Effect of interaction between two types of mycorrhizae and vermicompost on soil biological traits and growth of corn plant

Ameer salam abd alsada
Salwan AL-Maliki
ameer_salam@agre.uoqasim.edu.iq
salwan85@agre.uoqasim.edu.iq

Abstract

An experiment was conducted for year 2023-2024 in one of the agricultural fields in Al- Tajiya area, which is 6 km away from the center of Babylon province, during the spring season of corn (Zea mays) crop on 15\3\2024 in a soil with a clay texture. Two factors were used in the experiment, the first is vermicompost at four levels and the second is two types of mycorrhizae. The results of the study showed that the treatment of adding mycorrhizae at the second level M2 was superior to increasing biomass carbon, the percentage of mycorrhizal infection, the activity of microorganisms and the total yield of the plant, as it gave (4021 g kg-1 soil 83.75% - 26.7 mg CO2 g-1 soil - 2.16 tons hectares-1) for each of them in succession, while the treatment of adding vermicompost v3 was superior to all the factors of the study above and gave (5200 g kg-1 soil 79.44% - 29.46mg CO2 gm-1 soil - 2.89 tons hectares--1) for each of them respectively, while bi-interaction between mycorrhizae and vermicompost gave superiority to the V3M2 treatment which excelled in all study criteria and gave (6903 gm kg-1 soil 93.33% - 30.02mg CO2 gm-1 soil - 3.16 tons hectares--1) for each of them respectively .

Introduction

corn Zea mays is considered one of the most important food and industrial grain crops in many regions of the world, as it is a basic component in human and animal nutrition and has a major role in food industries of high economic importance (Molazem and Azimi, 2011) and its stems and leaves can be used in paper industry (Sachin and Misra, 2009). It ranks third in the world after wheat and rice in terms of cultivated area and production. The most important regions producing it in the world are North and South America, Eastern Europe, Russia, China and India, while in Iraq it ranks fourth after wheat, rice and barley, as the cultivated area is small. The 2021 statistics for the production rate of corn in Iraq showed a production of 374.4 thousand tons, a decrease of 45 thousand tons from the previous season, which amounted to 419.3, and this is not in line with the global productivity rate, which is low compared to the countries of the world (Directorate of Agricultural Statistics, 2020). Mycorrhizal fungi are spread in all types of soils and over a wide and large range of the ecosystem until they reach desert and tropical areas, aquatic environments and forest environments. We also guarantee the presence of mycorrhizal fungi in soils rich in organic matter and mineral elements. Plants growing in temperate regions have a greater density of mycorrhizal fungi, and there is little and weak evidence of the formation of mycorrhizal colonies in dry soils and also in hydroponic farms and swampy soils. There are several ways to add mycorrhizal inoculum to the root zone, either mixing the inoculum with soil or organic fertilizer or mixing the inoculum with seeds or direct injection into trees. Studies have shown that Mycorrhizal fungi stimulate plants to

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absorb nutrients in soils that suffer from a lack of elements, especially unavailable phosphorus, and thus increase plant growth. Mycorrhizal fungi also improve the ability of microorganisms to fix nitrogen (Barker and Tagu, 2000). Rajeshkannan et al. (2009) indicated that mycorrhizal fungi have the ability to stimulate root hair growth by increasing the amount of growth regulators in the medium (cytokinin, auxin, and gibberellin) that stimulate root hairs and thus increase the process of nutrient absorption from the soil. Due to the lack of studies in the country on these factors, the study aimed to

-1Study the effect of vermicompost and two types of mycorrhizae on soil biomass MB and growth and yield of corn

-2Finding the best level of vermicompost and mycorrhizae inoculum and its effect on soil biological properties and plant growth

-3Comparison of the effect of mycorrhizae types on soil biological properties and growth and yield of corn

Materials and methods

The experiment was coundected for year 2023-2024 in one of the agricultural fields in Al- Tajiyah area, which is 6 km from the center of Babylon province, during the spring season of corn (Zea mays) crop on 3/15/2024 in a soil with a clay texture. Two factors were used in the experiment, the first was vermicompost at four levels and the second was two types of mycorrhizae. The treatments were coded as follows:

Vermicompost (V0, V1, V2, V3) - (0, 5, 10, 20) tons ha-1

Mycorrhizae

M0 (control treatment(

M1 10 g experimental unit-1 of mycorrhizal fungus of the Mosse type

M2 10 g experimental unit-1 of mycorrhizal fungus of the Intredices type

studied traits

Total yield (ton ha-1)

It was calculated from the rate of multiplying the weight of the grains per plant × the plant density (Al-Sahoki, 1990)

Measuring the percentage and severity of mycorrhizal infection%

The method described by (Phillips and Hyman, 1970) was used to calculate the percentage and severity of mycorrhizal fungus infection according to the following equation:

Mycorrhizal infection percentage =(Number of pigment root pieces)/(Total number of pieces)×100

The severity of the injury was extracted according to the following equation:

Severity of infection=(Total number of infected pieces * degree of infection)/(The total number of pieces tested * Highest degree of infection)×100

Biomass carbon

Done according to the method described in (Horwath et al., 1996) by incubating the soil with chloroform cf

Total plant yield ton/dm-1

Calculated by multiplying the average grain weight per plant by the plant density used per hectare Sahoki, 1990

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Table 1 Chemical, physical and biological characteristics of field soil before planting

References	value	units	traits
	1		**Sample No soil**
Pege et al., 1982)	**3.5**	**dS m^{-1}**	**EC**
Pege et al., 1982)	**8.1**	**-**	**pH**
	5	**meq L^{-1}**	**SO_4**
Pege et al., 1982(	**12.8**	**mg.kg^{-1}**	**P**
	37.29		**N**
	139		**K**
Bashour and Al-Sayegh 2007	**6.00**	**Mmol.L^{-1}**	**Na**
	Nil		**CO_3**
	6		**HCO_3**
	10		**Ca**
	6		**MG**
	10.2		**CL**
Jackson,1958	**1.03**	**g.kg^{-1}**	**O.M %**
Bashour and Al-Sayegh 2007	**15**	**Centimeter of charge kg-1 soil**	**CEC**
Black,1965	**1.23**	**Mg.g^{-1}**	Bulk density
Black.1965	**0.45**	**%**	Oxidized organic carbon
Richards,1954	**6.3**	**Mmol L-1**	**SAR**
Black,1965	**42**	**g.kg^{-1}**	**Sand**
	25		**Silt**
	33		**Clay**
	Clay loam		**Texture**

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-3Results and discussion

Soil microbial activity of corn (mg CO2 gm-1 soil(

The activity of microorganisms expresses the release of carbon dioxide in the soil due to the decomposition of organic matter in it, as the results of the statistical analysis showed (Table 3) a significant effect of vermicompost on soil microbial activity, as treatment V3 was significantly excelled and gave the highest average of 29.46 mg CO2 gm-1 soil compared to control treatment V0 (without fertilization) which It gave the lowest average compared to the rest of the treatments, which amounted to 19.3 mg CO2 g-1 soil, and the reason is due to the availability of organic carbon in addition to the ability of these organisms to decompose the carbon present in the vermicompost and their ability to secrete organic acids and release CO2, as compost fertilizer is an important source for microorganisms present in the soil. It is also noted in the same table that there is a significant effect of mycorrhizal fungi on the activity of microorganisms mg CO2 g-1 soil, as the M2 fertilization treatment for mycorrhizal type intradices outperformed and gave the highest average of 26.7 mg CO2 g-1 soil, and the reason for this is attributed to .(the presence of a high rate of mycorrhizal infection in the root zone in addition to the decomposition of organic carbon, which increases the activity of microorganisms, which contributes to increasing the release of carbon dioxide. The results of bi-interaction between vermicompost and mycorrhizal fungi achieved a significantly excelled as shown in the same table, as the interaction treatment (V3M2) mycorrhizal type Intredeces recorded the highest average of 30.2 mg CO2 g-1 soil, which did not differ significantly from bi-interaction treatment (V3M1) mycorrhizal type Mossea, which gave an average of 24.2 compared to control treatment (V0M0) without fertilization, which recorded an average of 16.5 mg CO2 g-1 soil. The reason for this is that adding compost led to the provision of organic carbon, which works to increase the activity of mycorrhizal fungi, which contributed to increasing the percentage of released carbon (Oehl et al., 2003). Mycorrhizal fungi also have a major role, as they secrete clomalin in addition to proteins and sugars, thus making the soil a good and suitable medium for growth. Other microorganisms (Upadhyaya and Wright, 1996

