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EFFECT OF SPRAYING WITH A NUTRIENT SOLUTION AND ADDING COMPOST ON SOME INDICATORS OF GROWTH AND YIELD OF WHEAT *TRITICUM AESTIVUM* L.

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Abstract

A field experiment was conducted to grow the wheat crop, *Triticum aestivum* L., in one of the fields located in the Abu Gharak district of Babylon province, in the Sayed Ismail region, at the coordinates (44.3754175, 32.5268050), during the season 2021-2022.The effect of spraying with a nutrient solution (which contains a mixture of micronutrients) and adding compost on some indicators of growth and yield of wheat in a mixed soil, where the experiment included two factors and symbol it respectivelyS0, S1, S2.The second factor is the ground addition of co mpost fertilizer at three levels 0, 5 and 10 tons H-1 andwhich is symblois by C0, C1, C2, the experiment was implemented as a factorial experiment according to the randomized complete block design (R.C.B.D), at maturity the plant height, chlorophyll index and the number of branches were measured and the flag leaf area , and at the time of harvest, the biological yield and grain yield were measured.The results of the study indicated that there was a significant effect of the S2C2 bi-interaction treatment in all study indicators represented by vegetative growth traits and yield traits, as it was significantly excelled and it gave the highest values of the vegetative growth traits represented by plant height, chlorophyll index, flag leaf area and number of branching, which values were 112.57 cm, 55.73 spad unit, 54.97 cm^2, and 8, respectively .It also excelled significantly and gave the highest values of yield traits represented by grain yield and biological yield, which were 5.258 tons ha^{-1} and 15.49 tons ha^{-1}, respectively.

Keywords: Organic fertilization, wheat, *Triticum aestivum* L.

Introduction

Organic fertilization is the cornerstone that must be laid to raise the productive value of agricultural lands and reduce environmental pollution resulting from the excessive use of mineral (chemical) fertilizers. Therefore, recycling plant organic waste is one of the important factors that lead to the provision of quantities of organic fertilizers that meet the needs of Farmland , Compost is an organic fertilizer that is made from the aerobic decomposition of farm waste such as rice straw, corn stover, cotton stove, vegetable stalks, fallen tree leaves and palm fronds, tree reduction products, waste preparation and heap preparation, under conditions of good ventilation, appropriate humidity and stimulating materials for microorganisms. Where humus is formed and since these residues are characterized by a high percentage of carbon: nitrogen (C / N ratio) more than (40: 1) and may reach (90: 1), it is difficult to add them directly and mix them with the surface layer of the soil, as this leads to the depletion of the soil content of nitrogen as a result of the activity of microorganisms in decomposing these residues and building their bodies, and this

affects the soil content of temporarily soft nitrogen, which is naturally reflected in the growing crop.It is also preferable to make compost to convert the waste into organic fertilizer, where after maturity, the ratio of carbon: nitrogen is 10: 1. Studies indicate that it is preferable for the ratio to be between (18-20): 1, which increases its effectiveness in the soil .Compost helps to revitalize the soil and increase its fertility, as it contains elements necessary for plants such as nitrogen, phosphorus and potassium with manganese, so these elements are transferred from the soil to the plant in order to benefit from it, and the compost contains a large proportion of antibiotics, and this of course led to increased growth of plants It also helps eliminate fungi that harm agriculture . Wheat (Triticum aestivum L) is considered a herbaceous plant and belongs to the Graminaceae family. It is one of the most important strategic grain crops in Iraq and the world for its role in achieving food security .It comes at the forefront of field crops in terms of cultivated area and production because it constitutes a main food for most of the peoples of the world and is considered one of the main sources of energy needed by the human body. (Costa et al., 2013, FAOSTAT, 2015(As a result of the lack of studies on this subject in Iraq, specifically in the province of Babylon, because it is one of the provinces distinguished by the cultivation of this crop and its productivity. Therefore, the study aimed to know the effect of spraying with nutrient solution and adding compost and the interaction between them on some indicators of growth and yield of wheat.

