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The Effect of the Fungal Inoculation and Cow Manure and Dab Fertilizer in the Growth of Wheat Plant and the Availability of Iron and Zinc in the Soil

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Abstract. A field experiment was carried out for one of the fields in Al-Qadisiyah Governorate / Al-Shafi'iyah district, where the soil texture of the field was (Sandy loam) in order to study (the effect of fungal inoculation, cow manure and dab manure on the growth of wheat plants and the readiness of iron and zinc in the soil), which was planted in the winter season 2021/2022 and the experiment contained three factors, the fungal inoculation (G. mosseae) was at two levels (and no Addition G0, AdditionG1), cow manure at three levels (0-1-2) tons, ha, and dab manure three levels (0-50-100%). All results had significant differences, as when inoculating with (G. mosseae) the treatment (G1) was superior in plant height, chlorophyll, iron and zinc, which averaged (89.446) cm, (44,905) SPAD, (9.739) mg Fekg^{-1} Soil, (0.340) mg Zn kg $^{-1}$ soil, while when fertilizing with cow waste, where treatment (P1) was superior in plant height, chlorophyll and iron, while zinc was superior to treatment (P2), (92.083) cm, (46.226) SPAD and (10).850 mg Fe kg $^{-1}$ soil, (0.347) mg Zn kg $^{-1}$ soil, while the mineral fertilizer, where treatment (D2) was superior in plant height, chlorophyll and zinc except for iron, where treatment (D1) was superior to (88.640) cm, (45.292) SPAD and (0.339)) mg Zn kg $^{-1}$ soil, (9.871) mg Fe kg $^{-1}$ soil, while the bilateral interaction between (G. mosseae) and mineral fertilizer, where the treatment (G1D2) excelled in all characteristics, which averaged (91,444) cm, (46,509) SPAD and (10.416) mg Fe kg $^{-1}$ soil, (0.344) mg Zn kg ^{1} soil, while the interaction between cow manure and mineral manure, where the treatment (P1D) was superior in plant height, chlorophyll and iron except zinc, (94.137) cm, (48.418) SPAD and (11.552)) mg Fe kg $^{-1}$ soil, (0.349) mg Zn kg $^{-1}$ soil,871) mg Fe kg $^{-1}$ soil, while the bilateral interaction between (G. mosseae) and mineral fertilizer, where the treatment (G1D2) excelled in all characteristics, which averaged (91,444) cm, (46.509) SPAD and (10,416) mg Fe kg $^{-1}$ soil, (0.344) mg Zn kg $^{-1}$ soil, while the interaction between cow manure and mineral manure, where the treatment (P1D) was superior in plant height, chlorophyll and iron except zinc, (94.137) cm, (48.418) SPAD and (11.552) mg Fe kg $^{-1}$ soil, (0.349)) mg Zn kg $^{-1}$ soil,871) mg Fe kg $^{-1}$ soil, while the bilateral interaction between (G. mosseae) and mineral fertilizer, where the treatment (G1D2) excelled in all characteristics, which averaged (91,444) cm, (46.509) SPAD and (10,416) mg Fe kg $^{-1}$ soil, (0.344) mg Zn kg $^{-1}$ soil, while the interaction between cow manure and mineral manure, where the treatment (P1D) was superior in plant height, chlorophyll and iron except zinc, (94.137) cm, (48.418) SPAD and (11.552) mg Fe kg $^{-1}$ soil, (0.349)) mg Zn kg $^{-1}$ soil. As for the triple intervention, where the treatment outperformed (G1P1D2) in plant height, chlorophyll and iron except zinc, where the treatment (G1P2D2), (94.633) cm, (51.547) SPAD, (12.543) mg Fe kg $^{-1}$ soil and (0.352) mg Zn kg $^{-1}$ soil were superior.

Keywords. Mycorrhiza, Cow manure, Dab(DAP), Iron, Zinc, Wheat.

1. Introduction

The traditional farming methods depend on the use of chemicals of all kinds, whether fertilizers or pesticides, as it is not possible to maintain the integrity of soil systems for long periods of time, because these fertilizers work on environmental deterioration, which will be reflected in the structure of the soil and the high prices of chemicals, as well as on The high prices of produced foodstuffs, so farmers used easy and effective methods, which is the use of microbial systems that preserve food in a safe way [1].

