbalance in the application of NPK fertilizers [4]. The essentiality of micronutrients not less than macronutrients for plant nutrition because the deficiency of micronutrients causes a considerable reduction in the yield [5]. Plant nutrition in addition to the micronutrients depending on the soil characteristics like the ability of the soil to provide these nutrients to the soil solution [6]. The high-yielding varieties of plants coupled with increasing the consumption of micronutrients from the soil, because the uptake of metal by plants characterized by selectivity, accumulation and the nature of genotypes [7]. Reddy, 2004 [8] reported that Zn, Cu, Fe, and Mn, had an important role in chlorophyll formation, nucleic acid, protein synthesis and played a crucial role in increasing the activities of several enzymes of photosynthesis as well as respiration. Zinc has an important role either as a metal component of enzymes and a functional, structural or regulatory cofactor of a large number of enzymes, membrane integrity, and phytochrome activities [9,10]; Cu is important for physiological redox processes, pollen viability and lignifications [11], and Iron plays a role in biological redox system, enzyme activation and oxygen carrier in nitrogen fixation [12]. Many reports previously have evaluated the response of wheat crop micronutrients (soil or foliar) applications, but little information is available for the combined application of Zinc, Cu and Fe under field conditions, for this reason, the present investigation was conducted in order to evaluate the role of individual and combined between of Zn, Cu, and Fe on yield and yield components of wheat in calcareous soil from Kurdistan Region of Iraq

Material and Methods

A.Experimental Design

The field experiments were conducted at two different locations, the first one at Bakrajo Agricultural Research farm (35° 32' 31.8" N 45° 21' 049" E) and the second one at Kanypanka Agricultural Research farm (35° 22' 25" N 45° 43' 25" E) under rain-fed condition during winter growing season of 2014-2015. The experiments were laid out in a Randomized Complete Block Design (RCBD) with three replications. Three different doses of zinc, copper, and iron have applied in individually and combined in the form of $ZnSO_4$, $CuSO_4$ and Fe-EDDHA (Ethylenediamine Di-2-Hydroxyphenyl Acetate Ferric) 6% Fe. Basel fertilizer dose of NPK was 200-200-150 kg ha^{-1} in the form of Urea, Triple Super Phosphate and Potassium Sulphate respectively were applied to all treatments. .Half dose of nitrogen and a full dose of P_2O_5 and K_2O were applied at the time of sowing while remaining nitrogen was applied after 20 days of germination. Sowing was done by a man driven hand drill with the plant to plant and row to a row distance of 10 and 30cm, respectively. The net plot size was 2 x 3 m^2 the distance between plots was 1 m, and the distance between blocks was 2 m. A recommended seeding rate of 140 kg ha^{-1} of wheat variety *simito* was used. The detail of treatments are given as follow:

T_1= control	T_8= Fe (8 kg ha^{-1})
T_2= Zn (5 kg ha^{-1})	T_9= Fe (12 kg ha^{-1})
T_3= Zn (10 kg ha^{-1})	T_{10}= Fe (16 kg ha^{-1})
T_4= Zn (15 kg ha^{-1})	T_{11}= Zn + Cu + Fe (5 + 6+ 8 kg ha^{-1})
T_5= Cu (6kg ha^{-1})	T_{12}= Zn + Cu + Fe (10 + 8+ 12 kg ha^{-1})
T_6= Cu (8 kg ha^{-1})	T_{13}= Zn + Cu + Fe (15 + 10+ 16 kg ha^{-1})
T7= Cu (10 kg ha^{-1})	

The wheat crop from Bakrajo location was harvested on 6th/June/2015, while at Kanypanka location the harvest was conducted on 7th/ June/2015.

B. Soil Sample Collection and Physicochemical analysis

Soil samples were taken from 0 to 30 cm depths of the soil used in the field experiments; then air dried thoroughly mixed, ground passed through a 2 mm sieves and stored in plastic bottles prior to analysis. Some physical and chemical properties of the soil are given in Table 1. Soil particle size distribution was determined by the pipette method according to Gee and Bauder, 1986 [13]. Electrical conductivity (EC) and pH were measured for the soil saturation extract with EC-meter, model (Herman, Paulsn) and a pH-meter, The model (WTW respectively. Organic matter was determined by dichromate oxidation (Walkley and Black method) as described by Nelson and Sommer, 1986 [14]. The total calcium carbonate equivalent was determined by a rapid titration method as described by Rayment and Higginson, 1992 [15].Cation Exchange Capacity (CEC) was determined by saturation with 1*M* NaOAc at pH 8.2 as described by Suarez, 1996 [16].Soluble HCO_3^-, Cl^- and Ca^{2+} + Mg^{2+} titration methods, Na^+ and K^+ were determined by using (Flame Photometer) as described by Page *et al*., 1982 [17]. Available P was determined by Olsen *et al*., 1954 [18] methods. The micronutrients (Zn, Cu, and Fe) were extracted by DTPA according to the procedure of Lindsay and Norvell, 1978 [19], and they are measured by AAS PerkinElmer 800.

Table-1: Some physical and chemical properties of the soil of Bakrajo and Kanypanka used in a field experiment.

Location	*Physical properties of the studied soil Particle Size Distribution (PSD) g kg^{-1}*						
	Sand		*Silt*		*Clay*		*Texture Class*
Bakrajo	75.40		518.40		406.20		Silty clay
Kanypanka	234.00		570.00		196.00		Silty loam
	Chemical properties of the studied soil						
	pH	EC_e dS m^{-1}	*OM* g kg^{-1}	*CEC* Cmol$_c$ kg^{-1}	*Available P* mg kg^{-1}	*CaCO$_3$ equivalent g kg^{-1}* Total	Active
Bakrajo	7.80	0.38	16.06	29.76	9.61	230.00	117.00
Kanypanka	8.05	0.16	22.03	22.10	7.44	195.00	100.00
	Soluble ions mmol L^{-1}						
	Ca^{2+}	Mg^{2+}	Na^+	K^+	HCO_3^-	Cl^-	SO_4^{2-}
Bakrajo	2.20	1.80	0.10	0.13	2.34	0.80	0.88
Kanypanka	1.20	1.05	0.19	0.05	3.20	0.90	0.91
	Available micronutrients mg kg^{-1}						
	Zn		*Cu*		*Fe*		
Bakrajo	0.450		4.96		3.23		
Kanypanka	1.563		5.07		5.15		

C.Measurement Parameters

The measurement parameters comprise most of the yield components of wheat, such as plant height (cm), number of tiller per plant, number of grain per spike, grain yield (ton ha^{-1}), 1000-grain weight (g), biological yield (ton ha^{-1}), protein content, harvest index% and leaf chlorophyll content.

D.Harvest Index (HI%)

Harvest index (HI)(%) was calculated by using the following formula:

$$Harvest\ index\ (HI)(\%) = \frac{Grain\ Yield}{Biological\ Yield} x100 \qquad (1)$$

E.Grain Protein Content (%)

Grain protein contents were estimated as described by Merrill and Watt, 1973 [20] Protein contents were calculated by multiplying nitrogen by a factor of 5.70.

F.Leaf Chlorophyll Content (LCC) (SPAD Value)

Corresponding reading of chlorophyll content taken with a portable chlorophyll meter was determined. Chlorophyll meter readings were made using Minolta SPAD 502 chlorophyll meter [21]

G. Statistical Analysis

Statistical data analysis like pair-wise comparison (Duncan's multiple range test) was performed by XLSTAT version 7.5 [22]

RESULTS AND DISCUSSION

A. Plant Height (cm)

The data presented in Table 2 and 3 revelated that the application rates of Cu (8 kg ha^{-1}) and Fe (12 kg ha^{-1}) in Bakrajo and Kanypanka location respectively which were superior significantly at (P = 0.05) to all other treatments, while at Kanypanka location there were no significant differences among treatments except (T1, T_{12}, and T_{13}. Maximum plant height (92.47 cm and 96.97 cm) was obtained from T_{11} and T_9 for Bakrajo and Kanypanka location respectively. Minimum plant height (84.60 cm and 89.60 cm) were obtained from T_6 and T_3 for Bakrajo and Kanypanka location respectively. Similar findings were earlier reported by Zain *et al.*, 2015 [23], who found that the application of micronutrients significantly increased the plant height of wheat.

B. Number of Tiller $Plant^{-1}$

The environment, plant nutrition, and genotype of the plant influence the number of tillers $plant^{-1}$ [23]. The statistical analysis of the data present in Table 2 and 3 show that the application rates of (Zn (10 kg ha^{-1}) + Cu(8 kg ha^{-1}) + Fe(12 kg ha^{-1}) , which was superior significantly to all other treatments at Bakrajo location ,the maximum number of tillers (7.47) were obtained in combination treatment (T_{12}). Whereas, considerable minimum tillers (4.73) were observed in T_1. These results are in agreement with the results of Islam *et al.*1999 [24], who corroborated that zinc application improved productive tillers $plant^{-1}$. While the previous micronutrients had not affected significantly by the number of tillers $plant^{-1}$ from the Kanypanka location the maximum number of tillers, (7.67) were recorded from T_9 whereas the minimum tillers (6.33) obtained from T_1. These results are in a harmonic with the results of Asad and Rafique [1] who found that the application of zinc, copper, iron, manganese, and boron had non-significant at 5% level of significance on the number of tillers m^{-2}.

C. Number of Grain $Spike^{-1}$

The number of grain per spike which is an important yield component of the wheat plant not affected significantly by the application of micronutrients statistically from the Bakrajo location the maximum number of grains per spike (75.40) were noticed in T_8, and the minimum number of grain per spike (62.67) were found from T_4. While at Kanypanka location the highest mean value of a number of grains per spike was (90.27), which was superior significantly to all other treatments. Maximum grains(90.27) were produced by T_9 while T_1 produced a minimum number of grains(70.27). These results in agreement with the finding by Khan *et al.*, 2010 [25]who concluded that the application of micronutrients affects the number of grain per spike of the wheat plant.

D. Grain Yield (ton ha^{-1})

The data relating to grain yield (ton ha^{-1}) are present in Table 2 and 3, revealed that grain yield was not affected significantly ($P<0.05$) by the application of Zn, Cu, and Fe to the soil. Highest grain yield (8.97 and 5.56 ton ha^{-1}) was produced by T_9 and T_{12} from Bakrajo and Kanypanka respectively. While minimum grain yield (6.45 and 4.65) was produced by T_1 and T_2 from Bakrajo and Kanypanka respectively. These results are not matching with finding by Ziaeian and Malakouti, 2001 [26] and Maralian, 2009 [27]. They concluded that the application of micronutrients improved grain yield of the wheat plant.

E. 1000-Grain weight (g)

According to the analysis of variance Table 2 and 3, the mean comparison showed that the applicate rate of (Fe 8kg ha^{-1}) was superior to all other treatments at Bakrajo location but not significantly from the Kanypanka location. Maximum 1000-grain weight (56.67 and 45.00 g) was obtained T_8 and T_7 from Bakrajo and Kanypanka respectively. While the minimum 1000-grain weight(46.67 and 37.33 g) was obtained from T_5 and T_9 of Bakrajo and Kanypanka respectively. Boorboori *et al.*, 2012 [28] reported that the soil application with Fe, Zn, Cu, and Mn effect on 1000 grain weight was significant at the level of 1 %.

Biological Yield (ton ha^{-1})

The result regarding biological yield (ton ha^{-1}) of wheat is shown in Table 2 and 3 which showed that the application of Zn, Cu, and Fe to the soil not affected significantly on biological yield from both locations Bakrajo and Kanypanka. The maximum biological yield (20.32 and 14.58 ton ha^{-1}was produced by T_4 and T_{11} from Bakrajo and Kanypanka respectively. Whereas the minimum biological yield (15.65 and 11.28 ton ha^{-1}) was obtained from T_1 and T_2 for Bakrajo and Kanypanka location respectively. These results not in a harmonic with the finding by Khan *et al.*, 2010 [25] and Webb and Loneragan, 1990 [29].They concluded that the application of micronutrients enhanced the biological yield of the wheat plant.

F. Protein%

The data concerning protein% in grain wheat are shown in Table 2 and 3, and it revealed the soil application of Zn, Cu, and Fe had not a significant ($P<0.05$) effect on protein% content in grain of wheat for both of studied locations Bakrajo and Kanypanka. The maximum protein% (17.20% and 16.83%) were observed in T_8 and T_6 for Bakrajo and Kanypanka respectively. While the minimum protein content (14.90% and 15.33%) was recorded from T_2 and T_{13} for Bakrajo and Kanypanka location respectively. These results are similar to the results finding by Boorboori *et al.*, 2012 [28]. They found that different types of soil fertilizing and solution spraying with Fe, Zn, Mn, and Cu on the level of grain protein did not show any statistically significant effect in barley plant (*Hordeum vulgare* L.).

G. Harvest index%

The statistical analysis of variance in Table 2 and 3 showed that the Zn, Cu, and Fe fertilizers application to the soil affected significantly ($P<0.05$) from Bakrajo location but not affected significantly from Kanypanka location. The maximum harvest index (52.67% and 44.00%) was produced by T_9 and T_{13} from Bakrajo and Kanypanka location respectively. Whereas the minimum harvest index (38.90% and 35.00%) was observed in T_2 and T_{11} from Bakrajo and Kanypanka location respectively. The results of harvest index for Bakrajo location in a harmonic with the results of Zain *et al.,* 2015 [23], who found that harvest index of each treatment due to a foliar spray of micronutrients was noticeably different from other treatments. But the results of harvest index for Kanypanka location in agreement with the finding by Hussain *et al.,* 2005 [30], who found that the application of micronutrients did not affect significantly to harvest index of the wheat crop.

H. Leaf Chlorophyll Content (LCC) (SPAD Value)

The effect of the application of Zn, Cu, and Fe in the leaves of the wheat plant is given in Table 2 and 3. The statistical analysis of variance of the data showed that there were no significant differences between all treatments except (Zn 10kg ha $^{-1}$) and (Cu 8 kg ha $^{-1}$) at Bakrajo location.While no significant differences were noticed for all treatments at Kanypanka location. Maximum SPAD value of leaf chlorophyll content (79.90 and 93.53) was recorded from T_3 and T_7 to Bakrajo and Kanypanka location respectively. Whereas the minimum SPAD value of leaf chlorophyll content (60.03 and 69.97 SPAD value) was from T_6 and T_{11} for Bakrajo and Kanypanka location respectively. These results disagree with the finding by Al-Qing *et al.*, 2011 [31]. Who found that the application of Zn and Fe are leading to increasing in the leaf chlorophyll content of the wheat crop.

Table -2: Effect of some micronutrients application to the soil on yield and yield components of wheat at maturity at Bakrajo location.

Treatments	Plant height (cm)	No. of tiller/plant	No. of Grain/ Spike	Grain yield ton ha^{-1}	1000-Grain weight (g)	Biological yield ton ha $^{-1}$	Protein%	Harvest index%	LCC*(SPAD value)
T_1	89.53^{abcd}	4.73^{d}	64.33^{a}	6.45^{a}	50.67^{ab}	15.65^{a}	15.50^{a}	40.73^{ab}	68.10^{ab}
T_2	87.27^{cde}	5.73^{cd}	73.00^{a}	5.56^{a}	51.33^{ab}	17.65^{a}	14.90^{a}	38.90^{b}	69.83^{ab}
T_3	84.87^{e}	5.87^{cd}	69.00^{a}	8.20^{a}	50.67^{ab}	19.65^{a}	16.40^{a}	42.20^{ab}	79.90^{a}
T_4	91.53^{ab}	6.07^{bc}	62.67^{a}	8.03^{a}	48.00^{b}	20.32^{a}	15.83^{a}	39.43^{b}	66.37^{ab}
T_5	89.13^{abcd}	6.13^{bc}	72.00^{a}	7.70^{a}	46.67^{b}	17.82^{a}	16.57^{a}	42.67^{ab}	74.37^{ab}

T_6	84.60^{e}	5.80^{cd}	68.33^{a}	6.98^{a}	53.33^{ab}	16.48^{a}	15.43^{a}	42.07^{ab}	60.03^{b}
T_7	89.33^{abcd}	6.47^{abc}	65.87^{a}	8.59^{a}	50.00^{ab}	19.40^{a}	15.43^{a}	44.23^{ab}	74.87^{ab}
T_8	86.60^{de}	7.27^{ab}	75.40^{a}	7.23^{a}	56.67^{a}	18.15^{a}	17.20^{a}	39.80^{b}	62.93^{ab}
T_9	88.87^{bcd}	6.33^{abc}	64.40^{a}	8.97^{a}	47.33^{b}	17.65^{a}	16.03^{a}	52.67^{a}	74.13^{ab}
T_{10}	89.87^{abcd}	6.60^{abc}	64.33^{a}	7.61^{a}	48.67^{b}	17.82^{a}	16.23^{a}	42.50^{ab}	60.40^{ab}
T_{11}	92.47^{a}	6.93^{abc}	70.00^{a}	7.27^{a}	48.00^{b}	17.82^{a}	16.60^{a}	41.43^{ab}	68.53^{ab}
T_{12}	90.53^{ab}	7.47^{a}	66.80^{a}	8.03^{a}	50.00^{ab}	18.82^{a}	16.60^{a}	42.63^{ab}	67.87^{ab}
T_{13}	89.47^{abcd}	6.20^{bc}	65.67^{a}	7.65^{a}	50.67^{ab}	17.82^{a}	16.07^{a}	43.30^{ab}	65.83^{ab}

Means followed by a similar letter or letters do not differ significantly from each other at 5% level of significance.
*LCC= Leaf Chlorophyll Content (SPAD value)

Table -3: Effect of some micronutrients application to the soil on yield and yield components of wheat at maturity at Kanypanka location.

Treatments	Plant height (cm)	No.of tiller/plant	No. of Grain/ Spike	Grain yield ton ha^{-1}	1000-Grain weight (g)	Biological yield ton ha $^{-1}$	Protein%	Harvest index%	LCC*(SPAD value)
T_1	96.07^{ab}	6.33^{a}	70.27^{i}	5.45^{a}	39.67^{a}	13.35^{a}	16.47^{a}	41.00^{a}	86.83^{a}
T_2	89.73^{e}	6.67^{a}	83.73^{bcd}	4.65^{a}	39.33^{a}	11.28^{a}	16.17^{a}	42.00^{a}	76.20^{a}
T_3	89.60^{e}	6.67^{a}	81.20^{de}	4.90^{a}	40.00^{a}	11.88^{a}	15.93^{a}	41.00^{a}	85.40^{a}
T_4	92.93^{bcde}	6.67^{a}	81.73^{cde}	5.48^{a}	40.67^{a}	13.12^{a}	16.00^{a}	41.00^{a}	74.83^{a}
T_5	90.40^{de}	6.67^{a}	84.20^{bc}	4.80^{a}	40.00^{a}	12.72^{a}	15.83^{a}	38.00^{a}	83.80^{a}
T_6	92.83^{bcde}	6.33^{a}	79.07^{ef}	5.14^{a}	41.33^{a}	12.35^{a}	16.83^{a}	42.00^{a}	79.50^{a}
T_7	92.87^{bcde}	6.33^{a}	85.80^{b}	5.17^{a}	45.00^{a}	14.15^{a}	16.10^{a}	37.00^{a}	93.53^{a}
T_8	93.87^{abcd}	6.67^{a}	76.83^{fgh}	4.77^{a}	40.00^{a}	11.82^{a}	16.37^{a}	41.00^{a}	83.93^{a}
T_9	96.97^{a}	7.67^{a}	90.27^{a}	5.51^{a}	37.33^{a}	13.98^{a}	16.03^{a}	39.00^{a}	79.33^{a}
T_{10}	90.97^{cde}	6.67^{a}	74.13^{h}	5.17^{a}	40.67^{a}	13.28^{a}	16.07^{a}	40.00^{a}	85.70^{a}
T_{11}	94.40^{abc}	6.67^{a}	76.07^{gh}	4.94^{a}	42.67^{a}	14.58^{a}	15.80^{a}	35.00^{b}	69.97^{a}
T_{12}	91.63^{cde}	6.67^{a}	79.53^{ef}	5.56^{a}	40.00^{a}	13.35^{a}	15.73^{a}	41.00^{a}	82.87^{a}
T_{13}	93.63^{abcd}	6.33^{a}	78.20^{fg}	5.33^{a}	42.67^{a}	12.12^{a}	15.33^{a}	44.00^{a}	75.27^{a}

Means followed by a similar letter or letters do not differ significantly from each other at 5% level of significance.
*LCC= Leaf Chlorophyll Content (SPAD value)

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Effect of Soil Application of Zinc Fertilizer on Growth and Yield of Wheat at Bakrajow and Kanypanka locations in Sulaimani Governorate

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Effect of Soil Application of Zinc Fertilizer on Growth and Yield of Wheat at Bakrajow and Kanypanka locations in Sulaimani Governorate.

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Abstract:

This study was conducted during growing season of 2010 - 2011, to study the effect of four levels of Zinc as Zn- EDTA (0, 20, 40, 60 kg Zn ha^{-1}) on growth traits and yield of wheat variety *ovanto* at two different agricultural locations (Bakrajow and Kanypanka) using Randomized Complete Block Design (R.C.B.D.) with three replicates. The results showed that the increase in rates of Zn causes an increase in grain yield, grain zinc content and zinc uptake by plant, from both of locations. However the results showed that the relative yield was decreased with increasing of zinc application rate from both of locations.

Key words: Zinc fertilizer and Wheat Production, Zinc uptake, grain yield

1. Introduction:

Zinc is one of the essential micro nutrient for plants, animals and human [1]. Zn is needed by plants in small amount but the critical concentrations or if the available amount is not adequate, the plants and/ or animals will suffer from physiological stress brought about by the dysfunction of several enzyme systems and other metabolic functions in which zinc plays apart [2], He reported that the zinc which is available to plants is that present in the soil solution or is adsorbed in a labile form. The soil factors affecting the availability of zinc to plants are those which control the amount of zinc in the soil solution and its sorption-desorption from/ into the soil solution. These factors include: the total zinc content, pH, organic matter content, calcium carbonate content, redox conditions, microbial activity in the rhizosphere, soil moisture status, concentration of other elements, concentration of macro-nutrients, especially phosphorus and climatic condition.

Higher plants absorb Zn as divalent cations (Zn^{2+}) which acts either as a metal component of enzymes or as a functional structural, or a regulatory cofactor of a large number of enzymes [3], [4].On the other hand zinc deficiency is a global nutritional constraint for plant growth, particularly in calcareous soils of arid and semi arid regions [5]. One of the most important micronutrient deficiencies is attributed to zinc deficiency that is worldwide problem in human nutrition.

Wheat as one of the most critical nutrient sources for human and animals which plays an important role in production of food combinations worldwide. Among necessary elements for growth and development, zinc has been considered as one of fundamental elements for natural growth of wheat and other crops [6]. Soils with low organic material content and pH above 7 have potentially high zinc deficiency and in such a situation the problem is easily fixable using insoluble zinc granular fertilizers [7].

The objective of the present investigation is to study the effect of zinc application on growth and yield of wheat in calcareous soil.

2. Materials and Methods:

To consider effects of Zinc fertilizer application (to soil) on growth and yield of wheat in calcareous soil, the experiment was conducted at two different locations, the first one at Bakrajow Agricultural Research farm (743 masl $35^{o}32^{-}37.7^{''}$ N $45^{o}20^{-}53.9^{''}$E) and the second one at Kanypanka Agricultural Research farm (580 masl $35^{o}22^{-}37^{''}$ N $45^{o}20^{-}33^{''}$ E) under rain-fed condition during winter growing season of 2010-2011. To study the effect of four levels of Zinc as Zn-EDTA 15% Zn (T_1=0, T_2= 20, T_3=40 and T_4= 60 kg Zn ha^{-1}) were added to the soil in deep of 25 cm at a sowing time . The field experiment was set as Randomized Complete Block Design (R.C.B.D) with three replicates. The means were compared statistically according to Duncan multiple ranges using 0.05 as significant level, and the plot area was 6 m^2. On 27 and 29 December 2010 the plots were sown with seeding rate 140 kg ha^{-1} by direct seeding of wheat variety *Ovanto* at Bakrajow and Kanypanka locations. 200 kg ha^{-1} nitrogen fertilizer was added and splitted to two equal doses which were applied at the seeding time and after 20 days of germination. 200 kg P_2O_5 ha^{-1} as triple super phosphate TSP and 150 kg K_2O as KCl were applied at the seeding time. The plants from Kanypanka location were harvested on 19^{th}/June/2011, while at Bakrajow location the harvest was conducted on 21^{st}/ June/2011. Soil samples were taken from all experimental units at (0 to 30 cm) depth, then air dried thoroughly mixed, ground passed through a 2 mm sieve, and stored in plastic bottles prior to analysis. Some physical and chemical properties of the soils are given in (Table 1). Electrical conductivity (EC) and pH were measured for the soil saturation extract with EC-meter, model (WTW 82362 Weilheim, Germany) and a pH-meter, model (Microprocessor pH meter, Hanna pH 211) respectively. Organic matter was determined by dichromate oxidation (Walkley and Black method) as described by [8]. The total calcium carbonate equivalent was determined by a rapid titration method [9].Cation Exchange Capacity (CEC) was determined by saturation with 1*M* NH_4OAc at pH 8.1[10].Soluble HCO_3^-, Cl^- and Ca^{2+} + Mg^{2+} titration methods [11].Na^+ and K^+ were determined by using (Flame Photometer). $SO_4^{2-}$was indirectly determined from combined Ca and Mg by titration with (0.02*M*) EDTA di-sodium salt according to [12]. Available P was determined by [13]. The particle size was determined according to international pipette method as described by [14].

Biological parameters were calculated according to [15], [16]. As follow:

Relative yield = (yield of control / yield of fertilized treatment) x100……………....... (1)

Response %=[(fertilized yield – control yield) / fertilized yield] x 100……………… (2)

Table. 1: Some physical and chemical properties of soil used in field experiments.

Properties		Location	
		Bakrajow	Kanypanka
Particle Size Distribution(PSD) g kg^{-1}	Sand	115.4	234.0
	Silt	523.6	572.0
	Clay	361.0	196.0

Textural Class		SiCL	SiL
pH		7.90	7.60
EC_e dS m^{-1} at 25°C		0.40	2.60
Soluble ions mmolc L^{-1}	Ca^{2+}	1.70	12.00
	Mg^{2+}	0.31	4.60
	Na^{+}	0.48	4.20
	K^{+}	0.19	6.10
	HCO_3^{-}	2.95	3.20
	Cl^{-}	0.21	16.10
	SO_4^{2-}	0.81	20.10
Cation Exchange capacity $cmol_c$ kg^{-1}		29.76	22.10
Available Zn mg kg^{-1}		0.565	1.563
Organic matter. g kg^{-1}		17.60	22.03
Available Phosphorous mg kg^{-1}		6.50	9.00
$CaCO_3$ equivalent g kg^{-1}	Total	328.00	225.00

3. Results and Discussion:

Number of tillers per hill:

The highest number of tillers per hill(4.66) was recorded from T_2 while the lowest value (4.00) was obtained from T_4 for Bakrajow location but for Kanypanka location the highest numbers of tillers per hill (4.76) was recorded from T_2 while the lowest (4.32) was obtained from T_4. The effects of all treatments on numbers of tillers per hill were identical to each other (Table 2).

Plant height:

The highest plant height (78.33 cm) was observed in T_1 but the lowest plant height (74.66 cm) in T_4 for Bakrajow location, while for Kanypanka location the highest plant height (78.16 cm) was observed from T_3 and the lowest plant height (77.16) was recorded from T_1. The plant heights were found identical to each other for both Bakrajow and Kanypanka location (Table 2).

Weight of 1000 grains:

The maximum weight of 1000 grains (53.86 g) was obtained from T_3 treatment and the minimum value (52.26g) was found from T_2 treatment at Bakrajow location, while in Kanypanka location the maximum weight of 1000 grains(48.26g) was obtained from T_4 treatment and minimum value(46.53g) was found from T_2 treatment (Table (2). From the above results it has been observed that the application of Zn fertilizer has not a significant effect on number of tillers per hill, plant height and the weight of 1000 grains in both locations because the soil is calcareous soil and contain an excess of Ca^{2+} ions. These Ca^{2+} ions undergo reactions with the applied zinc and make it unavailable for plant uptake these results were agree with finding bye [17].

Grain yield:

The grain yield was generally higher in Kanypanka location than Bakrajow location. The highest grain yield was found from T_4 (871.68 kg ha^{-1}) and the lowest was found from T_1 (733.35 kg ha^{-1}) at Bakrajow location, while the highest grain yield was found from T_4 (1208.36 kg ha^{-1}) and the lowest was found from T_1 (1025.02 kg ha^{-1}) at Kanypanka location Table(3).

Table. 2: Effect of Zn application on number of tillers per hill, plant height and weight of 1000 grains.

Locations	Zn application (kg ha^{-1})	No. of tiller per hill	Plant height (cm)	Weight of 1000 grain (g)
Bakrajow	0	4.33a	78.33a	53.20a
	20	4.66a	77.33a	52.26a
	40	4.33a	76.33a	53.86a
	60	4.00a	74.66a	53.73a
Kanypanka	0	4.43a	77.16a	48.00a
	20	4.76a	77.50a	46.53a
	40	4.62a	78.16a	47.86a
	60	4.32a	77.25a	48.26a

Values in the same column of each location followed by the same letter are not different significantly $p<0.05$

Concentration of Zn in grain and Zn uptake:

The results showed that the Zn content in grain were nearly similar in both locations. The Zn concentration in grain increased with increasing Zn application. So, the highest Zn value was found from the highest Zn application, but the highest Zn content in grain was in plants grown at Kanypanka inspite of Zn application the value (1.70 mg kg^{-1}) was much higher in T_4 at Kanypanka location than T_4 at Bakrajow location which was (0.718 mg kg^{-1}). This was very evident in the Zn uptake by the crop (Table 3).The results showed that the Zn uptake by grain was increase with increasing of Zn application at both locations. So, the highest Zn uptake by grain was in grain plants grown at Kanypanka location. The value (2054.21 mg ha^{-1}) was much higher in T_4 at Kanypanka location than T_4 at Bakrajow location which was (625.86 mg ha^{-1}) (Table3).The reasons of low zinc uptake from both of locations maybe due to fixation of zinc by available calcium ion.

Locations	Zn application (kg ha^{-1})	Grain yield (kg ha^{-1})	Grain Zn concentration (mg kg^{-1})	Grain Zn uptake (mg ha^{-1})	Relative yield (control/fertilized)x 100	Response %
Bakrajow	0	733.35a	0.453a	332.20a	……………	………..
	20	755.02a	0.596a	450.00a	97.13	2.87
	40	855.02a	0.675a	577.14a	85.76	14.23
	60	871.68a	0.718a	625.86a	84.13	15.86
Kanypanka	0	1025.02a	0.435b	445.88b	……….	………
	20	1125.02a	0.455ab	511.88ab	91.11	8.88
	40	1156.7a	0.574ab	663.95ab	88.86	11.38
	60	1208.36a	1.700a	2054.21a	84.48	15.17

Table.3: Effect of Zn application on grain yield, grain Zn concentration , Zn uptake by grain, Relative yield and (Response %)

Values in the same column of each location followed by the same letter are not different significantly $p<0.05$

Effect of Zn fertilizer level on (Response %) and Relative yield:

Result in (Table 3) showed that the relative yield was decreased from 97.13 to 84.13 % for Bakrajow location and from 91.11 to 84.48% for Kanypanka location. While the response percentage for grain yield as it is opposite in trade with relative yield affected by Zn fertilizer level and soil type, the range of response percentage increased with increasing Zn fertilizer level from 2.87 to 15.86% for Bakrajow location and from 8.88 to 15.17% for Kanypanka location.

The response of wheat to Zn fertilization:

The results in Fig. 1. Refer to the significant effect of Zn fertilizer on grain yield of wheat plant in Bakrajow and Kanypanka locations in Sulaimani governorate. These results showed that increasing Zn fertilizer application from 20 to 60 kg Zn ha^{-1} as Zn-EDTA increased significantly the grain yield of wheat from 733.4 to 817.7 kg ha^{-1} for Bakrajow location and from 1025.02 to 1208.36 kg $ha^{-1}$for Kanypanka location comparing with control treatment.

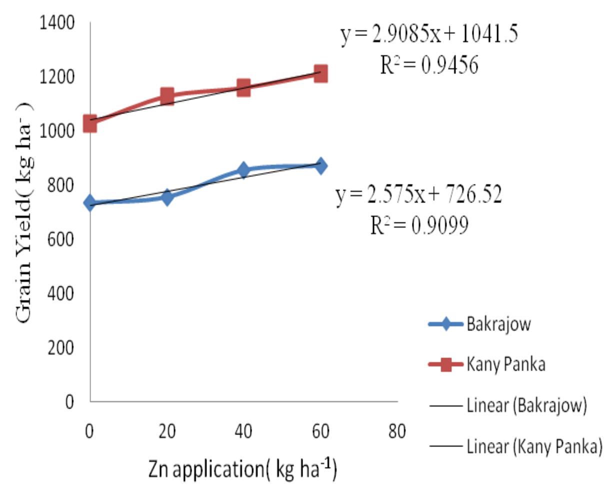

Fig.(1) effect of Zn application on grain yield of wheat.

IV. Conclusions:

According to results obtained from present study, it can be concluded that the increasing in Zn application lead to increase in grain yield and Zn uptake by plant. But the relative yield was decreased with increasing Zn application

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ESTIMATION OF THERMODYNAMIC ISOTHERMS FOR MN ADSORPTION IN SOME CALCAREOUS SOILS AT SULAIMANI GOVERNORATE.

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ABSTRACT

This study was conducted to determine the description of Mn adsorption phenomena through adsorption isotherms in some calcareous soils at Sulaimani governorate. Soil samples were taken at 0-30 cm depth from five different agricultural locations. Duplicate 1 gm of soil samples were equilibrated at 298 and 318°K with 50 ml of 0.01M $CaCl_2$ containing (0, 2.5, 5, 10, 20, and 40) mg Mn L^{-1} as ($MnSO_4$. H_2O). The concentration of Mn determined in solution by using ICP-OES. The amount of Mn adsorbed by each soil samples was calculated. The thermodynamic parameters ΔH°, ΔG°, ΔS° were determined using adsorption data and concentration of Mn in equilibrium solution at two different temperatures. The results indicated that the Freundlich equation is the best model to describe Mn adsorption in studied soils due to the result the higher (R^2), with lower (RMSE) and (AIC). The results of (ΔH°) indicated that the Mn adsorption processes in the Sharazor, Qaradagh and Mawat soils were exothermic reactions. While, the Mn adsorption processes in both Bazian and Surdash locations were endothermic reactions. The (ΔS°) values of these soils were as follows: Surdash > Bazian> Sharazor > Qaradagh > Mawat. The results of (ΔG°) indicated that the reaction in all studied soil locations at temperature 298 °K is spontaneous, also the reaction stay spontaneous with increase temperature to 318°K only in both Bazian and Surdash locations.

Key words: Manganese, adsorption models, Thermodynamic parameters, Batch equilibrium

تقدير طاقة الحراري لأمتزاز المنغنيز في بعض التربة الكلسية في محافظة السليمانية.

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المستخلص

اجريت هذه الدراسة لوصف ظاهرة امتزاز المنغنيز في بعض الترب الكلسية في محافظة السليمانية. اخذت نماذج التربة من العمق 0-30 سم من خمسة مناطق زراعية مختلفة. اخذ مكررين(1غم) من نماذج التربة ووزنت في درجة حرارة 298 و 318 كلفن مع 50 مللتر من 0.01 مولار من $CaCl_2$ يحتوي على التراكيز 0 و 2.5و 5و 10و 20 و 40 ملغم منغنيز لكل لتر على شكل $MnSO_4$. H_2O . قدر تركيز المنغنيز في المحلول باستخدام جهاز ICP-OES. وتم حساب كمية المنغنيز الممتزة من قبل التربة. واستعملت بعض المعايير الثرموديناميكية ΔH°, ΔG°, ΔS° لتحديد امتزاز تركيز المنغنيز من المحلول المتوازن في الدرجتين الحرارية المختلفتين. أشارت النتائج إلى أن معادلة Freundlichهي أفضل نموذج لوصف امتزاز المنغنيز في الترب المدروسة نتيجة الأعلى (R^2) ،مع انخفاض (RMSE) و (AIC). أشارت نتائج (ΔH°) إلى أن عمليات ادمصاص المنغنيز في تربة شهرزور، قرداغ و ماوت كانت تفاعلات طاردة للحرارة، بينما كانت عمليات ادمصاص المنغنيز في كل من مواقع بازيان و سورداش ردود فعل ماصة للحرارة. كان تقيم الإنتروبيا (SΔ°) لهذه التربة كمايلي: سورداش >بازيان >شهرزور >قرداغ >ماوت. أشارت نتائج (ΔG °) إلى أن التفاعل في جميع مواقع التربة المدروسة عند درجة حرارة 298 كلفن هو تلقائي ، كما أن التفاعل يبقى تلقائيًا مع زيادة درجة الحرارة إلى 318 كلفن في مواقع بازيان وسورداش.

كلمات مفتاحية: نماذج تربة، مناطق زراعية، الحرارة، الانتروبيا.

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INTRODUCTION

Manganese (Mn) is an important element in the earth crust, and is the eleventh element, its average content of total Mn in soils is estimated of 900 mg kg^{-1} (5). In agricultural area, adsorption of ionic form of elements from the soil solution by soil particle is an interest process for determine soil properties such as soil fertility (8). Adsorption of elements is processes of retention elements from the solution by the surface during a time and then reversible process will occur (28). There are many factors that affect Mn adsorption in soils which is: soil organic matter, pH of soil solution, and cation exchange capacity (20). Heavy metal adsorption and their distribution are mainly depending on many parameters which is soil type, metal speciation, metal concentration, and soil pH (10, 25 and 22). In general, soils with pH alkaline often have the higher ability to adsorptions metal, since these soils have lower solubility (6, 29, and 30). The bioavailability of Mn in soils significantly decreases with high pH value (16). Manganese is an essential element for the plant which needed in a small amount, the availability of this element chiefly depending on soil reaction. As we know Sulaimani Governorate soils is calcareous soil and have pH neutral to alkaline, so these cause to decrease the availability of this element in our agriculture soil, also the forms of the element changed in the soil, so we need to know the amount of Mn adsorbed in this area. Few studies have been carried out to identify the adsorption of Mn in the Sulaimani soils. For this reason this study was selected to evaluate: (i) the description of Mn adsorption phenomena through some adsorption isotherms and the individual adsorption behavior of Mn in calcareous soils. (ii)Using some isotherm models to assess which model will be fit with the Manganese adsorption. (iii)To determine the relation between soil properties and Mn adsorption in studied area.

MATERIALS and METHODS

Description of field sampling locations:

This study conducted on the five Agricultural soil samples around Sulaimani region, the sampling sites are located in Sharazor (N 35°15′ 27″; E 45° 42′ 21″), Qaradagh (N 35° 20′ 00″; E 45° 25′ 12″), Bazian (N 35° 37′ 01″; E 45° 05′ 38″), Mawat (N 35° 52′ 34″; E 45° 24′ 35″), and Surdash (N 35° 46′ 09″; E 45° 07′ 37″).

Sample collections

Soil samples were collected from 5 locations around Sulaimani, soil samples were taken from depth 0-30 cm to the Laboratory. Samples were air dried for a few days then sieved through sieve 2 mm and then storage in plastic bags to use for some chemical and physical analysis.

Laboratory analysis: Physico-chemical analysis

Several physical and chemical analyses were done for whole soil samples. The particle size distribution was determined using the pipette method described by (33). Soil reaction (pH) of the saturation extract was measured with pH-meter, and EC was determined according to (33). Total $CaCO_3$ equivalent was determined according to the method described by (19). Soil organic matter was determined using the Walkley-Black wet digestion method (32). Available Mn was extracted by using (0.005M DTPA + 0.01M $CaCl_2$ +0.1M TEA) method. Extractable Mn was measured by using ICP as described in (24).

Batch equilibrium for Mn adsorption

Adsorption process was studied by equilibrating a duplicate 1 gm of soil samples was placed in plastic bottles and equilibrated with 50 ml of 0.01 M $CaCl_2$ solution to keep the ionic strength almost constant, containing a series of Mn concentrations 0, 2.5, 5, 10, 20, and 40 µg Mn $.gm^{-1}$ as ($MnSO_4$. H_2O), two drops of toluene were added to each suspension to inhibit microbial activity. The suspension was shaken for 30 min. and then kept it at two difference temperatures 298°K and 318°K. The soil suspensions were immediately filtered through whatman paper No.42, then the concentration of Mn determined in solution by using ICP-OES. The amount of Mn adsorbed by each soil samples was calculated from the difference between the initial and final concentration in the extract solution.

Adsorption isotherm

Langmuir, Freundlich, Temkin and Dubinin-Radushkevich isotherm were used to describe Mn adsorption in studied area.

Langmuir isotherm

The Langmuir adsorption isotherm Langmuir, I. (23) was used to interpret adsorption phenomena. The linear form of Langmuir isotherm given in equation 1:

$$\frac{1}{q_{eq}} = \frac{1}{q_{max}\, k_L\, C_e} + \frac{1}{q_{max}} \quad \text{--- (1)}$$

Where q_{eq} is the amount of Mn adsorbed (mg g^{-1}), q_{max} is the maximum capacity of adsorption (mg g^{-1}), kL is an equilibrium constant (L mg^{-1}) related to adsorption energy which reflects the affinity between the adsorbent and adsorbate, and C_e is the concentration of Mn at equilibrium in (mg L^{-1}). The Langmuir adsorption isotherms were drawn by plotting the ratio of one over the amount of Mn adsorbed against one over equilibrium Mn concentration.

Freundlich isotherm model: The linear form of Freundlich adsorption isotherm Freundlich, H. (17) was used as shown in equation 2.

$$\log q_{eq} = \log K_F + 1/n \log C_e \quad (2)$$

Where, q_{eq} is amount of Mn adsorbed (mg g^{-1}), K_F is the Freundlich constant related to sorption capacity in (mg g^{-1}), n is related to the intensity of adsorption for the adsorbent, and C_e equilibrium constant of Mn (mg L^{-1}). The Freundlich constants were calculated from linear plot between log q_e against log C_e.

Temkin isotherm model: The Temkin isotherm was used to calculate the interactions between adsorbents and adsorbed elements in ionic form Das, B. et al.(12). The linear form of the Temkin isotherm shown in equation 3.

$$qe = B \ln A + B \ln C_e \quad (3)$$

Where: qe is the amount of Mn adsorbed at equilibrium (mg g^{-1}), A & B are constant, B is the heat of adsorption and A is the binding of equilibrium constant (L min^{-1}) conforming to the maximum binding energy, and Ce is concentration of Mn at equilibrium (mg L^{-1})

Temkin isotherms were drawn by plotting the amount of Mn adsorbed (q_e) against nature log equilibrium solution of Mn concentration (ln C_e).

Dubinin-Radushkevich isotherm; The Dubinin– Radushkevich (D-R) isotherm model Dubinin, et al (14) and Dubinin (15) was used to interpret the adsorption technique in heterogeneous surface (11). The linear form can be written as following equation 4.

$$\ln q_e = \ln q_D - 2B_D\, RT \ln (1 + 1/C_e) \quad (4)$$

Where, qe is the amount of Mn adsorbed (mg g^{-1}), q_D is the maximum adsorption capacity (mg g^{-1}), B_D is Dubinin-Radushkevich isotherm constant, R is the gas constant (8.314 kJ mol), T is temperature, Ce is Mn concentration at equilibrium (mg L^{-1})

Standard free energy ($\Delta G°$) = -RT ln K°

The enthalpy $\Delta H°$ calculated from integrated form of the Vant Hoff equation:

$\ln K2/K1 = \Delta H°/R[1/T1 – 1/T2]$

The standard entropy ($\Delta S°$) = ($\Delta H°$ - $\Delta G°$)/T

RESULTS AND DISCUSSION

Soil properties: The soil properties of five agriculture soils shown in Table 1, the soils were difference in texture classes ranging from (loam to Silty clay) which it means that the texture of these soils ranged from fine to moderately textured soils, (pH) value of soil samples ranged between (7.48 -7.9), and the soil were slightly to moderately alkaline. Electrical conductivity (EC) of the soil samples ranged between (0. 4-0.9 dS m^{-1}), this shows that the soil studied are non saline and this might be due to relatively higher precipitation and topography of these locations, which caused leaching of salts by natural drainage. Total Calcium carbonate ($T.CaCO_3$) ranged between (25 - 430 mg. kg^{-1}). This indicates that all soils are considered to be calcareous soils. Organic matter contents varied between the studied soils and ranged from (9-25 g kg^{-1}). The values of DTPA-extractable Mn ranged between 1.198-3.833 mg kg^{-1} in soil samples.

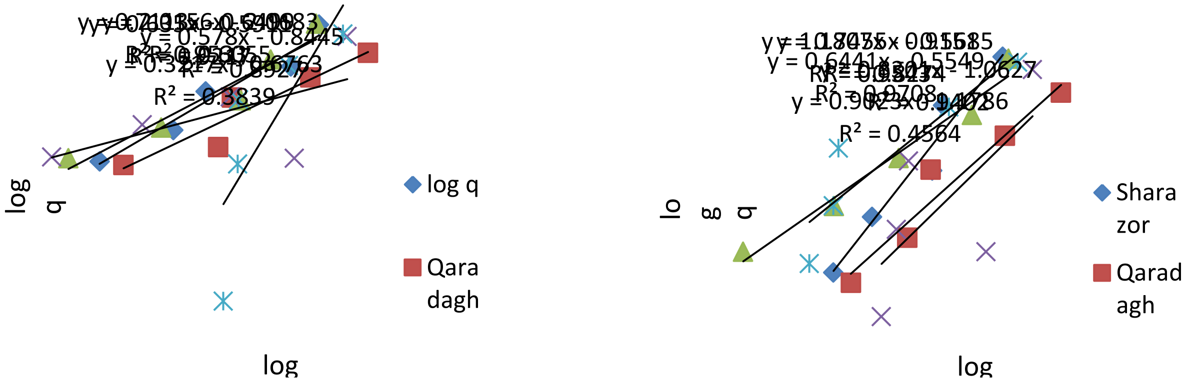
Table 1. Chemical and physical properties in studied soil samples

Locations	pH	Ec (ds m^{-1})	$T.CaCO_3$ (g kg^{-1})	O.M (g kg^{-1})	Sand	Silt (g kg^{-1})	Clay	Texture	CEC $Cmol_c\ kg^{-1}$	DTPA-Mn (mg kg^{-1})
Sharazor	7.49	0.6	180	25	37.2	475.1	487.7	SC	41.15	2.40
Qaradagh	7.65	0.7	25	17	383.5	370.3	246.2	L	26.93	3.46
Bazian	7.78	0.6	100	15	55.8	430.5	513.7	SC	41.57	7.67
Mawat	7.48	0.9	25	16	161.9	434.2	403.9	SC	39.42	5.42
Surdash	7.9	0.4	430	9	91.6	490.4	418.0	SC	36.39	2.91

SC, Silty Clay; L, Loam

Manganese adsorption in the studied soil

The simplest way of characterizing adsorption is in terms of size of the adsorbing surface (or the maximum adsorption) and the affinity of the surface for the adsorbate (binding energy of sorption). For the adsorption equation to be helpful in the interpretation of the experimental results it should not only give a satisfactory fit to the adsorption isotherm data, but also it should yield equation parameters with values meaningful in physicochemical sense (18). The results in Figure 1 (a and b) shows the Freundlich constants for Mn adsorptions were calculated from the fitting straight line between log q and log Ce at both temperature (298 & 318) °K in studied soils.



(a) **(b)**

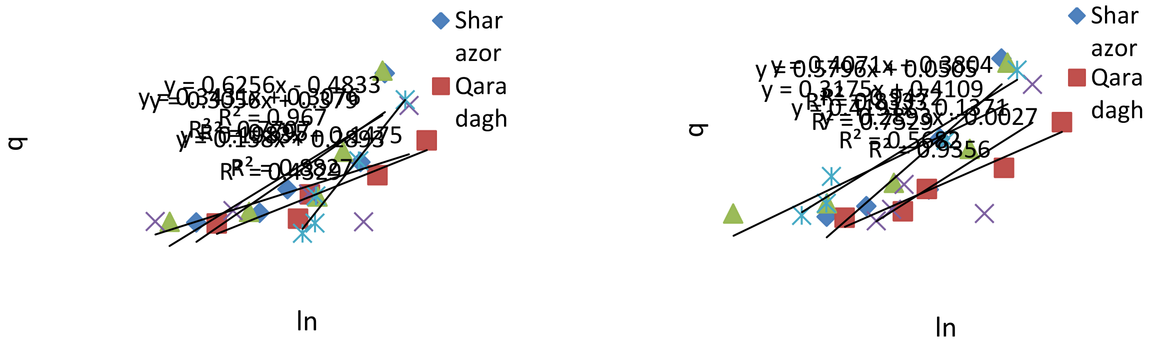
Figure 1. Linear form of Mn sorption in studied soil samples according to the Freundlich equation at 298 °K (a) and 318 °K (b).

Table 2 shows that higher value of (K_f) in Freundlich equation ranged between 3.900-117.22 at 298 °K, the highest value was in Surdash location, whereas lower value of (K_f) shown in Bazian location. These results also indicated that the Surdash location had a high capability to Mn adsorption when compared with other locations. This may be due to the high values of soil reaction in Surdash soil; high value of pH in soil solution cause to increase adsorption process of Mn. Mattias, et al. (26). The highest value of pH means low amount of H^+ in soil solution and the competition process will be decrease between H^+ and cations on the binding site, and then cause to adsorption of cations in the solution. (1). Further, the increase of adsorption process in Surdash might refer to the high amount of total $CaCO_3$ in the soil, high amount of $CaCO_3$ cause to increase adsorption process due to the hold of cations on the surface $CaCO_3$ site (physical adsorption). Moharami & Jalali (27) mentioned that the high value of Carbonate cause to increase Mn adsorption in the soil. Al-Janabi (4) and Al-Hassoon (3) observed that calcium carbonate cause to increase Cu adsorption process.

Table 2. Parameters of Mn adsorption for Freundlich, Temkin, Langmuir and Dubinin-Radushkevich equations in studied area at temperature 298 °K

Locations	Freundlich		Temkin		Langmuir		Dubinin-Radushkevich		
	K_f	n	B	A_T	q_{max}	K_L	q_D	B_D	E
Sharazor	4.464	1.407	0.343	2.451	0.904	0.390	1.027	0.364	1.173
Qaradagh	6.990	1.730	0.198	2.101	0.481	0.512	1.643	0.365	1.170
Bazian	3.900	1.574	0.306	3.453	0.592	1.120	1.165	0.257	1.396
Mawat	4.747	3.106	0.158	6.251	0.259	5.339	2.420	0.132	1.943
Surdash	117.22	0.496	0.626	2.167	0.028	0.145	4.702	2.857	0.418

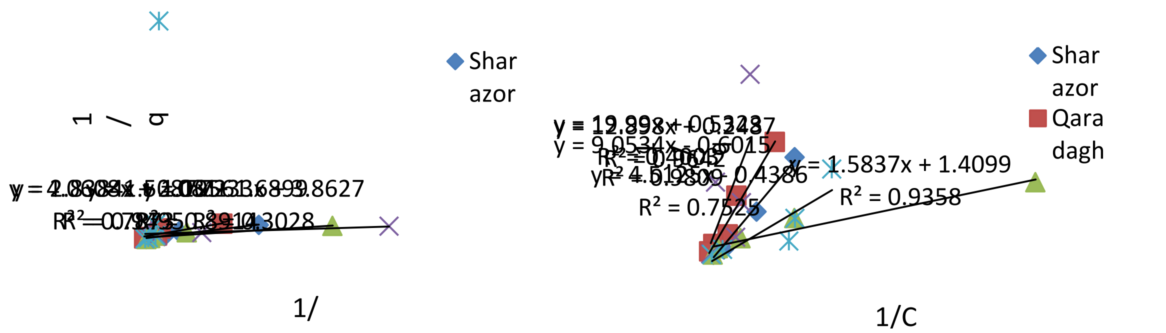
In Freundlich equation, (n) values interpret the strength of held cations by the soil, and the stability of formation complexes between cations and soil constituent. (9). The results in Table 2 shows that the Freundlich affinity values (n) for Mn in studied soils were ranged between (0.496-3.106), the highest value was in Mawat soil and the lowest value shown in Surdash soil. The value of (n) is less than one in Surdash soil. Temkin isotherm was drawn by plotting q against ln Ce at both temperature (298 & 318) °K in studied soils, as shown in Figure 2 (a & b). Also the Temkin constants for Mn adsorption were calculated in Table 2. The values of the heat of adsorption (constant B) ranged between (0.158-0.626), the highest value shows in Surdash location, while the lowest value shows in Mawat location. But the values of the maximum binding energy (At) ranged between (2.101 to 6.251), the highest value shows in Mawat, while the lowest value shows in Qaradagh locations.



(a) (b)

Figure 2. Linear form of Mn sorption in studied soil samples according to the Temkin equation at 298 °K (a) and 318 °K (b).

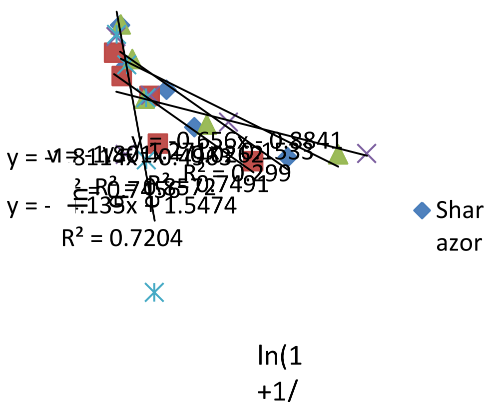
The results of Langmuir constants for Mn adsorption shows in Table 2, these constants were calculated from the fitting straight line between 1/q and $1/C_e$ at both temperature (298 & 318) °K in studied soils, as shown in Figure 3 (a & b). One of the benefits of the Langmuir equation is the ability of calculating the adsorption maximum and the binding energy from the regression line of equation.



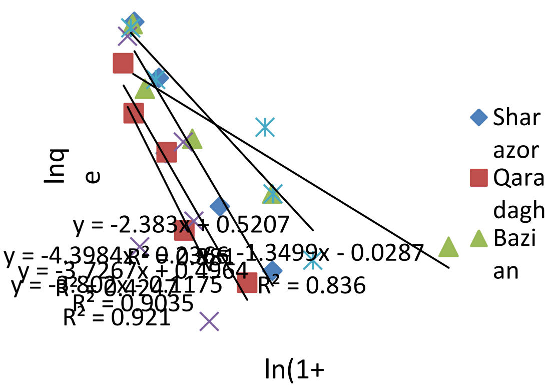
(a) (b)

Figure 3. Linear form of Mn sorption in studied soil samples according to the Langmuir equation at 298 °K (a) and 318 °K (b).

As shown in Table 2 the constant value of Langmuir equation, maximum adsorption (q_{max}) which is measuring of soil adsorption capacity, ranged between (0.028-0.904) at temperature 298°K in all studied soil locations, the highest value was in Sharazor soil and the lowest value was shown in Surdash soil. The value of (q_{max})ranged between (0.709-4.016) at temperature 318°K in all studied soil locations, the highest value was in Qaradagh soil and the lowest value was shown in Bazian soil. The Dubinin-Radushkevich constants for Mn adsorptions were calculated from the plotting straight line between ln qe and ln ($1+1/C_e$) at both temperature (298 & 318) °K in studied soils, Figure 4 (a, b).



