ROLE OF PLANT GROWTH PROMOTING IN IMPROVING PRODUCTIVITY AND QUALITY OF MAIZE

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ABSTRACT

This study was aimed to investigate effect of minerals, organic and bio- fertilizers on yield and quality of three synthetics varieties of maize. A field experiments were applied at the research station of the College of Agricultural Engineering Sciences - University of Baghdad during 2019 and at Abu Ghraib research station during 2020, using randomized complete block design (RCBD) within split-plot arrangement with three replicates. The experiments included two factors, the first in the main plots represented three synthetic varieties of maize, while the second in the sub plots represented five fertilizer treatments. The results showed that bhooth 5018 variety was superior in grain yield during second season, and oil at first season, while Baghdad 3 was superior in number of rows ear^{-1} in the first season produced highest mean 14.98 row ear^{-1}.While the fertilizer treatment (50% mineral fertilizer + 10% algae extract) was superior in both seasons in grain yield (9077, 7745 kg.h^{-1}) respectively, and most of yield components. The treatment of 100% mineral fertilizer was superior in first season in weight of 500 grains (111.78g).

Keywords: corn, mineral fertilizers, seaweed extracts, bio-fertilizers, grain yield.
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مجلة العلوم الزراعية العراقية -2022 :53(6):1437-1446 التميمي والحلفي

دور مشجعات النمو النباتية في تحسين انتاج ونوعية الذرة الصفراء

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المستخلص

بهدف دراسة تاثير الاسمدة المعدنية والعضوية والحيوية في حاصل ونوعية ثلاثة اصناف تركيبية من الذرة الصفراء. طبقت تجربة حقلية في المحطة البحثية التابعة إلى كلية علوم الهندسة الزراعية خلال الموسم 2019 وفي محطة ابحاث ابو غريب التابعة الى دائرة البحوث الزراعية خلال الموسم 2020 بأستعمال تصميم القطاعات الكاملة المعشاة وترتيب الالواح المنشقة بثلاثة مكررات. تضمنت التجربة عاملين، العامل الاول في الالواح الرئيسة ثلاثة أصناف تركيبية من الذرة الصفراء في حين مثل العامل الثاني في الالواح الثانوية خمس معاملات سمادية. اظهرت النتائج ان الصنف 5018 قد تفوق في حاصل الحبوب في الموسم الثاني ونسبة الزيت بالحبوب في الموسم الاول, بينما تفوق الصنف بغداد3 في عدد الصفوف بالعرنوص في الموسم الاول باعطائه اعلى قيمة بلغت 14.98 صف عرنوص$^{-1}$, بينما تفوقت المعاملة السمادية (50% سماد معدني+ 10% مستخلص طحالب) في كلا الموسمين في حاصل الحبوب (9077 و7745 كغم هكتار$^{-1}$) بالتتابع ومعظم مكوناته، بينما تفوقت المعاملة 100% سماد معدني في الموسم الاول في وزن 500 حبة (111.78 غم)

كلمات مفتاحية: اسمدة معدنية، مستخلصات طحالب بحرية، اسمدة حيوية، حاصل الحبوب.

