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Effect of Biofertilizers on the Growth and Yield of Wheat Grown Under Water Stress

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Abstract: The experiment was conducted on one of the farms in Babylon Governorate, the Nile region, during the winter agricultural season 2021-2022, to grow the wheat crop, TritiSum aestivum. To study the effect of water stress and biofertilizers on wheat growth, the experiment included two factors, the first being water stress. Where the irrigation was conducted taking into account the non-mixing of the irrigation water between the experimental units due to the different additions to each experimental unit. The second factor included the biofertilizers (Azotobacter chroococcum, mycorrhiza and Trachoderma fungus) in addition to the control treatment and symbolized by the symbol (F0, F1, F2 ,F3) a completely randomized block design (RSBD) by arranging the factorial experiments with two factors and the same importance for all treatments (Factorials Experiments and calculating the differences between the averages of the values by the Least Significant Difference (LSD) test at the probability level of 0.05. The results are as follows: F2 treatment was significantly excelled and gave the highest values for traits of plant height 67.53cm, grain yield 4.68 Mg.ha^{-1}, weight of 1000 grains 28.38 g, percentage of nitrogen, phosphorus and potassium in the leaves(2.61,1.11,3.38%). S0 and S2 treatments excelled and recorded the highest values for most of the studied traits. The interaction treatment of F2*S0 recorded significantly higher values for traits plant height 68.85cm, grain yield 5.26 Mg.ha^{-1}, weight of 1000 grains 29.54 g and The interaction treatment of F2*S2 recorded significantly higher values for traits percentage of nitrogen, phosphorus and potassium in the leaves(2.91,1.41,3.80)%

Keyword: water stress, biofertilizers, TritiSum aestivum

1. INTRODUCTION

The wheat crop (Triticum aestivum L.) is one of the most important grain crops in the world, and due to its extreme importance in alleviating the food requirements of the population, Iraq imports more than two-thirds of its need for wheat grains to feed its population, while local production covers about the remaining third of that need (FAO Arab for Agricultural Development, 2001).The crop faces the dangers of low productivity in the yield of a dunam (unit of area), which is due to the practice of old traditional methods and the failure to introduce modern scientific technologies in a wider way in the field of production. Therefore, thinking of new means that achieve this goal and increase the yield per unit area has become necessary, and among these means is the use of The technique of plant growth regulators, and it is now one of the common methods in modern agriculture, and among the widely used growth regulators is a group of compounds known as growth retardants. The addition of bacterial biological fertilizers is one of the modern techniques that were followed to reduce the excessive use of chemical fertilizers, which can be defined That it is all the additions of a biological source, which are called microbial inoculants, and if the soil is treated with it, it colonizes the areas surrounding the roots and stimulates plant growth by supplying the plants with their nutritional needs, including what they convert from the elements (in their vital activity) from their unready forms to their ready ones. For absorption as well as supplying them with substances that encourage and stimulate plant growth such as hormones and growth regulators, and fix atmospheric nitrogen through their symbiotic living, which contributes to reducing the use of chemical fertilizers. Auxins (Ghaderi et al2012).Iraq is currently suffering from a scarcity of water resources and is globally classified among the dry desert-hot countries in the Arid desert hot region, especially after the decline in water levels in the Tigris and Euphrates rivers as a result of the work of dams in Turkey, as well as the poor use of water resources in agriculture by following the inaccurate method in managing the number of Irrigation during the growing season, which requires finding scientific solutions to rationalize water and using it properly in agriculture and discovering new techniques that enable the crop to bear the 'water shortage', and that one of the most important methods of good water management is controlling the number of irrigations in each season by determining the period between one irrigation and another. Musa et al. (2005) mentioned that the irrigation period of 7 and 14 days led to an increase in the total dry matter yield of the wheat crop compared to the irrigation period of 21 days.The research aims to study the effect of biofertilizers on the growth of wheat grown under water stress.

