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Relationship between Bacterial Bio-Fertilization at Different Levels of Plowing Depths and Some of Soil Physical Characteristics, Growth and Yield af Wheat Crops (*Triticum astivum L.*)

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Abstract

Abstract:

The study included the implementation of a factorial field experiment at the agricultural extension station affiliated with the Agricultural Extension Department in the Warka District, located north of Al-Muthanna Governorate, during the winter season 2022-2023. The soil texture of the field was loamy clay soil and the wheat variety was Research 22. The factorial experiment was designed according to the split-plot arrangement and (RCBD) design with three replications. The first factor represents the biological inoculum with *B. subtilis* and *B. megaterium* bacteria, with four levels, B0 without the addition of the inoculum, B1 with *B. megaterium* bacteria, and B2 with *B. subtilis* bacteria, and the fourth treatment, B3, included the double inoculum B1 + B2, and the second factor represents plowing depths with four levels, D1 represents zero plowing depth, D2 represents 10 cm plowing depth, D3 represents 20 cm plowing depth and D4 represents 30 cm plowing depth. The results showed the following. The results showed that the plowing depth D4 was superior to the control treatment and recorded the highest values in both plant height (100.74 cm) and moisture content was 41.26, 15.59 % in both flowering and harvesting stages respectively, while the depth D3 recorded a significant superiority in the weight of 1000 grains (49.14 gm). The B3 bacterial inoculum addition treatment was significantly superior to the control treatment.The highest values were recorded for plant height, weight of 1000 seeds, and moisture content in the harvest and flowering stages .The values were 100.26 cm, 46.63 g, 13.25%, 31.91% respectively. The results of the statistical analysis showed that the interaction treatment of the

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bacterial inoculum and plowing depth D4B1 was superior in plant height, the D3B2 treatment increased in the weight of 1000 seeds, and the D3B3 treatment was superior in moisture content for the flowering and harvesting stages. The values were 104.09 cm, 54.76 g, 44.35% and 17.50% respectively.

Key words: Wheat, plowing depth, tillage, bacterial inoculum

Introduction:

The continuous deterioration of the Earth's natural resources and the increased use of chemical fertilizers that pollute soil and water represent a major concern for the future of agriculture. Therefore, biofertilizers play a major role in reducing these risks and increasing crop productivity by increasing soil fertility in the long term, as these fertilizers can Vitality enhances the growth of plants and crops and provides them with the nitrogen, phosphorus, zinc and other essential nutrients required for growth [1]. Bacterial biofertilizers are bacterial cells that dissolve nutrients such as phosphorus and potassium from minerals and rocks containing these elements. The effectiveness of the organisms used as biofertilizers varies in that they are phosphorous-dissolving, such as bacteria (*Bacillus spp*. *Peudomonas spp, Arthobacter ssp, Streptomyces spp*), or potassium-dissolving, such as (*Pseudomonas spp, B.circulans*) [2].

Tillage is one of the necessary agricultural operations because of its benefits, as it performs several operations, the most important of which are loosening and softening the soil and increasing ventilation in order to obtain a suitable bed for the seed to germinate correctly. Plowing also has a role in turning over the remaining plants in the soil and also getting rid of harmful weeds for the crops [3]. Tillage also improves the physical, chemical and biological properties of the soil, which leads to root growth and thus affects the hydraulic properties of the soil, which in turn affects the kinetic properties of irrigation water in the cultivated field [4]. In general, tillage improves the bulk density of the soil, and deep tillage practices reduce the bulk density of the soil and thus, the soil becomes more porous for optimal plant growth [5].

Therefore, this study aimed:

1- To Study the effect of adding an isolate of the bio-inoculum on the growth and yield of wheat.
2- To Study the effect of plowing depths on some properties of the soil.
3- To study the effect of the interaction between adding bio-inoculum and tillage depths on some properties of the soil and the plant..

Materials and Methods

A field experiment was carried out during the winter season (2022-2023) at the extension station of the Agricultural Extension Department/Ministry of Agriculture in the Warka District Center (15 km north of Muthanna Governorate) within a latitude (N31.469188) and longitude (E45.281100) with the aim of studying the role of the bio-inoculum. *Bacillus megaterium* and *Bacillus subtilus* affect the physical properties of the soil under different levels of tillage depths and the growth and productivity of wheat plants. The experiment was designed according to a split plot arrangement and randomized complete block design (RCBD) design, using two experimental factors and three replications.