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INTRODUCTION

Every crop has potential energy for production, and this energy is rarely accessible in the field due to the presence of one or more factors that determine production, and these factors can be distinguished and diagnosed in the field. These factors, including what could be controlled, and what is outside human control. Among these factors that could be controlled is the lack of nutrients and the balance state between the nutrients that the plant needs for growth and development during its different growth stages, the method of adding or spraying fertilizers with in soil and crop management. It is known that maize is one of the most important strategic crops not only in Iraq but in most regions of the world, as it ranks third after wheat and rice in terms of cultivated area and first rank in terms of production per unit area, it is high yield cereal crops, as it is a multi-uses crop, which allows it to spread in a wide range of agricultural environments (11,13).Many Studies have confirmed that the genetic composition has an effect on the yield and its components, as the varieties differed in general among themselves in the grains yield due to the genetic factors and the differences in physiological performance, which includes the expansion of the root system and the increase of tiny roots to absorb nutrients as well as the arrangement of the plant tent to reserve the largest amount of light to carry out photosynthesis process (12). Wahaib(27) indicated that the highest yield can be obtained when there is appropriate compatibility between genetic structure and growth factors available in that region when these factors are optimally invested. Since maize crop responds to large amounts of mineral fertilizers as it is a C4 plant, so there are attempts to replace part of these large amounts of mineral fertilizers with safe alternatives by applying the system of clean agriculture or organic and biodynamic agriculture to obtain highest quality, while maintaining the amount of yield per unit area and environmental factors from pollution. Recent studies and research indicated the possibility of reducing 50% of the recommended mineral fertilizers and replacing them with organic and biological fertilizers(7).Researchers showed that the use of algae of all kinds as biologically active organic fertilizers is better than mineral fertilizers, as they are a natural resource that is environmentally friendly, biodegradable, cheap, and non-polluting or harmful to human and animal health, especially in third world countries where the overuse of mineral fertilizers and pesticides that negatively affect soil fertility and causes many problems for farmers (2, 3, 15). Seaweed extracts contain all trace elements (9, 22) and some basic plant growth hormones (16 , 29). Seaweed extract contains natural plant growth regulators such as auxins, gibberellins and cytokinins, which gives a significant increase in the yield of some crops as a result of improving the plant metabolism function (26, 29). On the other hand, Malusà et al. (17) emphasized that biological fertilizers have ability to give a similar yield to mineral fertilizers and they have an important role in the nutrient management system in agricultural soils and reduce the negative effects of mineral fertilizers on the environment. Also Abasi et al. (1) confirmed that bio-fertilizers, whether fungal (MAF) or bacterial, have a positive effect on the growth and yield of maize, as well as the content of nitrogen and phosphorous, and the interaction effect between fungi and bacteria was more effective than if it used alone in absorbing elements by the plant. This study was conducted to investigate the effect of five treatments of fertilizers on yield and quality of maize, and the possibility of reducing the amount of mineral fertilizers.

MATERIALS AND METHODS

A field experiment was conducted, at the research station of College of Agricultural Engineering Sciences - University of Baghdad –Al- Jadiriyah during fall season of 2019 and at the Abu Ghraib research station affiliated to the Office of Agricultural Research - Ministry of Agriculture, Iraq, during fall season of 2020. The experiments carried using Randomized Complete Block Design (RCBD) within split plots arrangement with three replicates in soil characteristics show in Table 1. The experiment included three synthetic varieties of maize (bohooth 5018, Baghdad 3 and Sumer) in the main plots and the following fertilizer treatments:

1. Application mineral fertilizers according to recommendation (C1), control.
2. Application 50% mineral fertilizer + spraying seaweed extract at 5% (A1).
3. Application 50% mineral fertilizer + spraying seaweed extract at 10% (A2).
4. Application 50% mineral fertilizer + seeds pollution with Azotobacter chroococcum + Glomus mosseae (B1).
5. Application 50% mineral fertilizer + seeds pollution with Pseudomonas flourescens + Glomus mosseae (B2).

In sup plots, in order to study the impact of mineral fertilizers (Urea, Tri Calcium Super Phosphate, Potassium Sulfate), organic (seaweed extract) and bio (Azotobacter chroococcum, Pseudomonas flourescens, Glomus mosseae) on three synthetic varieties of maize and the possibility of replacing Mineral fertilizers with organic or biological fertilizers. After completing the research field preparation then was divided into experimental units (12 m^2), included four rows with a length of 3 m and the rows is 75 cm apart. a distance of 1 m was left between the experimental units and 1.5 m between the replicates to ensure that the added fertilizers would not transfer between the experimental units.

