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Phosphorus Levels Effects on Quantitative and Qualitative Characteristics of Corn in Presence and Absence of a Biofertilizer

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Abstract. By an experiment, the effect of phosphorus levels from diammonium phosphate source in presence and absence of a biofertilizer, Mycorrhiza from *Glomus mosseae* source, were studied on some quantitative and qualitative characteristics of corn SC-647 in Miyaneh region. In a field trail, a randomized complete block design based factorial experiment was used with three replications in 2009. Phosphorus fertilizer were applied at four levels (0, 50, 100, 150 kgP/ha) with and without Mycorrhiza inoculation (3 gr inoculant per plot). The results of analysis of variance showed significant effect of phosphorous fertilizer application and Mycorrhiza inoculation on the studied characteristics such as yield, biomass, harvest index, kernel weight, number of seeds on rows and protein content. The most yield was obtained by Mycorrhiza inoculation with 150 $kgP.ha^{-1}$ application. Increasing phosphorus increased plant height and it caused increased corn yield. Based on the results, application of 150 kg/ha phosphorous with Mycorrhiza inoculation could be recommended as the best treatment for corn yield increase in Miyaneh region.

Keywords: Bio-fertilizer, Mycorrhizal inoculation, Phosphorus, Corn.

1. Introduction

In organic agriculture guidlines, bio-fertilizer application such as the arbuscular Mycorrhiza (*Glomus mosseae*), is one of the principal way to attain sustainability. They are most abundant fungi in soils, and were known as efficient microorganisms for sustainable nutrition of plants specially phosphorus (Paul *et al.* 1993; Olson *et al.,* 1999; Dodd, 2002; Barea *et al.,* 2002; Ryan and Graham, 2002; Harrier and Watson, 2003). Vesicular Arbuscular Mycorrhiza (VAM) to be said as an important factor to mobilizing phosphorus of soil toward roots (Michelsen and Rosendahl, 1990). According to Baltruschatb and Dehne (1988), higher amount of phosphorus in soil decreased VAM activity. In VAM symbiosis, plant supply energy for VAM and VAM supplies inorganic nutrients, hormones and protect roots against soil pathogens (Barakah and Heggo, 1998.)

One of the important roles of VAM on corn and sorghum is increasing crop yield, especially in poor soils. VAM increased leaf area, dry matter, leaf special area, xylem pressure, as well as phosphorus absorpsion, but VAM increased root length more than phosphorus fertilizer absorpsion (Osonubi, 1994). The same result was acquired in wheat (Shirani-Rad *et al.*, 2000).

The nitrogen and phosphorus absorption were improved by *Glomus mosseae* inoculation with or without P application. In maize it was shown that although final dry weight was equal to inoculated and non-inoculated plants, but inoculated plants reached to higher dry matter by soils with lower P content (Asmah, 1995). Faria (1985) showed that VAM increased cowpea seed yield, dry matter, leaf area, leaf P content and P, Cu, and Zn absorption in low P content soils. Davies *et al.* (2005) revealed that in a low P content soil, all Mycorrhiza inoculated plants showed higher growth, root/shoot ratio, phosphate use efficiency (PUE) and low leaf/tuber ratio in potato.

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This research was conducted to determine the suitable level of phosphorous fertilizer application in presence or absence of Mycorrhiza biofertilizer in Miyaneh region.

2. Materials and Methods

The plants were grown at research a wheat-followed farm of Islamic Azad University- Miyaneh Branch (latitude. 35° 47′ N., long. 55° 37′ E.) from May to September 2009, when the average daily temperature was more than 16°C. Its soil belongs to *calcareous montmorilonitic fluventic, camborthids* taxonomic family. Primarily, the corn seeds were treated with two levels of Mycohrriza inoculation (0 and 3 gr inoculant per plot seeds) and four levels of phosphorus (0, 50, 100, 150 kgP.ha^{-1}) from diammonium phosphate (DAP) source, as a factorial trail based on a randomized complete block design (RCBD) with three replications, then the seeds of maize (*Z. mays* L.) cv. SC-647 were planted by 25 cm distance on furrows with 75cm apart. The plots were irrigated by pool water (table 2) to reach field capacity (FC) every week.

Table 1. Field soil samples analysis results before sowing corn.

depth (cm)	pH	EC dS. m^{-1}	Na^+	Mg^{2+}	Ca^+	Cl^-	HCO_3^-	K^+	P	Mn^{2+}	SP (%)
			----------mg/kg----------								
0-30	7.9	1.0	2.3	1.1	4.0	8.7	2.8	307.0	10.8	7.9	35.0
30-60	7.9	0.4	1.7	1.1	2.3	5.0	3.3	225.0	4.7	6.1	34.6
60-90	7.9	0.7	2.0	0.3	2.1	3.2	3.6	188.0	3.4	6.0	36.0

Table 2. Chemical components of water sample taken from the pool.

pH	EC dS. m^{-1}	Na^+	Mg^{2+}	Ca^{2+}	Sum cation	HCO_3^-	$CO^=$	Cl^-	sum anion	SAR
		----------meq.l^{-1}----------								
7.7	0.4	0.5	0.5	3.5	4.5	2.4	0.0	0.7	4.5	0.4

3. Results and discussion

Table (3) shows mean squares of the traits studied in the experiment. The data analysis of variance showed that the effect of phosphorous fertilizer application and Mycorrhiza inoculation was significant on yield, biomass, harvest index, 1000 kernel weight and seed protein content. However, there was no significant interaction between phosphorus and Mycorrhiza levels for characteristics studied in the experiment, except total kernel weight.

