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The response of yield components of sunflower to mycorrhiza inoculation and phosphorus fertilizer

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ABSTRACT

The present research was conducted to study the effects of mycorrhiza and different phosphorus levels on yield of sunflower (Progress cultivar). The field experiment was conducted as a factorial design based on a randomized complete block with eight treatments and three replications in Boyerahmad area of Iran in 2012. The treatments including two levels of mycorrhiza (Glomus intradices) $M_1$and M_0 (with and without mycorrhiza) and four levels of triple phosphorus (TP) (0, 50, 100 and 200 kg/ha) applied through triple super phosphate fertilizer. The results showed that, application of mycorrhiza had significant effect on the seed yield, Biological yield and seed hollownes. The application of phosphorus fertilizer showed statistically significant effect on the seed yield, Biological yield and 1000-seed weight. The highest seed yield (2372.2 kg/ha) of sunflower was recorded with the application of 0 kg P/ha with application of mycorrhiza treatment (M_1P_0). The treatment combinations of M_1P_{200} and M_0P_{200} did not show significant different in terms of seed yield of sunflower. The highest Biological yield (35806 kg/ha) was obtained by M_1P_0 and lowest Biological yield (21317 kg/ha) was observed in M_0P_{50}. The lowest rate of seed hollowness percentage (6.68 percent) was obtained by M_1P_0 without significant difference with M_0P_{100} treatment.

Key words: mycorrhiza, phosphorus fertilizer, yield, sunflower

INTRODUCTION

Sunflower for being resistant to drought, compatible with different climatic conditions, well grown in most soils, high quality of edible oil, no cholesterol, short growing period (90 to 150 days) and possibility of cultivation as the second crop after wheat and barley, accounts over 120000 hectares of cultivated land annually. Among the oil seeds, the area under cultivation and production of plant is in the first place [5]. Phosphorus is one of the vital elements for plants, and there are in various forms of organic and inorganic in soil [2]. For problems precipitated phosphates and entering phosphorus in the lakes and wetlands, modern farming, uses of methodys that cause increased the absorption of phosphorus from the soil. In this regard, using of microorganisms that cause increased absorption of phosphorus from the soil [2]. Mycorrhiza fungi are essential factor in the sustainable soil-plant system, that are symbiotic with more than 97 percent root of plant [6]. Mycorrhiza fungi receiving energetic carbon resources form plant, fungus facilitates the uptake of many inorganic nutrients such as phosphorus, zinc, molybdenum, copper and iron for it. The symbiotic relationship between mycorrhiza and plants is one of the most abundant symbiotic activities in plant kingdom which exists in most of the ecosystems [7]. Solimanzadeh (2010) reported that application of mycorrhiza in sunflower increased head diameter, seed yield and oil yield [8]. Mycorrhiza and moderate levels of phosphorus is increasing root function [9]. So mycorrhiza fungi form a symbiotic relationship with plant roots, is able absorbs phosphorus and water from the soil and make it available to plants [1]. It reduces phosphorus fertilizer on farms, without reducing the quality and quantity of plants [4]. Phosphorus is one of the most important factors limiting in crop production. But the use of the large amounts of phosphorus causes to reduction of physiological activities and population of mycorrhiza fungi [3].

MATERIALS AND METHODS

The field experiment was conducted as a factorial design based on a randomized complete block with eight treatments and three replications in Boyerahmad area of Iran in 2012. Some physical and chemical properties of experimental field are presented in Table 1. The treatments including two levels of mycorrhiza M_0 (control) and M_1 (application of mycorrhiza) and four levels of phosphorus (0, 50, 100 and 200 kg/ha) applied through triple super phosphate fertilizer. The size of each experimental plot was 6 m^2 (2×3 m) with successive plots distance of 50 cm. Each plot consisted of 4 rows, 3m long with 50 cm spaced between rows and 20 cm distance between plants on the rows. Seed bed preparation was done in spring. One-third dose of nitrogen fertilizer and 50 kg/ha potassium solphate and 80 kg/ha mycorrhiza bio-fertilizer was applied time at planting. In the harvest stage, two m^2 was harvested in the middle of plot the measured parameters included: seed yield, Biological yield, 1000 seeds weight and seed hollowness percentage, were assessed. Statistically of the result was done by using SAS. Mean were compare using the Duncan's Multiple Range Test at %5 level of probability.