Table 1. Physical and chemical properties of field soil for the 2019 and 2020 planting seasons for the two research sites

Attributes	measuring unit	value	
		season 2019	season 2020
N	Ppm	40.7	31.5
P		14.6	11.4
K		376.0	310.0
Ca	Meq/L.	16.4	12.5
Mg		30.8	20.0
Na		2.31	2.84
O.M	%	2.21	1.23
EC	$Ms.cm^{-1}$	1.97	2.87
Ph		7.2	7.8
Sand	%	34.8	12.8
Silt		50.0	37.1
Clay		15.2	50.1
Soil texture		Silty loam	Silt Clay Loam

The sowing date was 16/7/2019 at first season and 19/7/2020 at second season, Urea (46%N) was used as a nitrogen source at a rate of 300 kg. h^{-1} and was added in two doses, the first at the stage of six leaves, and the second after 30 days from the first dose, Tri superphosphate fertilizer (20%P) was added as a source of phosphorous element at a rate 300 $kg.h^{-1}$ once before planting, As for potassium, potassium sulfate fertilizer K_2SO_4 (45% K) was used as a source of it and was added at a rate of 225 $kg.h^{-1}$ (18). All spraying operations were carried out in three stages of plant life which are (4, 8 and 12 leaf) stage. Prepare a bio-bacterial fertilizer consisting of two isolates of bacteria, Azotobacter chroccocum and Pseudomonas fluorescens by preparing a medium suitable for their growth and a day before planting the bacteria were injected into the growth medium after that kept under appropriate conditions (low temperature) until the time of use. 30 minutes before planting, the planting seeds were treated with bio-fertilizer at rate 10 gm bio-fertilizer per 1 kg of seeds and homogenized well by adding gum Arabic at ratio 1:10 to ensure stuck bio-fertilizer to the seeds (6). As for the mycorrhizal fungus G. mosseae consisting of dry soil, spores and infected mycorrhizal roots, it was added all at once in contact with the seeds inside the planting hole 10 g per hole. As for the seaweed extract (Spirulina alga), the characteristics of which are reveal Table 2, it was prepared by taking 10 gm of dried powder and soaking it in 100 ml of distilled water, then placing it in the autoclave for 30 minutes and then cooling and filtering using a cloth, thus we obtain a liquid seaweed extract with a concentration 100% (20). The required concentration of the liquid extract is prepared according to the dilution equation. Data were recorded and statistically analyzed using analysis variance by statistical software package Genstat version (12). The differences

among the treatment means were compared using least significant difference (LSD) test at the level of 0.05 probabilities (25).

Table 2. Seaweed Extract Nutrients and Plant Growth Regulators Content

Nutrient elements (mg L^{-1})	Value	Growth regulators (µg/100g)	Value
nitrogen	23	auxins	8
phosphorous	80	gibberellins	95
potassium	392	cytokinins	184
Sodium	412		
Calcium	163		

Studied characters

1. Mean number of ears per plant (ears $plant^{-1}$).
2. Mean number of rows in the main ear (rows ear^{-1}).
3. Mean number of grains per row (grains row^{-1}).
4. Mean weight of 500 grains (gm): 500 grains were counted after separates the grain of ear for ten plants taken randomly and weighs, using a sensitive scale, then the weight was adjusted on the basis of a humidity 15.5% based on the following equation:

Weight of 500 grains at 15.5 % moisture = weight of grains at original moisture 84.5 x 100 (El-sahooki, 10).

