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RESEARCH PAPER

Combination Effect of Mycorrhizal Inoculation and Phosphorus Fertilizer on Yield Components of two Wheat Species

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A B S T R A C T:

A pot experiment was conducted in green house of college of Science, University of Salahaddin- Erbil, during November 9th 2009 to May 4th2010, to study the effect of two levels (0, 20g.pot^{-1}) of mycorrhizal inoculation, four levels (0.0, 25, 50, 75kg.dounm^{-1}) of phosphorus fertilizer and their combination on yield components, on two wheat species *Triticum durum* L. and *Triticum aestivum* L. by using factorial complete randomized design (CRD) with three replicates. The result showed that the application of mycorrhizal inoculation in both wheat species significantly ($p \leq 0.05$) affected total dry matter, grain weight, straw weight, grain yield and biological yield. While the application 50kg.dounm^{-1} of phosphorus fertilizer increased grain yield by 22.554% in *Triticum durum* L. and 22.554% in *Triticum aestivum* L. over control. Whereas application of 25kg.dounm^{-1} of phosphorus fertilizer with mycorrhizal inoculation, increased grain yield by 65% in *Triticum durum* L. and 50kg.dounm^{-1} of phosphorus fertilizer with mycorrhizal inoculation, increased grain yield by 135.372% in *Triticum aestivum* L. compared to control.

KEY WORDS: Mycorrhizae, phosphorus and wheat.
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1. INTRODUCTION:

Wheat is the main cereal crop in Iraq and constitutes the main food in the country, particularly the north region which has a total cultivation area. It is average and total production are not consistently increasing to meet up the growing demand of Iraq population, thus a special attention should be given to produce higher yield, due to increase the population in the world on one hand and rise of price on the other hand. Mycorrhizal fungi are an important symbiotic relationship between fungi and plant roots, whereas the mycorrhazal infection enhances plant growth, yield, and nutrient uptake like phosphate, especially when phosphate and other immobile nutrients are in short supply, they may also be beneficial when water in short supply. However, such mycorrhizae are of a great agronomic and ecological significance (Khanam, *etal.*, 2006).

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In many agriculture production system, phosphorus has been identified as the most efficient essential nutrient after nitrogen, because the most essential function of phosphorus is the storage and transfer of energy, there are many researchers studied the effect of mycorrhizal inoculation on some yield component of crop like (Kucey, 1987,Giorgio *etal*,2004 and Babana and Antoun, 2006), they showed that the mycorrhizal inoculation have the positive role on yield component of wheat. While (Dawood, 1976, Gerwing, *etal.*,1999 , Mehdi, *etal.*,2001,Samad, *etal.*,2002,Shah, *etal.*,2003, Alam, *etal.*,2003 and Li, *etal.*, 2005) were explained the positive role of phosphorus fertilization in wheat yield. Whereas there are a few studied about Combination effect of mycorrhizal inoculation and phosphorus fertilizer on yield components of wheat in Iraq Kurdistan region (Shekhany, 2001, Raiesi and Ghollarata, 2006 and Muhammad, *etal.*, 2004) explained that the application of phosphorus fertilizer with mycorrhizal inoculation led to increase the yield component of wheat, while the application of high level of phosphorus causes the decrease in infection of plants with mycorrhiza. The calcareous soil is wide spread throughout the world involved Kurdistan region soils, thus the availability of phosphorus in these soil is low due to the high calcium carbonate ($CaCO_3$) content which led to chemical fixation of phosphorus (Barker and pilbeam, 2007). The objective of this investigate to Study the effect of mycorrhizal inoculums, phosphorus fertilization, and their combination on yield components of two wheat species.

