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Effect of biological fertilizer on yield and morphological traits of corn (*Zea Maize*) KSC 704 under eyvan climate conditions

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Key words: Phosphorus Fertilizer, Nitrogen Biofertilizer, Corn, Yield.

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Abstract

Biological fertilizers are natural inputs that can be applied in sustainable agriculture as an alternative to chemical fertilizers. In order to study the effect of biofertilizers on yield and yield components of corn, an experiment was conducted in factorial design based on randomized complete blocks with three replications in Eyvan, Ilam province, Iran 2011. Treatments were four levels of Nitrogen biofertilizer (nitroxyne, Nitrocara, supernitroplas and control) and four levels of phosphorus biofertilizer (biophosphate, phosphate fertilizer 2, phosphate fertilizer 3 and control). The results indicated that phosphorous and nitrogen biofertilizer levels had significant effect on all of studied traits. This result showed that with Nitroplas, stalk diameter, ear height, ear diameter and corn plant yield produced 3/16 cm, 112/47 cm, 6/21 cm, 11874 kg per hectar respectively and Nitrocara resulted in 198/3 cm plant height. Application of phosphate fertilizer 2, resulted in 190/8 cm, 2/95 cm, 108 cm, 5/59 cm and 11998 kg per hectar for plant height, ear diameter, ear diameter, ear height and yield respectively. Interaction between Nitrogen biofertilizer in phosphorus biofertilizer on kernel weight, cob diameter with phosphate fertilizer 2 + supernitroplas resulted in 414/88 gr and 7/16 cm respectively and phosphate fertilizer 2 + nitroxyne produced 27/1cm in ear length. In general, the result of this study showed that using various resources of biological Nitrogen and phosphorus fertilizer increase grain yield by improving yield components.

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Introduction

Using modern scientific methods for providing increasing needs of growing population is necessary. There fore, agricultural systems management should be seriously considered and new methods should be designed that their priority is their long-term stability with keeping short-term production (Mirhashemi *et al.*, 2009). One of the appropriate options that can ensure soil fertility and plant yield without environment destruction is using biological fertilizers. For compensating lack of Nitrogen and phosphorus by ways other than chemical fertilizers, many studies have been done in the world including mixing seeds with micro Organisms such as Azotobacter and Azospirillum and sodomonas (Fasihi *et al.*, 2006).The results of field experiments conducted by Reynderz and Vlassak (1982) showed that the inoculation of wheat seeds with Azospirillum ahs led to increase product performance from 9% to 15%. Musavi Jangali *et al.*, (2004) showed although phosphorus chemical fertilizer or phosphate solvent bacteria each alone had effect on corn yield and growth but when biological fertilizers were used with phosphorus chemical fertilizers had a more desirable effect. In fact, results of this study indicates that using bacteria and biological fertilizer not only reduces phosphorus chemical fertilizer but also increase yield. The inoculation of plants with Azospirillum in addition to reducing the use of nitrogen fertilizer in about 30-35 percent has resulted to improve the growth of plant and increasing the amount of yield. The most beneficial effect has been attributed to the production of stimulating plant growth promuting hormones such as Auxin (Zimmer, 1998). Inoculated plants are usually created the changes in morphology of their root system, the length and number of lateral roots and their branches and also the number and the length of fatal fibers and their head ramifications are increasing. The increasing of absorptive surface of roots develops the absorption of water and nutrient elements by plant (Okon, 1986). In the experiment, inoculation of plants such as sorghum (Sorghum bicolor L.) and corn (Zea mays L.) with pseudomonas increase of yield about 10 to 30 percent (Kapoor, 2004) researchers have showed that at least pseudomonas levels can be effective in different ways such as production of plant growth regulators and increasing of water absorption and nutrient elements in developing of plant growth (Sharma, 2002). On this basis, regarding activities of growth stimulating bacteria it was a necessity to study the ability of the mentioned bacteria. Therefore, this study was conducted for determining the most appropriate PGPR as biological fertilizer for corn production in agricultural system with sufficient yield in Eyvan condition.