Table 3. The mean squares of different Phosphorus levels and Mycorrhizal inoculation treatments at seedling stage of corn

Source of variation	df	mean squares						
		1000 kernel weight	Yield	Biomass	protein	total kernel weight	harvest index	seeds no. on rows
Replication	2	204.65^{ns}	1802.89 ^{ns}	3.005 ^{ns}	0.00^{ns}	2907.03^{ns}	83.26 ^{ns}	53.45 **
Mycorrhizal (A)	1	418.17*	29779.65**	18984.37**	0.329**	37921.50**	504.167 **	11.34 **
Phosphorus (B)	3	1057.75**	45689.62**	34750.38**	1.31**	57632.50**	669.47 **	29.63 **
A×B	3	43.21^{ns}	1463.11^{ns}	1914.38 ^{ns}	0.014^{ns}	3188.50**	46.31^{ns}	0.03 ^{ns}
Error	14	85.55	475.68	704.07	0.06	26.236	27.85	0.32
CV (%)	-	3.05	7.89	5.62	12.68	1.42	9.22	1.00

*, ** and ns: significant at 0.05 and 0.01 probability levels and non significant, respectively.

The highest yield was obtained by Mycorrhiza inoculation and 150 kgP.ha^{-1} and the least yield was produced by no application of Mycorrhiza inoculation and no phosphorus application. The effects of Mycorrhiza and phosphorus interaction were significant on total kernel weight. The most yield was obtained

by Mycorrhiza inoculation with 150 kgP.ha^{-1} application. Increasing phosphorus increased plant height (fig. 1). Mycorrhiza could increases water and light absorption and increases plant growth. Increasing plant height could result in new leaves production which increases light absorption and thus photosynthesis efficiency.

The 1000 kernels weight and yield of corn were increased by increasing phosphorous levels application (figs. 2 and 3). The findings were in agreement with results obtained by Tavassoli *et al*. (2000), Subramanian and Charest (1997), Ojala *et al*. (1983) and Guttay and Dandurand (1989). The effect of Mycorrhiza in increasing crop yield has been reported by other researchers. According to Osonubi (1994), an important effect of Mycorrhiza on corn is increasing crop yield, especially in poor soils. It increased leaf area, dry matter, leaf special area, xylem pressure, as well as phosphorus absorpsion. Subramanian and Charest (1997) also showed that *Glomus intraradices* improved N, P, K, Zn, Mn and Mg content in corn. The same results have been reported in wheat, soybean, onion, pepper and red clover (Bryla and Duniway, 1998; George *et al.*, 1992; Michelsen and Rosendahl, 1990; Osonubi, 1994; Shirani-Rad *et al.*, 2000, Tarafdar and Marschner, 1994).

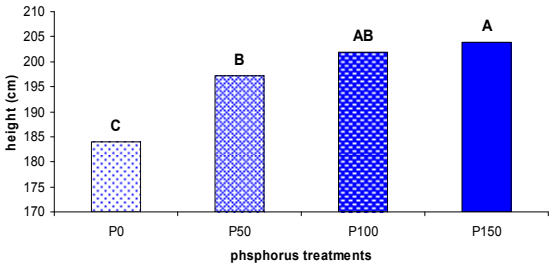

Fig. 1: Effects of phosphorus levels on height of corn (cv. SC-624)

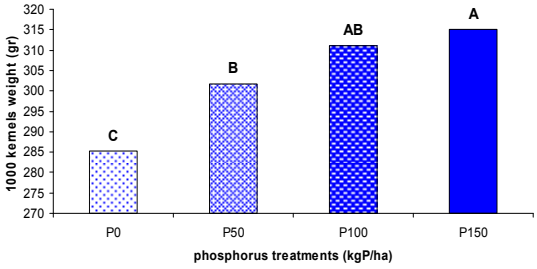

Fig. 2: Effects of phosphorus levels on 1000 kernels weight of corn (cv. SC-624)

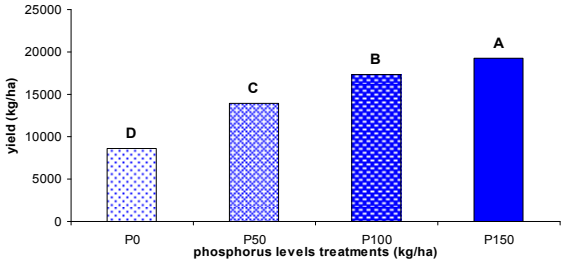

Fig. 3: Effects of phosphorus levels on yield of corn (cv. SC-624)

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