Field experiment factors

The first factor

Biofertilizers of four types have the following symbols:

B0 without the addition of bacterial inoculum

B1 = Addition of *Bacillus megaterium* vaccine

B2 = Addition of *Bacillus subtilis* vaccine

B3 = Add *Bacillus subtilis* + *Bacillus megaterium* vaccine

The second factor

Tillage depths (four depths from the soil surface):

D1=0cm

D2=10cm

D3 = 20cm

D4=30cm

Three replicates were made, so that the number of experimental units became 4 x 4 x 3. 48 experimental units. The experiment was applied in a completely randomized block design (RCBD) according to the split plot design, where the first factor was the bacterial inoculum, represented by the secondary panels, and the second factor was the tillage depths, represented by the main panels.

Studied Measurements

Plant height (cm)

The height of ten randomly selected plants from each experimental unit was measured, starting from the soil surface to the bottom, using a measuring tape[6].

Weight of 1000 grains (g)

Quantities of grain yield were taken from the experimental units at random and weighed with a sensitive electronic balance.

Moisture content

The moisture content of the soil was measured at the stage before planting, flowering, and harvesting using the gravimetric method. The soil was weighed and then dried in the oven at a temperature of 105 degrees Celsius until the weight was constant. The percentage was calculated on the basis of dry weight [7].

Pw =Mw/Ms x100

Where:

Pw= Percentage of soil moisture based on dry weight (%)

Mw = Weight of moisture in the soil (g)

Ms = Weight of dry solid particles (g)

Counting of bacteria

The method of dilution and plate counting was used to estimate the numbers of bacteria by growing them on Nutrient Agar medium[7].

Table (1) Some chemical and physical characteristics of the soil before planting

Value	Unit	Adjective
7.7	-	Soil ph
4.8	ds m-1	Electrical conductivity (Ece)
17	%	Moisture Content
1.31	Mgm-3	Bulk Density
2.67	Mgm-3	Particles Density
50.936	%	Porosity
Silty loam	-	Texture
5.7×10^{8}	Cfu g-1 dry soil	Total of bacteria
1.2×10^{3}		B.megtarum
2.4×10^{3}		B. subtilis

Statistical analysis

The experiments were designed according split block arrangement and randomized complete block design (RCBD) to study the effects of plowing and *B.megtarum* and *B. subtilis* inoculums and interactions among the treatments. The means were compared using the least significant difference test (LSD Test) at the probability level of 0.05[8].

Results and Discussion

Plant height (cm)

It is clear from the statistical analysis table (1) that there are significant differences in the height characteristic of wheat plants inoculated with biological inoculation with *B. megaterium* and *B. subtilus* bacteria, where the highest rate was recorded in the double pollination treatment B3, amounting to 100.26 cm, and the percentage increase was 10.57% compared to the double pollination treatment B3. Comparison B0 gave the lowest rate of 90.67 cm. The reason for the superiority of the inoculated treatments over the non-inoculated treatment may be attributed to the role of bacteria in providing phosphorus through their secretion of organic acids, in addition to their secretion of growth-regulating substances such as indole, phenol, gibberellin, and cytokines, which in turn work to stimulate growth. Plant by increasing cell growth and division and increasing the growth of root hairs, which increases their effectiveness in absorbing nutrients, which leads to an increase in the height of the plant. These results are consistent with [9][10].

The results in Table (1) showed that soil plowing depths had a significant effect on the height of wheat plants, the D4 and gave the highest average of 100.74 cm, and did not differ significantly from depth D3, which gave an average of (99.72 cm), and differed significantly with depth D2, where Its average was 96.50 cm, while the comparison treatment D1 gave the lowest average of 91.33 cm. The percentage increase was 9.41%. The reason is due to increasing the depth, which led to the roots spreading easily in the soil and increasing the size of the root system, which reflects positively on the increase in the growth of the vegetative system and thus it led to the elongation of the internodes and then the elongation of the plant stem. These results are consistent with the results obtained by.[11][12].

Table (1) The effect of bacterial bioinoculum, plowing depths, and their interaction on plant height values (cm).