2. MATERIALS AND METHODS

The experiment was conducted on one of the farms in Babylon Governorate, the Nile region, during the winter agricultural season 2021-2022, to grow the wheat crop, TritiSum aestivum. To study the effect of water stress and biofertilizers on wheat growth, the experiment included two factors, the first being water stress. Where the irrigation was conducted taking into account the non-mixing of the irrigation water between the experimental units due to the different additions to each experimental unit. The second factor included the biofertilizers (azotobacter chroococcum , mycorrhiza and Trachoderma fungus) in addition to the control treatment and symbolized by the symbol (F0, F1, F2 ,F3) Bacterial and fungal inoculums were obtained from the Department of Agricultural Research at the Ministry of Science and Technology, and a sample was taken to conduct physical and chemical analyzes of the soil before planting. The analysis was conducted in the laboratories of the College of Science, University of Babylon, and the results of the analysis are recorded in Table (1).

Table 1 physical and chemical properties of field soil

field initialization

The experimental land was prepared by plowing the land with two by perpendicular tillage by Moldboard plows smoothing it with the disc harrow plow, leveling the field, then dividing the field into three sectors, leaving a 2m interval between one sector and another.Each sector was divided into 12 experimental units with dimensions (2 x 3) m. The study coefficients were randomly distributed to each sector. The experimental unit included 6 lines of 3 meters in length and a planting distance of 20 cm between the lines.

3-4. Studied traits:

plant height (cm)

It was measured from the surface of the soil to the end of the spike, and the height was calculated as an average of the plants taken from the experimental unit, and the average was extracted.

Determination of the nitrogen, phosphorus and potassium content of the leaves

The nitrogen, phosphorus and potassium content of the leaves were estimated during the flowering stage according to the method described by LabetowiSz (1988).

weight of 1000 grain(gm)

1000 grains were counted manually, then the grains were weighed with a sensitive scale, and the average was calculated for each treatment in the experimental unit.

grain yield

It was calculated by harvesting three midlines from each experimental unit and converted on the basis of ton.ha-1 and according to the following equation:

The product of multiplying the grain rate per plant × the plant density used per hectare

3-4.Experimental Design

The data were analyzed using the Genstat program for statistical analysis with a completely randomized block design (RSBD) by arranging the factorial experiments with two factors and the same importance for all treatments (Factorials Experiments (Al-Sahuki and Wahib, 1990) b2 and calculating the differences between the averages of the values by the Least Significant Difference (LSD) test at the probability level of 0.05.

3. RESULTS AND DISCUSSION

plant height (cm)

The results of table (2) showed that biofertilization had a significant effect on the plant height (cm) of wheat plants. F2 treatment achieved the highest average plant height of 67.53cm F0 treatment recorded the lowest plant height of 62.40cm.The water stress treatment (S0) was significantly higher than the rest of the other treatments and gave the highest average plant height of 66.28cm, followed by the S1 treatment, which gave a plant height of 64.67cm, while the treatment (S2) recorded the lowest plant height of 64.17cm.The results of table (2) showed that the interaction treatment (F2 *S0) was significantly excelled to the rest of the other interaction treatments and gave the highest plant height of 68.85cm, while the interaction treatment (F0S2) gave the lowest plant height of 61.18cm.

Table 2. Effect of water stress and biofertilization and their interaction on plant height (cm)

average Biofertilizers	**water stress(S(**			**Biofertilizers**)F(
	S2	**S1**	**S0**	
62.40	61.18	62.51	63.51	**control)F0(**
64.56	63.55	64.10	66.04	**Azotobacter**) F1(
67.53	67.08	66.66	68.85	**F2) mycorrhiza**
65.66	64.87	65.41	66.71	**trachoderma**)F3(
	64.17	64.67	66.28	**water stress average**
SF= 0.3704		**F= 0.1492**	**S= 0.2162**	**LSD 0.05**

grain yield (Mg.ha^{-1})

The results of Table (3) showed that biofertilization had a significant effect on grain yield (Mg.ha^{-1}), The results showed that F2 treatment was significantly excelled and gave the highest grain yield of 4.68Mg.ha^{-1}, while the F0 treatment recorded the lowest grain yield of 3.65Mg.ha^{-1}.The results also showed that the water stress had a significant effect on the characteristic of grain yield. The water stress treatment (S0) recorded the highest rate of grain yield amounting to 4.73Mg.ha^{-1}, while the treatment (S2) recorded the lowest grain yield amounted to 3.75Mg.ha^{-1}1.The results of Table (3) showed that the bi-interaction between biofertilization and water stress had a significant effect on increasing the grain yield Mg.ha^{-1},The interaction treatment (F2* S0) was significantly excelled to the rest of the other interaction treatments and gave the highest grain yield of 5.26Mg.ha^{-1}, while the interaction treatment (F0S0) gave the lowest grain yield of 3.28Mg.ha^{-1}.

