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Effect of algae and Bio-fertilizers on some growth characteristics and yield of wheat *Triticum aestivum* L.

Ali Ahmed Hussein Al- Myali[1]

[1]University of Kerbala / College of Sciences / Biology Department/ Karbala - Iraq
***Corresponding author e-mail: Ali.hussien@uokerbala.edu.iq**

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Abstract

The experiment was carried out in the wooden canopy which belongs to the Soil and Water Department/ Technical College- Al-Mussaib/ Mashru Al-Mussaib area/ Babylon Governorate, during winter season 2020. The study aimed to know the effect of three concentrations of (0, 2.5, and 5 ml.L-1) of algae fertilizer (Biozyme TF) and three concentrations (0, 1.5, and 3 ml.L-1) of bio-fertilizer (EM1) and their interactions on the growth and yield of wheat crop. A factorial experiment was applied according to the Randomized Complete Block Design (RCBD) with three replicates. The results revealed that the addition of algae fertilizer (5 ml.L-1) and spraying with bio-fertilizer (3 ml.L-1) individually led to a significant increase in all characteristics of vegetative growth and yield components (plant height, area of flag leaf, number of spurs, length of spike, number of grains / spike and the weight of 1000 grains). Moreover, the dual interaction between the two factors of the study significantly affected most of the studied traits except (plant height and spike length), where the combination between (5 ml.L-1 algae fertilizer + 3 ml.L-1 biofertilizer) was superior in giving the highest averages, while the comparison treatment gave the lowest averages. It can be concluded from this study that it is possible to rely with a high percentage on the use of environmentally friendly biological extracts as part of the fertilization program for field crops, including wheat.

Keywords: Wheat, algae fertilizer, bio- fertilizer.

Introduction

The Ammi Wheat crop *Triticum aestivum* L. occupies the first place in the world in terms of the cultivated area and the production where the statistical data indicated that the international production reached about 700.80 million tons in 2015 [1]. The importance of this crop is due to being the main food for more than 60 countries in the world (equivalent to 35% of the world's population). The nutritional importance of wheat is that it provides most of the calories consumed by the individual because it is rich in protein, which can be a substitute for the protein in meat, as vegetarians enjoy a lower level of cholesterol in the blood compared to those who eat meat [2]. Iraq is one of the original places for the emergence of wheat and one of the countries where the success factors of its cultivation are available, but the cultivation and production of

this crop is still below the required level as the local production was (2372 tons. ha-1) in 2016 [3]. Therefore, Iraq still imports large quantities of wheat to meet its needs, and one of the reasons for this may be the lack of adoption of modern technologies in the field of crop service at critical stages of its life cycle.

The use of nutrients as a spray on the vegetative system has a significant impact on the physiological processes associated with improving the yield in terms of quantity and quality, especially organic fertilizers, including marine extract fertilizers, which have been widely used globally because they contain various mineral elements, both major and minor, as well as organic compounds and growth regulators that help in increasing the growth of plant and its yield [4].

In recent years, researchers have turned to the use of biofertilizers, as adding them to agricultural media as a biofertilizer is of great importance. The (EM1) solution is a biological preparation rich in microorganisms that works on faster decomposition of the organic matter, which leads to its availability in large quantities to the roots, as the plants treated with the biological solution have faster growth, greater leaf production and yield, less pest infestation, and more effective water and nutrient absorption processes Which helps the movement and distribution of nutrients [5]. Based on the foregoing, this study aims to identify the best concentrations of algae fertilizer and biofertilizer, and the interaction between them in improving the characteristics of vegetative growth, yield and its components of wheat under Iraqi conditions.

Materials and Methods

The experiment was carried out in the wooden canopy which belongs to the Soil and Water Department/ Technical College- Al-Mussaib/ Mashru Al-Mussaib / Babylon Governorate, during winter season of 2020, in order to know the effect of different concentrations of algae fertilizer (Biozyme TF) and bio-fertilizer (EM-1) on the growth and yield of wheat. A month before planting, soil samples were randomly taken with a depth of (0-30) cm and were analyzed in the laboratory of the Soil and Water Department Technical Collage/ Al-Musaib.