As well as mycorrhizal fungi have an important feature that distinguishes them from the rest of the other fungi, which is their inability to grow in industrial circles, because they are forced to feed on all living organisms and also exist in different types of agricultural soil, because they live in a non-symbiotic relationship, that is, they absorb some elements The mycorrhiza also contain internal hyphae that penetrate the roots, as well as contain minute structures called dendritic structures, as these structures exchange nutrients from and to the roots, as well as contain another type of hyphae called external hyphae, which are inside which spores are formed In order to attack the roots of the plant and also have an important role, which is dissolving phosphates and converting them from a complex form to a ready-to-absorb form, and also have the ability to produce growth regulators also, organic fertilizers (cow manure) significantly increase the yield of wheat grains compared with chemical fertilizers. Also, the yield rise increases when the levels of fertilizers are added to the soil. The organic fertilizers also increase plant height, chlorophyll content and grain yield, which is attributed to this result. Improving the physical and chemical properties as well as increasing its fertility, as the percentage of protein in the crop is 143% compared to chemical fertilizers[2]، and the addition of organic waste (poultry, cows, sheep) and urea leads to the emergence of significant differences, in addition to a significant increase In the percentage of protein in cereals when adding organic waste, and this was indicated by [3].

Dab fertilizer (0-46-18) Diammonium Phosphate is a group of salts produced when ammonia reacts with phosphoric acid. It is used as a fertilizer for crops as well as a source of nitrogen and phosphorous to make the soil more acidic, due to the decomposition of ammonium. Also, nitrogen is an important element and a major compound Which enters into the composition of the plant, as the symptoms of its deficiency start first on the lower leaves (old) and then start on the upper parts, and adding it in large quantities works to delay the plant's maturation [4].

Iron is one of the most important micronutrients that contribute to the activity of many enzymes, as well as increasing the proportion of chlorophyll, although it is not included in its composition [5] , and its iron content is very high in agricultural soils, and in some soils its content is low, because iron contains high percentages of lime, which works to aerate the soil, and thus there is a shortage of iron for plants grown in calcareous soils [6] , and that the critical value of iron in some types of Iraqi soils is 6.19 kg [7]،there are many types of Iraqi soils in which zinc deficiency occurs, and in order to increase this element, mineral and organic fertilizers must be used in order to obtain the highest amount of zinc element, as well as the results were obtained to obtain a higher amount of this element through the addition of zinc in the form of Zn-EDTA, which works on a clear increase in the wheat yield, as well as that the organic matter dissolves the zinc element in the base soils [8].

The wheat crop is one of the most important crops, which is the main source of human food, because it contains bad proportions of carbohydrates, which are among the necessary materials that must be provided to the human body with calories, and also wheat belongs to the grassy family (Triticum aestivum L)[9]،and one grain of the wheat crop contains 8% starch, 1.5-2% sugar, 1.5-2% cellulose, 2.5-2% water and other materials, and the total cultivated area is 736.5 thousand hectares. The cultivated area in Iraq is 739.9 million tons [10] . the Thesis aims to study the following points:-

- The Effect of Glomus mosseae on the growth and yield of local
- The Effect of the interaction between fertilizer DAP and cow manure on the growth and yield of local.
- The Effect of Glomus mosseae, Cow manure and fertilizer DAP and the interaction between them on the growth and yield of local.

2. Materials and Methods

A field experiment was carried out in the winter agricultural season (2021-2022) according to the design of randomized complete sectors (RCB D) in one of the fields belonging to the Shafi'i district, where the wheat crop (Ednah 99) was planted, where the field was divided into three sectors and each sector contains 18 experimental unitsHThe area of each unit is 16 m (4 x 4 m), and the cultivation was carried out using the scattering method, as well as samples were taken to conduct physical and chemical analyzes of the field soil before planting, and the treatments were the mycorrhizal vaccine, which includes two levels (G0 (no addition) and (G1 addition of the vaccine), which was obtained from the Agricultural Research Department / Al-Zafaraniya, and cow residues with three levels (0-1-2) tons. hectares, and the mineral fertilizer dab fertilizer (0-50%-100%) as it was added at once, and three batches of urea (0-46-18) as the first batch was added before planting, as well as the second batch after 45 days, i.e. a month and a half from Planting, the third batch in the flowering stage, studying the studied traits, conducting statistical data analysis and testing the least significant difference L. S. D at the 0.05 level.

