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

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ABSTRACT:

A pot experiment was conducted in green house of college of Science, University of Salahaddin- Erbil, during November 9th 2009 to May 4th 2010, 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≤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.

DOI: http://dx.doi.org/10.21271/ZJPAS.33.s1.10
ZJPAS (2021), 33(s1):93-102.

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, et al., 2006).

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 et al., 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, et al., 1999, Mehdi, et al., 2001, Samad, et al., 2002, Shah, et al., 2003, Alam, et al., 2003 and Li, et al., 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, et al., 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 (CaCO₃) 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 Salalahaddin- Erbil during November 9th 2009 to May 4th 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)°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)°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).

\[
\text{Grain yield} = \frac{(\text{Grain weight.pot}^{-1} / \text{Area of pot}) \times 10000}{10000}
\]

- **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).

\[
\text{Increase grain yield} \% = ((\text{Grain yield of fertilized pot-Grain yield of control pot})/\text{Grain yield of control pot}) \times 100
\]

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           | Sand  | Silt  | Clay  |
|------------------------------|-------|-------|-------|
| Particle Size Distribution g.kg⁻¹ | 638.14 | 295.18 | 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 CaCO₃ 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 (58.053g.pot⁻¹, 21.000g.pot⁻¹, 37.049 g.pot⁻¹, 1672.327kg.ha⁻¹ and 4622.052kg.ha⁻¹) of mentioned yield component were recorded in mycorrhizal treatment (M₁), respectively. While the lowest values (49.485g.pot⁻¹, 17.090g.pot⁻¹, 32.392g.pot⁻¹, 1360.933kg.ha⁻¹ and 3939.893kg.ha⁻¹) of the same yield components were recorded in case of non mycorrhizal treatment (M₀) respectively. However, the grain yield with mycorrhizal inoculation (M₁) increased by (22.880%) over non mycorrhizal inoculation (M₀). 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, et al., 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 % |
|------------|---------------------------|------------------------|------------------------|-----------------------|---------------------------|------------------------|
| M₀         | 49.485                    | 17.090                 | 32.392                 | 1360.933              | 3939.893                  |                        |
| M₁         | 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≤0.05) the total dry matter, grain weight, straw weight, grain yield and biological yield. The highest values (57.568 g.pot⁻¹, 38.920 g.pot⁻¹, 4583.404 kg.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 (P₁) and (P₂) respectively. While the lowest values (48.474 g.pot⁻¹, 17.260 g.pot⁻¹, 31.211 g.pot⁻¹, 1374.478 kg.ha⁻¹ and 3859.399 kg.ha⁻¹) of total dry matter, grain weight, straw weight, grain yield and biological yield were recorded in the treatment P₀ respectively. The result indicated that the application (50 kg.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, et al., 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 % |
|------------|---------------------------|-----------------------|-----------------------|------------------------|---------------------------|------------------------|
| P₀         | 48.474                    | 17.260                | 31.211                | 1374.478               | 3859.399                  |                        |
| P₁         | 57.568                    | 18.650                | 38.920                | 1484.688               | 4583.404                  | **8.018**              |
| P₂         | 55.807                    | 21.160                | 34.650                | 1684.484               | 4443.253                  | **22.554**             |
| P₃         | 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 mycorrhizal inoculation and phosphorus fertilizer on some yield components:

Table (4) indicated that the combination between mycorrhizal inoculation and phosphorus fertilizer affected significantly (p≤0.05) the total dry matter, grain weight, straw weight, grain yield and biological yield. Result showed that the highest values (67.669 g.pot⁻¹, 24.560 g.pot⁻¹, 43.109 g.pot⁻¹, 1955.392 kg.ha⁻¹ and 5387.676 kg.ha⁻¹) of total dry matter, grain weight, straw weight, grain yield, and biological yield were produced by combination treatment (M₀P₀) 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 1013.984 kg.ha⁻¹ of (total dry matter, straw weight, biological yield) and (grain weight, grain yield) were recorded in the combination treatment (M₀P₀) and (M₀P₁) 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 % |
|------------|----------------------------|------------------------|------------------------|------------------------|-----------------------------|----------------------------------|
| **M₀**     |                            |                        |                        |                        |                             |                                  |
| P₀         | 36.977                     | 14.885                 | 22.092                 | 1185.084               | 2944.028                    |                                  |
| P₁         | 47.466                     | 12.736                 | 34.730                 | 1013.984               | 3779.131                    | 14.438                           |
| P₂         | 49.224                     | 18.215                 | 31.009                 | 1450.233               | 3919.110                    | 22.374                           |
| P₃         | 64.273                     | 22.538                 | 41.735                 | 1794.431               | 5117.304                    | 51.418                           |
| **M₁**     |                            |                        |                        |                        |                             |                                  |
| P₀         | 59.971                     | 19.642                 | 40.329                 | 1563.871               | 4774.770                    | 31.963                           |
| P₁         | 67.669                     | 24.560                 | 43.109                 | 1955.392               | 5387.676                    | 65.000                           |
| P₂         | 62.390                     | 24.099                 | 38.291                 | 1918.735               | 4967.395                    | 61.907                           |
| P₃         | 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≤0.05) the yield component in sterilized and non-sterilized soil. The highest values (97.440 g.pot⁻¹, 34.539 g.pot⁻¹, 62.901 g.pot⁻¹, 2749.912 kg.ha⁻¹ and 7757.984 kg.ha⁻¹) of total dry matter, grain weight, straw weight, grain yield and biological yield, were recorded from combination treatment (M₁P₁S₁) respectively. While the lowest values (28.503 g.pot⁻¹, 10.394 g.pot⁻¹, 18.110 g.pot⁻¹, 827.509 kg.ha⁻¹ and 2269.374 kg.ha⁻¹) of mentioned yield components, were recorded from combination treatment (M₁P₃S₀) 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 % |
|------------|-----------------------------|------------------------|------------------------|------------------------|-----------------------------|----------------------------------|
| **M₀**     |                             |                        |                        |                        |                             |                                  |
| P₀         | 36.977                      | 14.885                 | 22.092                 | 1185.084               | 2944.028                    |                                  |
| P₁         | 47.466                      | 12.736                 | 34.730                 | 1013.984               | 3779.131                    | 14.438                           |
| P₂         | 49.224                      | 18.215                 | 31.009                 | 1450.233               | 3919.110                    | 22.374                           |
| P₃         | 64.273                      | 22.538                 | 41.735                 | 1794.431               | 5117.304                    | 51.418                           |
| **M₁**     |                             |                        |                        |                        |                             |                                  |
| P₀         | 59.971                      | 19.642                 | 40.329                 | 1563.871               | 4774.770                    | 31.963                           |
| P₁         | 67.669                      | 24.560                 | 43.109                 | 1955.392               | 5387.676                    | 65.000                           |
| P₂         | 62.390                      | 24.099                 | 38.291                 | 1918.735               | 4967.395                    | 61.907                           |
| P₃         | 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≤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 (M₁) 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 above yield component, were recorded in the non mycorrhiza treatment (M₀) 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 % |
|------------|----------------------------|-----------------------|-----------------------|------------------------|---------------------------|-------------------------|
| M₀         | 34.312                     | 16.095                | 18.217                | 1281.433               | 2731.859                  | 14.627                  |
| M₁         | 38.495                     | 18.449                | 20.046                | 1468.870               | 3064.918                  |                         |
| L.S.D.     | 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≤0.05) by phosphorus fertilizer application. The result indicated that the highest values (43.162g.pot⁻¹, 20.045g.pot⁻¹, 1595.953kg.ha⁻¹ and 3436.496kg.ha⁻¹) of above yield components, were recorded in treatment P₂ respectively. While the lowest values (26.811g.pot⁻¹, 12.832g.pot⁻¹, 1021.628kg.ha⁻¹ and 2134.639kg.ha⁻¹) of above yield components, were recorded in the treatment P₀ 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 50kg.dounm⁻¹ beyond which the decline in yield component observed. The result partially agreed with (Marschner *et al.*, 2006 and Gerwing, *et al.*, 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 % |
|------------|----------------------------|-----------------------|-----------------------|------------------------|---------------------------|-------------------------|