(a)



(b)

Figure 4. Linear form of Mn sorption in studied soil samples according to the Dubinin-Radushkevich equation at 298 °K (a) and 318 °K (b).

According to Dubinin-Radushkevich equation shown in Table (2, 3) the highest value of adsorption capacity (q_D) in Surdash locations were (4.702 and 1.683) at temperatures (298 & 318) °K, respectively; this is may be due to the high amount of pH and calcium carbonate in Surdash location compared to other locations. The value of free energy (E) in Dubinin-Radushkevich equation helps us to determine the mechanism of Mn adsorption in the studied locations. The value of (E) ranged from 0.418-1.943 and 0.751-1.355 KJ mol^{-1} at temperatures (298 & 318) °K, respectively. All these values less than 16 KJ mol^{-1}, this means the mechanism of Mn adsorption in these five locations happening by ion exchange process according to Unlu & Ersoz (31).

Table 3. Parameters of Mn adsorption for Freundlich, Temkin, Langmuir and Dubinin-Radushkevich equations in studied area at temperature 318 °K

Locations	Freundlich		Temkin		Langmuir		Dubinin-Radushkevich		
	K_f	n	B	A_T	q_{max}	K_L	q_D	B_D	E
Sharazor	8.224	0.847	0.580	1.091	1.666	0.066	1.646	0.752	0.815
Qaradagh	11.561	1.205	0.289	1.010	4.016	0.019	1.123	0.768	0.807
Bazian	3.588	1.553	0.317	3.648	0.709	0.890	1.029	0.272	1.355
Mawat	15.066	1.109	0.419	1.388	1.890	0.026	1.268	0.886	0.751
Surdash	3.703	1.342	0.407	2.546	2.269	0.098	1.683	0.481	1.020

A comparison between different isotherms using for Mn adsorption

These figures were plotted according to the linear form of Freundlich, Langmuir, Timken, and Dubinin-Radushkevich equations. The fitness of these models is compared with the determination of coefficient (R^2) value of their regression lines, the standard error of estimate (RMSE) and Akaike information criterion (AIC). The results in (Figure 4 and Table 4, 5) indicate that the Dubinin-Radushkevich equation does not coincide very well with adsorption data of Mn as indicated by the R^2 with mean value of 0.674 and 0.793 at 298 and 318°K temperature respectively, in comparison to Freundlich, Temkin and Langmuir equations (Table 4, 5). The results in (Figure 3 and Table 4, 5) shows that the Langmuir equation does not fit well with adsorption data of Mn as indicated by the R^2 with mean value of 0.669 and 0.807 at 298 and 318°K temperature respectively, in comparison to Freundlich and Temkin equations (Table 4 , 5). The Temkin equation gave a better fit of the equilibrium Mn adsorption data than the Langmuir and Dubinin-Radushkevich equations. (Figure 2 and Table 4, 5). The mean R^2 value for the Temkin equation was higher than the Langmuir and Dubinin-Radushkevich equations these values were 0.749 and 0.807 at 298 and 318°K temperatures respectively.

Generally, the Freundlich equation have good coincide with adsorption data of Mn in comparison to Temkin, Langmuir and Dubinin-Radushkevich equations equations, depending on the R^2 and RMSE. The results in Table 4, 5 indicated that the mean values of the R^2, RMSE and AIC were 0.751, 0.283 and -13.515 respectively at 298°K temperature and means 0.829, 0.205 and -16.318 respectively at 318°K temperature Fig. 1& 2. Jar Allah (21) indicated that Freundlich equation have the best fit to Iron adsorption. The above equation describes Mn adsorption well over the range of equilibrium Mn concentrations used in this study. The effectiveness of these equations in accordance to these results can be arranged as follows:Freundlich > Temkin> Langmuir > Dubinin-Radushkevich. These results are in agreement with earlier reportes by Willett and Bond (34) which indicated that both Langmuir and Freundlich equations gives best fit to the Mn adsorption data.

Effect of temperature on Mn adsorption:

Generally, the Freundlich constant (K_f) values of Mn adsorption increased with increasing temperature from 298 to 318°K in Sharazor, Qaradagh and Mawat locations as shown in Table 4 and 5. The higher value of constant (K_f) found in Surdash soil at 298°K temperatures. This was also clear in the higher Mn adsorption capacity of this soil in comparison with other soils.

Table 4. Determination of coefficient (R^2), standard error of estimate (RMSE) and Akaike information criterion (AIC) at 298 ◦K for linear Freundlich, Temkin, Langmuir and Dubinin-Radushkevich equations

Locations	Freundlich			Temkin			Langmuir			Dubinin-Radushkevich		
	R^2	RMSE	AIC	R^2	RMSE	AIC	R^2	RMSE	AIC	R^2	RMSE	AIC
Sharazor	0.953	0.110	-20.599	0.771	0.302	-10.511	0.950	0.899	28.804	0.857	0.445	-6.655
Qaradagh	0.893	0.148	-17.664	0.883	0.123	-19.539	0.787	2.015	8.451	0.745	0.524	-5.014
Bazian	0.922	0.143	-18.004	0.695	0.360	-8.767	0.891	1.232	3.530	0.749	0.590	-3.833
Mawat	0.384	0.380	-8.219	0.433	0.388	-8.010	0.303	3.372	13.600	0.299	0.934	0.767
Surdash	0.605	0.635	-3.088	0.967	0.104	-21.213	0.412	51.433	40.849	0.721	1.231	3.525
Means	0.751	0.283	-13.515	0.749	0.255	-13.608	0.669	11.790	19.047	0.674	0.745	-2.242

Table 5. Determination of coefficient (R^2), standard error of estimate (RMSE) and Akaike information criterion (AIC) at 318 ◦K for linear Freundlich, Temkin, Langmuir and Dubinin-Radushkevich equations

Locations	Freundlich			Temkin			Langmuir			Dubinin-Radushkevich		
	R^2	RMSE	AIC	R^2	RMSE	AIC	R^2	RMSE	AIC	R^2	RMSE	AIC
Sharazor	0.954	0.123	-19.480	0.833	0.285	-11.109	0.981	0.705	-2.052	0.903	0.413	-7.409
Qaradagh	0.940	0.126	-19.282	0.936	0.105	-21.094	0.964	1.101	2.407	0.921	0.333	-9.561
Bazian	0.971	0.086	-23.036	0.753	0.324	-9.813	0.936	0.951	0.939	0.836	0.473	-6.041
Mawat	0.456	0.467	-6.176	0.568	0.398	-7.759	0.400	7.025	20.941	0.424	1.105	2.448
Surdash	0.827	0.222	-13.616	0.947	0.144	-17.941	0.753	2.236	9.491	0.881	0.424	-7.134
Means	0.829	0.205	-16.318	0.807	0.251	-13.543	0.807	2.404	6.345	0.793	0.550	-5.539

The effect of temperature on Mn adsorption can be expressed through some thermodynamic parameters of Mn adsorption like (ΔH°), (ΔG°) and (ΔS°) in these studied soils. The value of enthalpy (ΔH°) in these soils we can express the heat energy transferred into or out of a system during Mn adsorption process in these soils. Generally, the value of (ΔH°) of Mn adsorption in the Sharazor, Qaradagh and Mawat soils were negative as shown in Table (6) which indicated that the Mn adsorption processes in these soils were exothermic reactions (heat transfer in from the system to the surroundings). While, positive value recorded in Bazian and Surdash soils which indicated that the Mn adsorption processes in both locations were endothermic reactions (heat transfer from surroundings in to the system). As shown in the Table 6 the value of (ΔH°) for Sharazor, Qaradagh, Bazian, Mawat and Surdash were -23.869, -31.793, 4.442, -86.968

and 21.028 respectively. The lowest values for (ΔH°) were found in the Mawat soil. This would be expected due to the present of lower amount of T.$CaCO_3$ and pH value in Mawat soil in comparison with the other soils, while the Surdash soil has higher value of (ΔH°) due to the high amount of T.$CaCO_3$ in the Surdash soil with the higher value of soil pH. A lower value of ΔH° of Mn adsorption in Mawat may be attributed to more specific adsorption of Mn in this soil. Battacharyya and Tenuv (7), and Al-Hassoon, et al.(2) reported that the adsorption of cations in soils affected by soil properties as pH, calcium carbonate content, organic matter, …The values of (ΔS°) in studied soils were negative in the Sharazor, Qaradagh and Mawat soils. Whereas, positive in Bazian and Surdash soils. ΔS° used to measure of the order or disorder formed in a system during a given reaction. Apparently one would look for that the adsorption of ions from solution would form more order in a given system since the random movement of ionic species in solution has become subjected to prevent adsorption force of the surface. The (ΔS°) values of these soils were in the order of Surdash > Bazian> Sharazor > Qaradagh > Mawat. The higher (ΔS°) value present in Surdash soil is could be due to the high amount of T.$CaCO_3$ may be of the high activity of Ca^{+2} which is react rapidly with Mn in that system. These results indicated that Surdash soils adsorbed higher amounts of Mn as compared with the other soils. The values of free energy found (ΔG°) were negative at both temperatures and in all five locations except Sharazor, Qaradagh and Mawat locations which is positive at temperature 318°K as shown in Table (6), obviously there was a increase in (ΔG°) with increasing in temperature from 298 to 318°K in Sharazor, Qaradagh and Mawat locations. While, the value of (ΔG°) increase more negative value with increase temperature from 298 to 318 °K in Bazian and Surdash locations. The results indicated that the reaction in all studied soil locations at temperature 298 °K is spontaneous, also the reaction stay spontaneous with increase temperature to 318 °K in both Bazian and Surdash locations. The negative value of (ΔG°) indicated that the reaction is spontaneous (13).

Table 6. Calculated values of enthalpy (ΔH°), free energy (ΔG°) entropy (ΔS°) and (K) for the Mn adsorption in studied area:

Locations	Temperatures (°K)	ΔH° ($kJ\ mol^{-1}$)	ΔG° ($kJ\ mol^{-1}$)	ΔS° ($J\ mol^{-1}\ k^{-1}$)	K°
Sharazor	298	-23.869	-1.114	-76	1.568
	318		0.413	-76	0.855
Qaradagh	298	-31.793	-0.407	-105	1.178
	318		1.700	-105	0.526
Bazian	298	4.442	-1.347	19	1.723
	318		-1.736	19	1.928
Mawat	298	-86.968	-2.061	-285	2.297
	318		3.638	-285	0.253
Surdash	298	21.028	-0.198	71	1.083
	318		-1.623	71	1.847

The Mn adsorption data were better described by Freundlich isotherm than were described by Temkin, Langmuir and Dubinin-Radushkevich isotherms. The majot properties of soil affecting Mn adsorption in calcareous soil are Calcium carbonate content and pH of the soil. The adsorption of Mn increase with increases both pH and calcium carbonate content in the soil. Thermodynamic parameter shows that Mn adsorption in five studied soils was spontaneous at temperature 298°K. The adsorption of Mn in Sharazor, Qaradagh and Mawat soils were exothermic reactions. While the Mn adsorption processes in both Bazian and Surdash locations were endothermic reactions. This suggests that the adsorption capacity of Bazian and Surdash increased with an increase temperature. Further more research requires determining effect of the type of the mineral on the Mn adsorption in the studied locations.

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Manganese Release Kinetics in some Calcareous Soils from the Sulaimani Governorate in Iraqi Kurdistan Region

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ABSTRACT

This study was carried out in the Sulaimani Governorate, Iraqi Kurdistan Region, to estimate manganese release kinetics in five calcareous soils including (Sharazor, Qaradagh, Bazian, Mawat, and Surdash). The highest amount of Mn release during 48 hours was least in soil Surdash (64.00 mg kg^{-1}), while Soil Mawat exhibited the highest release (541.82 mg kg^{-1}). The value of first order release rate constant (k_1) from first order differed from 0.076 to 0.102 with a mean of (0.091 h^{-1}). The mean values of the rate constant (a and b) from the power function model were (2.128 mg Mn $kg^{-1}(h^{-1})^b$ and 0.916 mg Mn $kg^{-1})^{-1}$) respectively varied widely with the five soil. The value of second order release constant (k_2) from second order model, varied from (-0.012) to (-0.005) with a mean of (-0.008 mg Mn $kg^{-1})^{-1}$. The first order, power function, and second order were the best-fitted model used to describe Mn release process very well in the investigated soils.

Keywords: Manganese, release, Kinetic, calcareous soils, first order, power function and second order.

INTRODUCTION

The availability of manganese to plants depends on their oxidation state: the modified form of (Mn^{4+}) is not available to plants, while the reduced form (Mn^{2+}) is available to them. Generally, oxidation reactions are primarily biological, however, the reduction can be both biological and chemical in nature (Rengel, 2000). When the growth medium is reduced in oxygen, NO^{3-}, Mn, and Fe act as elective electron acceptors for microbial respiration and are converted to decreasing ionic species. This process increases the solubility and availability of manganese and iron. The most influential soil characteristics that control Mn species in soil solution are redox potential and pH. The oxidation states for Mn are +2 representing MnCO3, +3 representing MnOOH and +4 representing MnO2, respectively, where the amounts of pe + pH are less than 14, 14 to 16.6 and greater than 16.6. (Lindsay, 1991). Ghasemi-Fasaei *et al*., (2012) showed a higher Mn release in clay soils compared to sandy loam soils, this was significantly related to higher initial rates of Mn release in the former than in the latter. Differences in the nature and content of Mn-bearing minerals between soils, according to Krishnamurti and Huang, (1992), result in changes in Mn release characteristics and plant availability. The desorption of sorbed ions from a solid process controls ion availability and leaching into soils. The distribution coefficients, which provide information on the mobility of metals, can be correlated with the absorption and contamination of the plant (Vidal *et al*., 2009). According to Jalali and Moharami, (2013), Fe was released at a faster rate than Mn, which implies that Fe was released more quickly from contaminated soils. In native soils, the Fe and Mn distributions were identical, with Fe-Mn oxides and organic matter (OM) fractions being the most abundant. The key processes that regulate the bioavailability of metals, including Mn, in soils are adsorption, desorption, and precipitation-dissolution (Strawn and Sparks, 2000). According to Graham *et al.*, (1991), the availability of Mn for plants is controlled mainly by precipitation and oxidation reactions, and adsorption and desorption processes play a minor role. In a step-by-step regression analysis of the constant values of the best fitted models and the selected soil parameters. GhasemiFasaei, *et al*., (2009) concluded that the quality of the easily reducible Mn oxides (ERMn) was the only soil characteristic capable of predicting any constant value from the best fitted models. According to the equations, the Mn release concentrations increased as the amount of ERMn increased. As a result, ERMn is determined to be the main cause of Mn release in these calcareous soils. Using DTPA as the extraction solution, Bostani and Twofighi, (2010) noted that six mathematical equations (zero order, first order, second order, power function, simplified Elovich, and parabolic diffusion) could be used to explain and quantify manganese. release kinetics in six composite soil samples from Iran. The power function equation, which was used to characterize Mn release kinetics, was the best equation as it had the highest coefficient of determination and the lowest value of the estimation standard among all equations. The kinetics of manganese release in some calcareous soils of the Sulaimani governorate in the Iraqi Kurdistan region was relatively small. As a result, the current investigation began with the following objectives: study the Mn release characteristics of the studied soils & identify the most

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effective models for characterizing the kinetics of Mn release in the soils under investigation.

MATERIALS AND METHODS

Soil samples were obtained from the soil surface at a depth of (0-30) cm in some calcareous soils in the Sulaimani governorate in Kurdistan Region of Iraq, including (Sharazor, Qaradagh, Bazian, Mawat, and Surdash). The study area is located between (longitudes 35 ° 15 to 27 N; latitudes 45 07 to 37 E) as shown in the (Fig.1). All five soils were classified as (Argixerolls, Rendolls, Pelloxererts, Rendolls, and Argixerolls) according to the Soil Survey Staff, (2004). Soil samples are air-dried, crushed, and sieved through a 2-mm sieve before analysis and Mn release studies. Some of the basic physicochemical properties of the soil studied include particle size distribution, pH, EC, percentage of organic matter, percentage of calcium carbonate, and CEC determined according to the soil analysis methods as outlined by (Page *et al.*, 1982 and Rayan J. *et al.*, 2001), available Mn content in the soil was determined using the DTPA procedure (Lindsay and Norvell, 1978).

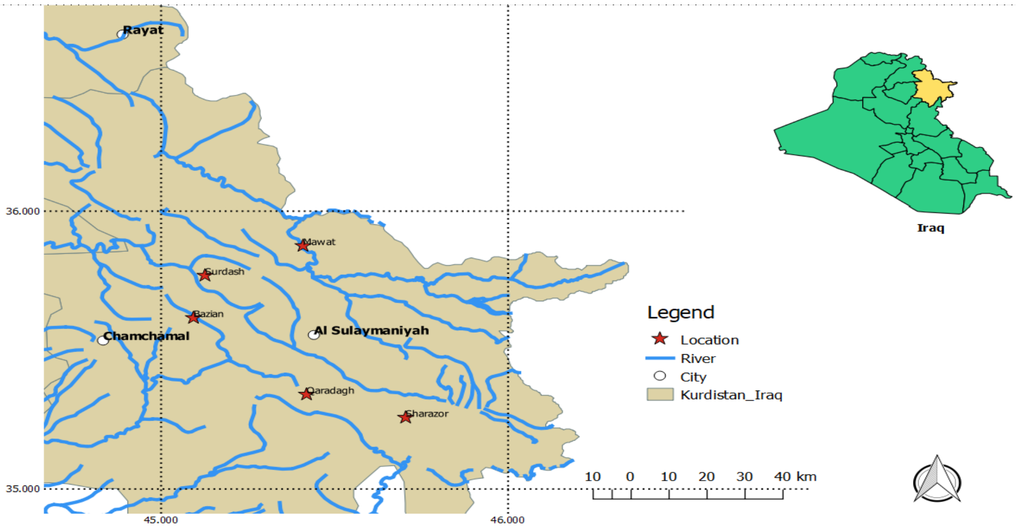

Fig. 1. Soil sampling from studied sites.

Kinetic study procedure:

The DTPA-extracting solution (0.005 *M* diethylene triamine pentaacetic acid, 0.1 *M* triethanolamine, and 0.01 *M* $CaCl_2$) was used to determine the release kinetics at pH=7.3; (Lindsay and Norvell 1978) as an extractant as follows: 50 g of duplicate oven-dried soil were extracted with 100 ml of DTPA-extracting solution at a ratio (m/v of 1:2) of 25 ºC ±1 in a constant temperature shaker for 0.5, 1, 2, 4, 6, 8, 24,48 hours.

To prevent microbiological activity, five drops of toluene have been added. For each shaking period, the soil suspension was filtered instantly through Whatman paper No. 42, then the Mn concentration in a solution was determined using Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES). Eight models, including: Zero order, First order, Second Order, Third Order, Simple Elovich, Parabolic diffusion, Power function, and Hyperbolic, were used to describe the manganese release in the studied soil (Lopez-Pineiro, and Navarro, 1997) as shown in (Table 1). The model that gave the highest value of the coefficient of determination (R^2) ,and the minimum value of the root mean square error (RMSE) was considered the best model.

Table 1. Eight kinetic models used to describe manganese release in the studied soils.

Models	Equations	Parameters
Zero order	$q_t{}^* = q_0{}^* - k_0 t$	k_0 , zero-order rate constant (mg Mn kg $^{-1}$ h^{-1})
First Order	$\ln q_t = \ln q_0 - k_1 t$	k_1 , first-order rate constant (h $^{-1}$)
Second order	$1/q_t = 1/q_0 + k_2 t$	k_2, second-order rate constant [(mg Mn kg $^{-1}$) $^{-1}$]
Third order	$1/q_t{}^2 = 1/q_0{}^2 - k_3 t$	k_3 , third-order rate constant[(mg Mn kg $^{-1}$) $^{-2}$ h $^{-2}$]
Simple Elovich	$q_t = 1/\beta s \ln(\alpha s \beta s) + 1/\beta s \ln t$	αs, initial Mn desorption rate constant (mg Mn kg $^{-1}$ h^{-1}) and βs, Mn desorption rate constant [(mg Mn kg $^{-1}$) $^{-1}$]
Parabolic diffusion	$q_t = q_0 - k_p t^{1/2}$	kp, diffusion rate constant [(mg Mn kg $^{-1}$) $^{-0.5}$]
Power function	$\ln qt = \ln a + b \ln t$	a, initial Mn desorptiorate constant [(mg Mn kg $^{-1}$(h $^{-1}$)^b] and b , desorption rate coefficient
Hyperbolic	$q_t / t = (q_0 / t\,½)\, t$	t ½ semi decomposition time

***qt represents the quantity of soil Mn released by DTPA (mg Mn kg $^{-1}$) after t (h) of extraction, and q_0 represents the initial Mn concentration at time = 0.**

The determination coefficient and the root mean square error value was calculated according to the following equations:

The coefficient of determination (R^2) = Σ (*q* meas−*q*aepred)^2 /Σ(*q*meas−*q*aepred)^2 + (*q*meas−*q*pred)^2

Root mean square error (RMSE) = {Σ (*q* meas– *q*pred) ^{2} /n -2} $^{1/2}$

Where qmeas and qpred , qaepred represent the measured , predicted , and average predicted Mn released, and n is the number of measurements.

Statistical Analysis

For statistical operations, the XLSTAT software program (Version, 2016) was used.

RESULTS AND DISCUSSION

Physicochemical properties of the soil

Some chemical and physical properties of the soils presented in (Table 2) revealed that the soils differ in their texture from silty clay to loam, with a range of organic matter, and total calcium carbonate contents ranging from 90 to 25, and 25 to 430 g kg $^{-1}$ respectively. Most of the soil had a neutral reaction (7.48 to 7.90). EC of the soil ranged between 0.40 to 0.90 dS m^{-1}. The CEC values ranged from 26.93 to 41.57 cmolc kg^{-1}, while the extractable Mn by DTPA differed from 2.40 to 7.67 mg kg^{-1}. The texture classes of the studied soils ranged from (loam to Silty clay), indicating that the texture of these soils ranged from fine to moderately textured soils, and that the soils were slightly to moderately alkaline, with values ranging from (7.48 – 7.9). The electrical conductivity (EC) of the soil samples ranged from 0. 4 to 0.9 dS m^{-1}, indicating that the soils investigated are non-saline. This could be attributed to the relatively higher precipitation and topographic variance of these areas. All soil termed as calcareous soil due to calcium carbonate content was between (25 – 430 gm kg^{-1}).

Table 2. Chemical and physical characteristics of the five soils.

Soil No.	pH	EC (dS m $^{-1}$)	T.CaCO3 (g kg $^{-1}$)	O.M g kg $^{-1}$	Sand g kg $^{-1}$	Silt g kg $^{-1}$	Clay g kg $^{-1}$	Textural class	DTPA Mn mg kg $^{-1}$	CEC cmolc kg $^{-1}$
Sharazor	7.49	0.60	180.00	25.00	37.20	475.10	487.70	Silty clay	2.40	41.15
Qaradagh	7.65	0.70	25.00	17.00	383.50	370.30	246.20	loam	3.46	26.93
Bazian	7.78	0.60	100.00	15.00	55.80	430.50	513.70	Silty clay	7.67	41.57
Mawat	7.48	0.90	25.00	16.00	161.90	434.20	403.90	Silty clay	5.42	39.42
Surdash	7.90	0.40	430.00	9.00	91.60	490.40	418.00	Silty clay	2.91	36.39

The pattern of Mn release

The amount of Mn released in the studied soil as a function of time (0.5 to 48 hours) with DTPA extracting solution is shown in the (Fig.2). The pattern of manganese release models is often characterized by an initial quick reaction, followed by a gradual slowdown until equilibrium was reached after 48 hours. Our findings are similar to those of Bostani and Twofighi, (2010), who observed that Mn release was very rapid in all samples at first (with 25–55 percent of total Mn released during the first 10 hours), then gradually declined until it reached zero in soils after 720 hours.On the other hand, The Kinetics of native Mn release by ammonium bicarbonate diethylenetriaminepentaacetic acid (AB-DTPA) from 10 highly calcareous soils were evaluated for periods ranging from 1 to 1440 minutes by GhasemiFasaei, (2009). The results showed that Mn-release rates were quick at first, then much slower, and that more than 60% of maximum Mn was released from the investigated soils through the first 15 min. They also stated that the pattern of Mn released over time implies that as Mn-release processes continued, Mn-release energies increased. After a 2084-hour kinetic analysis, Jalali and Moharami, (2013) revealed that Fe and Mn concentrations in all fractions decreased, while the Fe-Mn oxides fraction remained the dominant Fe and Mn fraction. During each of the three desorption investigations, the concentration of dissolved manganese content increased initially (within minutes), then declined over the next few hours before reaching a steady value after 4–6 hours (Richard *et al*., 2013). Similarly, Shi *et al*., (2014) observed that metal desorption from monodentate sites is fast, but desorption from bidentate sites is slow. In soil Surdash, the largest amount of Mn released for 48 hours was the least (64.00 mg kg $^{-1}$)., on the other hand, Mawat soil had the highest release (541.82 mg kg^{-1}). It could be caused by CEC, organic matter, pH, or clay content. The order of the amount of manganese released into the soil was as follows: Mawat > Sharazoor > Bazian > Qaragh > Surdash. Soil factors such as CEC, organic matter clay content, and pH, play a big role in Mn release patterns. Our findings are consistent with McBride's, (1989) who stated that metal sorption behavior in soil ranges from one soil to another and is impacted by soil properties such as CEC, clay content, pH, and OM. Similarly, Motlagh, (2012) found that the main active parameters controlling copper release in calcareous soil from northern Iran are CEC and clay content. When anions such as sulfate, carbonate, hydroxide, and phosphate are present. In alkaline soils, precipitation appeared to be the primary metal immobilization process, especially when metal ion concentrations were high (Adriano, 2001).

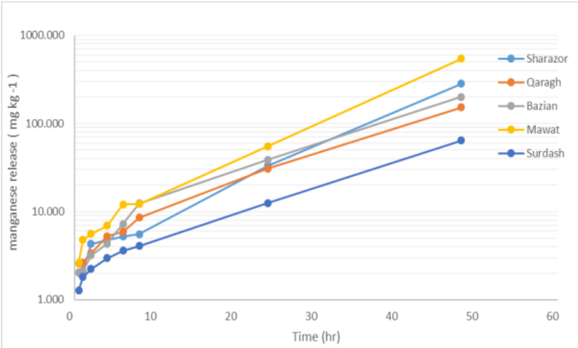

Fig.2 Mn release by DTPA as afunction of time

Mathematical kinetic models used to fit the Mn release data

Eight kinetic models were employed to characterize manganese release in the studied soils by DTPA extracting solution from 0.5 to 48 hours, including zero-order, first-order, second-order, third-order, simple Elovich, parabolic diffusion, power function, and hyperbolic. The model equation, which gave the highest value of determination coefficient (R^2) and the lowest value of root mean square error (RMSE) was considered the best model equation. Due to their high R2 (0.968, 0.850, and 0.566) and low RMSE (0.290, 0. 638, and 0.125), the first order, power function, and second order models given the best fit to Mn release kinetics (Table 3, and 4). While third order, hyperbolic, zero order, parabolic, and simple Elovich could not properly describe Mn release kinetics due to their relatively high values of (RMSE). This is in agreement with the findings of Bostani and Twofighi, (2010), who showed that due to their low standard errors and relatively high correlation coefficients, the first-order, second-order, and parabolic diffusion equations were the best models for predicting Mn release kinetics. While Ghasemi-Fasaei, (2009) showed that two constant rate, simple Elovich, and parabolic diffusion were the best-fitted models for describing Mn release kinetics of agricultural fields of Fars province in southern

Iran. On the other hand, the two best models for describing the desorption Mn data in all soils were two-constant rate and parabolic – diffusion equations Reyhanitabar (2014). Table 4 shows the variable ranges and means of R^2, and RMSE for the studied soils, and eight kinetic models. The average of R^2, RMSE for all the five soil ranked as follows: first order > power function > second order > third order > hyperbolic > zero order > parabolic > simple Elovich.

Table3. The root mean square error (RMSE) and determination coefficient (R^2) of eight kinetic models used to characterize manganese release in the investigated soils.

Eqauation	Sharazor		Qaradagh		Bazyan		Mawat		Surdash	
	RMSE	R^2	RMSE	R^2	RMSE	R^2	RMSE	R^2	RMSE	R^2
Zero order	38.338	0.867	16.354	0.914	21.736	0.913	76.298	0.858	7.078	0.907
First order	0.244	0.982	0.254	0.972	0.434	0.936	0.297	0.974	0.222	0.974
Second order	0.125	0.579	0.096	0.635	0.142	0.521	0.094	0.485	0.168	0.609
Third order	0.086	0.315	0.051	0.407	0.087	0.328	0.046	0.222	0.180	0.327
Simple Elovich	77.795	0.452	39.030	0.512	51.502	0.514	150.800	0.445	16.268	0.509
Parabolic diffusion	56.684	0.709	26.691	0.772	35.254	0.772	110.955	0.699	11.266	0.764
Power function	0.793	0.805	0.585	0.854	0.555	0.896	0.738	0.841	0.519	0.856
Hyperbollic	1.544	0.363	1.555	0.003	1.207	0.209	2.470	0.512	0.779	0.032

Table 4. Range and mean of root mean square error and determination coefficient (R^2) (RMSE) of eight kinetic models were used for describing manganese release by DTPA in the studied soils.

Equation	RMSE		R^2	
	Range	Mean	Range	Mean
Zero order	7.078 - 76.298	31.961	0.858 - 0.914	0.892
First order	0.222 - 0.434	0.290	0.936 - 0.982	0.968
Second order	0.094 - 0.168	0.125	0.485 - 0.635	0.566
Third order	0.046 - 0.18	0.090	0.222 - 0.407	0.320
Simple Elovich	16.268 - 150.8	67.079	0.445 - 0.514	0.486
Parabolic diffusion	11.266 - 110.955	48.170	0.699 - 0.772	0.743
Power Function	0.519 - 0.793	0.638	0.805 - 0.896	0.850
Hyperbolic	0.779 - 2.47	1.511	0.003 - 0.512	0.224

Kinetic Parameters

Table 5 shows the constant values of the best fitted models. Some of these values vary significantly between the investigated soils, possibly due to differences in Mn release rates. The intercept and slope of the linear curves are represented by the constants (q0, a and 1 / q0) and (k1, b and k2) of each model. In the first-order model, q0 represents the intercept, which can be used to indicate the initial release of Mn or the amount of Mn released at time zero, and k1 represents the slope, which can be used as a constant rate of the index of the first order. release. The value of q0 ranged between 1,876 and 4,435 with a mean of 3,023 (mg kg-1). The highest value of q0 recorded in the Mawat soil and the lowest value attributed to the Surdash soil. While k1 represents the lowest value in Surdash soil attributed to its lower organic matter and cation exchange capacity. On the other hand ,

Table 5. Rate constant values for three kinetics models that best described manganese release by DTPA in the soils investigated.

Soils	First order		Power function			Second order	
	q_0	k1 (h^{-1})	a (mg Mn kg -1(h^{-1})^b	B (mg Mn/kg^{-1})$^{-1}$	ab	1/q_0	k2 (mg Mn kg $^{-1}$)$^{-1}$
Sharazor	2.611	0.100	1.886	0.968	1.826	3.104	-0.008
Qaradagh	3.186	0.085	2.315	0.850	1.968	3.570	-0.007
Bazian	3.009	0.093	1.983	0.981	1.945	0.317	-0.008
Mawat	4.435	0.102	3.051	1.021	3.115	0.197	-0.005
Surdash	1.876	0.076	1.407	0.762	1.072	0.479	-0.012
Min	1.876	0.076	1.407	0.762	1.072	0.197	-0.012
Max	4.435	0.102	3.051	1.021	3.115	3.570	-0.005
Mean	3.023	0.091	2.128	0.916	1.949	1.533	-0.008

The value of 1 / q0 ranged between 0.197 and 3.570 with a mean of 1.533, while k2 represents the lowest value in Surdash soil. The lower value of k1 and k2 could be attributed to their lower organic matter, this was consistent with the statistical analysis. Curtin, Ryan, and Chaudhary, (1980) have reported similar results reporting that the rate of Mn release was considerably different in the calcareous soils of Lebanon. These differences can be attributed to the difference in the amount of Mn that it supports. minerals in the soils studied (Krishnamurti and Huang, 1988). The value of (a) ranged between 1.407 and 3.051 with a mean of 2.128 and, (b) ranged between 0.762 and 1.021 with a mean of 0.916. The values of the velocity constant (a and b) with the mean are (2.128 and 0.916) from the equation of the power function very different from the five soils (Table 5). The values of (ab) were calculated and listed for the soil studied in (Table 5). According to the statistical study, the Mawat soil had the highest value of constant (ab), equivalent to (3,115), and the Surdash soil had the lowest value, equal to (1,072). This may be due to a higher content of organic matter and CEC in the soil in Mawat soil compared to Surdash soil. The variation in the values of b suggests that the Mn of the soils that provides energy is different. Our results are in agreement with the findings of Dang *et al*., (1994), who believe that an increase in the value of a and / or a decrease in the value of b is an indication of a higher rate of nutrient release.

CONCLUSION

The results of this study showed that the pattern of manganese release models is often characterized by an initial quick reaction, followed by a gradual slowdown until equilibrium was reached after 48 hours. The best model was the first order, power function, and second order based on the highest value of R^2, and the lowest value of RMSE for the description of Mn release from some calcareous soil of Sulaimani governorate, Iraqi Kurdistan Region. For the first order, power function, and second order models, the values of (k1), (a, and b), and k2 were related with some soil characteristics like organic matter and CEC in the studied soils.

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حركية تحرر المنغنيز في بعض الترب الجيرية لمحافظة السليمانية في إقليم كردستان العراق.

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أجريت هذه الدراسة في محافظة السليمانية، إقليم كردستان العراق، لتقدير حركية تحرر المنغنيز لخمسة أنواع من الترب الجيرية هي (شارزور، قرداغ، بازيان، ماوت، سورداش)، وكانت أكبر كمية تحرر للمنجنيز خلال ٤٨ ساعة أقل في سورداش (٦٤,٠٠ مجم كجم $^{-١}$)، في حين أظهرت تربة ماوت أعلى تحرر (٥٤١,٨٢ مجم كجم$^{-١}$). تفاوتت قيمة ثابت معدل التحرر من الدرجة الأولى (k1 من ٠,٠٧٦ إلى ٠,١٠٢ بمتوسط ($0.091\ h^{-1}$) و القيم المتوسطة لثابت المعدل (أ، ب) من نموذج دالة القدرة كانت ($Mn\ kg^{-1}\ h$) (2.128^{b} ($^{-1}$ مجم) ، (0.916^{-1} (Mn / kg^{-1} مجم)) على التوالي تباينت بشكل كبير لترب الخمسة. تراوحت قيمة ثابت معدل التحرر من الدرجة الثانية من نموذج الدرجة الثانية (k2 من (- ٠,٠١٢) إلى (- ٠,٠٠٥) بمتوسط (-٠,٠٠٨$^{-١}$ ($Mn\ kg^{-1}$ مجم))، كانت الدرجة الأولى ، دالة القدرة ، والدرجة الثانية هي أفضل النماذج المستخدمة لوصف عملية تحرر المنغنيز بشكل جيد للغاية في الترب المدروسة.

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Influence of Different Organic Fertilizers on Growth and Yield of Wheat

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Abstract: Manure not only supply many nutrients for crop production, but it also valuable sources for increasing soil organic matter content and improving soil structure. The field experiment was conducted at Bakrajow Agricultural Research farm which lies between 35°32ˉ36.8” north latitude and 45°21ˉ09.6” east longitude, under rain-fed condition during winter growing season of 2013-2014 to study the influence of different manures on some vegetative growth of wheat variety *Semito.* The treatments including T_1 = control, T_2 = 20 t ha^{-1} sheep manure, T_3 = 20 t ha^{-1} cow manure and T_4 = 20 t ha^{-1} poultry manure, using Randomized Complete Block Design (RCBD) with four replications. The results showed that the poultry manure is the most efficient one compared to sheep and cow manures. The values of grain yield, biological yield and grain protein content were 6.750 t ha^{-1}, 15.666 t ha^{-1} and 14.955%, respectively, for poultry manure treatment.

Key words: Organic Fertilizers · Manure · Wheat

INTRODUCTION

Wheat (*Triticum aestivum* L) is the most important cereal crop in the world and it is one of the main sources of carbohydrate and also contains a considerable amount of protein, minerals and vitamins [1]. There is a need to increase the yield of wheat per unit area in the world to fulfill its demands resulted from the rapid growth of the world population. The use of modern varieties of the wheat and judicious fertilization are the important factors which can help the increase of wheat production. It is well recognized that crop productivity depends on adequate plant nutrient and organic matter content of the soil. Manure plays an important role in improving physical, chemical and biological properties of the soil. Manures are content low concentration of plant nutrients and they have a slow acting nature, organic manure alone may fail to tend the high nutritional requirements of crops [2]. Continuous additions of the manures to the soil increase its organic matter content year after year, improving physical and chemical soil properties [3]. This improvement is due to providing of a suitable soil structure, increasing soil cation exchange capacity, increasing the quantity and availability of plant nutrients in addition to furnishing the microbial activities.

Organic fertilizers including sheep manure, cow manure and poultry manure are may be used for crop production as substitute of chemical fertilizers because the importance of organic manures cannot be overlooked [4]. Using manure in wheat production cropland is an alternative method to reduce feedlot environmental impact [5] and thus to achieve an integrated farming system [6].The prolonged and over usage of chemicals has, however, resulted in human and soil health hazards along with environmental pollution. Farmers in the developed countries are, therefore, being encouraged to convert their existing farms into the organic farm [7]. Organic materials act as chelating agents and hold the minerals desorbed from the soil. During the decomposition of organic matter acids are also produced which increase the availability of minerals nutrients in the soil for plants [8].

The aim of this study was to evaluate the use of sheep manure, cow manure and poultry manure in partial or total replacement of inorganic fertilizers in wheat production and assess their impact on soil properties.

MATERIALS AND METHODS

The proposed research study was conducted at Bakrajow Agricultural Research Farm which lies between 35°32ˉ36.8” north latitude and 45°21ˉ09.6” east longitude,

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under rain-fed condition during winter growing season of 2013-2014. Soil samples were drawn before sowing the crop kernel to the depth of 30 cm and were subjected to physic-chemical analysis. The analysis report of soil samples was showed that the ratio of sand (115.4 g kg^{-1}), silt (523.6 g kg^{-1}) and clay (361.0 g kg^{-1}) indicated the soil texture class is silty clay loam (SiCL), having pH= 7.27, EC0.17 dS m^{-1}, organic matter 1.33%, available P 14.44 ppm, total $CaCO_3$ 24.5%, available total nitrogen 0.11%, soluble Ca^{2+} 1.9 meq L^{-1}, soluble Mg^{2+} 1.7 meq L^{-1}, soluble K^+ 0.056meq L^{-1}, soluble Na^+0.056meq L^{-1}, soluble HCO_3^- 2.0 meq L^{-1}, soluble Cl^- 0.2 meq L^{-1} all physical and chemical analysis were determined according to the methods of soil analysis described by [9]. The sheep, cow and poultry manures were also subject to nutrient analysis. They were analyzed according to [10] and the observations were as follows:

The experiment was laid out in Randomized Complete Block Design (RCBD) having a net plot area 2 x 3 m with four replicates. The experiment comprised of four treatments; T_1= control, T_2= 20 t ha^{-1} sheep manure, T_3= 20 t ha^{-1} cow manure and T_4= 20 t ha^{-1} poultry manure. Wheat cultivar *Semito* was sown with hand drill on 28th December 2013, using seeding rate of 140 kg ha^{-1}. The crop was harvested on 10 Junth2014 and individual samples were threshed manually. The data was collected and analyzed according to Fischer's analysis of variance technique with the least significant difference test (LSD) at 5% level of probability [11].

RESULTS AND DISCUSSION

The presented data in Table 2 shows the effect of manures on some vegetative growth, biological yield and some of the yield components as follow;

Plant Height: Data obtained showed that, T_4 had significant difference in plant height with T_1, T_2 and T_3 and also T_3 had significant difference with T_1. While there was no significant difference between T_2 and T_3 for this trait. The poultry manure treatment had increased plant height by 10.7% compared to control treatment (no organic fertilizer application). Similar results were found by [12] and [13]. They concluded that the yield components of wheat crop were significantly affected by the treatments which were treated with organic matter over control.

Number of Tiller per Plant: Analysis of data for number of tiller/plant showed that T_4 was different from T_1, T_2 and T_3, significantly. The treatment T_3 also had a significant difference with T_1, while T_2 and T_3 showed similar number of tiller per plant. The number of tiller per plant for T_4 was increased by 70.59% compared to control treatment.

Number of Grains per Spike: The results showed that the number of grain per spike obtained at all treatments were similar statistically. Our finding is disagreeing with the results obtained by [2]. They found that the different levels of organic fertilizer application significantly increased number of grains per spike.

1000 Grain Weight (g): Data analysis showed that there were no significant differences between the treatments for 1000 grain weight of wheat. Different results regard this trait were found by [2]. They found that the different levels of organic fertilizer application significantly increased 1000 grain weight.

Biological Yield: Similar to other traits, the biological yield obtained from T_4 had the highest value, which was different significantly with the data obtained from T_1, T_2 and T_3. The highest biological yield may be due fact that the poultry manure supplies directly available nutrients such as NPK to the plants more than other fertilizer sources. Organic manures are an excellent source for multi nutrient supply to crop plants, although in a variable manner are depending on their type and quality [14]. Among the organic manure treatments, application of poultry manure was performed better than the others through improving plant characters. This may be due to the fact that in poultry manure the mineralization is rapid. A large portion of nitrogen in poultry manure is in organic fraction, but 20 to 40 percent of the total nitrogen is present in inorganic form [15]. Our results are in agreement with the results of [16]. They reported that the high biological yield may be due to fact that the organic manures supplies direct available nutrients such as nitrogen to the plant and the organic manures improve the proportion of water stable aggregates of the soil.

Grain Yield: Wheat grain yield under different manures application are presented in Table 2. The data showed that poultry manure had a significant difference with all other treatments, the maximum value of grain yield was 6.750 t ha^{-1} from T_4, while the minimum value was 5.425 t ha^{-1} for T_2. The high concentration of NPK in poultry manure compared to other treatments might be a reason for the superiority of grain yield value for T_4 (Table 1). Similar results are in agreement with those obtained by [17]. Who found that farm yard manure significantly increased grain yield of wheat.

Table 1: Some chemical properties of manures used in the study

Organic fertilizers	pH	EC dS m^{-1}	N%	Available Pppm	soluble K^+ meq L^{-1}	soluble Na^+ meq L^{-1}
Sheep manure	7.78	2.04	1.48	273.43	12.05	12.05
Cow manure	8.05	5.36	1.17	448.85	25.38	23.38
Poultry manure	7.36	12.51	1.72	451.61	117.95	117.95

Table 2: Effect of manure application on some growth characteristics of wheat plant grown in calcareous soil

Treatments	Plant height (cm)	No. of tillers $plant^{-1}$	No. grains $spike^{-1}$	1000- grain weight (g)	Biological yield (t ha^{-1})	Grain yield (t ha^{-1})	Harvest index%
T_1	78.50 ^{c}	4.250 ^{c}	53.00 ^{a}	46.473 ^{a}	11.291 ^{b}	5.473 ^{b}	49.30 ^{a}
T_2	80.55 ^{bc}	5.275 ^{bc}	54.00 ^{a}	46.850 ^{a}	11.666 ^{b}	5.425 ^{b}	46.50 ^{ab}
T_3	83.05 ^{b}	5.875 ^{b}	54.00 ^{a}	42.658 ^{a}	12. 791 ^{b}	5.615 ^{b}	43.90 ^{bc}
T_4	86.90 ^{a}	7.250 ^{a}	49.00 ^{a}	45.450 ^{a}	15.666 ^{a}	6.750 ^{a}	43.10 ^{c}

Table 3: Nitrogen content%, phosphorus and potassium concentration of grain wheat under different manure application

Treatments	Grain Protein content%	Con. N (%)	Con. P (ppm)	Con. K (ppm)
T_1	12.475 ^{b}	1.996^{b}	40.425 ^{a}	2882.00 ^{a}
T_2	12.400 ^{b}	1.984^{b}	42.910 ^{a}	2688.00 ^{a}
T_3	13.100 ^{ab}	2.096^{ab}	39.060 ^{a}	2688.00 ^{a}
T_4	14.95 ^{a}	2.392^{a}	40.252 ^{a}	2664.25 ^{a}

Harvest Index%: The statistical analysis of data obtained shows that there are a significant difference between T_1 with T_3 and T_4 and also between T_2 with T_4 for this trait. The highest value of harvest index was 49.3% from T_1 and the lowest value was 43.1% from T_4.

Means of each category followed by the same latters are not significantly different at 5% level of probabilities.

Means of each category followed by different latters are significantly different at 5% level of probabilities.

Data presented in Table (3) reveals the effect of manures on, protein and some macro nutrients content in grain wheat plant as follow:

Grain Protein Content%: Statistical analysis of means value of grain protein content% indicated significant difference between T_4 and both of T_1 and T_2 due to different manure application. Results showed that protein content of wheat grain were ranged from 12.475 to 14.95 percent. One important result in our finding was the significant increase in grain protein content when poultry manure was used, because this manure contains high concentration of NPK that acted positively in more uptakes of water and nutrients. The results are in conformity with the findings of [18]. The reported that the application of compost had a significant effect on seed protein and the maximum amount of seed protein was observed in 60 Mg compost ha^{-1} treatment.

Grain Nitrogen, Phosphorus and Potassium Content: Statistical analysis of means value of nitrogen content% indicated significant difference between T_4 and both of T_1 and T_2 due to different manure application, while the results from all traits showed that there are no significant differences for phosphorus and potassium content at all the treatments studied.

Means of each category followed by the same latters are not significantly different at 5% level of probabilities.

Means of each category followed by different latters are significantly different at 5% level of probabilities.

CONCLUSION

Through the results of current study it has been concluded that the poultry manure treatment is the most efficient one among all manure sources used. It showed the highest grain yield, biological yield and grain protein content compared to the other treatments performed. Manure is a nutrient source for agricultural production, however the slow release of nitrogen from manure and building of P and K in soil solution, may cause the potential environmental implications.

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هۆبەی توێژینەوەی بەروبوومی ڕووەکی


Growth and yield quality of sweet corn, as influenced by nitrogen fertilization levels in Sulaimani Region

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GROWTH AND YIELD QUALITY OF SWEET CORN, AS INFLUENCED BY NITROGEN FERTILIZATION LEVELS IN SULAIMANI REGION

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ABSTRACT

Four sweet corn varieties (*Zea mays ssp. Saccharata*), Gold Rush (v_1) and Chocolate (v_2), originated from Japan and 001(v_3), and 003 (V_4) are France originated, were cultivated under the effect of three different levels of nitrogen fertilization (120, 170and 230) kg ha^{-1}as (N1, N2, and N3) in two different locations in Sulaimani region (Bakrajo and Kanipanka), Iraqi Kurdistan Region in order to investigate the effects of some environmental and climatic factors on growth performance and yield quality of sweet corn varieties in the open field. By using a factorial experiment within RCBD with three replications, the results revealed that indicated to significant differences in the response of four varieties under the effect of the Nitrogen fertilization levels in both locations in the criteria concerned with sweetness such as TS%,TSS%, and NSS%, while the significant effect of Nitrogen levels N2 and N3 were revealed in quality related criteria TS% and TSS% in both locations.

***Key words: sweet corn, environmental and climatic conditions, sweetness, varieties responses*.**

تأثير مستويات السماد النايتروجيني لنوعية النمو والحاصل في الذرة السكرية في منطقة السليمانية

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المستخلص

زرعت أربعة أصناف من الذرة الحلوة (*Zea mays ssp. Saccharata*)،(Gold Rush (v1و(Chocolate (v2 من فرنسا و(001(v3 و003(v4) من اليابان، في الموقعين المختلفين في منطقة السليمانية (بكرجو وكانى بانكة) تحت تأثيرثلاثة مستويات مختلفة من التسميد النيتروجيني (170،120و230) كغم/هكتار بأستعمال التجربة العاملية في تصميم القطاعات الكاملة المعشاة وبثلاث مكررات، أظهرت النتائج تفوق معنوي في استجابة أربعة أصناف المذكورة تحت تأثير مستويات التسميد النيتروجيني في كلا الموقعين لصفات المتعلقة بالحلاوة مثل TS٪ وTSS٪ و NSS٪، في حين أن التأثير الكبير لمستويات النيتروجين أظهرت تحت مستويات النيتروجين(170و230) كغم/هكتار في TSS٪ وTS٪ لكلا الموقعين.

الكلمات المفتاحية: الذرة الحلوة، والظروف البيئية والمناخية،حلاوة،استجابة الأصناف.

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INTRODUCTION

Sweet corn (*Zea mays* ssp. *saccharata*) is an important vegetable which produced kernels consisting mostly sugar rather than starch, it became more valued in recent years, it is consumed as fresh, frozen or conserved and also used in the salads. However, the sugar in the kernels rapidly converts to starch after its prime harvest stage; sweet corn can be harvestedwhen it reaches the milk stage, while kernel moisture is at approximately 72 to 76 percent, "When sweet corn is ripe, waiting is not an option (22). There are three types of sweet corn, normal, sugar enhanced and super sweet, each one contains a different level of sucrose, changing the flavour and texture of the corn. Sweeter varieties will stay sweeter for longer after harvest. Components of sweet corn include 5 to 6% sugar, 10 to 11% starch, 3% water-soluble polysaccharides, and 70% water; it also contains moderate levels of protein, vitamin A (yellow varieties) and potassium, (16 and18). Fertilization with nitrogen will adjust the balance between yield and quality; include application rate and fertilizer materials, placement, and timing (9).Results of previous studies indicated in effect, of nutrition levels which caused yield, and also affected the chemical composition and quality of the marketable ear and it is genotype-dependent. Higher fresh ear yield of sweet corn under the effect of middle nitrogen treatment in comparisonto other two treatments, as well as the soluble sugar content and protein content of middle nitrogen level was the highest among different nitrogen levels.The application of 200 kg N/ha for sweet corn, which assumed 50% availability of the total N(20). Sweet corn kernels and ear leaves were digested and analysed for 12 macro- and micronutrients showing significant variation in response of sweet corn varieties and other tested crops (21). Application of 80 kg N/ha produced a significantly highest number of prime cobs (62,328 ha), green-cob yield (9.80 tonnes/ha), length (17.5 cm) and girth (16.7 cm) of cobs, green-forage yield (17.35 t/ha), (19, 10, 11and 22). According to the results of other researchers (12), Sweet corn means corn with sweetness that the total soluble solids content not to be less than 9 degrees Brix. Sweet corn shall be whole with or without husk and the kernel shall be on the cob. Results of variation in sowing time, the sweetness of the green cob i.e., TSS% (Brix) value varied significantly due to different sowing dates with different climatic conditions(15). The quality of fresh market sweet corn is judged by its fresh, uniform appearance, uniform and well filled rows; it is consumed in the immature stage of the crop. The taste of sweet corn kernels is 25-30% sweeter than normal corn. At optimum market maturity, sweet corn will contain 5 to 6% sugar, 10 to 11% starch, 3% water-soluble polysaccharides, and 70% water (18). Although sweet corn prefers full sun and fertile, well drained soil for maximum yield, but till now it has been cultivated inside the plastic house under semi-control conditions in our region, that may related to the high temperature in the growth season of the this crop which effect its sweetness, so that this present study is considered as the first attempt in Sulaimani region for cultivation in the open field, so in this study, we investigate the effects of environmental conditions of two different locations on growth performance and yield and quality of four sweet corn varieties that treated with three levels of nitrogen fertilizations.

MATERIALS AND METHODS

Four different varieties of sweet corn (*Zea mays spp.saccharata*) Gold Rush, Chocolate, originated from Japan and 001, and 003 which are France originated, were cultivated at the experimental fields of Agricultural Research Center of Sulaimani, in 2015 at two different locations Bakrajo and Kanipanka. Two different field experiments were implemented by factorial experiment within RCBD using three replications. The sowing date was on

11/4/2015 and 20/4/2015 at Bakrajo and Kanipanka, respectively. The 4thdifferent varieties were considered as treatment no.1 and three different nitrogen levels (120, 170and230kg.ha^{-1}) as the second treatment (N_1, N_2, and N_3). The nitrogen fertilizer was used by two different application times, the 1stpart was applied at sowing while the 2nd part in the growth stage(the period between 4 leaf stage and tasseling) was applied (4,8). The cultivation area was isolated over 100 m from other experimental fields of corn crop (7). The data were analysed by Analysis of variance and the means compared using Duncan Multiple Range atthe 5% level. Some vegetative and reproductive criteria were studied, including (no. of days required to 50% tasseling, no. of days required to 50% silking, plant fresh weight, plant dry weight, Leaf Area Index measured by Elsahookie method (5), ear length and freshyieldKg.ha^{-1}), as well as chemical criteria at harvesting such as (Moisture content%, TS%, TSS% and NSS%), the harvesting date was adjusted 20 days post silking, at the early dough stage. Chemical criteria related to the sweet corn quality were tested at labs. Of FAS-Univ. of Sulaimani as following:

1-The moisture content (M %) was determined according to standard methods (2).

2-Total solids (TS %): Total solids have been determined according to (1), calculated by the following formula: TS%= 100 - % moisture content (M %).

3-Total Soluble Solids (TSS %): Hand Refractometer (LCD digital model) was used to determine TSS%. A drop of the fruit extract was placed on the prism of digital Refractometer and the total soluble solids values were read in °Brix (1).

4-Non soluble solids (NSS %) = TS% - TSS%.

5-Ear length (cm) calculated by digital vernier calipers.

RESULTS AND DISCUSSION

No. of days required to 50% tasseling and 50% silking:

At both locations, there was not significant differences in number of days required to 50% tasseling and to 50% silking, among sweet corn varieties and effect of nitrogen levels, but the growth period to 50% tasseling was between (60.000 to 63.556) days recorded by varieties (V_2 and V_3) respectively, and the period to 50% silking was between (73.000 to 74.333) days showed by ($V_4$and V_3), respectively in Bakrajo (Tables 1 and 2). at periods to 50% tasseling and 50% silking in Kanipanka were much shorter than Bakrajo in which number of required days to 50% tasseling was between (52.111 and 56.333)days recorded by (V_1 and V_3),respectively, while the length of the period to 50% silking was between (67.222 to 69.444) days shows by (V_4 and V_2), respectively (Tables 3 and 4), Indicating to a great effect of climatic conditions of the two locations on growth performance of sweet corn varieties. The results are also similar to those obtained by other researchers (14, 16). Effect of nitrogen levels showed no significant differences at both locations as well as the lowest variations, especially in the number of days to 50% silking at Bakrajo which was between (73.167 to 74.417)days, but shorter period for these two stages was noticed at Kanipanka (52.750 to 54.833)days and (68.166 to 68.833) days.

Plant fresh and plant dry weights:

Effect of sweet corn varieties and nitrogen levels on plant fresh weight which represents plant biological yield showed no significant differences in both locations, but there were variations among varieties. At Bakrajo, the plant fresh weight ranged from (460.444 to 606.778 g) recorded by (V_1 and V_4), respectively, while at Kanipanka, it was ranged from (908.888 to 1186.556 g) shown by (V_4 and V_3),respectively, that directly affected plant dry weight which in Kanipanka showed higher value between (115.555 and 138.555 g) by (V_4 and V_1),respectively in compare to lower range in Bakrajo (84.889

and 110.778 g)that shown by varieties(V_1 and V_3),respectively (4). Higher fresh and dry weights of plant in Kanipanka reveal the positive response of sweet corn varieties to higher temperature and humidity of Kanipanka during vegetative growth in April and May. Levels of nitrogen were non significantly affectedon both plant fresh weight and plant dry weight at both locations, although highest dry weight was recorded under the effect of level N_3 at both locations, results were in agreement with (21).