2-Materials and Methods

This research was carried out in the glass house of the College of Science, University of Salahaddin- Erbil during November 9^{th} 2009 to May 4^{th} 2010, to study the effect of mycorrhizal inoculation and different levels of phosphorus fertilizer on yield component of two wheat species *Triticum durum* L. and *Triticum aestivum* L.The plastic pots with diameter of 40cm and 20cm in height were used in this experiment, each pot packed with 20kg of air-dried soil. The soil sieved through 4 mm sieves, then divided to two parts, the first part sterilized by microwave oven in high power (1100w) which described by (Razavi darbar and Lakzain, 2007), while the second part remained unsterilized. Some physical and chemical properties of the soil were recorded in Table (1). These soil properties were determined according to methods described by (Allen, 1974 and Rechards, 1954) ..Before planting, wheat grains were surface-sterilized in 3% sodium hypochlorite solution for 10 minutes and then soaked in distilled water for 12hours(Li, 2005), then eleven grains were planting in each pot after germination thinned to five. For preparing the mycorrhizal inoculation the seeds of *Vicia faba* was sown in the field and irrigated four times in a week, after growing the roots of faba bean were taken for producing mycorrhizal inoculation. The roots were washed with water to remove the remaining adhering soil particles, then cut in to 1cm segments then mixed with sterilized soil after emphasized the present of mycorrhizal infection , each pot received 20 g.pot^{-1} of mycorrhazal inoculation(Mustafa, 2000).The infection of root was confirmed, by examine the root after clearing it by 10% KOH for 24 hours, then add to 10% HCl for 10 minutes after that washed it by tap water and stained with trypan blue in lacto glycerol, which described by (Phillips and Hayman, 1970). The microscopic examination under (10x and 40x) explain that the mycorrhizal fungi was classified under vesicular-arbascular mycorrhizal fungi (VAMF). Fertilizers treatments consist of four levels (0, 25, 50, 75 kg.dounm^{-1}) of super phosphate, and two level (0, 20g.pot^{-1}) of mycarrhizal inoculation. Mycorrhizal inoculation was applied to each pot with sowing. Phosphorus fertilizer was applied ten days after germination. The fertilizer was evenly mixed with the soil. The factorial experiment was laid out in a complete randomized design (CRD) with three replicates. At harvest the plants were cut at soil surface from each pots, placing in weighted bag oven dried at $(65)^0$C for (48) hours and after that immediately the dry weight was obtained, then plant were separated to straw and grain to calculate some characteristic as follows:-

- Total dry matter (g.pot^{-1}): The weight of total dry matter was obtained after oven dried at $(65)^0$C for (48) hours**.**

- Straw weight (g.pot^{-1}): After harvesting the straw separated and weighted.

- **Grain yield (kg.ha^{-1}):** The grain yield was calculated by using this formula(Islam, *etal.*, 2002).

Grain yield= (Grain weight.pot^{-1}/Area of pot)*10000

- Biological yield (kg.ha^{-1}): The biological yield of plant was calculated by this formula (Islam, *etal.*,2002). Biological yield= (Total dry matter.pot^{-1}/Area of pot)* 10000

- Increase grain yield (%): The increase grain yield was determined by using this formula as described by (Quanbao, *etal.*, 2007).

Increase grain yield %= ((Grain yield of fertilized pot-Grain yield of control pot)/Grain yield of control pot))*100.

Data was statistically analyzed by the computer using SPSS program. The pair comparisons were performed by least significant difference test (L.S.D) and Tukey's MSD produced at 5%and 1%level of probability (Steele and Torrie, 1969).

Table 1: Some physical and chemical properties of soil under study

physical properties		
Particle Size Distribution $g.kg^{-1}$	Sand	638.14
	Silt	295.18
	Clay	66.68
Soil texture	Sandy loam	
Saturation%	29.50	
Field capacity%	14.58	
Chemical properties		
pH	7.94	
ECe $dS.m^{-1}$	0.70	
Organic matter $g.kg^{-1}$	8.23	
Total $CaCO_3$ $g.kg^{-1}$	270	
Total nitrogen $g.kg^{-1}$	0.290	
Total phosphorus $g.kg^{-1}$	0.118	
Available phosphorus $mg.kg^{-1}$	2.78	
Cation $mmol.L^{-1}$		
Potassium	0.60	
Iron	0.0097	

2-1 Results and Discussion

2-1-1- *Triticum durum* L.

2-1-2- Effect of mycorrhizal inoculation on some yield components:

Data present in Table (2) indicated that total dry matter, grain weight, straw weight, grain yield and biological yield were significantly affected by application of mycorrhizal inoculation. The highest values (58.053$g.pot^{-1}$, 21.000$g.pot^{-1}$, 37.049 $g.pot^{-1}$, 1672.327$kg.ha^{-1}$ and 4622.052$kg.ha^{-1}$) of mentioned yield component were recorded in mycorrhizal treatment (M_1), respectively. While the lowest values (49.485$g.pot^{-1}$, 17.090$g.pot^{-1}$, 32.392$g.pot^{-1}$, 1360.933$kg.ha^{-1}$ and 3939.893$kg.ha^{-1}$) of the same yield components were recorded in case of non mycorrhizal treatment (M_0) respectively. However, the grain yield with mycorrhizal inoculation (M_1) increased by (22.880%) over non mycorrhizal inoculation (M_0). This result could be explained on the ground that the mycorrhizal fungi colonize the plant roots and distributed into the surrounding soil, then extending the root beyond the depletion zone around the root system, eventually increase water and nutrient transport to plant root tissues. This result is similar to that reported by (Al-karaki, *etal.*,1998) , they indicated that the shoot dry matter was higher in mycorrhizal infected wheat than for non- infected wheat.