Table 2 Effect of interaction between two types of mycorrhizae and vermicompost on the activity of microorganisms CO2 -1 soil

Average effect of vermicompost	Mycorrhizal levels			Vermicompost levels
	M_2	M_1	M_0	
19.3	18.8	17.3	16.5	V_0
22.01	21.1	19.00	17.2	V_1
24.00	23.5	22.1	17.8	V_2
29.46	30.2	24.2	18.3	V_3

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	26.7	23.12	20.3	Average effect of mycorrhizae
mycorrhizal	interaction		vermicompost	L.S.D (0.05)
M	M*V		V	
0.76	1.12		0.88	

3-2Percentage of mycorrhizal infection in roots(%)

The results of the statistical analysis Table 4 showed a significantly excelled of adding compost fertilizer (vermicompost) in the percentage of mycorrhizal infection%, where treatment V3 was significantly excelled and gave an average of 79.44% compared to control treatment , which gave a lower average of 68.33%. The reason for this is the increase in the percentage of mycorrhizal infection when adding vermicompost to the presence of a high percentage of carbon, phosphorus and nitrogen elements that stimulate fungal growth, which increases the percentage of mycorrhizal infection (AL- Fahdawi, 2016). In the same context, the presence of organic matter led to providing a suitable environment for fungal growth and increasing the production of biomass for plants, which increases the percentage of mycorrhizal infection. We also note the presence of a significant effect of adding mycorrhizae on the percentage of mycorrhizal infection %, as treatment M2 was significantly excelled and gave the highest average of 83.75% compared to control treatment M0 which recorded 64.58%, and the reason for this is that adding mycorrhizae led to an increase in the number of spores in the soil, which led to an increase in the percentage of mycorrhizal infection. These results are consistent with what was stated by (Zhe Hu et al., 2005, Sharif et al., 2010, Rakshit and Bhadori, 2010), as researchers recorded a significantly excelled when inoculating with mycorrhizal fungus (Glomus Mossea) for the corn crop, and this is what the results showed in Table (4) came, where mycorrhizae type Mossea M1 recorded an average of 73.33% and showed a significantly excelled compared to treatment M0 (without vaccination) gave an average of 64.58%. We also note the presence of a significant effect of bi-interaction between mycorrhizal fungi and vermicompost on the percentage of mycorrhizal infection %, as the V3M2 treatment (Intredecs mycorrhizal) was significantly excelled and gave the highest average of 93.33, which did not differ significantly from bi-interaction treatment (V3M1) (Mossea mycorrhizal) which gave an average of 80.00 compared to control treatment (V0M0) which recorded 60.33. These results are consistent with what many studies have shown, Daei et al. (2009), Rahi et al. (2014) and Giri et al. (2009), which indicated that the availability of vermicompost in the soil improves soil aeration because it improves its morphological composition and thus facilitates the process of root penetration in addition to the ability of hyphae to optimally utilize organic matter and absorb water and nutrients, which increases the percentage of mycorrhizal infection .

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Table 3 Effect of interaction between two types of mycorrhizae and vermicompost on the percentage of mycorrhizal infection(%)

Average effect of vermicompost	Mycorrhizal levels			Vermicompost levels
	M_2	M_1	M_0	
68.33	73.33	68.33	60.33	V_0
70.56	81.67	68.33	61.67	V_1
77.22	86.67	76.67	68.33	V_2
79.44	93.33	80.0	65.0	V_3
	83.75	73.33	64.58	Average effect of mycorrhizae
mycorrhizal	interaction		vermicompost	L.S.D (0.05)
M	M*V		V	
2.74	5.49		3.17	