Table 3. Effect of water stress and biofertilization and the interaction between them on grain yield (Mg.ha^{-1})

average Biofertilizers	**water stress(S(**			**Biofertilizers**)F(
	S2	**S1**	**S0**	
3.65	3.28	3.61	4.05	**control)F0(**
4.18	3.90	3.96	4.68	**Azotobacter**) F1(
4.68	4.25	4.52	5.26	**F2)mycorrhiza**
4.21	3.55	4.17	4.91	**trachoderma**)F3(
	3.75	4.07	4.73	**water stress average**
SF= 0.24		**F= 0.15**	**S= 0.12**	**LSD 0.05**

Weight of 1000 grains (gm)

The results of table (4) showed that biofertilization had a significant effect on the weight of 1000 grains (gm). The results showed that F2 was significantly excelled and gave the highest average weight for 1000 grains, which amounted to 28.38gm, followed by treatment F1, which gave an average weight of 1000 grains amounted to 26.88 gm. While the F0 treatment recorded the lowest, the weight of 1000 grains was 26.13g.The results also showed that water stress had a significant effect on the weight of 1000 grains. The water stress treatment (S1) gave the highest average weight of 1000 grains, amounting to 29.02 gm, while the treatment (S2) recorded the lowest weight of 1000 grains, amounting to 24.88 gm.The results of table (4) showed that the bi-interaction between biofertilization and water stress had a significant effect on increasing the weight of 1000 grains.The interaction treatment (F2* S0) was significantly excelled to the rest of the other interaction treatments and gave the highest weight of 1000 grains, reaching 29.54 gm, while the interaction treatment (F0S0) gave the lowest weight of 1000 grains, amounting to 24.27gm.

Table 4. The effect of water stress and biofertilization on the weight of 1000 grain (g)

average Biofertilizers	**water stress(S(**			**Biofertilizers**)F(
	S2	**S1**	**S0**	
26.13	24.27	27.70	26.41	**control)F0(**
27.56	24.75	29.63	28.30	**Azotobacter**) F1(
28.38	25.91	29.70	29.54	**F2)mycorrhiza**
27.20	24.60	29.05	27.96	**trachoderma**)F3(
	24.88	29.02	28.05	**water stress average**
SF= 0.6807		**F= 0.5821**	**S= 0.2796**	**LSD 0.05**

Nitrogen content in plant (%)

The results of table (5) showed that biofertilization had a significant effect on the nitrogen content in the plant (%). The results showed that the F2 treatment (Mycorrhiza) was significantly excelled and gave the highest nitrogen content in the plant, which amounted to 2.61 %.Followed by treatment F1, which gave a nitrogen content of 2.53 %, while treatment F0 recorded the lowest nitrogen content of 2.05 %.The results also showed that the water stress had a significant effect on the nitrogen content in the plant. The water stress treatment (S2) was significantly excelled to the rest of the other treatments and gave the highest rate of nitrogen content in the plant, which amounted to 2.99 %, followed by the S1 treatment, which gave a nitrogen content of 2.35 $Mg.ha^{-1}$, while the control treatment (S0) recorded the lowest nitrogen content of 1.92 %. that the bi-interaction between biofertilization and water stress had a significant effect on increasing the nitrogen content in the plant.The interaction treatment (F1S2) was significantly excelled to the rest of the other interaction treatments and gave the highest nitrogen content in the plant amounted to 3.75 %, while the interaction treatment (F0S0) gave the lowest nitrogen content in the plant amounting to 1.68 %

Table **5**. Effect of water stress and biofertilization and the interaction between them on plant nitrogen content (%)

average Biofertilizers	**water stress(S(**			**Biofertilizers**)F(
	S2	**S1**	**S0**	
2.05	2.50	1.97	1.6823	**control)F0(**
2.53	3.75	1.94	1.9	**Azotobacter**) F1(
2.61	2.91	3.13	1.78	**F2)mycorrhiza**
2.49	2.79	2.363	2.305	**trachoderma**)F3(
	2.99	2.35	1.92	**water stress average**
SF= 0.48		**F= 0.27**	**S= 0.35**	**LSD 0.05**