Mean B	4	3	2	1	D / B
90.67	95.55	95.96	90.23	80.97	0
98.91	104.09	100.09	100.24	91.23	1
98.43	99.90	100.81	100.41	92.62	2
100.26	103.44	102.00	95.12	100.49	3
	100.74	99.72	96.50	91.33	Mean D
D*B= 3.258		D=1.722	B=1.653		L.S.D(0.05)

Weight of 1000 grains (g)

It is clear from the statistical analysis table (2) that there are significant differences in the height characteristic of wheat plants inoculated with biological inoculation with *B. megaterium* and *B. subtilus* bacteria, where the highest rate was recorded in the double pollination treatment B3, amounting to 46.63 grams, and the percentage increase was 26.91%. Compared to the comparison treatment B0, which gave the lowest rate of 36.74 grams, this superiority in the double inoculation treatment B3 may be attributed to the ability of the bacteria to secrete some growth regulators (auxin, gibberellin, and cytokinin) and their positive effect on plant growth and stimulating the root hairs to absorb elements,

which led to increased filling and storage. Nutrients in the grain This was confirmed by[13][14].

The results of statistical table (2) indicated that there were significant effects on plowing depths and average weights of 1000 grains. It exceeded the average value of treatment D3 and gave a value of 49.14 grams, an increase of 46.90%. It differed from the average value of treatment D1, which gave a value of 33.45 grams and did not differ significantly from depth D4. While it differed significantly from depth D2, their averages were (48.66, 39.17), respectively. The reason is attributed to the role of tillage in providing optimal conditions for plant and root growth, in addition to the fact that the growing bushes were at a lower rate, and thus the competition between plants and bushes to absorb nutrients and water decreased, and this is consistent with what was reflected. Regarding the weight of 1000 grains, these results agree with [15][16][17].

From the results of Table (2), we notice that the intervention had a significant effect on the weight characteristic of 1000 grains, as the intervention treatment D3B2 achieved the highest rate of 54.76 grams, and the percentage of increase was 83.82%. As for the lowest rate, it was in treatment D1B1, which amounted to 29.79 grams. The reason may be due to the environmental conditions that The abundance of plowing and getting rid of the growing bushes by treating the soil with plowing led to the bacteria secreting some of their specialized growth regulators, such as (auxin, gibberellin, and cytokinin).

The use of bacterial inoculum also leads to an increase in soil aggregation and stability as a result of its secretion of some polysaccharides and binding materials, which leads to improving its structure and working to chelate the binary positive ions responsible for stabilizing phosphorus, as well as its production of organic acids, which have an important role in reducing soil PH values and thus increasing phosphorus readiness. This was consistent with the results of. [13][14][15][65][17] [18]

Table (2) Effect of bacterial bioinoculum, plowing depths, and their interaction on the weight of 1000 grains (g).

Mean B	4	3	2	1	D / B
36.74	40.40	39.69	32.19	34.66	0
42.29	50.65	49.60	39.12	29.79	1
44.76	49.72	54.76	38.76	35.82	2
46.63	53.85	52.53	46.63	33.51	3
	48.66	49.14	39.17	33.45	Mean D
	D*B=2.906	D=1.535	B=1.475		L.S.D(0.05)

Moisture content at flowering stage

It is clear from the statistical analysis table (3) that there are significant differences in the moisture content characteristic at the flowering stage of wheat plants inoculated with biological inoculation with *B. megaterium* and *B. subtilus* bacteria, where the highest rate was

recorded in the double pollination treatment B3, amounting to 31.91%, and the percentages of increase were for them. 30.40% compared to the comparison treatment, which gave the lowest rate of 24.47%. This may be a natural result of the role of bioinoculation in improving soil structure and its indirect effect in increasing the soil's ability to hold water, as bioinoculations used as biofertilizers have a positive effect in improving the physical properties of the soil. Including moisture content, these results are consistent with[19].

The results in Table (3) showed that soil plowing depths had a significant effect on the amount of relative soil moisture for the flowering stage, as depth D4 exceeded it and gave the highest average of 41.26%, and it differed significantly with depths D2 and D3, where their averages reached (.0925, 32.23)%, respectively, while The comparison treatment gave the lowest average of 16.33%, with a percentage increase of 152.66%. The reason is attributed to the environmental conditions affecting soil depth levels, such as ground gravity, which has a role in attracting water and its descent to the bottom, as plowed soils maintain a higher moisture content than unplowed soils. This agreed with What was indicated by.[20].