5. Grain yield (kg h^{-1}).
6. The percentage of protein and oil in grains (%).

RESULTS AND DISCUSSION

Number of ears per plant (ears $Plant^{-1}$)

Table 3 shows that varieties had did not difference significant in this trait for both seasons .While the fertilizer treatments significant affected to the number of ears $plant^{-1}$ in both seasons. Treatment A2 was superior in both seasons and gave the highest mean for this trait (1.43 and 1.17 ear $plant^{-1}$) respectively, while treatments C1 and A1 in the first season had the lowest mean (1.23 ears $plant^{-1}$) for both treatments. Treatment C1 also gave the lowest mean reached1.06 ear $plant^{-1}$ at second season. This due to containing of seaweed extract appropriate amounts of plant growth regulators such as auxins, cytokinins, gibberellins, macronutrients and micronutrients, which made it a good fertilizer source, in addition to the state of balance in absorbing nutrients by plant caused by spraying seaweed extracts during critical stages of plant growth, as addition of mineral fertilizers in half of the recommendations reduced. The negative effect resulting from adding large amounts of mineral fertilizers, which increases the soil pH, which reduces the availability of most macro and micronutrients to uptake, and this is consistent with the results of Mohanty et al.(21) they found that seaweed extract enhance the growth and yield of various crops. Seaweed extracts contribute to increasing soil fertility, increasing the availability of scarce nutrients, and this is consistent with the results Al-Alusi and Al Sahooki, (5) .They indicated the sank strength increases in a maize varieties with more than one ear compared to the maize varieties with the single ear when the growth requirements are met and in appropriate quantities and ready for absorption by the plant, which is reflected on the increase yield and its components. Data in Table 3 shows non-significant difference interaction (varieties × fertilizer treatments).

Table 3. Effect of varieties and fertilizer treatments and the interaction between them in mean number of ears per plant

	fall 2019				fall 2020			
Fertilizer treatments	varieties 5018	Baghdad-3	Sumer	Treatments r	varieties 5018	Baghdad-3	Sumer	Treatments mean
C1	1.23	1.26	1.20	1.23	1.10	1.06	1.03	1.06
A1	1.23	1.23	1.23	1.23	1.06	1.10	1.10	1.08
A2	1.40	1.46	1.43	1.43	1.20	1.16	1.16	1.17
B1	1.33	1.36	1.30	1.33	1.13	1.06	1.10	1.10
B2	1.30	1.33	1.23	1.28	1.16	1.13	1.13	1.14
L.S.D 0.05		n.s		0.10		n.s		0.06
Varieties mean	1.30	1.33	1.28	1.30	1.13	1.10	1.10	1.11
0.05L.S.D		n.s				n.s		

Number of rows per ear (rows ear^{-1})

from Table 4 It is noticed the number of rows ear^{-1} was significantly had affected by the studied varieties at first season only, as the Baghdad 3 variety outperformed significantly and gave the highest mean number of rows in ear, reached 14.98 rows ear^{-1}, which had non-significant differences from the Sumer variety, which gave rows number mean per ear reached 14.78 rows ear^{-1}, while the 5018 variety gave the lowest rows number mean per ear, which was 14.48 rows ear^{-1}. Fertilizer treatments had a significant effect on this trait in both seasons, A2 was superior in both seasons and gave the highest mean (15.08 and 15.02 rows ear^{-1}) sequentially, while treatment A1 gave the lowest mean ear in the first season (14.48 row ear^{-1}), treatment C1 gave the lowest mean in the second season (14.46 row ear^{-1}). The increase in number of rows ear^{-1} could be due to the role of seaweed extracts to providing the necessary nutrients for growth and development, as well as increasing the production of plant growth hormones, which leads to an increase in green area, and increase the accumulation of dry matter and improving growth, this results are harmony with the results of (23 ,28).They indicated the number of rows per ear^{-1} increased by increasing the availability of nutrients in the different stages of plant growth. The interaction between two factors had non-significant effect on the number of rows ear^{-1}.