3-3Biomass carbon mbc (mg kg-1 soil(

The results in Table 5 showed a significantly excelled of biomass carbon when adding compost, as treatment V3 was significantly excelled and gave the highest averages of 5200 compared to control treatment V0, which gave the lowest value among the averages of 2907. The reason for this is that vermicompost increases the percentage of organic carbon present in the soil and thus increases biomass carbon, in addition to containing potassium, which is considered to have a major role in stimulating the photosynthesis process, the products of which represent most of the secretions present in the root zone, including organic carbon, which is a major source of energy and food for microorganisms (Lal, 2004). It was also noted that there was no significantly excelled of biomass carbon when adding mycorrhizal fungi, as treatment M2 did not outperform, which gave an average of 4021 compared to control treatment M0, which gave an average of 3390. While the treatment of bi-interaction between mycorrhizal fungi and vermicompost recorded a significantly excelled of the interaction, as the interaction treatment V3M2 gave the highest average of 6903 compared to control treatment V0M0, which gave the lowest average of 2671. The reason for this is that compost contributes to providing nutrients that increase carbon, which contributes significantly to the process of photosynthesis, between 4-20% of the photosynthesis process is transferred to fungi and used to produce bacteria and biomass in the soil (Smith and Read, 2008.(

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Table 4 Effect of interaction between two types of mycorrhizae and vermicompost on biomass mbc g kg-1 soil

Average effect of vermicompost	Mycorrhizal levels			Vermicompost levels
	M_2	M_1	M_0	
2907	2853	2732	2671	V_0
4512	5109	4963	4244	V_1
4934	5486	5409	4882	V_2
5200	6903	6594	6268	V_3
	4021	3906	3390	Average effect of mycorrhizae
mycorrhizal	interaction		vermicompost	L.S.D (0.05)
M	M*V		V	
1060	2368		1578	

Total plant yield ton dunm-1

The results of the statistical analysis in Table 5 showed a significantly excelled of the total yield (ton d-1) when adding compost fertilizer, as treatment V3 outperformed and gave the highest average of 2.89 (ton d-1) compared to control treatment V0 which gave the lowest average of 0.84 (ton d-1). The reason for this is due to the role of organic matter in improving soil properties by releasing organic acids that contribute to reducing the degree of soil reaction (pH) in addition to increasing the supply of nutrients necessary for plant growth, which led to a positive reflection on the vegetative growth of the plant and thus an increase in the yield (Havlin et al., 2005) and Al-Dahri et al. (2006.(

The results of the statistical analysis also showed a significant effect of adding mycorrhizal vaccines on the total yield (ton d-1), as treatment M2 was significantly excelled and gave the highest average of 2.16 (ton d-1) compared to control treatment M0, which gave 1.83 (ton d-1). The reason for this is that mycorrhizal works to absorb the NPK nutrients and also the microelements such as Zn, in addition to producing growth regulators that work to stimulate the root hairs of the plant, thus increasing productivity (AL-Khaliel et al., 2010). It was also noted that there were significant differences in the bilateral interaction between mycorrhizal fungi and vermicompost in the total yield (ton d-1), as the interaction treatment V3M2 was significantly excelled and gave the highest average of 3.16 (ton d-1) compared to control treatment which gave the lowest average of 0.63 (ton d-1). The reason for this is that the relationship between mycorrhizal fungi and vermicompost provides the plant with its nutritional needs, which contributes significantly to activating the vital and physiological processes within the plant, as it enters into the composition of proteins and enzymes and the composition of the chlorophyll pigment responsible for the photosynthesis process which leads to the formation of sugars, which contributes to

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increasing the productivity of the total yield of the plant (Miransari, 2011 .(

Table 5 Effect of interaction between two types of mycorrhizae and vermicompost on the total yield of the plant, ton d-1

Average effect of vermicompost	Mycorrhizal levels			Vermicompost levels
	M_2	M_1	M_0	
0.84	1.21	1.16	0.63	V_0
2.22	1.57	1.53	1.48	V_1
2.51	2.26	2.12	1.59	V_2
2.89	3.16	2.17	1.97	V_3
	2.16	2.10	1.83	Average effect of mycorrhizae
mycorrhizal	interaction		vermicompost	L.S.D (0.05)
M	M*V		V	
0.22	0.34		0.19	

-4Conclusions

-1

The use of vermicompost at a concentration of (20 tons h-1) leads to improving soil conditions in addition to increasing the availability of nutrients in the soil, which leads to improving the total yield of the plant.