Leaf Area Index (LAI):

Tables 1 and 2, reveal variations in leaf area index among four sweet corn varieties at both locations, in which the higher means of LAI of all varieties at Kanipanka in compare to Bakrajo is considered as clear indication to larger area of photosynthesis that led increase in gross photosynthesis and greater biomass and better growth performance of all varieties in this location if the respiration means will not rise under the effect of higher day-night temperature, because temperature is the most important among all environmental factors that influence the rate of plant development(17). The value of LAI in Bakrajo was between (1.442 to 1.722) by varieties (V_1 and V_3) respectively, while higher value at Kanipanka was ranged between (2.583 to 3.268) by varieties (V_1 and V_2) respectively, differences in LAI between genotypes were reported previously by researchers such as (3). Effect of nitrogen levels on LAI was no influenced significantly at both locations with higher value at Kanipanka which was between (2.719 to 2.953)by the effect of N_3 and N_2 respectively while at Bakrajo was between (1.308 to 1.558) for N_3 and N_1 respectively.

Moisture content, TS%, TSS%, NSS%, and Ear Length:

Moisture content is an important character for marketing, according to the data shows in theTables 1 and 2, the M% of harvested ears was between (59.9% to 65.9%)recorded for (V_3 and V_1) at Bakrajo, while higher moisture content was recorded at Kanipanka(68.137% to 73.080%) for (V_1 and V_4)respectively, with significant differences among sweet corn varieties, in which V_4 exceeded others by 73.080% at this location, the M% in Kanipanka was in accordance to standard levels(18). There were significant differences among sweet corn varieties in studied criteria TS%, TSS%, in both locations, while significant differences of NSS% was at Bakrajo only. As showsinTables 1 and 2, TS% recorded by V_3(40.152%)was exceeded other varieties at Bakrajo,while at Kanipanka the superiority was back to V_1 by (31.418%), relatingto TSS% , the exceeding was gained by V_1 at both locations by (21.600% and 18.105%) respectively, but V_2 exceeded significantly in NSS% in compare to other varieties in Bakrajo by (24.265%) and minimum value was shown by V_1 which was (11.208%), the resultsof studied criteria TS%, TSS% and NSS% were greater in Bakrajo than Kanipanka, that may related to higher moisture content of sweet corn kernels(68.137% to 73.080%) in Kanipanka. There were significant differences of effect of levels of nitrogen on TSS% and NSS% at Kanipanka, in which the highest effect shows by N_1 exceeding other levels by 17.600%, while N_3 was with the minimum effect recording (14.158%), but the superiority of level N_3 was in NSS% criteria by (15.130%) and minimum value of NSS% was recorded under the effect of N_1 which was (11.449%). Sweet corn size is determined either by the length of the cob with or without husk, as showsin Tables 1 and 2, the length of ear of four sweet corn varieties at Bakrajo was between (20.566 to 22 033 cm) produced by (V_1 and V_3) respectively, but under the effect of nitrogen levels, the range was between (20.050 to 22.169 cm) shown by (N_3 and N_2)levels respectively, while this range at Kanipanka was between (20.633 to 23.688 cm) registered by (V_4 and V_3)respectively and between (21.150 to 21.883 cm) under the effect of (N_3 and N_1) levels, ear products of four sweet corn varieties were classified as size number[1]according to(12) classification of length of sweet corn ear with husk (8).

Fresh yield

Tables 1 and 2 indicate to significant differences among all the varieties in both locations, means of fresh yield of all varieties were between 9887.500 to 13027.500 kg.ha^{-1} by varieties V_3 and V_1 respectively at Bakrajo which was lower than at Kanipanka that ranged between 14802.500 to 16452.500kg.ha^{-1} by varieties V_3 and V_4 respectively. Effect of nitrogen levels on fresh yield was not significant at both locations, results agree withthe results of other Researchers (8,10,13, 15,21).

The Interactions

Tables 5, 6, 7 and 8 reveal the effect of interactions between four sweet corn varieties and three different nitrogen levels on the studied criteria at both locations. There were significant differences of effect of interactions between the two treatments in some studied criteria at Bakrajo. The interaction (V_2N_3), exceeded other interactions in TS% and NSS% by (45.206 and 27.906%), respectively, while the interactions (V_1N_3 and V_3N_2) showed

Table (1). Effect of sweet corn varieties and nitrogen levels on vegetative characters inBakrajo

Treatments	No. of days 50% Tasseling	No. of days 50% Silking	Plant fresh Wt.(g)	Plant Dry Wt. (g)	LAI
V1	62.667a	74.111a	460.444a	84.889a	1.442a
V2	60.000a	73.667a	516.111a	93.222a	1.722a
V3	63.556a	74.333a	555.667a	110.778a	1.555a
V4	62.444a	73.000a	606.778a	85.667a	1.562a
N1	61.000a	73.167a	542.417b	72.667a	1.552a
N2	61.333a	73.750a	537.250a	102.750a	1.430a
N3	64.167a	74.417a	524.583a	105.500a	1.308a

Table (2). Effect of sweet corn varieties and nitrogen levels on some quality related characters in Bakrajo

Treatments	M%	TS%	TSS%	NSS%	Ear Length (cm)	Ear Fresh Yield (Kg.ha^{-1})
V1	65.880a	32.808b	21.600a	11.208b	20.566a	13027.500a
V2	59.968a	40.032a	15.766b	24.265a	21.211a	10277.500a
V3	59.847a	40.152a	19.466ab	20.686ab	22.033a	9887.500a
V4	61.986a	38.013ab	18.533ab	19.480ab	20.836a	11195.000a
N1	61.343a	38.656a	21.108a	17.548a	21.266a	10832.500a
N2	60.278a	39.721a	18.625a	21.096a	22.169a	11062.500a
N3	66.790a	33.021b	17.791a	17.084a	20.050a	11395.500a

Table (3). Effect of sweet corn varieties and nitrogen levels on vegetative characters in Kanipanka

Treatments	No. of days 50% Tasseling	No. of days 50% Silking	Plant fresh Wt.(g)	Plant Dry Wt. (g)	LAI
V1	52.111a	68.777a	942.778a	138.555a	3.268a
V2	54.555a	69.444a	1186.667a	137.888a	2.583a
V3	56.333a	68.777a	1005.556a	124.222a	2.683a
V4	53.333a	67.22a	908.888a	115.555a	2.759a
N1	54.833a	68.666a	955.000a	115.833a	2.783a
N2	54.666a	68.833a	967.000a	125.083a	2.953a
N3	52.750a	68.166a	1110.417a	146.250a	2.719a

The minimum value of these two criteria that related to quality recording (32.270 and 13.183%),respectively, but the interactions (V_3N_2 and V_1N_3) showed superiority in criteria TSS% and fresh yield by (25.800 and 14667.500 kg.ha^{-1}),respectively, and the minimum percentage of the TSS% was recorded by (V_2N_2)interaction which was (13.200%), while the lowest fresh yield was shown by the interaction (V_3N_1) yielding 8250 kg. ha^{-1}.

Table (4). Effect of sweet corn varieties and nitrogen levels on some quality related characters in Kanipanka

Treatments	M%	TS%	TSS%	NSS%	Ear Length (cm)	Ear Fresh Yield ($Kg.ha^{-1}$)
V1	68.137b	31.418a	18.105a	13.312a	20.644a	16415.000a
V2	70.486ab	29.531ab	16.170ab	13.35a	21.266a	16137.500a
V3	71.366ab	28.633ab	16.122ab	12.511a	23.688a	14802.500a
V4	73.080a	26.920b	14.166b	12.753a	20.633a	16452.500a
N1	70.950a	29.049a	17.600a	11.449b	21.883a	14812.500a
N2	70.627a	29.038a	16.970ab	12.367ab	21.641a	16515.000a
N3	70.711a	29.289a	14.158b	15.130a	21.150a	16527.500a

Table (5).Effect of Interaction between sweet corn varieties and levels of nitrogen on vegetative characters inBakrajo

VxN	No. of days 50% Tasseling	No. of days 50% Silking	Plant fresh Wt.(g)	Plant Dry Wt. (g)	LAI
V1N1	61.333a	73.000a	449.338a	81.333a	1.620a
V1N2	61.333a	74.667a	538.000a	84.333a	1.393a
V1N3	65.333a	74. 667a	394.000a	89.000a	1.321a
V2N1	57.333a	73. 667a	516.000a	86.667a	1.411a
V2N2	57.333a	74. 333a	483.000a	94.333a	1.150a
V2N3	65.333a	73. 000a	549.333a	98.667a	1.700a
V3N1	64.667a	73. 000a	544.000a	67.333a	1.700a
V3N2	65.333a	74. 667a	556.333a	133.333a	1.542a
V3N3	60.667a	75. 333a	566.667a	131.667a	1.430a
V4N1	60.667a	73. 000a	660.333a	55.333a	1.485a
V4N2	61.333a	71. 333a	571.667a	99.000a	1.660a
V4N3	65.333a	74. 667a	588.333a	102.667a	1.542a

At Kanipanka, the effect of the interactions between the two treatments did not reach the significantdifferences except on the criteria TSS%, in which the superiority was to V_2N_1 by (21.500%) and the lowest value (11.433%) was shown by the interaction (V_2N_3). There were differences in response of four sweet corn varieties to the three nitrogen levels in the two locations, there were positive responses to nitrogen levels N_2 and N_3 in Bakrajo, as shown in (V_2N_3, V_3N_2 and V_1N_3), however, at Kanipanka, the situation was not similar which may be related to higher fertility of Kanipanka soil and climatic conditions (6).

Table (6). Effect of Interaction between sweet corn varieties and levels of nitrogen on some quality related characters and ear fresh yield in Bakrajo

VxN	M%	TS%	TSS%	NSS%	Ear Length (cm)	Ear Fresh Yield ($Kg.ha^{-1}$)
V1N1	65.390a	32.610b	25.566ab	18.044ab	23.366a	13082.500ab
V1N2	60.453a	39.546a	21.366abc	18.180ab	19.600a	11332.500ab
V1N3	66.396a	32.270b	17.866abc	20.770ab	18.733a	14667.500a
V2N1	64.706a	35.293ab	16.800abc	18.493ab	22.266a	10332.500ab
V2N2	60.406a	39.593a	13.200c	26.393a	21.933a	11250.000ab
V2N3	54.793a	45.206a	17.300abc	27.906a	19.433a	9250.000ab
V3N1	57.746a	42.253a	18.133abc	24.120a	20.833a	8250.000b
V3N2	61.016a	38.983a	25.800a	13.183b	23.733a	11000.000ab
V3N3	60.780a	39.220a	14.466abc	24.753a	21.533a	10415.000ab
V4N1	66.530a	33.470ab	19.933abc	13.536b	18.600a	11665.000ab
V4N2	59.236a	40.763a	14.133bc	26.630a	23.410a	10665.000ab
V4N3	60.193a	39.808a	21.533abc	18.273ab	20.500a	11250.000ab

Table (7). Effect of Interaction between sweet corn varieties and levels of nitrogen on vegetative characters in Kanipanka

VxN	No. of days 50% Tasseling	No. of days 50% Silking	Plant fresh Wt.(g)	Plant Dry Wt. (g)	LAI
V1N1	57.000a	67.000a	930.000a	142.333a	3.176a
V1N2	54.666a	69.333a	940.000a	127.333a	3.371a
V1N3	44.666a	70.000a	958.333a	146.000a	3.259a
V2N1	56.333a	70.000a	1323.333a	137.666a	2.501a
V2N2	52.333a	68.666a	1113.333a	118.000a	2.525a
V2N3	55.000a	69.666a	1123.333a	158.000a	2.725a
V3N1	54.333a	69.333a	823.333a	102.333a	2.675a
V3N2	57.333a	69.000a	996.666a	131.333a	2.854a
V3N3	57.333a	68.000a	1196.666a	139.000a	2.525a
V4N1	51.666a	68.333a	743.333a	81.000a	2.802a
V4N2	54.333a	68.333a	820.000a	123.666a	3.094a
V4N3	54.000a	65.000a	1163.333a	142.000a	2.404a

Table (8). Effect of Interaction between sweet corn varieties and levels of nitrogen on some quality related characters and ear fresh yield inKanipanka

VxN	M%	TS%	TSS%	NSS%	Ear Length (cm)	Ear Fresh Yield ($Kg.ha^{-1}$)
V1N1	69.973a	30.026a	20.266a	9.760a	21.666a	16950.000a
V1N2	67.081a	31.585a	18.350ab	13.235a	20.300a	16825.000a
V1N3	67.356a	32.643a	15.700ab	16.943a	19.968a	15475.000a
V2N1	67.196a	32.803a	21.500a	11.303a	23.533a	14965.000a
V2N2	73.390a	26.610a	15.600ab	11.010a	21.266a	16365.000a
V2N3	70.820a	29.180a	11.433b	17.746a	19.000a	17082.500a
V3N1	72.576a	27.423a	14.066b	13.356a	23.000a	12640.000a
V3N2	68.510a	31.490a	18.566ab	12.923a	23.500a	17307.500a
V3N3	73.013a	26.986a	15.733ab	11.253a	24.566a	14457.500a
V4N1	70.056a	28.944a	14.566ab	13.376a	19.333a	14690.000a
V4N2	73.530a	26.470a	14.166ab	12.303a	21.500a	15565.000a
V4N3	71.653a	28.346a	13.766ab	14.580a	21.066a	19100.000a

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SOIL SCIENCE

EFFECTS OF BIOCHAR AND *STENOTROPHOMONAS MALTOPHILIA* (SB16) ON SOIL PROPERTIES AND GROWTH OF SWEET CORN

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ABSTRACT

Laboratory and glasshouse studies were conducted in the Faculty of Agriculture, University Putra Malaysia during in the year 2014 to determine the effect of empty fruit bunch biochar and nitrogen-fixing bacteria *Stenotrophomonas* sp. (Sb16) on soil microbial populations, enzymes, mineral composition and growth of sweet corn. Five rates of biochar (0, 0.25, 0.5, 0.75 and 1%) were applied to sterilized and non-sterilized soil either with or without bacteria Sb16 and incubated for 40 days under laboratory condition. The treatment was arranged in a complete randomized design with three replications. Sweet corn was grown in pots containing 6 kg soil and applied with five levels of biochar (0, 5, 10, 15 and 20 t/ha) either with or without bacteria Sb16. The factorial experiment was organized in a randomized complete block design, with five replications. Results of laboratory study showed that application of biochar at 0.5 percent without inoculation and 0.25 percent with bacteria Sb16 in both soils significantly increased population of soil bacteria, fungi, actinomycetes and N_2-fixing bacteria, enzymes (urease, acid phosphatase and fluorescein diacetate hydrolysis activity), and soil chemical properties (pH, organic C, total N, available P and exchangeable K, Ca and Mg. Glasshouse experiment showed that application of biochar at 5 tons per hectare with bacteria inoculated significantly ($P<0.05$) improved growth of corn (shoot and root biomass, root length, root volume, plant height and leaf chlorophyll content). The biochar (5 t/ha) and bacteria (Sb16) stimulated soil quality and growth of sweet corn. Addition of high rates of biochar to soil negatively affected all observed parameters. Addition of biochar to soil with N_2-fixing bacteria may be an alternative solution in improving nutrients, enzymes and diversity of microorganisms in soil and thus led to improve plant growth.

Keywords: ***Zea mays rugosa; Zea mays saccharata;*** **sweet corn; EFB biochar; N_2-fixing bacteria; *Stenotrophomonas* sp; corn growth; Malaysia.**

INTRODUCTION

Sustainable agriculture provides environmental and economic impacts on conserving natural resources and protecting the environment. New term of biochar is naturally occurring in some of the highly fertile soils in the world and gives large crop yields and enhances soil fertility despite the fact that surrounding soils are infertile. However, infertile soil can be ameliorated effectively by applying liming material, organic matter, bio-fertilizer, biochar or other amendments. In order to control infertile soil, soil properties need to be substantially improved. Application of oil palm waste into soil can be an alternative to improve soil fertility. Empty fruit bunch (EFB) has been turned to EFB biochar roughly 20 tons/day by a Nasmeck company in Malaysia (28). A farmer will gain a profit from biochar, when biochar amendment replaces agricultural lime or the profit of crop production given with biochar application as a substitute for lime, on the other hand, getting a benefit will depend on the price of biochar (33, 35).

Countries in different parts of the world have a long history with using biochar in sustainable agricultural soils. Biochar was produced by ancient, indigenous human habitation; these areas still remain highly fertile soils despite centuries of leaching from heavy tropical rains, due to the incorporation of large amounts of biochar into these soils (7, 14). Studies should that chemical changes in the soil are central to the darkening of these soils stimulated soil physicochemical properties, microbial and enzymes activity and thus causing in soil quality and yield production (13, 37). Biochar has the potential to offer multiple environmental benefits where they do not only contribute to carbon storage, but at the same time act as a soil amendment (11, 19). Biochar is applied to soil as intention to improve a range of soil physical properties including; pore-size distribution, total porosity, soil density, water holding capacity and soil moisture content (2, 36). Biochar is becoming a popular alternative to organic amendments that are being applied to soils to increase soil nutrient (20, 23). The addition of biochar to highly leached and infertile soils has shown to give an almost immediate increase in the availability of basic cations (14, 33), and a significant improvement in crop yields (21). Agricultural wastes are important in soil agro-ecosystems as these are able to provide plant nutrients such as C, N, K, P, Ca, and Mg. Comprehending interactions between biochar and application conditions, soil texture, organic matter (OM), macronutrients and soil pH will be a main factor in deciding long-term influences of biochar application on soils.

Enzymes are proteins produced by soil microbial community that allow to involve in innumerable reactions to proceed at faster rates by reducing the energy and soil organic matter as well as nutrient cycling (22, 34). Soil enzymes, such as urease, phosphatase and fluorescein diacetate hydrolysis activity (FDA) play an important role in decomposition of organic matter, nutrient cycling for microbial activity and plant nutrient uptake (19). However, enough information is not available on the short-and longer-term influences of biochar on soil enzyme activities.

Biochar has potential to absorb organic and inorganic molecules in a wide range, may provide a mechanism to protect these enzymes (21, 37), but in general, there is a little information exist of the possible impacts of biochar on soil enzymes. Biochar has been reported as a possible means to improve soil nutrient and biological activity (43), enhancing soil microbial population (17). Biochar can amend soil habitat due to interactions with soil mineral, organic matter and microbial oxidation (10, 30). However, the relationships between chemical and physical properties of biochar and their influences on soil microbial activity and probable concomitant impacts on soil processes are poorly understood.The potential benefits of using biochar for agricultural soils and crop production have received significant attention from researchers in recent years. Biochar can be applied as means as a soil amendment to enhance soil fertility and crop production in a wide range of soils (3, 33). A pot experiment (20) recorded that addition of biochar increased biomass of rice and cowpea. These findings may relate to level of nutrient in organic soil amendment. The effect of biochar application on sweet corn and soybeans also resulted in the greatest dry root biomass weight in mineral soil (36). Also in a four year field study, yields of maize grain increased upto 140 percent on a Colombian savanna Oxisol (23). Increased nutrient retention by biochar may be the most important factor for increasing crop yields on infertile acid soils (1, 11).

From the limited information available, no optimum range or type of biochar application has been produced to improve plant productivity. Biochar from many sources of biomass can be produced through the pyrolysis process in the absence of oxygen and high temperature. Different types of biochar have different characteristics depending on the feedstock and pyrolysis conditions. All biochar production is not equal or unique. Quite the contrary, different types of biochar havewidely different physical, chemical and biological specifications that may have an important effect on the opportunities of application in the field (44).In Malaysia, there are two potential biomasses from industrial wastes that can be used as biochar; oil palm empty fruit bunches and rice husks (RH). It is reported that around 20 million tonnes of EFB was produced annually during the processing in the mills and number is expected to increase greatly by the year. In Malaysia, the chemical characterization of EFB biochar showed that total C, pH, CEC and other substantial amounts of micro-nutrients are mostly higher than other types of biochar (27). Biochar may be added to soils with the intention to improve soil functions and plant growth as well as appreciable carbon sequestration value. In addition, the conversion of EFB biomass to biochar can be an alternative to the sustainable management of the industrial waste. However, there is very limited information on the properties of commercial EFB biochar produced in Malaysia to be used as soil amendments in remediating contaminated soil. Malaysian soils are mostly acidic or infertile soil that affects soil quality and plant growth. Acid soils are limiting crop production in 30-40% of the world's arable land and are a major growth-limiting factor for plants in many parts of the world (34).Tropical soils are most common where high precipitation, free drainage favors leaching, biological production of acids and the low population of indigenous microorganisms (34).Tropical soil can be ameliorated effectively by applying liming material, organic matter, bio-fertilizer, biochar and other amendments (41). Other than biochar, bio-fertilizer or beneficial inoculation, such as N_2-fixing bacteria can be used to ameliorate soil fertility by fixing N and transferring nutrients in soil (15, 25). Several crops such as rice, wheat and maize need 20 to 40 kg soil N per hectare to satisfy the N requirements for each tonne of grain produced (31). To face such large demand, farmers must apply inorganic N fertilizers that have negative environmental effects or rely on beneficial microbes such as biological nitrogen fixation (BNF) and the input of organic wastes, such as manure or biochar. Two types of nitrogen fixing bacteria are known: free-living (non-symbiotic) bacteria, such as cyanobacteria and Azotobacter with cereal crops (wheat, rice and corn) and symbiotic bacteria associated with leguminous plants (9, 12). Several of soil bacteria responsible or capable for transforming atmospheric N_2 into ammonium (NH_4), which is a form of N that can be used directly by plants. Nitrogen cycling in natural ecosystems relies by N_2-fixing bacteria for agricultural production. N_2-fixing bacteria produce nitrogen, which is much more effective and less costly to improve plant growth. However, free-living N_2 bacteria in the soil may provide substantial amounts of nitrogen (0 to 60 kg N/ha/ year) (7, 17). This could be important in organically amended soils, which typically have a lower proportion of nitrogen in available forms.

EFB biochar can be applied with free-living N_2 fixing bacteria to improve soil fertility, microbial activity and plant growth. Therefore, this study was conducted to investigate the effect of soil sterilization, oil palm EFB biochar as a soil amendment and N_2-fixing bacteria *Stenotrophomonas sp.* Sb16 on soil enzyme activity, indigenous microbial population, chemical properties and growth of sweet corn.

MATERIALS AND METHODS

Soil and EFB biochar preparation: A Laboratory and glasshouse experiments were carred out in the faculty of Agriculture, University Putra Malaysia (UPM) during the year 2014. The soil samples were collected randomly from UPM farm top soil (0 - 15 cm depth). Soil samples were air-dried for five days, ground and sieved through (2.00 mm) mesh for laboratory and (4.00mm) mesh for glasshouse study. The EFB biochar was made from an empty fruit bunch of oil palm which was provided by Nasmech Sdn. Bhd., Selangor. This biomass was gone through the pyrolysis process between 350-450 ^{0}C to produce EFB biochar. The soil and EFB biochar were analyzed for their chemical characteristics and the results are shown in Table 1.

Preparation of free- living N_2-fixing bacteria: The bacterial culture of *Stenotrophomonas sp.* (Sb16) was used for soil inoculation (30). The bacteria were obtained from Faculty of Agriculture, UPM. The strain was sub-cultured in 100 ml Erlenmeyer flask with Jensen's N-free broth and shaken continuously for 36 h (100 rpm at 28 ^{0}C) (30), until reaching approximately 10^8 (cfu / ml).

Laboratory experiment: Five rates of oil palm EFB biochar (0, 0.25, 0.5, 0.75 and 1%) were applied to sterilized and non-sterilized soil. Each conical flask contained 150 g of sterilized or non-sterilized soil with different levels of EFB biochar (0, 0.375, 0.75, 1.125 and 1.5 g) were mixed properly. Bacterial treatments in both soils were inoculated with one ml 10^{8} (cfu) N_2-fixing bacteria Sb16. The flasks were covered with aluminum foil and incubated for 40 days at room temperature. Factorial study was conducted using a completely randomized design with three replications. The soil was analyzed for microbial populations, enzyme activity and chemical properties.

Glasshouse experiment: The soil and EFB biochar used in this study was sieved (2.00 mm) before mixing them thoroughly. Six kilogram of the soil was mixed thoroughly with EFB biochar at five rates (0, 5, 10, 15 and 20 t / ha) and placed in drained pots, either in the presence or absence of N_2-fixing bacteria (Sb16). The soil and EFB biochar mixture in pots were incubated for 20 days to interact with soil before planting with corn. Uniformly sized grain corn seeds were used. Five seeds were planted into the soil at 5.0 cm below. One ml 10^{8} (cfu/ml) of N_2-fixing bacteria (Sb16) was applied to each seed of bacterial treatments. All pots were watered daily. When the seeds had germinated, only one seedling in each pot was left to grow. Then, the recommended rate of N, P and K fertilizers for corn cultivation was applied uniformly in all the treatments after two weeks of sowing in the form of urea (60 kg / ha), triple superphosphate (TSP) (60 kg / ha) and muriate of potash (MOP) (90 kg / ha), respectively. The treatments were arranged in RCBD, with five replications. The corn plants were harvested at tasseling stage and the parameters of tops and roots were recorded before they were oven.

Chemical analysis of soil and EFB biochar: The pH soil and EFB biochar were determined using the Beckman Digital pH meter in a 1:2.5 (w/v) for soil and 1:10 (w/v) for EFB biochar: water ratio (27). Determination of organic C was done on the LECO CR-412 carbon Analyzer using combustion method (25).Total N was determined according to Kjehdahl Method (6). Available phosphorus was found using Bray II Method (4) and analyzed by Auto Analyzer (Lachat instruments, Quik Chem® FIA+ 8000 series). Determination of CEC, K, Ca and Mg in soil was determined by using a leaching method (5, 16) and analyzed by an atomic absorption spectrophotometer (AAS) (Perkin Elmer, 5100 PC), but for total elements in biochar was done by digesting EFB biochar technique (27).

Measurement of leaf chlorophyll content from a hand-help SPAD-502 Meter: Absolute chlorophyll concentration measurements by SPAD meter makes simple, rapid, and non-destructive measurements provide a relative indication of leaf chlorophyll concentration compared to the extraction methods. Sweet corn leaf tissue for these measurements was determined by taken three times for each leaf and average calculated at tasseling stage.

Determination of plant growth parameters

The plant height was first measured before harvesting. The plant height was measured by a standard ruler from the growth media surface to tip of the main stem. The measurement of plant height was expressed as centimeter (cm). Five plants were harvested from each treatment and separated into root and shoot. Combination of stem and leaves part was considered as part of shoot. After separation of the plant parts, it was dried individually under sunlight for one day and then oven dried at 65 ^{0}C for 48 h. The shoot and root dry part was recorded by using digital balance (QC 35EDES- Sartorius- Germany). The dry weight of the root and shoot were presented as gram (g). Root volume was also determined using water cylinder for counting the volume of each root (8).

Root scanning: After harvesting the plants from the pots these were enclosed in a plastic bag immediately to prevent the dehydration, washed carefully with tap water and separated into shoot and root to the root growth. After root being washed, the root was prepared for the determination of root length by scanning using a root scanner (Model Epsom Expression 1680) which is connected to a computer program Win RHIZO 2007. To do this test, fine electrical wire of three different diameters was cut. Scan the segments and tooks as many scans as possible with a total lengths and of segments with different diameters. Finally root length was calculated by WinRHIZO against actual root length.

Soil microbial populations: Soil microbial community (bacteria, fungi, actinomycetes and N_2-fixing bacteria) were determined using 10 g of fresh soil following the dilution plate technique (28). A 100 µl of sample at selected dilutions was transferred onto Nutrient agar (NA) for bacteria, Rose Bengal Streptomycin Agar (RBSA) for fungi (24), Actinobacteria isolation agar (A.A) for actinomycetes and N_2-free media for NFB. The colonies were counted as colony forming unit (cfu) dry soil^{-1}, and then transformed to log^{10} values for statistical analysis.

Determination of soil enzyme activity: Soil samples were air-dried and sieved through 2 mm. Soil phosphatase activity was determined as described earlier (39). Soil urease activity was determined as described by Tabatabai and Bremner (40). Fluorescein diacetate hydrolysis Assay (FDA) was conducted for measuring the enzyme activity of microbial populations and can provide an estimate of overall microbial activity in an environmental sample (27).

Statistical analysis: The data were recorded and analyzed using analysis of variance 2 way (ANOVA) by Statistical Analysis System (SAS) version 9.3 for Windows. The significant difference of treatment means was checked by the Tukey's General Linear Model Test (GLM) at the 5 percent level.

RESULTS AND DISCUSION

Chemical characterization of EFB biochar and soil

The chemical composition of soil and EFB biochar are listed in Table 1. Soil is acidic soil, while the oil palm EFB biochar is alkaline pH (pH 9.39) and it was abundantly higher than soil.The EFB biochar had almost 26 times higher of total carbon content, 8 times of CEC and 16 times of value total N than soil sample. EFB biochar was found to contain substantial amounts of nutrients with high concentration of K, Ca and Mg.

Table 1. The chemical analysis of soil and EFB biochar

Properties	Soil	EFB biochar
pH	4.6	9.39
Carbon %	2.01	52
Total N %	0.1	1.58
Available P (mg / kg)	34	--
Total P %	--	0.22
Exch K (cmol $_{(+)}$ / kg)	0.2	--
Total K %	--	4.9
Exch Ca (cmol $_{(+)}$ / kg)	23.	--
Total Ca %	--	0.11
Exch Mg (cmol $_{(+)}$ / kg)	0.8	--
Total Mg %	--	0.14
CEC (cmol $_{(+)}$ / kg)	8.1	63.2

Laboratory study

Effects of soil sterilization, EFB biochar and N_2-fixing bacteria (Sb16) on soil microbial populations: Indigenous soil bacteria, fungi, actinomycetes and N_2-fixing bacteria significantly ($P<0.05$) increased and associated with EFB biochar and N_2-fixing bacteria Sb16 application in sterilized and non-sterilized soil (Fig. 1). EFB biochar amended soil was observed to stimulate the soil microbial community. In sterilized soil, addition of EFB biochar at 0.25% positively improved soil bacteria, fungi and NFB populations, while higher actinomycetes were found at 0.5%. All EFB biochar treatments were better than no biochar rate (control). In non-sterilized soil, EFB biochar at 0.25% positively responded soil fungi activity, while the others were found at 0.5%. Application of EFB biochar at 0.5% was given the highest populations of microbes, but combining N_2-

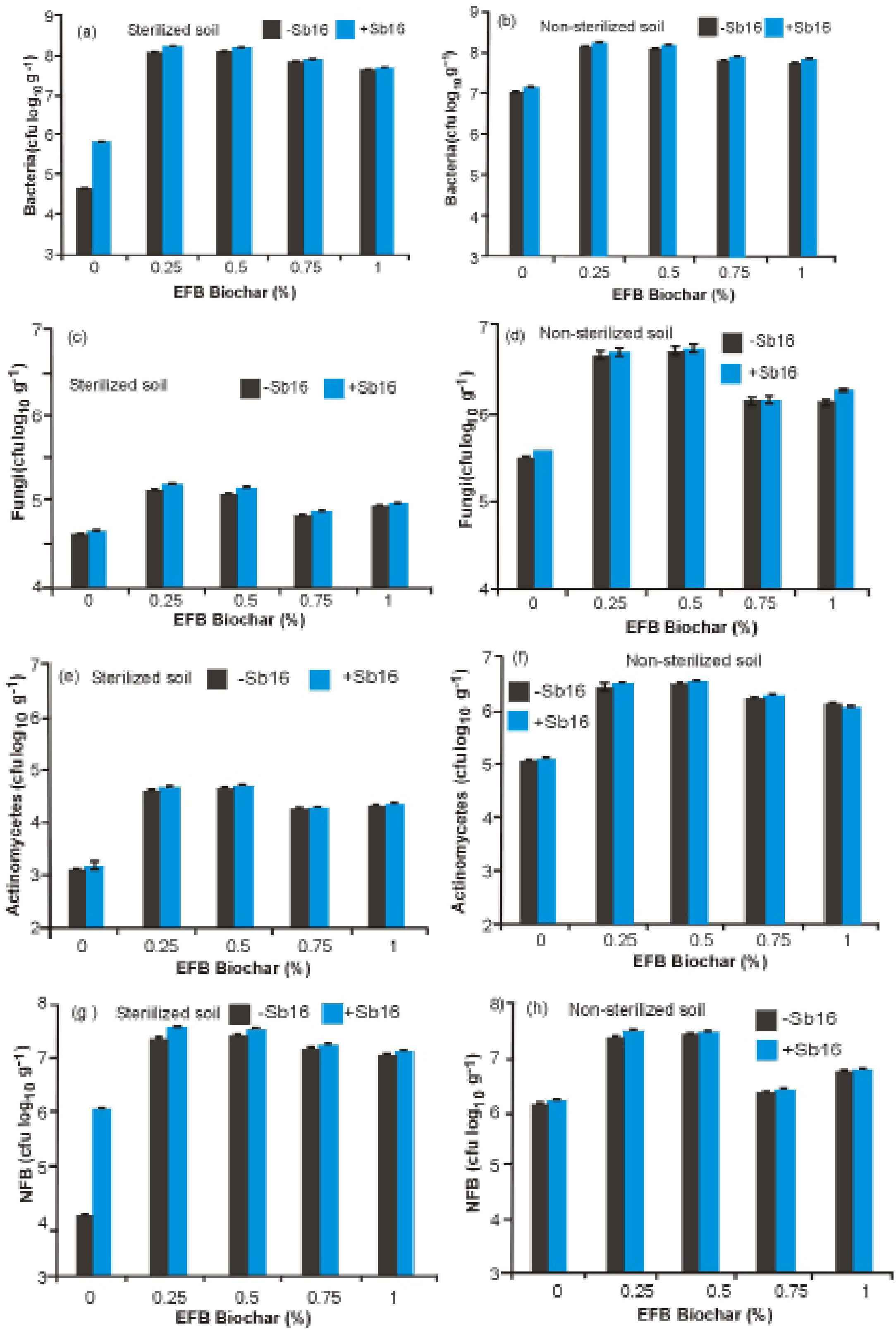

Fig. 1. Effect of soil sterilization, EFB biochar and N_2-fixing bacteria (Sb16) on soil bacteria, fungi, actinomycetes and N_2-fixing bacterial populations.
Vertical bars represent S.E. of means followed by the same letter or not significantly differnet at P ≤ 0.05.

Sterilized soil	Bacteria	Fungi	Actinomycetes	N_2-fixing bacteria
EFB Biochar	0.0001*	0.0001*	0.0001*	0.0001*
Sb16	0.0001*	0.0001*	0.0014*	0.0001*
EFB Biochar*Sb16	0.0001*	0.1722^{ns}	0.4958^{ns}	0.0001*
Non-sterilized soil	**Bacteria**	**Fungi**	**Actinomycetes**	**N_2-fixing bacteria**
EFB Biochar	0.0001*	0.0001*	0.0001*	0.0001*
Sb16	0.0001*	0.0001*	0.0001*	0.0001*
EFB Biochar*Sb16	0.0008*	0.0039*	0.0003*	0.0200*

Means in each column for each variable do not significantly differ according to Tukey's test at 5%.

fixing bacteria Sb16 with oil palm biochar at 0.25% significantly improved soil microbial activities. Soil bacterial inoculation was better than non-inoculated. There was no interaction between the factors of soil fungi and actinomycetes in sterilized soil. The oil palm biochar at 0.25% and N_2-fixing bacteria Sb16 significantly enhanced soil microbial community, except the actinomycetes population responded more positively to EFB biochar at 0.5% and bacteria Sb16 in both soils. Lower microbial population was decreased with increasing EFB biochar rate. All EFB biochar treatments with and without bacteria Sb16 showed more effective than no biochar amended soil. Application of EFB biochar at 0.75% and 1% with and without bacteria inoculated adversely affected soil microbial activity. Enhancement population of microbes could be due to increase of pH and available nutrient in soil, which affected by EFB biochar and bacterial inoculation. Biochar may also have a suitable habitat to protect beneficial microbes from predators in soil. Some previous scientists (38, 39) were found that addition of biochar may contain growth promoting compounds and essential nutrition for microbial growth. Biochar has high surface area and porosity that enables it to retain nutrients and also provide a suitable habitat for beneficial microorganisms to flourish (43).The abundance bacteria in biochar amended soils might be attributed to the properties and characteristics of EFB biochar itself and soil. Rachel and Randey (30) reported that biochar is providing a suitable habitat, where indigenous microorganisms may escape from predators, as well as providing substrates to meet many of their diverse carbon, energy, and nutrient demands. EFB biochar is alkaline nature (pH 9.39) and has an important role to increase microbial activity in acidic soils by improving soil pH.

Effects of soil sterilization, EFB biochar and N_2-fixing bacteria (Sb16) on soil enzyme activity

EFB biochar and N_2-fixing bacteria Sb16 significantly ($P<0.05$) affected soil urease, phosphatase and fluorescein diacetate hydrolysis (FDA) activity in both soils (Fig. 2). There was no significant difference between oil palm biochar and N_2-fixing bacteria on soil phosphatase and FDA in both soils. Among all treatments, 0.5% EFB biochar resulted in higher value of enzymes activity in sterilized and non-sterilized soil. All EFB biochar rates proved to be more effective than no biochar rates (control). Organic amendment at 0.25% and N_2-fixing bacteria Sb16 differentially affected soil urease activity in sterilized and non-sterilized soil. The potential activity of EFB biochar at 0.5% and N_2-fixing bacteria Sb16 significantly improved soil phosphatase and FDA in both soils. Compared to the control, urease activity was higher in sterilized soil than non-sterilized, while soil phosphatase and FDA were better in non-autoclaved soil. The results showed that selected enzyme in soil significantly declined when EFB bochar rate increased. The N_2-fixing bacteria Sb16 decreased the high amount of EFB biochar to lower rate. Lower rate of EFB biochar with inoculation was sufficient to improve soil urease, phosphatase and FDA activity in soil. Organic carbon rich and free living N_2-fixing bacteria significantly impacted soil enzyme activity and were higher in non-sterilized soil than sterilized soil.

The research on the impacts of organic amendment in activities of soil enzymes is still scarce, although an influential number of articles have appeared lately. Biochar has the capacity to absorb a wide range of organic and inorganic molecules may provide a mechanism to protect enzyme's activity (22). Application of biochar amendment positively affected soil enzyme activities may be due to high pH, surface area, pore size distribution, and charge properties (17). Krull *et al.* (18) reported that when the organisms require for P increased, application of P in soil improved acid phosphatase activity. Organic carbon having abundant microorganisms can influence enzyme activity in soil and activity of N_2-fixing bacteria to improve N in soil that be a reason to enhance soil enzymes activity. When the chemical P fertilizer supply exceeded organism demand for P, the acid phosphatase activity was inhibited by P fertilizer. Asai *et al.* (1) reported that application of biochar was stimulated soil microbes which are widely produced some enzymes. Soil enzymes may positively influence soil quality and it is very important to understand the probable roles of soil enzymes in order to maintain soil health and its fertility management in ecosystems. The nutrients of soil are very important for plant growth which improved with EFB biochar and N_2-fixing bacteria application.

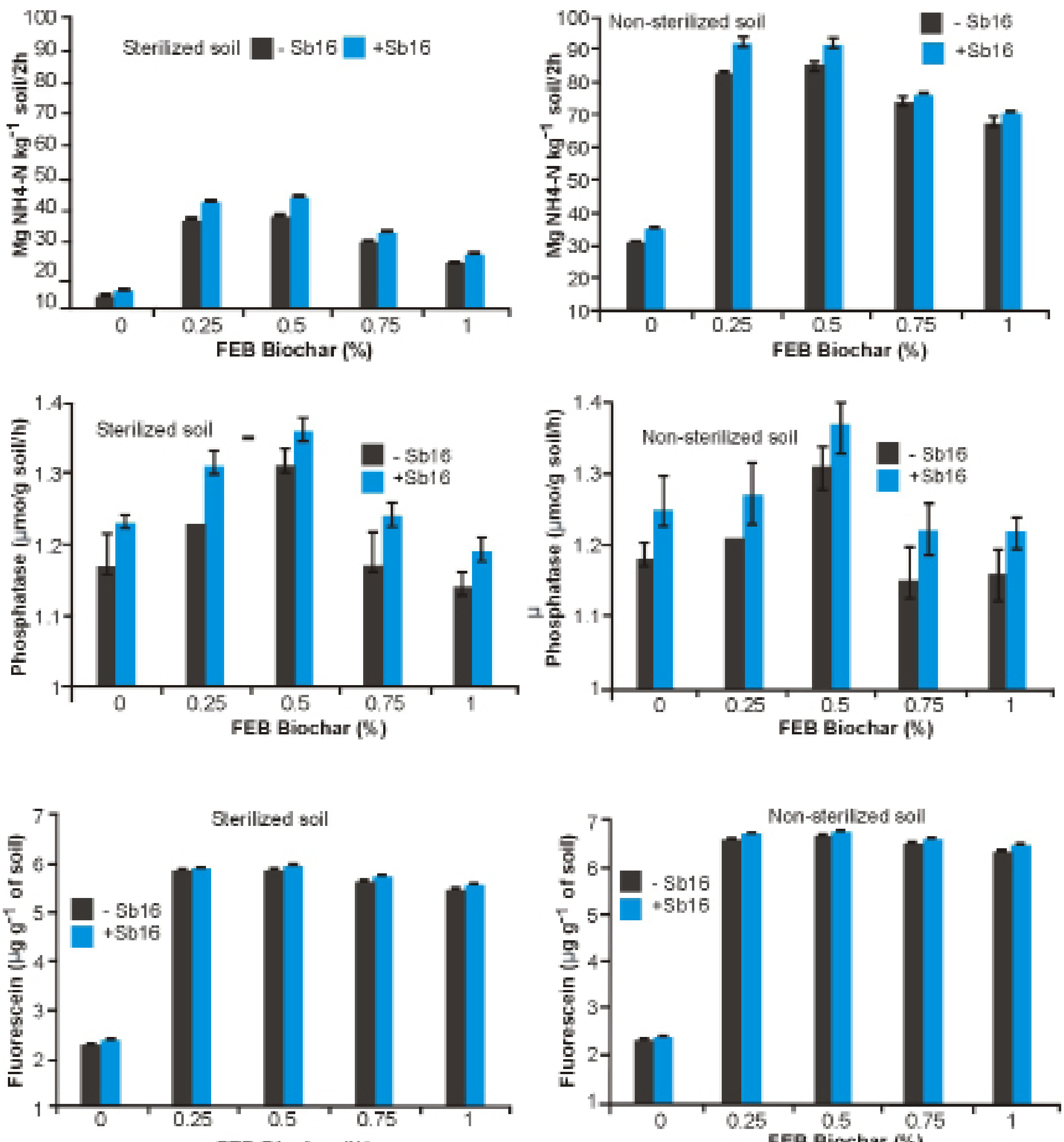

Fig. 2. **Effect of soil sterilization, EFB biochar and N_2-fixing bacteria in soil urease, phosphataseand FDA activity. Vertical bars represent S.E. of means followed by the same letter are not significantly different at (P ≤ 0.05).**

Sterilized soil	Urease	Phosphatase	FDA
EFB Biochar	0.0001*	0.0001*	0.0001*
Sb16	0.0001*	0.0001*	0.0001*
EFB Biochar*Sb16	0.0004*	0.8275^{ns}	0.9987^{ns}
Sterilized soil	**Urease**	**Phosphatase**	**FDA**
EFB Biochar	0.0001*	0.0001*	0.0001*
Sb16	0.0001*	0.0001*	0.0001*
EFB Biochar*Sb16	0.0304*	0.9905^{ns}	0.7258^{ns}

Means in each column for each variable are not significantly different according to Tukey 's test at 5%.

Effects of soil sterilization, EFB biochar and N_2-fixing bacteria (Sb16) on soil chemical properties

Application of oil palm biochar and N_2-fixing bacteria Sb16 in sterilized and non-sterilized soil significantly improved soil chemical properties (Table 2 and 3). Among all EFB biochar rates, 0.25% showed the highest value of exchangeable P and potassium K in sterilized soil, while the other chemical properties observed at 0.5% EFB biochar. Higher value of organic C and P was found at 0.25% EFB biochar in non-sterilized soil, while the others showed at 0.5%. There were no significant differences between oil palm biochar and N_2-fixing bacteria Sb16 of soil pH, organic C, total N and exchangeable K in sterilized soil and also no significant difference between bacteria Sb16 and EFB biochar on pH and P in non-sterilized soil. Bacterial inoculation was better than non-inoculated. The EFB biochar amendment at 0.25% and 0.5% and N_2-fixing bacteria Sb16 showed the highest value of soil chemical properties in both soils. Alkaline EFB biochar at 0.5% and bacteria Sb16 slightly improved soil pH in both soils. Soil pH was better in non-sterilized soil than sterilized soil. Higher soil pH (pH 5.8) was recorded at 0.5% EFB biochar and N_2-fixing bacteria Sb16 in non-sterilized soil (Table 3), while the lowest (pH 4.5) was observed at 0% EFB biochar rate in sterilized soil (Table 2). Applying of Alkaline EFB biochar the decreased soil acidity. Similar finding was noted by Martin (24) where improved soil pH with application of alkaline biochar.

Highest value of organic C was observed at 0.5% EFB biochar in non-sterilized soil, while the lowest was found at zero percent EFB biochar in sterilized soil. Addition of EFB biochar at 0.25% and bacteria Sb16 showed the highest value in both soils (2.78 and 3.19%). Organic C was higher in non-sterilized soil than sterilized soil. High total carbon (52% C) in EFB biochar can affect soil organic C in soils. Soil organic C increased may be explained by the carbon and energy substrates provided by biochar itself or remains in the soil as humus and dead microbial cells may also directly increase the soil organic C pool (27, 29).

EFB biochar amendment at 0.25% and N_2-fixing bacteria Sb16 application resulted in the highest total N in non-sterilized soil (0.22%) (Table 3). Combination of EFB biochar with bacteria Sb16 was more effective for total N in sterilized soil than non-sterilized soil. The increase of EFB biochar rate with or without bacteria Sb16 adversely affected the total N than that found at other treatments. Release of excess nutrient elements from EFB biochar and activity of N_2-fixing bacteria could be a reason to increase N input in soil. The initial increase in total N content could be due to the macronutrients abundant in the biochar, fixing N by beneficial bacteria and mineralization of organic N in the biochar which released ammonium-N as one of the degradation products (9, 10, 23). The high mineral N content in soil may be affected by soil pH and activity of bacteria Sb16 to convert atmospheric N to ammonium into soil. The light fraction organic matter in the soil and microbial biomass could have resulted in better nutrient release from EFB biochar.

Addition of EFB biochar at 0.5% resulted in higher P than other biochar rates in both soils. Lower value of soil P was observed at 0.25% EFB biochar and bacteria Sb16 in both soils. However, soil available P was higher in sterilized soil than non-sterilized which soil may be due to increase of phosphate solubilizing bacteria population to solubilize P in soil or decomposing of chemical properties in EFB biochar. Gaskin *et al.* (13) indicated that soluble PO_4^{-3} increased due to the abundant macronutrients in biochar and mineralization of soil organic P. This was similar to the exchangeable potassium K. The increase could be due to the high cation contents in EFB biochar. The unamended soil (control) showed no changes of amount K during the incubation study. There was a slight increase of K in soil treated with bacteria Sb16 alone. Application of EFB biochar at 0.25% and N_2-fixing bacteria Sb16 gave the highest K (0.90 cmol (+) /kg) in non-sterilized soil (Table 3). This increase of soil K may be due to the presence of K in EFB biochar. Application of oil palm biochar with and without N_2-fixing bacteria Sb16 significantly enhanced chemical and biological properties and enzyme activity in an acidic soil. EFB biochar may have potential for enhancing soil quality upto a certain limit as beneficial soil amendment but at higher rates its contamination can affect harm for the soil properties.

Table 2. Effect of EFB biochar and N_2-fixing bacteria Sb16 in sterilized soil on soil chemical properties.

EFB biochar (%)	pH	C%	N%	P(mg/kg)	K (com (+)/kg-1)
0 – Sb16	4.5 ± 0.03	1.87 ± 0.01	0.004 ± 0.01	28 ± 0.91 g	0.17 ± 0.01
0 + Sb16	4.7 ± 0.03	1.92 ± 0.01	0.006 ± 0.01	31 ± 0.93 g	0.20 ± 0.01
0.25 – Sb16	5.5 ± 0.03	2.71 ± 0.01	0.06 ± 0.01	81 ± 0.90 c	0.80 ± 0.01
0.25 + Sb16	5.6 ± 0.03	2.78 ± 0.01	0.09 ± 0.01	96 ± 0.57 a	0.85 ± 0.01
0.5 – Sb16	5.6 ± 0.03	2.73 ± 0.02	0.08 ± 0.01	85 ± 0.57 c	0.75 ± 0.02
0.5 + Sb16	5.7 ± 0.03	2.75 ± 0.02	0.11 ± 0.01	91 ± 0.96 b	0.81 ± 0.01
0.75 – Sb16	5.4 ± 0.03	2.2 ± 0.01	0.06 ± 0.01	60 ± 0.98 e	0.65 ± 0.01
0.75 + Sb16	5.5 ± 0.03	2.23 ± 0.02	0.08 ± 0.01	69 ± 0.95 d	0.69 ± 0.01
1 – Sb16	5.3 ± 0.03	1.96 ± 0.01	0.04 ± 0.01	50 ± 0.97 f	0.44 ± 0.02
1 + Sb16	5.4 ± 0.03	2.01 ± 0.01	0.06 ± 0.01	56 ± 0.95 e	0.47 ± 0.01
Biochar	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*
Sb16	0.0001*	0.0001*	0.0001*	0.0001*	0.0006*
Biochar*Sb16	0.2781^{ns}	0.2124^{ns}	0.2390^{ns}	0.0133*	0.8252^{ns}

Means in each column for each variable do not significantly differ according to Tukey 's test at 5%.

Table 3. Effect of EFB biochar and N_2-fixing bacteria Sb16 in non-sterilized soil on soil chemical properties.

EFB biochar (%)	pH	C%	N%	P(mg/kg)	K (com (+)/kg-1)
0 – Sb16	4.6 ± 0.06	2.10 ± 0.01	0.11 ± 0.01	34 ± 1.15 g	0.21 ± 0.01 f
0 + Sb16	4.8 ± 0.09	2.12 ± 0.01	0.12 ± 0.01	38 ± 1.00 g	0.22 ± 0.01 f
0.25 – Sb16	5.6 ± 0.03	3.11 ± 0.02	0.17 ± 0.01	68 ± 1.15 c	0.82 ± 0.01 c
0.25 + Sb16	5.7 ± 0.06	3.19 ± 0.01	0.22 ± 0.01	73 ± 0.60 a	0.90 ± 0.01 a
0.5 – Sb16	5.7 ± 0.03	3.13 ± 0.01	0.19 ± 0.01	70 ± 0.60 c	0.85 ± 0.01 b
0.5 + Sb16	5.8 ± 0.09	3.17 ± 0.01	0.21 ± 0.01	80 ± 0.07 b	0.87 ± 0.01 b
0.75 – Sb16	5.4 ± 0.09	2.91 ± 0.01	0.16 ± 0.01	56 ± 1.15 e	0.72 ± 0.01 d
0.75 + Sb16	5.6 ± 0.09	2.95 ± 0.01	0.17 ± 0.01	63 ± 2.30 d	0.74 ± 0.01 d
1 – Sb16	5.4 ± 0.09	3.03 ± 0.02	0.13 ± 0.01	50 ± 2.10 f	0.65 ± 0.01 e
1 + Sb16	5.5 ± 0.06	3.05 ± 0.01	0.14 ± 0.01	58 ± 1.15 e	0.67 ± 0.01 e
Biochar	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*
Sb16	0.0001*	0.0001*	0.0001*	0.0001*	0.0002*
Biochar*Sb16	0.0884^{ns}	0.0480*	0.0343*	0.2548^{ns}	0.0007*

Means in each column for each variable do not significantly differ according to Tukey 's test at 5%.

Glasshouse study

Effects of N_2-fixing bacteria Sb16 and EFB biochar on growth of sweet corn: The study showed that application of N_2-fixing bacteria Sb16 and EFB biochar significantly improved growth of corn plants (as indicated by root and shoot biomass, root length, root volume, plant height and leaf chlorophyll content) and nutrient uptake (Fig. 3). Application of EFB biochar with or without bacteria Sb16 resulted in better plant growth than without EFB biochar and bacterial inoculation. EFB biochar with N_2-fixing bacteria Sb16 significantly ($P<0.05$) increased corn growth at tasseling stage. All EFB biochar levels showed a relatively larger increase in growth compared to without EFB biochar (control). Among all treatments EFB biochar, 5 t/ha showed highest (48.5 g/plant) of shoot biomass, while the lowest (41.2 g/plant) was observed at 20 t/ha EFB biochar. Root development was affected by application of EFB biochar at 5 and 10 t/ha. The results showed significant improvement in plant height and leaf chlorophyll content due to addition of EFB biochar at 10 t/ha compared to other EFB biochar rates. Application of N_2-fixing bacteria slightly improved growth of corn than non-inoculated. Higher weight (61.4 g/plant) of shoot biomass was found at 5 t/ha EFB biochar and N_2-fixing bacteria Sb16, while the lowest value (20.6 g/plant) was observed at 0 t/ha EFB biochar (control). Root biomass increased two folds with EFB biochar 5 t/ha and bacterial inoculation compared to control. Root length and root volume showed better growth at 5 t/ha EFB biochar and bacteria Sb16 than other treatments. Similarly, leaf chlorophyll or leaf greenness and plant height in corn significantly improved by EFB biochar at 5 t/ha and bacteria Sb16 application. Leaf greenness increased 144 percent times compared to unamended soil (control). Increase levels of EFB biochar with and without bacteria Sb16 negatively affected growth of corn. EFB biochar which is alkaline product can improve soil pH and CEC and thus improve soil nutrient and plant growth. EFB biochar provides a conducive environment for beneficial microbes, especially the activity of N_2-fixing bacteria to increase total N in a form that can plant absorb easily from the soil. Lower rate of EFB biochar i.e. 5 t/ha could possibly provide adequate nutrient and suitable conditions for microbes to enhance nutrient in soil and plant growth.