Table (2): Effect of mycorrhizal inoculation on some yield components of *Triticum durum* L..

Treatments	Total dry matter ($g.pot^{-1}$)	Grain weight ($g.pot^{-1}$)	Straw weight ($g.pot^{-1}$)	Grain yield ($Kg.ha^{-1}$)	Biological yield ($Kg.ha^{-1}$)	Increase grain yield %
M_0	49.485	17.090	32.392	1360.933	3939.893	
M_1	58.053	21.000	37.049	1672.327	4622.052	**22.880**
L.S.D. (0.05)	**4.737**	**1.746**	**4.088**	**139.031**	**377.127**	

2-1-3- Effect of phosphorus fertilizer on some yield components:

Table (3) indicated that phosphorus fertilizer application affected significantly ($p \leq 0.05$) the total dry matter, grain weight, straw weight, grain yield and biological yield. The highest values (57.568g.pot^{-1}, 38.920g.pot^{-1}, 4583.404kg.ha^{-1}) and (21.160 g.pot^{-1}, 1684.484 kg.ha-1) of (total dry matter, straw weight, biological yield) and (grain weight, grain yield) were recorded in the treatment (P_1) and (P_2) respectively. While the lowest values (48.474g.pot^{-1}, 17.260g.pot^{-1}, 31.211g.pot^{-1}, 1374.478kg.ha^{-1} and 3859.399kg.ha^{-1}) of total dry matter, grain weight, straw weight, grain yield and biological yield were recorded in the treatment P_0 respectively. The result indicated that the application (50kg.dounm^{-1}) of phosphorus fertilizer led to increasing grain yield by (22.554%) comparing with control. The probable reasons could be that adequate P fertilizer application to soil improving the root growth, then enhancing the shoot growth, subsequently increased the yield component of crop. (Busman, *etal.*, 2002)

Table (3): Effect of phosphorus fertilizer on some yield components of *Triticum durum* L..

Treatments	Total dry matter (g.pot^{-1})	Grain weight (g.pot^{-1})	Straw weight (g.pot^{-1})	Grain yield (Kg.ha^{-1})	Biological yield (Kg.ha^{-1})	Increase grain yield %
P_0	48.474	17.260	31.211	1374.478	3859.399	
P_1	57.568	18.650	38.920	1484.688	4583.404	**8.018**
P_2	55.807	21.160	34.650	1684.484	4443.253	**22.554**
P_3	53.227	19.130	34.100	1522.872	4237.836	**10.796**
Tukye's(0.05)	**6.699**	**2.469**	**5.781**	**196.619**	**533.338**	

2-1-4- Combination effect of mycarrhizal inoculation and phosphorus fertilizer on some yield components:

Table (4) indicated that the combination between mycorrhizal inoculation and phosphorus fertilizer affected significantly ($p \leq 0.05$) the total dry matter, grain weight, straw weight, grain yield and biological yield. Result showed that the highest values (67.669g.pot $^{-1}$, 24.560g.pot^{-1}, 43.109g.pot^{-1}, 1955.392kg.ha^{-1}and 5387.676kg.ha^{-1}) of total dry matter, grain weight, straw weight, grain yield, and biological yield were produced by combination treatment (M_1P_1) respectively. While the lowest values (36.977g.pot $^{-1}$, 22.092g.pot^{-1}, 2944.028kg.ha^{-1}) and (12.736g.pot^{-1}, 1013.984kg.ha^{-1}) of (total dry matter, straw weight, biological yield) and (grain weight, grain yield) were recorded in the combination treatment (M_0P_0) and (M_0P_1) respectively. As well as the result indicated that the application 25 kg.dounm^{-1} of phosphorus fertilizer with mycorrhizal inoculation significantly increased yield component particularly the grain yield which increased by 65.000% comparing with control and the same amount of Phosphorus fertilizer without mycorrhizal inoculation. This result could be explained on the basis that application of phosphorus fertilizer on low quantity improved plant growth particularly roots, this improving made a convenient situation for fungi colonization plant root, whereas the application the high quantity of phosphorus fertilizer to soil decrease the fungi and root association this result and explanation agree with those recorded by (Dalpe and Monreal, 2004) they indicated that the higher phosphorus can inhibit mycorrhizal colonization of plant root.