The studied characteristics were studied:

- Plant height: Five plants were randomly selected from each experimental unit and their height was measured at the end of the season from the surface of the soil to the highest peak of the plant and this was done using the measuring tape and the average was extracted for it.
- Chlorophyll content (SPAD) :- The chlorophyll content in five leaves was measured randomly at the flowering stage by a chlorophyll 502-meter device and its average was calculated.
- Determination of iron and zinc in the soil:- Where these elements were estimated by taking 10 gm of soil and adding 20 ml of a solution to it.Standard DTPA (0.005), after which it was shaken for two hours, filtered and estimated using atomic absorption spectrometer (PG 990).

Table 1. Shows the physical and chemical analyzes of field soil before planting.

Unit	the value		Adjective
gm kg soil $^{-1}$	619.8	Clay	Soil Separators
	231.9	Sand	
	148.9	Silt	
	Sandy loam		texture
-	7.9		pH
ds. m^{-}1	2.9		Ec
CmoIc L-^{1}	12.34		CEC
gm kg soil $^{-1}$	7.0		O. M
Amalgam kg soil $^{-1}$	19.50	N	Ready ions
	15.59	P	
	115.57	K	
mmol liter $^{-1}$	16.4	Ca	Positive dissolved ions
	19.07	Mg	
	15.30	Na	
	Nill	CO3	Negative dissolved ions
	5.24	HCO3	
	19.12	SO4	
CFU gm $^{-1}$ dry soil	1.93×10^{3}		holistic fungi

3. Results and Discussion

3.1. Plant Height

Table No. (2) shows that inoculation with a fungus (Glomus mosseae) has a significant effect, where the treatment (G1), which averaged (89.446) cm, outperformed the treatment of no addition (G0), which averaged (86,486). This is because the process of pollination with the fungus (Glomus mosseae) works to re-improve photosynthesis and increase the absorption of nutrients, especially phosphorous, and this increases the height of the plant as well as increasing growth regulators, and this is consistent with the results [11].

The table also shows that organic fertilization has a significant effect, where the treatment outperformed (P1) It averaged (92.083) cm on the comparison treatment (P0), where it averaged (81.353), because organic fertilization works to increase nutrients by the roots as well as increase the readiness and dissolution of phosphorous element and thus increases the amount of absorption by the plant and increase the height of the plant and this It agrees with the results The same table shows that mineral fertilization has a significant effect, as the treatment (D2), which averaged (89.640) cm, while the comparison treatment (D0), which averaged (86.10) cm, is due to the fact that mineral fertilizer works to increase root cells as well as works to absorb nutrients and increase plant growth and this is consistent with the results of [12].

Table No. (2) shows that the binary interaction between (Glomus mosseae) and mineral fertilizer had a significant effect, where the treatment (G1D2), which averaged (91.444) cm, outperformed, while the control treatment (G0D0), which averaged (85.190) cm, was due to the fact that the fungus works to increase the height of the plant and also works to absorb Many nutrients and elements, including phosphorous, and the effect of interaction between fertilizers decreases when the level of mineral fertilizer increases, and this is consistent with [13]،As for the bilateral interaction between organic and mineral fertilizers, it had a significant effect, and the treatment outperformed (P1D2), which averaged (94.137) cm, while the comparison treatment averaged (79.800) cm, due to the fact that the interaction between organic and mineral fertilizers has a significant effect on the decrease in phosphorous, which is a source of mineral support [14].

As for the triple interaction, which gave a significant effect, the treatment outperformed (G1P1D2), which averaged (94.633) cm, while the comparison treatment averaged (76,430) cm.