Table (1): Some chemical and physical properties of soil used for agriculture

Characteristics		The value
pH		7.6
Ec ds.m^{-1}		2.95
N mg.kg^{-1}		28.0
P mg.kg^{-1}		26.9
K mg.kg^{-1}		332
Organic matter %		0.78
Soil Structure	The sand %	43.6
	Silt %	18.4
	Clay %	38.0
Soil texture		Clay loam

Wheat seeds (Barcelona variety approved by the Ministry of Agriculture) were sown manually on (15/11/2018). The seeds were planted in plastic anvils with a diameter of 30 cm and a volume of 10 kg of soil. The anvils were filled with the soil that was prepared for them according to the treatments of the experiment, with three anvils for each experimental unit. After that, soil and crop service operations were carried out by irrigation, thinning, patching and fertilizing. The wheat plants were harvested when they reached the stage of full maturity on (3/5/2019).

Experiment design and study factors

The experiment was carried out as a factorial experiment (3 * 3) according to the Randomized Complete Block Design (RCBD) with three replicates. The experiment included two factors, the first factor was the ground application of algae extract (Bi-ozyme TF) with three concentrations of 0, 2.5, and 5 ml.L-1, while the second factor was the foliar spraying of the bio-fertilizer (EM1) 0, 1.5 and 3 ml.L-1, in addition to the interaction between them. Treatments were carried out 4 times, starting from the germination stage, and repeated every 30 days. Spraying was carried out using a 20-liter capacity hand sprayer.

Table (2): Demonstrates Biozyme TF Marine Algae Extract Ingredients●

The Substance	The Value
Plant Hormones	78.87%
IAA	32.2 ppm
GA3	32.2 ppm
Zeatin	83.2 ppm
Mineral Elements	1.86%
Magnesium Mg	0.14%
Sulfur S	0.44%
Boron B	0.30%
Iron Fe	0.49%
Manganese Mn	0.12%
Zin Zn	0.37%
Other Materials	19.20%

●Source: Arysta Life Science, the French company that produced the extract.

Studied Characteristics:

Characteristics of Vegetative Growth:

1. Plant Height (cm): It was calculated as an average of seven plants randomly from each experimental unit from the level of the soil surface to the top of the spike of the main branch without awns

2. Flag Leaf Area (cm2): It was calculated from the average of ten flag leaves of the main stems taken randomly for each experimental unit according to the following equation:
Area of the flag paper = length of the flag paper x width at the center x 0.95 [6].

3. Number of Tillers. Plant-1: The number of tillers for seven plants was determined and their average was taken for each experimental unit.
4. Spike Length (cm): The average length of seven spikes was randomly measured for the main stem from the base of the spike to the end of the terminal spike without the awns for each experimental unit.

The Characteristics of the Crop:
1. Number of Grains per Spike: It was calculated as an average number of grains of seven spikes taken randomly from each experimental unit.
2. Weight of 1000 Grains (gm): It is the average weight of 1000 grains taken randomly from the grain yield of each secondary experimental unit and weighted with a sensitive scale [7].

Statistical Analysis
The experimental was applied according the randomized complete block design (RCBD) and the average was compared according to Least Significant Deference (L.S.D) below the level of 5% by using Microsoft excel [8].

Results and Discussion
Characteristics of Vegetative Growth
1. Plant Height (cm):

The results of Table 3 showed that there were significant effects of algae fertilizer on plant height, as the concentration 5 ml.L-1 significantly exceeded the rest of the other concentrations by giving the highest average plant height of 64.50 cm, compared to the control plants that gave the lowest average plant height of 77.22 cm. Perhaps the reason for the increase achieved with the increase in the concentration of algal fertilizer is due to its content of organic acids and growth regulators, especially auxin, which leads to an increase in the number and size of cells and their elongation, in addition to the fact that it contains potassium, which is an ionic osmotic regulator that affects the opening and closing of stomata and the consequent effect on absorption of water and nutrients that activate the process of photosynthesis and increase its products, and then increase the elongation and division of cells, which leads to an increase in the height of the plant [9]. Significant impact was found in plant height by the effect of spraying with the bio-fertilizer, as the concentration of 3 ml. L-1 excelled in giving the highest average plant height of 75.76 cm superior to the rest of the other concentrations, while the comparison treatment gave the lowest average of 68.93 cm. The reason for this may be due to the role of the biological fertilizer in influencing some plant hormones that contribute to stimulating cell division and thus its elongation, as the biological fertilizer improves cells and their division through its positive effect in the process of division

and elongation, and this pushes towards an increase in the averages of metabolism and then increased manufacturing and accumulation Dry matter resulting in increased plant height. The result agreed with [10] who indicated a significant increase in the wheat plant height when sprayed with biological fertilizer. The interaction between algae fertilizer and bio-fertilizer was not significant in the height of the plant.