Table (4): Combination effect of mycorrhizal inoculation and phosphorus fertilizer on some yield components of *Triticum durum* L..

Treatments		Total dry matter g.pot^{-1}))	Grain weight (g.pot^{-1})	Straw weight g.pot^{-1}))	Grain yield Kg.ha^{-1}))	Biological yield Kg.ha^{-1}))	Increase or decrease grain yield %
M_0	P_0	36.977	14.885	22.092	1185.084	2944.028	
	P_1	47.466	12.736	34.730	1013.984	3779.131	**14.438**
	P_2	49.224	18.215	31.009	1450.233	3919.110	**22.374**
	P_3	64.273	22.538	41.735	1794.431	5117.304	**51.418**
M_1	P_0	59.971	19.642	40.329	1563.871	4774.770	**31.963**
	P_1	67.669	24.560	43.109	1955.392	5387.676	**65.000**
	P_2	62.390	24.099	38.291	1918.735	4967.395	**61.907**
	P_3	42.181	15.716	26.465	1251.312	3358.369	**5.588**
Tukye's(0.05)		**14.167**	**5.222**	**12.227**	**415.844**	**1127.996**	

2-1-5- Combination effect of mycorrhizal inoculation and phosphorus fertilizer on some yield components in sterilized and non-sterilized soil:

Table (5) indicated that the combination between mycorrhizal inoculation and phosphorus fertilizer affected significantly ($p \leq 0.05$) the yield component in sterilized and non-sterilized soil. The highest values (97.440g.pot^{-1}, 34.539 g.pot^{-1}, 62.901g.pot^{-1}, 2749.912kg.ha^{-1}and 7757.984kg.ha^{-1}) of total dry matter, grain weight, straw weight, grain yield and biological yield, were recorded from combination treatment ($M_1P_1S_1$) respectively. While the lowest values (28.503g.pot^{-1}, 10.394g.pot^{-1}, 18.110g.pot^{-1}, 827.509kg.ha^{-1} and 2269.374kg.ha^{-1}) of mentioned yield components, were recorded from combination treatment ($M_1P_3S_0$) respectively,the same combination treatment increases the grain yield by 98.076% over control, whereas the grain yield decreased by some other treatments. It appears when inoculums were applied, the root colonization of plants by the mycorrhizal fungus was very extensive, and hence the fungus affected plant development markedly. This result interpreted that in the non-sterilized soil the extensive microbial activities in rhizosphere, which colonized by a wide range of microbes, may be they inhibit the fungi plant association, via exudates substances has a toxic effect on mycorrhiza (Miransari, *etal.*, 2009).

Table (5): Combination effect of mycorrhizal inoculation and phosphorus fertilizer on some yield components of *Triticum durum* L. in sterilized and non sterilized soil.

Treatments		Total dry matter g.pot^{-1}))	Grain weight (g.pot^{-1})	Straw weight g.pot^{-1}))	Grain yield Kg.ha^{-1}))	Biological yield Kg.ha^{-1}))	Increase or decrease grain yield %
M_0	P_0	36.977	14.885	22.092	1185.084	2944.028	
	P_1	47.466	12.736	34.730	1013.984	3779.131	**14.438**
	P_2	49.224	18.215	31.009	1450.233	3919.110	**22.374**
	P_3	64.273	22.538	41.735	1794.431	5117.304	**51.418**
M_1	P_0	59.971	19.642	40.329	1563.871	4774.770	**31.963**
	P_1	67.669	24.560	43.109	1955.392	5387.676	**65.000**
	P_2	62.390	24.099	38.291	1918.735	4967.395	**61.907**
	P_3	42.181	15.716	26.465	1251.312	3358.369	**5.588**
Tukye's(0.05)		**14.167**	**5.222**	**12.227**	**415.844**	**1127.996**	

2-2-1- *Triticum aestivum* L.