Biochar has been known to have the ability to amend soil properties, leading to impact beneficially on plant growth and nutrient uptake (1 , 2). Application of biochar improved soil acidity, pore structure, surface area, essential nutrients and changes of microbial populations, thus increasing crop productivity. By contrast, EFB biochar application with bacterial inoculation resulted in a strong positive rate-dependent impact on plant growth in tropical soils. Leaf greenness is widely known that is an essential parameter for plant status, such as, photosynthetic potential, N uptake and plant productivity. Solubilization and porosity of ash-biochar may control the release of soluble nutrients and available to absorb by plants (8). The biochar may catalyses the breakdown of organic matter by supplying microbial habitat carbon substrate and nutrients. Biochar affected microbial activity by improving the physical and chemical in soil (36). Application of biochar to poor fertile soil has been found to provide longer-lasting improvements in soil fertility (44). Biochar positively affected the soil nutrient availability in two common ways: nutrient addition and nutrient retention. The ash in biochar contains plant nutrients, mostly are macronutrients and micronutrients (11). Biochar retains, attracts and holds nutrients of soil directly via negative charge that evolves on its surfaces, and this negative charge can buffer acidity in the soil or exchange by soil and plant roots (42). Several groups of microorganisms recognized in biochar were able to regulate plant growth through nutrient cycling (32). Enzymes and more compounds were promoted characteristics in biochar and could also enhance plant growth. Combining EFB biochar and N, P as well as K fertilizer possibly provide adequate nutrient with bacterial plants to increase nutrient in soil and corn growth. Application of biochar generally increased the root hairs and effective root surface areas beyond common root absorption zones causing in higher nutrient transfer beneficial for plant production and nutrient uptake (41). Lower rate of EFB biochar and bacteria Sb16 may release adequate nutrient into soil and can be easily taken up for plant growth by beneficial organism. However, research is needed in order to better understand how the addition of biochar and inoculation improve soil quality and plant growth before it becomes a common practice. There are many problems that are directly or indirectly linked to the application of biochar on agricultural system. Oil palm EFB biochar with or without bacterial inoculation improved growth of sweet corn, nutrient uptake and soil properties. Addition of EFB biochar to soil at higher levels adversely affected plant growth and soil properties. Addition of EFB biochar may be an alternative solution in enhancing the quality in acid soil. Inoculation of bacteria Sb16 not directly aids to enhance the soil condition conducive for the release of nutrients from EFB biochar. This finding supported the earlier reports on positive influence of biochar in stimulating soil fertility and plant growth (30). The incorporation of oil palm biochar and N_2-fixing bacteria can induce ameliorating changes to chemical and biological properties and enzyme activity of acidic soils and improve crop production. Future research needs to evaluate the effect of other beneficial microbes such as arbuscular mycorrhizal fungi (AM) or plant growth promoting rhizobacteria (PGPR) applied with EFB biochar in acidic soils under field conditions.

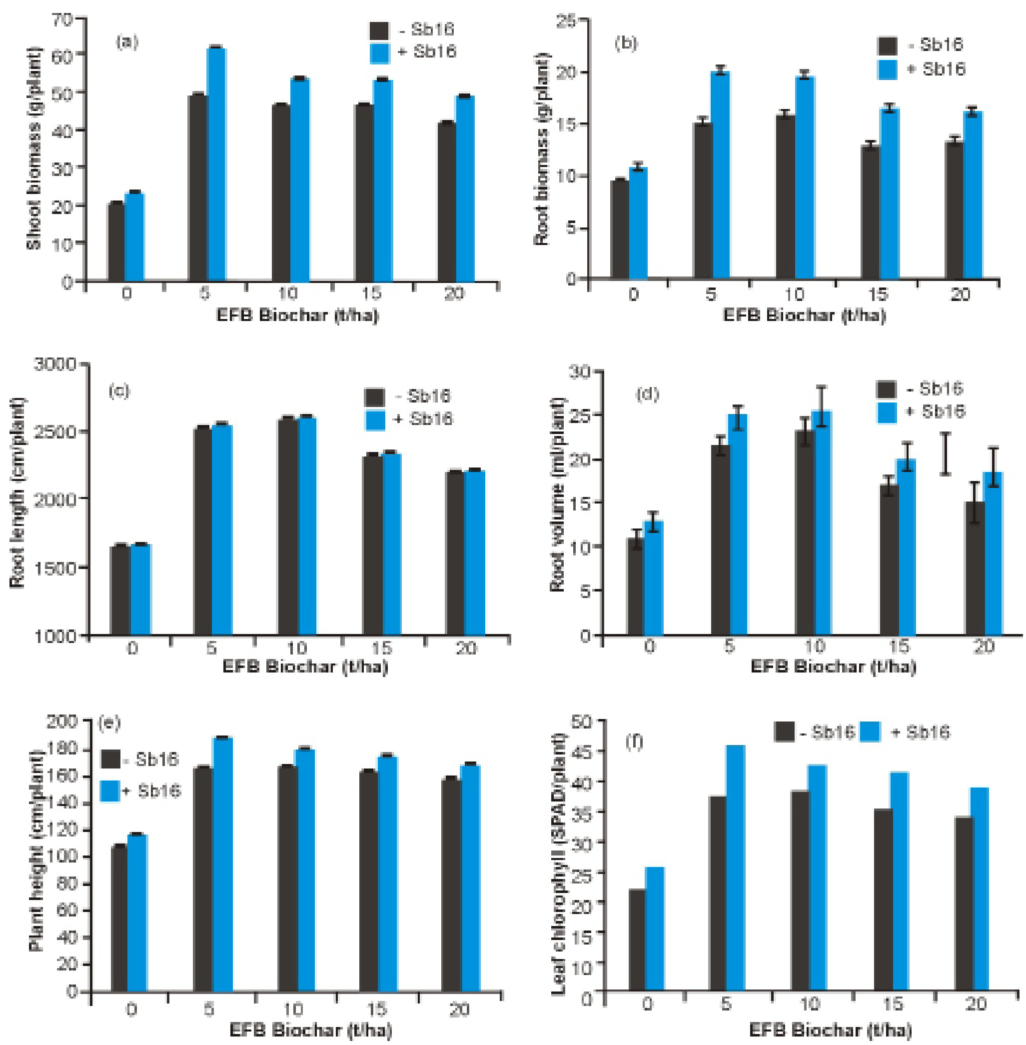

Fig. 3. Effect of EFB biochar and N_2-fixing bacteria Sb16 on shoot biomass (a), root biomass (b), root length (c), root volume (d), plant height (e) and leaf chlorophyll content (f).

CONCLUSION

The results of study concluded that EFB biochar made from agricultural waste oil palm EFB at 5 t/ha or 0.25% with N_2-fixing bacteria practically performed better as a soil amendment. Bacterial soil inoculation improved chemical and biological properties, enzyme activity and growth of corn than non-inoculated. Addition of high amendment rates to soil adversely affected plant growth and soil properties. Special attention should be paid to processing conditions and types of biochar applied. Premixed biochar with soil and N_2-fixing bacteria look necessary for stabilization of the soil and better growth of corn. It is interesting to note that lower rate of EFB biochar 5 t/ha with N_2-fixing bacteria promoted highest plant growth. Smaller additions and longer mixing times are strongly recommended. The incorporation of oil palm biochar with N_2-fixing bacteria can induce ameliorating changes to chemical and biological properties and enzyme activity of acidic soils and improve plant production. The suitable rate of EFB biochar application affordable by farmers is 10 t/ha without inoculation or 5 t/ha with bacterial inoculation.

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Evaluation of growth, yield and some quality characteristics of sweet corn under effect of different nutrient sources

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Evaluation of growth, yield and some quality characteristics of sweet corn under effect of different nutrient sources

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Abstract

In order to investigate the effect of organic and chemical nutrients on the growth and yield and yield quality of two varieties of sweet corn, two different field experiments were conducted in spring and autumn seasons in 2017, the experimental design was laid out as a split-plot design with three replications. Two sweet corn varieties Goldrash and Chocleta putted in the main plots while three different nutrient sources were fixed in sub-plots. Several vegetative and reproductive growth criteria were studied as well as the rate of accumulated dry matter that allocated to the leaves and stem in two different growth stages pre and post silking were measured. The quality related criteria M%, TS, TSS, and NSS was evaluated. Results of both seasons demonstrated the effectively of organic nutrient sources in exceeding chemical fertilization in a number of criteria or approaching its level in another, The interaction between second organic nutrient and Goldrash showed a maximum yield in the spring season, while the yield in autumn season was non significantly resulted.

Introduction

Sweet corn is a type of maize (*Zea mays ssp. Saccharata*) with an increase in sugar or polysaccharide content in the kernels. Unlike other corn species, which are harvested at or post physiological maturity, sweet corn, is cut off when immature and fresh at the milk stage, marketed as a delicious vegetable, as well as other diverse end uses. Sweet Corn is a good source of the phenolic flavonoid antioxidant, Ferulic acid. Several research studies suggest that Ferulic acid plays a vital role in preventing cancers, aging, and inflammation in humans. The quality traits of sweet corn such as sweetness, flavour, and tenderness are the preferable characteristics for marketing [1].

Organic farming describes systems with the fundamental basis for minimizing chemicals and optimizes natural processes for the production of crops [2 and 3]. In organic farming a wide range of agricultural processes and natural products will use instead of pollutant chemicals, organic fertilizers as a source nutrient for plants can directly reduce the environmental problems associated with the use of inorganic fertilizers[4], while the performance of different genotypes will vary with different environmental and climatic conditions[5]. Juntharathep *et al.,* 2007[6]Found that fermented chicken manure was an efficient fertilizer produced the highest yields of fresh yield of sweet corn. Response of sweet corn varieties to different organic fertilization vary with different genotypes, the concentration of liquid organic fertilizer did not increase growth and yields of organically grown sweet corn. Sweet corn of Asian Honey had the best responses to locally-based liquid organic fertilizer, followed by Muktamar *et al.,* 2016[7].The organic fertilizer gave a significantly higher marketable yield than chemicalfertilizersthe use of organicmineralfertilizers reduces nitrate losses due to leaching and improves soil structure[8]. Nitrogen fertilization sourced from processing of plants is important for sustainability and maintaining organic farming [9].Large quantity of nitrogen residual remains in soil post crop harvesting, especially seasonal vegetables [10 and 11]. Application of the recommended rates for field vegetables may take into account amounts ofresidual soil Nmin [12],especially if crops/vegetables are harvested before maturity, as is the case of sweet corn[9].

The environmental risks have been generated from the continuous application of chemical fertilizers which increased because of the accumulated residuals. Fertilization from organic sources for crops can effectively mitigate the environmental problems, as well as producing healthy products of different vegetables and field crops. Recently the different organic nutrients were used such as crop rotation, growing a diversity of crops, planting cover crops, and adding organic matter to the soil. The organ system increases an income adequate to maintain a good standard of living by producing an abundance of high-quality food, while at the same time nurturing the soil, protecting the environment, and ensuring that the land will be healthy and productive for generations to come. The objective of the present study is investigating the response of two different sweet varieties to effect of organic and chemical nutrients.

Materials and Methods

Two different field experiments were conducted in spring season on April 24, 2017 and autumn season on Aug. 01, 2017 in Kanipanka Agricultural Research Centre in order to investigate the effect of chemical and organic fertilization on the growth, yield and yield quality of two different varieties of sweet corn which were (Goldrash (V_1) and Chocleta(V_2)). The experiments were laid out as a split-plot design with three /replications, the nutrient sources include organic fertilizers were treated as the main factor while the two varieties were located in sub- plots. The nutrient sources involved in the study were organic and chemical fertilization, the organic fertilizations were coming from two different organic sources which were Liquid Organic fertilizer Majesto, (T_1), and local poultry manure (T_2), while recommended chemical Nitrogen and phosphorous fertilization, (170 Kg ha^{-1}N and 75 Kg ha^{-1}P2O5) used as (T_3). The Majesto organic fertilization was used according to the company's instructions, (3 lt. ha^{-1}) 14cc/16 Lt. Water every 10 days in May 23, Jun, 04, and Jun 14. The Poultry manure was applied before planting at the base of 850 Kg ha^{-1}, the nitrogen fertilizer was applied in two split doses, and the first was applied with cultivation and the second dose at seedling stage. The area of main experimental units were 2.50 m ×8.00 m, which was planted with V_1 or V_2, and divided into 3 sub plots for T_1,T_2 and T_3, there were four rows in each subplot, the space between two rows was 75 cm, and 25 cm for each two plants within rows. All agricultural processes were carried out as required. For determining rate of varieties growth through dry matter accumulation, destructive samples were taken pre-silking and after 21 days at post-silking. The fresh samples were oven dried at 70°C till stable weight, and then calculated according to the following equation:

Dry Weight (g) = $DW_1 \times (FW_t \backslash FW_2)$

Where:

DW1 = Dry weight of fresh sample taken from the leaf or stem

FWs = Fresh weight of the sample taken from the leaf or stem

FWt = Fresh weight of the plant leaves(all leaves) or stem

The studied criteria include criteria related to the growth and performance of the two sweet corn varieties under effect of organic and chemical fertilization in both spring and autumn seasons and their interactions, include no. of leaves, leaf area /plant (cm²) conducted at silking, and also growth stage periods, no. of days required to 50% tasseling and no. of days required to 50% silking, as well as the rate of dry matter accumulation that partitioned to the leaves and stem carried in two different stages pre-silking and post-silking, and also fresh yield per plants (Kg pl^{-1}). The quality of the two varieties of sweet corn was evaluated through different criteria related to the quality as moisture content%, TS, TSS, and NSS as well as the Ear diameters. The fresh, immature ears of two intermediate rows in the sub plots were harvested when the silks on the husk of the ears dry and change color to dark brown at 20 days post silking.

Quality evaluations

The fruit quality parameters were evaluated after harvest

1-The moisture content (M %) was determined according to standard methods [13].

2-Total solids (TS %): Total solids have been determined according to [14], calculated by the following formula: TS%= 100 - % moisture content (M %).

3-Total Soluble Solids (TSS %): Hand Refractometer (LCD digital model) was used to determine TSS%. A drop of the fruit extract was placed on the prism of digital Refractometer and the total soluble solid values were read in °Brix [14].
4-Non soluble solids (NSS %) = Total solids (TS %) - Total Soluble Solids (TSS %).
5-Ear length (cm) calculated by digital Vernier calipers.
The obtained Data were analysed statistically by using analysis of variance techniques with (XLSTAT). The Least significant differences test was used to compare the differences among the data means at significant level of 5%.

Results and Discussion

Growth Performance

The growth performance of the two sweet corn varieties in spring season were varied in their responses to the effect of different nutrient sources, table (1) reveals studied criteria related to vegetative growing and growth periods to tasseling and silking in both seasons, although almost of differences among studied characters was not extended to a significant level, but the results confirm affectivity of organic sources which approaching chemical fertilizers[5 and 7].
Figs. 1, and 2, demonstrate variation in the rate of dry matter accumulation that partitioned to the leaves and stem under effect of three different nutrient sources T_1,T_2 and T_3, pre and post silking in both seasons, there were generally increasing in the accumulated dry matter to both leaves and stems in both growth stages in spring growing season, the maximum value of both components were achieved with T_3, while in Autumn season the liquid organic fertilizerT_1 exceeded significantly other nutrient sources in the quantity of accumulated dry matter to stem presilking with (11.722)g,while T_2 was with lowest quantity of dry matter accumulation(7.823)g, as well as higher value of the T_1 for leaf and stem post silking. Fig.3, show performance of both varieties V_1 and V_2 in accumulating dry matter that allocated to leaf and stem in the two seasons. There were higher values of the potentials of both varieties in dry matter accumulation in spring season comparing with the autumn growing season, the Chocleta variety was with higher rates of dry matter accumulated in the leaves stems post silking in spring, results with agreement of previous research [7 and 15].

Table-1: Effect of nutrient sources on the vegetative and growth criteria in both seasons

Seasons	*Treatments*	*Plant Height (cm)*	*Plant Leaf Area(cm^2)*	*Stem thickness (cm)*	*No. of days to 50% Tasseling*	*No. of days to 50% Silking*
Spring	T_1	165.250	419.563	1.766	45.000	56.833
	T_2	168.500	420.637	2.066	44.833	56.333
	T_3	179.083	484.301	1.933	45.166	56.166
	$LSD_{(P\leq 0.05)}$	24.901	122.346	0.363	2.698	2.476
Autumn	T_1	122.583	2231.563	1.316	42.333	55.333
	T_2	100.333	1377.025	1.283	43.000	57.500
	T_3	112.583	1751.900	1.250	42.833	56.666
	$LSD_{(P\leq 0.05)}$	21.247	627.182	0.269	1.363	1.848

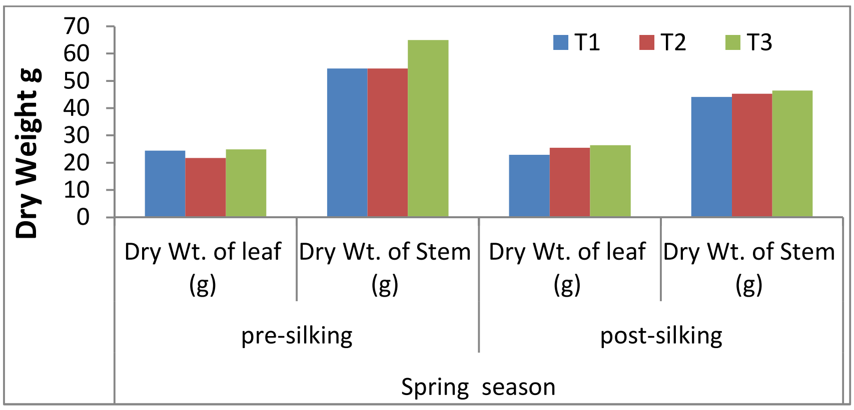

Fig.1: Dry matter accumulation in leaf and stem under effect of nutrient sources in spring season

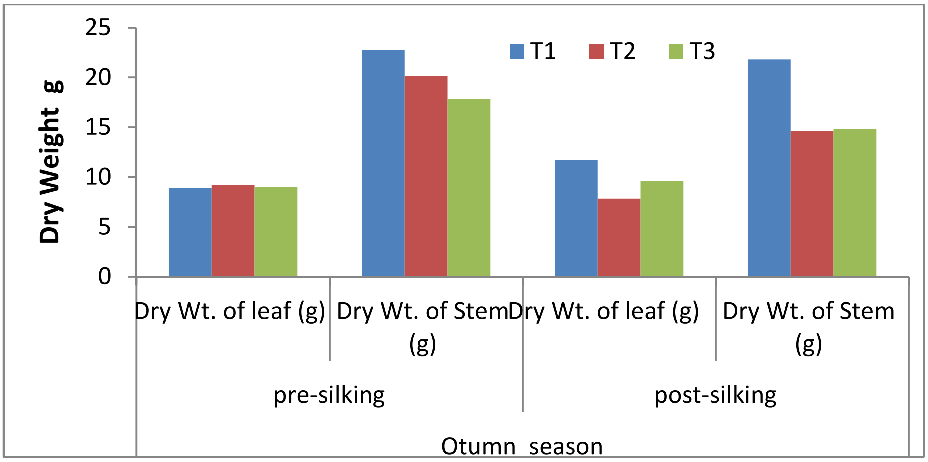

Fig.2: Dry matter accumulation in leaf and stem under the effect of nutrient sources in autumn season

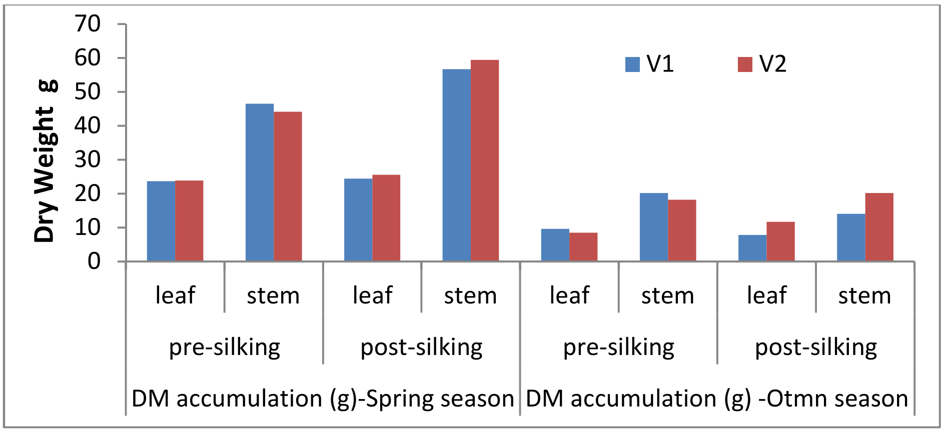

Fig.3: Dry matter accumulation in leaf and stem of both varieties in both seasons

Interactions:

Fig.4, indicate to interactions between the influence of the nutrient sources (T_1, T_2, and T_3), and two sweet varieties (V_1 and V_2), showing various responses in both growing seasons. The highest value obtained from the (variety x nutrients) interactions, was for the liquid organic fertilizer T_1 and Chocleta variety V_2 in the quantity of dry matter accumulated in the leaves and stems with 13.393 g and 26.246 g post silking in autumn growing season, the results agree with[16,5 and 9].

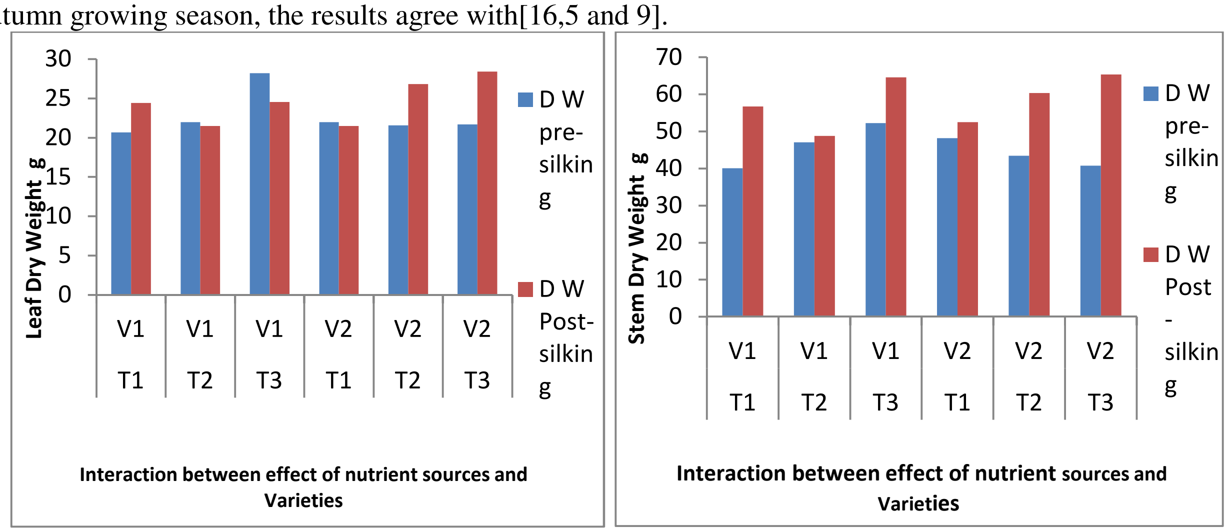

Fig.4: Effect of the interaction between the effect of nutrient sources and both varieties on dry matter accumulation

Quality related criteria:

Tables 2 and 3 indicate to quality related criteria in both seasons, which include ear diameters and chemical tests and yield under the influence of three nutrient sources. At spring season, there wasa similar effect of the nutrient sources with higher value of organic sources in all studied criteria except TSS in which the superiority was to chemical fertilization with 18,533. The highest yield of fresh sweet kernel yield /plant was to liquid organic source. At autumn season, while all of the studied criteria were not significantly differentiated, the highest fresh yield was to chemical fertilization with 9.123 gplant^{-1}, but it was with a no significant excess of organic sources T_1 and T_2. Evaluating of influence of nutrient sources on the quality related criteria indicate to the affectivity of organic sources to approaching the effect of chemical fertilization source, the results are with agreement with previous work of [6 and 4].

Table-2: Effect of nutrient sources on the quality related criteria in spring season

Treatments	Ear Length cm	Ear Width cm	M%	TS	TSS	NSS	Yield g plant^{-1}
T1	*20.475*	*4.15*	*79.913*	*20.086*	*17.033*	*3.053*	*5.402*
T2	*18.2*	*4.066*	*77.192*	*22.808*	*17.833*	*4.974*	*4.713*
T3	*17.016*	*4.108*	*77.963*	*22.036*	*18.533*	*3.503*	*4.765*
$LSD_{(P\leq0.05)}$	*4.641*	*0.172*	*2.315*	*2.315*	*3.645*	*2.573*	*1.152*

Table-3: Effect of nutrient sources on the quality related criteria in autumn season

Treatments	Ear Length cm	Ear Width cm	M%	TS	TSS	NSS	Yield g plant^{-1}
T1	*21.333*	*3.812*	*76.215*	*23.725*	*16.442*	*7.279*	*7.935*
T2	*20.72*	*3.94*	*77.143*	*23.06*	*16.275*	*6.785*	*8.956*
T3	*20.748*	*4.005*	*76.115*	*23.616*	*16.366*	*7.25*	*9.123*
$LSD_{(P\leq0.05)}$	*1.518*	*0.283*	*1.043*	*1.224*	*1.354*	*2.421*	*2.481*

Sweet corn varieties:

Figs 4,and 5 clarifies significant differences between the two sweet corn varieties, in spring growing season there was exceeding of V_1 in ear width and fresh yield with (4.082cm and 9.611) respectively, while V_2 exceeded V_1 in TSS with 17.95. At autumn season there was not significant, exceeding between both varieties in the fresh yield, while the V_2 was with superiority in ear length and TSS with 19.283 and 19.422 respectively, results are in agreement with[1, 16 and 17].

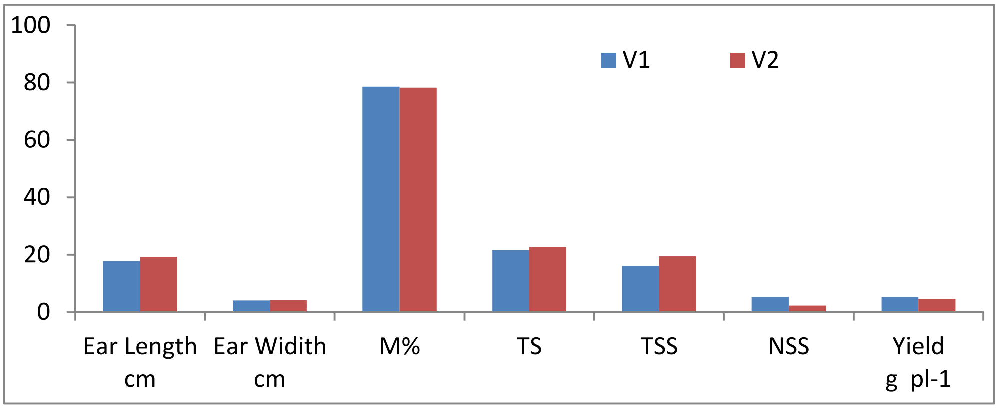

Fig.5: Performance of both varieties in the quality related criteria in spring season

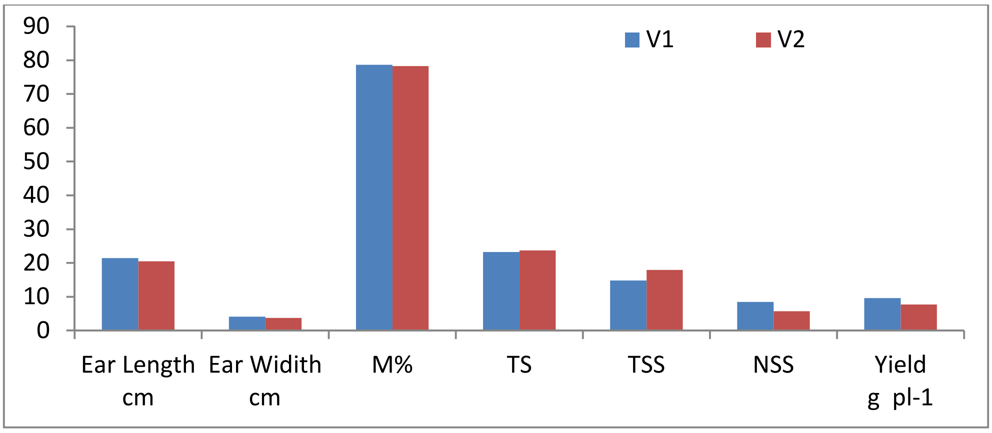

Fig.6: Performance of both varieties in the quality related criteria in autumn season

Interactions:

Table 4 and 5 demonstrate the effect of the interactions between the influence of the nutrient sources and response of both sweet corn varieties(V_1 and V_2), there were significant differences between the interactions of the two components of most of studied criteria in both seasons, at spring season the superiority was to the interactions between organic sources and sweet corn varieties in criteria ear diameters (T_1V_1), and T_1V_1 and T_2 V_1 for criteria NSS%, and Yield, with 9.176, and 10.626 respectively. At autumn season there were significant exceeding of the interaction between organic sources T_1 and T_2 and sweet cornvarieties in ear length,TS, TSS, and NSS, showed in the interactions (T_1V_1, T_2V_2, T_2V_2, and T_2V_1), while the differences between the yield of chemical and organic sources did not reach significant variation[10,2 and 11].

Table-4: Interactions between nutrient sources and responses of both varieties in quality related criteria in spring season

Treatment combinations	*Ear Length cm*	*Ear Width cm*	*M%*	*TS*	*TSS*	*NSS*	*Yield g plant^{-1}*
$T_1 V_1$	22.333	4.100	73.827	24.171	14.983	9.187	8.176
$T_2 V_1$	20.776	4.090	77.136	22.864	14.983	7.881	10.626
$T_3 V_1$	21.163	4.056	77.432	22.699	14.350	8.349	10.030
$T_1 V_2$	20.333	3.523	76.603	23.281	17.900	5.371	7.693
$T_2 V_2$	20.663	3.790	77.150	23.255	17.556	5.688	7.286
$T_3 V_2$	20.333	3.953	74.799	24.534	18.383	6.151	8.216
$LSD_{(P\leq 0.05)}$	1.773	0.335	1.450	1.956	4.642	3.243	2.033

Table-5: Interactions between nutrient sources and responses of both varieties in quality related criteria in autumn season

Treatment combinations	*Ear Length cm*	*Ear Width cm*	*M%*	*TS*	*TSS*	*NSS*	*Yield g plant^{-1}*
$T_1 V_1$	20.566	3.95	79.338	20.661	15.666	4.995	5.95
$T_2 V_1$	17.65	4.033	77.483	22.516	15.333	7.183	5.293
$T_3 V_1$	15.316	4.166	78.568	21.432	17.533	3.898	5.716
$T_1 V_2$	20.383	4.35	80.488	19.512	18.4	1.112	4.853
$T_2 V_2$	18.75	4.1	76.9	23.1	20.333	2.766	4.133
$T_3 V_2$	18.716	4.05	77.358	22.642	19.533	3.108	3.813
$LSD_{(P\leq 0.05)}$	4.591	0.599	4.982	4.98	4.642	5.317	1.962

Conclusions:

The organic nutrient sources, liquid organic majesto and poultry manure are with available results in comparing with the results of the effect of chemical fertilizer. There were significant, exceeding of T1 and T2 in some studied criteria , while these two organic nutrient effects approached effect of chemical fertilizer source in other studied criteria, so organic sources are considerable nutrient source in sweet corn productivity especially they are with non-harmful influence of the soil and environment as well as produce healthy product to human consumers.

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Effect of two growing seasons on growth, yield and its components of lentil varieties under rainfall condition in north of Iraq

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Abstract

The investigation was conducted at Bakrajo in Sulaimani Province at two seasons (2011-2012 and 2012-2013) to select the best varieties for growth and yield characteristics of lentil that adapted to the environment of Sulaimani province. Eight lentil varieties were utilized in the study. The experiment was designed as a Randomized Complete Block Design (R.C.B.D) with three replications. Mean comparison was carried out by the least significant difference (L.S.D) at a significant level of 5%. The result confirmed the interaction between average seasons and varieties on some growth and forage characteristics for the two seasons. Consequently, the highest value for the characters; plant height with 36.33, days to %50 flowering with 118.33, and days to maturity with 152 were realized by the varieties V.3, V.7, and V.5 consecutively. The characters, number of branches.plant^{-1} with 3.33 for the variety V.1, first pod height with 15 for variety V.6, and variety V.3 for no. of branch nodules.plant^{-1} with 36.677. In the 2012-2013 season, variety V.5 gave the maximum value for plant height with 44 cm, days to %50 flowering with 121.66 days for the variety V.3, days to maturity with 161 days for the variety V.8, no. of branches with 19.33 for the variety V.5, and no. of bacterial nodules/plant for the variety V.3 with 31.66. Effect of the interaction between seasons and varieties on seed yield and its components for two seasons. The variety V.2 produced the highest seed yield and some of its yield components for both seasons. The effect of seasons showed that in season 2011-2012 gave the maximum values for all characters of growth and seed yield components for lentil varieties except for no. of seeds/pod and no. of seeds/plant.

Keywords: Lentil, Legume crops, Varieties, Growth, Yield, Seed production.

Introduction

Lentil (*Lens culinaris* Medik.) belonging to the family Fabaceae is considered an ancient, domesticated, economically important winter legume crop agriculturally cultivated worldwide as human food. Due to the short life of lentil, it is very suitable to be involved in the rotation system, especially with cereals, reducing the effect of weeds, diseases, and soil erosion (2).Pulse crop acres, particularly field peas and lentil, have been expanding in the Northern Plains states and Canadian States (5) Lentils are considered to be a good source of protein. This high protein content in lentils and other pulses makes them a significant food source for developing countries and low-income people (6). Lentil is richer in total soluble fiber than peas and chickpeas. Also, its content of dietary fiber is higher than beans and chickpeas. Like most legumes, lentil is a rich protein source between 20.6% and 31.4% proteins (8) . Lentil Lens culinaris Medik., faba bean Vicia faba L. and chickpea *Cicer arietinum* L. provide a considerable portion of the people's diet in this region. For example, Rwanda bean supplies 65% of the national dietary protein, compared to 4% from animal protein, and 32% of the energy (7). The seeds of this plant are commonly used as an edible pulse. Lentils are nutritional valued for their high protein content of about 30% and a good source of vitamins and other nutrients (6). Lentil has become an important food legume crop in the farming and food systems of many countries globally. The straw is a valued animal feed. Its seed is a rich source of minerals, protein, and vitamins for human nutrition. It is capability carbon sequestration and in nitrogen get better soil nutrient status (15). The crop is known to tolerate hard environmental conditions (8). It has received little research attention to improving quality and yield(13). Pulse crop acres, particularly field peas and lentil, have been expanding in the Northern Plains states and Canadian States (12). Lentil is known to have a tolerance for extreme environmental conditions such as drought and high temperature and can be grown in semiarid regions without irrigation(1).Lentil contributes significantly to soil fertility, having the capability of fixing the atmospheric nitrogen through a symbiotic relationship with nitrogen-fixing *Rhizobium* bacteria. Cool-season grain legumes are important protein-rich food crops of East Africa. Climate Lentils require a minimum of 350mm rainfall a maximum of 550mm; in the higher rainfall areas with good drainage is essential; waterlogging will have a great effect on yields and disease spread (3). Lentil is very rich compared to cereals for higher protein content of 28%. The straw also is a valued fodder containing a reasonable amount of minerals 2% (11). In this study, our objectives were to evaluate eight varieties of lentil under two growth seasons for growth and yield and select the more adaptable varieties to the Sulaimani province Iraqi Kurdistan region.

Materials and Methods

Field Experiment

For two winters growing seasons 2011-2012 and 2012-1013, eight lentil varieties, large seeds, were utilized in this investigation; Flip 2004-56L, Flip2005-2L, Flip2007-11L, Flip2007-12L, Flip2007-19L, Flip2007-29L, Flip 2007-30L, and local check denoted by (V.1-V.8) respectively. They were obtained from the Agricultural Research Station of Bakrajo-Sulaimani. The varieties were grown at Bakrajo. The experiment was laid out according to a Randomized Complete Block Design (RCBD) with three replications in both seasons. A line of 2m length and 30cm apart. Plots have consisted of four rows .The seed rate of 100 kg.ha^{-1} was applied for all varieties in November for both seasons. Also, an amount of 160 kg.ha^{-1} DAP, 40 kg.ha^{-1} urea fertilizer was applied during sowing. Mechanical weed control was applied to the experiment. Data were recorded from the whole plot for seed yield, biomass, and harvest index, while for other traits; the average value from ten plants in each plot was recorded. The measured traits included; plant height cm, days to %50 flowering, days to maturity, no. of branches per plant, first pod height cm, no. of pods per plant, no. of seed per plant, first pod length cm, no. of nodules, no. of seeds per pods, 100 seeds, seed yield kg.ha^{-1}. Seed yield in kg.ha^{-1} as a yield rate per hectare by tons, counted by converting the yield of plot area into a hectare. The average weight of the whole plants for each plot converted to kg.ha^{-1}, and harvest index (HI), counted as the ratio of grain yield to biological yield (16).

Harvest Index (HI %) =

$$\frac{\text{Economic yield(seed yield)}}{\text{Biological yield}} \text{ X } 100$$

All possible comparisons among the means would be carried out using the Least Significant Difference test LSD at a significant 5% level after showing their significance in the general test.

Results and Discussions

Data from Table (1) presents the Means of eight lentil varieties' response in some growth characteristics for the season 2011-2012. Data was found to be significant Difference at 5% (LSD) for plant height, days to maturity, and no. of bacterial nodules/plant, but no significance for days to %50 flowering, no. of branches per plant, and no. of bacterial nodules/plant. The variety Flip 2004-56L gave maximum value for no. of branches per plant and first pod height with 3.33 and 14.33, respectively.

Table 1: Performance of means traits of eight lentil varieties in the growing season 2011-2012.

varieties	Plant height (cm)	Days to%50 flowering	Days to maturity	No. of branches .plant^{-1}	First pod height (cm)	No. of bacterial nodules. Plant^{-1}
V.1	36.33	116.33	147.33	3.33	14.33	**27.333**
V.2	40.66	117.00	147.66	3.00	13.66	**28.333**
V.3	35.33	117.33	145.66	3.00	14.32	**36.667**
V.4	37.66	116.66	144.33	2.63	13.60	**24.667**
V.5	42.00	117.33	152.00	2.65	13.33	**20.667**
V.6	36.33	116.32	148.00	3.00	14.00	**21.667**
V.7	37.66	118.33	150.00	3.00	13.00	**18.000**
V.8	42.01	116.66	145.60	3.00	14.31	**31.333**
LSD (5%)	3.80	N.S	5.073	N.S	N.S	**12.124**

N.S= Non signifiant

Variety V.3 produced maximum value for no. of nodules/plant with 36.66. Variety V.4 recorded the minimum value for days to maturity and no. of branches/plant with 144.33 and 2.63, respectively. Variety V.5 maximum value for plant height 42.00 cm Variety V.6 recorded the lowest value for days to %50 flowering with 116.32.

Table 2: Differences between means eight lentil varieties in the yield and yield components in the growing season 2011-2012.

Varieties	No. of pod. $Plant^{-1}$	No. of Seed. $Plant^{-1}$	No. of seed $.pod^{-1}$	Pod length (cm)	100 seed weight (gm)	Seed yield $kg.ha^{-1}$	Biological yield kg. ha^{-1}	Harvest index%
V.1	40.330	45.000	1.300	1.330	5.560	2635.050	6896.373	**38.3**
V.2	38.000	47.330	1.600	1.560	6.16 0	2759.390	7049.723	**39.1**
V.3	44.330	33.330	1.600	1.260	5.900	2749.570	7842.650	**35.0**
V.4	38.000	39.600	1.010	1.300	6.700	2662.350	7114.870	**37.4**
V.5	38.000	40.000	1.000	1.230	6.400	2485.020	6852.420	**36.2**
V.6	40.000	32.330	2.100	1.460	6.200	2474.830	6426.907	**38.5**
V.7	32.000	34.660	2.000	1.500	6.330	2319.053	5618.603	**41.2**
V.8	32.000	39.330	1.620	1.200	5.700	2571.490	6581.947	**39.0**
LSD (5%)	6.940	10.9 40	N.S.	0.260	N.S.	121.891	176.688	**N.S.**

N.S.= Non signifiant

Data represent in Table (2) explain the performance of seed yield and its components of eight lentil varieties for season 2011-2012. It was noticed that the differences among varieties were significant at 5% (LSD) for no. of pod/plant, no. of $seed.plant^{-1}$, pod length, seed yield, and biological yield. But not significant for no. of $seed.pod^{-1}$, 100 seed weight, and harvest index. Variety V.1 gave maximum value for 100 seed weight with 5.56 gm. However, variety V.2 recorded the highest value for no. of $seed.plant^{-1}$, pod length, seed yield, and biological yield with 47.33 gm, 1.56, gm 2759.39 $kg.ha^{-1}$, and 7049.72 $kg.ha^{-1}$, respectively. Variety V.3 produced the highest value for no. of $pod.plant^{-1}$, while the lowest value recorded in harvest index with 35%. Variety V.4 gave maximum value for 100 seed weight with 6.70 gm, while no. of $seed.pod^{-1}$ gave the minimum value of 1.01. Variety V.6 gave the highest value for no. of $seed.pod^{-1}$ with 2.10. Variety V.7 gave maximum value for the harvest index with 0.41. While the minimum values for no. of $pod.plant^{-1}$, no. of $seed.plant^{-1}$, seed yield, and biological yield with 32.00, 34.66, 2319.05 $kg.ha^{-1}$, and 5618.60 $kg.ha^{-1}$, respectively. The lowest value recorded for the characters; no. of $pod.plant^{-1}$ and pod length with 32.00 and 1.20 cm, respectively, this result in agreement with previous studies (4).

Table 3 Performance of means of traits of eight lentil varieties in the growing season 2012-2013.

Varieties	Plant height (cm)	Days to %50 flowering	Days to maturity	No. of branches .plant^{-1}	First pod height (cm)	No. of bacterial nodules. plant^{-1}
V.1	37.330	117.660	158.330	3.030	17.000	26.333
V.2	42.333	118.667	159.000	3.010	19.000	19.333
V.3	38.660	121.660	158.00	3.030	17.333	31.667
V.4	35.000	118.660	159.333	3.020	19.333	21.333
V.5	44.000	120.660	157.667	4.000	17.000	25.000
V.6	42.330	118.330	158.667	3.020	16.333	15.333
V.7	36.000	117.330	157.33	3.030	18.333	14.000
V.8	39.330	120.333	161.000	3.000	17.000	21.667
LSD (5%)	6.375	2.129	1.921	N.S.	2.088	N.S.

N.S= Non signifiant

The results in Table(3) revealed significant differences between varieties in all characters except for no. of branches.plant^{-1} and no. of bacterial nodules.plant^{-1}. Variety V.3 recorded maximum value for days to %50 flowering and no. of nodules .plant^{-1} with 121.66 and 31.66, respectively, but days to maturity showed a minimum value of 158. Variety V.4 produced the highest value for the first pod height with 19.33 cm and showed the lowest value for plant height with 35.000 cm. Variety V.5 gave maximum value for plant height and no. of branches.plant^{-1} with 44 and 4 respectively, while variety V.6 gave the lowest value for the first height with 16.333 cm, and variety V.7 also recorded the lowest value for the first pod height and no. of nodules.plant^{-1} with 117.33 cm and14.00, respectively. Variety V.8 recorded the highest value with 161.00 by the days to maturity, while no. of branch.plant^{-1} gave minimum value with 3.00 Table (3).

Table 4: performance of means of seed yield and its components of eight lentil varieties for season 2012-2013 average.

varieties	No. of pod. Plant^{-1}	No. of Seed. Plant^{-1}	Pod length (cm)	100 seed weight (g)	Seed yield kg/ha	Biological yield kg.ha^{-1}	Harvest index %
V.1	34	20.660	1.86	5.500	1253.55	5617.543	22.3
V.2	46	25.660	1.66	6.160	1332.25	4628.337	28.6
V.3	42	29.000	1.733	5.660	1264.44	5326.507	23.0
V.4	50	28.660	1.400	6.160	1264.40	4552.450	27.7
V.5	60	29.330	1.460	6.500	1157.11	5044.943	22.9
V.6	36	26.000	1.500	5.830	1159.67	4949.333	23.4
V.7	28	31.660	1.566	6.200	1060.17	4502.863	23.5
V.8	46	36.660	1.56 67	5.166	1281.77	5496.490	23.3
LSD (5%)	6.63	9.219	0.24	N.S.	69.26	142.588	0.09

N.S= Non signifiant

Table 4 displays the performance of means of seed yield and its components of eight lentil varieties for season 2012-2013 performance of means of seed yield and its components of eight lentil varieties for season 2012-2013. Indicated the significant difference between the treatment for most of the characters; however, no. of seed.pod^{-1} and 100seed weight were not significant. Variety V.1 gave the highest value was 1.860 cm achieved by pod length, and the lowest value was 20.66, 5617.54 kg.ha^{-1} and 22 % for no. of seed.plant^{-1}, biological yield, and harvest index, respectively. At seasons 2011-2012, the variety V.2 gave maximum values for seed yield kg.ha^{-1}, biological yield, and harvest index with 1332.25, 4628.33, and 28.6% respectively, while exhibited the lowest value for pod length with 1.400 recorded by the variety V.4, which is similar to previous research result (9). Variety V.5 recorded the highest value with 60 by no. of pod/plant. However, variety V.7 produced the lowest value with 28 for no. of pod.plant^{-1}. Variety V.8 gave a maximum value of 36.66 for no. of seed.plant^{-1}, while 100 seed weight recorded the lowest value with 5.16gm. Which is similar to previous research result **[14].**

Table 5: means of some growth characters of eight lentil varieties for seasons 2011-2012

varieties	Plant height (cm)	Days to%50 flowering	Days to maturity	No. of branches .plant^{-1}	First pod height (cm)	No. of bacterial nodules. Plant^{-1}
V.1	34.333	117.000	152.833	3.166	15.510	26.833
V.2	37.666	117.833	153.333	3.333	16.500	23.8333
V.3	37.500	119.500	151.833	3.166	15.666	34.166
V.4	34.000	117.666	151.835	3.000	16.666	23.000
V.5	37.3333	119.000	154.833	3.333	15.500	22.833
V.6	35.6667	117.333	153.333	3.000	15.667	18.500
V.7	32.500	117.833	153.667	3.1666	16.166	16.000
V.8	32.8333	118.500	153.333	3.000	15.500	26.500
LSD (5%)	0.070	0.0284	0.0455	0.0231	0.025	0.171

Table 5 explains the means of some growth characters of eight lentil varieties for seasons 2011-2012. As the average of both seasons, the interaction effect between varieties and seasons was highly significant for all characters. Variety V.1 showed the highest value for no. of branches.plant^{-1} with 3.16, while the lowest value was recorded days to %50 flowering with 117 days. It was observed that the variety V.2 gave the maximum value for plant height with 37.66. Variety V.3 produced maximum value for days to %50 flowering with 119.50, while days to maturity recorded the minimum value of 151.83 days.

Variety V.4 showed the highest value for the first pod highest with 16.66 cm. In the 2012-2013 season, variety V.5 produced maximum value for the character days to maturity reached 154.83, while exhibited the lowest values for no. of branches.plant^{-1} and first pod height was reached 3.33cm and 15.50, respectively. However, variety V.6 recorded the lowest value for no. of branches.plant^{-1}with 3.00. In contrast, variety V.7 gave the minimum value for the plant high and no. of bacterial nodules.plant^{-1} with 32.500 and 16.00, respectively.

Table 6 illustrates the average of traits of seed yield and its components of some lentil varieties for seasons 2012-2013. It was noticed that the differences among varieties were significant for all traits studied; no. of pod.plant^{-1}, no. of seed.plant^{-1}, no. of seed.pod^{-1}, pod length (cm), 100 seed weight (gm), seed yield (kg.ha^{-1}), biological yield (kg.ha^{-1}), and harvest index.

Table 6: Average of some lentil varieties on seed yield and its components for seasons 2012-2013

varieties	No. of pod. Plant^{-1}	No. of seed.plant^{-1}	No. of seed .pod^{-1}	Pod length (cm)	100 seed weight (gm)	seed Yield kg.ha^{-1}	Biological yield Kg.ha^{-1}	Harvest index %
V.1	37.500	23.166	1.331	1.600	5.533	1944.300	6256.958	30.1
V.2	42.000	24.500	1.665	1.616	6.166	2045.820	5839.030	33.8
V.3	43.333	17.3330	1.66 4	1.500	5.783	2007.010	6584.578	29.7
V.4	44.333	20.500	1.16 7	1.350	6.433	1963.380	5833.660	32.5
V.5	49.000	20.666	1.500	1.350	6.450	1821.070	5948.681	29.5
V.6	38.333	16.833	1.66 3	1.483	6.016	1817.250	5688.120	30.9
V.7	30.000	17.833	1.833	1.533	6.366	1689.610	5060.733	32.3
V.8	39.000	20.333	1.333	1.383	5.433	1926.630	6039.218	31.1
LSD (5%)	0.080	0.092	0.0137	0.0029	0.010	1.177395	2.6464	29.3

The lowest value for no. of seed.pod^{-1} and 100 seed weight recorded by the variety V.1 reached 1.33 and 5.53gm, respectively. Variety V.2 produced the maximum value for no. of seed.plant^{-1}, seed yield (kg.ha^{-1}), and harvest index with 24.50, 2045.82, and 0.33, respectively. Variety V.5 recorded the highest value for no. of pod/plant, 100 seed weight, and biological yield with 49.00, 6.45gm, and 5948.68, respectively, whereas the lowest value for harvest index was 29.5gm. Moreover, variety V.6 and V.7 provided the lowest value for no. of seed.plant^{-1}, no. of pod.plant^{-1}, seed yield, and biological yield with 16.83, 30.00, 1.38, 1689.61 Kg.ha^{-1}, and 5060.73 Kg.ha^{-1}, respectively, while pod length recorded the minimum value for no. of seed.pod^{-1} with 1.83.

Data represented in Table 7 Effect of the seasons on some growth and forage characters of eight lentil varieties for both seasons. Showed in that were found to affect all characters significantly for both seasons. Variety V.3 produced the highest value for no. of bacterial nodules.plant^{-1} with 36.67.

Table 7: Effect of the seasons on some growth and forage characters of eight lentil varieties for both seasons.

Seasons	varieties	Plant height (cm)	Days to %50 flowering	Days to maturity	No. of branches per plant	First pod height (cm)	No. of bacterial nodules. $plant^{-1}$
2011 - 2012	V.1	31.333	116.333	147.333	3.333	14.100	23.733
	V.2	33.000	117.000	147.666	3.000	14.310	28.333
	V.3	36.333	117.333	145.666	3.010	14.120	36.677
	V.4	33.000	116.66	144.333	2.666	14.020	24.646
	V.5	30.666	117.333	152.000	2.636	14.200	20.636
	V.6	29.000	116.323	148.000	3.020	15.000	21.616
	V.7	29.010	118.333	150.000	3.011	14.220	18.000
	V.8	26.333	116.66	145.666	3.000	14.014	31.323
2012 - 2013	V.1	37.333	117.666	158.333	3.030	17.000	26.333
	V.2	42.333	118.666	159.000	3.666	19.000	19.313
	V.3	38.666	121.666	158.000	3.343	17.333	31.666
	V.4	35.000	118.666	159.333	3.313	19.333	21.333
	V.5	44.000	120.666	157.666	4.000	17.000	25.000
	V.6	42.333	118.333	158.666	3.000	16.313	15.334
	V.7	36.000	117.333	157.333	3.333	18.333	14.000
	V.8	39.333	120.333	161.000	3.000	17.000	21.666
LSD (5%)		LSD (5%)	0.040	0.064	0.0327	0.074	0.243

Regarding the varieties V.4, V.5, V.6, V.7, and V.8 gave the lowest values for days to maturity, plant height, no. of $branches.plant^{-1}$, days to %50 flowering, and first pod height with 144.33 days, 29.00cm 2.63, 116.32 days, and 14.014cm, respectively, for the seasons 2011-2012. While days to %50 flowering gave maximum value with 121.66 recorded by the variety V.3. The characters of first pod height, no. of branches, and days to maturity provided maximum value realized by m varieties V.4, V.5, V.6, and V.8 with 19.33cm, 44.00, 4.00, and 161.00 days, respectively, for seasons 2012-2013. It is concluded that this variation is due to differences in temperature degrees, which affected the lateness and earliness of plant development to reach this stage.

Table 8: Effect of the seasons on seed yield and its components characters of eight lentil varieties for both seasons.

Seasons	varieties	No. of pods. $Plant^{-1}$	No. of seeds. $Plant^{-1}$	No. of seed .pod-1	Pod length (cm)	100 seed weight (g)	Seed yield kg $.ha^{-1}$	Biological yield $Kg.ha^{-1}$	Harvest index %
2011 - 2012	V.1	40.333	45.000	1.333	1.333	5.566	2635.050	6896.373	38.2
	V.2	38.000	47.333	1.676	1.566	6.166	2759.390	7049.723	39.1
	V.3	44.333	42.666	1.656	1.266	5.900	2749.576	7842.650	35.0
	V.4	38.000	39.666	1.333	1.300	6.700	2662.356	7114.870	37.4
	V.5	38.000	40.000	1.635	1.230	6.400	2485.020	6852.420	36.1
	V.6	40.000	32.333	1.334	1.466	6.212	2474.833	6426.906	38.4
	V.7	28.000	34.666	1.666	1.500	6.533	2319.053	5618.603	41.2
	V.8	32.000	39.33	1.027	1.200	5.700	2571.490	6581.946	39.0
2012 - 2013	V.1	34.666	49.666	1.323	1.866	5.500	1253.553	5617.543	22.1
	V.2	46.000	46.000	1.668	1.666	6.166	1332.256	4628.336	28.6
	V.3	42.333	33.333	1.666	1.733	5.833	1264.440	5326.506	23.7
	V.4	50.666	41.333	1.020	1.400	6.166	1264.403	4552.450	27.7
	V.5	60.000	51.000	1.000	1.466	6.521	1157.113	5044.943	22.8
	V.6	36.666	44.666	2.022	1.500	5.833	1159.673	4949.333	23.4
	V.7	32.000	51.000	2.030	1.566	6.200	1060.173	4502.863	23.5
	V.8	46.000	59.333	1.675	1.566	5.166	1281.773	5496.490	23.3
LSD (5%)		0.11406	0.18971	0.019416	0.019416	0.130	1.665085	0.0009	374.2

Table 8 explains Effect of the seasons on seed yield and its components characters of eight lentil varieties for both seasons. At the average of two seasons of the interaction, the highest value for seed yield was 2759.39 $kg.ha^{-1}$ recorded by the interaction between variety V.2 and season 2011-2012. In addition, the maximum value for biological yield $kg.ha^{-1}$ was 7842.65 recorded by the variety V.3 and season 2011-2012. The highest value for pod length (cm) and 100 seed weight (gm) was 1.30cm and 6.70 gm, respectively. In contrast, the lowest value for no. of seeds/plant with 32.33 recorded by the variety V.6 and season 2011-2012. In addition, the lowest value for no. of pod. $Plant^{-1}$ was 28.000 recorded by the interaction between variety V.7 and season 2011-2012. The highest value for harvest index was 0.41 produced by variety V.7 and season 2011-2012. At season 2012-2013, no. of $pod.plant^{-1}$ recorded the maximum value with 60.00 by variety V.5 and the season. Nevertheless, the lowest value for no. of seed/pod with 1.00 was recorded by the variety V.5 and 2012-2013 season. The character no. of seed/pod with 2.03 was recorded by variety V.7. While minimum value for seed yield ($kg.ha^{-1}$) and biological yield ($kg.ha^{-1}$) were 1060.173 and 4502.86, respectively, shown by variety V.7 and the 2012-2013 season. The highest value for no. of $seed.pod^{-1}$ with 2.03 was produced by the variety V.7 and the 2012-2013 season. Variety V.8 gave maximum value for no. of $seed.plant^{-1}$ with 59.33 in the 2012-2013 season. In contrast, the lowest value for pod length and 100 seed weight with 1.56 and 5.16, respectively, was recorded by variety V.8.

Table 9 explains the effect of seasons on the growth of lentil varieties. Significant effects were found in both seasons for all characteristics. It is observed that the second season realized more yielding than the first season in all characters, Plant height (cm), Days to %50 flowering, Days to maturity, No. of branches.plant^{-1}, First pod height (cm), No. of bacterial nodules.plant^{-1} by 26.67, 1.85, 15.76, 12.67, 25.06, and 19.46, respectively.

Tables 9: Effect of averages of both seasons on growth characters of eight lentil varieties.