Table (3): Effect of algae and bio-logical fertilizer and their interaction on plant height (cm)

Bio- Fertilizer / Algae Fertilizer	0.0	1.5	3.0	Mean
0	61.97	64.63	66.91	64.50
2.5	67.56	70.43	70.64	69.55
5	77.26	81.78	89.73	82.92
Mean Bio- Fertilizer	68.93	72.28	75.76	
L.S.D 0.05	**Alga 3.5**	**Bio 3.5**	**Interaction N. S**	

Number of Tillers. Plant^{-1}

It is evident from the results of Table 4 that there were significant effects in the number of skeletons per plant by the effect of algae fertilizer, as spraying plants at a concentration of 5 ml.L-1 was superior in giving the highest average number of skeletons per plant, which amounted to 5.56 tiller. plant-1, compared to the control plants that gave the lowest average of 4.78 tiller. plant-1. The reason for the increase in the number of tiller may be attributed to the seaweed extracts containing high concentrations of potassium in addition to other nutrients, which led to activating the carbon-building process and then affecting the manufacture of carbohydrates in the leaves and their transfer to the stem, which provided nutritional support for the growth of the largest number of them and its development until the end of the season, which was positively reflected in the increase in the number of players, and this is consistent with what was mentioned [11].

Significant effects were found for the concentrations of the bio-fertilizer on the number of tillers. Plant-1, as the concentration of 3 ml. L-1 was superior by giving the highest average of the number of tillers. plant-1, which amounted to 4.94 tiller. plant-1, while the comparison treatment gave the lowest average of 5.40 tiller. plant-1. The reason for the increase may be due to the role of the biological fertilizer in increasing the effectiveness of the enzymes that play an active role in increasing the carbon metabolism process, which contributes to the manufacture of foodstuffs that improve the vegetative characteristics of wheat plants, which were at the same time with the stages of emergence and development of the tillers and ears and this led to the accumulation

and transportation of dry matter Inside the plant and then clearly reflected in the increase in the number of tiller. plant-1. This is consistent with the results obtained previously [12].

The interaction between algae and biological fertilizers had a significant effect on the number of tillers in the plant, as the combination (5 ml. L-1, 3 ml. L-1) gave the highest average which was 5.70 tiller. plant-1, while the comparison gave the lowest average in the number of skeletons, which amounted to 4.59 tiller. plant-1. The reason may be due to the increase in the activity of microorganisms that play an important role in the availability of nutrients for absorption and the provision of dry matter in the critical period of the development of the tillers and the increase in their demand for manufactured materials resulting from the net photosynthesis process, which leads to an increase in the number of tillers per plant [13].

Table (4): Effect of algae and bio-logical fertilizer and their interaction on the number of tillers Per Plant

Bio- Fertilizer / Algae Fertilizer	0.0	1.5	3.0	Mean
0	4.95	4.81	4.93	4.78
2.5	4.85	5.32	5.57	5.25
5	5.37	5.60	5.70	5.65
Mean bio fertilizer	4.94	5.24	5.40	
L.S.D 0.05	**Alga 1.11**	**Bio 1.11**	**Interaction 1.92**	

Flag Leaf Area cm^2

It is clear from Table 5 that there were significant effects on the area of the flag leaf as a result of spraying plants with algal fertilizer, where the concentration (5 ml.L-1) was significantly superior to the rest of the other concentrations by giving the highest average for the area of the flag leaf that reached 36.86 cm2 compared to the control plants that gave the lowest rate of 31.84 cm2. This may be due to the fact that seaweed extracts contain Zn, an element that encourages branch elongation and leaf size increase through its role in building the amino acid tryptophan, which is the initiator of the building of auxin, which increases cell division and elongation, as well as containing major elements such as potassium, nitrogen, and phosphorous, as well as their containing amino acids, all of which together lead to an increase in the content of chlorophyll through the growth of leaves and the increase in cell division and expansion, which is reflected positively on the increase in the area of the flag leaf [14].