-2The mycorrhizal inoculum of the Intredecs type is relatively better than the mycorrhizal inoculum of Mossea

-3Bi-interaction between mycorrhizal fungi and organic fertilizer (compost) contributed to improving most of the soil fertility and vitality characteristics in addition to the growth and productivity characteristics of the corn plant

References

{1}Al-Sahouki, Madhat Majeed (1990). Corn, its production and improvement. University of Baghdad, Ministry of Higher Education and Scientific Research, Iraq, p. 488

{2}Al-Dahri, Abdullah Abdul-Jamil, Essam Khadir Al-Hadith, and Muhammad Musleh Al-Alwani. 2006 Effect of moisture stress levels and organic matter on some morphological and physiological characteristics of white corn, Anbar Journal of Agricultural Sciences: 4 (1): 49 – 61.

{3}Bishour, Issam, Antoine Al-Sayegh, 2007. Methods of soil analysis in arid and semi-arid regions, American University of Beirut - Lebanon.

Directorate of Agricultural Statistics, Ministry of Planning, Republic of Iraq (2020). Production of cotton, corn and potatoes

{4}Alfahdawi.Aws Ali .(2016).Efficiency of dual inoculation with Glomus mosseae and Rhizobium leguminosarum in reducing chemical fertilization in Broad bean Vicia faba L. Master Thesis.College of agriculture.University of Al- Anbar.

{5}Al-Khaliel A. S. 2010. Effect of salinity stress on mycorrhizal association and growth

response of peanut infected by Glomus mosseae. Plant, Soil and Environment., 56, (7): 318–324.

{6}Barker, S.J. and D. Tagu. 2000. The roles of auxins and cytokinins Mycorrhizal symbiosis. J. of Plant Growth Regulation (19). 2:144 - 154.

{7}Havlin, J.L., J.D.Beaton, S.L.Tisdale. and W.L.Nelson .2005. Soil fertility and fertilizers: 7th Ed.An introduction to nutrient management Upper .Saddle River, NewJersey. USA.

{8}Horwath, W. R., Paul, E. A., Harris, D., Norton, J., Jagger, L., & Horton, K. A. 1996. Defining a realistic control for the chloroform

{9}Miransari ,M. 2011. Interactions between arbuscular mycorrhizal fungi and soil bacteria . Appl. Microbiol. Biotechnol., 89: 917-930.

{10}Molazem, D., & Azimi, J. (2011). Proline reaction, peroxide activity and antioxidant enzymes in varieties of maize (Zea mays L.) under different levels of salinity. Australian Journal of Basic and Applied Sciences, 5(10), 1248-1253.

{11}Oehl, F., E. Sieverding, K. Ineichen, P. Mader, T. Boller and A.Wiemken. 2003. Impact of land use intensity on the species diversity of arbuscular mycorrhizal fungi in agroecosystem of Central Europe. Applied Environ. Microbial., 69:2816-2824.

{12}Page , A. L. ; R. H. Miller and D. R. Keeney .1982.Methods of soil Analysis .Part 2 .Chemical & Microbiological properties . Am. Soc. Agron.Madision, WI.

{13}Rajeshkannan ,V., Sumathi, CS and Manian,S .2009. Arbuscular mycorrhizal fungi colonization in upland rice as influenced by agrochemical application. Rice Science 16:307-313. fumigationincubation method using microscopic counting and 14 C - substrates. Canadian Journal of Soil Science, 76 (4), 459 -467.

{14}Sachin, D. N., & Misra, P. (2009). Effect of Azotobacter chroococcum (PGPR) on the growth of bamboo (Bambusa bamboo) and maize (Zea mays) plants. Biofrontiers, 1(1), 24-31.

{15}Smith, S.E. and D. J. Read .2008. Mycorrhizal Symbiosis, 3rd Ed; Academic Press, London : 787.

{16}Wright, S.F and Upadhyaya, A.1996. Extraction of an abundant and unusual protein from soil and comparison with hyphal protein of arbuscular mycorrhizal fungi. Soil Sci., 161 :575-586

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