Seasons	Plant height (cm)	Days to %50 flowering	Days to maturity	No. of branches .plant^{-1}	First pod height (cm)	No. of bacterial nodules. Plant^{-1}
2011-2012	39.375	119.166	158.666	3.333	17.666	26.083
2012-2013	31.083	117.000	147.583	2.958	14.125	21.833
LSD (5%)	0.036	0.022	0.034	0.006	0.014	0.053

The first season recorded a significant difference for plant height, days to %50 flowering, days to maturity, no. of branches.plant^{-1}, first pod height (cm), and no. of bacterial nodules.plant^{-1}with 39.37cm, 119.16 days,158.66, days 3.33cm, 17.66cm, and 26.08, respectively.

Table-10: Effect of averages of both seasons on seed yield and its components of eight lentil varieties.

Seasons	No. of pods. Plant^{-1-}	No. of seeds. pod^{-1}	No. of seeds. Plant^{-1}	Pod length (cm)	100 seed weight(g)	Biological yield kg/ha	Seed yield kg.ha^{-1}	harvest index
2011-2012	43.041	1.500	38.958	1.595	6.145	6797.936	2582.096	0.380
2012-2013	37.8333	1.541	48.208	1.358	5.900	5014.808	1221.673	0.244
LSD (5%)	0.0240	0.004216	0.05636	0.0190	0.0054	0.4090	1.6328	0.0003

Data represented in table 10 indicated effects for both seasons' on seed yield and its components of lentil varieties under study. In the first season, no. of pod.plant^{-1}, pod length (cm), 100 seed weight (gm), biological yield (kg.ha^{-1}), seed yield (kg.ha^{-1}), and harvest index with 43.04, 1.59cm, 6.145gm, 6797.93 kg.ha^{-1}, 2582.09 kg.ha^{-1}, and 38%, respectively, were recorded highest values. However, no. of seed.pod^{-1} and no. of seed.plant^{-1} produced the lowest value with 1.50 and 38.95, respectively. In the second season, no. of seed/pod and no. of seed.plant^{-1} with 1.54 and 48.20 gave the maximum value. While no. of pod/plant, pod length (cm), 100 seed weight (gm), biological yield (kg.ha^{-1}), seed yield kg.ha^{-1}, and harvest index with 37.833, 1.35, 5.90, 5014.80 kg.ha^{-1}, kg.ha^{-1} 1221.67 kg.ha^{-1}, and 24%, respectively, gave the minimum values.

Conclusions

Lentil is one of an important legume crop and plays a crucial role in human, animal feeding, and soil improvement.. It is a cool-season food legume playing a significant role in human and animal nutrition and soil fertility maintenance (10). The result of the current investigation indicated the significant differences among the varieties for most of the traits studied, we concluded that the first season 2011-2012 gave the maximum value for days %50 flowering, days to maturity, no. of branches.plant^{-1}, first pod height (cm), and no. of bacterial nodules.plant^{-1} However, the second season realized the highest value for no. of pod.plant^{-1}, pod length, 100 seed weight, biological yield, seed yield, and harvest index of lentil varieties compared to the first season. Depending on the study results, it can be recommended that the variability of variety performance was associated mainly with the climatic conditions and the genetic variation among varieties at each location. Thus, varieties should be carefully selected and released for corresponding regions depending mainly on seasonal weather conditions. Therefore, the Lentil variety V.2 and variety V.3 were selected. Moreover, the first season was better than the second one for planting lentil in the region attributed to climatic differences.

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Appendix

Appendix (1) Mean squares of variance Analysis of Lentil for some growth Characters

		Mean square					
S.O.V	d.f	Plant height (cm)	Days to%50 flowering	Days to maturity	No. of branches .plant^{-1}	First pod height (cm)	No. of bacterial nodules . Plant^{-1}
Replications	2	1.33333	1.08333	6.8125	0.14583	1.27083	55.2708
Year	1	825.021	56.3333	1474.08	1.6875	150.521	216.75
Varieties	7	26.7589	4.33333	5.7976	0.11607	1.37798	183.655
Year*Varieties	7	33.4494	4.14286	16.8452	0.40179	2.52083	30.4167
Year*Replications&Random	2	6.33333	2.33333	5.6453	0.1875	1.02083	13.6875
Varieties*Replications [Year]&Random	28	6.02381	0.97024	2.4910	0.64286	0.78869	35.4554

Appendix (2) Mean squares of variance Analysis lentil for seed yield and its components

		Mean squares							
S.O.V	d.f	No. of pod. Plant^{-1}	No. of Seed. Plant^{-1}	No. of seed .pod^{-1}	Pod length (cm)	100 seed weight (gm)	Seed yield kg.ha^{-1}	Biological yield kg.ha^{-1}	Harvest index
Replications	2	69.9375	106.083	11.0833	0.00271	0.04333	1809.56	7332.56	0.00068
Year	1	325.521	1026.75	16987.7	0.67688	0.72521	2.22775	3.82778	0.22427
Varieties	7	191.473	109.19	45.2113	0.06807	0.97235	82899.2	1178463	0.0015
Year*Varieties	7	160.854	79.0357	41.5923	0.05687	0.08568	8629.89	606944	0.00129
Year*Replications& Random	2	2.77083	15.25	14.250	0.00438	0.14333	31.9959	802.998	0.00044
Varieties*Replications [Year]& Random	28	7.80655	21.5952	10.2857	0.01068	0.14286	1663.51	8404.73	0.0005

Evaluation of Some Genotypes of Bread Wheat Cultivated in Sulaimanyah City for Their Physical, Chemical and Rheological Traits

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Abstract

Seven genotypes of bread wheat (Bora, Sagittario, Scetro, Hesio, Sulaimani-2, Al-Wafia, and Bingal) were evaluated in their physical, chemical and rheological properties of their grains and flour. The varieties were selected and sowed in Bakrajo field station belongs the Directorate of Agricultural Research Center in Sulaimanyah. The result showed that the specific weight, the weight of one thousand kernel and flour extraction rate for tested wheat ranged from 79.3 to 82.8 kg/hectoliter, 43.75 – 48.89 g and 58.33- 68.42% respectively. The result also showed that Bingal contained the high percentage of protein (14.2%). The rheological results showed that Sagittario had the lower value of Amylograph peak viscosity (670 AU) compared with Sulaimani-2 which had the highest value (1300 AU). Farinograph stability time parameter ranged between 1.3 and 2.1 for tested wheat. However, Hesio was the better in most of farinograph parameters compared with other samples. Also, Hesio had the higher loaf volume (225cm^3) and loaf specific weight (2.46 cm^3/g).

Keywords: Bread wheat, Genotype of wheat, Quality traits, physical properties, chemical composition.

Introduction

Bread wheat in the worldwide and in the Mediterranean basin, in particular is considered as an important cereal crop (Al-Salih & Brennan 2012). Bread wheat production consists of more than half cereal crop production in Iraq and northern area of Iraq as total production. Wheat (*Triticum aestivum* L.) belongs to family Poaceae tribe Hordeae. It is the most important winter season crop of Iraq. Wheat provides a lot of energy and protein for humans and animals. Wheat proteins (9–15%) are very important for its functionality, although starch is the major component of the grain, accounting for 60–75% of the total dry weight. Wheat flour is used to make a wide variety of products including cakes, pasta, bread, noodles, and biscuits, which is possibly because of the gluten proteins in wheat, which possess the viscoelasticity properties (Shewry *et al*., 2009). During the last century, in many countries, wheat breeding efforts concentrated on yield increases, with grain quality improvement being a secondary breeding objective. Furthermore, studies that assess genetic gains have frequently referred to yield and associated traits, while the enhancement of grain quality has received little attention (Sanchez-Garcia, *et al*., 2015). It is well known that the characteristics of flours depend not only on the properties of the raw material but also from the technological process of milling, which is often held responsible for the decreasing of the flour quality (Danza, *et al*., 2014). Wheat end-use quality such as flour is strongly related to the properties of the gluten matrix, which are determined primarily by the quantity and quality of gluten proteins (Sanchez-Garcia, *et al*., 2015).

The aim of this study is to study the physical, chemical, Rheology traits and baking properties of some new genotypes cultivated in Agricultural Research Centre, Bakrajo, Sulaymaniyah to introduce new wheat types in order to fulfill the bread market demands and bread making.

Materials and Methods

Material: seven genotypes of bread wheat (Bora, Sagittario, Scetro, Hesio, Sulaimani-2, Al-Wafia, Bingal) were sown in Bakrajo field belongs the Directorate of Agricultural Research Center in Sulaimanyah city. The station altitude is 756 m above the sea level, Latitude (35. 55 31), longitude (45. 35 39). The wheat varieties were sown in the mid November 2017 – 2018 and the annual rainfall was 508 mm. This research has been done under the same ecological and variation agronomy conditions.

Bread making materials

Instant Yeast (saf + plus) from S.I.leaftre/Turkey: Iodized Salt (ZER) from Turkey; Sugar (Al-Osra) from the Kingdom of Saudi Arabia; the Oil (Al-afia) from Jeddah/KSA and Milk type (Nido) nestle from Dubai-U.A.E, were purchased from the local market to be used in preparing Loaf pan bread.

Chemicals: All chemicals were used in this research are annular.

Methods:

Physical tests: The weight of one thousand kernel was achieved by counting out 1000 kernels of wheat and then weighted them (in gram), whereas test weight (kg hecoliter) of wheat grains was carried out according to AACC method No.55-10.01 (AACC, 2000).

Wheat mill: Wheat grains were milled in a local milling shop in Sulaymaniyah. The mill discs were adjusted to reduce the extraction rate of flour grains as possible as it can. The flour was then sieved through sieve No. 9xx (150µ). The percentage of flour produced from 100g wheat presents the flour extraction rate (%).

Chemical composition: moisture, protein, fat, ash, wet and dry gluten percentages were determined according to AACC (2000) methods: 44-15.02, 46-12.01, 30-10.01, 08-01.01, 38-10.01 respectively. Total carbohydrates were determined by difference (Nitrogen free extract) according to AOAC (2012).

Rheological tests: Amylograph and Farinograph tests were achieved according to AACC (2000) methods: 61-01.01, 54- 21.02 respectively.

Baking test: Loaf pan bread for all flour samples was prepared according to the (AACC, basic straight-dough bread-baking method and long fermentation method No. 10-09.01) (AACC, 2000) with some modification in loaf recipe. Loaf bread made from (100g flour, 4g sugar, 4g milk, 1.5g yeast, 1.5g salt and 2ml oil). The ingredients were mixed for 5-10 minutes in a Mixer to form dough and then fermented at 30°C for 3hours. Three times of punching were carried out at 60,120- and 180-min. during dough fermentation. Fermented dough was divided to 100g pieces; hand molded and sheeted, and the paned bread was then proofed to 25 min. at 30 °C and 85% R.H.(relative humidity). The breads were baked in an electric oven for 20 min at 220 °C. The specific volume of bread was determined by the following equation according to AACC, Method No. 10-05.01, 2000.

$$specific\ loaf\ volume\ (ml\ /\ g) = \frac{loaf\ volume\ (\ ml)}{loaf\ weight\ (\ g\ )}$$

Statistical Method: Analysis of variance (ANOVA) followed by Least Significant Difference (LSD) were performed using SPSS 16.0 (2007) (SPSS Inc., Chicago, IL, USA). All the calculations were done at the significance level of $p<0.05$.

Results and Discussion:

Physical Properties: Table.1shows the values of physical properties of studied wheat cultivars. The results showed that all studied samples have high values of specific weight which were more than the range of European Commission between 73 and 77kg/hl, for acceptable soft wheat European Commission (2010). Specific weight is directly related to the density and soundness of the grain (Emvula, 2012). Rankin, (2009) reported that anything that impacts the movement of nutrients to the kernel during grain fill or degrades the integrity of the kernel once it is filled, is believed to lower grain specific weight, in addition to the physical properties of the kernel, including kernel shape, kernel size, kernel condition, and grain density. The results also, showed that there were a slightly but significant differences among wheat cultivars in this characteristic which ranged between 79.3 in Hesio genotype and 82.8 kg/hl in Al-Wafia. These results were in agreement with Dangi and Khatkar (2017).

The results also showed that there were significant differences among the genotypes in their weight of one thousand kernel which ranged between 43.75 g for Al-wafia and 48.89 g for Scetro. These results were in agreement with Al- Saleh and Brennan (2012) who studied some physical characteristics of Syrian and English bread wheat. The high value of weight 1000 grains indicates to wheat content of heavy weight, starch and protein components.

Flour extraction rate also significantly differs among the wheat samples since Al- wafia produced the lower amount of flour (58.33%) while Bingal had the highest flour extraction rate (68.42%) depending on this parameter and by taking in consideration the other two parameters, it can say that Bingal type exceeded on the other types in its physical characteristics.

Table 1. Physical properties for Studied Wheat types:

Wheat Sample	Specific weight Kg. hectoliter^{-1}	Weight of thousand grains g	Flour Extraction rate %
Bora	79.5	46.03	60.00
Sagittario	81.4	44.69	63.15
Scetro	81.6	48.89	60.00
Hesio	79.3	44.2	64.70
Sulaimani-2	81.6	44.5	59.09
Al-Wafia	82.8	43.75	58.33
Bingal	82.5	47.90	68.42
LSD	0.53	0.32	1.20

Chemical Composition: The results of wheat chemical composition (table 2) showed that there were significant differences among the genotypes in all determined chemical components. The low value of moisture indicates to the proper storage for these samples of wheat. The results also showed that, except Bingal which contained 14.2% protein, there were slight significant differences among the other types of wheat. This range of protein percentages exceed than the value of Iraqi official Standards for bread flour which is 10% (Ayoob, 2014). Tayyar (2010) reported that, in general, high protein flours give rise to better results since they have a high loaf volume potential with higher water absorption.

The results also showed that the ash and crude lipid for the flour of studied wheat were higher than the white flour may be due to the method of mill which was used to produce wheat flour. Local disc mill was used in this research instead of roll mill caused increasing of ash to be between 0.99 to 1.00%. Increasing of ash may increase flour color in addition to weaken the gluten.

Although, carbohydrate is less impact on flour quality compared with protein but percentage of damaged starch and paste temperature may have an effect on loaf quality. However, carbohydrate also slightly significantly differed among the studied wheat flour due to the differences between the other components especially protein.

Table 2. Chemical Composition of Studied Wheat flour

Wheat Sample	Moisture %	Protein %	Ash %	Crude lipid %	Carbohydrate %
Bora	8.4	12.4	0.99	3.01	75.20
Sagittario	8.3	12.4	0.99	2.87	75.44
Scetro	8.8	12.9	0.99	3.10	74.21
Hesio	7.9	11.4	0.99	2.77	76.94
Sulaimani-2	7.9	11.6	1.00	3.08	76.42
AlWafia	8.7	12.3	1.00	3.26	74.74
Bingal	8.2	14.2	0.99	3.11	73.50
LSD	0.26	0.13	0.02	0.13	0.55

Gluten content:

The results of wet and dry gluten (table 3) shows the significant differences among most studied wheat flour in their content of wet and dry gluten which, they ranged from 14.5 for Al-Wafia to

37.40% for Bingal and from 4.30 for Al-Wafia to 13.30% for Sagittario respectively. This result is in agreement with Ceseviciene and Butkutė (2012) who determined the wet and dry gluten of more than 200 cultivars of common and spelt wheat. Gluten plays a key role in determining the unique baking quality of wheat by conferring water absorption capacity, cohesivity, viscosity and elasticity on dough(Wieser, 2007). As it is known, these values represent only the quantity of gluten but farinograph or other tests can determine the quality of gluten. However, gluten washing method may give an acceptable guess about its quality as indicated that Ceseviciene and Butkutė (2012).

Rheological properties

Amylograph: The results (table 4) showed that there were significant differences between some types of wheat in paste temperature parameter which the values ranged from 59°C for Scetro to 63.5°C for Hesio. These values coincided with the values of the wheat varieties. In general, the high value of paste temperature may permit for more increasing of loaf volume (Horstmann, *et al*., 2016).

Table3. Wet and dry gluten content in studied wheat types.

Sample	Wet gluten %	Dry gluten %
Bora	15.00	5.00
Sagittario	35.10	13.30
Scetro	33.30	12.10
Hesio	23.10	8.20
Sulaimani-2	30.20	11.10
AL-Wafia	14.50	4.30
Bingal	37.40	13.10
LSD	1.36	0.89

The results also showed that there were significant differences among all tested wheat flour in peak viscosity which the values ranged from 670 AU for Sagittario to 1300 AU for Sulaimani2. The optimum value of peak viscosity must be about 600AU which mean an optimum activity of amylases is present in the flour to produce a good quality of bread. Increasing of the value of this parameter means a weak activity of amylase while the decrease means a highly activity of this enzyme. Both of these behaviors may negatively influence on bread quality (Hadnađev and Pojić, 2012).

Temperature of peak viscosity parameters is an indicator, as general, to end of starch granules gelatinization in addition to be a measure for capability of gelatinized starch to resist the breakdown as a result of heat and mixing effect. Bora had the lower value of this parameter (91.5°C) while Sulaimani2, Alwefia and Bingal had the higher value (95°C). However, these values stay within the values of Iraqi wheat flour (Zainulabideen (1984).

Table 4. Amylograph parameters results of studied wheat flour

sample	Paste temperature	Peak viscosity AU	Temperature of peak viscosity
Bora	61.5	820	91.5
Sagittario	61	670	93
Scetro	59	760	92
Hesio	63.5	1090	93
Sulaimani-2	61.5	1300	95
Alwafia	60	1020	95
Bingal	60	1080	95
LSD	1.3	5.78	0.66

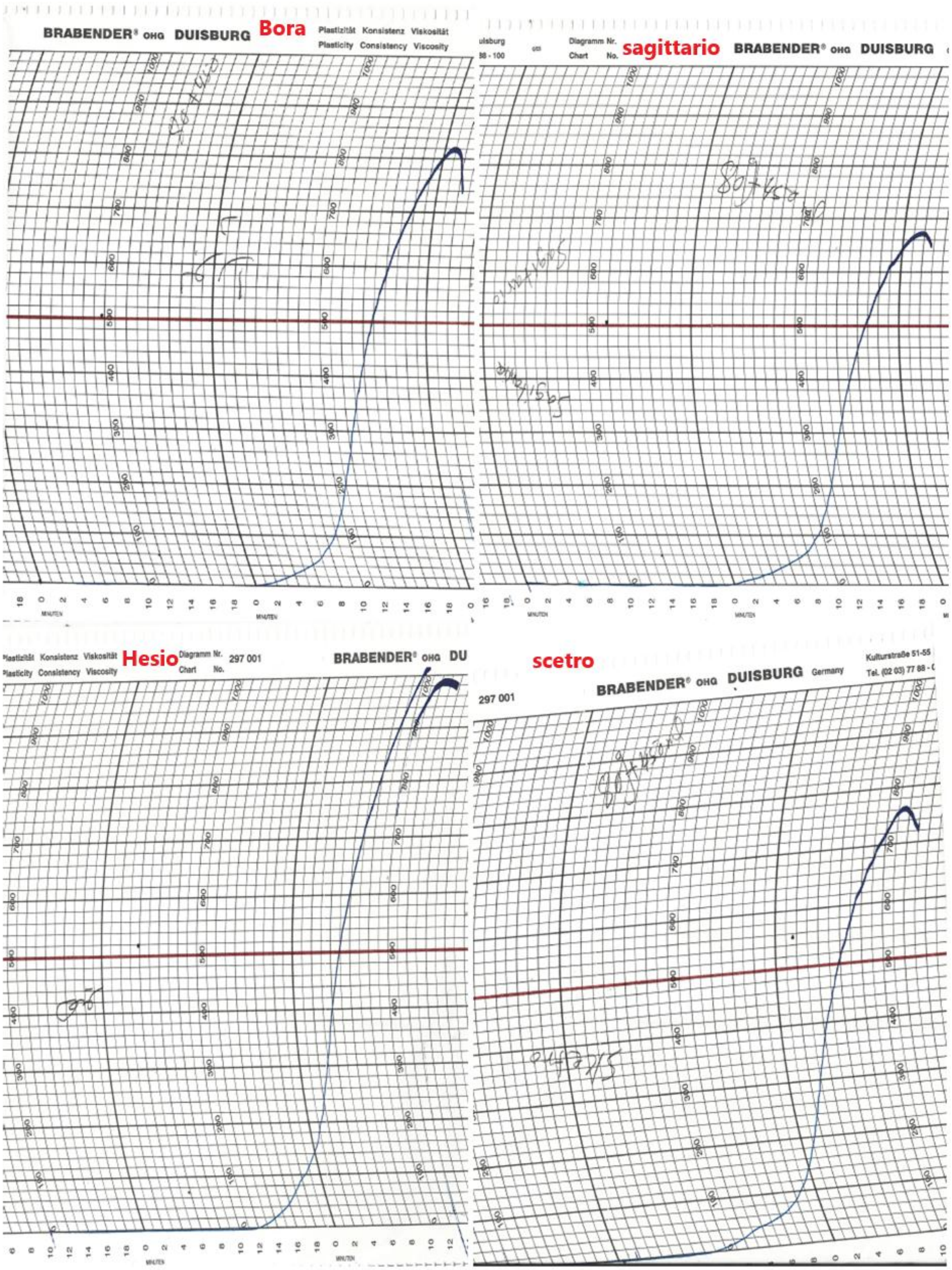

Figure 1. Amylogram for some studied wheat types

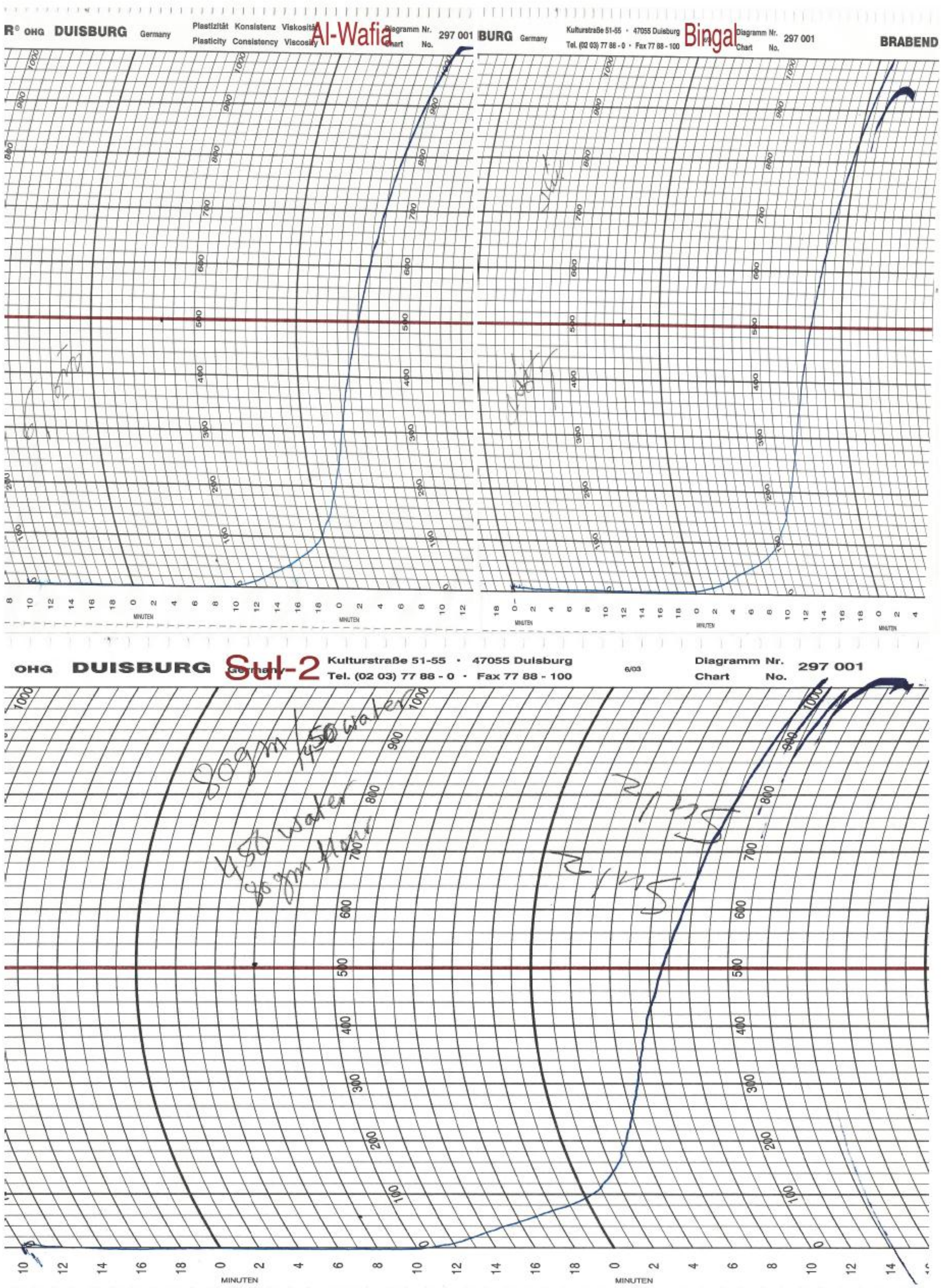

Figure 2. Amylogram for some studied wheat types

Farinograph: Farinograph results (table 5 and figure 2) cleared presence of significant differences between most tested wheat flour in most parameters. Farinograph water absorption ranged from 66.1% for Hesio to 74.6% for Bingal indicated to the significant difference between wheat types. Increasing of water absorption means that flour contains good quantity and quality of protein especially gluten, in addition to this characteristic is wish able from bakery since it will produce more bread. Aydoğan *et al.*, (2015) reported that Farinograph absorption correlated also with dough stability. High water absorption is desirable and combined with low degree of softening indicates good quality flour, whereas a high water absorption combined with a high degree of softening indicates poor quality flour.

Table 5. Farinograph parameters results of studied wheat flour

Flour sample	Water absorption %	Development time minute	Stability Time minute	Mixing Tolerance index FU	Time to breakdown minute
Bora	73.9	3.2	1.7	76	4.4
Sagitario	73.1	2.8	1.9	64	4.4
Scetro	74.5	3.0	1.8	78	4.0
Hesio	66.1	3.2	2.1	68	4.8
Sulaimani-2	74.3	3.5	1.6	71	4.7
AL-Wafia	71.6	3.0	1.3	160	3.7
Bingal	74.6	3.5	1.7	121	4.2
LSD	0.68	0.11	0.03	1.3	0.10

The results of development time showed that the difference among the samples was slight, although it was significant for some types, which ranged from 2.8 for Sagittario to 3.5min. for Bingal and Sulaimani 2. Decrease of time to develop the dough is closely correlated with the short time to prepare the dough. Stability time is an important farinograph parameter because it is indicator to the capability of dough to resist the breakdown by the continuous of mixing. The results showed that all samples had a very low value of this parameter which ranged from 1.3 min. for Al-Wafia to 2.1min. for Hesio. These values emphasized the weakness of these type of wheat. In addition to the type of wheat, this result may also attribute to the use of local mill that produces flour with high content of fiber and less quality of gluten.

The results of parameters, Mixing Tolerance Index (MTI) and Time to Breakdown (TB) emphasized on the weakness of the flour of all wheat types. MTI ranged from 64 FU for Sagittario to 160 FU for Al-Wafia while TB ranged from 3.7min for Al- wafia to 4.8min. for Hesio. These results were in agreement with Moradi *et al*., (2014) who found that the high extraction flour, that contains a high percentage of ash as a result of bran addition, had softening effect in dough and by increasing the bran content in flour, there is an increase in the Farinographic properties such as water absorption and MTI and in contrast, development time and stability of the dough decrease.

According to the most important of farinograph characteristics, stability time, mixing tolerance index and time to break time, it can say that Hasio sample had the better farinograph characteristics while Al- Wafia was the worst.

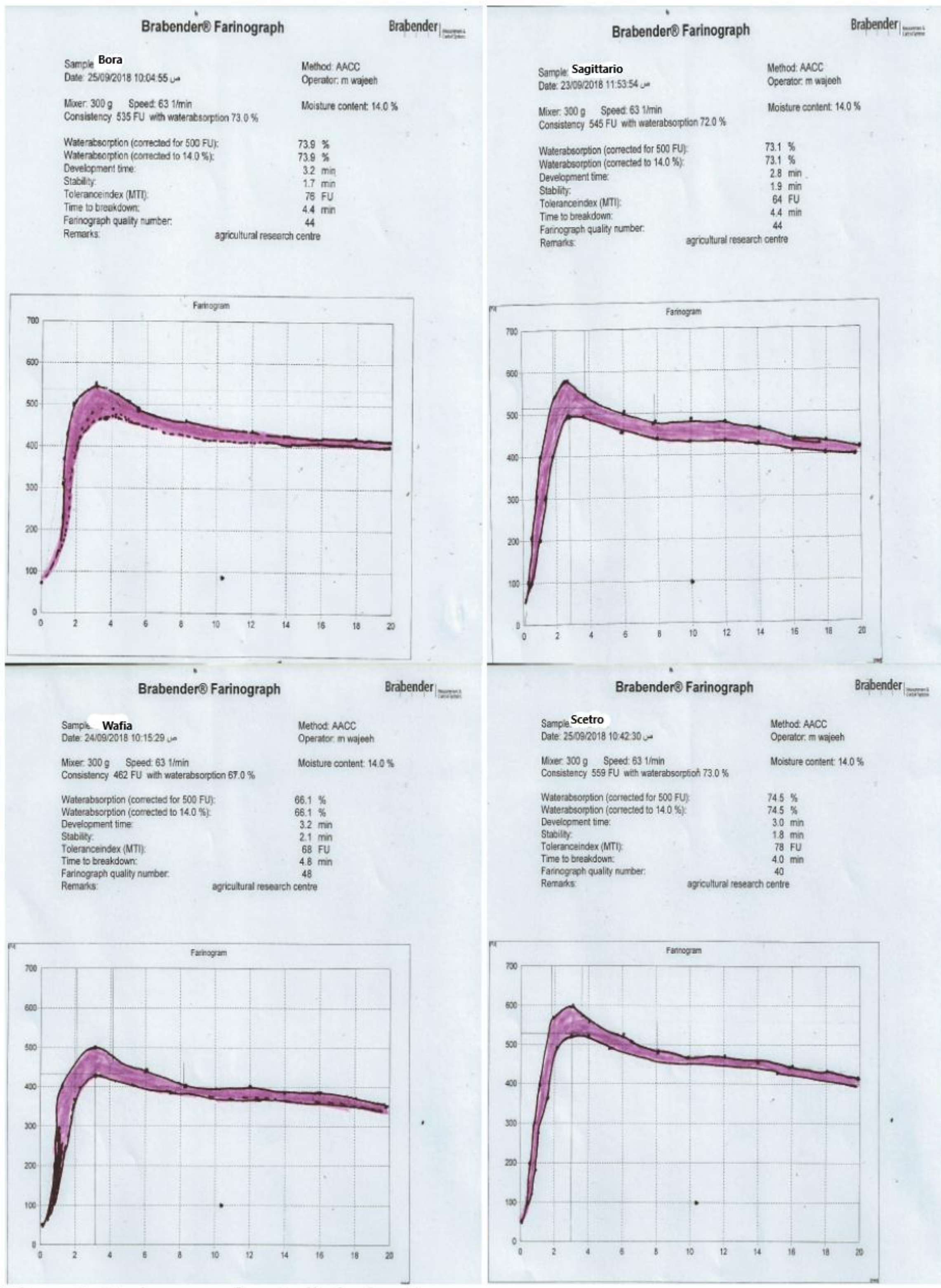

Figure 3. Farinogram for studied wheat types

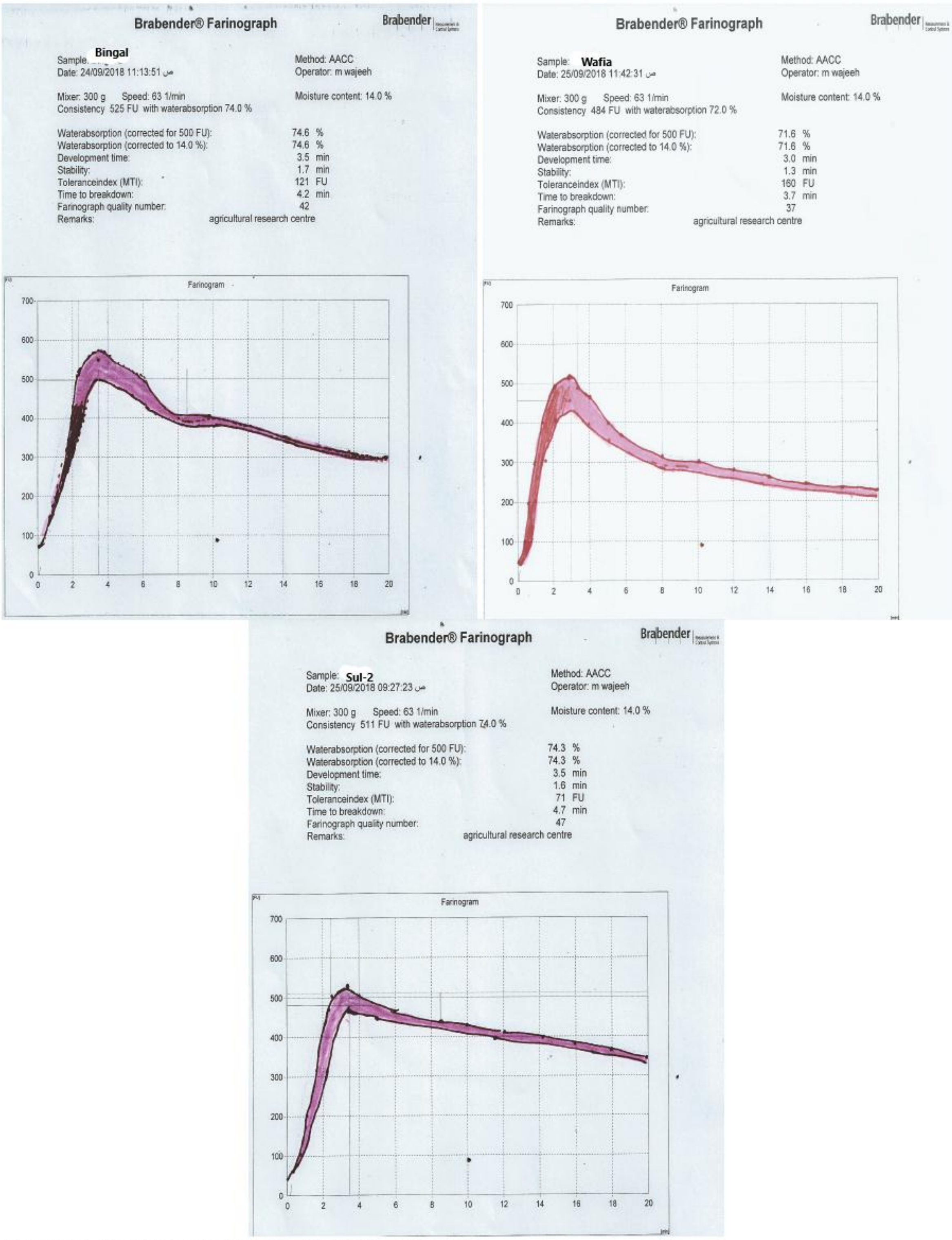

Figure 4. Farinogram for studied wheat types

Loaf characteristics

Table (6) shows the results of baking test which cleared that there were significant differences between some samples in some loaf characteristics. Weight of loaf ranged between 90.2 g for Scetro and 92.1g for Bora, meaning that the loafs dough lost about 9.8 -7.9% of their weight as a moisture during baking. Although, the oven temperature is the cause of the moisture loss but also there are individual factors among the samples of wheat assist to resist the moisture loss such as late of protein denaturation and breakdown of gelatinized starch granules.

The results also showed that loaf volumes significantly differed among the wheat samples which ranged from 195 cm^3 for Bora to 225 for Hesio. Loafs dough rises during baking depending on the ability of gluten to extend and keep on the gas, in addition to the less effect factors such as the temperature of starch paste and the amount of wheat pentosane and its ability to hold the water.

Loaf specific weight (LSW) is a resultant of the values of loaf weight and volume therefore; the results showed that there were significant differences among some samples. LSW ranged from 2.11 for Bora to 2.46 $g.cm^{-3}$ indicating that all wheat samples were weakness since the standard of LSW must be at least 2.5$g.cm^{-3}$. These results were in agreement with Fadle *et al.*, (2010) who tested some local cultivars of Yamani soft wheat. Using of local disc mill is one of some factors may be attributed to effect on flour quality because it increased the ash and bran percentages which may cause decrease of flour quality due to dilute of gluten. These results may emphasizes that Hesso and Sulaimani2 are the better types compared with the other types of tested wheat

Table 6. Loaf characteristics of studied wheat flour

Sample	Weight g	Volume cm^3	Loaf Specific Weight(LSW) $g.cm^{-3}$
Bora	92.1	195	2.11
Sagittario	91.6	213	2.32
Scetro	90.2	200	2.21
Hesio	91.3	225	**2.46**
Sulaimani-2	91.0	222	2.43
AL-Wefia	91.5	200	2.18
Bingal	92.0	220	2.39
LSD	0.85	3.83	0.17

CONCLUSION

It is obvious that in the Mediteranean basin bread wheat account as one of the important food stuff in daily people consumption. The current research conducted in the Directory of agricultural research in Sulaimaniah in cooperation with Food Science Technology in Sulaimanyah University. Seven cultivars (Bora, Sagittario, Scetro, Hesio, Sulaimani-2, Al-Wafia, Bingal) were used in this research. The results show that cultivar Bingal have 14.2% of protein which is the highest protein content between cultivars. Also, the rheological trait of Saggitario cultivar showed lower value of amylograph peak viscosity (670 AU) compared with Sulaimany-2 which has high value (1300 AU). Hesio cultivar showed the better farinograph parameter compared with other six cultivars. Regarding loaf volume Hesio had the higher loaf volume which has (225 cm^3) and loaf specific weight (2.11 – 2.46 $g.cm^{-3}$). Further research is required in the future on these bread wheat cultivars to highlight the variation in physical, chemical and rheological traits and then the dough characteristics and finally the bread making process.

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Genetic variability and heritability estimates of agronomic traits in lentil (Lens culinaris Medik.)

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GENETIC VARIABILITY AND HERITABILITY ESTIMATES OF AGRONOMIC TRAITS IN LENTIL (*Lens culinaris* Medik.)

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ABSTRACT

Assessing genetic variability and heritability of the targeted traits is among the crucial first steps toward lentil crop breeding. With the aim of estimating genetic variability and heritability of the crop traits and screening the most promising genotypes, a total of 12 lentil genotypes (11 lines from ICARDA, Syria, and one local cultivar) were evaluated at three locations of the Sulaimani region, northern Iraq during 2018-2019 season. Results showed a significant ($P\leq0.05$) genetic variation among the lentils for most of the agro-morphological traits. In pairwise comparisons, ICARDA lines Flip 93-36L and Flip 2009-70L showed the best performance for most of the evaluated traits and were identified as the most promising for local cultivation and breeding goals. The very significant positive and negative correlations were between seed yield with biomass (r=0.89) and number of days to emergence (r=-0.89). The highest to lowest broad-sense heritability (H^2) values were recorded for 100 seed weight (0.74), number of days to flowering (0.67), first pod height (0.55), biomass (0.47), harvest index (0.37), number of days to maturity (0.36) and 100 seed yield (0.36). Principal components analysis (PCA) supported by cluster analysis was used to analyze the variability among the genotypes based on agro-morphological traits. The first three principal components explained 84.16% of the variability among the genotypes. In addition to the identification of potential lentil genotypes for cultivation uses and lentil breeding in northern Iraq, our variability and heritability data would contribute to the body of lentil breeding knowledge.

Keywords: lentil, genetic variability, broad sense heritability, agro-morphological traits, principal component analysis.

INTRODUCTION

Cultivated lentil (*Lens culinaris* Medik.) is a self-pollinated legume crop with 14 chromosomes (2n=2x=14) and is considered as the most ancient cultivated crop among the legumes (Cokkizgin and Munqez, 2013). Lentils are nutritionally invaluable because they provide a significant level of beneficial nutrients such as proteins, fibres and micronutrients (Karak et al., 2012). According to FAO statistics 2014, the biggest proportion (61%) of lentil production belongs to Asian countries. Concerning the exact origin of this crop, archaeological, botanical and genetic studies emphasize on a core area within the Fertile Crescent comprising southeast of Turkey and North of Syria, near the springs of the Tigris and Euphrates rivers where is supposed to be the real cradle of agriculture (Lev-Yadun et al., 2000; Sonnante et al., 2009).

Study of genetic variability of crops germplasm and estimating the heritability of the traits are among first crucial steps toward breeding crops for desired agronomic traits. Agro-morphological traits have widely been used to investigate genetic diversity among various lentil germplasm including wild accessions (Singh et al., 2020), ICARDA germplasm (Pouresmael et al., 2018), local accessions (Abbasov et al., 2014), and cultivars (Mohammed et al., 2019). For example, in an investigation on the variability of 35 lentil genotypes at agro-morphological levels, Mohammed et al. (2019) identified potential genotypes for dry environment cultivation. In another study on ICARDA germplasm, a significant variations was

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reported among the investigated lentil germplasm (Pouresmael et al., 2018).

Broad sense heritability (H^2) is defined as the proportion of phenotypic variance attributed to total genotypic variance including dominance, additive, and epistatic variance (Schmidt et al., 2019). In more simple words, H^2 is defined as a part of phenotypic differences between genotype that can potentially be inherited to the next generations. In breeding programs H^2 is used to predict the response to selection and, hence gives breeders the ability to predict and decide about the success of breeding programs (Piepho and Möhring, 2007; Russu et al., 2019). Broad sense heritability has been estimated for different characteristics of lentil plants including agro-morphological traits (Laskar and Khan, 2017; Singh et al., 2018; Kumar et al., 2018; Debbarma et al., 2018). In a study on 96 lentil genotypes, the H^2 estimation for different agronomic traits ranged between 0.58-0.95 percent (Kumar et al., 2018). In another study a wide H^2 range for different traits from 30.1% for days to maturity to 88.5% for number of fruiting branches have been observed (Singh et al., 2018).

Although Iraq generally and particularly its northern part fall within the main lentil domestication area which harbour a considerable amount of cultivated lentil germplasm, very little research has been done on genetic diversity and heritability of different characteristics including agronomic traits in lentil. In a study on nine ICARDA and local lentil genotypes using agro-morphological traits and RAPD markers Abdulrazzak and Omer (2017) investigated genetic variation and found a high variation among lentils with a considerable part of the variation being between Local and ICARDA populations. Moreover, screening prominent genotypes for particular regions based on environmental conditions would be crucial and helpful for enhancing lentil yield among farmers. Therefore, the main objectives of the present study were to investigate 12 lentil genotypes which are commonly grown in Sulaimani region, northern Iraq, firstly, to assess the phenotypic/genotypic variation and estimate broad-sense heritability of agronomic traits and secondly, to screen and identify prominent genotype(s) in terms of yield performance for cultivation uses across variable environmental condition in the region.

MATERIAL AND METHODS

Plant Materials

The experimental plant material comprised twelve lentil genotypes, including 11 lines introduced from International Center for Agriculture Research in the Dry Areas, ICARDA, Syria and one local cultivar of Sulaimani region (Table 1). The seeds were provided from the Agriculture Research Center in Bakrajo-Sulaimani. These genotypes are the most common lentil genotypes, introduced from ICARDA and are currently cultivating in this region.

Table 1. List of the lentil lines originated from ICARDA (Syria), with the exception of Sulaimani-Local which is a local cultivar

Genotypes	Origin	Type	Code
Flip 93-36L	ICARDA	line	G1
Flip 04-60L	ICARDA	line	G2
Flip 04-64L	ICARDA	line	G3
Flip 05-51L	ICARDA	line	G4
Flip 2008-7L	ICARDA	line	G5
Flip 2009-24L	ICARDA	line	G6
Flip 2009-52L	ICARDA	line	G7
Flip 2009-54L	ICARDA	line	G8
Flip 2009-64L	ICARDA	line	G9
Flip 2009-70L	ICARDA	line	G10
L10728	ICARDA	line	G11
Sulaimani-Local	Sulaimani	cultivar	G12

Field Experiment

A field experiment was carried out at three locations in Sulaimani region including Bakrajo (location 1) 35°32'42.67"N, 45°21'5.66"E and 738 m, Chamchamal (location 2) 35°31'55.28"N, 44°48'50.66"E and 731 m and Girdjan (location 3) 36°12'33.32"N, 44°47'25.93"E and 533 m (Google Earth Pro, 2020). All three locations are research stations belonging to Agriculture Research Center of Sulaimani. Soil properties for all the three locations are listed in Table 2. The seeds were sown in autumn 2018 at different sowing times on 26th November, 19th December and 4th December of 2018, for all three locations, respectively.

A factorial experiment was run in CRBD design with three replicates. Three environmental conditions were assumed as the levels of first factor and the twelve lentil genotypes were assumed as the levels of second factor. The seed rate of 80 kg/ha was applied for all the genotypes at all three locations. Seeds were planted on lines in plots of 3.2 m^2, each plot comprised of 4 lines, each line with 4 m length and 20 cm distance between the lines. The genotypes were grown in fallow land with no fertilization for all three locations under rainfed condition. Mechanical weed control was applied to the experiment.

Table 2. Some chemical and physical properties of the soil samples in the three locations

Properties	Bakrajo (L_1)	Chamchamal (L_2)	Girdjan (L_3)
Nitrogen%	0.13	0.21	0.19
Phosphorus (ppm)	10.6	12.02	11.708
K^+ Meq/L	0.069	0.138	0.071
Organic Matter %	1.75	1.86	1.67
EC ds.m^{-25C}	0.128	0.17	0.14
pH	7.54	8.03	7.95
Cl^- Meq/L	0.6	0.6	0.4
$CaCO_3$%	18	15	29

Collecting agro-Morphological data

The agro-morphological data were measured following the descriptors proposed by the International Plant Genetic Resources Institute (IPGRI). Data were recorded from the whole plot for seed yield, biomass, and harvest index, while for other traits the average value from ten plants in each plot was recorded. The measured traits include; Seed yield (SY) in kg/hectare as a rate of yield per hectare by tons, counted by converting the yield of plot area into a hectare, Days to emergence (DE), counted as the number of days spent from sowing till the emergence of the first seedling, Days to 50% flowering (DF), Days to 50% maturity (DM), First pod height (FPH), 100 seed weight (SW), Biomass (B), was the average weight of the whole plants for each plot converted to ton/ha, and Harvest index (HI), counted as the ratio of grain yield to biological yield, according to Rehman et al. (2009).

$$\text{Harvest index (HI)} = \frac{\text{Economic yield(seed yield)}}{\text{Biological yield}} \text{ X } 100$$

Estimating Broad sense heritability

Broad sense heritability (H^2) was measured using a combined variance component procedure according to Comstock and Moll (1963) using a mixed model with genotype × locations interactions considering location and blocks as random genotypes as a fixed variable. After extracting variance components i.e. genotypic ($\sigma^2 g$), genotype × location interaction ($\sigma^2 gl$) and error ($\sigma^2 e$) variances from combined ANOVA table, H^2 was measured using the following formula.

1. $$\sigma^2 g = \frac{MSG - \sigma^2 e - \sigma^2 gl}{RL}$$

Where MSG is the mean square of genotype variable in the ANOVA table, R is the number of replications and L is the number of locations.

2. $\sigma^2 gl = \frac{MSGL - \sigma^2 e}{R}$

Where MSGL is the mean square of genotype × location interaction and R is the number of replications.

3. $\sigma^2 p = \sigma^2 g + \sigma^2 gl + \sigma^2 e$

4. $H^2 = \frac{\sigma^2 g}{\sigma^2 p} = \frac{\sigma^2 g}{\sigma^2 g + \sigma^2 gl + \sigma^2 e}$

Data Analysis

Data collected for all the three locations were subjected to the combined analysis of variance (ANOVA) based on factorial CRBD experimental design. Means were compared by using Duncan's test at the 0.05 probability level. Prior to the ANOVA analysis, Bartlett test was used for the test of variance homogeneity of the data. ANOVA, compare means for both genotypes and locations for agro-morphological traits and Pearson correlation coefficient between traits was performed using XLSTAT version 2016 and SPSS Statistics Version 2019 (SPSS Inc., IBM Company). Hierarchical clustering based on Euclidean distance coefficients and Principal component analysis (PCA) was analyzed using XLSTAT software.

RESULTS AND DISCUSSION

Analysis of variance

A considerable variation among the genotypes was found for the agro-morphological traits. The results of the analysis of variance revealed a significant ($P \leq 0.05$) genotype variation for agro-morphological traits: seed yield (SY), days to 50% flowering (DF), days to 50% maturity (DM), first pod height (FPH), 100 seed weight (SW), biomass (B), and harvest index (HI). However, the genotype effect was not significant on days to emergence (DE). Also, the effects of location and the interaction of genotype × location was statistically significant ($P \leq 0.05$) for all of the evaluated traits (Table 3). These data indicate a significant genotypic variation for the studied agro-morphological traits, except DE and phenotypic variation resulted from environmental factors or their interaction with genetic factors.

Table 3. Two-way ANOVA results for different agronomic traits of studied lentil genotypes

ANOVA (MS±SE)[a]			
Trait	Genotype	Location	Genotype × Location
SY	156065±43816**	7510202.4±41082**	45097± 8471**
DE	14.7±16.52	3512.1±17.5**	16.6±0.48**
DF	353±47.7**	10152.5±46.8**	47.5±1.1**
DM	97.4±34.8*	9654.6±35.3**	34.8±0.6**
FPH	59.2±9**	483.7±13.3**	9±2.2**
SW	2.9±0.27**	4.6±0.4**	0.27±0.01**
B	823499.8±8493**	54474356.6±142163**	156701±41324.3**
HI	0.015±0.002**	0.21±0.002**	0.003±0.001*

*, **: significant at 0.05 and 0.01levels, respectively.
[a] the numbers represent mean square ± standard error.

Pairwise comparisons were carried out between the three locations and between the 12 genotypes using Duncan's comparison of the means. According to the comparisons, significant differences were observed between all three locations (Table 4).

Under conditions of locations 1 and 3 the values for traits SY, B, DE, SW and FPH were close but different from those of location 2. For example, the means of SY in locations 1 and 3 were 1027.9 and 1186.2, whereas it was 327.9 in location 2. Also, while DE mean was 36.9 in location 2, it was 21.4 and 18.5 in locations 1 and 3, respectively. Soil fertility and dried condition especially during growth and seed filling period could be one of the reasons for the highest seed yield obtained in Bakrajo and Girdjan (location 1 and 3) compared to the yield of location 2. Differences in the elevation between Bakrajo and Girdjan (300 m) seems to have no negative impact on the performance of lentil at both locations, being less sensitive to the climate and soil features, as lentil has the ability to grow in wide environmental condition and elevation rate from 200 m up to 3000 m above sea level (Ansari et al. 1990; Cokkizgin and Munqez 2013). The means of seed yield among the genotypes over the locations ranged from 670.2 to 1084 kg/ha. In pairwise comparisons, genotypes G10 and G1, with means of 1084.4 and 1019.4 kg/ha, showed the highest performance for SY. In addition, G1 and G10 along with G12 produced the highest amount of biomass among all the genotypes (Table 4).

Table 4. Duncan's compare means results for genotype and locations

Genotype^{a}/ Location	Traits							
	SY	DE	DF	DM	FPH	SW	B	HI
G1	1019.4^{ab*}	23.7^{e}	104.1^{j}	148.2^{g}	11.4^{b}	3.1^{f}	2537.7^{a}	0.417^{abc}
G2	670.2^{h}	24.7^{d}	115.6^{de}	154.4^{d}	7.8^{de}	2.7^{i}	1750.1^{e}	0.400^{c}
G3	906.1^{cd}	25.0^{cd}	114.6^{e}	152.8^{e}	9.1^{cd}	4.5^{a}	2143.5^{bc}	0.427^{abc}
G4	812.5^{efg}	24.9^{cd}	111.0^{g}	153.4^{e}	9.1^{cd}	3.4^{d}	1876.6^{de}	0.427^{abc}
G5	670.6^{h}	25.6^{c}	112.2^{f}	155.2^{cd}	7.1^{ef}	2.9^{h}	1700.6^{e}	0.40^{4bc}
G6	886.0^{cde}	24.3^{de}	111.8^{fg}	155.1^{cd}	9.5^{c}	3.6^{c}	2122.4^{bc}	0.424^{abc}
G7	787.3^{fg}	24.3^{de}	105.7^{i}	153.0^{e}	8.8^{cd}	3.5^{cd}	2028.2^{cd}	0.408^{bc}
G8	778.2^{fg}	26.4^{b}	116.3^{d}	155.6^{c}	9.1^{cd}	2.4^{j}	2057.8^{bcd}	0.389^{c}
G9	971.4^{bc}	27.6^{a}	118.2^{c}	155.1^{cd}	11.4^{b}	2.9^{gh}	2262.6^{b}	0.443^{ab}
G10	1084.4^{a}	26.7^{b}	109.0^{h}	149.1^{f}	5.8^{f}	3.0^{fg}	2508.1^{a}	0.448^{a}
G11	846.2^{def}	26.9^{ab}	120.7^{b}	157.3^{b}	13.3^{a}	3.8^{b}	2172.1^{bc}	0.411^{abc}
G12	736.2^{gh}	27.0^{ab}	126.3^{a}	160.4^{a}	14.8^{a}	3.3^{e}	2654.1^{a}	0.292^{d}
Location 1	1027.9^{b}	21.4^{b}	130.4^{a}	165.2^{a}	13.6^{a}	3.2^{b}	3160.2^{a}	0.33^{c}
Location 2	327.9^{c}	36.9^{a}	114.1^{b}	161.9^{b}	6.3^{c}	3.7^{a}	780.87^{c}	0.42^{b}
Location 3	1186.2^{a}	18.5^{c}	96.9^{c}	135.3^{c}	9.3^{b}	2.9^{c}	2512.4^{b}	0.48^{a}

* means with the same lowercase have no significant difference at p=0.05 level.

Both G1 and G10 with the highest seed yield, biomass and harvest index showed to be the most productive out of all the genotypes. High variations in the seed yield of the lentil genotypes is in accordance with the results other researchers (Vanda et al., 2013; Mekonnen et al., 2014; Sharma et al., 2014). Biomass is important characteristic and its improvement especially at the early growth stage would contribute further in assimilation of nitrogen to have reflecting the seed productivity (Whitehead et al., 1980).

From the viewpoint of earliness in maturity and ripening which would be crucial in arid and semi-arid climates, G1 showed the best performance, requiring fewer days to emergence (DE) flowering (DF) and maturity (DM). Highly significant differences among 16 lentil genotypes for the studied agro-morphological traits in Hallabja province have been identified by Ali et al. (2017), including the genotypes sourced from ICARDA with local cultivars. The analysis of variance in the current study revealed highly significant differences among lentil genotypes at all three locations, indicating a high degree of genetic variation, having great potential in future breeding programs through selection. In other studies, agro-morphological traits have been used to study variation among lentil genotypes and to screen potential genotypes for cultivation and breeding as well (Abdulrazzak and Omer, 2017; Debbarma et al., 2018). In a study on 10 lentil genotypes, three genotypes were identified as suitable for seed production based on genetic factors such as earlier development and seed yield quantification in individual plants (Debbarma et al., 2018). In another investigation on ICARDA germplasm, quantitative traits grain yield, seed weight per plant and pod weight per plant indicated the most coefficient of variation among a set of quantitative traits. In addition, the genotypes with the highest performance for 100 seed weight and grain yield were identified (Pouresmael et al., 2018). In an investigation on lentil genotypes in dry environments Mohammed et al. (2019) reported very less time needed for the development of the genotypes than what found in the present study which could be because of the critical environmental differences between the regions under which the two studies had been carried out, or the genetic construction could be the reason. Overall, among all genotypes investigated in this study, G1 showed to be best for the evaluated traits except for FPH and SW which showed lower ranks that could be attributed to negative correlations between the traits (Table 4). Therefore, G1 followed by G10 are suggested as suitable genotypes to be introduced to farmers in the region for direct cultivation as well as to be employed in future lentil breeding programs of high yield potential and more resistant to the local uncertain environmental condition and maybe for other rainfed regions with similar environmental conditions.