TABLE 1. Soil physical and chemical properties of experimental field

Parameter	Value	Parameter	Value
Soil depth	0-30	**K (ppm)**	426
Sp (%)	56	**Soil texture**	CL
ECe (ds/m)	.3	**O.C. (%)**	.9
pH	7.7	**Sand (%)**	26
Total N (%)	.09	**Silt (%)**	40
P (ppm)	14	**Clay (%)**	34

RESULTS AND DISCUSSION

The variance analysis data presented in Table 2 show that seed yield of sunflower was significantly affected by mycorrhiza. The mycorrhiza application (M_1) gave seed yield of 2093 kg/ha, however no mycorrhiza application treatment (M_0) produced seed yield of 1859.9 kg/ha. The results also indicate that phosphorus had a significant effect on seed yield. The maximum seed yield (2055.5 kg/ha) of sunflower was produced with the application of 200 kg/ha triple super phosphate (Table 3). Soleimanzadeh (2010) also recorded that mycorrhiza and phosphorus fertilizer had significantly effects on seed yield. The interaction of mycorrhiza and phosphorus fertilizers on seed yield was significant (Table 2). The highest seed yield (2372.2 kg/ha) was recorded with the application of 0 kg p/ha with application of mycorrhiza treatment (M_1P_0). In terms of seed yield the treatment combinations of M_1P_{200} and M_0P_{200} did not varied significantly of sunflower. The treatment of M_0P_0 (no application of mycorrhiza and phosphorus) gave lowest seed yield (1688.9 kg/ha) of sunflower (Table 4). According to the results of this experiment, application of mycorrhiza in present of treatments P0 and P200 kg/ha had an appropriate performance and could increase seed yield, so it could be considered as a suitable substitute for chemical phosphorus fertilizer in organic agricultural systems.

The biological yield was significantly affected by phosphorus fertilizer and mycorrhiza (Table 2). The mycorrhiza application (M_1) gave biological yield of 29178 kg/ha, however no mycorrhiza application treatment (M_0) produced biological yield of 24168 kg/ha.The maximum biological yield of 31525 kg/ha obtained in P_{200} kg/ha which was not significantly different from P_0 treatment, the minimum biological yield of 22197 kg/ha obtained in P_{50} kg/ha. The interaction effects of mycorrhiza and phosphorus fertilizers on biological yield was significant (Table 2). The mycorrhiza and phosphorus treatments in combination: M_1P_0, M_1P_{200}, M_0P_{200}, M_1P_{100}, M_0P_0, M_1P_{50} and M_0P_{100} produced biological yield of sunflower to the tune of 35806, 33928, 29122, 23900, 23872, 23078 and 22361 kg/ha, respectively. The treatment of M_0P_{50} produced lowest biological yield (21317 kg/ha) (Table 4). On the basis of this study it seems that the application of mycorrhiza with no phosphorus fertilizer did have much positive effects on biological yield. It can be also concluded that, the adequate initial soil phosphorus causes no response of plant to phosphorus application.

The 1000 seed weight of sunflower was not significantly affected by mycorrhiza but, was influenced by phosphorus (Table 2). Application of 0, 50 and 100 kg/ha phosphorus produced 42.36, 42.89 and 43.33 gr in sunflower, respectively. The treatment of phosphorus (200 kg/ha) gave lowest 1000 seed weight (36.13 gr) in sunflower (Table 3). The interaction of mycorrhiza and phosphorus fertilizers on 1000 seed weight was significant (Table 4).The mycorrhiza and phosphorus treatments in combination, M_1P_{50}, M_0P_{100}, M_1P_0, M_1P_{200}, M_1P_{100}, M_0P_0 and M_0P_{50} produced 47.60, 44.13, 43.56, 42.55, 42.53, 41.17 and 38.19 gr 1000 seed weight in sunflower, respectively. The treatment of M_0P_{200} produced lowest 1000 seed weight (29.71gr) in sunflower (Table 4).