Table 2. Effect of fungal inoculation, cow manure and dab fertilizer on wheat plant growth and the Availability of iron and zinc in soil on the content of plant height (cm).

G*P	dab fertilizer			Cow manure	Fungi
	D2	**D1**	**D0**		***Glomus mosseae***
77.519	78.777	77.350	76,430	P0	
92.153	93.640	92.130	90,690	P1	G0
89.784	91.090	89.813	88.450	P2	
85,187	87.587	84.803	83.170	P0	
92.013	94,633	93.750	87.657	P1	G1
91.138	92.113	91.090	90.210	P2	
0.329 LSD G*P		0.569		LSD G*P*D	
			G*D		
medium fungi	D2	D1	D0	Fungi	
86.486	87.836	86,431	85,190	G0	
89,446	91.444	89,881	87.012	G1	
0.190 LSD G		0.329		LSD G*D	
			P * D		
average residue	D2	D1	D0	Cow manure	
81.353	83.182	81.077	79.800	P0	
92,083	94.137	92.940	89.173	P1	
90,461	91.602	90,452	89.330	P2	
0.232 LSD		0.403		LSD P*D	
	89.640	88.156	86.101	Dab fertilizer averages	
		0.232		LSD D	

3.2. Chlorophyll

Table No. (3) shows that fertilization with mushrooms (Glomus mosseae) has a significant effect, as the treatment (G1), which averaged (44,905) SPAD, outperformed the treatment of no addition, which averaged (42.194) SPAD, and the reason for this is that the mycorrhizal system works to increase the absorption of elements, including nitrogen and magnesium, as well as works to increase chlorophyll and the proportion of Infection as well as root density, and this is consistent with the results of [15] , and Table No. (3) shows that organic fertilization has a significant effect, where the treatment (P1), which averaged (46.226) SPAD, outperformed the comparison treatment (P0), which averaged (40.431)SPAD, and the reason for this is that organic fertilizers have an important role as they release nutrients including (NPK) and some of them in promoting growth, improving soil properties and increasing the efficiency of microorganisms as well as in promoting plant growth [16],The table also shows that mineral fertilizers has a significant effect, as the treatment (D2) outperformed, which averaged (45.292) SPAD on the comparison treatment, which averaged (42.386) SPAD, and this is due to the fact that mineral fertilizers have a significant impact on chlorophyll content and nutrient levels, which led to an increase in nitrogen content in the plant, which plays directly in the formation of chlorophyll pigment [17].

The binary interaction between fungi (Glomus mosseae) and mineral fertilizer had a significant effect, as the treatment (G1D2) and its average (46,509) SPAD outperformed the control treatment (G0D0), which averaged (42.194) SPAD, and the reason for this is that the fungus (Glomus mosseae) works to extend its cells, dissolve and prepare nutrients Including phosphorous, which increases the content of chlorophyll, and this is consistent with the results of [18].

As for the bilateral interaction between the organic and mineral fertilizers, it had a significant effect, where the treatment outperformed (P1D2), which averaged (48.418) SPAD on the comparison treatment (P0D0), which averaged (39.962) SPAD, and the reason for this is that the interaction between fertilizers has an important effect as it increases the chlorophyll content in the plant and this is consistent with the results [19].

As for the triple interaction, which gave a significant effect, the treatment outperformed (G1P1D2) which averaged (51.547) SPAD on the comparison treatment (G0P0D0), which averaged (38.777) SPAD

Table 3. Effect of fungal inoculation cow manure and dab fertilizer on wheat plant growth and the Availability of iron and zinc in soil on the content of chlorophyll in leaves (SPAD).