Correlations between the traits

Understanding relationships among the characters is required for improving a target character via indirect selection of characters more heritable and easier to select (Dugassa et al., 2015). According to Pearson's correlation coefficients between the traits, there was a significant high negative correlation ($P \leq 0.01$, $r=-0.89$) between SY and DE (Table 5). Whereas, there were significant negative correlations between SY with DF ($r=-0.21$, $P \leq 0.05$) and DM ($r=-0.53$, $P \leq 0.01$). The correlation between SY and SW was significantly negative. Although, biomass (B) showed strong positive correlations with either SY or FPH, it was negatively correlated to either DE, DM or SW. Furthermore, there was a significant positive correlation between SW and DE and DM. However, harvest index (H) was negatively correlated to DF, DM, FPH and B. A negative correlation between SY and prolonged development time was reported in other studies. Depar et al. (2016), concluded that prolonged flowering and maturity of lentil had an adverse effect on yield which is consistent with our study concerning the negative correlation between seed yield with DF and DM traits.

Growing lentil under rainfed condition of the current investigation making clear reduction in the yield by shrinking the flowering and seed filling period. Yield reduction of lentil has been identified by delaying flowering in an investigation by (Yuan et al., 2017). In agreement with our results, other investigations reported negative correlations between seed yield and number of days to maturity (Debbarma et al., 2018) and days to flowering (Abo-Hegazy et al., 2012). Overall, the correlation data presented here suggests giving emphasis on earliness (earlier DE and DM) and biomass in lentil breeding for improved yield for an environmental condition like what given here. A variation of three weeks for days to flowering among the studied genotypes is considered as an effective mechanism for drought escape and seed setting before the onset of terminal drought in grain legumes (Zhang et al., 2000; Shrestha et al., 2006), because the effect of water deficit during the reproductive and grain filling stages is more critical on the yield loss (Farooq et al., 2009; Pushpavalli et al., 2015), especially for the rainfed agriculture condition of Sulaimani Region. The major contributed traits to yield could be emphasized during the development of the improved genotypes of lentil for rainfed conditions (Bhartiya et al., 2015).

Table 5. Pearson's coefficients of correlation (r) and coefficients of determination (R^2) between 8 agro-morphological traits

Trait[a]	SY[b]	DE	DF	DM	FPH	SW	B	HI
SY		-0.89**	-0.21*	-0.53**	0.46**	-0.35*	0.86**	0.17
DE	0.79		0.19*	0.51**	-0.45**	0.41**	-0.82**	-0.03
DF	0.04	0.04		0.89**	0.50**	0.16	0.21*	-0.78**
DM	0.28	0.26	0.79		0.21*	0.31*	-0.15	-0.68**
FPH	0.21	0.2	0.25	0.04		-0.07	0.72**	-0.50**
SW	0.12	0.17	0.03	0.1	0.00		-0.32**	-0.03
B	0.74	0.67	0.04	0.02	0.52	0.10		-0.33**
HI	0.03	0.00	0.61	0.46	0.25	0.00	0.11	

[a] the numbers above the diagonal of table indicate the correlation coefficients between different traits and those below the diagonal indicate the coefficients of determination (R^2).
**, * correlations are significant at 0.01 and 0.05 levels respectively (2-tailed).

Broad sense heritability (H^2) of the traits

Following the extraction of variance components from the ANOVA table, broad-sense heritability (H^2) was calculated for the evaluated agro-morphological traits (Table 6). The highest value of H^2 (0.74) was estimated for 100 seed weight (SW). The H^2 value of DF and FPH was 0.67 and 0.55, respectively, showing that these three traits are highly under the control of genetic factors and the genetic response and breeding progress would be more predictable for these traits than other traits with lower H^2 values.

Table 6. Estimation of variance components and broad sense heritability for the evaluated traits among the lentil genotypes

Trait	Variance components				H^2
	$\sigma^2 e$	$\sigma^2 gl$	$\sigma^2 g$	$\sigma^2 p$	
SY	8471.23	12208.50	11388.55	32068.28	0.36
DE	0.48	5.38	-0.27	5.60	0.00
DF	1.13	15.45	33.81	50.39	0.67
DM	0.61	11.41	6.88	18.90	0.36
FPH	2.16	2.28	5.35	9.78	0.55
SW	0.01	0.09	0.29	0.39	0.74
B	41324.33	38458.89	69497.17	149280.39	0.47
HI	0.0015	0.0005	0.0011	0.0031	0.37

σ^2e: error variance (environment effect); σ^2gl: genetic × location variance; σ^2g: genetic variance.
σ^2p: phenotypic variance; H^2: broad sense heritability.
SY - Seed yield; DE - Days to emergence; DF - Days to 50% flowering; DM - Days to 50% maturity;
FPH - First pod height (cm); SW - 100 seed weight; B - Biomass (kg/ha); HI - Harvest index.

Supporting these results, Debbarma et al. (2018) reported a high H^2 and genetic advance for a set of agro-morphological traits including days to first flowering, days to maturity, 1000 seed weight and seed yield per either plant or plot. In another study in Diyarbakir, Turkey where is geographically and environmentally close to our region, Bicer and Sakar (2010) estimated H^2 values for days to flowering, days to maturity and seed weight as 71%, 80%, 98%, respectively. These are partly consistency with our results for SW, DF and DM (Table 5). In a one year and one location basis, Dugassa et al. (2015) estimated the heritability values for biomass yield and days to emergence as >60% while for days to maturity, days to flowering, and harvest index as between 40% and 60% which are close to our results while they neither considered experiment repetition for years nor locations. The H^2 value for DE was estimated 0.00 which could be due to the non-significant genetic variance of this trait (ANOVA results, Table 3) resulted from high differences between location 2 with locations 1 and 3 leading to critical effects of both location and location × genotype interaction dominating over pure genotype effects. Whereas, one-way ANOVA for the genotype effect in any of the locations separately, showed a significant genotype effect for DE (data not shown).

Hierarchical clustering and principal component analysis

The Euclidean distance and unweighted pair-group average were followed to estimate dissimilarity between the lentil genotypes. The dissimilarity values were varied from the lowest value of 0.99, between G2 and G5, to the highest of 7.038, between G1 and G12 (Table 7). Cluster analysis clustered the genotypes into 3 main groups (Figure 1). Out of 12, seven genotypes were grouped into the largest cluster including two sub-clusters. The first sub cluster included G3, G6, G4 and G7 and the second one included G2, G5 and G8. Both G1 and G10 gathered in a cluster while G11 and G9 grouped together and with a less similarity grouped with G12, a local genotype from the Sulaimani region.

Table 7. The Euclidian distances used for hierarchical clustering between 12 lentil genotypes

	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12
G1	0											
G2	4.895	0										
G3	3.961	4.019	0									
G4	3.631	2.076	2.310	0								
G5	5.117	0.990	3.989	2.027	0							
G6	3.266	2.850	1.866	1.258	2.933	0						
G7	3.182	2.576	2.569	1.214	2.512	1.516	0					
G8	4.684	2.088	4.188	2.649	2.062	3.042	3.187	0				
G9	4.488	4.080	3.773	3.289	3.971	3.227	4.030	2.598	0			
G10	3.451	4.962	4.020	3.866	4.800	3.801	3.986	4.207	3.493	0		
G11	5.157	4.106	3.101	3.256	4.059	3.009	3.909	3.223	2.390	5.092	0	
G12	7.038	5.874	6.077	6.029	6.024	5.678	6.217	4.675	5.056	7.378	3.871	0

This clustering results support the results of the pairwise comparisons based on the compare means data (Table 3). For example, G1 and G10 which were identified as the best for seed yield earliness, biomass and harvest index, were clustered together as well. Additionally, nearly such coordination was between the two sets of the data for other groups of the genotypes.

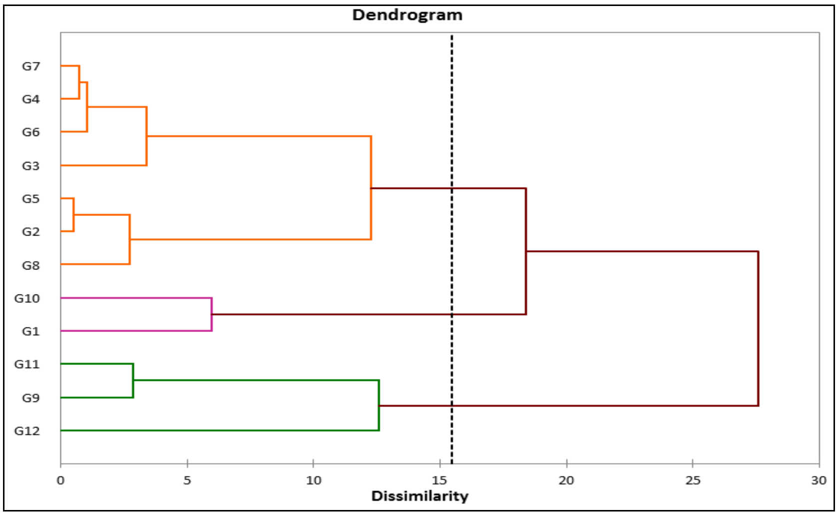

Figure 1. Hierarchical clustering of 12 lentil genotypes based on Euclidean distance using the data from three locations and eight agro-morphological traits

Transformation of the evaluated traits into principal components (PCs) produced 8 eigenvectors. The first eigenvector expressed the highest eigenvalue 3.56 and only first three Principal Components (PCs) gave eigenvalues more than one (Table 8) and thus were considered in determining the variability of agro-morphological traits among the genotypes (Kaiser, 1960). This suggests that variation among the genotypes was due to a relatively high contribution of fewer traits rather than a small contribution of each trait. Principal component analysis (PCA) reflects the importance of the largest contributor to the total variation at each axis of differentiation and identifies the traits that contribute most to the variation within genotypes (Bhartiya et al., 2015). The first three PCs explained 84.16% of the total variation with PC1, PC2 and PC3 accounting for 44.5%, 25.9% and 14.7% of total variation, respectively (Table 8 and Figure 2).

Table 8. The eigenvalues and related variability for corresponding 8 component characters explained by the principal components used in the analysis of the variation among 12 lentil genotypes

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
Eigenvalue	3.561	1.996	1.176	0.853	0.282	0.075	0.053	0.003
Variability (%)	44.514	24.947	14.705	10.663	3.530	0.943	0.666	0.032
Cumulative (%)	44.514	69.461	84.166	94.829	98.359	99.303	99.968	100.000

The largest percent of variation was contributed in PC1 by DF and DM (24.3% each), PC2 by B and SY (41.4 and 35.7) and PC3 by DE and SW (28.6 and 58.2), respectively (Table 9). Analysis of PCA was used to study the variability of agro-morphological traits in lentil germplasm in India (Kumar and Solanki, 2014; Bhartiya et al., 2015), Saudi Arabia (Mohammed et al., 2019), Algeria (Gaad et al., 2018), Bangladesh (Ahamed et al., 2014) and wild lentil accessions around the world (Singh et al., 2020). Bhartiya et al. (2015) showed that the first four components of PCA explained 83.3% of the cumulative variance and highly significant positive correlation of PCI was observed with harvest index, number of pods per plant, days to maturity, seed yield per plant and days to 50% flowering. Moreover, Kumar and Solanki (2014) reported the maximum contribution of days to 50% flowering, plant height and days to maturity to total diversity among lentil accessions.

Table 9. Contribution of the lentil agro-morphological traits to the variation explained by first three principal components (PCs) used to analyze the variation among 12 lentil genotypes

Characteristics	PC1	PC2	PC3
Days to emergence (DE)	10.460	4.773	28.612
Days to 50% flowering (DF)	24.333	0.142	0.725
Days to 50% maturity (DM)	24.301	3.045	0.563
First pod height (cm) (FPH)	14.480	9.942	8.431
100 seed weight (SW)	0.033	4.522	58.184
Biomass (kg/ha) (B)	1.004	41.449	0.257
Seed Yield (kg/ha) (SY)	6.838	35.718	1.806
Harvest index (H)	18.551	0.409	1.423

The PCA biplot of the first two PCs separated the 12 lentil genotypes on the plot (Figure 2). The genotypes were gathered in as similar groups as for cluster analysis and also supported the data of compare means and pairwise analyses. As can be observed on the plot, G1 and G10 that were identified as the most promising for cultivation and future breeding were grouped together.

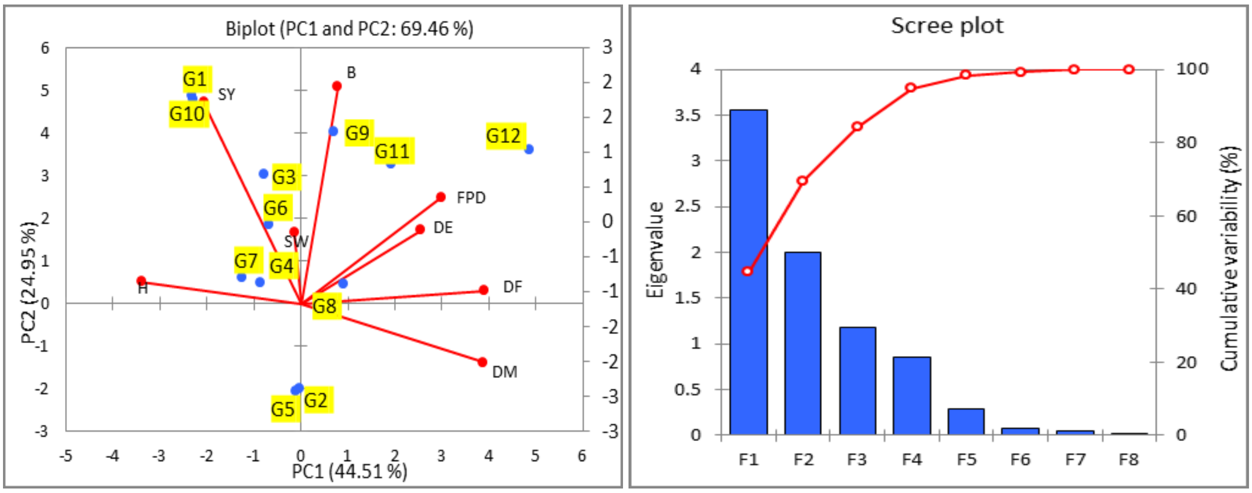

Figure 2. Pricipal component (PCA) biplot (left) showing the distribution of 12 lentil genotypes (blue dots) based on data from three locations and eight evaluated traits (red dots).
The scree plot (right) showes the variability given by eight principal components (F1- F8).
SY - Seed yield; DE - Days to emergence; DF - Days to 50% flowering; DM - Days to 50% maturity;
FPH - First pod height (cm); SW - 100 seed weight; B - Biomass (kg/ha); HI - Harvest index.

Like the cluster analysis, the local genotype (G12) was positioned close to G9 and G11 while G5 and G2 grouped together and the other genotypes were scattered close together on the up-left quarter of the plot. The local cultivar (G12) with G9 and G11 seem to be sharing the same ancestor, by other mean both G9 and G11 could have better performance to cope with the uncertain abiotic fluctuation as the local does in adaptation. Altogether, the PCA results supported those of hierarchical clustering and both are in accordance with the pairwise analysis of the genotypes differences/similarities for the evaluated agro-morphological traits.

CONCLUSIONS

In this study, genetic variability and broad-sense heritability among 12 lentil genotypes were estimated for eight agro-morphological traits.

The highest level of broad-sense heritability was found for seed weight followed by days to 50% flowering flowed and first pod height.

Among lentil genotypes, two ICARDA lines Flip 93-36L (G1) and Flip 2009-70L (G10) were proven to be the most suitable for cultivation under rainfed condition of Sulaimani region, northern Iraq, however further field trial is recommended to optimize the best sowing date for the lentil genotypes under rainfed condition of the region. These genotypes showed the best performance for yield and earliness in growth and development and therefore can potentially be valuable sources for genetic analysis and future lentil breeding in this region.

AUTHOR CONTRIBUTIONS

Conceived and designed the experiment: N.S.A, J.G.R and D.J.M. Analyzed the data: N.S.A. and N.M. Contributed materials/analysis tools: N.S.A., N.M. and J.G.R. Wrote the paper: N.S.A. and N.M.

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EURASIAN JOURNAL OF AGRICULTURAL RESEARCH

Evaluation of Some Wheat Cultivars as Roughage

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Abstract

This study was carried out during the growing season of 2015-2016 to determine the roughage value of some wheat cultivars. In the study, 3 bread wheat (Pehlivan, Aras, Cham-6) and 5 durum wheat (Eminbey, Bakrajo-1, Ovanto, Simito and Acsad-65) cultivars were used as plant material. Experiments were conducted in randomized complete blocks design with three replications. Plant height, green herbage yield, dry herbage yield, crude protein ratio, protein yield, acid detergent fiber, neutral detergent fiber, calcium, magnesium, phosphor and potassium ratios were investigated. Plant heights between 70.3 and 81.8 cm, green herbage yields between 694.0 and 2560.0 kg da^{-1}, dry herbage yields between 237.4 and 824.9 kg da^{-1}, crude protein ratios between 10.60 and 12.85%, protein yields between 29.6 and 98.5 kg da^{-1}, acid detergent fiber ratios between 30.78 and 34.92%, neutral detergent fiber ratios between 51.86 and 57.26%, calcium ratios between 0.36 and 0.47%, magnesium ratios between 0.11 and 0.17%, phosphor ratios between 0.35 and 0.38% and potassium ratios between 1.61 and 2.22% have changed. In the study, Aras and Acsad-65 cultivars for high green herbage, dry herbage and protein yields; Simito and Bakrajo-1 cultivars for low acid detergent fiber, neutral detergent fiber ratios and high calcium and magnesium contents were better results as roughage at wheat cultivars.

Keywords: ADF, herbage yield, NDF, nutrient content, wheat

INTRODUCTION

Our country has the deficit of roughage. Even if the rate of forage crops cultivation has reached to 8-9% among field crops in result of the supports in recent years, it is obvious that this level is not sufficient to meet the deficit. Therefore, new sources are required to meet the roughage deficit in Turkey.Small grain cereals such as wheat, barley, oat, rye and triticale can be harvested as herbage and utilized as roughage in addition to be cultivated for its grains and be used as human food. In our country like in the entire world, the utilization of cereals as fodder is widespread. The herbage derived from cereals is fed animals in green, dry and silage forms (Tan and Serin, 1997).

In dry regions, cereals can be cultivated for dry herbage production. Although all cereals can be used for that purpose, barley, oat, and wheat are preferred. The hays of cereals which are harvested in the proper period and dried are considered as good forage for ruminant animals. It is proposed to harvest cereals for herbage at the milk dough stage. Cereals should be harvested to produce good herbage at heading stage. Hays can be yielded from cereals between 500 kg and 1500 kg per hectare depending on land fertility and maintenance (Acikgoz, 2013).

Cereals are so delicious and nutritious in the vegetative period for animals and include crude protein of 15-35%. Digestibility rate of nutrients is at 80%. It has a high carotin amount and low rate of cellulose, is rich in B vitamins and minerals. Cereals are quietly proper at the vegetative period for young animals and dairy cattles (Acikgoz, 2001). Cereals have a crucial potential to feed animals as a forage source with regards to yield, quality and mineral contents (Yolcu, 2008).

In Anatolia where cereal cultivation has been carried out throughout the history, it is considered that utilization of cereals as roughage source would contribute to meet the roughage deficit. For this reason, this study aims to unfold forage potential of certain wheat species by investigating yield and forage quality in the latter.

MATERIAL and METHODS

Material

This study has been conducted at the Bingol University Research and Practice Area during 2015-2016 growing season. The wheat cultivars used as study materials in the research and the institutions that have provided the cultivars are given in Table 1. The figures related to Bingol climate conditions are given in Table 2.

Table 1. The wheat cultivars used in the study and the providing institutions

No	Variety Name		Institutions and Organizations
1	Pehlivan	Bread wheat	GAP International Agricultural Research and Training Centre
2	Aras	Bread wheat	Sulaymaniyah Agricultural Research Institute / Iraq
3	Cham-6	Bread wheat	Sulaymaniyah Agricultural Research Institute / Iraq
4	Eminbey	Durum wheat	GAP International Agricultural Research and Training Centre
5	Bakrajo-1	Durum wheat	Sulaymaniyah Agricultural Research Institute / Iraq
6	Ovanto	Durum wheat	Sulaymaniyah Agricultural Research Institute / Iraq
7	Simito	Durum wheat	Sulaymaniyah Agricultural Research Institute / Iraq
8	Acsad-65	Durum wheat	Sulaymaniyah Agricultural Research Institute / Iraq

Table 2. Monthly average climate figures of Bingol for long years (2000-2015) and first half of 2016

Months	Average Temperature (°C)			Total Precipitation (mm)			Relative Humidity (%)		
	Long Years	2015	2016	Long Years	2015	2016	Long Years	2015	2016
January	-2.5	1.8	-2.8	154.0	147.2	257.8	73.3	75.1	75.4
February	-0.9	1.9	2.5	137.7	119.8	95.3	72.2	74.4	73.3
March	4.9	5.5	7.0	124.1	155.3	131.0	64.2	66.9	60.2
April	10.9	10.7	14.0	103.8	66.7	46.8	61.2	60.1	43.4
May	16.2	16.4	16.3	66.8	21.2	66.2	55.8	53.9	57.4
June	22.6	22.6	22.3	18.4	8.1	34.4	42.5	38.4	43.5
July	27.0	27.4	26.9	7.3	0.1	7.0	36.7	28.1	43.3
August	26.8	27.1	-	5.4	0.6	-	36.8	30.8	-
September	21.3	23.6	-	16.4	0.4	-	42.2	30.0	-
October	14.2	14.4	-	70.3	18.9	-	58.9	68.6	-
November	6.5	14.4	-	91.8	46.2	-	64.7	56.4	-
December	0.2	1.3	-	121.8	219.1	-	70.7	58.6	-
Total/Ave.	12.3	13.9	12.3	917.8	803.6	638.5	56.6	53.4	56.6

Source: General Directorate of Meteorology (Bingol)

As seen in the table, the long year’s temperature average of Bingol is 12.3 °C. Accordingly in 2015, when the study was conducted, the annual average temperature was 13.9 °C. We can say that 2015 was a warm year for Bingol compared to previous years. Until the month of July, when the harvest took place, 2016 average temperature was 12.3 °C. During the first half of 2016 the figures were similar to those of long years’ averages.

It has been determined that 2015 total precipitation level is lower than the total precipitation level of previous years. But during the first half of 2016, the amount of precipitation was higher than the previous years. In terms of relative humidity values, the average figure for the long years was 56.6% but in 2015 this figure became 53.4% and during the first half of 2016 it was 56.6%. It has been observed that the figures acquired for relative humidity were close to the previous year’s average.

In conclusion, we can say that in Bingol, 2015 and the first half of 2016 was warmer, with less precipitation and similar moisture levels when compared to long years’.Soil samples have been taken from ten different points of the study area, from a depth of 0-30 cm, and then the samples were mixed. The analysis of the resulting sample took place at the Bingol University Faculty of Agriculture Department of Soil Science and Plant Nutrition Laboratories. Results of the analysis have been assessed by taking the limit values defined by Sezen (1995) and Karaman (2012) as a basis. Results of the analysis are given in Table 3.

Table 3. Soil texture, saturation, pH, salinity, lime content, organic matter content, phosphor and potassium amounts of the study area

Texture	Saturation (%)	pH	Salinity (%)	$CaCO_3$ (%)	Organic Matter (%)	P_2O_5 (kg da^{-1})	K (kg da^{-1})
Loamy	43.31	6.37	0.0066	0.15	1.26	7.91	24.45

As seen in Table 3, the soil texture of the study area was “loamy”, with “mildly acidic” pH, no “salinity”, “low” levels of lime, organic matter ratio was “low”, phosphor ratio was “average” and potassium ratio was “sufficient”.

Method

The trial has been established on 16 October 2015 over a randomized complete block experimental design with 3 repetitions. Planting was made where parcels lengths were 5 m, row spacing was 20 cm and each parcel had 6 rows. 500 seeds have been used per square meter during planting. Right before planting, 4 kg nitrogen (N), 8 kg phosphor (P_2O_5) fertilizer was applied over pure matter per decare. Then during the bolting period of the plans, 4 kg nitrogen (N) fertilizer was applied over pure matter per decare to increase the nitrogen (N) quantity to 8 kg da^{-1}. The trial was conducted under dry conditions. Harvesting of the plants took place on 12 May 2016.

Plant height, randomly selected from each parcel, 10 plants have been measured from soil surface to the top, including the awn, in cm and the average has been taken. The harvested herbage from each plot was weighed to get green herbage yields. Then, plot herbage yields were converted into yields per decare. From each green herbage harvest, 0.5 kg was dried at 70 ^{0}C for 48 hours (Anonymous, 2016). Dried samples were weighed to get dry herbage yields of the plots. Then, these values were also converted into dry herbage yields per decare.

Crude protein, ADF (Acid Detergent Fiber), NDF (Neutral Detergent Fiber), calcium, magnesium, phosphor and potassium analyses were performed at laboratories of Dicle University Scientific and Technological Research Center with NIRS (Near Infrared Spectroscopy - Foss Model 6500) analysis device.

Statistical Model and Assessment Method

The gathered data has been analysed by the help of JUMP statistics package program (software of SAS program) in accordance with randomized complete block experimental design with three repetitions. The factor averages that were statistically significant according to the variance analysis results have been compared to LSD test (Kalayci, 2005).

RESULTS and DISCUSSION

The plant height, green herbage yield and dry herbage yield averages observed in wheat cultivars are given in Table 4.

Table 4. Plant height, green herbage yield and dry herbage yield averages determined in wheat cultivars

		Plant Height (cm)	Green Herbage Yield (kg da^{-1})	Dry Herbage Yield (kg da^{-1})
1	Pehlivan	70.8 bc*	2237.1 b**	671.0 b**
2	Aras	78.8 ab	2560.0 a	801.8 a
3	Cham-6	81.8 a	1595.0 d	526.5 cd
4	Eminbey	70.3 c	1872.4 c	611.6 bc
5	Bakrajo-1	79.6 a	999.0 f	327.8 ef
6	Ovanto	80.6 a	1352.7 e	422.6 de
7	Simito	74.8 abc	694.0 g	237.4 f
8	Acsad-65	81.2 a	2454.0 ab	824.9 a
	Average	77.2	1720.5	552.9
	CV (%)	5.97	7.95	11.24

*) statistically significant at a level P≤0.05, **) statistically significant at a level P≤0.01

Different wheat cultivars are statistically significant at a level of 5% in terms of plant height and of the 1% in terms of green herbage and dry herbage yields.

Plant Height (cm)

The highest plant height has been obtained from Cham-6 cultivar by 81.8 cm, Acsad-65 cultivar by 81.2 cm, Ovanto cultivar by 80.6 cm and Bakrajo-1 cultivar by 79.6 cm and it was respectively followed Aras (78.8 cm) and Simito (74.8 cm) cultivars, statistically in the same group. The lowest plant height has been obtained from Eminbey cultivar by 70.3 cm.

The plant height average of the cultivars has been defined as 77.2 cm. Our findings are parallel to those obtained under Turkey conditions by Kaya (2004) 86.5 cm, by Mut et al. (2005) 66.9-98.8 cm, by Gumustas (2014) 79.4 cm.

Green Herbage Yield (kg da^{-1})

The highest green herbage yield has been obtained from Aras cultivar by 2560.0 kg da^{-1} and it was followed Acsad-65 cultivar by 2454.0 kg da^{-1}. The lowest green herbage yield has been obtained from Simito cultivar by 694.0 kg da^{-1}. The green herbage yield average of the cultivars has been defined as 1720.5 kg da^{-1}. The green herbage yield of wheat was determined to be 336.75 kg da^{-1} by Yolcu (2008).

Dry Herbage Yield (kg da^{-1})

The highest dry herbage yield has been obtained from Acsad-65 cultivar by 824.9 kg da^{-1} and Aras cultivar by 801.8 kg da^{-1}. The lowest dry herbage yield has been obtained from Simito cultivar by 237.4 kg da^{-1}. The dry herbage yield average of the wheat cultivars has been defined as 552.9 kg da^{-1}. The dry herbage yield of wheat was determined to be 175.54 kg da^{-1} by Yolcu (2008) and 65.1-477.5 kg da^{-1} by Tolu et al. (2013). The crude protein ratio, protein yield, acid detergent fiber and neutral detergent fiber averages observed in wheat cultivars are given in Table 5.

Table 5. The crude protein, protein yield, acid detergent fiber and neutral detergent fiber averages determined in wheat cultivars

		Crude Protein (%)	Protein Yield (kg da^{-1})	ADF (%)	NDF (%)
1	Pehlivan	11.22	75.1 b**	34.92 a**	56.90 ab**
2	Aras	12.27	98.5 a	34.25 ab	57.04 ab
3	Cham-6	10.60	55.8 cd	34.48 ab	56.69 ab
4	Eminbey	11.16	68.1 bc	33.52 ab	56.49 ab
5	Bakrajo-1	12.01	39.3 e	30.78 c	51.86 d
6	Ovanto	12.85	53.4 d	32.72 bc	54.54 bc
7	Simito	12.19	29.6 e	31.02 c	52.40 cd
8	Acsad-65	11.42	94.2 a	34.02 ab	57.26 a
	Average	11.71	64.2	33.21	55.40
	CV (%)	8.89	12.13	3.59	2.66

*) statistically significant at a level P≤0.05, **) statistically significant at a level P≤0.01

Different wheat cultivars are statistically significant at a level of 1% in terms of protein yield, acid detergent fiber and neutral detergent fiber.

Crude Protein Ratio (%)

Wheat cultivars are statistically insignificant in terms of crude protein contents. The crude protein content of the wheat cultivars to range from 10.60 to 12.85%. The crude protein average of the wheat cultivars has been defined as 11.71%. The crude protein content we have obtained were similar to those reported by Yolcu (2008) 13.11% and by Tolu et al. (2013) 4.0-14.0%.

Protein Yield (kg da^{-1})

The highest protein yield has been obtained from Aras cultivar by 98.5 kg da^{-1} and Acsad-65 cultivar by 94.2 kg da^{-1}. The lowest protein yield has been obtained from Bakrajo-1 cultivar by 39.3 kg da^{-1} and Simito cultivar by 29.6 kg da^{-1}. The protein yield average of the wheat cultivars has been defined as 64.2 kg da^{-1}. The protein yield was determined to be 21.26 kg da^{-1} by Yolcu (2008).

Acid Detergent Fiber (%)

The lowest acid detergent fiber has been obtained from Simito cultivar by 31.02% and from Bakrajo-1 cultivar by 30.78%. The highest acid detergent fiber has been obtained from Pehlivan (34.92%), Cham-6 (34.48%), Aras (34.25%), Acsad-65 (34.02%) and Eminbey (33.52%) cultivars. The acid detergent fiber average of the wheat cultivars has been defined as 33.21%. The acid detergent fiber was determined to be 34.21% by Yolcu (2008), 38.4-48.5% by Tolu et al. (2013) and 27.6% by Canbolat (2012).

Neutral Detergent Fiber (%)

The lowest neutral detergent fiber has been obtained from Bakrajo-1 cultivar by 51.86% and from Simito cultivar by 52.40%. The highest acid detergent fiber has been obtained from Acsad-65 (57.26%), Aras (57.04%), Pehlivan (56.90%), Cham-6 (56.69%) and Eminbey (56.49%) cultivars. The acid detergent fiber average of the wheat cultivars has been defined as 55.40%. The acid detergent fiber was determined to be 58.64% by Yolcu (2008), 49.2-60.8 by Tolu et al. (2013) and 49.9% by Canbolat (2012). The calcium, magnesium, phosphor and potassium averages observed in wheat cultivars are given in Table 6.

Table 6. The calcium, magnesium, phosphor and potassium averages determined in wheat cultivars

		Calcium (%)	Magnesium (%)	Phosphor (%)	Potassium (%)
1	Pehlivan	0.40 cd*	0.12 cd**	0.36	2.01
2	Aras	0.36 d	0.11 d	0.36	1.83
3	Cham-6	0.39 cd	0.14 b	0.36	1.90
4	Eminbey	0.38 cd	0.13 bc	0.36	1.99
5	Bakrajo-1	0.46 ab	0.14 b	0.38	1.96
6	Ovanto	0.43 abc	0.11 d	0.38	2.22
7	Simito	0.47 a	0.17 a	0.36	1.61
8	Acsad-65	0.40 bcd	0.13 bcd	0.35	1.83
	Average	0.41	0.13	0.36	1.92
	CV (%)	8.29	7.48	3.53	10.04

*) statistically significant at a level P≤0.05, **) statistically significant at a level P≤0.01

Different wheat cultivars are statistically significant at a level of 5% in terms of calcium and of the 1% in terms of magnesium.

Calcium (%)

The highest calcium content has been obtained from Simito cultivar by 0.47%. It was respectively followed Bakrajo-1 (0.46%) and Ovanto (0.43) cultivars, in the same statistically group. The lowest calcium content has been obtained from Aras cultivar by 0.36%. The calcium content average of the wheat cultivars has been defined as 0.41%. The calcium ratio was determined to be 0.57% by Yolcu (2008).

Magnesium (%)

The highest magnesium content has been obtained from Simito cultivar by 0.17%. The lowest magnesium content has been obtained from Aras and Ovanto cultivars by 0.11%. The magnesium content average of the wheat cultivars has been defined as 0.13%. The magnesium ratio was determined to be 0.27% by Yolcu (2008).

Phosphor (%)

Wheat cultivars are statistically insignificant in terms of phosphor content. The phosphor content of the wheat cultivars to range from 0.35 to 0.38%. The phosphor content average of the wheat cultivars has been defined as 0.36%. The phosphor ratio was determined to be 0.35% by Yolcu (2008).

Potassium (%)

Wheat cultivars are statistically insignificant in terms of potassium content. The potassium content of the wheat cultivars to range from 1.61 to 2.22%. The potassium content average of the wheat cultivars has been defined as 1.92%. The potassium ratio was determined to be 1.44% by Yolcu (2008).

CONCLUSIONS

The highest plant height has been obtained from Cham-6, Acsad-65, Ovanto and Bakrajo-1 cultivars; the highest green herbage yield has been obtained from Aras cultivar; the highest dry herbage yield has been obtained from Acsad-65 and Aras cultivars; the highest protein yield has been obtained from Aras and Acsad-65 cultivars; the lowest acid detergent fiber and neutral detergent fiber has been obtained from Simito and Bakrajo-1 cultivars; the highest calcium and magnesium content has been obtained from Simito and Bakrajo-1 cultivars. However, wheat cultivars are statistically insignificant in terms of crude protein ratio, phosphor and potassium content. Based on these results; Aras and Acsad-65 cultivars with high green herbage, dry herbage and protein yields, Simito and Bakrajo-1 cultivars with low acid detergent fiber and neutral detergent fiber ratios and high calcium and magnesium content were recommended for wheat hay as roughage.

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The Effect of Genotypes and plant distances on leaf miner infestation in pea plant (*Pisum sativum L.)*

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ABSTRACT

Green pea plants are liable to infestation by vegetable leaf miner Liriomyza spp. (Diptera: Agromyzidae) ,is a polyphagous species spread around the world, becoming vegetable crop pests. An experiment was carried out in the directory of agricultural research, Iraq, Sulaimanyah in Plant Protection Research Station in Bakrajo region during season 2020 to study the effect of different genotypes and planting spaces on the population density of Leaf miner infesting pea plants. The obtained results revealed that the population density of leaf miner on pea plants not differed significantly according to the planting spaces (5cm, 15cm and 25cm) during the season. Planting of pea seeds in the planting space (5cm) population density of leaf miner decreased by the first planting space (%16.895). The pea plants were sown in the planting space (15cm) infested by the highest level of the insect (leaf miner) (%18.452) followed by pea plants sowing at the planting space (25cm) which infestation level was (%17.967) respectively. for the physical characters of the plant (plant high, total weight and weight of 100 grains) the results shows that the sowing pea in the spacing of (15cm) were significantly difference, followed by (5cm) while planting distance of (25cm) showed lowest levels of result for last three parameters.

Keywords: Leaf miner, Genotypes, Infestation, Plant spacing, Pea plant

1. INTRODUCTION

Liriomyza spp. (Burgess) (Diptera: Agromyzidae) are polyphagous vegetable leaf miners that have spread over the world and become pests of vegetable crops. In all Mediterranean-bordering countries, it is universally recognized (Chaney, 1995). The damage is punctures caused by females during the feeding and ovipositional processes can result in a stippled appearance on foliage, especially at the leaf tip and along the leaf margins (Chaney, 1995) and (Wilkerson, et al., 2005). However, the major form of damage is the mining of leaves by larvae, which results in destruction of leaf miner.

Three to four days after ovipositional, the mine forms and grows in size as the larva grows (Capinera, 2001). (Bueno, et al 2007). The mining pattern is unpredictably erratic. Leaf mining and stippling can both significantly reduce a plant's photosynthetic rate. Premature leaf drop can also result in a lack of shade and fruit scalding as a result of extensive mining (Bueno, et al 2007). Wounding of the foliage also allows entry of bacterial and fungal diseases (Abou-fakhr-Hammad and Nemer. 2000). Pea Pisum sativum, Citrine (Leguminaceae) is one of the most important economic vegetables (Onwueme and Sinha, 1991 and FAO, 1993) its cultivated area was increased during the last years especially in new reclaimed land for local consumption.

As a result, 100-120 kg nitrogen per hectare is required after harvest, equating to 20-25 tons of organic fertilizer, which is sufficient for the establishment of another crop. Green peas have a total cultivated area of roughly 2.8 million acres around the world.

Many studies have been conducted in the past on the effects of planting spaces, climatic conditions, and plant age on the infestation of particular insects that infest leguminous plants, Meena and Bhargava (2001); Mishra et al. (2001); Wale (2002); AbdElmalak and Salem (2002); Shalaby (2004); Mittal and Ujagir (2005); Arif et al. (2006); Hanafy A.R.I (2007); Hanafy et al. (2008); Afsah (2009); Hussein et al., (2010); Abdel Hamed et al. (2011) and Omaprakash and Raju (2014); Shaalan, H. S. and Maha, S. El-Ghanam(2016).

The aim of the present study to determine the suitable genotype of pea plant to be sowing to avoiding from the infestation of leaf miner, which causes a serious damage of leaves and study the effect of three tested planting spaces.

2. RESEARCH METHOD

Field experiment was carried out to study the effect of planting space and different genotypes on the population density of Leaf miner infesting pea plants (Pisum sativum L.). The pea seeds (Viola and Kaspa) were obtained from Department of crop fields, Directory of Agriculture Research. An area of about 36 m2 was cultivated in three planting space, 5cm, 15cm and 25cm in Plant Protection Research Station in Bakrajo region, Sulaimanyah Governorate throughout season 2019. the experimental area was divided into 18 plots; each replicate was 2 m2. Each planting space was represented by three replicates. All replicates were arranged in Randomized Complete Block Design. All agricultural practices were done and no pesticide treatments were applied. monthly randomized samples of pea leave (20 of each replicate) were taken after foliage appearance and continue for three months. Each sample from each replicate were kept in tightly closed paper bags and transferred to the laboratory where all samples were thoroughly examined by the aid of stereomicroscope to count the number of leaf miner. Data were analyzed according to XLSTAT program and mean separation was conducted by using Duncan's multiple range test in this program.

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3. RESULTS AND DISCUSSION

Effect of difference genotypes on pea leaves infestation by leaf miner

Tale 1: comparison between to Genotypes of Pea on infestation level of leaf miner, plant high, total weight and weight of 100 grains

Genotype	% leaf infestation	plant hight/cm	Total weight/gm	weight of 100 grain/gm
Kaspa	12.642 b	88.556 a	1155.216 a	0.259 a
Viola	22.900 a	76.444 b	1033.437 b	0.217 b
Pr > F(Model)	0.004	< 0.0001	< 0.0001	0.000
Significant	Yes	Yes	Yes	Yes

Results in Table (1) revealed that the infestation of leaf miner on pea plants was significantly differed according to the genotype, data in Table (1) showed that the infestation of the leaf miner increased by the viola genotype. The pea plants in the genotype of (kaspa) were infested by the significantly lowest numbers of leaf miner. however, for last three parameters (plant height, total weight and weight of 100 grains) there were significant difference for the (kaspa) with the comparisons of (viola).

Effect of plant spacing on pea leaves infestation by leaf miner

Table 2: Effect of three plant distance on infestation levels, plant height, total weight and weight of 100 grains

Plant distance	% leaf infestation	plant height/cm	Total weight/gm	weight of 100 grain/gm
15	18.452 a	99.833 a	2175.333 a	0.294 a
5	16.895 a	81.000 b	1107.167 b	0.244 b
25	17.967 a	66.667 c	0.480 c	0.175 c
Pr > F(Model)	0.004	< 0.0001	< 0.0001	0.000
Significant	Yes	Yes	Yes	Yes

The data illustrated in table (2) showed that the infestation levels of leaf miner not significantly differed according to the planting spaces for both genotypes, data in Table (1) showed that in the planting distance (5 cm) population density of leaf miner decreased by the first planting space (%16.895). The pea plants were sown in the planting space (15 cm) infested by the highest level of the insect (leaf miner) (%18.452) followed by pea plants sowing at the planting space (25cm) which infestation level was (%17.967). for the last three parameters (plant high, total weight and weight of 100 grains) there were significantly difference for the planting distance (15 cm), followed by (5 cm), while planting distance of (25 cm) showed lowest levels of result for last three parameters.

Interaction between genotype and plant spacing on the leaf miner infestation

Table 3. The interaction between genotype and plant distance on the level of infestation

Genotype*plant distance	% leaf infestation	plant hight/cm	Total weight/gm	weight of 100 grain/gm
Kaspa*15	14.753 b	107.333 a	2259.667 a	0.340 a
Viola*15	22.150 a	92.333 b	2091.000 a	0.248 bc
Viola*5	23.767 a	74.333 c	1009.000 b	0.213 cd
Kaspa*5	10.023 b	87.667 b	1205.333 b	0.275 b
Viola*25	22.783 a	62.667 c	0.312 c	0.189 cd
Kaspa*25	13.150 b	70.667 c	0.648 c	0.161 d
Pr > F(Model)	0.004	< 0.0001	< 0.0001	0.000
Significant	Yes	Yes	Yes	Yes

The results in Table (3) shows the interaction of plant distances and genotype on infestation levels. Data illustrated in the table shows that (viola) in the plant distance of (5cm) differed significantly by infestation of highest level of leaf miner (%23.767), followed by (viola) (25 and 15cm) that recorded (%22.783 and %22.150). (kaspa) in the plant spacing (5cm) recorded best result of infestation level (%10.023), followed by (kaspa) in the plant distance (25cm) that the levels of infestation were (%13.150), while the highest level of infestation in the (kaspa) genotype was (%14.753) respectively. However, for the plant high, total weight and weight of 100 grains (kaspa) in plant spacing (15cm) showed the best results.

4. CONCLUSION

Leaf miner incidence and severity not depended on the plant spacing, that mean sowing the seeds in plant spacing (5cm), (15cm) and (25cm) not important for pea plant to prevent infesting of leaf miner (Table 2), on another hand not have significant differences between all three spacing, that's because of growing the plant vertically and having no much foliage. Although the results of Kapsa genotype shows to be more resistance against leaf miner infestation (Table 3).

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MAINTENANCE POMEGRANATE FRUITS QUALITY BY COATING WITH FLAXSEED, BLACK SEED OILS AND CHITOSAN DURING DIFFERENT STORAGE PERIODS

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Abstract

This study was conducted on the Salakhani pomegranate fruit, to study the impact of coating with (0.5 and 1) % of flaxseed, (0.5 and 1)% of black seed oil, and (0.5 and 1)% of chitosan plus control treatment and with five storage periods. The fruits were harvested at full ripening stage on 2/November /2020 from a private orchard in the Sazan village of Halabja governorate. The fruits were divided into groups according to the concentrations of flaxseed oil, black seed oil and chitosan in addition to the comparison treatment and storage periods. Fruits were dried well after the coating process and placed in special boxes (carton boxes), the fruits were stored for five storage periods at a temperature of 5±1°C and with 85-90% relative humidity in the cold storage. The factorial experiment within the complete randomized design (CRD) was used with three replicates and 15 fruits for each experimental unit. Coating fruits with flaxseed oil at a concentration of 0.5% and 1% and black seed oil at a concentration of 1% had an effect in reducing the weight loss of fruits during cold storage also for chitosan at a concentration of 1%. All treatments coating (flaxseed, black seed oil, and chitosan) caused to maintain the visual evaluation quality, and decrease the rate of infection of fruits with chilling injury, also increased total soluble solid, total sugars and anthocyanin in fruits juice content than control except coating 0.5% flaxseed oil. The storage for 4 months was significantly superior to the percentage of total sugars, the content of anthocyanin in arils, maintained the visual evaluation quality and decreases the rate of infection of fruits with chilling injury.

Keywords: cold storage, **treatments coating**, **weight loss, chilling injury**.

المحافظة على جودة ثمار الرمان بتغليفها بزيتي بذور الكتان والحبة السوداء والجيتوسان أثناء فترات التخزين المختلفة

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المستخلص

أجريت هذه الدراسة على ثمار الرمان صنف **Salakhani**، لدراسة تأثير التغليف بزيت بذور الكتان بتراكيز (0.5 و1)٪ وزيت الحبة السوداء بتراكيز (0.5 و1)٪ و بتراكيز (0.5 و1)٪ من الجيتوسان بالإضافة إلى معاملة المقارنة ومع خمس فترات تخزين. قطفت الثمار في مرحلة النضج الكامل بتاريخ 2/تشرين الثاني/2020 من بستان خاص (اهلي) في قرية سازان

بمحافظة حلبجة. تم تقسيم الثمار إلى مجموعات حسب تراكيز زيتي بذور الكتان والحبة السوداء والجيتوسان بالإضافة إلى معاملة المقارنة وفترات التخزين. حيث تم تجفيف الثمار جيدًا بعد عملية التغليف، ووضعت الثمار في صناديق خاصة (علبة كرتون)، وخزنت الثمار حسب فترات تخزين عند درجة حرارة 5 ± 1°م ورطوبة نسبية 85−90٪ في المخزن المبرد. استخدمت التجربة العاملية ضمن ضمن التصميم العشوائي الكامل (CRD) بثلاث مكررات و 15 ثمرة لكل وحدة تجريبية. بينت النتائج بانه كان لتغليف الثمار بزيت بذور الكتان بتركيز 0.5٪ و 1٪ وزيت حبة السوداء بتركيز 1٪ تأثير في تقليل الفقدان في وزن الثمار أثناء التخزين البارد وكذلك الجيتوسان بتركيز 1٪. تسبب جميع معاملات التغليف (بزيت بذور الكتان وزيت الحبة السوداء والجيتوسان) في الحافظ على جودة التقييم البصري وقلل من نسبة الإصابة بأضرار البرودة، وكذلك في زيادة المواد الصلبة الذائبة الكلية والسكريات الكلية والأنثوسيانين في محتوى عصير مقارنةً بمعاملة المقارنة باستثناء التغليف بتركيز 0.5٪ من زيت بذور الكتان. كان التخزين لمدة 4 أشهر متفوقًا بشكل كبير على النسبة المئوية للسكريات الكلية ومحتوى الأنثوسيانين في الحبات وحافظ على جودة التقييم البصري وقلل من نسبة الإصابة بأضرار البرودة.

الكلمات المفتاحية: التخزين البارد، معاملات التغليف، الفقد في الوزن، أضرار البرودة.

INTRODUCTION

Pomegranate (*Punica granatum* L.) is one of the Punicaceae family's earliest known edible fruits. Most of the sources indicate that Asia in general and Iran, in particular, is the original home of pomegranate, and from there it spread its cultivation to different countries of the world, as it is believed that China, India, and Iraq may be among the places of the first emergence of pomegranate (1). Pomegranate fruits are considered non-climacteric (2). It is the necessary to harvest fully ripened fruits, pomegranate fruits are very sensitive to storage conditions, as this causes fruit spoilage, weight loss and chilling injury (3, 4). The peel hardens, stains brown, and reduces the attractiveness of the fruit (5). Cold damage (chilling injury) is also a major problem after harvest, which reduces the marketability of the fruit. The main symptoms of cold damage are necrotic pitting of the skin and pallor of the beads, the skin color change to brown, and the white parts that separate between the arils (6). Another problem of pomegranate fruits during storage is damage caused by gray mold (*Botrytis cinerea*) (7). Losses due to rotting may be up to 30% of the pomegranate yield if no control measure is taken (8).

Flaxseed oil has been identified as one of many foods high in α-linolenic acid (ALA) (9). which has been reported to provide some healing properties in lowering low-density lipoprotein (LDL) that is causative for heart disease (10). Antioxidant compounds may also be found in flaxseed, whole flaxseed provides functional advantages in addition to nutritional benefits, such as antifungal activity, viscosity modification characteristics, water binding capacity, and emulsification activity (11, 12). Therefore, flaxseed oil may possess some advantages to be applied as an additional ingredient in the coating foods and fruits. Recent studies have appeared that the use of flaxseed oil has a big role in an extent storage period of pomegranate fruits which cause reduce weight loss and cold damage and prolonging the storage period (13). Due to the little studies on use oils plant-like (black seed and flaxseed oils) especially in Iraq about improving the storability of pomegranates.

Several studies have indicated that the use of black seed oil to an extent the storage period of pomegranate fruits caused to reducing weight loss and cold damage and prolonging storage period, as well as reducing the percentage of microbial damage and maintaining the quality and marketability of pomegranate fruit (13-15), and on banana (16).

Chitosan is a positively charged, high molecular weight polysaccharide that is soluble in dilute organic acids and has the ability to extend shelf life by controlling spoilage of many fruits such as pears, grapes, and strawberries (17-19).

The fruits of Salakhani cultivar have been described as medium to large in size and have a thick reddish-yellow peel saturated with pink. Moreover, the arils are red to pink and juicy, it tastes sour-sweet with good flavor, and the fruits of this cultivar are the most important for export in Kurdistan Iraq (20). Therefore, the present study aimed to evaluate the effect of coating with flaxseed, black seed oil, and chitosan in maintaining the storage quality characteristics and prolong the storage period and shelf life of the "Salakhani" pomegranate fruits.

MATERIALS AND METHODS

This study was carried out on the “Salakhani” pomegranate fruits were harvested manually from fifteen years old trees at full ripening stage (2 November 2020), from the private orchard in the Sazan village of Halabja Governorate in the Iraqi Kurdistan region. Pomegranate fruits were harvested early in the morning using shears. The fruits were selected that were uniform as possible in maturity, size, and color, also free from phenotypic defects such as cuts, bruises, and diseases at harvest. The harvested fruits were transferred to the laboratory of the Technical College of Applied Sciences in Halabja Governorate on the same day. The fruits were divided into groups according to the storage period and the concentrations of flaxseed oil, black seed oil and chitosan plus control treatment as mentioned below:

First Factor: Immersing treatments

(T1) Fruits immersed in distilled water for one minute as control treatment.

(T2) Fruits immersed in 0.5% of flaxseed oil for one minute.

(T3) Fruits immersed in 1% of flaxseed oil for one minute.

(T4) Fruits immersed in 0.5% of black seed oil for one minute.

(T5) Fruits immersed in 1% of black seed oil for one minute.

(T6) Fruits immersed in 0.5% of chitosan for one minute.

(T7) Fruits immersed in 1% of chitosan for one minute.

Second Factor: Storage periods, the fruits were stored in five months as storage periods. Fruits were dried well after immersing process and placed in special boxes (carton box), then fruits were stored according to their treatments and replications in a cold room at 5ºC with a relative humidity of 85-90%.

Solutions preparation methods

Flaxseed oil is obtained by cold pressing flax seeds to obtain 100% pure oil, and then 10 ml of flaxseed oil dissolved in ethanol by adding 90 ml of ethanol (70%) to it, and stirring for one day and then filtered and diluted the final solution with distilled water to prepare the required concentrations of the treatments (0.5% and 1%) as mentioned by (14).

The same method is used to extract black seed oil and prepare the required concentrations of 0.5% and 1%. Chitosan coating was prepared according to Han's method (21), Chitosan was dissolved in distilled water Contains 0.2% glacial acetic acid with 0.1% Tween 20, then the mixture was mixed to homogeneity and the pH of the solution was maintained at (5) by adding 0.5 with 1 M sodium hydroxide.

Design and Statistical Analysis:

The factorial experiment (7 x 5) within a complete randomized design (CRD) was used with three replicates and 15 fruits for each experimental unit. Collected data were analyzed by using SAS 9.1 software and the Duncan comparison method at the level of 5% was utilized for comparing the mean of treatments.

Characteristics of storage fruits quality:

At the end of each storage period, the following characteristics of pomegranate fruits were determined:

Weight loss (%)

It was estimated by taking the weight of the fruits at the beginning of storage and at the end of each storage period.

Chemical juice parameters:

Compound juice sample

A compound juice sample (250 ml) was prepared by collecting 50 ml of juice from each of the five fruits in a plastic container. The sample was then filtered through a filter paper and 50 ml of obtained juice was placed in a plastic bottle with a tight lid and kept in the freezer until the juices of all samples were completed (22, 23). Eventually, the various chemical properties of the juice were studied as follows:

Total soluble solids (TSS) % was measured by Hand Refractometer as Brix %. While Titratable Acidity (TA) % fruit juices were titrated with NaOH using phenolphthalein indicator and the acidity was determined as citric acid content followed by the method of (24). According to (25), total sugars were determined by using 1ml of the sample in the test tube followed by adding 1ml of phenol 5%, shake well, and then adding 5 ml H2SO4 (97%). Afterward, the solution was put in the water bath for thirty minutes at 60 ˚C. Before it was centrifuged at 3000 rpm, for 15 minutes, finally, total sugars were estimated by spectrophotometer at 490 nm. Anthocyanin (mg.100 ml^{-1} juice) was estimated according to (24) by adding 5 ml of juice and 25 ml of the solution (95% ethanol and 1.5 N hydrochloric acid (HCl) at 85:15 each respectively) and the mixture was mixed well. Then, it was stored overnight in a refrigerator at 4°C, after that, it was placed in the centrifuge for 15 minutes at 3000 rpm. Anthocyanin was measured by using a spectrophotometer at the wavelength 535 nm.

Visual evaluation (%):

This evaluation was carried out at the end of each storage period, by taking 3 fruits randomly (from each replication) after removing them from the cold storage conditions and keeping them at room temperature for 4 days, It was analyzed according to the measures that were suggested by (14, 26) as follows; 0, stained dried fruits have a lot of defects and/or a lot of microorganisms; 1, 51-60 percent fruit dryness, significant defects, and/or bacterial attack; 2, fruit dryness by 31-50% and/or moderate defects; 3, fruit dryness of 11-30% and/or the presence of slight defects; 4, 1-10% dryness and/or the presence of defects on the fruit; 5 fruits have less than 1% scratches, no defects, and no attacks by microorganisms.