Phosphorus content in plants ($mg.kg^{-1}$)

The results of table (6) showed that biofertilization had a significant effect on the phosphorus content in the plant (%). The results showed that treatments (Mycorrhizae) significantly excelled, and it gave the highest phosphorus content in the plant, which reached 1.11%, respectively, while the phosphorus content in the plant decreased in the control treatment F0, which recorded 0.55%, and the water stress treatment (S2) was significantly excelled on the rest of the other treatments and gave the highest rate of phosphorus content in the plant, which reached 1.49 %, while the control treatment (S0) recorded the lowest phosphorus content of 0.42%.The results of table (6) showed that the interaction between biofertilization and water stress had a significant effect on increasing the phosphorus content in leaves, where the interaction treatment (F1S2) gave the highest phosphorus content in the plant amounted to 2.25 %.

Table 6. Effect of water stress and biofertilization and the interaction between them on plant phosphorus content ($mg.kg^{-1}$)

average Biofertilizers	**water stress(S(**			**Biofertilizers**)F(
	S2	**S1**	**S0**	
0.55	1.00	0.47	0.18	**control)F0(**
1.03	2.25	0.44	0.40	**Azotobacter**) F1(
1.11	1.41	1.63	0.28	**F2)mycorrhiza**
0.99	1.29	0.86	0.81	**trachoderma**)F3(
	1.49	0.85	0.42	**water stress average**
SF= 0.06		**F= 0.04**	**S= 0.02**	**LSD 0.05**

Potassium content in the plant (%)

Table (7) showed that biofertilization had a significant effect on the potassium content in the plant (mg.kg-1). The results showed that the F2treatment was significantly excelled and gave the highest potassium content in the plant amounting to 3.38%, while the F0 treatment recorded the lowest potassium content of 2.99%.The results also showed that the water stress had a significant effect on the potassium content in the plant. The water stress treatment (S2) was significantly excelled on the rest of the other treatments and gave the highest mean of the potassium content in the plant, which amounted to 3.65%, while treatment (S0) recorded the lowest potassium content of 2.88%While the results of table (6) showed that the bi-interaction between biofertilization and water stress had a significant effect on increasing the potassium content in the plant, the interaction treatment (F1S2) was significantly excelled on the rest of the other interaction treatments and gave the highest potassium content in the plant amounted to 3.9%

Table 7. The effect of water stress and biofertilization and the interaction between them on potassium content in plants %

average Biofertilizers	**water stress(S(**			**Biofertilizers**)F(
	S2	**S1**	**S0**	
2.99	3.20	3.20	2.56	**control)F0(**
3.21	3.9	2.90	2.83	**Azotobacter**) F1(
3.38	3.80	3.58	2.75	**F2)mycorrhiza**
3.52	3.7	3.5	3.37	**trachoderma**)F3(
	3.65	3.29	2.88	**water stress average**
SF= 0.06		**F= 0.04**	**S= 0.02**	**LSD 0.05**

The results showed that biofertilizers had a significant effect on increasing plant height, grain yield, and weight of 1000 grains. Through its fixation of atmospheric nitrogen and the dissolution of insoluble phosphorus, and its importance lies through its secretion of some organic acids with low molecular weights, which work to reduce the degree of pH, which increases the readiness of the microelements needed by the plant and thus improves plant growth, and this is consistent with its findings. (Mahato et al2018)