2-2-2- Effect of mycorrhizal inoculation on some yield components:

table (6) indicated that the total dry matter, grain weight, straw weight, grain yield and biological yield were affected significantly ($p \leq 0.05$) by mycorrhizal inoculum application. The result showed that the highest values (38.495g.pot^{-1}, 18.449g.pot^{-1}, 20.046g.pot^{-1}, 1468.870kg.ha^{-1} and 3064.918 kg.ha^{-1}) for above yield components, were recorded in mycorrhizal inoculation treatment (M_1) respectively, while the lowest values (34.312g.pot^{-1}, 16.095g.pot^{-1}, 18.217g.pot^{-1}, 1281.433kg.ha^{-1} and 2731.859kg.ha^{-1}) for aboveyield component, were recorded in the non mycorrhiza treatment (M_0) respectively. In general the highest values of yield components were recorded in case of mycorrhizal inoculation plant. Also the result indicated that grain yield was increased by 14.627% with mycorrhizal inoculation compared to control. This result is similar to those reported by Alkaraki *et al.*, (1998) and Kucy, (1987). This result interpreted on the ground that the mycorrhizal enhanced nutritional and water status of the plants and this led to the stimulation of plant growth, nutrient uptake and finally increasing productivity. The water status of the plants improved by increasing the xylem pressure potential by increasing root biomass and therefore, improving water uptake (Newman and Davies, 1987).

Table (6): Effect of mycorrhizal inoculation on some yield components of *Triticum aestivum* L.

Treatments	Total dry matter ($g.pot^{-1}$)	Grain weight ($g.pot^{-1}$)	Straw weight ($g.pot^{-1}$)	Grain yield ($Kg.ha^{-1}$)	Biological yield ($Kg.ha^{-1}$)	Increased grain yield %
M_0	**34.312**	**16.095**	**18.217**	**1281.433**	**2731.859**	
M_1	**38.495**	**18.449**	**20.046**	**1468.870**	**3064.918**	**14.627**
L.S.D. (0.05)	**2.419**	**1.216**	**1.433**	**96.786**	**193.323**	

2-2-3- Effect of phosphorus fertilizer on some yield components:

Table (7) shows that total dry matter, grain weight, straw weight, grain yield and biological yield were affected significantly ($p \leq 0.05$) by phosphorus fertilizer application. The result indicated that the highest values ($43.162 g.pot^{-1}$, $20.045 g.pot^{-1}$, $23.117\ g.pot^{-1}$, $1595.953 kg.ha^{-1}$and $3436.496 kg.ha^{-1}$) of above yield components, were recorded in treatment P_2 respectively. While the lowest values ($26.811 g.pot^{-1}$, $12.832 g.pot^{-1}$, $13.979 g.pot^{-1}$, $1021.628 kg.ha^{-1}$ and $2134.639 kg.ha^{-1}$) of above yield components, were recorded in the treatment P_0 respectively. However, the result revealed that with phosphorus fertilizer application, grain yield was increased by 31.958% to 56.216%over the control. The data analysis in the same table shows that the yield components were increased up to application of $50 kg.dounm^{-1}$ beyond which the decline in yield component observed. The result partially agreed with (Marschner *etal.*,2006 and Gerwing, *etal.*, 1999). This results were interpreted on the basis that the application of the phosphorus fertilizer in adequate quantity improved and developed good root system, then enhancing the root surface area for absorption. However, a high concentration of available phosphorus in the root zone increasing the shoot growth. The application of higher levels of phosphorus fertilizers reduces the plant growth properties, the reason may be due to that the application of higher levels of phosphorus fertilizer causes nutrient imbalance and disrupted the equilibrium state between all forms of phosphorus in soil eventually reduce the nutrient uptake.

Table (7): Effect of phosphorus fertilizer on some yield components of *Triticum aestivum* L.

Treatments	Total dry matter ($g.pot^{-1}$)	Grain weight ($g.pot^{-1}$)	Straw weight ($g.pot^{-1}$)	Grain yield ($Kg.ha^{-1}$)	Biological yield ($Kg.ha^{-1}$)	Increased grain yield %
P_0	26.811	12.832	13.979	1021.628	2134.639	
P_1	40.088	19.278	20.810	1534.905	3191.719	**50.241**
P_2	43.162	20.045	23.117	1595.953	3436.496	**56.216**
P_3	35.554	16.932	18.621	1348.120	2830.700	**31.958**
Tukye's(0.05)	**3.421**	**1.719**	**2.027**	**136.876**	**273.400**	

2-2-4-Combination effect of mycorrhizal inoculation and phosphorus fertilizer on some yield components:

Table (8) indicated that the combination between mycorrhizal inoculation and phosphorus fertilizer affected significantly ($p \leq 0.05$) the total dry matter, grain weight, straw weight, grain yield and biological yield. Result showed that the highest values ($46.045 g.pot^{-1}$, $24.597\ g.pot^{-1}$, $3665.992 kg.ha^{-1}$) and ($21.544 gm.pot^{-1}$, $1715.256\ kg.ha^{-1}$) of (total dry matter, straw weight, biological yield) and (grain weight, grain yield) were recorded from combination treatments (M_1P_2) and (M_1P_1) respectively. While the lowest value ($20.587\ g.pot^{-1}$, $9.834 g.pot^{-1}$, $10.753\ g.pot^{-1}$, $782.949\ kg.ha^{-1}$ and $1639.058 kg.ha^{-1}$) for above parameter, were recorded from combination treatment (M_0P_0). Moreover, the same combination treatment (M_1P_1) increases the grain yield by 119.076% over the control. As well as, the result shows that the combination between the lower level of phosphorus fertilizer and mycorrhizal inoculation has the greatest effect on yield component. This may be due to that the mycorrhizal inoculation in combination with phosphorus increased dry and fresh weight, leaf area and leaf number of plants compared to application of phosphorus alone, because soluble phosphorus fertilizer applied to soil rapidly become unavailable or fixed due to adsorption and formation of poorly soluble compounds but the application of mycorrhizal inoculation with phosphorus fertilizer solved this problem, because mycorrhizal inoculation produce symbiosis with plant root and increased availability through solubilization of poorly available phosphates by lowering the pH or excreting organic acids. Results and interpretation have been reported by (Dalpe and Monreal, 2004).

Table (8): Combination effect of mycorrhizal inoculation and phosphorus fertilizer on some yield components of *Triticum aestivum* L.

Treatments		Total dry matter ($g.pot^{-1}$)	Grain weight ($g.pot^{-1}$)	Straw weight ($g.pot^{-1}$)	Grain yield ($Kg.ha^{-1}$)	Biological yield ($Kg.ha^{-1}$)	Increased grain yield %
M_0	**P_0**	20.587	9.834	10.753	782.949	1639.058	
	P_1	37.081	17.013	20.068	1354.554	2952.285	**73.006**
	P_2	40.280	18.643	21.637	1484.314	3207.001	**89.579**
	P_3	39.301	18.889	20.412	1503.915	3129.091	**92.083**
M_1	**P_0**	33.036	15.829	17.206	1260.306	2630.219	**60.969**
	P_1	43.095	21.544	21.552	1715.256	3431.153	**119.076**
	P_2	46.045	21.447	24.597	1707.592	3665.992	**118.097**
	P_3	31.806	14.976	16.830	1192.325	2532.309	**52.286**
Tukye's(0.05)		**7.235**	**3.636**	**4.287**	**289.488**	**578.232**	

2-2-5- Combination effect of mycorrhizal inoculation and phosphorus fertilizer on some yield components in sterilized and non-sterilized soil:

Table (9) indicated that the combination between mycorrhizal inoculation and phosphorus fertilizer affected significantly ($p \leq 0.05$) the total dry matter, grain weight, straw weight, grain yield and biological yield in sterilized and non-sterilized soil. The result showed that the highest values (57.079$g.pot^{-1}$, 27.088$g.pot^{-1}$, 29.992$g.pot^{-1}$, 2156.648$kg.ha^{-1}$ and 4544.520$kg.ha^{-1}$) for the mentioned yield component were produced by combination treatment ($M_1P_2S_0$). While the lowest value (16.831 $g.pot^{-1}$, 8.159 $g.pot^{-1}$, 8.672 $g.pot^{-1}$, 649.630 $kg.ha^{-1}$ and 1340.086$kg.ha^{-1}$) for mentioned yield component, were recorded from combination treatment ($M_0P_0S_1$) respectively, which received no mycorrhizal no fertilizer. Furthermore, the result indicated that application 50$kg.dounm^{-1}$ of phosphorus fertilizer with mycorrhizal inoculation in non-sterilized soil increased grain yield by 135.372% compared with control. The probable reason could be that a mycorrhizal inoculation can increased phosphorus assimilation and other nutrients, eventually led to increase some chemical component like chlorophyll by plant.

Table (9): Combination effect of mycorrhizal inoculation and phosphorus fertilizer on some yield components of *Triticum aestivum* L. in sterilized and non-sterilized soil.