Materials and methods

The experiment was conducted in one of the agricultural fields belonging to the Abi Ghareq district in the Sayed Ismail area, which is located north of Babylon province, at latitude and longitude (44.37 and 32.52). The experiment was implemented as a global experiment for the cultivation of wheat (Triticum aestivum L) in the spring season (2021-2022).The soil was classified as a sedimentary soil with a loam texture, classified to a level under the Great Typic Torrifuvent group, and according to the modern American classification (soil survey staff, 2006), soil samples were taken to a depth of (0-30) cm.The samples were air dried, ground, and sifted with a sieve with a diameter of 2 mm, then the samples were mixed well to homogenize them, and a compound sample was taken and placed in nylon bags for the purpose of preservation, as some soil traits were estimated before planting, Table 1. Shows some chemical and physical properties of the experimental soil, which include:

Table 1: Some chemical and physical properties of field soil

values	**units**	traits
3.65	**$Ds.m^{-1}$**	Electrical conductivity (ECe)
7.50		PH
9.43	**Centimol kg^{-1} soil**	Cation exchange capacity (CEC)
2.13	**$g.kg^{-1}$ soil**	gypsum
1.35	**$Mg.m^{-3}$**	bulk density

7.21	**g.kg^{-1}**	organic matter (O.M.)
available ions		
31.3	**mg.kg^{-1}**	available nitrogen
16.4		available phosphorous
186.1		available Potassium
4.32		available iron
1.85		available copper
0.41		available zinc
341	**g.kg^{-1}**	sand
393		silt
264		clay
Loamy		texture

The experiment was conducted on a land with a total area of 468 square meters and dimensions of 39 m x 12 m. The land was plowed with a plow, then the operations of smoothing, leveling and modification were carried out, and three watercourses were opened on the ground. After that, the field was divided into three replicates, each replicate containing 9 experimental units and each experimental unit. Its area is 6 square meters, with dimensions of (2 x 3) meters.A separating distance (1 m) was left between one experimental unit and another, and between one replicate and another, in order to ensure that transactions do not mix during their application between one experimental unit and another, and between one replicate and another. The experiment consists of two factors,The first factor is spraying the nutrient solution at three levels S0, S1 and S2, i.e. with a concentration of 0, spraying water only and 1 and 2 ml L^{-1} in succession for each treatment, and the second factor is the ground addition of compost at three levels C0, C1 and C2, i.e. in quantities 0, 5 and 10 tons ha^{-1} in sequence for each treatments,

Thus, the number of treatments became 9 with three replications, meaning that the number of experimental units = 3 x 3 x 3 = 27 experimental units.

The seeds of the wheat plant, IPA 99, were sown on (11-15-2022), with a seed quantity of 120 kg ha^{-1}, on equal lines, 9 lines in each experimental unit, with a depth of 2-3 cm. The distance between one line and another is 20 cm, then the plants are thinned after 14 hours. the day of the emergence of the wheat plant,Chemical fertilizers were added during the cultivation process and according to the fertilizer recommendation (Al-Sahoki, 1990), which is 250 kg N ha^{-1} in the form of urea (N 46%), in three batches at planting, two weeks after emergence and 60 days after emergence, and 200 kg P ha^{-1} was added. In the form of triple superphosphate fertilizer in one batch and 150 kg

KH-1 of potassium sulfate fertilizer K2SO4,The plants were irrigated according to the field capacity of the soil at the beginning, and irrigation continued as needed throughout the study period. The process of spraying the nutrient solution was carried out in three stages (when forming branches, when elongating, and when lining). As for the addition of compost, it was added to the soil before planting and on batch format.

studied traits

growth indicators

plant height (cm)

Plant height was measured as an average of ten plants per experimental unit by using a metal tape measure from the soil surface level to the end of the tip of the spike in the main stem, according to Donaldson (1996).

The number of branches

The number of forks bearing a spike was calculated as an average of ten plants in each experimental unit

Flag leaf area (cm2)

The flag leaf area was calculated for ten flag leaves as an average of ten plants in each experimental unit and according to the equation below:

Flag leaf area = max length of flag x max width of flag x 0.95

Chlorophyll Index (Spad unit)

The chlorophyll in the leaves was measured using a device (SPAD-502 Chorophyll meter), and it was measured as an average of ten readings from each experimental unit, by placing the upper leaf between the jaws of the device only (Reyonolds et al., 1998).

yield traits

Grain Yield (ton $ha^{-1)}$

After the crop was ripe, one square meter was harvested from each experimental unit, dried, and the total weight of the crop was taken.

biological yield (grain + straw)

Where it was calculated on the basis of (ton ha^{-1}) and from the area of one square meter of each experimental unit, according to Donaldson (1996).