The statistical analysis in Table (3) shows that there are no significant differences in the interaction between the vital bacterial inoculum and the tilling depths and moisture content in the flowering stage.

Table (3) Effect of bacterial bioinoculum, plowing depths, and their interaction on moisture content, flowering stage%

Mean B	4	3	2	1	D / B
24.47	36.40	26.93	20.35	14.18	0
28.48	41.70	32.50	23.87	15.84	1
30.05	42.58	33.81	26.36	17.45	2
31.91	44.35	35.68	29.77	17.84	3
	41.26	32.23	25.09	16.33	Mean D
	D*B =N*S	D=1.586	B=1.873		L.S.D(0.05)

Moisture content at Harvest stage %

It is clear from the statistical analysis table (4) that there are significant differences in the moisture content characteristic at the harvest stage of wheat plants inoculated with biological inoculation with *B. megaterium* and *B. subtilus* bacteria, where the highest rate was recorded in the double inoculation B3 treatment, amounting to 13.62%, and the increase rates were 43.51 % compared to the comparison treatment, which gave the lowest rate of 9.49%. The reason may be due to the role of microorganisms in improving the physical properties of the soil through the decomposition of components and secretions that they carry out, and because of the activity of microorganisms that add some connective materials that work to bind soil particles, which improves By building the soil, and then increasing its grip and moisture retention, in addition to the fact that the bacterial inoculum led to improving the moisture content of the soil [21].

The results in Table (4) showed that soil plowing depths had a significant effect on the amount of moisture content at the harvesting stage. Depth D4 gave the highest average of 15.59%, and it differed significantly with depths D2 and D3, where their averages reached (11.51, 13.86)%, respectively, while it gave The comparison treatment had the lowest average of 6.50%, with an increase of 139.84%. The reason is that the plant growth period has a highly significant effect on the moisture content of the soil. Soil moisture decreased at the end of the growing season by a percentage compared to the beginning of the growth period. This is due to the increase in plant water consumption as a result of increased absorption of water by the plant roots as the growing season progresses, in addition to increased evaporation from the soil surface as a result of higher temperatures during the end of the growing season (month) (April) compared to the beginning of the season (flowering stage). This is consistent with the findings of [22] [23], who indicated a decrease in soil moisture content as the plant growing season progresses.

Table (4) Effect of bacterial bioinoculum, plowing depths, and their interaction on moisture content at harvest stage%.

Mean B	4	3	2	1	D / B
9.49	12.43	12.18	9.19	4.17	0
12.33	16.00	15.19	12.19	5.96	1
12.39	16.44	14.35	12.07	6.70	2
13.25	17.50	13.71	12.61	9.17	3
	15.59	13.86	11.51	6.50	Mean D
	D*B =N*S	D=1.017	B=0.778		L.S.D(0.05)

References

1. Nosheen, S., I. Ajmal, and Y. Song, (2021). "Microbes as Biofertilizers, a Potential Approach for Sustainable Crop Production" Sustainability 13: 1- 20.

2. Ahemad , M . , Kibret . (2014) . Mechanisms and applications of Plant growth promoting rhizobactera : Current perspective . Journal of king Saud University – Science 26: 1-20.

3. Choudhury, Shreyasi Gupta, et al. (2014). Tillage and residue management effects on soil aggregation, organic carbon dynamics and yield attribute in rice wheat cropping system under reclaimed sodic soil. Soil and Tillage Research 136: 76-83

4. Ahmad, M., D. Chakraborty, P. Aggarwal, R. Bhattacharyya & R. Singh. (2018). Modelling soil water dynamics and crop water use in a soybean-wheat rotation under chisel tillage in a sandy clay loam soil. Geoderma. 327: 13-24.

5. Amin, M., M.J. Khan, M.T. Jan, M. Rehman, J.A. Tariq, M.. Hanif and Z. Shah (2014). Effect of different tillage practices on soil physical properties under wheat in semi-arid environment. Soil Environ, 33(1), 33-37.