Table 4. Effect of variety and fertilizer treatments and the interaction between them on the number of row per ear

	fall 2019				fall 2020			
Fertilizer treatments	varieties			Treatments ı	varieties			Treatments
	5018	Baghdad-3	Sumer		5018	Baghdad-3	Sumer	mean
C1	14.86	14.46	14.66	14.66	14.66	14.40	14.33	14.46
A1	14.26	14.80	14.40	14.48	14.80	14.60	14.53	14.64
A2	14.73	15.40	15.13	15.08	15.20	15.00	14.86	15.02
B1	14.33	15.20	15.06	14.86	14.93	14.80	14.66	14.80
B2	14.20	15.06	14.66	14.64	14.80	14.66	14.66	14.71
L.S.D 0.05		n.s		0.36		n.s		0.33
Varieties mean	14.48	14.98	14.78	14.75	14.88	14.69	14.61	14.72
0.05L.S.D		0.25				n.s		

Number of grains per row (grains row^{-1})

Results in Table 5 indicate that non-significant differences among varieties in number of grains row^{-1} in both seasons, but the treatments of fertilizers had significantly differed in this trait in both seasons. Treatment A2 was superior in number of grains row^{-1} in both seasons (39.34 and 41.11 grain row^{-1}) which had not significantly differed in both seasons from treatment B2 (38.11 and 40.37 grains row^{-1}). The reason could be due to the role of organic extracts and bio-fertilizers on increasing plant height and leaf area, thus obtaining high photosynthesis and transferring its products to the sink, at the same time, the plant height reduced the shading of the leaves above the ear, which is reflected in the increase rate of pollination , and the number of grains increases. Wuhaib et al. (28) It also works to increase the availability of the nitrogen element, which works to regulate work of hormones and then control the action of auxin in occurring apical dominance of the ear, where cytokinins work to prevent the transfer of auxins from old grains to new grains (19).while treatment C1 produced the lowest mean in both seasons (37.13 and 37.99 grains row^{-1}). The interaction between varieties and fertilizer treatments did not effect significantly on this trait.

Table 5. Effect of varieties and fertilizer treatments and the interaction between them on the mean number of grains per row

	fall 2019				fall 2020			
Fertilizer treatmer	varieties			Treatments mean	varieties			Treatments m
	5018	Baghdad-3	Sumer		5018	Baghdad-3	Sumer	
C1	37.57	36.30	37.53	37.13	38.07	37.40	38.50	37.99
A1	38.03	37.83	37.77	37.88	38.00	40.87	39.73	39.53
A2	39.33	39.40	39.30	39.34	40.87	41.17	41.30	41.11
B1	36.87	38.70	37.90	37.82	41.13	39.20	39.47	39.93
B2	38.73	37.17	38.43	38.11	40.20	40.77	40.13	40.37
L.S.D 0.05		n.s		1.44		n.s		1.68
Varieties mean	38.11	37.88	38.19	38.06	39.65	39.88	39.83	39.79
L.S.D 0.05		n.s				n.s		

Weight 500 grains (gm)

Shows from Table 6 that varieties did not differed significantly in this trait, on the other hand, the fertilizer treatments significantly differed caused by their effect with the weight of 500 grains. In the first season, Treatment C1 was superior in weight of 500 grains (111.78 gm), which did not differed significantly from treatments B1 (108.89 gm) and A1 (108.22 gm). Treatment A2 gave the lowest mean (103.44 gm). In the second season, Treatment B1 was superior and gave the highest mean weight of 500 grains (107.56 gm), which did not differed significantly from treatment B2 which gave 104.33 gm mean of this trait, while treatment C1 gave lowest men for this trait (100.00 gm). The reason for the superiority of treatment C1 in the first season attributed to relative reduction in the yield components represented by the number of ears per plant, the number of rows per ear and the number of grains per row, which led to the accumulation of dry matter obtained by the plant from the photosynthesis process and its collection in a smaller number of sinks, which was reflected to increase the weight of grain. It should be noted that the increases in the weight of the grain has not compensated the decrease in the number of ears per plant and the number of grains per ear, which was reflected on the total grain yield reduction. The reason could be attributed to the role of bio-fertilizers in improving the growth of the maize plant and increasing its productivity, as bacteria encourage the absorption of water and nutrients, through the secretion of hormones, enzymes, and some organic acids. They also play an important role in changing the soil pH and contribute to the dissolution of some nutrients and then increase their availability (14). This was reflected in the fullness of the grain and the increases in its weight.