The Seed hollowness of sunflower was significantly affected by mycorrhiza (Table 2). Application of mycorrhiza (M_1) decreased (20.41%) the seed hollowness percentage in sunflower significantly compared to no mycorrhiza application treatment (M_0) (Table 3). The Seed hollowness percentage of sunflower was not significantly affected by phosphorus (Table 2). The interaction between the effects of mycorrhiza and phosphorus fertilizers on Seed hollowness percentage was significant (Table 2). The treatments M_0P_{200}, M_0P_{50} and M_0P_0 produced highest Seed hollowness percentage to the tune of 12.45, 9.40 and 9.13% , respectively. The treatment of M_1P_0 gave lowest Seed hollowness percentage (6.68 %) of sunflower.

TABLE 2. Analysis variance and mean squares of measured parameters

s.o.v	df	Seed yield	Biological yield	1000 seed weight	Seed hollowness
Rep	2	190482.71*	47920684^{ns}	64.853^{ns}	3.104^{ns}
M	1	236125.55*	150577805*	198.950^{ns}	22.932*
P	3	36461.13*	132290202*	68.899*	7.289^{ns}
M*P	3	145777.5*	35290558*	64.477*	8.892*
Eror	14	63968.49	43618946	72.672	4.888
Cv%		12.79	22.76	20.70	25/77

, Significant at P=0.05 and P=0.01 Level, respectively; NS= Not significant*

TABLE 3. Mean comparisons of the main effects

Treatment	Seed yield (kg/ha)	Biological yield (kg/ha)	1000 seed weight(gr)	Seed hollowness percentage(%)
Mycorrhiza levels				
M_0	1859.9^{b}	24168^{b}	38.303^{a}	9.55^{a}
M_1	2093^{a}	29178^{a}	44.061^{a}	7.60^{b}
Phosphorus levels				
P_0	2030.5^{a}	29839^{a}	42.36^{a}	7.90^{a}
P_{50}	1900^{b}	22197^{b}	42.89^{a}	9.06^{a}
P_{100}	1919.8^{b}	23131^{b}	43.33^{a}	7.46^{a}
P_{200}	2055.5^{a}	31525^{a}	36.13^{b}	9.88^{a}

Means which have at least one common letter are not significantly different at the 5% level using

TABLE 4. Mean comparisons of the interaction effects

Treatment	Seed yield (kg/ha)	Biological yield (kg/ha)	1000 seed weight (gr)	Seed hollowness percentage(%)
M_0P_0	1688.9^{c}	23872^{b}	41.17^{ab}	9.13^{ab}
M_0P_{50}	1861.1^{b}	21317^{c}	38.19^{ab}	9.40^{ab}
M_0P_{100}	1928.5^{b}	22361^{c}	44.13^{ab}	7.23^{c}
M_0P_{200}	1961.1^{ab}	29122^{ab}	29.717^{c}	12.45^{a}
M_1P_0	2372.2^{a}	35806^{a}	43.56^{ab}	6.78^{c}
M_1P_{50}	1938.9^{b}	23078^{b}	47.603^{a}	8.71^{bc}
M_1P_{100}	1911.1^{b}	23900^{b}	42.53^{ab}	7.69^{bc}
M_1P_{200}	2149.9^{a}	33928^{a}	42.55^{ab}	7.32^{bc}

Means which have at least one common letter are not significantly different at the 5% level using

CONCLUSION

Results form the present study indicated that seed yield, biological yield and Seed hollowness have been affect significantly by application of mycorrhiza, because this biofertilizer can enhance absorption of phosphorus by plant.

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