G*P	**dab fertilizer**			**Cow manure**	**Fungi**
	D2	**D1**	**D0**		***Glomus mosseae***
39,423	40.240	39.253	38.777	P0	
44.194	45,290	44.827	42.467	P1	G0
46.101	46.697	46.267	45.340	P2	
41.439	41.753	41.417	41.147	P0	
48,257	51.547	50.903	42.320	P1	G1
45.019	46.227	44.563	44.267	P2	
0.265 LSD G*P		0.458		LSD G*P*D	
			G*D		
medium fungi	D2	D1	D0	Fungi	
43.240	44.076	43,449	42.194	G0	
44.905	46.509	45,628	42.578	G1	
0.153 LSD G		0.265		LSD G*D	
			P * D		
average residue	D2	D1	D0	bovine waste	
40,431	40.997	40,335	39.962	P0	
46.226	48.418	47.865	42.393	P1	
45,560	46.462	45.415	44.803	P2	
0.187 LSD		0.324		LSD P*D	
	45,292	44.538	42.386	Dab fertilizer averages	
		0.187		LSD D	

3.3. Concentration of Ready Iron in The Soil

Table No. (4) shows that inoculation with a fungus (Glomus mosseae) has a significant effect, as the treatment (G1), which averaged (9.739) mg Fe kg $^{1-}$ soil, outperformed the non-additive treatment (G0), which averaged (9.460) mg Fe kg $^{1-}$ soil, due to the fact that the Mycorrhizal fungus works on Increasing the readiness of the elements and converting them from the unprepared form to the ready form, and this is done through the process of reduction, and this is consistent with the results of [20] and the table also shows that the organic fertilization has a significant effect, where the treatment (P1) outperformed, which averaged (10.850) mg Fe kg $^{-1}$ soil, as for the comparison treatment (P0) where it averaged (7.491) mg Fe kg $^{-1}$ soil, and the reason for this is that organic fertilizers have an important function which is decreasing the soil pH value as well as increasing the availability of nutrients including iron, which plays an important role in absorbing Iron deposits and increasing its availability in the soil [21], as well as the same table shows that mineral fertilizer has a significant effect, where the treatment (D1) outperformed, which averaged (9.871) mg Fe kg $^{-1}$ soil, and the comparison treatment (D0) where it averaged (9.126) mg Fe kg $^{-1}$ soil, and the reason for this is that mineral fertilization works to absorb phosphorous, as well as a decrease in the sedimentation process in the soil and an increase in its readiness in the soil, and this is consistent with [22] .

The binary interaction between fungi (Glomus mosseae) and mineral fertilizer had a significant effect, where the treatment (G1D2), which averaged (10,416) mg Fe kg $^{-1}$ soil, was superior, while the control treatment (G0D0) had an average of (9.187) mg Fe kg ^{1} soil, and the reason for this is that the interaction Between bio-fungal fertilization and mineral fertilizer works to increase the absorption and dissolution of nutrients by extending the mycorrhizal fungi and secreting growth-stimulating substances and hormones that increase the availability of iron and this is consistent with [23], while the bilateral interaction between organic and mineral fertilization has an effect Significantly, the treatment (P1D2), which averaged (11.552) mg Fe kg $^{-1}$ soil, was superior, while the control treatment (P0D0), which averaged (7.175) mg Fe kg ^{1} soil, was due to the fact that the interaction increases the amount of phosphorous that leads to Low iron solubility as well as low soil pH value and this is in agreement with the results [24].

As for the triple interaction, which gave a significant effect, the treatment outperformed (G1P1D2), which averaged (12.543) mg Fe kg $^{-1}$ soil, as for the control treatment (G0P0D0), which averaged (6.620) mg Fe kg $^{-1}$ soil.

Table 4. Effect of fungal inoculation, cow manure and dab fertilizer on wheat plant growth and the Availability iron and zinc on the concentration of ready iron in the soil (mg kg^{1-} soil).

G*P	dab fertilizer			bovine waste	mushroom
	D2	D1	D0		*Glomus mosseae*
6.951	7.457	6.777	6.620	P0	
10,537	10,560	10,487	10.563	P1	G0
10.891	9.543	11.630	11.500	P2	
8.030	8.327	8.033	7.730	P0	
11.163	12,543	12,080	8.867	P1	G1
10.023	10.377	10.217	9,477	P2	
0.233 LSD G*P		0.403		LSD G*P*D	
		G*D			
medium mushroom	D2	D1	D0	mushroom	
9,460	9.561	9.631	9.187	G0	
9.739	10.416	10.110	8.691	G1	
0.134 LSD G		0.233		LSD G*D	
		P * D			
average residue	D2	D1	D0	bovine waste	
7.491	7.892	7.405	7.175	P0	
10.850	11,552	11,283	9.715	P1	
10.457	9.960	10.923	10,488	P2	
0.165 LSD		0.285		LSD P*D	
	9.801	9.871	9.126	Dab fertilizer averages	
		0.165		LSD D	