Treatments	Total dry matter (g.pot^{-1})	Grain weight (g.pot^{-1})	Straw weight (g.pot^{-1})	Grain yield (Kg.ha^{-1})	Biological yield (Kg.ha^{-1})	Increase or decrease grain yield %
$M_0P_0S_0$	24.342	11.508	12.833	916.269	1938.031	
$M_0P_0S_1$	16.831	8.159	8.672	649.630	1340.086	**-29.100**
$M_0P_1S_0$	40.527	19.883	20.643	1583.068	3226.645	**72.773**
$M_0P_1S_1$	33.635	14.143	19.492	1126.039	2677.924	**22.893**
$M_0P_2S_0$	39.896	18.747	21.149	1492.613	3176.442	**62.901**
$M_0P_2S_1$	40.664	18.539	22.125	1476.015	3237.560	**61.089**
$M_0P_3S_0$	39.070	18.554	20.516	1477.265	3110.669	**61.226**
$M_0P_3S_1$	39.533	19.224	20.309	1530.564	3147.514	**67.043**
$M_1P_0S_0$	37.227	17.787	19.440	1416.136	2963.907	**54.554**
$M_1P_0S_1$	28.844	13.872	14.972	1104.476	2296.532	**20.540**
$M_1P_1S_0$	38.035	17.709	20.326	1409.988	3028.264	**53.883**
$M_1P_1S_1$	48.156	25.378	22.778	2020.524	3834.041	**120.516**
$M_1P_2S_0$	57.079	27.088	29.992	2156.648	4544.520	**135.372**
$M_1P_2S_1$	35.011	15.807	19.203	1258.537	2787.465	**37.354**
$M_1P_3S_0$	35.558	16.454	19.104	1310.023	2831.077	**42.973**
$M_1P_3S_1$	28.053	13.497	14.556	1074.628	2233.541	**17.283**
Tukye's(0.05)	**5.116**	**2.571**	**3.032**	**204.699**	**408.872**	

4. CONCLUSIONS

The application of mycorrhizal inoculation increased significantly ($p \leq 0.05$) the total dry matter,grain weight ,grain yield and biological yield in both *Triticum durum* L. and *Triticum aestivum* L. wheats .The grain yield was increased by 22.880% with mycorrhizal inoculation treatment of *Triticum durum* L. wheat compared to non mycorrhizal inoculation treatment .While the application of 50kg.dounm^{-1} phosphorous fertilizer increased grain yield by 22.554% in *Triticum durum* L. wheat compared to control. Also application 25%of phosphorus fertilizer with mycorrhizal inoculation increased grain yield by 65% A The application of 50kg.dounm-1 phosphorous fertilizer increased grain yield by 31.958% to 56.216% in *Triticum aestivum* L. wheat compared to control. While grain yield increased by 135.372% in combination treatment (M_1 P $_2S_0$) compared to control.

5. REFERENCES

.Khanam, D; M. A. U. Mridha and A. R. M. Solaiman (2006). Comparative study of arbuscular mycorrhizal association with different agricultural crops among four aezs of Bangladesh. Journal of Agricultural Research. 44 (2): 147-160.

Kucey, R. M. N. (1987). Increased phosphorus uptake by wheat and field beans inoculated with phosphorus–

solualizing *penicillium bilaji* strain and with vesicular–arbuscular mycorhizal Fungi. Applied and Environmental Microbiology. 53(12): 2699-2703

Giorgio, D. D; D. Sisto; D. Ubaldo and A. V. Vonella (2004).The effects of N-fertilization levels and root mycorrhizal colonization on plant-growth and grain yield in durum wheat. 13th International Soil Conservation Organisation Conference- Brisbane, July:762

Babana, A. H. and H. Antoun (2006). Effect of tilemsi phosphate rock-solubilizing microorganisms on phosphorus uptake and yield of field-grown wheat (*Triticum aestiuvm* L.) in Mali. Plant and Soil. 287:51-58.

Dawood, F. A. (1976). Winter wheat response to nitrogen, phosphorus and potassium in a sub-humid region . MSc. Thesis. Graduate School. University of Missouri-Columbia.

Gerwing, J; R. Gelderman; A. Heuer and A. Bly (1999). Fertilizers influence on soil test and spring wheat yield. Soil and Water Research. University of South Dakota: 1-3.

Mehdi, S. M; N. sajjad; M. Sarfraz; R. Ahmad; M. Asghar and G. Hassan (2001) . Comparative efficiency of P-Carriers in saline sodic soil .On Line Journal of Biological Sciences. 1(4):261-262.

Samad, M. A; C. A. Meisner; A. Rahman; M. Rahman ; J. M. Dxbury and J. G. Lauren (2002). Wheat root growth in phosphorus depleted soils.17th World Congress of Soil Science.14-9. Thailand. 1464-1473.

Shah, K. H; S. H. Siddiqui; M. Y. Memon; M. Imtaiz and P. Khan (2003). Performance of fertigation technique for P usage efficiency in wheat. Asain Journal of Plant Science. 2(15): 1088-1091.