And that the increase in the weight of 1000 grains is due to the influential role of fungi used in the experiment in increasing the leafy area of the plant, which was positively reflected in the increase in carbon metabolism within the leaves, which reinforced the process of moving the manufactured materials from the leaves to their storage places in the grains, this result was confirmed by many researchers(Hassan, and Bano 2016).). The increase in yield is due to the activity of bacteria through the production of some enzymes and organic acids, which work to increase the readiness of macro and micro elements, especially nitrogen, phosphorus and potassium, and thus the availability of it increases in the soil, and this will be reflected in the increase in the absorption of it by the roots of the plant and fill its nutritional needs as Each of these elements has a vital role in the metabolic processes, through its formation of energy compounds or its role in the process of transporting carbohydrates from the areas of their synthesis to the storage area, and this is what increases the weight of the grain and thus the total yield of the plant (Chegini et al., 2015)The decrease in grain yield under water stress levels is attributed to the decrease in the amount of materials transported and stored in the grain. This is due to the role of stress in reducing the stages of growth and forcing the plant to complete its life cycle and produce grain within a short period of time due to the low percentage of water available to the plant inside the soil, and this is what urges the plant To increase the growth of the roots in order to search for moisture, and this is what works to deplete most of the energy produced in the vegetative system, and this affects the components of the yield, in addition to the effect of water stress on delaying the emergence of silk from the head of the ear and to the almost complete fall of pollen under these conditions, and it may be due The reason for this is the lack of solubility of some nutrients, which have the ability to increase plant resistance to stressful conditions, which leads to a sharp decrease in yield, and this result is consistent with what was indicated by (Bangash, et al 2021)And that the reason for the decrease in plant height with the increase in the levels of stress may be due to the decrease in the moisture content of the soil with the increase in the levels of stress, and this may affect the movement of nutrients inside the soil as well as the influential role of water in the vital processes that take place inside the plant, so the decrease in the water supply of the plant from the soil will It leads to a cellular water deficit that affects the process of cell division and its elongation for each of the stem and leaf cells and their small size. This reduces the efficiency of intercepting and converting light energy into carbon compounds from which dry matter is produced, as well as inhibiting the synthesis, transmission and metabolism of the plant hormone oxygen, which is responsible for stimulating growth. vegetative as a result of increased levels of active oxygen roots and thus affected the height of the growing plant in light of the limited irrigation water and this is consistent with what was mentioned (Kachroo, and Razdan, 2006).

4. REFERENCES

[1] Ghaderi-Daneshmand, N., Bakhshandeh, A., & Rostami, M. R. (2012). Biofertilizer affects yield and yield components of wheat. *International Journal of Agriculture: Research and Review*, *2*(6), 699-704.

[2] Musa , L.M., E.M. Abd El Malik , M.E. Hamed and A.A.Salih. 2005. Effects of irrigationinterval, nitrogen and phosphorus on grain yield and blomass of wheat . Gezira Journal of Agricultural Science. (Sudan). 3 (1): 24-31.

[3] FAO. FAO Cereal Supply and Demand Brief. Retrieved on December 20, 2019, from http://www.fao.org/worl dfoodsituation/csdb/en/

[4] Labetowicz, J. (1988). The Chosen of analyzed Method of Soil, Plant and Fertilizer. Editor: SGGW-AR Warszawa, Poland, 119-123.

[5] Al-Sahoki, Medhat Majeed and Karima Muhammad Wahb. (1990). Applications in Design and Analysis of Experiments. Ministry of Higher Education and Scientific Research. Dar Al-Hikma for Printing and Publishing. Iraq.

[6] Mahato, S., Bhuju, S., & Shrestha, J. (2018). Effect of Trichoderma viride as biofertilizer on growth and yield of wheat. *Malays. J. Sustain. Agric*, *2*(2), 1-5.

[7] Hassan, T. U., & Bano, A. (2016). Biofertilizer: a novel formulation for improving wheat growth, physiology and yield. *Pak. J. Bot*, *48*(6), 2233-2241.

[8] Chandra, S., Askari, K., & Kumari, M. (2018). Optimization of indole acetic acid production by isolated bacteria from Stevia rebaudiana rhizosphere and its effects on plant growth. *Journal of Genetic Engineering and Biotechnology*, *16*(2), 581-586.

[9] Bangash, N., Mahmood, S., Akhtar, S., Hayat, M. T., Gulzar, S., & Khalid, A. (2021). Formulation of biofertilizer for improving growth and yield of wheat in rain dependent farming system. *Environmental Technology & Innovation*, *24*, 101806.

[10] Kachroo, D., & Razdan, R. (2006). Growth, nutrient uptake and yield of wheat (Triticum aestivum) as influenced by biofertilizers and nitrogen. *Indian Journal of Agronomy*, *51*(1), 37-39.