The concentrations of the bio-fertilizer significantly affected the area of the flag leaf, as the concentration (3 ml.L-1) was significantly superior to the rest of the other concentrations in giving the highest average of the area of the flag leaf reached 35.44 cm2, while the comparison treatment gave the lowest average of 33.20 cm2 (Table 5). The reason may be that the bio-fertilizer played an important role in increasing the growth indicators and the content of elements in the leaves, because it includes a compatible group of beneficial microorganisms [15], which, in turn, increases metabolism products and the effectiveness of enzymes that contribute to the absorption of nutrients by the plant, which affects the increase in cell division, which is reflected in the expansion and increase in the area of the flag leaf [16].

The interaction between the two factors of the study had a significant effect on the area of the flag leaf as the plants treated with (5 ml.L-1 + 3 ml.L-1) gave the highest average of 38.52 cm2, while the comparison treatment gave the lowest average of 29.45 cm2 (Table 5). The reason may be due to the role of algal fertilizer in increasing the activity of microorganisms contained in the biofertilizer, which helps to form humus, which is a complex structure that leads to an increase in the exchange capacity of the soil. Bacteria also work to fix atmospheric nitrogen, which leads to an increase in the nitrogen content in the soil, which plays an important role in increasing the efficiency of the photosynthesis process. Microorganisms also secrete growth regulators such as cytokinins, auxins and gibberellins that stimulate cell formation and division, which leads to an increase in leaf area and the number leaves [17].

Table (5): Effect of algae and bio-logical fertilizer and their interaction on the area of flag leaf (cm^2)

Bio- Fertilizer / Alga extract	0.0	1.5	3.0	Mean
0	29.45	32.44	33.64	31.84
2.5	34.49	35.33	34.18	34.67
5	35.68	36.37	38.52	36.86
Mean Fertilizer	33.20	34.72	35.44	
L.S.D 0.05	**Alga 1.5**	**Bio 1.5**	**Interaction 2.6**	

The Spike Length (cm):

The results of Table 6 indicated that there were significant effects of plants treated with algae fertilizer on spike length, where the concentration (5 ml.L-1) outperformed the rest of the other concentrations by giving the highest rate of 11.65 cm, while the comparison treatment gave the lowest average of 10.38 cm. The reason for the increase in the length of the spike may be attributed to the time of spraying algae fertilizer, which created conditions that reduced the competition between the fast-growing spike for this stage on the one hand, and the growth of other plant organs such as leaves and stems on the other hand, by increasing the effectiveness of photosynthesis in providing the products of carbon metabolism during the short period that preceded the stage of emergence and development of the spike, which coincides with the early growth stages of the plant's life, such as branching and elongation, which is one of the largest developmental stages in the life of the wheat crop, which was positively reflected in the increase in the length of the spike [18].

Significant differences were found in the effect of spraying with different concentrations of the bio-fertilizer in the length of the spike, where the concentration (5 ml.L-1) was significantly superior to the other concentrations, as it gave the highest rate of 11.21 cm, while the control treatment gave the lowest average of 10.57 cm (Table 6). The reason may be attributed to the fact that spraying the bio-fertilizer created a better incentive for the growth and development of the spike as a result of the availability of continuous food supply, and on the other hand, the role of these nutrients in raising the efficiency of the photosynthesis process, which encouraged better growth of the spike, which was clearly reflected in the increase in its length and the availability of appropriate environmental conditions before the stage The spikes reduced the competition between the spike and other plant parts for nutrients, which was reflected in the increase in spike length (10). The interaction between algae fertilizer and biofertilizer was not significant in the length of the spike.

Table (6): Effect of algae and bio-logical fertilizer and their interaction on the spike length (cm)

Bio fertilizer / Alga extract	0.0	1.5	3.0	Mean
0	10.08	10.45	10.61	10.38
2.5	10.45	11.29	10.94	10.89
5	11.18	11.70	12.08	11.65
Mean Bio- Fertilizer	10.57	11.15	11.21	
L.S.D 0.05	**20.4 Alga**	**0.42 Bio**	**Interaction N. s**	

Yield Characteristics

1. Number of the Grains of the Spike

The results of Table 7 showed that there were significant effects of plants treated with algae fertilizer on the number of grains in the spike, where the concentration (5 ml.L-1) was superior to the rest of the other concentrations by giving the highest average of (65.91) grains. spike-1, while the comparison treatment gave less average (55.07) grain.spike-1. The reason for the increase in the number of grains. spike -1 may be attributed to the components of algae fertilizer from major elements, including potassium and minor, including boron, and growth regulators, including cytokinin, which helped in the formation, pollination and fertilization of flowers, and then increased the number of grains grain.spike-1. This is consistent with what was found by [19].