Table 6. Effect of the variety and fertilizer treatments and the interaction between them on the mean weight of 500 grains (gm)

	fall 2019				fall 2020			
Fertilizer treatments	varieties			Treatmer mean	varieties			Treatments r
	5018	Baghdad-3	Sumer		5018	Baghdad-3	Sumer	
C1	111.00	115.00	109.33	111.78	98.00	101.33	100.67	100.00
A1	107.67	106.67	110.33	108.22	100.33	102.67	101.00	101.33
A2	106.00	100.33	104.00	103.44	103.67	104.00	102.00	103.22
B1	116.33	101.00	109.33	108.89	108.33	108.00	106.33	107.56
B2	107.33	106.67	105.67	106.56	103.33	105.33	104.33	104.33
L.S.D 0.05		n.s		5.35		n.s		4.06
Varieties mean	109.67	105.93	107.73	107.78	102.73	104.27	102.87	103.29
L.S.D 0.05		n.s				n.s		

Grain yield (kg h^{-1})

From Table 7, it is shows that the varieties had not significantly differed in this trait in both season. Fertilizer treatments significantly affected the trait of grain yield in both seasons, Treatment A2 outperformed in both seasons gave the highest mean (9077 and 7745 kg h^{-1}) respectively, superior to the control treatment C1 in both seasons with an increased rate 13.51 and 19.17%, respectively, while the lowest mean was for treatment A1 in the first season and the control treatment C1 in the second season, which gave 7732 and 6499 kg h^{-1}, respectively, and the superiority of the fertilizer treatment A2 is due to its superiority in most of the components of the yield represented by the number of ears per plant, the number of rows per ear and the number of grains per row. This is consistent with the results Singh et al. (24) who found an increase in maize grain yield when spraying with seaweed extract. The effect of interaction between varieties and fertilizer treatments was significant on this trait in the second season only, Generally, the interaction between variety bohooth 5018 and fertilizer treatment A2 gave the highest men (8302 kg ha^{-1}) , While the interaction between the variety Sumer and the fertilizer treatment C1 gave the lowest men (6077 kg ha^{-1}).

Table 7. Effect of variety and fertilizer treatments and the interaction between them on the grain yield mean (kg ha^{-1})

	fall 2019				fall 2020			
Fertilizer treatments	varieties			Treatmen mean	varieties			Treatments r
	5018	Baghdad-3	Sumer		5018	Baghdad-3	Sumer	
C1	8055	7946	7549	7850	7256	6163	6077	6499
A1	7653	7783	7759	7732	6381	7229	6623	6744
A2	8886	9145	9202	9077	8302	7937	6998	7745
B1	8440	8373	8486	8433	8036	7284	7183	7501
B2	8017	8295	7723	8017	7583	7579	7281	7481
L.S.D 0.05		n.s		554.82		649.1		
Varieties mean	8214	8308	8144	8222	7512	7238	6832	7194
L.S.D0.05		n.s				n.s		

Grain protein content (%)

Table 8 shows non-significant effect of varieties on protein content of the grains in both seasons. As for the fertilizer treatments was differed significantly in both seasons. The treatment A2 outperformed in both seasons and gave the highest mean of protein 10.33 and 9.92% respectively, Treatment A2 did not differed significantly in the first season from treatments B1 and B2 (10.14 and 9.84%) respectively, and in the second season from treatment B1, which gave 9.76%. On the other hand, treatment A1 in the first season gave the lowest mean (9.46%). In the second season, treatment C1 gave the lowest mean (8.72%). The reason may be attributed to the role of seaweed extracts and bio-fertilizers in improving the plant's metabolic function during the physiological changes that occur in the grain at growth stages due to the content of these extracts and the production of bio-fertilizers from natural plant growth regulators such as auxins, gibberellins, and cytokinins that affect cell division and stimulate plant growth, which leads to an increase in the vegetative total and photosynthesis then transfer manufactured materials to their storage places.