| P₀         | 26.811                     | 12.832                | 13.979                | 1021.628               | 2134.639                  |                         |
| P₁         | 40.088                     | 19.278                | 20.810                | 1534.905               | 3191.719                  | 50.241                  |
| P₂         | 43.162                     | 20.045                | 23.117                | 1595.953               | 3436.496                  | 56.216                  |
| P₃         | 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≤0.05) the total dry matter, grain weight, straw weight, grain yield and biological yield. Result showed that the highest values (46.045g.pot⁻¹, 24.597 g.pot⁻¹, 3665.992kg.ha⁻¹) and (21.544gm.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 (M₁P₂) and (M₁P₁) respectively. While the lowest value (20.587 g.pot⁻¹, 9.834g.pot⁻¹, 10.753 g.pot⁻¹, 782.949 kg.ha⁻¹ and 1639.058kg.ha⁻¹) for above parameter, were recorded from combination
treatment (M₀P₀). Moreover, the same combination treatment (M₁P₁) 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 % |
|------------|---------------------------|-----------------------|-----------------------|-----------------------|---------------------------|------------------------|
| M₀         |                           |                       |                       |                       |                           |                        |
| P₀         | 20.587                    | 9.834                 | 10.753                | 782.949               | 1639.058                  |                        |
| P₁         | 37.081                    | 17.013                | 20.068                | 1354.554              | 2952.285                  | 73.006                 |
| P₂         | 40.280                    | 18.643                | 21.637                | 1484.314              | 3207.001                  | 89.579                 |
| P₃         | 39.301                    | 18.889                | 20.412                | 1503.915              | 3129.091                  | 92.083                 |
| M₁         |                           |                       |                       |                       |                           |                        |
| P₀         | 33.036                    | 15.829                | 17.206                | 1260.306              | 2630.219                  | 60.969                 |
| P₁         | 43.095                    | 21.544                | 21.552                | 1715.256              | 3431.153                  | 119.076                |
| P₂         | 46.045                    | 21.447                | 24.597                | 1707.592              | 3665.992                  | 118.097                |
| P₃         | 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≤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 (57.079g.pot⁻¹, 27.088g.pot⁻¹, 29.992g.pot⁻¹, 2156.648kg.ha⁻¹ and 4544.520kg.ha⁻¹) for mentioned yield component were produced by combination treatment (M₁P₁S₀). 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 1340.086kg.ha⁻¹) for mentioned yield component, were recorded from combination treatment (M₀P₀S₁) respectively, which received no mycorrhizal no fertilizer. Furthermore, the result indicated that application 50kg.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 % |
|--------------|-----------------------------|------------------------|------------------------|------------------------|----------------------------|----------------------------------|
| M₀P₀S₀       | 24.342                      | 11.508                 | 12.833                 | 916.269                | 1938.031                   |                                  |
| M₀P₀S₁       | 16.831                      | 8.159                  | 8.672                  | 649.630                | 1340.086                   | -29.100                          |
| M₀P₁S₀       | 40.527                      | 19.883                 | 20.643                 | 1583.068               | 3226.645                   | 72.773                           |
| M₀P₁S₁       | 33.635                      | 14.143                 | 19.492                 | 1126.039               | 2677.924                   | 22.893                           |
| M₀P₂S₀       | 39.896                      | 18.747                 | 21.149                 | 1492.613               | 3176.442                   | 62.901                           |
| M₀P₂S₁       | 40.664                      | 18.539                 | 22.125                 | 1476.015               | 3237.560                   | 61.089                           |
| M₀P₃S₀       | 39.070                      | 18.554                 | 20.516                 | 1477.265               | 3110.669                   | 61.226                           |
| M₀P₃S₁       | 39.533                      | 19.224                 | 20.309                 | 1530.564               | 3147.514                   | 67.043                           |
| M₁P₀S₀       | 37.227                      | 17.787                 | 19.440                 | 1416.136               | 2963.907                   | 54.554                           |
| M₁P₀S₁       | 28.844                      | 13.872                 | 14.972                 | 1104.476               | 2296.532                   | 20.540                           |
| M₁P₁S₀       | 38.035                      | 17.709                 | 20.326                 | 1409.988               | 3028.264                   | 53.883                           |
| M₁P₁S₁       | 48.156                      | 25.378                 | 22.778                 | 2020.524               | 3834.041                   | 120.516                          |
| M₁P₂S₀       | 57.079                      | 27.088                 | 29.992                 | 2156.648               | 4544.520                   | 135.372                          |
| M₁P₂S₁       | 35.011                      | 15.807                 | 19.203                 | 1258.537               | 2787.465                   | 37.354                           |
| M₁P₃S₀       | 35.558                      | 16.454                 | 19.104                 | 1310.023               | 2831.077                   | 42.973                           |
| M₁P₃S₁       | 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≤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 (M₁P₂S₀) compared to control.

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