Chilling injury (%)

To calculate the cold damage of the fruits as in the visual evaluation, at the end of each storage period, by taking 3 fruits randomly (from each replication) after they were removed from the cold storage conditions and kept at room temperature for 4 days, the chilling injury of the pomegranate is calculated According to previously proposed scales (14, 26) put the measurements 0-3, as follows: 0, none visible; 1, slight (≤25%); 2, average (26-50%); and 3 severe (>51%).

RESULTS AND DISCUSSIONS

Weight loss (%):

The results in **Fig. 1.** show the effect of immersion in oils (flaxseed, black seed) and chitosan on fruits weight loss. The results indicated that most of the fruits coating treatments were significantly superior to the control treatment for reducing weight loss, especially, the fruits coated with (T2, T3, T5, and T7), and the lowest weight loss (8.33%) among all treatments was recorded from fruits coated with 0.5% of the oil Flaxseeds. This result is in agreement with the result of the study conducted by (27) in their study, it was concluded that fruits immersed in 1% chitosan reduced the weight loss of fruits compared to fruits in the control treatment. (14) Studied the effect of black seed oil use on the post-harvest quality of the exquisite pomegranate cultivar. These researchers reported that black seed oil was a good protection against weight loss in pomegranate. The results of the current study also agreed with the results of the study (28) where it was mentioned that the use of black seed at a concentration of 200 ppm reduced the weight loss of pomegranate fruits compared to the control treatment fruits. The results of the current study agree with the result of a study conducted on the positive effect of oils (black seed and flaxseed) in reducing the weight loss of Salakhani pomegranate fruits during the cold storage compared to the control treatments, where it was stated that it may be due to the formation of a thin layer of oil around the peel of the fruit (13). On the other hand, (29) the effect of flaxseed gum as an edible active topping for quality ready-to-eat pomegranate was examined. The results indicated that flaxseed gum was somehow effective in reducing weight loss from pomegranate arils. In a study carried out on the post-harvest quality of the (Hicaznar) cultivar of pomegranate fruit, (30) showed that fruits immersed in 1% chitosan for one minute were significantly superior on the control treatment in the weight loss, which was close to the results of the present study. (31) studied the effect of chitosan treatment on cooling injuries and quality characteristics of pomegranate fruits during cold storage and reported that fruits treated with 1% and 2% chitosan lost about 8% and 6% of their weight, respectively, which was significantly less weight loss form fruits in the control group (32). It was concluded in his study that the fruits immersed in a concentration of 1% chitosan significantly reduced weight loss compared to the control fruits. The positive effect of the oils on reducing weight loss is due to the thin layer of oil around the fruit, where the oil treatment methods act as a barrier to permeable of moisture, CO_2, O_2, and reduce respiratory rates and water loss (33, 34). In this study, an increased reduction in weight loss when using flaxseed and black seed oils could be due to the fact that the oil has good water vapor barrier properties (35). Using the oil coating to form a thin layer around the fruit, lead to a lower rate of water loss, which leads to reduced weight loss.

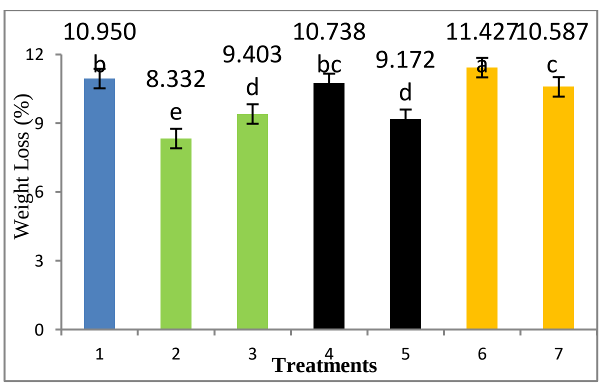


Fig. 1. Effect of flaxseed oil, black seed oil and chitosan concentrations on weight loss of the Salakhani pomegranate fruits.

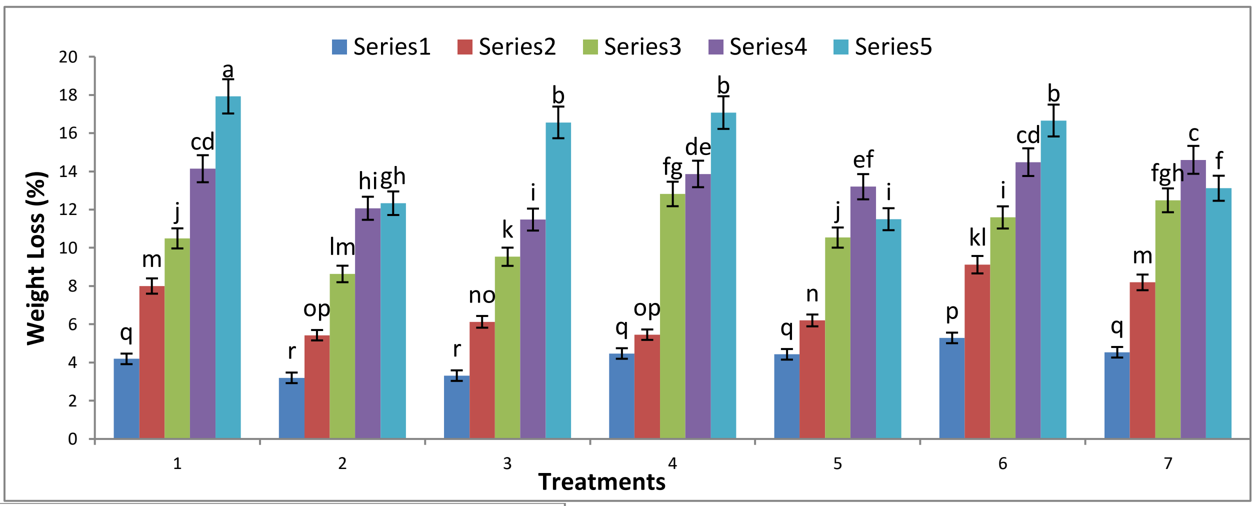
Usually, weight loss increases with increasing the storage periods, as expected, the results showed that weight loss percentage increased gradually and significantly with increasing the storage periods, the fruits lost 4.20% of their weight in the first month of storage and this percentage reached 15.02% after five months of storage **Fig. 2.** This decrease of the weight loss may be due to the decreasing peel moisture with increasing the storage periods **Fig. 3.**

Pomegranate fruit weight loss is one of the most common postharvest issues. Long and inefficient storage results in significant losses in weight, as well as fruit quality and farmer revenue. Weight loss also causes the husk to harden and the rind to darken), weight loss can be seen as a sign of agricultural produce's freshness. The findings of the present study were also supported by the results reported by (36).

Similar results were found by (14) indicated that the weight of pomegranate fruits was higher at the end of the experiment period compared to the beginning of the study who found an increasing trend of loss of pomegranate fruits weight during the storage period. Pomegranate fruit is very sensitive to storage conditions, and it loses weight and quality over time. Pomegranate fruit suppliers and marketers face a major problem in maintaining the quality post-harvest. The results of the current research are close to the results of the study (37) on the pomegranate fruits cv. (Armishty), where the rate of weight loss increased with the prolonged storage period.

(control) nested with the fifth months of storage which reached (17.92). The best interaction treatments for reducing weight loss to (3.20) was coating fruits with 0.5% flaxseed oil nested with two months of storage.

Fig. 3. The effect of interaction between the treatments and the storage periods on weight loss.



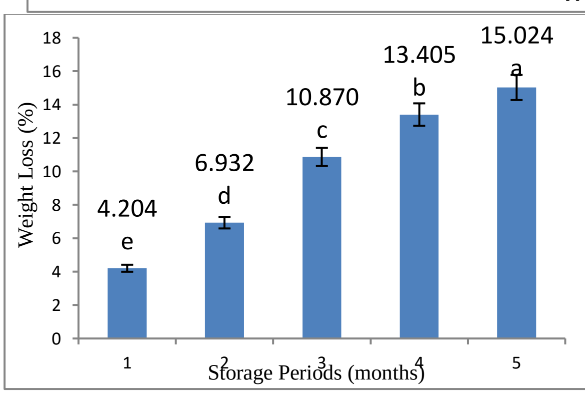


Fig. 2. Effect of storage periods on weight loss of Salakhani pomegranate fruits

The effect of the interaction between treatments and storage times on weight loss. Through **Fig. 3.** it was found that the highest fruits weight loss in the untreated fruits

Total soluble solids (TSS) %:

The results in (fig.3.10) indicated that there are significant differences among treatments in the total soluble solids of pomegranate fruits juice, the fruits coated with 0.5%chitosan gave a higher percentage of total soluble solids which significantly superior to the fruits in the control treatment. The lowest total soluble solids content was observed in fruits coated with 0.5% flaxseed oil. Interestingly, pomegranate fruits treated with (0.5) chitosan gave a higher TSS content than those treated with 1% chitosan. TSS is defined as the measurement of the carbohydrates, organic acids, proteins, fats, and minerals in the fruit, and as the fruit grows it becomes less acidic and sweeter. It is critical that the grower strives to achieve a satisfactory balance between TSS and fruit acidity (38). This increase of TSS in fruits treated with T6 may be due to the increase of water loss in this fruit **(fig.1)**.

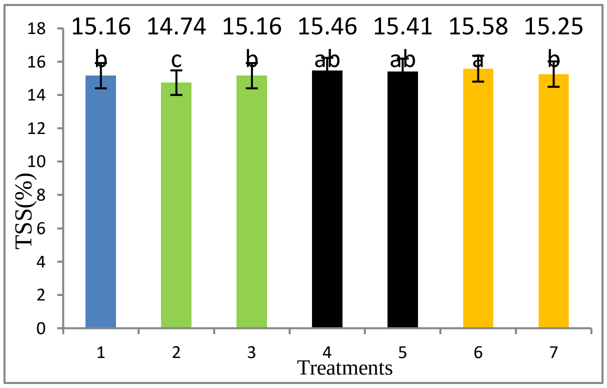


Fig. 4. Effect of flaxseed oil, black seed oil and chitosan concentrations on TSS% of the Salakhani pomegranate fruits

This result coincides with the studies conducted on the effect of chitosan coating on pomegranate fruit (39) and different types of fruits of peach (40), of mango (41) Chitosan coating application has shown effects on total solubility dissolved solids conten .

In this study, the effect of storage duration was highly significant on the TSS ratio (fig.5). In the second month of the storage the highest TSS content (16.20%) was observed, it is maybe due to a decrease in the rate of respiration in the second month which cause to lack of consumption of the reserved dry matters in the fruits, while the lowest amount of TSS (14.84%) was observed in the third month of the storage. (36) revealed that the TSS of fruits was increased, but not significant, from 1 to 45 days of the storage, and then, a slight decrease was observed from 45 to 135 days of the storage, in a study by (30), a slight decrease in the TSS content of pomegranate fruit juice was observed during the storage period; However, its effect was not statistically significant. In another study with similar results, (32) indicated that storage duration had no significant effect on the TSS ratio of pomegranate juice.

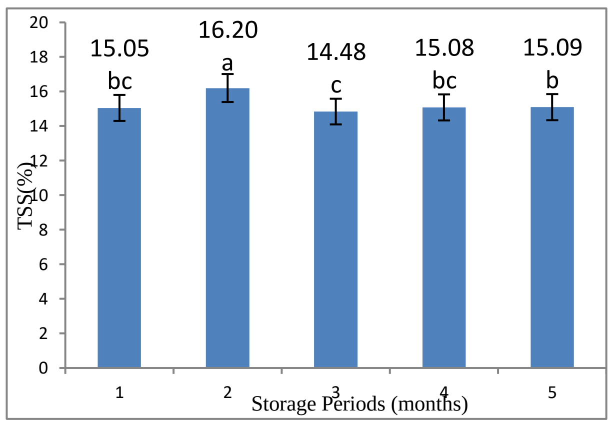


Fig. 5. Effect of storage periods on TSS% of Salakhani pomegranate fruits.

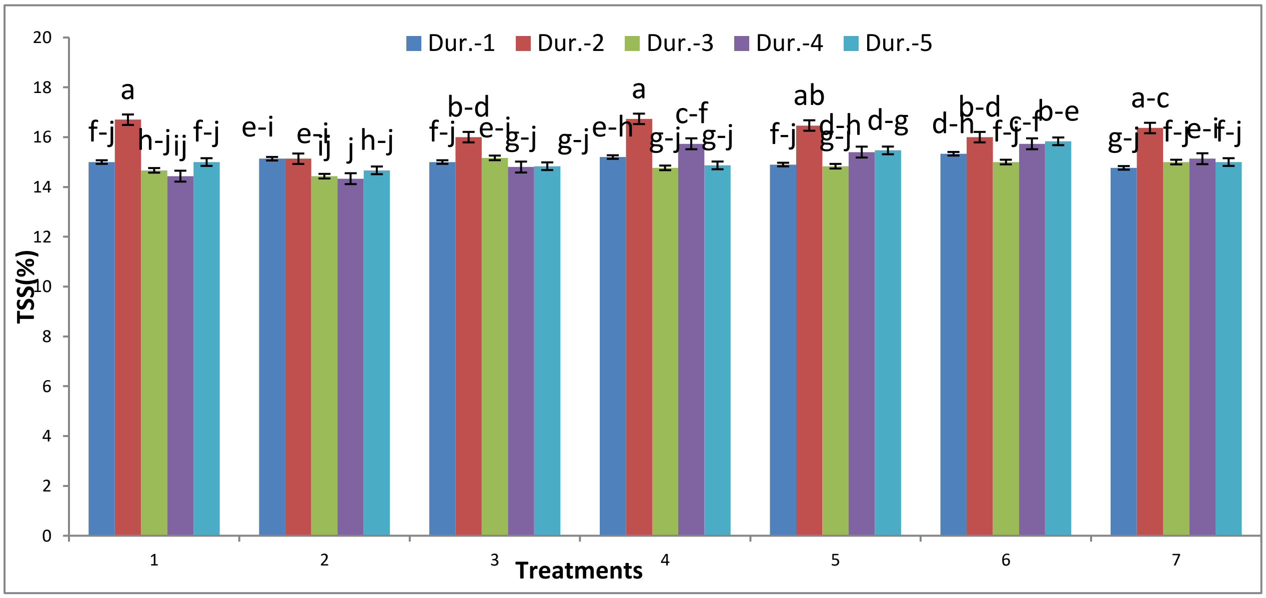


Fig. 6. The effect of interactions between the treatments and the storage periods on TSS (%)

As for the interactions between the treatments and the duration of storage on TSS of juice contains the highest percentage of total soluble solids was observed in the second month of the storage in the fruits coated with 0.5% black seed oil (16.73%). While recorded the lowest TSS (14.43%) in fruits coated with 0.5% flaxseed oil and stored for four months of the storage (fig.6).

Total acidity (TA) %:

Through (fig.7), the results show that the positive effect on TA%, that fruits of all treatments (flaxseed oil, black seed oil, and chitosan) contain a higher amount of TA% compared to the untreated fruits. The highest percentage was obtained in fruits treated with 0.5% black seed oil.

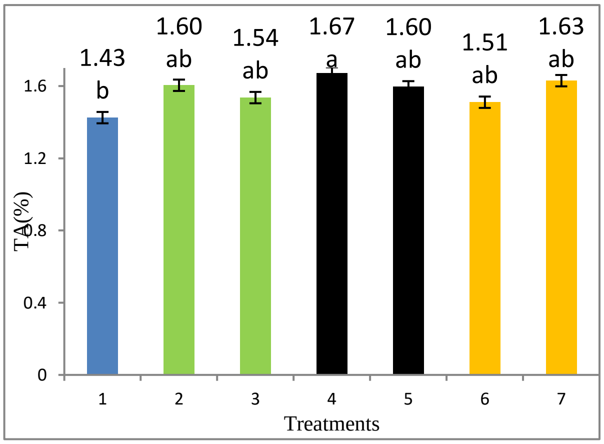


Fig. 7. Effect of flaxseed oil, black seed oil and chitosan concentrations on TA% of the Salakhani pomegranate fruits

As for the effect of the storage period on the TA%. Figure (8) shows that in contrast to the TSS content approximately, the highest percent of TA was observed in the fruits that were stored for five months, while the lowest percent of TA was obtained from the fruits juice that was stored for two months. This may be due to the conversion of organic acids into other compounds like sugars and vice versa as shown in (fig. 5) as the highest TSS in the second month had similar results with a study (42). (36) reported that during the storage period, %TA content showed a decreasing rate until the end of the storage and this reversed with our results. These changes of TA% in our study may be due to the changes which occur of the stored compounds in the fruits during the respiration process as convert the carbohydrate compounds to organic acids or to phenolic compounds or to amino acids and in contrast.

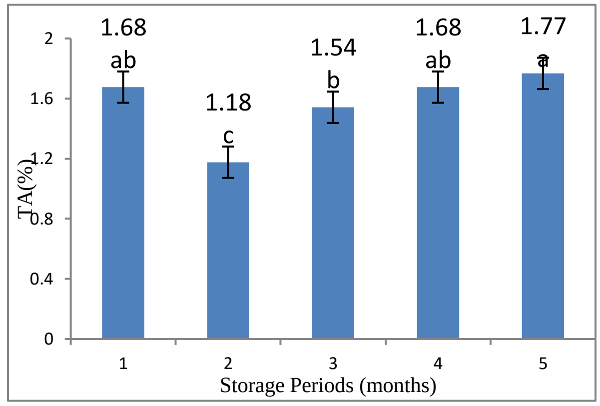


Fig. 8. Effect of storage periods on TA% of Salakhani pomegranate fruits.

As for the interaction effect between immersion in (flaxseed, black seed, and chitosan oils) and storage time, when considering the TA content of fruit juice in (fig. 9) the fruits immersed in 0.5% flaxseed oil at the first month of the storage showed the highest amount of TA (2.26%).

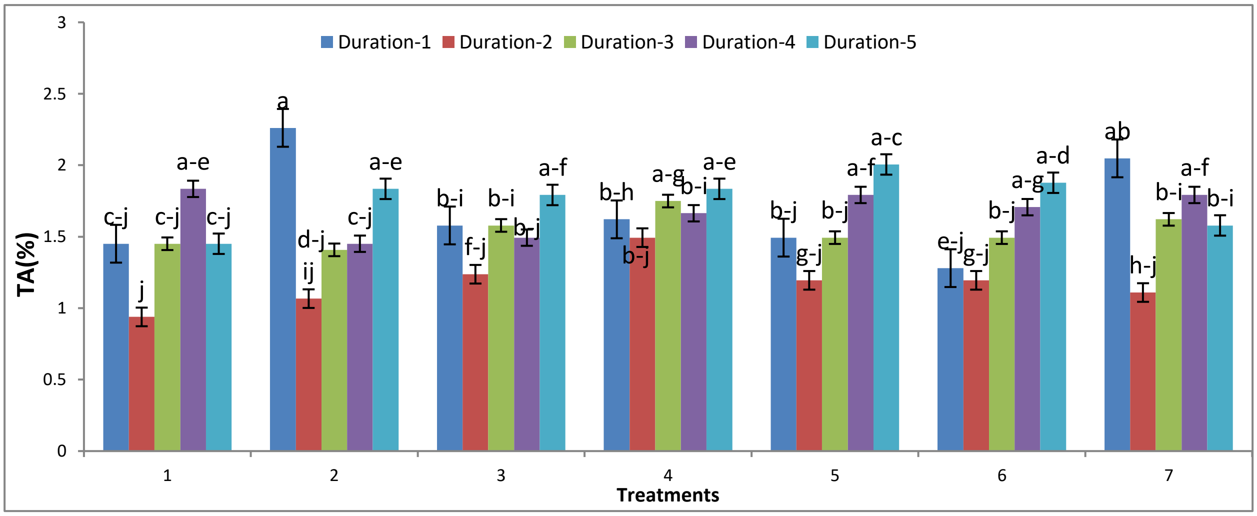


Fig. 9. The effect of interactions between the treatments and the storage periods on TSS (%).

On the contrary, untreated fruit juice (control group) at the second month of the storage showed the lowest amount of TA (0.94%).

Total sugars (%)

Through (fig.3.19) there are significant differences between the treatments, that the results of this study indicated that the fruits covered with 1% black seed oil gave the highest percentage of total sugars (3.82) and were significantly superior to the control fruits. On the other hand, the lowest percentage was obtained in fruits treated with 0.5% flaxseed oil (T2). This decrease in total sugars may be due to the increment in the respiration rate in this treatment which caused to raising the consumption of sugars during the respiration process or convert it to other compounds. In addition, the positive effect of the fruit coating reduces the weight loss of the fruit and this may be due to it makes a thin

The layer of coating around the peel of the fruit. This layer acts as a barrier against moisture loss and air exchange, thus reducing oxidation, reactions, and water loss (33, 34). The results of the current study are similar to the results of the study (13) the results of the current study are similar to the results of a study on flaxseed oil and black seed when the pomegranate fruits were immersed in 2% black seed oil and 1% and 2% flaxseed oil, the total sugar content in the immersed fruits was significantly superior to the fruits in the control group.

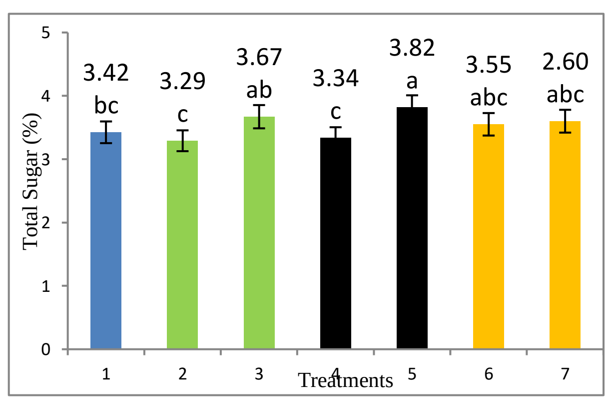


Fig. 10. Effect of flaxseed oil, black seed oil and chitosan concentrations on total sugar (%) on the Salakhani pomegranate fruits

Related to the effect of the storage period on the percentage of total sugars in the (fig. 11) the minimum was in the second month (2.08%), where the higher the respiratory rate the percentage of sugars decreases, as sugars are the main subject matter that is consumed in the respiration process. Then this percentage gradually increased until the end of the study. These increases in the total sugars content in the fruit may be due to the gradually increasing water loss in the fruit during storage periods (fig. 2), which resulted in the concentration of fruit juice and thus the increase in total sugars in it.

oil at a The concentration of (1%) in the fifth month significantly outperformed the comparison and other treatments (5.91%) in maintaining the total sugar content. The lowest percentage of total sugars for treatment of flaxseed oil concentration (0.5%) in the second month (1.66%).

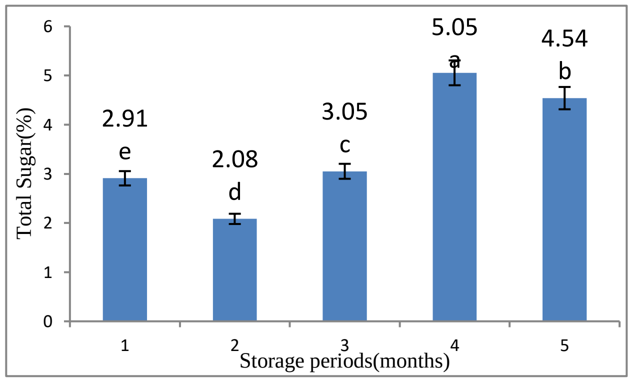
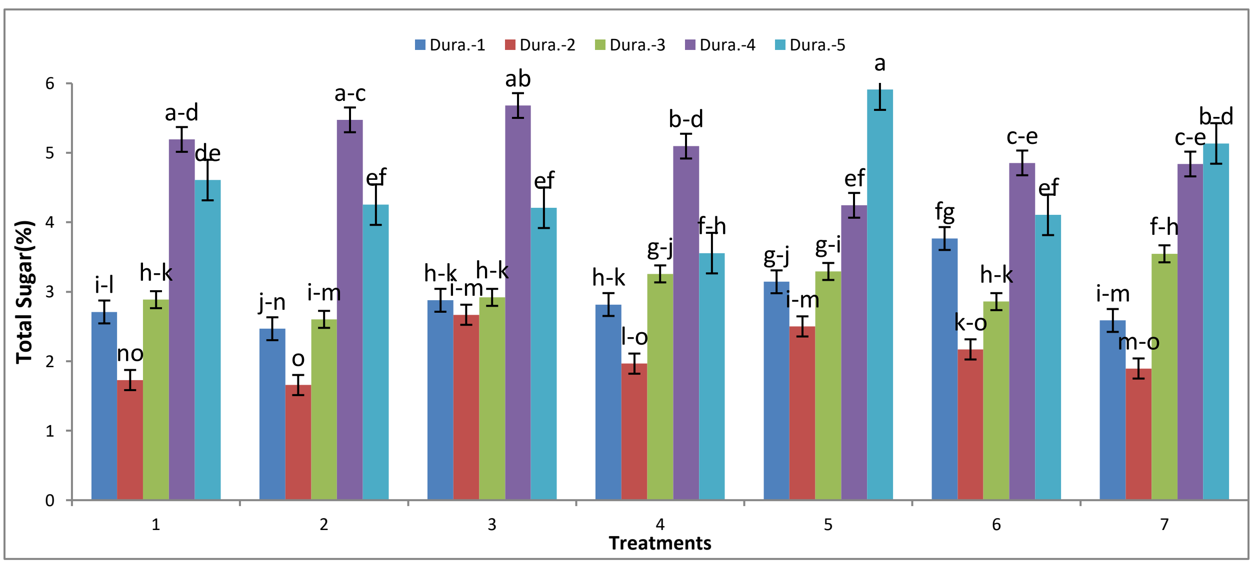


Fig. 11. Effect of storage periods on total sugar (%) of Salakhani pomegranate fruits



Regarding the effect of interactions among oil immersion (flaxseed, black seed), chitosan, and storage period, through (fig. 12) it was found that the treatment of black seed

Fig. 12. The effect of interactions between the treatments and the storage periods on Total sugar (%)

Anthocyanin content (mg.100ml⁻¹ juice)

The effect of treatments on anthocyanins in pomegranate juice was presented in (fig. 13). Through the results, it was found that there are significant differences among the treatments, all treatments significantly increased the anthocyanin content compared to the control except T2 (0.5% flaxseed oil) which gave the lowest value (11.46%). This may be as a result of the increase in the respiratory rate of fruits in T2, as ((43)) mentioned that any increase or decrease in anthocyanin is affected by CO2, O2 levels. They also showed that chitosan increased anthocyanin content compared to fruits in the control group. Similar results were found by (31), who reported the positive effects of 1% and 2% chitosan on increasing the total anthocyanin content in (Malas e Saveh)pomegranate cultivar. Furthermore, our findings revealed that coating treatments reduced anthocyanin degradation over time. This was likely due to the fact that coating treatment reduces the activity of polyphenol oxidase and peroxidase enzymes in response to changes in the internal environment of the coated fruit (44). The results of this study agree with the results of the study (13) by increasing anthocyanins in oil-coated fruits of flaxseed and black seed oil compared to uncoated fruits.

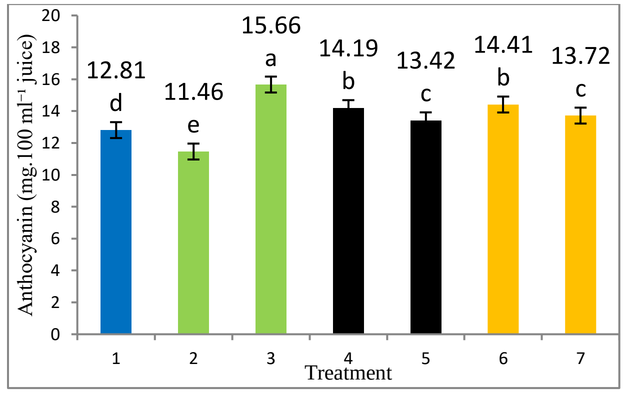


Fig. 13. Effect of flaxseed oil, black seed oil and chitosan concentrations on Anthocyanin content (mg.100ml⁻¹ juice) of the Salakhani pomegranate fruits.

A non-uniform trend of changes in the anthocyanin content of pomegranate fruits during the storage period was observed. Most of the amounts of anthocyanins belong to fruit juice stored for four months (15.65) the anthocyanins may be reverted to sugars (fig. 11), while the lowest amounts were observed in fruit juice stored for three months (11.07) (Figure 14).

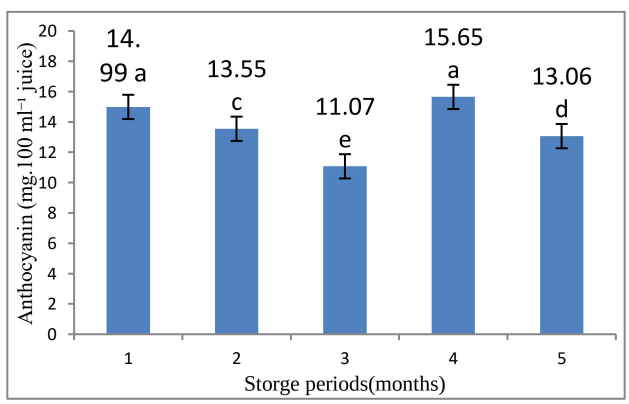


Fig.14. Effect of storage periods on Anthocyanin content (mg.100ml⁻¹ juice) of Salakhani pomegranate fruits**.**

(30) noticed that the color of the Hicanzar pomegranate fruit was redder in the first four

months of cold storage as a result of the increase in its contents of anthocyanins, and then there was a loss of anthocyanin contents and a decrease in the red color of the arils at the end of the storage period and the duration of the marketing life.

The (fig. 15) show the effect of the interactions between treatments and storage period, the significant differences were observed among them, also found that the highest value (19.52%) of anthocyanin content in fruits immersed in 1% flaxseed oil which stored for the two months, while the lowest value (9.36%) was found from fruits treated with 0.5% flaxseed oil which stored for the three months.

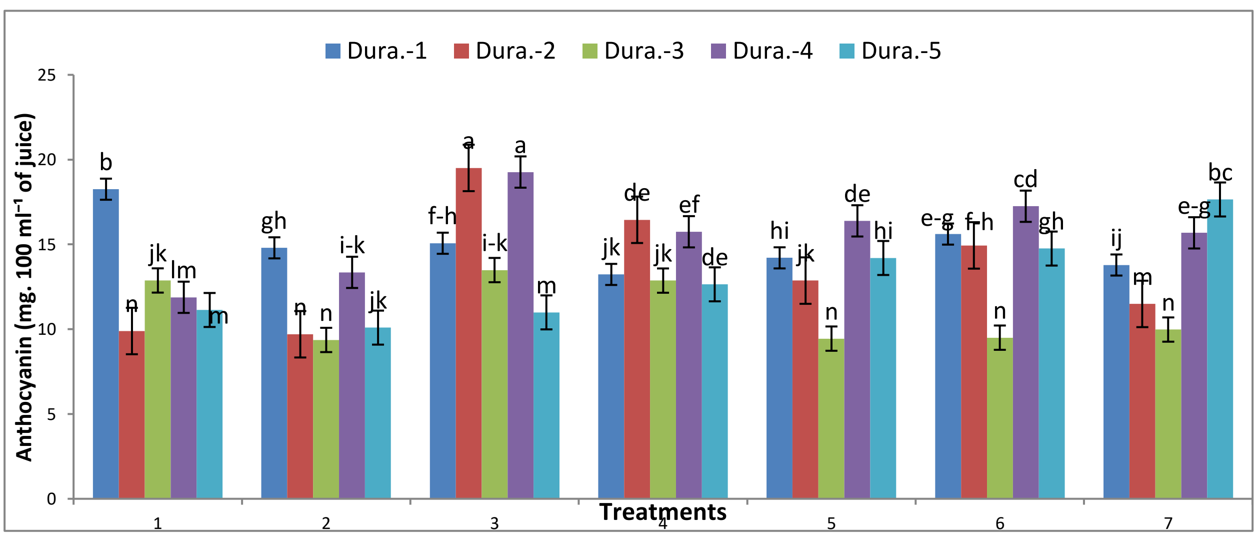


Fig. 15 The effect of interactions between the treatments and the storage periods on Anthocyanin content (mg.100ml^{-1}juice)

Visual evaluation (%)

From the (fig. 16) the results indicated that all treatments were significantly superior to maintain the quality of the fruits than uncoated fruits and 0.5% flaxseed oil, the fruits coated with 1% chitosan were significantly superior to the other treatments, which got the highest percentage (3.99%). While the lowest percentage was recorded in uncoated fruits. This indicated that treatments coating helped preserve the freshness of the pomegranate fruits and their arils until the end of storage. (27) also indicated in their study on pomegranate (cv. Tarom) that chitosan can directly inhibit spore germination and fungal growth on the fruit peel and prolong the fruit storage period, which may be related to its ability to form a film on the surface of the fruit. indicated in their (14) indicated in a study on (Wonderful) pomegranate fruits that black seed oil helps to protect the visual quality by weighting the fruits by preventing their drying and preventing the occurrence of mold, and also proved that the black seed oil-coated fruits obtained a higher score than the uncoated fruits with respect to visual quality. Also, the results are similar to the results of (13) indicating that the oils (black seed and flaxseed) have the ability to reduce the physiological disorders of the Salakhani pomegranate fruits compared to the uncoated fruits.

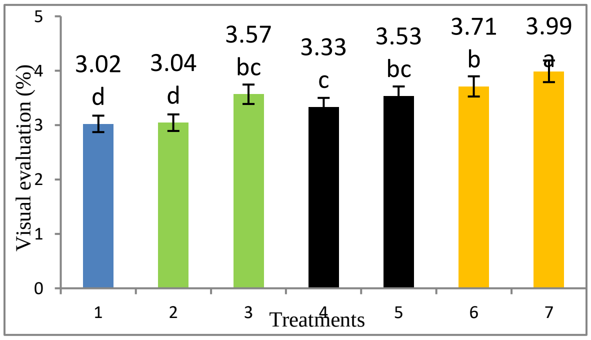


Fig. 16. Effect of flaxseed oil, black seed oil and chitosan concentrations on visual evaluation (%) of the Salakhani pomegranate fruits

Visual quality scores: 5=less than 1% of dents, absence of blemishes, and absence of microorganism attack; 4=1–10% of the fruit was blemished or dry; 3=11–30% of the fruit was dry or showed minor blemishes; 2=31–50% of the fruit was dry or had moderate blemishes; and 1=51–60% of the fruit was dry and had severe blemishes or microorganism attack; 0, dry with very severe blemishes or widespread microorganism attack.

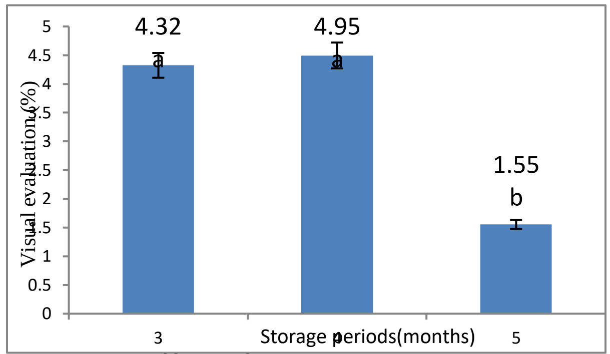


Fig. 17. Effect of storage periods on visual evaluation of Salakhani pomegranate fruits.

As for the effect of storage periods studied in the last three months, it was shown in (fig. 17) that the third and fourth months of cold storage significantly outperformed the preservation of the fruit's quality compared to the fifth months. It is explained by the decrease in the respiratory rate (fig.3.32) in the third and fourth months, which helped to preserve the quality of the fruit.

The visual quality of the studied pomegranate fruits was affected by the interaction of treatments and storage duration, and the best performance was observed of in the fruits coated with 1% flaxseed oil when stored for the four month (4.73), while the fruits coated with 0.5% flaxseed oil at the fifth month of the study showed the lowest visual quality grade (fig. 18).

Fig. 18: The effect of interactions between the treatments and the storage periods on visual evaluation (%)

Chilling injury (%):

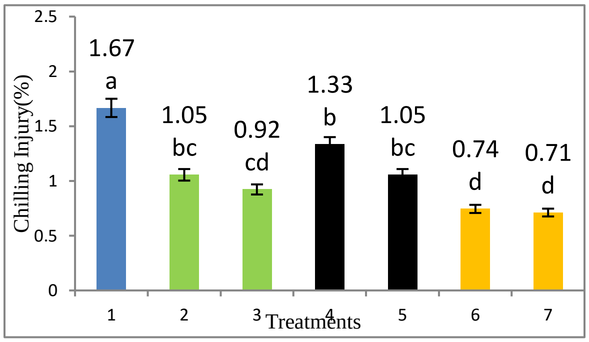
Chilling injury in pomegranate fruits in the form of darkening and pecking in the peel of the fruit, which is very sensitive to damage (45), most of these symptoms may reach arils, which leads to a decrease in the internal quality of the fruits and leads to an effect on the hardness, color of arils and the content of ascorbic acid in the fruits (46). Color changes in fruits as a result of enzymatic activity are one of the main problems that occur during the processes of harvesting, transportation, and storage of fruits, and the deterioration of qualities is not acceptable by the consumer (47).

As for the effect of treatments on chilling injury of fruits, figure (19) shows that all coating treatments are significantly superior on the uncoated fruits for reducing the chilling injury of fruits. In a study with similar results, (14) found that using 0.1% and 0.5% black seed oil for coating had a positive effect on reducing cold damage in pomegranate fruits. Also, to support our findings, (31) reported that the use of chitosan for coating has a significant effect on reducing cooling damage compared to uncoated fruits. The reason may be attributed to as mentioned by (48) in their study on avocado fruit that packing or wrapping the fruits reduces the dryness of the peel cells, which leads to the cells maintaining their stability, and thus reducing the oxidation of anthocyanin (fig. 13), which is the main cause of the brown color of fruits affected by chilling injury.

Fig. 19. Effect of flaxseed oil, black seed oil and chitosan concentrations on chilling

injury (%) of the fruits of Salakhani pomegranate.

Chilling injury scores were given according to



the following scale: (0) none visible; (1) slight (25%); (2) moderate (26-50%) and (3) severe (>51%).

Related to the effect of the storage period on chilling injury of the fruits, as shown in (fig. 20), it was founded that there are significant differences among them, with increasing of the storage periods gradually increased the infection of fruits with chilling injury.

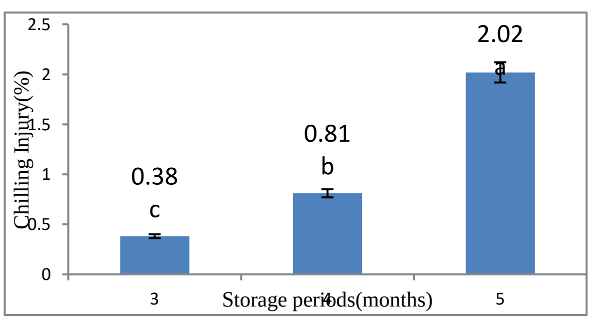


Fig. 20. Effect of storage periods on chilling injury(%) of the Salakhani pomegranate fruits

The effect of the interactions between immersion treatments (flaxseed oil, black seed oil, chitosan) and the storage periods. Noticed from the (fig. 21) that there are significant differences among the interaction treatments, that the control fruits at fifth month were more affected by chilling injury compared to most of the other interaction treatments, however, fruits coating with (flaxseed oil, black seed oil, and chitosan) at the third month of storage period were the most efficient in preserving the fruits from the chilling injury.

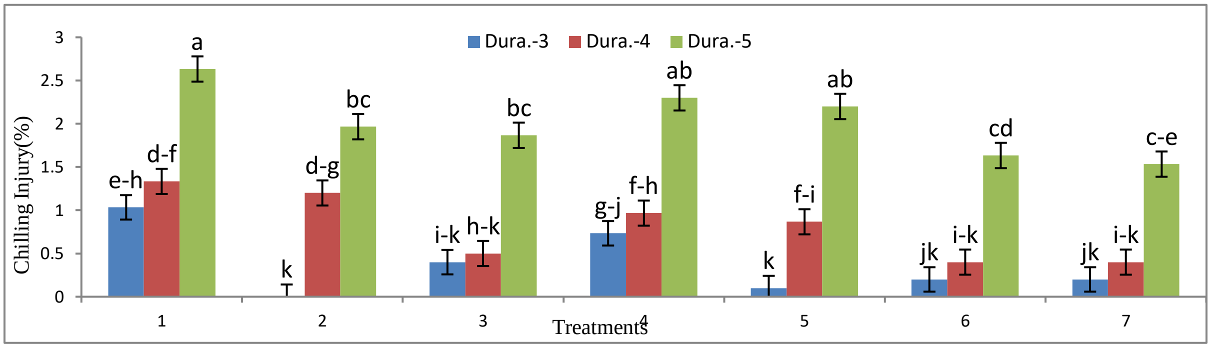


Fig. 21. The effect of interactions between the treatments and the storage periods on chilling injury(%)

Conclusions

Based on the results of the current study, can be concluded that the flaxseed oil at 0.5% and 1% concentrations as well as black seed oil at 1% concentration had a higher effective on reducing weight loss of pomegranate fruits. All coating treatments significantly reduced the infections by chilling injury, also preserved the quality of the visual fruits , hence they can be used for coating pomegranate and even other fruits because its safety for humans and the environment. On the other hand, all coating treatments maintaining the chemical properties of pomegranate juice than the control treatment except 0.5% of flaxseed oil. Storing "Salakhani" pomegranate fruits for five months at 5˚C causes to reduction in the visual evaluation and increment the infection of fruits with chilling injury, thus prefer do not storage fruits of this cultivar at this temperature for more than 4 months.

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وێستگەی توێژینەوەی کشتوکاڵی چەمچەماڵ

COMPARISON OF ROOTING SITUATIONS FOR SALAKHANI AND ZIVZIK POMEGRANATES UNDER DIFFERENT IBA DOSES

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COMPARISON OF ROOTING SITUATIONS FOR SALAKHANI AND ZIVZIK POMEGRANATES UNDER DIFFERENT IBA DOSES

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Abstract. Rooting performance of Salakhani, a local variety of Iraq and Zivzik (*Punica granatum* L.), a local pomegranate of Siirt, were compared in our study. For this purpose, the effect of different doses of indole butyric acid (IBA) (0.00, 1000, 2000, 4000, 6000 mg / L) on rooting was examined. Cuttings were kept in the rooting environment for five months and rooting rates, root number, root lengths, survival rates, shoot lengths, shoot and leaf number were determined. Salakhani were found to be the best cultivar only in terms of the root length, sprout length, shoot number and leaf number. Zivzik were found to be the best variety with regard to the other properties. IBA application of 4000 ppm was found to be the best all the shoot number, leaf number and root length. The hormone dose of 6000 ppm was found to be the most beneficial for survival and rooting rates. Application of 1000 ppm was found to be the best dose among the doses of hormone only on account of root number.
Keywords: *plant growth regulators, Punica granatum L., cutting production, vegetative growth, hormone effect*

Introduction

Pomegranate is one of the first five important fruits together with fig, date, olive and grape which are old known cultivated plants. The domestication of pomegranate started 3000-4000 BC in the North of Iran and Turkey (Usanmaz et al., 2014). It is a perennial plant grown in tropical and subtropical regions (Schubert et al., 1999). Iran and the Himalayas of Northern India are the central origin of pomegranate. This fruit grows well in semi-arid temperate and subtropical climate and it is naturally grown in any climate with cool winter and hot summer. Pomegranate is deciduous in the subtropics and is evergreen in the tropical regions.

It is a species found in temperate forests that requires high temperatures in summer in order to reach full maturity and achieve commercial production (Melgarejo and Martinez, 1989). For most species of pomegranate, the suitable temperature degrees are between 21°C and 27°C during day-time and 15°C of night-time temperatures (Hartmann et al., 1997). It is naturally grown and is well adapted to the regional climate in Afghanistan, China, Morocco, Palestine, India, Iraq, Iran, Israel, Italy, Cyprus, Egypt, Syria, Saudi Arabia, Thailand, Tunisia, Turkey. Iran, Spain, Tunisia and Turkey are the countries exporting pomegranates (Özgüven and Yılmaz, 2000). India is first in terms of pomegranate production and production area. When it comes productivity, Spain (18.5 t/ha) comes first, traced by USA (18.3 t/ha). On the other hand, Iran (60.000 t/year) is first in point of exports, chased by India (37.176 t/year) (Chandra et al., 2006, 2008; Chandra and Meshram, 2010; Silva et al., 2013).

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Pomegranate cultivation is done in different soil types, such as sand, gravel, clay and heavy clay soils. Optimal development of pomegranate is observed in deep, permeable, alkali and sandy loam soils. In Turkey, pomegranate cultivation can be done in all regions, except for very cold regions. Furthermore, pomegranate can withstand the lowest temperature range from -10°C up to -15°C, while the temperature lower than -20ºC causes the death of the plant. Period of vegetative growth ranges between 180-215 days. In addition, the flowering period ranges between 50-75 days, and the fruit growth and development period ranges between 120-160 days (Onur, 1983).

Its fruit is rich in vitamins, iron, folic acid, potassium and polyphenol antioxidants, which are used to treat different diseases and pomegranate extract is used as an alternative method for the treatment of especially different types of cancer, such as breast cancer and prostate cancer, skin cancer, colon cancer, and lungcancer. Pomegranate extract includes seed oil and pomegranate juice, pomegranate peel, and different parts of the plant roots, bark and flowers (Kavaklı et al., 2011). Several parts of pomegranate have the biological properties of extracts, which have been used in therapeutics, such as in the prevention of infection, inflammation, cancer, and in other applications (Miguel et al., 2010). Fruit juice is an excellent source of sugars, vitamins (B and C) and minerals, potassium, iron, antioxidants, polyphenols, and some parts of the pomegranate tree, such as leaves, immature fruits, fruit peel, flower buds are used inmedicinal applications and also for the tanning of leather. Wild pomegranate has a very tart flavor and is of a little value, it is used only as a souring factor. The double-flowered pomegranate used for decorative purposes (non-fruitful) is grown in parks and ornamental gardens for its beautiful red flowers and for the beauty of its appearance (Raj and Kanwar, 2010). Recent studies suggest that pomegranate juice contains anticancer, antimicrobial, and antiviral components (Reddy et al., 2007; Kotwal, 2007; Schwartz et al., 2009).

The propagation of pomegranate is performed either sexually by seeds or by using the vegetative method (asexual) with cuttings and less frequently it is performed using layers, suckers or graftings (Hartmann et al., 1997; Melgarejo et al., 2008; Polat and Çalışkan, 2009). The propagation from cutting (cloning) is an easy, quick and economical method which produces a plant of the same characteristics as the mother plant and which is uniform in sprouting, comes into bearing and fruiting earlier than the seedling and does not need any new techniques in grafting, budding and layering. The success of this process depends on some factors such as the condition of the mother plant, the age of the plant, planting time, temperature, and rooting media (Frey et al., 2006). Cutting is the simple and successful method of pomegranate propagation with 15-20 cm in length and of the pencil size or bigger in diameter and the use of semi-hardwood or hardwood rooting hormone is possible in this method (Melgarejo et al., 2008; Saroj et al., 2008; Polat and Çalışkan, 2009). The cuttings collected at the end of February have a higher rooting potential than those collected at the beginning of October (Polat and Çalışkan, 2009). Grafting is one of the propagation methods which is used for varieties to be propagated of which there are barely specimens from which cutting can be obtained; this process should be conducted at specific times, in May or in July, although it can also be done at the end of the summer (with dormant buds) (Melgarejo and Martinez, 1992). Tissue culture (micropropagation), which is another method of vegetative reproduction of fruit crops, helps in overcoming problems of sexual propagation, producing new plants of the same characteristics with their parents, quick, and mass production of planting materials (El-Agamy et al., 2009).

Aim of this study is to compare effects of the application of IBA growth hormone on sprouting and rooting situations of two local pomegranate varieties, Salakhani, in Halabja province in North of Iraq and Zivzik, in South East of Turkey. There is no experiment about either Salakhani or Zivzik varieties on rooting with cuttings until now. Therefore this study is unique and important to guide subsequent studies.

Literature Research

Melgarejo et al. (2008) reported that the application of exogenous auxins to pomegranate cuttings resulted in the increase of rooting percentages up to three folds. Owais (2010) stated that the application of rooting hormones can increase the rooting percentage of pomegranate cuttings at the rate of 49-73%. Rooting is significantly increased by the addition of synthetic auxins (Hartman and Kester, 1983). Polat and Çalışkan (2009) revealed that some factors, such as the physiological conditions of the parent plant, cutting types, the dates of their taking and medium type, affect the rooting of pomegranate cuttings. They suggested that the cuttings collected at the end of February had a higher rooting potential than those taken at the beginning of October.

In other investigation accomplished under mist chamber by Singh (2014) it was shown that different concentrations of IBA had a significant effect on some growth characteristics of hardwood cuttings in *Punica granatum* L. It was noted that the maximum rooted percentage, root length, sprouted length and leaf number percutting were obtained at the 5000 ppm dose of IBA, while the minimum value was reached in the control group. Alikhani et al. (2011) conducted an experiment to determine the effects of the kind of medium and the kind of pomegranate cuttings on the rooting ability and growth of cuttings under greenhouse conditions. In this experiment, two different medium cultures (sand/peat and sand) and three kinds of pomegranate cuttings (one bud, three buds, more than three buds) were used. At the end of the study, it was revealed that the effect of cutting type on leaf number was significant ($\rho<0.05$). However, it was found out that the effects of medium and interaction between cutting type and medium type on leaf number were not so significant, additionally, the type of the cutting had an influence on leaf number. It was noted that the cutting type had a significant effect on shoot number. On the contrary, the effect of medium and interaction between cutting type and medium type on shoot number was not significant. In terms of raised bud numbers, the effect of medium and cutting type was not significant. However, the effect of cutting type on raised bud number and the effect of interaction between medium type and cutting type on raised bud number were significant. Eventually, the effect of medium and cutting types and the effect of interaction between them on root length were significant.

Abu-Zahra et al. (2013) examined in their study the application of exogenous auxins to ornamental plants such Rosemary, Hedera, Syngonium and Gardenia (all of them are difficult to root without using a rooting hormone) in six different concentrations of NAA (0, 1000, 2000, 3000, 4000 and 5000 ppm NAA). Result of their study showed that the highest rooting percentages as the number of roots, the best length, in comparison to the control treatment, were obtained with 3000 ppm NAA in Rosemary and Hedera cuttings, while the best results were obtained with 4000 and 1000 ppm NAA in Gardenia and Syngonium cuttings, respectively. Adekola and Akpan (2012) realized an experiment to assess the effect of the application of two growth hormones, NAA and IBA, on sprouting and rooting behaviours of Nigerian (*Jatropha*). The growth regulator was applied by adopting the slow dip method (for 24 h). In addition, the

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untreated replication was accepted as a control group. The results showed that there were no significant treatment differences in the survival percentage and sprouting behaviour of *J. curcas*. A slight selective response to the application of growth hormones was observed in terms of rooting behaviour, as IBA treated cuttings rooted better than the NAA-treated cuttings. However, the untreated cuttings gave the best performance for all the parameters assessed on the sprouting and rooting ability of *J. curcas*. Hence, the untreated cuttings can be used for the mass production of *Jatropha* since they are good propagating materials.

Sharma et al. (2009) executed an experiment to improve the rooting and reduce the mortality of rooted cuttings under field conditions. The results clearly indicated that the treatment of IBA 500 ppm with Borax 1% produced the greatest root number and root length in semi-hardwood and hardwood cuttings of pomegranate. Consequently, the semi-hardwood and hardwood cuttings of pomegranate cultivars. Ganesh treated with IBA 500 ppm + Boron 1%, IBA 300 ppm + Borax 2% and IBA 5000 ppm gave 100% survival of the rooted cuttings under field conditions. Babaie et al. (2014) investigated the effect of different IBA concentrations (control, 2000, 4000 and 6000 ppm) and the time of taking acutting (late June and early September) on the rooting growth and survival of *F. Binnendijkii* ‘Amstel Queen’ cuttings. Detected that at 6000 ppm and 4000 ppm of IBA and the time of cutting in early September, the highest percentage of rooting ranging from 100% to 96.66%, respectively, the longest root length (16.61 cm) and the greatest number of roots were recorded (15.69 and 14.27, respectively). Whereas the greatest length of new shoots was obtained in the IBA concentration of 2000 ppm and 4000 ppm in late June, the maximum number of new leaves was obtained in the IBA concentration of 2000 ppm and 4000 ppm, with the cutting taken in late June.

Ansari (2013) noticed in his testing that different media and pomegranate cutting separation dates had highly significant effects on rooting characteristics. If suitable media are used, a better cutting separation takes place at the end of they are in terms of a higher rooting percent and increasing root number (Singh, 2009; Janner, 2012; Young, 2012). Furthermore, among different media, vermiculite and its mix with sand were the best for a higher rooting percent and root number. A research actualized on five pomegranate varieties by Owais (2010) was determined all of them had root ability higher than 80% at 9000 ppm IBA treatment, and although the ability of generating roots was enhanced by IBA treatment, it seemed to be that much variability was related to the variety. Hardwood cuttings of pomegranate varieties seem to have a clearly higher root ability than those of semi-hardwood cuttings at different IBA levels for different pomegranate varieties.

Singh et al. (2011) carried out a search to study the effect of planting time and IBA (Indole Butyric Acid) on rooting and vegetative growth of pomegranate cuttings (Ganesh) with different concentrations of IBA 50, 100 and 200 ppm (s.d) for 24 h and IBA 1000, 1500, and 2000 ppm (q.d) for 15 s, on December 15 and January 15, respectively. The results showed that there were significant differences between the time of plantation, IBA treatment concentrations and their interaction with regard to sprouting and last survival percentage of cuttings and statistically significant differences were observed between the dates of plantation and IBA concentrations applied with regard to the number of roots, length of the longest root and root weight characteristics, as well as significant variations between the time of plantation and growth regulator concentrations were observed with regard to the plant height.

In another study succeeded in July, December and January by Kahlon (2007) it was shown that season and shoot part had a significant effect on the sprouting percentage and growth of pomegranate. Also, in that experiment was noted that the greatest sprouting was observed in January and the least one in July plantings and a much higher one was observed in January plantings. Furthermore, the sprouting percentage was the highest in the middle part when compared to the basal and sub-apical types of cuttings. Melgarejo et al. (2000) worked on the effect of 2000, 4000, 8000 and 12.000 ppm indole butyric acid (IBA) concentrations and wounding at the cutting base in pomegranate. Results showed that IBA markedly increased the percentage of rooting (although not at all concentrations), with a high concentration of 12.000 ppm producing the best results in the clones studied. Moreover, wounding carried out at the base of the cutting further increased the percentage of rooting in most of the clones studied.

Mehraj et al. (2013) achieved a trial to study the influence of IBA on the sprouting and rooting potential of (*Bougainville spectabilis*) stem cutting during the period from May to August, with different concentrations of Indole Butyric Acid (control, IBA in dust form, 500 ppm, 1000 ppm, 2000 ppm). The cuttings were soaked in IBA solution for (24 h) and the IBA dust was attached to the cutting just before the establishment in soil. They found out that IBA at 1000 ppm resulted in most sprouting, rooting and a higher survival percentage of rooted cuttings along with a higher number of roots, sprout buds, maximum root length and diameter. Singh et al. (2015) conducted one another experiment under valley condition to study the effect of different growing conditions (two different conditions, namely, shade house and mist chamber) and various concentrations (control, 1000, 1500, and 2000 ppm) of IBA on the rooting and shooting of hardwood cutting of phalas (*Grewia asetica* L.) in the month of September. Result of the study showed the greatest success of hardwood cuttings in the mist chamber growing condition, while IBA 2000 ppm gave the highest success rate of cuttings in all aspects, such as rooting percentage, the length of shoot, the length of root, thickening of root and leaf sprouting in the shoot.