Alam, S. M; S. A. Shah and M. Akhter (2003).Varietal differences in wheat yield and phosphorus use efficiency as influenced by method of phosphorus application. Songklanakarin Journal of Science Technologist. 25(2): 175 – 181

Li, H.Y; Y. G. Zhu; P. Marschner; F. A. Smith and S. E. Smith (2005). Wheat responses to arbuscular mycorrhzal fungi in highly calcareous soil differ from those of clover, and change with plant development and P supply. Plant and Soil. 277:221-232.

Shekhany, K. A. M. (2001). Effect of some fungicides and phosphorus levels on the efficiency of vesicular-arbuscular mycorrhizal fungus *Glomus mosseae*. MSc. Thesis. College of Science. University of Sulimani-Iraq.

Raiesi, F. and M. Ghollarata (2006). Interactions between phosphorus availability and an AM fungus (*Glomus intraradices*) and their effects on soil microbial respiration, biomass and enzyme activities in a calcareous soil. Pedobiologia. 50: 413-425.

Mohammad, A.; B. Mitra and A. G. Khan (2004). Effect of sheared root inoculums of *Glomus intaradices* on wheat grown at different phosphorus level in the field. Agriculture, Ecosystem and Enviroment. 103: 245-249.

Barker, A. V. and D. J. Pilbeam (2007). Hand book of plant nutrition. CRC Press, United state of America: 51-186.

Razavi darbar, S. and A. Lakzain (2007). Evaluation of chemical and biological consequences of soil sterilization methods. Caspian Journal Environmental Science. 5(2): 87-91.

Allen, S. E. (1974).Chemical analysis of ecological materials. Black well scientific publication Osney Mead, Oxford : 64-214.

Richards, L. A. (1954). Diagnosis and improvement of saline and alkaline soils united states salinity laboratory staff, USA. Hand book No. 60.

Li, H. (2005).Roles of mycorrhizal symbiosis on growth and phosphorus nutrition of wheat in a highly calcareous soil. Ph. D. Thesis. Schools of earth and Environmental Sciences. University of Adelaide.

Mustafa, Kh. Kh. (2000). Effect of bacteria Rhizobium, mycorrhizae fungi and there interaction on some biological activities on broad bean *Vicia faba* plant. MSc. Thesis .College of Education .University of Sallahadin/Erbil – Iraq.

Phillips, J. M. and D. S. Hayman (1970). Improved procedures for cleaning roots and staining parasitic and VA mycorrhizal fungi for rapid assessment of infection. Transactions British Mycological Society.55: 158-161.

Islam, Z. U; S. Khan; J. Bakht and W. A. Shah (2002). Frequency of various N levels, loding and seed quality in wheat. Asain Journal of Plant Science. 1(5): 510-512.

Quanbao, Y; Z. Hongcheng; W. Haiyan; Z. Ying; W. Benfu; X. Ke; H. Zhongyang; D. Qigen and X. Ke (2007). Effect of nitrogen fertilizer on nitrogen use efficiency and yield of rice under different soil conditions. Front. Agriculture of China. 1(1):30-36.

Steele, R.G. and J.H. Torrie (1969). Principle and procedure of statistic. McGraw Hill Book Co. Inc. New York: 1-530.

Al-karaki, G. N; A. Al-Raddad and R. B. Clark (1998). Water stress and mycorrhizal isolate effects on growth and nutrient acquisition of wheat. Journal Plant Nutrition. 21:891-902.

Busman, L; J. Lamb; G. Randall; G. Rehm and M. Schmitt (2002). The nature of phosphorus in soil. University of Minnesota. Retrieved from websit (www.extension. umn. edu.).

Dalpe, Y. and M. monreal (2004). Arbuscular mycorrhizal inoculum to support sustainable cropping systems. Crop management net work.

Miransari, M; H. A. Bahrami; F. Rejali and M. J. Malakouti (2009). Effect of soil compaction and arbusculare mycorrhiza on Corn (zea mays L.) nutrient up take. Soil and Tillage Research. 103:282-290.

Newman, S. E. and F. T. Davies-Jr. (1987). High soil temperature and water relations of endomycorrhizal nursery crops. Journal of Environmental Horticulture. 5(2): 93-96.

Marschner, P; Z. Solaiman and Z. Rengel (2006). Rhizosphere properties of *Poaceae* genotypes under P-limiting conditions. Plant and Soil. 283:11-24.