Materials and method

This experiment was carried out in 2011 in Eyvan, Ilam province, Iran. The climate of the region was temperate. For determining soil characteristics before conducting the experiment sampling was done at the depth of 0-30 cm of soil and its quality was examined (table 1).

The experiment was a factorial design based on randomized complete blocks with three replications. It included two factors, biological Nitrogen fertilizer in four levels (Nitroxyne, Nitrocara, supernitroplas and control) and biological phosphorus fertilizer (biophosphorus, phosphate fertilizer 2, phosphate fertilizer 3 and control). 16 treatments in each replication and total 48 treatments were conducted in farm. Excel was used for arranging data and data analysis was done by SAS and MINITAB and Duncan Multiple Range test (DMRT) was used for comparing trait means.

Results and discussion

Plant height

According to the results of the study various resources of biological Nitrogen and phosphorus fertilizers had a significant effect on plant height (table 2). In Nitrogen biofertilizer, the highest plant height was obtained by Nitrocara 1198/3 cm (table3). Ansari *et al.*, (2010) reported that corn inoculation with Nitroxyne biological fertilizer and supernitroplas had a significant effect on bush height. Also, in phosphorus fertilizer, the highest plant height belonged at phosphate biofertilizer 2, 190/8 cm (table

4). Hernandez *et al.*, (1995) reported increasing plant height by inoculation of corn with Pseudomonas fleurscente bacteria.

Ear Height

The results of the study showed that various resources of Nitrogen and phosphorus biological fertilizer had a significant effect on ear height (table2). In Nitrogen fertilizer, the highest height belonged at supernitroplas 3/16cm (table3). Shalan (2005) concluded that inoculating Nigella seed with biological fertilizers of Azospirillum, Azotobacter and sodomonas causes better plant growth properties as plant height. Also, in phosphorus fertilizer, the highest ear height was obtained by phosphate fertilizer 2, 108cm (table 4).

Table 1. Physical and chemical properties of soil sample.

Depth (cm)	N (%)	P (ppm)	K (ppm)	PH	Clay (%)	Sand (%)	silt (%)
0-30	0.19	11	450	7.34	30	25	45

Stalk Diameter of plant

Findings showed that various resources of Nitrogen and phosphorus biological fertilizer have a significant effect on stalk diameter of corn plant (table2). Nieto and Frankenberger (1991) found that the inoculation of corn seed leads to increase stem diameter with Azotobacter chroococcum. In nitrogen biofertilizer, the highest stalk diameter belonged at supernitroplas 3/16 cm (table 3). Hamidi *et al.*, (2006) reported increasing a talk diameter for corn by inoculation with growth stimulating bacteria. Also, in phosphorus biofertilizer, the highest stalk diameter belonged at phosphate biofertilizer 2, 2/95 cm (table 4).

Table 2. Analysis of variance for studied traits of corn in this experiment.

		MS			
s.o.v	d.f	Plant height	Ear height from ground	Stalk Diameter of plant	Ear length
Rep	2	1959.1*	1745.2**	0.914**	18.26**
Nitrogen biofertilizer	3	3773.5**	12.94**	1.817**	34.18**
Phosphorus biofertilizer	3	2003.7*	641.5*	0.594**	29.65**
Phosphorus × Nitrogen	9	478.3	155.4	0.161	6.85*
Error	30	449.4	183	0.124	3
(%)CV	–	11.95	13.28	12.97	7.13

Continued Table 2. Analysis of variance for studied traits of corn in this experiment.

		MS			
s.o.v	d.f	Ear weight	Ear diameter	Ear cob diameter	Grain yield
Rep	2	6211.6**	0.936*	0.01	28531781**
Nitrogen biofertilizer	3	2947.8**	5.58**	2.202**	31487960**
Phosphorus biofertilizer	3	9003.8**	1.15*	2.348**	25838461**
Phosphorus × Nitrogen	9	2722.7*	0.308	1.126**	1212712
Error	30	1049.4	0.260	0.136	3197805
(%)CV	–	10.15	9.70	5.82	16.35

Were significant differences at 0.05 and 0.01 probability levels, respectively. ** and*.