Singh et al. (2014), performed a search in the mist house to study the effect of different concentrations (control, 1000, 2000, 3000, 4000, 5000 ppm) of IBA on inducing rooting in stem cutting (softwood cutting) of *Duranta erecta* var. golden. Softwood cuttings of *Duranta erecta* var. golden were obtained from 2 to 4-year-old plants and 15 cm long cuttings with the apical part. They found out that IBA at 4000 ppm resulted in the maximum percentage of rooted cuttings, followed by 5000 ppm concentration of IBA and the minimum percentage of rooted cuttings was observed under control. Fouda and Schmidt (1995) informed the effect of different concentrations (500, 1000, and 2000 ppm) of IBA on root development in *Rosa canica and Rosa rougosa* leafy cuttings. They found out that IBA increased rooting percentage in *Rosa canica*, the maximum rooting percentage was achieved with the cuttings collected at the beginning of June and treated with 1000 ppm IBA.

Ghosh et al. (1988) declared the effect of NAA and IBA on adventitious root formation in the stem cutting of pomegranate (*Punica granatum* L.) under intermittent mist. They found that IBA was more effective than NAA in inducing rooting of hardwood, semi-hardwood and softwood cutting. IBA at 5000 ppm resulted in the maximum rooting success (83.33%), but at higher concentration (10.000 ppm), a greater number of roots and increased root length were recorded. The greatest rooting success was obtained with hardwood cutting. Hedge and Sulikeri (1989) studied the effect of indole butyric acid (IBA) on the rooting in the air layers of pomegranate. In the trials

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with cv. Jyothi, mature shoots were treated with IBA at 250-1500 ppm and air layered between June and August. Rooting increased with IBA concentration from 84.38% at 250 ppm to 93.75% at 1500 ppm and 68.75% in the control.

Hansen (1986) carried out a research under the controlled greenhouse condition for 13 weeks to study the effects of cutting position and stem length in *Schefflera arboricola* and to develop propagation technique to obtain a fast and uniform root formation. Eight cuttings from the sub-apical to basal regions were excised from each stock plant. The stem length above the node was the same for all cuttings, whereas the stem length below the node was cut to different lengths, ranging from 0.5 to 3.0 cm. He found that cuttings from sub-apical positions rooted more slowly, produced fewer roots and had a lower rooting percentage than cuttings from the more basal regions, furthermore, the number of roots and rooting percentage increased with the length of the stem below the node.

Materials and Methods

Plant Material

This study was carried out in 2015-2016, at 25ºC room conditions in the Physiology Laboratory of the Department of Horticulture, Faculty of Agriculture, Siirt University in Turkey. In this experiment, a private orchard of pomegranate Salakhani and Zivzik were selected, and the plant age ranged between 20-25 years for Salakhani and 20-25 years for Zivzik and trees were selected on the basis of their uniformity in appearance, growth habits and vigour. Salakhani variety is a local pomegranate genotype grown naturally, specifically in Halabja province, Northern of Iraq, and Zivzik variety is considered to be one of the local varieties available in Siirt province in the Southeast of Turkey. Cuttings of Salakhani variety were collected from their natural area in Halabja and cuttings of Zivzik variety were collected from Zivzik Village in Şirvan district of Siirt at the beginning of the Spring.

Preparation of Experiment

Our experiment was conducted to study effect of different concentrations of (IBA) Indole Butyric Acid on rooting percentage, survival percentage, branches number, sprout length, root number, root length and leaves number of pomegranate cuttings of Salakhani cultivars and Zivzik cultivars, during the period from May to August. Five treatments (control, 1000 ppm, 2000 ppm, 4000 ppm and 6000 ppm) were applied in the experiment with three replications. 25 cm in lenght cuttings were obtained from 1 m in lenght cuttings. 10 cuttings were used per treatment in a pot with three replications. Therefore, there were 30 cuttings in each treatment and 300 cuttings in total were used in the experiment for both cultivars (Salakhani and Zivzik variety). The data on the root and shoot characteristics were collected five months after planting. Perlite and peatmoss were used as rooting media. A mix of peatmoss and perlite at a ratio 1-1 was used for both varieties.

Hormone solutions were prepared by dissolving 0.1, 0.2, 0.4 and 0.6 g, respectively, of IBA pure powder and diluting with 50% alcohol (ethanol), and adding 50% pure water to make 100 ml of each concentration. Pure water and alcohol were used as control treatment. Preparation process of cuttings was conducted in the laboratory of the Department of Horticulture, Agriculture Faculty, Siirt University. Vigorous shoots from

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the previous year of grown and healthy pomegranate trees were used for obtaining the cuttings, and the cuttings of a standard size were washed with tap water. Subsequently, a sharp knife was used in the preparation of cuttings for the experiment to avoid the injury of the cutting. The cuttings of uniform lengths, approximately 15 cm in length, were taken in the month of February when the plants are dormant with wounding by making two opposite longitudinal incisions at the base of each cutting. At least three nodes were included in each cutting. The bottom of the cuttings was treated with hormone of Indole Butyric Acid (IBA) at different concentrations. Basal 1-1.5 cm portion of the cutting was dipped in the growth regulator solution of IBA for 10 seconds (q.d) and immediately inserted in the media at a slight angle to the vertical, to a depth of 10-11 cm (as shown in *Figure 1*).

Figure 1. *Preparing of the cuttings*

Experimental Procedures and Statistical Calculations

Parameters obtained from our experiment were measured in the laboratory of the Department of Horticulture, Siirt University. These traits included the rooting percentage, number of roots per cutting, survival cutting rate, number of shoots per cutting, root length (mm), sprout length (mm) and the number of leaves per cutting, which were recorded at the termination of the experiment (*Figure 2*) after five months, at harvesting early in August. The roots were examined by lifting cuttings carefully from the rooting media and washing them with tap water. The measurement process was conducted by a tape-measure. The data were collected from all of the cuttings and then the mean value was calculated. Experimental design used which was factorial design in randomised plots. The treatment in each experiment had three replicates and each pot (container) consisted of 10 cuttings. The results of the experiment were statistically analysed and the means were compared using Duncan’s Multiple Range Test at the level of 0.05. All analyses were performed by JMP Version 5.0.1 statistical software and letterings were shown in graphs (*Figures 3 and 4*) and *Table 1*.

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Results and Discussions

The following findings were obtained in our rooting study. When the data on rooting percentage were examined, there was found 1% statistical significance in terms of varieties and hormone doses. While 5% significance level in terms of IBA type hormone interactions.

Figure 2. *A view of the experiment*

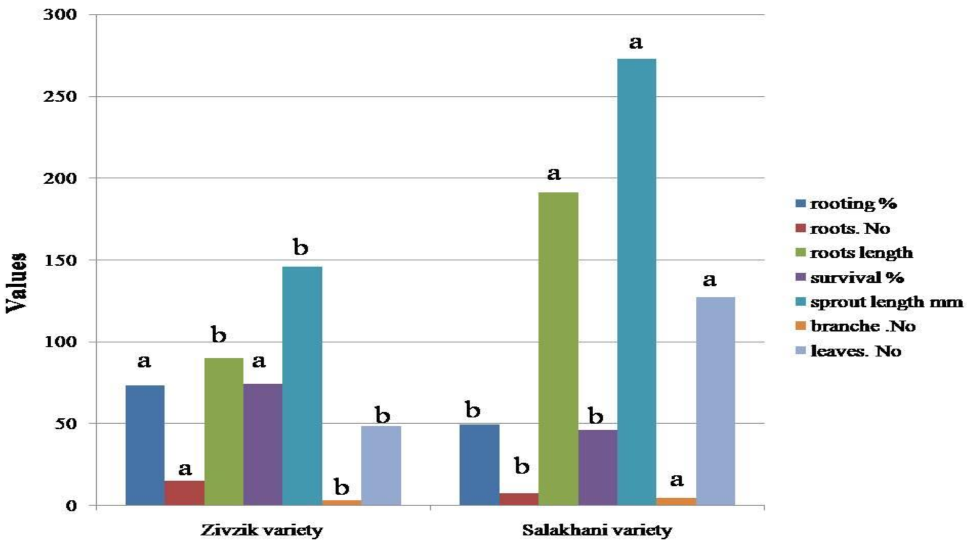

Figure 3. *Effect of different IBA treatments on rooting forms of Zivzik and Salakhani varieties. *Letterings were obtained from statistical data: P <0.001; 0.05% level of probability using LSD*

Rooting Findings

Rooting Percentage (%)

Highest percentage of rooting (73%) was observed in Zivzik variety, Siirt native. While, Salakhani variety was the second and last one with the rooting percentage of 49%, respectively (*Figure 3*). Among the hormone doses used, the highest percentage (72%) of the hormone dose was a demonstrated at 6000 ppm, while, the control group was the second one with 67% rooting percentage (*Figure 4*). The hormone dose group

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with the lowest percentage of rooting (43%) was the 4000 ppm dose group. The highest (93%) rooting percentage in the variant IBA hormone interactions was found to be related to the 6000 ppm dose applied to Zivzik variety, while the lowest value (23%) was obtained in the case of Salakhani variety with the 4000 ppm dose of IBA (*Table 1*). Hormone use is more effective in clones, especially in rooting fractions (Melgarejo et al., 2000). However, that the untreated stem cuttings had the best performance in terms of rooting of (*Punica granatum* L.) Salakhani variety could be due to the fact that growth hormones may not be the essential major factor influencing root induction in that variety. The rooting of cuttings may be influenced more by other factors such as the physiological age of cuttings and the status of rooting media in terms of aeration and drainage properties as stated by Narin and Watna (1983). In this experiment, the highest hormone concentration was the most positive effective dose in terms of the rooting percentage. This result is in conformity with the findings of Melgarejo et al. (2000) and Singh et al. (2015) who reported that the highest percentage of rooting was observed due to the increased hormone concentration. Similar results were also reported by Mehraj et al. (2013), Fouda and Schmidt (1995). Owais (2010) indicated that IBA had a significant effect on the rooting. Abu-Zahra et al. (2013) found different results, so it is thought that the hormones used are derived from different types.

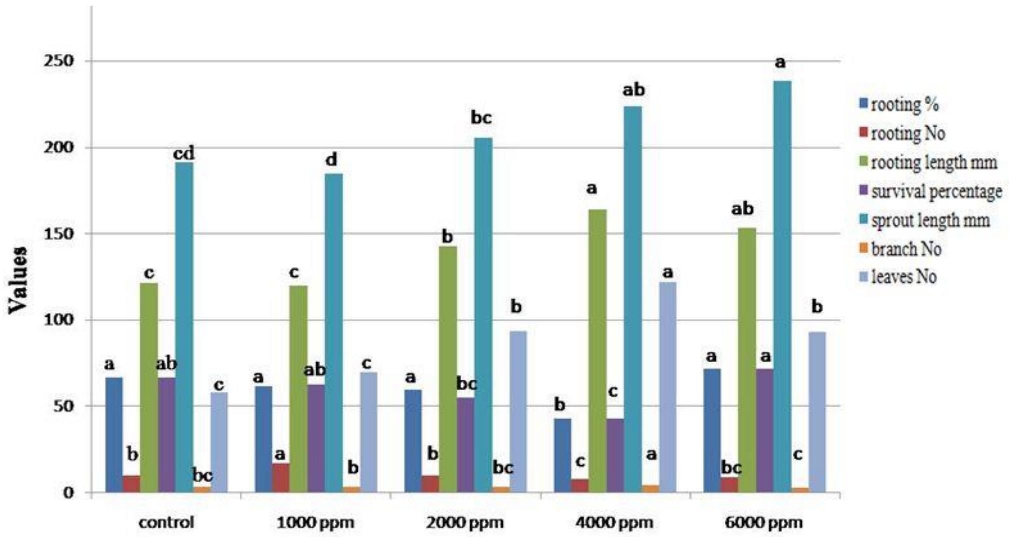

Figure 4. *Effect of IBA concentrations on survival performance and growth of the cuttings. *Letterings were obtained from statistical data: P <0.001; 0.05% level of probability using LSD*

Number of Root

When the measurements of rooted number were examined for Zivzik and Salakhani pomegranate, it was observed that Zivzik variety increased the number of roots up to two folds compared to Salakhani variety, whereas, the values obtained for both cultivars in the root number percentage were as follows: 14.7 for Zivzik variety and 7.03 for Salakhani variety (*Figure 3*). Considering the root characteristics such as the number of roots per cutting for both varieties (Salakhani and Zivzik cultivars), it was determined that Zivzik cultivars produced the maximum root number and that the IBA treatment at 1000 ppm produced the highest root number (17.06) and the lowest number of roots (7.93) was determined with IBA at 4000 ppm (*Figure 4*). When the table is examined according to the IBA type hormone interactions in terms of the number of rooted seedlings, it is seen that the number of seedlings rooted at the highest level (27.08) is in Zivzik variety at 1000 ppm. In contrast, the lowest number (5.44) of seedlings rooted is in Salakhani variety, with 4000 ppm of IBA (q.d) treatment (*Table 1*). From the present study, it is revealed that soaking the cutting in IBA solution increases the number of rootson cuttings due to the rooting ability of IBA. Hartmann et al. (1997) stated that the concentration of auxins substantially higher than that normally found in plant tissues may play an inhibitory role for the growth and root formation. Ramdayal et al. (2001) and Gupta et al. (2002) also found the maximum number of rootsat 1000 ppm IBA. The findings related to the number of rooted seedlings were found to be parallel with the findings of Ghosh et al. (1988) who applied doses of 5000-10.000 ppm, Hegde and Sulikeri (1989) who applied 250-1500 ppm IBA and Mehraj et al. (2013) who used doses of 500-1000 and 2000 ppm. The difference in regard to the findings of Abu-Zahra et al. (2013) could be attributed to the difference of hormones used.

Table 1. *Effect of the interaction among IBA doses and vegetative growth of the cuttings*

Cultivars	hormone doses	rooting rate (%)	roots number	roots length (mm)	survival rate (%)	shoot length (mm)	shoot number	leaves number
Zivzik	0	0.67 BC	13.59 B	89.08 D	0.67 BC	110.47 G	3.13 CD	23.03 G
	1000	0.73 B	27.08 A	84.79 D	0.77 AB	128.69 FG	3.17 CD	39.37 FG
	2000	0.67 BC	12.74 BC	98.91 D	0.70 B	148.51 EF	2.58 D	49.76 EFG
	4000	0.63 BC	10.42 CD	100.31 D	0.63 BC	162.83 DE	3.17 CD	71.73 DE
	6000	0.93 A	9.68 D	76.50 D	0.93 A	177.48 D	2.70 D	56.38 EF
Salakhani	0	0.67 BC	7.05 EF	153.98 C	0.67 BC	273.01 AB	3.68 BC	93.94 D
	1000	0.50 C	7.03 EF	155.84 C	0.50 CD	241.50 C	4.31 B	100.96 CD
	2000	0.53 C	7.16 EF	186.98 B	0.40 DE	262.62 BC	4.28 B	137.70 B
	4000	0.23 D	5.44 F	227.69 A	0.23 E	285.55 AB	5.44 A	177.44 A
	6000	0.50 C	8.47 DE	230.76 A	0.50 CD	300.23 A	3.65 C	130.19 B

Length of Root (mm)

While the highest root length (191.05 mm) was determined in the seedlings belongs to Salakhani variety, Zivzik seedlings were the lowest one with the length of 89.92 mm (*Figure 3*). When the effects of hormone doses on root length were examined, it was found out that the longest roots (164 mm) were obtained at dose of 4000 ppm, whereas the lowest one (120.32 mm) was obtained at dose of 1000 ppm (*Figure 4*). At the same time, the control group without hormone treatment had longer lengths (121.53 mm) than the 1000 ppm dose group (*Figure 4*). Based on the analysis of variance of the effect of IBA type hormone interactions on root lengths, the highest root length values (230.76 mm) compared to other subjects were obtained in Salakhani variety with 6000 ppm IBA hormone (q.d) treatment, while the lowest root length values were obtained in Zivzik variety with 6000 ppm hormone dose (*Table 1*). Statistical significance at the 1% significance level was found in all subjects. The findings of Abu-Zahra et al. (2013)

were different, which was due to the differences in the hormones used. The findings of Hartman and Kester (1983) who indicated that rooted seedlings increased significantly; Owais (2010) and Sharma et al. (2009) who found that the longest roots were derived from hormone-containing plants; Singh et al. (2011) and Ghosh et al. (1988) who identified the statistical differences between practices are similar to the findings in this study.

Survival Cutting Rates

The highest value (74%) in terms of the survival rate was obtained from Zivzik variety. Whereas, the survival rate value measured in Salakhani variety used in the experiment was determined to be 46% as shown in *Figure 3*. Parallel results between the rooting rates and survival cutting rates were determined. When the effects of the hormones used in different doses on survival rates were examined, it was found that 6000 ppm of hormone application provided the highest survival rates with 72%, the control group (T0) was the second with 67% survival rates value while 4000 ppm hormone dose application was the last (*Figure 4*). When the values of the IBA type hormone interaction were examined in terms of the survival rates, it was determined that the highest value (93%) belonged to Zivzik variety with IBA at 6000 ppm. The interaction of Salakhani variety control group was better than other interactions. It is observed that Salakhani variety and 4000 ppm hormone dose interaction was in the last place with the value of 0.23% survival rates (*Table 1*).

Length of Sprout (mm)

The highest value of sprout length (272.58 mm) was found in Salakhani variety and the lowest value (145.59 mm) was found to belong to Zivzik variety (*Figure 3*). When the effects of hormone doses on sprout length were examined in Zivzik and Salakhani varieties, it was found that among the hormone doses applied 6000 ppm dose gave the highest (238.85 mm) sprout length and IBA at 1000 ppm hormone dose gave the lowest (185.09 mm) sprout length (*Figure 4*). Among the IBA type hormone interaction, the highest sprout length (300.23 mm) was determined in Salakhani variety with IBA at 6000 ppm and the lowest sprout length value (110.47 mm) was determined in Zivzik variety without hormone treatment (control group) as shown in *Table 1*.

Number of Shoot

It was determined that the average number of shoot in Salakhani variety (4.27) was higher than in Zivzik variety with 2.95 (*Figure 3*). According to the effects of hormone doses on shoots number, it was found out that the value belonging to 4000 ppm hormone dose application (4.31) was higher than the values of other hormone doses. The lowest shoots number (3.18) was found in 6000 ppm application (*Figure 4*). The shoots number of Salakhani variety observed in the hormone and variety interactions is superior to Zivzik variety. When the interactions were examined, the highest average value of shoots number (5.44) was obtained in Salakhani variety with the 4000 ppm IBA hormone dose and the lowest value of shoot number (2.58) was obtained in Zivzik variety with 2000 ppm (*Table 1*). Especially, the number of shoots and survival rates increased with the use of hormones in parallel with the findings of Janick (1972) and Hartmann and Kester (1983) who determined that the use of natural hormones increases the survival percentage as well as all vegetative developments in seedlings.

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Number of Leaves

When the varieties and hormone doses were examined in terms of the number of leaves, it was determined that the highest leaf number average value (127.05) was obtained from Salakhani variety and the lowest leaf number average value (48.05) was obtained from Zivzik variety (*Figure 3*). It was noted that the hormone dose of 4000 ppm had the highest mean leaf number value (122.09) and the control value was the lowest value of the mean leaf number (58.48) (*Figure 4*). It has been determined that the leaf number is influenced by the variety and hormone interaction but not statistically significant. However, the highest leaf number average value (177.44 mm) was obtained from the interaction of Salakhani variety with IBA at 4000 ppm (q.d) treatment and the lowest value (23.03 mm) was obtained from Zivzik variety without hormone treatment (control treatment) (*Table 1*). Babaie et al. (2014) who performed similar studies and used IBA as a hormone reported that the largest number of leaves was available at doses of 2000 and 4000 ppm. Mehraj et al. (2013) found that the maximum vegetative growth was achieved with 1000 ppm of IBA.

Furthermore, more adventitious roots were observed on the pomegranate seedlings belonging to Zivzik variety. Meanwhile, strong and thick roots were observed on the pomegranate seedling of Salakhani variety which was more when compared to Zivzik cultivars. Moreover, the period required for the first sprouting of Salakhani variety ranged between 10-11 days. Whereas, the period required for the first sprouting of Zivzik variety reached 12-13 days. The above-mentioned period was considered to be the period between the days of planting the cutting to the day of sprouting the first bud on the cutting.

Conclusion

Upon examining sprouting and rooting behaviour in stem cuttings, highly contrasting responses to IBA addition were indicated among various concentrations of IBA, each variety had superiority to the other one in different aspects. Zivzik variety had a higher value of rooting number, rooting percentage and survival percentage than Salakhani variety. Salakhani variety had a higher value of root length, sprout length, shoots number and the number of leaves than Zivzik variety pomegranate. The highest dose of hormone (6000 ppm) was found to be the most effective on rooting percentage, survival percentage and sprout length, while 4000 ppm was found to be the most effective on root length, shoots number and the number of leaves. The 1000 ppm dose was determined to significantly increase the root number compared to other doses. Regarding to the interaction effect of IBA doses, it was shown that the best performance in terms of rooting percentage, survival percentage, root length and sprout length was observed at the 6000 ppm dose of IBA, whereas 4000 ppm was found to be the most effective on shoots number and leaves number. The 1000 ppm dose was determined to significantly increase root number compared to other doses. Hence, it can be concluded from the present experiment that the higher concentrations of IBA (6000 ppm) and (4000 ppm) positively affect the sprouting and rooting ability in the stem cuttings of pomegranate cv. Zivzik and Salakhani. In contrast, the optimum IBA concentration for the number of roots per cutting was found to be 1000 ppm (Shoots and roots of the cuttings rooted in different hormone doses are given in *Figure 5* and *Figure 6*). Based on the findings of current investigation, the results have proved that Zivzik variety gives better results than Salakhani variety in terms of rooting percentage, survival percentage and roots number in Turkey environmental conditions. From the results obtained in the present experiment and discussion, from the economic point of view, it can be concluded soaking the cut stem on 1000 ppm IBA solution for 10 second (q.d) before the establishment of the stem cuttings show maximum result in terms of root number was obtained at the 1000 ppm dose of IBA and we recommend using 1000 ppm of IBA, which will provide a significant increase in root number compared to other doses. In conclusion, pomegranate cuttings with different doses of IBA were successfully rooted in our study. As it is known, pomegranate is produced without vaccination. Therefore, it is important that pomegranate seedlings can be reproduced quickly and rapidly with cuttings. Because of this reason, further studies also can be done using different hormones and their doses to obtain the best sprouting and rooting results for cuttings of both Salakhani and Zivzik variety.

Figure 5. *Root and shoot views of the cuttings (Control&1000 ppm IBA dose).*

Figure 6. *Root and shoot views of the cuttings (2000&4000&6000 ppm IBA doses)*

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INFLUENCE OF SOME ANTIOXIDANTS AND LICORICE ROOT EXTRACT ON SOME CHARACTERISTICS OF SALAKHANI POMEGRANATE CUTTING

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ABSTRACT

This study was conducted on the effect of dipping basic of Salakhani pomegranate cuttings in ascorbic acid, citric acid and salicylic acid (0, 150, 300, 450) mg.L^{-1} each of them, and licorice roots extract (0, 5, 10, 15) g.L^{-1}, on some cuttings properties. The results indicated that 450 mg.L^{-1}ascorbic acid significantly increased diameter and length shoot, leaf area, vegetative dry weight percentage and root dry weight percentage compared to control. Concerning the effect of citric acid, cuttings treated with 300 mg.L^{-1}increased length shoot, leaf area, vegetative dry weight percentage and root dry weight percentage significantly compared to control. On the other hand, dipping in 450 mg.L^{-1} of the salicylic acid solution significantly raised diameter and length shoot, leaf area, vegetative dry weight percentage, number and length root and root dry weight percentage than control. As for licorice roots extract cuttings dipping in 10 or 15 g.L^{-1} caused to recording the highest diameter and length shoot, leaf area, vegetative dry weight percentage, number and length root and root dry weight percentage than the control treatment.

***Keywords*:** Ascorbic acid, Citric acid, Salicylic acid, Licorice roots, Salakhani pomegranate.

Introduction

Pomegranate (*Punica granatum L.*) is native to the subtropical region with high fruit nutritional values. The pomegranate propagated can be by stem cuttings, grafting and layering. Damar *et al.* (2014) indicated that the propagation of commercially pomegranate done by cuttings. Plants increase through cutting which is more convenient way and also by the cuttings a stronger plant can be advanced considerably in the minimal period. Also, Frey *et al.* (2006) reported that success stem cutting reduplication of horticultural crops depend on several agents such as mother plant condition, planting time, part of the tree, and tree age from where the condition of the tree part that is taken from it the cuttings, humidity and rooting media, rainfall, care during planting and next care.

Considered ascorbic acid is essential for plant growth. Smirnoff, (2000) showed that it has been known that Ascorbic acid has the positive effect on plant growth, and there is vigorous proof that wall ascorbate is related to cell expansion. Furthermore, daily spraying with citric acid or ascorbic acid solutions can be promoted ex vitro rooting and survival of sweet cherry micro shoots in greenhouse (Vasar, 2001). On the other hand, Dore, (1965) indicated that in some plants can be get better rooting of cuttings by utilize some vitamins such as; vitamin C, K and some of the B-group.

Pomegranate is one of the most horticultural crops produced in Iraqi Kurdistan especially cv. Salakhani in Shahrazor area due to its suitable climate for this cultivar. The fruits are characterized as a medium to enlarge fruits in size, and the peel is thick reddish-yellow in color, impregnated with pink color. Further, arils are juicy with a red to pink color, with a good flavor and sour-sweet taste. This cultivar is also the most important for exports to other countries (Al-Jabary, 2007).Since Salakhani cultivar is in demand for exporting, and its fruits have a good quality, also the propagation by cuttings (cloning) produces plants having characteristics as their own parent. Wherefore, this study was conducted to knowledge the influence of some antioxidants and licorice root extract on some characteristics of Salakhani pomegranate cuttings.

Material and Methods

This experiment was carried out at Chamchamal Research Station belong to Directorial of Agriculture research/Sulaimani, Iraqi Kurdistan region, during the period from February to August 2019. This is to study the effect of some antioxidants such as; Ascorbic acid, Citric acid and Salicylic acid with three concentrations (0, 150, 300, 450) mg.L^{-1} and Licorice roots extract (0, 5, 10, 15) g.L^{-1}, were applied on some Salakhani pomegranate cuttings properties. Ten cuttings were planted for each treatment and a total of 390 cuttings were tested in the plastic greenhouse. By utilizing Factorial experiment within Complete Randomized Design (CRD) with three replicates. The data was offered to the analysis of variance by using XLSTAT software. Mean comparisons were conducted by using the Duncan test at 0.05.

Terminal shoot cuttings were collected from Salakhani pomegranate trees 25 years' old, vigor shoots and healthy. On the collected branches uniform lengths, 15 cm in lengths and 11.41 mm was recorded as an average of cuttings diameter, from a private orchard in Halabja governorate. Cutting of basal ends 1-1.5 cm of the cutting were dipped in dilute solution for ten (10) seconds and immediately planted in the rooting media. For rooting media, sand was mixed with peat moss in the ratio of (1:1) and placed in polyethylene bags.

All the studied root and shoot properties were recorded at the termination of the experiment at the last week of August. Shoot and root number was measured by calculating the number of shoots and roots formed on pomegranate cutting. Length (mm) and diameter (mm) of shoot and root were measured by using the Vernier. Leaf area (cm^2) was measured as mentioned by (Dvornic, 1965). Vegetative and root dry weight of pomegranate cutting were measured according to (Horwitz, 2000).

Results and Discussion

Vegetative Growth

The maximum shoot number per cutting were produced in 450 $mg.L^{-1}$ of salicylic acid and 5 $g.L^{-1}$ licorice root extract, but the minimum shoot number per cutting was observed in 10 $g.L^{-1}$ licorice root extract. Although, 300, 450 $mg.L^{-1}$ of salicylic acid and 450 $mg.L^{-1}$ of ascorbic acid significantly influenced the shoot diameter compared to control, and the highest shoot diameter was observed in 300 $mg.L^{-1}$ of salicylic acid but the lowest shoot diameter was observed in 150 $mg.L^{-1}$of citric acid. While concerning the shoot length most of the treatments significantly superior on the untreated cutting, the highest shoot length was recorded the in 5 $g.L^{-1}$ licorice root extract that significantly superior on other treatments in this parameter (Table 1).

The Data in (Table 1) shows the higher leaves number per cutting was observed in cutting treated with 300 $mg.L^{-1}$salicylic acid which significantly superior on the other treatments, while the lowest leaves number was noted in cutting treated with 150 $mg.L^{-1}$ citric acid. As regards leaf area, also cutting treated with 300 ppm Salicylic acid recorded the maximum value of leaf area which significantly superior on the control, which does not differ significantly from most other treatments.

The results in (Table 1) shows the cuttings treated with all concentrations of antioxidant and licorice root extract significantly promoted the percentage of vegetative dry weight compared with the control, except cuttings treated with 300 $mg.L^{-1}$ ascorbic acid, 150 $mg.L^{-1}$ citric acid and 450 $mg.L^{-1}$salicylic acid.

Table 1 : Effect of some antioxidants and licorice root extract on number, diameter and length of shoot, leaves number, leafarea and Vegetative dry weight of Salakhani pomegranate cutting.

Treatment	Shoot number	Shoot diameter (mm)	Shoot length (mm)	Leaves number	leaf area (cm^2)	Vegetative dry weight (%)
Control	5.000 ab	1.826de	25.033e	190.133 b	4.626 b	51.451d
Ascorbic Acid 150	4.867abc	1.720fg	24.700e	175.467cde	4.458 b	55.285c
Ascorbic Acid 300	4.667 bc	1.653 g	24.423 e	142.533i	4.976ab	51.747d
Ascorbic Acid 450	4.733 abc	1.937abc	28.453 b	170.200 de	5.025 ab	57.862b
Citric Acid 150	4.800 abc	1.513h	24.940e	139.133i	4.660ab	51.220d
Citric Acid 300	4.667 bc	1.780ef	27.687bc	157.533gh	5.057ab	54.405c
Citric Acid 450	5.000 ab	1.870 bcde	25.573 de	178.130 cd	4.560 b	53.784 c
Salicylic acid 150	4.867 abc	1.849 cde	27.283 bc	180.867 c	4.802 ab	54.915 c
Salicylic acid 300	4.867 abc	2.008 a	24.602 e	214.000 a	5.293 a	60.952 a
Salicylic acid 450	5.333 a	1.967 ab	28.403 b	166.933 ef	5.269 a	51.047 d
licorice root 5	5.267 ab	1.907 bcd	29.940 a	176.533 cd	4.579 b	53.643 d
licorice root 10	4.333 c	1.923 abcd	26.517 cd	155.400 h	4.884 ab	57.193 b
licorice root 15	4.867 abc	1.890 bcd	26.570 cd	162.667 fg	4.908 ab	54.347 c

The same letter within column indicate non-significant difference between treatments according to the Duncan multiple test at the 0.05 level.

Root Growth

As related with root parameters, cuttings treated with 300 $mg.L^{-1}$Salicylic acid and 10 or 15 $g.L^{-1}$ licorice root extract significantly increased root number per cutting as compared with other treatments (Table2). The results in the same table show that the maximum root diameter was noted in cuttings treated with 5 $g.L^{-1}$ licorice root extract, which is did not differ significantly from some of the other treatments, whilst the minimum root the diameter was observed in cuttings treated with 10 $g.L^{-1}$ licorice root extract.

Among the different concentrations of antioxidant and licorice root extract, application of 15 $g.L^{-1}$ licorice root extract resulted in significantly highest root length over the other treatments except for the cuttings treated with 450 $mg.L^{-1}$ of Salicylic acid. As regarding the percentage of root dry matter weight, cuttings treated with 450$mg.L^{-1}$citric acid significantly superior over other treatments except cuttings treated with 150$mg.L^{-1}$Salicylic acid, while the minimum percentage was observed in cuttings treated with 150$mg.L^{-1}$citric acid (Table2).

Standardi and Romani, (1990) indicated that some physiological and biochemical aspects of the rooting stay unknown. This investigation clearly reported that antioxidants and licorice root extract with their concentrations which were studied have negatively or positively influence on shoot and root properties.

Although some studies reported that ascorbic acid have non-significant influence on rooting of different types (Lis-

Balchin, 1989; Standardi and Romani, 1990). While Vasar, (2001) noticed promote the ex vitro rooting by using ascorbic acid of sweet cherry microshoots. Our results show that the ascorbic acid clearly enhanced some parameters of vegetative growth and root. The increasing of diameter and length shoot, leaf area and vegetative dry weight in cuttings treated with 450 mg.L^{-1} may be come back to its role to increase the length and dry weight of root, consequently, led to the formation of the vigorous root system (Table 2), so raised nutrients uptake which enhanced the vegetative growth, and obverse. Li *et al*., (2007) reported that ascorbic acid enhances catalase and superoxide dismutase activities, which were associated to the rooting of cuttings. Also, found that ascorbic acid works as a cofactor of many enzymes involved in the biosynthesis of gibberellin and ethylene that reported by (Prescott and John, 1996). In addition, consider ascorbic acid as an important factor of the progression in the cell cycle during cell division, impacts meristem expansion that found by (Liso *et al*., 1984; Kato and Esaka, 1999).

Concerning increasing the number and length of root in cuttings treated with 300 mg.L^{-1}Salicylic acid, maybe due to its role to the increasing of vegetative growth (leaves number and leaf area) (Table1) which led to producing the nutrients more through the photosynthesis process, Which was consumed to increasing the number and diameter root rather than storing it as dry matter in the root, so caused to reducing the percentage of root dry matter weight (Table 2), and inversely

.

Table 2 : Effect of some antioxidants and licorice root extract on number, diameter and length ofroot and root dry weight of Salakhani pomegranate cutting.

Treatment	Root number	Root diameter (mm)	Root length (mm)	Root dry weight (%)
Control	34.200 c	0.700 a	12.596 de	52.671 d
Ascorbic Acid 150	31.867 d	0.560 bc	11.663 f	53.643 cd
Ascorbic Acid 300	28.933 e	0.590 bc	13.103 de	53.792 cd
Ascorbic Acid 450	28.800 e	0.589 bc	13.583 cd	60.468 b
Citric Acid 150	27.203 f	0.573 bc	12.887 de	51.503 d
Citric Acid 300	33.733 c	0.650 ab	13.203 de	59.469 b
Citric Acid 450	26.333 f	0.587 bc	13.473 cde	62.947 a
Salicylic acid 150	32.000 d	0.599 bc	12.497 ef	60.797 ab
Salicylic acid 300	44.533 a	0.685 a	13.140 de	52.976 d
Salicylic acid 450	31.400 d	0.690 a	14.557 ab	51.855 d
licorice root 5	31.933 d	0.723 a	14.327 bc	53.152 d
licorice root 10	38.467 b	0.521 c	12.710 de	59.904 b
licorice root 15	38.267 b	0.697 a	15.283 a	55.662 c

The same letter within column indicate non-significant difference between treatments according to the Duncanmultiple test at the 0.05 level.

Enhancing the characteristics of the vegetative growth and root in cuttings were immersed in licorice roots extract, could become back to its contain the vital part of gibberellin that is the Mevalonic acid which leads to the expansion of the leaf cells. Moreover, the increase in the leaf area is due to the presence of salts and sugars in the extract which stimulated vegetative growth. Also, this extract contains nutritional elements such as N, Fe, Zn, Mg, and Cu, these minerals have a major effect of chlorophyll formation a specially nitrogen (Marschner, 1995). Consequently, caused to increasethe root number and the percentage of root dry matter weight (Table 2).

Conclusion

Our results indicated that this cultivar sensitivity differ upon the antioxidants and concentrations maybe due to its effects on the peroxidase activity that has a good role for rooting consequently, influenced on shoot and root properties. However, the results of study Standardi and Romani, (1990) reported that utilize antioxidants to minimize peroxidase activity during induction inhibits rooting, whilst utilize antioxidants to minimize peroxidase activity during the initiation and elongation of roots enhances rooting.

According to the results of this study can be conclude that most of the concentrations of antioxidants and licorice root extract improved the length of shoots and roots, vegetative and roots dry weight and leaf area compared with control treatment.

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COMPARATIVE ANALYSIS FOR PRODUCTION TRAITS OF LOCAL CHICKEN AND ISA BROWN IN KGR-IRAQ

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ABSTRACT

The research work has been constructed at Sulaimani Research Station–Director of Agricultural Research to study the effect of three lines of local chickens: Pure black (line 1), Black with brown Neck (line 2), White (line 3) and Isa Brown (line 4) at four periods (19-32, 33-43, 44-60 and 61-75 weeks) on egg production traits. The age at first day of egg production, first week of production, sexual maturity, when reach to 50% and peak egg production and long duration of peak egg production were recorded. In addition to estimate the egg/hen/all periods, egg/hen/week, egg/ hen/ all period% and hen day egg production%. No significant difference between lines on age at first day of egg production, first week of production, sexual maturity and reach to peak production. Line 2 significantly (p<0.05) reach to 50% before other lines about 8-21 weeks. Moreover, line 3 significantly (p<0.05) has the shorter duration of egg production compared with other lines. Hen day egg production% at age at sexual maturity, at 50% production and throughout long duration of production did not significantly differed between lines. Peak production% of line 2 was significantly (p<0.05) higher than other lines. Egg weight was significantly (p<0.05) higher in line 4 compared with lines 1,2 and 3, but did not significantly differed with line 3 in egg/ hen/ all periods and egg/ hen/ week. As for percentage of egg production, line 2 was significantly (p<0.05) higher in percentages (33.20 and 34.30%) for egg/ hen/ periods% and Hen Day Production%, respectively. As the age increased the egg weight was increased, while egg/ hen/ period, egg/ hen/ week and percentage of egg production were significantly (p<0.05) higher at period 3.

Key words: *Local chickens, egg production, egg weight, age at production.*

INTRODUCTION

Over the years, the chicken is considered one of the important sources for the provision of animal protein through meat and eggs. In addition it emerged as a biological model to resolve more problems related to diseases (Bacon *et al.*, 2000), nutrition and genetics (Haeslar *et al.*, 2004). In the last period many countries resolved food security problems faced by the partial depending on egg production at the rural level (Usman *et al.*, 2014), due to its flavor compared with the strains and various commercial hybrids that have in abundance on the first production and egg weight. But, regardless of the small size of the domestic chicken eggs and the lack of production are such that enjoys other specifications and is immune against disease, environmental adaptation and in addition to that a lot of customers bought eggs at a price more expensive than the price of commercial chicken eggs.

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Although studies on the local chickens in Kurdistan Region were started in the few years ago, and some researchers (Hermiz *et al.*, 2012; Hermizand Ali, 2012; Abas *et al.*, 2014 and Abdulla *et al.*, 2016) used same lines in their studies, more researches are needed to increase knowledge about its performance and economic utilization. Generally more developing countries of the world now turn to the local rating their chickens by studying the chemical and physical properties of the egg, as well as the economics of production. Moreover, several researchers were studying the performance of local chicken lines, strains and breeds (Rahman *et al.*, 1997; Adedokun and Sonaiya, 2002; Khan, 2004; Sunder *et al.*, 2005 and Tixier-Boichard *et al.*, 2006).

Production differences between these genetic lines for egg production traits, age at first egg and egg weight until now are not well known. The aim of this study was to estimate the differences between these genetic lines for egg production traits, such as age at first egg, peak production, and egg weight at different periods.

MATERIALS AND METHODS

The present study was conducted at Animal Production Division of Agricultural Research Center in Sulaimani, Ministry of Agriculture and water recourse, KGR, Iraq. The research was designed to compare the egg production egg weight, age at first egg production and egg production between three lines of local chicken and ISA brown under the semi open system of production. Three lines of local chicken (generation 11) were identified according to the color of feather as Pure black (line 1), Black with brown Neck (line 2), White (line 3) and Isa Brown (line 4).

Experimental periods initiated at week (19) continue to week (75) age old, were classified to 4 periods: period 1(19-32), period 2 (33-43), period 3 (44-60) and period 4 (61-75). Age at first egg (day and week), reach to sexual maturity (5% egg production), reach to (50%) egg production and reach to peak production were recorded.

Egg collection was recorded daily to evaluate egg production traits at each period (Age at sexual maturity (5% egg production), reach to 50% production, peak production and long duration of egg production. Hen day production (%) was determined by the following:

Hen day production (HDP %) = [egg number/ (periods X number of hen)] X100

Egg collection daily was to determine the egg weight, egg/ hen/ for all periods and its percentage, egg/ hen/ weeks for all different lines and periods.

Statistical Analysis
The analysis of variance was carried out for all recorded data to find out the differences between groups Statistical program PASW Statistics Student Version 18 (SPSS, 2007). An ANOVA using the general linear models procedure included the main effects of genetic groups and periods on some egg production traits. Collected data were subjected to two-ways analysis of variance for egg weight and egg production traits during different periods and significant differences between means were furtherseparated using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS

Although there were no significant differences between lines for the first day or week of egg production, reach to 5% production, but the differences between lines to reach 50% production peak production, and long duration of peak production were significant ($p<0.05$) (Table 1 and 2). The line 2 showed the least period (138.50 day or 19.79 week) to produce egg, followed by line 3 (140.60 day or 20.14 week), line 1 (145.60 day 20.80 week) and line 4 (167.57 day 23.44 week). Concerning to reach 5% and 50% production, line 2 had the least period (9 weeks) to reach (5.71%) and (29 weeks) to reach (50.95%) HDP%, respectively. While the HDP% of line 1 did not reach to 5% production before (week 23) which reached (7.94%) and at (week 37) reached (46.83) HDP%. As well as the exclude production of lines 3 and 4 were 46.83, 45.58 and 43.65 at week 50 and 52, respectively. Line 2 significantly ($p<0.05$) reached to peak production (63.10) egg at week 55 after the other 3 lines followed by line 1, which reach to peak production (47.62) at week 51.Line 3 had showed numerically the least period to reached peak production at week 50. Line 1, 2 and 4 significantly showed longer duration 9, 8 and 7 weeks, respectively to produce egg before and after peak production compared with line 3 that was 3 weeks. Furthermore, the long duration of line 1 was between 49- 57 weeks, line 2 was between 51-58 weeks, line 3 was between 48-56 weeks and line 4 was between 48-54 weeks with average HDP % 40.86, 50.60, 38.50 and 38.63%, respectively.

Table 1: Effect of different genetic lines of on age at first egg and age at sexual maturity (5% eggproduction).

Traits		Lines			
		1	2	3	4
First day of egg production		145.60 ±9.85	138.50 ±6.34	148.00±9.37	167.57 ±9.98
First week of production		20.80±0.41	19.79 ±0.91	21.14 ±0.3	23.86 ±0.42
Age at sexual maturity (5% egg production)	week	23 ± 1.05	19 ±1.00	20 ±1.04	25 ±1.05
	HDP %	7.94 ±0.08	5.71 ±0.07	4.76 ± 0.07	5.10 ±0.06

Table 2: Effect of different genetic lines on egg production (50%, peak and long duration of peak egg production) at different periods.

Traits		Lines			
		1	2	3	4
Reach to 50% production	week	37 ±2.48^{ab}	29 ±2.49^{a}	50 ±3.08^{b}	52 ±3.18^{b}
	HDP %	46.83 ± 5.47	50.95 ± 5.46	45.58 ± 5.24	43.65 ±5.27
Peak Production	week	51 ± 6.45	55 ± 7.89	50 ± 6.47	52 ± 6.54
	HDP %	47.62 ± 7.15^{b}	63.10±8.45^{a}	45.58±6.54^{b}	43.65 ±3.98^{b}
Long duration of peak egg production	week	9± 1.97^{a}	8 ± 1.45^{a}	3 ± 0.25^{b}	7±1.24^{a}
	HDP %	40.86 ± 3.45	50.60 ± 4.09	38.50 ± 2.00	38.63 ± 5.23

$^{a–b}$ For each means of same traits in each row with different letters differ significantly (P<0.05).

Egg weight of line 4 was significantly (p<0.05) heavier than line 3, which also significantly (p<0.05) heaviest than line 1 and 2 as showed in (Table 3). Egg number/ hen for all periods were significantly (p<0.05) different between lines. Line 3 and 4 significantly (p<0.05) had higher number of eggs (108.75 and 102.75) respectively, than line 2 (84.50), that also significantly (p<0.05) differed with line 1 (75.58). The egg/ hen/ week was significantly (p<0.05) higher in line 4 3.66 eggs compared with line 2 and 1 (2.85 and 2.34 eggs), respectively. Concerning egg/ hen/ all periods% and HDP%, the line 2 was significantly (p<0.05) showed the higher percentage (33.20 eggs and 34.30%), respectively (Table 3).

Table 3: Effect of different genetic lines of chicken on egg weight and egg production performance.

Traits	Lines			
	1	2	3	4
Egg weight (g)	57.45 ± 1.00^{bc}	56.58 ±0.74^{c}	60.00 ±0.62^{b}	66.25 ±0.75^{a}
Eggs/ hen for all periods	75.58 ±12.28^{c}	84.50±10.04^{b}	108.75 ±15.60^{a}	102.75 ± 17.06^{a}
Egg/ hen/ week	2.34 ±0.45^{c}	2.85 ±0.40^{bc}	3.15 ±0.50^{ab}	3.66 ±0.57^{a}
Egg/ hen/ all periods %	21.48 ± 4.10^{c}	33.20 ±3.51^{a}	25.62 ±3.96^{b}	23.35 ±4.06^{bc}
Hen Day Production%	21.95 ±4.02^{b}	34.30 ±4.02^{a}	25.89 ±3.66^{b}	22.99 ±3.41^{bc}

$^{a-c}$ For each means of same traits in each row with different letters differ significantly (P<0.05).

Results in Table 4 showed that hens at period 4 attained significantly (p<0.05) the heaviest weights compared with the other periods (1, 2 and 3). Thesignificant (p<0.05) large number and percentage of eggs/ hen for each period were obtained at period 3 (139.58) eggs and (42.56%) followed by period 2, 1 and 4 (117.58, 69.92 and 44.25) eggs and (28.82, 17.73 and 14.54%), respectively. Although there was no significant difference between period 2 and 3of egg/ hen/ week and hen day production%, there was an observed significant difference between these periods with period 1 and period 4.

Table 4: Effect of different periods on egg weight and egg production performance of genetic lines of chicken.

Traits	Periods			
	1	2	3	4
Egg weight (g)	59.92 ± 1.06^{b}	58.25 ± 1.70^{b}	59.58 ±1.62^{b}	62.53±1.43^{a}
Eggs / hen/ period	69.92 ±8.66^{c}	117.58 ±7.21^{b}	139.83 ±10.55^{a}	44.25 ±9.70^{d}
Egg/ hen/ week	2.18 ± 0.83^{b}	4.36 ±0.90^{a}	4.20 ±1.36^{a}	1.26 ±1.15^{c}
Egg/ hen/ periods %	17.73 ±3.75^{c}	28.82 ±1.88^{b}	42.56 ±2.00^{a}	14.54 ±1.77^{c}
Hen day production%	18.09 ±13.24^{b}	37.43 ±8.44^{a}	35.77±5.82^{a}	13.85 ±5.85^{c}

$^{a–c}$ For each means of same traits in each row with different letters differ significantly (P<0.05).

DISCUSSION

There was no significant difference (p>0.05) in the first day or week of egg production, and reach to 5% production among all the genetic lines (Table 1). These local genetic lines lay the first egg earlierthan that mentioned by Hossary and Galal (1994) there were also, found no significant differences in age at first eggs (days) between three lines of Fayoumi hens, but Tixier-Boichard *et al.* (2006) found significant differences between Fayoumi and ISA Brown chickens and their crosses in age at first egg (days). The age at first egg (days) of Fayoumi was (136) days compared with ISA Brown (127) days which isearlier than ISA Brown (167days) in this study. This finding was agreed with Rahman *et al.* (1997); Tadelle *et al.* (2000); Adedokun and Sonaiya (2002) and Khanh (2004) when they found no significant differences in age at first egg weeks between breeds. This result however did not consistent with the findings of Sunder *et al.* (2005) who observed that age at first egg (weeks) for White Leghorn was significantly earlier than local chickens. Also, Sharma (2004) found that the age at first egg (weeks) of local hens and its crosses with Indian breeds were significant. The results from these studies indicate that age at first of local chicken was later than the local genetic lines chicken in the present study.

In the present study (Table 2), means showed that reaching sexual maturity (weeks) of local chickens had an earlier ages than resulting by Taha and Abd El-Ghany (2013) when they found that reaching sexual maturity of El-Salam and Mandarah was significant and they attributed their results to the genetic makeup of different lines. As well as, the Egyptian strains Mandarah and Salam reached sexual maturity significantly at an earlier age than Canadian Shaver strains (Taha *et al.*, 2012). Differences in age at sexual maturity between different lines of poultry were agreed with Udeh (2007); Niranjan *et al.* (2008); Yahaya (2009); Udeh (2010) and Udeh and Omeje (2011), but disagree with Al-Nasser *et al.* (2008) who found that there were no differences in age at sexual maturity for Lohmann LSL-Classic white and brown strains. Badreldin *et al.* (1961) reported that age at sexual maturity of Fayoumi was earlier than White Leghorn. Sexual maturity age of local Kei chickens was comparatively earlier than those reported by Halima *et al.* (2007) for local chickens and Melesse *et al.* (2011) for Ethiopian naked-neck chickens reared under intensive management conditions. Udeh and Omeje (2011) found significant age at peak production of two exotic and local chicken, and age at first egg, age at peak egg production, egg weight, hen day rate were significantly (p<0.01) decreased in the two exotic but not in the local chicken. Fotsa and Manjeli (2010) and Kreman (2012) found minor differences observed probably due to the conjugated effect of genetic diversities, environments, and the rearing conditions of different local hens used by these authors.

The egg weight of line 4 significantly higher than other the genetic lines, as well as line 3 attained significantly higher egg weights compared with other genetic lines (Table 3). These finding were confirmed by Hermiz *et al.* (2012) when found the same different genetic lines significantly affected egg weights, although the Black with Brown Neck attained higher egg weight followed by Isa Brown, Pure Black and White. Several studies reported significant differences in egg weights between breeds, strains and lines (Silversides and Scott, 2001; Monira *et al.*, 2003; Zita *et al.*, 2009 and Ali, 2010). Differences in egg weights between different genotypes were also recorded by Abou El-Ghar *et al.* (2009) and Yousria *et al.* (2010). Moreover, Iraqi (2002) confirmed significant effects of breed on egg quality character and disagreed with Ezzeldinand El-Labban (1989) who found non-significant breed effects on egg weight. Ansari (2000a, b) found insignificant differences in egg weight between generation 1 and 2 of the Isfahan breed.

The eggs/ hen for all periods and egg/ hen/ week were significantly higher in genetic line 3 and 4. The eggs/ hen for all periods % and Hen Day Production% were significantly higher in genetic line 2 followed by genetic line 3, 4 and 1, respectively (Table 3). Differences in these traits of local chickens were recorded by several studies. The rate of lay% of different local chickens by Sunder *et al.* (2005) was less than the results in this study. Also Tadelle *et al.* (2000) showed that the eggs/ hen/ year and rate of lay (%) for first and second year of different local chicken were less than the results in the present study.

Minh *et al.* (2004) found the hen-day egg production rate of the Tamhoang breed significantly higher than the Ri breed. Although, the number of eggs and rate of lay% egg production in 8 months of four local breeds from northern Viet Nam did not significant showed by Khanh (2004) this rate in range approximately higher than the results in this study. The eggs/ hen and rate of lay percentage of local chickens in other studies were higher in some lines and lesser than the results in present study (Benabdeljelil *et al.*, 2001; Mwalusanya *et al.*, 2001 and Njenga, 2005).

The egg weight at period 4 was significantly (p<0.05) higher at period 3 than other periods for all genetic lines, but eggs/ hen/ period and egg/ hen/ period% were significantly (p<0.05) higher at period 3 (Table 4). In addition, the gg/ hen/ week and hen day production % were significantly (p<0.05) higher at period 3 and 2 compared with period 1 and 4. Tahaand Abd El-Ghany (2013) found that the egg weight and egg number of local chickens increased at different periods (90 days, 42 weeks and 65 weeks). The results in this study for egg number may attributed to the experimental periods that were longer than the total periods of the study by Taha *et al.* (2012). Several results were studying the effects of different periods on egg weight and egg production of local chickens. In central and southern parts of Senegal, Missohou *et al.* (1998) recorded that lay 60 eggs/ year (rate of lay of 16.4 percent) with an egg weight of 31 grams. Bessadok *et al.* (2003) reported that 127 eggs were obtained over a one-year laying period. Mwalusanya *et al.* (2001) that eggs/ hen/ year (31.6) and egg weight (44.1g). Msoffe (2003) found that the egg size (37-49g) for seven Tanzanian ecotypes kept under station conditions. Altamirano (2005) indicated that the rate of lay was (55.8%) and egg weight (52.6g). Melesse *et al.* (2013) also found that local Kei chickens reached their peak egg production at about 38 weeks of age.

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دراسة مقارنة الصفات الانتاجية لدجاج المحلي وايزا براون في منطقة اقليم كوردستان- العراق

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تم تطبيق هذا البحث في محطة البحوث الزراعية التابعة لدائرة الزراعة-السليمانية لتقدير تاثير ثلاثة خطوط من الدجاج المحلي: دجاج ذات الريش الاسود (الخط ١)، دجاج ذات الريش الاسود مع رقبة حمراء (الخط ٢)، ذات الريش الأبيض (الخط ٣) مع سلالة ايزا براون (خط ٤) في أربع فترات مختلفة (١-٣٢، ٣٣-٤٣،٤٤-٦٠ و٦١-٧٥) أسبوع على الصفات الانتاجية. تم تسجيل العمر عند انتاج اول بيضة (ايام واسبوع)، النضج الجنسي، والوصول الى ٥٠% وقمة انتاج البيض واطول فترة عند قمة انتاج. بالإضافة الى تقدير بيض/ دجاج/ الفترة الكلية، بيض/دجاج/اسبوع، ونسبة بيض/دجاج/ الفترة الكلية ونسبة انتاج البيض اليومي. اظهرت البيانات عدم وجود فروق معنوية بين الخطوط لكل من العمر بالأيام والأسابيع عند إنتاج لأول بيضة وعمر النضج الجنسي والوصول إلى قمة انتاج. بينما خط٢ وصل الى ٥٠% انتاج قبل الخطوط الاخرى بشكل معنوي ($p<0.05$)حوالي (٨-٢١) اسبوع. وكذلك خط٣ استمر معنويا عند قمة الإنتاج لمدة أقصر مقارنة بالخطوط الأخرى. نسبة إنتاج البيض عند عمر نضج الجنسي و ٥٠% إنتاج وطول قمة الانتاج لم تختلف بين الخطوط المختلفة بشكل معنوي. نسبة قمة إنتاج البيض لخط ٢ كانت معنويا أعلى من الخطوط الأخرى. وزن البيض كان معنويا أعلى في خط ٤ عند المقارنة مع الخطوط الثلاثة الاخرى، في حين لم يختلف عن خط ٣ فيما يخص بيض/دجاج/ الفترة الكلية وبيض/دجاج/ أسبوع. بالنسبة لإنتاج البيض، فإن خط ٢ كان لها معنويا أعلى نسبة (٣٣.٢٠ بيض و ٣٤.٣٠%) لكل من نسبة بيض/دجاج/ فترة ونسبة إنتاج البيض اليومي على التوالي. مع زيادة تقدم عمر الدجاج ازداد وزن البيض، بينما بيض/دجاج/ فترة، بيض/دجاج/ أسبوع ونسبة إنتاج البيض كان أعلى بشكل معنوي في الفترة الثالثة.