6. Elsahook. M.M.(2009) .seed Growth Relationships. (in Arabic) coll. Of Agric..univ.of Baghdad 12775. Iraq. European Academic Res. (2):127-62

7. Black, C.A. (1965) . Methods of Soil Analysis, Part 2. Chemical and microbiological properties, Am. Soc. Agron. Inc. Madison , Wisconsin, USA.

8. Al-Rawi Khasha Mahmoud, Khalafallah, and Abdul Aziz Mohsen (1980) Design and Analysis of Agricultural Experiments, Ministry of Higher Education and Scientific Research. University of Baghdad

9. Mansour, Montazer Hammadi (2014). The effect of bioorganic phosphate fertilization on soil phosphorus readiness and yellow corn (Zea mays L) productivity, College of Agriculture. Baghdad University

10. Al-Hassani Ayat Hassan Abd (2022). The effect of the efficiency of local isolates of Paenibacillus Polymyxa bacteria on soil phosphorus readiness and the growth and yield of wheat plants. Triticum aestivum L) College of Agriculture - Al-Muthanna University

11. Al Aridhee, J. K., Abood, A. M., Kassar, F. H., Łsiak, G., & Dakhil, M. M. (2022). ImpacT OF Mill Rolls Gabs and Delay of Harvesting Date of Wheat crop on Some Properties of Flour. *Int. J. Agricult. Stat. Sci. Vol*, *18*(1), 2071-2076.

12. Łysiak, G., Kulig, R., & Kowalczyk-Juśko, A. (2023). Toward New Value-Added Products Made from Anaerobic Digestate: Part 2—Effect of Loading Level on the Densification of Solid Digestate. *Sustainability*, *15*(9), 7396.

13. Keston, Oliver Willard Nijra. (2013). Microbial Contributions in Alleviating Decline in Soil Fertility. British Microbiology Research Journal. 3(4); 724-742

14. Jabbar, Abdullah Karim, Ghanem Bahloul Nouni, and Muhammad Radwan Mahmoud. (2018) The effect of adding levels of NPK complex fertilizer, the bacterial inoculum Bacillus subtilis, and the Glomus mosseael fungus on the growth and productivity of yellow corn. Zea maps L. Syrian Journal of Agricultural Research (25): 169 -178

15. WoŸniak, A. (2020). Effect of Cereal Monoculture and Tillage Systems on Grain Yield and Weed Infestation of Winter Durum Wheat. International Journal of Plant Production, 14(1), 1-8.

16. Al Aridhee, J.K., A.M. Abood, F.H. Kassar, G. Łysiak, , and M.M. Dakhil , (2020) Influence of Tractor Slip on Some Physical Properties of the Soil and Fuel Consumption at Varying Tillage Depths and Speed. Plant Archives 20 (1),141-145.

17. Łysiak, G., Al Aridhee, J. K., Kulig, R., Różyło, R., & Wójcik, M. (2021). Examination of the Peleg and Normand equation during relaxation of wheat: The effect of holding time. *Journal of Texture Studies*, *52*(2), 157-168.

18. Odoh, C. K., Sam, K., Zabbey, N., Eze, C. N., Nwankwegu, A. S., Laku, C., & Dumpe, B. B. (2020). Microbial consortium as biofertilizers for crops growing under the extreme habitats. In Plant microbiomes for sustainable agriculture (pp. 381-424). Springer, Cham.

19. Bashan, Y. and H. Levanony (1991). Alteration in membrane potential Plant Soil .137: 99-103.

20. Borodychev, V. V., and Lytov M. N.. (2020). Irrigation management model based soil moisture distribution profile. In IOP on Conference Series: Earth and Environmental Science, 577(1), p. , A. 012022. IOP Publishing.

21. Nguyen, T. T. (2013) compost effects on soil water content, plant growth under drought and nutrient leaching. Thesis the degree of doctor of philosophy, school of Agriculture, food and wine faculty of Sciences, the University of Adelaide

22. Al-Shami, Yahya Ajeb Odeh (2013). The effect of adding amendments and moisture levels on the physical properties of clay soil and the water use efficiency of yellow maize crops under drip and irrigation systems. Master Thesis. College of Agriculture - University of Basra

23. Jassim Ali Hussein Muhammad (2015) The effect of magnetizing different types of water on some chemical and physical properties of mixed clay soil and the growth and German consumption of the barley crop Hordeum vulgare. Master's thesis, College of Agriculture - University of Basra - Iraq.