Ear length

Findings showed that in addition to the main effect of treatments, interaction between treatments had a significant effect on ear length (table2). The highest ear length was obtained by phosphate fertilizer 2 + Nitroxyne 27/1cm. Sani *et al.*, (2007) reported that growth stimulating bacteria Azotobacter and Azospirillum had a significant effect on ear length.

Ear weight

Findings showed that in addition to the main effect of experiment treatments, interaction between treatments had a significant effect on ear weight (table2). The highest ear weight belonged at phosphate fertilizer 2 + supernitroplas 414/88. Yazdani *et al.*, (2008) reported that inoculation of corn with phosphor solvent bacteria and growth stimulating bacteria had a significant effect on ear weight.

Table 3. Mean comparisons traits under Nitrogen biofertilizer application.

Biofertilizer	Plant height (cm)	Ear height from ground (cm)	Stalk Diameter of plant (cm)	Ear length (cm)	Ear weight (cm)	Ear diameter (cm)	Ear cob diameter (cm)	Grain yield (kg)
Nitroxyne	182.23 ab	103.38 a	2.62 b	25.25 ab	304.56 c	5.06 b	6 c	11807.07 a
Nitrocara	198.32 a	103.81 a	2.86 b	25.35 a	333.90 b	5.15 b	6.47 b	11540.76 a
Supernitroplas	173 bc	112.47 a	3.16 a	24.75 c	377.37 a	6.21 a	6.90 a	11874.46 a
Control	155.88 c	87.55 b	2.24 c	21.78 d	259.57 d	4.59 c	6.01 c	8513.85 b

Means with the same letter(s) were not significantly differences at 0.05 probability level.

Table 4. Mean comparisons traits under Phosphorus biofertilizer application.

Biofertilizer	Plant height (cm)	Ear height from ground (cm)	Stalk Diameter of plant (cm)	Ear length (cm)	Ear weight (cm)	Ear diameter (cm)	Ear cob diameter (cm)	Grain yield (kg)
biophosphorus	176.66 ab	103.8 a	2.78 a	24.21 b	325.07 b	5.27 a	6.28 b	11463.55 a
phosphate fertilizer 2	190.84 a	108.02 a	2.95 a	26.07 a	343.24 a	5.59 a	6.76 a	11998.47 a
phosphate fertilizer 3	181.85 a	104.18 a	2.73 a	24.6 b	327.51 b	5.31 a	6.59 b	11511.07 a
Control	160.08 b	91.21 b	2.41 b	22.25 c	279.58 c	4.84 b	5.76 c	8763.04 b

Means with the same letter(s) were not significantly differences at 0.05 probability level.

Ear diameter

According to the results, various resources of Nitrogen and phosphorus biological fertilizers significantly affected ear diameter (table 2). In Nitrogen fertilizer, the highest ear diameter was obtained by supernitroplas 6/21 cm (table3). Also in phosphorus fertilizer, the highest ear diameter belonged at phosphate fertilizer 2, 5/59 cm (table 4). Zarabi *et al.*, (2011) reported that phosphate solvent bacteria inoculation with corn seed significantly affected ear diameter.

Ear cob diameter

Findings showed that apart from main effect of treatments, interaction between treatments had a significant effect on cob diameter (table 2). The highest cob diameter was obtained by supernitroplas + phosphate fertilizer 2, 7/61 cm. Zarabi *et al.*, (2011) reported that inoculating phosphate solvent bacteria with corn seed significantly affected cob diameter.

Grain yield

According to the obtained results, various resources of Nitrogen and phosphorus biological fertilizers had a significant effect on grain yield (table 2). In Nitrogen fertilizer, the highest grain yield belonged at supernitroplas 11874 kg per hectare, that showed 39% increase than control treatment (table 3). Shalan (2005), studying the effect of inoculation with Azotobacter, Azospirillum and Pseudomonas fleurscente on Nigella yield, reported increasing grain yield in different treatments than control treatment. Also, in phosphorus fertilizer, the highest grain yield belonged at phosphate fertilizer 2, 11998 kg per hectare that showed 36% increase than control treatment (table 4). Musari Jangali *et al.*, (2004) reported that application of phosphate solvent bacteria with chemical fertilizers increase grain yield significantly.

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