Table 8. Effect of variety and fertilizer treatments and the interaction between them on the percentage of protein in grain

	fall 2019				fall 2020			
Fertilizer treatments	varieties			Treatments mean	Varieties			Treatments m
	5018	Baghdad-3	Sumer		5018	Baghdad-3	Sumer	
C1	9.63	9.63	9.42	9.56	8.93	8.70	8.53	8.72
A1	9.35	9.49	9.54	9.46	8.99	8.66	8.63	8.76
A2	10.61	10.30	10.07	10.33	10.17	9.79	9.80	9.92
B1	10.18	10.03	10.20	10.14	9.88	9.82	9.58	9.76
B2	10.04	9.72	9.76	9.84	9.51	9.49	9.19	9.39
L.S.D 0.05		n.s		0.62		0.66		0.27
Varieties mean	9.96	9.83	9.80	9.86	9.49	9.29	9.15	9.31
0.05L.S.D		n.s				n.s		

Grain oil (%)

Table 9 shows a significant effect of the varieties on the oil percentage in grains at the first season only, where the bohooth 5018 variety significantly outperformed in the grains oil content and had the highest mean (3.83%) which had not significantly differed with the Baghdad -3 variety (3.53%), while Sumer variety gave the lowest mean (3.36%). As for the fertilizer treatments, they had significantly differences in both seasons. In the first season, treatment A1 was superior and had the highest mean (3.94%), which did not differed significantly from treatment B2, which gave (3.56%), while the treatment C1 gave the lowest (3.30%). In the second season, treatment B2 was significantly outperformed and gave the highest mean (3.43%), which significantly with treatments C1 and A1 (3.40 and 3.41%) for this trait, respectively. Whereas, treatment A2 gave the lowest mean (3.02%), this might be attributed to the nature of the relationship between the grain content of protein, carbohydrates, and oil. we find a decrease in the protein% in treatments A1 at the first season and B2 at a second season. and this lead to a decrease in the percentage of the enzyme reductase nitrate, in addition to a decrease in the percentage of carbohydrates in plants. Accordingly, the proportion of protein in the grains decreases, and in such circumstances, an imbalance would occur in the grain between its basic nutritional components (carbohydrates, proteins and oils), which affects the biosynthesis of these compounds and thus provides an opportunity to increase the proportion of oil at the expense of other components. The interaction between varieties and fertilizer treatments did not affect significantly on this trait.

Table 9. Effect of the variety and fertilizer treatments and the interaction between them on the percentage of oil (%) in grain

	fall 2019				fall 2020			
Fertilizer treatme	varieties			Treatments m	Varieties			Treatments m
	5018	Baghdad-3	Sumer		5018	Baghdad-3	Sumer	
C1	3.63	3.16	3.10	3.30	3.03	3.43	3.73	3.40
A1	4.06	4.10	3.66	3.94	3.33	3.46	3.43	3.41
A2	3.86	3.50	3.20	3.52	2.96	2.93	3.16	3.02
B1	3.83	3.50	3.30	3.54	3.00	3.10	3.36	3.15
B2	3.76	3.40	3.53	3.56	3.50	3.60	3.20	3.43
L.S.D 0.05		n.s		0.40		n.s		0.30
Varieties mean	3.83	3.53	3.36	3.57	3.16	3.30	3.38	3.28
L.S.D 0.05		0.31				n.s		

CONCLUSIONS

It can be concluded from this study that the seaweed extract at 10% concentration and bio-fertilizers of both kinds (bacteria+ fungi) had contributed to reducing the amounts of mineral fertilizers by 50% from recommendations,

taking into consideration the preservation of the environment, improving soil properties, and reduction of production costs.

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