Results and discussion

plant height

The results of the statistical analysis in Table (2) showed that there is a significant effect for all the study indicators represented by the spraying of the nutrient solution and the ground addition of compost in the characteristic of plant height (cm),The spraying treatment with nutrient solution S2 gave the highest average value of 108.84 (cm) compared to treatments S1 and S0, whose values were 103.07 and 97.42 (cm), with an increase rate of 5.51% and 11.7%, respectively.The addition of compost significantly affected the description of plant height (cm), as the compost addition treatment C2 in the same table gave the highest value of 106.64 (cm) compared to treatments C1 and C0, whose values were 104.08 and 98.61 (cm), with an increase of 2.4%. 8.14%,Also, the results showed in the same table that there is a significant effect of the bi-interaction between the

application of the nutrient solution and the ground addition of compost on the plant height (cm),Whereas, the bi- interaction treatment S2C2 gave the highest mean value of 112.57 cm compared to the control treatment S0C0, which had a value of 95.70 cm, with an increase of 17.6%.

Table 2 Effect of spraying with nutrient solution and adding compost and the interaction between them on wheat plant height (cm)

averages	ground adding			Spraying the nutrient solution (S)
	compost (C(			
	C_2	C_1	C_0	
97.42	99.17	97.40	95.70	S_0
103.07	108.20	104.87	96.13	S_1
108.84	112.57	109.97	104.00	S_2
	106.64	104.08	98.61	averages
L.S.D) 0.05(				
interaction	compost			nutrient solution
2.28	1.31			1.13

The number of branches

The results of the statistical analysis in Table (3) showed that there was a significant effect for all the indicators of the study represented by spraying the nutrient solution and adding compost on the trait of the number of branches of the wheat plant, as spraying the nutrient solution significantly affected the number of branches of the wheat plant. The spraying treatment with nutrient solution S2 gave the highest average value of 6.67 branches compared to treatments S1 and S0, whose values were 6.00 and 3.89, with an increase rate of 11.16% and 71.4%, respectively.The ground addition of compost affected significantly the characteristic of the number of branches of the wheat plant, as the ground compost treatment C2 in the same table gave the highest value of 6.65 compared to treatments C1 and C0, whose values were 5.44 and 4.56, with an increase of 20.5% and 43.85%. The results in the same table show that there is a significant effect of the dual interaction between spraying the nutrient solution and compost on the number of branches of the wheat plant.The transaction S2C2 gave the highest value of 8.00 compared to the control treatment S0C0, which had a value of 3.33, with an increase of 140.2%.

Table 3 Effect of spraying with nutrient solution and adding compost and the interaction between them on the number of branches of wheat plant.

averages	ground adding			Spraying the nutrient solution (S)
	compost) (C			
	C_2	C_1	C_0	
3.89	4.67	3.67	3.33	S_0

6.00	7.00	6.00	5.00	**S_1**
6.67	8.00	6.67	5.33	**S_2**
	6.56	5.44	4.56	**averages**
L.S.D) 0.05(				
interaction	**compost**			**nutrient solution**
0.99	0.57			0.57

Flag leaf area (cm2)

The results of the statistical analysis indicated in Table (4) that there was a significant effect of spraying the nutrient solution and adding compost and their interactions in increasing the trait of the flag leaf area (cm2), where the treatment of spraying with the nutrient solution S2 significantly affected the characteristic of the flag leaf area (cm2) and gave the highest value that reached 51.94 (cm2) compared to the two treatments S1 and S0, which had values of 46.49 and 44.26 (cm2).With an increase rate of 11.7 and 17.3% respectively, it is also noted from the same table that there is a significant effect of adding compost in the trait of the flag leaf area (cm2), as treatment C2 gave the highest value of 49.81 (cm2) compared to treatments C1 and C0 whose value was 47.07 and 45.81 (cm2), with an increase of 5.8 and 8.7%, It is also noted from the same table that the bilateral interaction between spraying the nutrient solution and adding compost was significant on the trait of the flag leaf area (cm2), as the overlap treatment S2C2 gave the highest value of 54.97 compared to the control treatment S0C0, whose value was 41.87 (cm2), with an increase of 31.2%.