Significant differences were found for spraying with different concentrations of the bio-fertilizer on the number of grains in the spike, where the concentration (3 ml. L-1) was significantly superior to the rest of the other concentrations, as it gave the highest average (62.78) grains. spike-1, while spraying plants in the comparison treatment gave less average (59.85 grain. Spike-1 (Table 7). The reason for the increase is physiological reasons as a result of the increase in the products of carbon metabolism resulting from the components of bio-fertilizer, which causes an increase in the number of flowers for each plant and an increase in the area of the flag leaf (Table 5), which was positively reflected in the increase in the number of grains in the spike [20].

The interaction between the algal extract and the bio-fertilizer significantly affected the number of grains in the spike, as the combination (5 ml.L-1- algae fertilizer + 3 ml. L-1 bio-fertilizer) gave the highest average of (67.70) g, while spraying the control treatment gave the lowest average reached (53.33) g (Table 7).

Table (7): Effect of algae and bio-logical fertilizer and their interaction on the number of the grain per spike

Bio fertilizer / Alga extract	0.0	1.5	3.0	Mean
0	53.33	54.59	57.29	55.07
2.5	61.66	63.57	63.36	62.86
5	64.57	65.45	67.70	65.91
Mean Bio- Fertilizer	59.85	61.20	62.78	
L.S.D 0.05	**Alga 1.082**	**Bio 1.082**	**Interaction 2.16**	

2.The Weight of 1000 Grain

The results of Table 8 indicated that there were significant effects of spraying with algae fertilizer on the weight of 1000 grains, as the concentration (5 ml.L-1) was

superior to the rest of the other concentrations by giving the highest average of (38.53g), while the comparison treatment gave the lowest average of (30.75 g). The reason for this increase can be attributed to the addition of algae fertilizer and its contents and its effect on increasing the area of the flag leaf (Table 5), and then increasing the efficiency of the photosynthesis process, which was reflected in the increase in manufactured materials, especially carbohydrates, in addition to the role of potassium in transferring manufactured materials in leaves (source) to grains (downstream), which reflected positively on the weight of the grains [21].

Significant differences were found as a result of spraying with different concentrations of the bio-fertilizer on the weight of 1000 grains, where the concentration (3 ml.L-1) was significantly superior to the rest of the other concentrations and gave the highest average (36.34g), while spraying plants in the comparison treatment gave the lowest average (32.63g). The reason may be attributed to the fact that spraying with bio-fertilizer led to an increase in the area of the flag leaf (Table 5) and this positively affected the prolongation of the leaf's vitality and carrying out the photosynthesis process, which allowed the photosynthesis products to move towards all ears to fill the grain, which contributes to increasing the weight of the grain. Moreover, the addition of the bio-fertilizer has a role in increasing the effectiveness of the vital enzymes that have a role in activating the effectiveness of the downstream in receiving manufactured materials, and this result agreed with [22 and 23].

The interaction between the study factors had a significant effect on the weight of 1000 grains, as the combination (5 ml.L-1 algal fertilizer + ml.L-1 biofertilizer) gave the highest average amounted to (40.37g), while the spraying of plants in the comparison treatment gave the lowest average reached (27.67 g).

Table (8): Effect of algae and bio-logical fertilizer and their interaction on the weight of 1000 grains gm

Bio fertilizer / Alga extract	0.0	1.5	3.0	Algae Extract
0	27.67	31.64	32.96	30.75
2.5	33.33	35.90	35.69	34.97
5	36.90	38.32	40.37	38.53
Bio mean	32.63	35.29	36.34	
L.S.D 0.05	**Alga 0.426**	**Bio 0.426**	**Interaction 0.841**	

It could be concluded from the current study that it became necessary to add algae extract and bio-fertilizer to wheat plant fertilization because they boost the growth characteristics because they contain major nutrients elements such as nitrogen ,

phosphorus , potassium and micro nutrients such as iron , zinc, magnesium, manganese, and other elements , as well as containing growth regulators such as auxins, cytokines and gibberellins which in turn contribute to increasing cell division and the activity of bio activity of the plant and its reflection on the increase of yield components such as the number of grains , per spike and the weight of the grain.

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