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Study of influence of azotobacter and bio-phosphate fertilizers on yield and yield components of wheat

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Abstract

In order to evaluate of influence of Azotobacter and Bio-phosphate fertilizers on yield and yield components of Wheat, an experiment was conducted during 2012-13 in rain-fed conditions of Noor Abad, Fars province, Iran. Factorial testing was carried out in a randomized complete block design (RCBD) in four replications. First factor included Azotobacter treatment at two levels (none Azotobacter and Azotobacter consumption "200 grams per hectare") the second factor Bio-phosphate (none Bio-phosphate and Bio-phosphate consumption "100 kg per hectare"). After pedological testing, Seeds prepared from research centers and they were planted in the plots Designed. Measured traits include plant height, number of spikes per square meter, number of grains per spike, Thousand-seed weight, number of tillers on per shrub, biological yield and grain yield. The results of variance analysis showed that the interaction of Azotobacter and Bio-phosphate had significant effect on stem height, number of spikes per square meter, number of grains per spike and grain yield at the level 1%. The highest grain yield and biological performance was observed in investigated plant at N_2P_2 treatment (interaction of Azotobacter and Bio-phosphate). Based on our results, in order to increase biological yield and grain yield of rain-fed wheat, using of Azotobacter and Bio-phosphate is recommended for cultivation in areas that climatic conditions similar to NurAbad.

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Introduction

Today, global approach of agricultural production goes toward creating sustainable farming systems and applying managerial techniques, one of these approaches is the use of bio-fertilizers. The first bio-fertilizer was used in the late nineteenth century and then, other bio-fertilizers have been made (Sharma, 2002). Bio-fertilizers can be expected to reduce the use of chemical fertilizers and pesticides. Use of bio-fertilizers is one of the important components of nutrient management, as they are renewable source of plant nutrients to supplement the chemical fertilizers for sustainable agriculture (Sood *et al.*, 1993). The role and importance of bio-fertilizers in sustainable crop production has been analyzed and reported by several researchers (Katyal *et al.*, 1994; Wani and Lee, 1992., Kumari and Lakshmi2009; Kalaigandhi *et al.*, 2010; Kanimozhi and Panneerselvam, 2011). The main advantages of plant growth promoting bacteria are producing regulating and plant growth stimulating hormones, developing root system and improving the uptake of water and nutrients, improving germination and seedling emergence, the synergistic effect of rhizobium, improving plant access to phosphorus, biological nitrogen fixation (Hafeez and Hassan, 2012; Hamidi *et al*, 2009). *Azospirillum* and *Azotobacter* have been used in agricultural systems as bio-fertilizer for their beneficial effects on plant growth (Tilak *et al.*, 1982). Research of Dobbelaere *et al* (2002) showed *Azotobacter* and *Azospirillum* increased plant growth, nutrient uptake and yield. Biari *et al.*, (2008) reported *Azospirillum* and *Azotobacter* had positive effects on yield and growth parameters of corn under field conditions. The use of biological fertilizers which contain Azospirillum and Azotobacter increased bush height and dry and wet weight of shoot in Salvia officinalis (Youssef *et al*, 2004).

In general, phosphatic fertilizers are recommended to be broadcasted and incorporated into soil before sowing (Malik, 1992). Phosphate solubilizing microorganisms are considered as a kind of bio-fertilizer which can improve the plant growth by dissolving phosphorus in sparingly soluble phosphate minerals such as rock phosphate (Hafeez and Hassan, 2012; Liu *et al*, 2009) The average recovery of phosphorus fertilizer by crops is very low and varies from 15-20% on single crop basis (Rashid, 1994). This may be attributed to reversion of applied phosphates to less available forms such as octa calcium phosphates, carbonate apatite, hydroxy apatite and flour apatite by reacting with clays and calcium compounds (Tisdale *et al.*, 1985). According to Rashid and Din (1993), degree of phosphorus fixation depends on the ratio of applied phosphor; the fixation of broadcasted phosphorus is much greater than the phosphorus applied through bands.