Table 4 Effect of spraying the nutrient solution and adding compost and the interaction between them on the area of the flag leaf (cm^2)

averages	**ground adding ة**			**Spraying the nutrient solution (S)**
	compost) C(			
	C_2	**C_1**	**C_0**	
44.26	46.97	43.93	41.87	**S_0**
46.49	47.50	46.53	45.43	**S_1**
51.94	54.97	50.73	50.13	**S_2**
	49.81	47.07	45.81	**averages**
L.S.D(0.05)				
interaction	**compost**			**nutrient solution**
1.71	0.99			0.99

Chlorophyll index

The results of the statistical analysis in Table (5) indicated that all indicators of the study, consisting of spraying the nutrient solution and the interaction between them, had a significant effect on the quality of the chlorophyll index, as the spraying of the nutrient solution had a significant effect on the quality of the chlorophyll index.The treatment of spraying with the nutrient

solution S2 significantly affected the chlorophyll index and gave the highest value, which amounted to 52.89 Spad unit, compared to treatments S1 and S0, which had values of 48.32 and 46.72 Spadunit, with an increase of 9.4 and 13.2%, respectively.It is also noted from the same table that there is a significant effect of the addition of soil compost in the trait of chlorophyll index, as treatment C2 gave the highest value of 51.48 Spadunit, compared to treatments C1 and C0, whose values were 49.43 and 47.02 Spadunit, with an increase of 4.1 and 9.4%. It is also noted from the same table that the effect of the bilateral interaction between spraying the nutrient solution and adding compost was significant on the trait of the chlorophyll index, as the interaction treatment S2C2 gave the highest value of 55.73 Spadunit compared to the control treatment S0C0, whose value was 43.77 Spadunit, with an increase of 27.3%.

Table 5 Effect of spraying the nutrient solution and adding compost and the interaction between them on the quality of Spadunit chlorophyll index.

averages	ground adding compost) C(			Spraying the nutrient solution (S)
	C_2	C_1	C_0	
46.72	48.20	48.20	43.77	S_0
48.32	50.50	48.07	46.40	S_1
52.89	55.73	52.55	50.90	S_2
	51.48	49.43	47.02	averages
L.S.D(0.05)				
interaction	compost			nutrient solution
2.13	1.23			1.23

It is noted from the tables (2, 3, 4 and 5) that the spraying of the nutrient solution and the soil addition of compost and the interaction between them had a significant effect on all growth traits of the wheat crop. Thus, increasing photosynthesis and energy formation, and also works to elongate plant cells. The responsible for this is that the zinc element works on the synthesis of tryptophan acid, which is responsible for the formation of the hormone indole acetic acid (IAA). Thus, this hormone works to elongate the cells and then increase Leaf area and plant height, as well as an increase in the percentage of chlorophyll in the leaves (Hotz and Brown, 2004, Cakmak et al., 1998), that spraying the nutrient solution on the plant that contains iron, zinc and manganese affected the vital processes inside the plant, as these elements affect the vital processes in the plant such as metabolism Photosynthesis, respiration, and many other processes such as the formation of nucleic acids, fatty acids, and energy production, and thus providing a high storage of food in the plant leads to non-competition of plant parts among themselves. on food, and this leads to providing a better opportunity for growth, increasing leafy area, plant height, and branch formation. In addition, these elements have a role in building many metabolic and synthetic compounds that contribute to the growth, expansion, and formation of new cells, thus increasing

plant height, increasing the area of the flag leaf, and also contributing to increasing The percentage of chlorophyll (Marten et al., 1997), and these results are consistent with the findings of (Al-Salmani et al., 2013, Al-Tamimi et al., 2015, Mohsen and Al-Asadi, 2016, Abdel-Khaleq 2017, Abdel-Karim 2016, Hassan and Kharbit 2014), who obtained a significant increase in all Growth characteristics such as chlorophyll content in leaves, flag leaf area, plant height, and number of branches. Also, micronutrients, including copper, increase the absorption of macronutrients from the soil (N, P, and K). Thus, these elements contribute, through their functions within the plant, to an increase in the area of the flag leaf, and thus a good absorption of sunlight, and this leads to an increase in the formation of energy and nutrients within the plant, which It leads to an increase in the rest of the traits, such as the number of branches, plant height, and many growth traits (Shill et al., 2007).