3.4. Ready Zinc Concentration in Soil

Table No. (5) shows that inoculation with a fungus (Glomus mosseae) had a significant effect, where the treatment (G1), which averaged (0.340) mg Zn kg $^{-1}$ soil, excelled, while the non-addition treatment (G0), which averaged (0.326) mg Zn kg $^{-1}$ soil, was superior to that because the mycorrhizal fungus has the ability to increase root cells as well as increase Nutrients and their uptake by the plant and this is consistent with the results of as well as the table shows that organic fertilization has a significant effect where the treatment (P2) excelled, which averaged (0.347) mg Zn kg $^{-1}$ soil, while the comparison treatment (P0), which averaged (0.308) mg Zn kg $^{-1}$ soil, and this is due to the fact that organic fertilizer works to decompose compounds and convert them from one form to another, as well as it has the ability to preserve some elements from sedimentation processes, including zinc and the rest of the other elements, and this is consistent with the results [25], and the table also shows that mineral fertilization has a significant effect, where the treatment (D2) outperformed, which averaged (0.339 mg Zn kg $^{-1}$ soil. As for the comparison treatment (D0), which averaged (0.326) mg Zn kg $^{-1}$ soil, the reason for this is that mineral fertilization increases the availability of nutrients, as well as that microorganisms have the ability to excrete some elements, including zinc, and this It agrees with the results [26].

The binary interaction between fungi (Glomus mosseae) and mineral fertilizer had a significant effect, where the treatment (G1D2) was superior, and its average was (0.344) mg kg $^{-1}$ soil, while the comparison treatment averaged (0.316) mg Zn kg $^{-1}$ soil, and the reason for this is that the interaction between the fungus and mineral fertilizer works on The conversion of the elements from an unprepared form to a ready form, as well as a decrease in the value of soil pH and an increase in microorganisms in the soil, and this is consistent with the results of [27], while the bilateral interaction between organic and mineral fertilizers has a significant effect, where the treatment (P2D2) outperformed and reached Its average was (0.349) mg Zn kg $^{-1}$ soil, while the comparison treatment (P0D0) averaged (0.291) mg Zn kg $^{-1}$ soil, and the reason for this is that the interaction increases the availability of nutrients as well as increasing the solubility of phosphorous and this is consistent with the results of [28,29]، As for the triple interaction, which gave a significant effect, the treatment outperformed (G1P2D2), which averaged (0.352) mg Znkg $^{-1}$ soil, while the control treatment (G0P0D0), which averaged (0.263) mg Znkg $^{-1}$ soil.

Table 5. Effect of fungal inoculation, cow manure and dab fertilizer on wheat plant growth and the availability of iron and zinc on the concentration of ready zinc in the soil (mg kg $^{-1}$ soil).

G*P	dab fertilizer			bovine waste	mushroom
	D2	D1	D0		*Glomus mosseae*
0.290	0.310	0.296	0.263	P0	
0.344	0.345	0.345	0.344	P1	G0
0.345	0.346	0.347	0.342	P2	
0.326	0.333	0.327	0.318	P0	
0.345	0.347	0.346	0.343	P1	G1
0.350	0.352	0.350	0.347	P2	
0.004 LSD G*P		0.007		LSD G*P*D	
			G*D		
medium fungi	D2	D1	D0	mushroom	
0.326	0.334	0.329	0.316	G0	
0.340	0.344	0.341	0.336	G1	
0.002 LSD G		0.004		LSD G*D	
			P * D		
average residue	D2	D1	D0	Cow manure	
0.308	0.321	0.312	0.291	P0	
0.345	0.346	0.345	0.343	P1	
0.347	0.349	0.348	0.344	P2	
0.003 LSD		0.005		LSD P*D	
	0.339	0.335	0.326	Dab fertilizer averages	
		0.003		LSD D	

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