Also, the addition of ground compost significantly affected the growth traits of the wheat crop, as it led to a significant increase in the growth characteristics. Good moisture for the soil environment, as it increases the effectiveness of microscopic soil revival, which works to analyze the organic matter present in compost and release nutrients. Also, compost affects the available of nutrients N, P, and K through a direct effect on the PH, as it works to reduce it and thus Increasing the available of nutrients, which are responsible for many metabolic activities within the plant, regulating the osmotic effort within the plant sap, increasing the absorption of nutrients through the roots, and thus increasing the food stock within the plant, and this leads to elongation of meristematic cells and tissues, and thus an increase in plant height, leaf area, and the percentage of chlorophyll in Leaves (Al-Hasnawi et al., 2018), and the organic matter, when decomposed inside the soil, releases acids Organics such as fulvic and humic acid, which increase the availability of phosphorus and several nutrients because they contain active compounds such as carboxylate, phenol and alcohol, which also affect the pH and increase the availability of major and minor nutrients (Stevenson and Fitch, 1986). The addition of compost also affects soil CEC. By its effect on the fertilizing capacity of the soil and thus increasing the CEC of the soil and increasing the availability of nutrients (Brady and Weil, 2002), the addition of compost leads to an increase in the content of macro nutrients within the soil, which contribute to stimulating the process of photosynthesis and the formation of proteins and nucleic acids and increasing the growth of roots and thus increasing the trait of The growth of the plant, such as the height of the plant, the area of the flag leaf, the number of branches, and the content of chlorophyll.

Grain Yield (ton.ha^{-1})

The results of the statistical analysis in Table (6) indicated that all the indicators of the study, which consisted of spraying the nutrient solution and the interaction between them, had a significant effect on the yield of wheat grains, where the treatment of spraying with the nutrient solution S2 significantly affected the yield of wheat grains and gave the highest value, which amounted to 5.258 (ton.ha^{-1}) compared to treatments S1 and S0, whose values amounted to 4.108 and 3.451 (ton.ha^{-1}), with an increase of 27.9 and 52.3%, respectively.It is also noted from the same table that there is a significant effect of adding compost on the yield of wheat grains, where treatment C2 gave the highest value of 4.871 (ton.ha^{-1}) compared to treatments C1 and C0 whose values

were 4.277 and 3.669 (ton.ha^{-1}), with an increase rate of 13.8 and 32.7%. It is also noted from the same table that the effect of the bi- interaction between spraying the nutrient solution and adding compost was significant on the yield of wheat grains.Where the bi-interaction treatment S2C2 gave the highest value amounting to 6.273 (ton.ha^{-1}) compared to the control treatment S0C0, whose value was 3.067 (ton.ha^{-1}) with an increase rate of 104.5%. An increase of 68.6%.

Table 6 Effect of spraying nutrient solution and adding compost and the interaction between them on wheat grain yield (ton.ha^{-1})

averages	ground adding			Spraying the nutrient solution (S)
	compost (C(			
	C_2	C_1	C_0	
3.451	3.870	3.417	3.067	S_0
4.108	4.470	4.240	3.613	S_1
5.258	6.273	5.173	4.327	S_2
	4.871	4.277	3.669	averages
L.S.D(0.05)				
interaction	compost			nutrient solution
0.56	0.32			0.32

Biological yield (ton.ha^{-1})

The results of the statistical analysis in Table (7) indicated that all the indicators of the study, which consisted of spraying the nutrient solution and the interaction between them, had a significant effect on the biological yield, where the treatment of spraying with the nutrient solution S2 significantly affected the biological yield and gave the highest value, which amounted to 15.49 (ton.ha^{-1}) Compared to treatments S1 and S0, whose values amounted to 14.39 and 14.64 (ton.ha^{-1}), with an increase of 7.6 and 5.8%, respectively. It is also noted from the same table that there is a significant effect of adding compost on the biological yield, as treatment C2 gave the highest value of 15.49 (ton.ha^{-1}) compared to treatments C1 and C0, whose values were 14.83 and 14.07 (ton.ha^{-1}), with an increase of 4.45. And 10%. It is also noted from the same table that the effect of the dual interaction between spraying the nutrient solution and adding compost was significant on the biological yield.Where the bi-interaction treatment S2C2 gave the highest value of 16.13 (ton.ha^{-1}) compared to the comparison treatment S0C0, whose value was 13.50 (ton.ha^{-1}), with an increase of 19.4%. S2C1 treatment also excelled significantly and gave a value of 15.21 (ton.ha^{-1}). Compared to the control treatment S0C0 with an increase of 12.6%

Table 7 Effect of spraying the nutrient solution and adding compost and their interactions on the biological yield (ton.ha^{-1})

averages	ground adding compost) C(			Spraying the nutrient solution (S)
	C_2	C_1	C_0	
14.64	15.63	14.80	13.50	S_0
14.39	15.11	14.50	13.56	S_1
15.49	16.13	15.21	15.14	S_2
	15.49	14.83	14.07	averages
L.S.D(0.05)				
interaction	compost			nutrient solution
0.29	0.17			0.17

It is noted through the results contained in tables (6 and 7) that there is a significant effect of spraying the nutrient solution and the ground addition of compost and the interaction between them on the characteristics of wheat yield, as the study indicators led to a significant increase in these traits. The reason may be due to the spraying of microelements, including iron, which has a role in energy transfer and in the process of fixing nitrogen by reducing it. It also has a role in building chlorophyll, thus increasing energy production and increasing the efficiency of the photosynthesis process, and this leads to increased growth, fertilization, and the formation of spikes. Increasing grain formation and yield, and when the vegetative growth increases, the biological yield increases (Focus, 2003), and these results are consistent with what was reached by (Mohsen and Al-Asadi, 2016, Al-Aboudi, 2015, and Abdel-Khalek, 2017) who concluded that there was a significant increase in all yield traits of Grain yield and biological yield.

The reason for the significant increase in the above traits is due to the fact that spraying the microelements led to an increase in plant growth, as the microelements work to activate the action of plant enzymes and then activate the work of the roots and thus increase the absorption of macro and micronutrients from the soil, which has a positive effect on vital activities. Inside the plant, including photosynthesis and the building of chlorophyll, which led to the supply of carbohydrates to the grain and led to an improvement in the fertilization process and thus an increase in the characteristics of the crop. Also, spraying micronutrients on the plant, including iron, zinc and copper, which have a role in the manufacture of nucleic acids, DNA and RNA important in the process of protein formation, and this leads to a significant increase in the leaf area, which works to increase the process of photosynthesis and respiration and the activity of the plant in the absorption of water and nutrients through the roots Which reflects positively on the grain fullness and weight increase in addition to its metabolism in proteins and thus increase the characteristics of the yield (Saleh, 2004).

It is also clear from the same tables that the addition of compost significantly affected the traits of the yield. The reason may be attributed to the fact that the addition of compost led to an increase in the soil content of organic matter, which increases the activity of microorganisms and thus increases the liberation of nutrients and converts them from a form that is not available for absorption into a form that is not ready for absorption. It is available for the plant as it affects the cationic exchange capacity and thus increases the supply of macro and micro nutrients, which have a role in many vital activities within the plant by increasing vegetative growth and increasing cell elongation and then increasing yield characteristics and also contributes to the formation of proteins and energy and this leads to an increase in processes Fertilization and grain filling, and thus increasing yield characteristics (Al-Allaf, 2018), and these results are consistent with what was reached by (Vimila et al., 2006, and Al-Halfi and Fleih, 2017). Those who obtained a significant increase in yield trait when adding organic matter to the soil.

conclusions

Level 2 ml L^{-1} with compost land addition at level 10 ton.ha^{-1}achieved significant superiority in all indicators of growth, yield and its components

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