Wheat is the most important agricultural good in international market and also it is one of the strategic agricultural productions which have daily and universal consumption (Mollasadeghi and shahryari, 2011). Of course, wheat produces in limited ecological conditions and geographical areas, and its diffusion extent is higher than any other species due to high compatibility with environmental different weather conditions, and crop is the main food for majority of worldwide increasing population (Habibpor *et al.*, 2011). More than one-third of the world Population is feed by wheat. Wheat is the major crop in Iran (Keshavars *et al.*, 2003). It is cultivated over a wide range of environments, because of wide adaptation to diverse environmental conditions. In Iran, 6.2 million hectares are under wheat cultivation, of which 33% is irrigated and 67% is rain fed, the irrigated wheat growing areas (2 million hectares) are located mostly in southern, central and eastern of Iran (Keshavars *et al.*, 2003; Badie *et al.,* 2014).

Results of Noori *et al* (2014) showed that effect of mycorrhiza and nitrogen on grain yield, harvest index weight of 1000 grain had significant effect. In another experiment, Leithy *et al.* studied the positive effects of using Azotobacter bio-fertilizer in increasing the essential oils of rosemary herb (Leithy *et al*, 2006).

Gerretsen (1998) Observed that, plants with two strains of gram phosphate solubilizing bacteria was caused increased root colonization, a significant increase in the concentration of phosphorus plant and stimulate plant growth is increased ultimately.

The use of biological resources or manufacturing plant nutrients such as phosphorus and nitrogen stabilizer will be in addition to being an important role in reducing the use of chemical fertilizers, are increase fertility and sustainable agricultural systems. In our area overdose using of chemical fertilizers by farmers were led to irreparable damage on the health of people such as Types of cancers. This problem was caused we decided to test influence interaction of Azotobacter and Bio-phosphate on wheat farms of Nurabad., until farmers learn more about Biological fertilizers and replace chemical fertilizers by it. This project was performed in order to evaluate the effectiveness of Azotobacter and Bio-phosphate on yield and yield component of wheat

Materials and methods

Plan locality

The present research was conducted during 2012-13 in agricultural lands Taleghani that located 25 km West Nurabad Mamasani with height of 1245 meters above sea level (Jafari, 2014).

Ecological condition

Nurabad has a warm climate with hot and dry summer, according to obtained statistics from province weather Office and according to Ambrgeh climate. average annual precipitation is about 458 mm, and average annual evaporation is 1012 mm. most rainfall in the months of December, January and February are located and distribution of rainfall is difference in the months and years varies. so that in some years more than 680 mm and in recent years due to drought is less than 180 mm. the minimum and maximum absolute temperature is +2.3 and +46.3° C, respectively, in January and July (Jafari, 2014).

Soil analysis

The results obtained from the soil sample analysis, taken from experimental field prior to planting, are demonstrated in table 1.

Traits of Experiment

The experimental factors included Azotobacter at two levels (none Azotobacter and Azotobacter consumption "200 grams per hectare") and Bio-phosphate (none Bio-phosphate and Bio-phosphate consumption "100 kg per hectare") (Jafari, 2014).

The studied traits included plant height, number of tillers per square meter, number spike per square meter, thousand grain weight, number of grains per spike, grain yield and biological yield.

The experimental method

First, action of plowing done by the disk perpendicular then hunk was crushed. Samples were planted 3*4 plots at a distance of one meter. Requirements of Phosphorus and potassium fertile type of ordinary super phosphate were distributed before planting in the plots. Seeds of wheat required to be calculated and according plots applied with fertilized Bio-phosphate and Azotobacter in all plots were planted in the same hands. Operation and maintenance will be doing the same for all plots. After harvest, the middle of each plot was sampled to eliminate the marginal. effect of one square meter While the number of stems per square meter, cut the plants from the crown area, and placed in a paper bag and transported to the laboratory and the number of spikes per square meter, number of grains per spike, Thousand Seed weight and grain yield were measured. Finally the samples were placed in an oven for 72 hours at 60 ° C and then biomass of wheat was calculated (jafari, 2014).

Method of yield calculates:

The following equation was used to determine the performance of the components.

$Y = (K + F * E * R * 1000) / 1000$

Y، K، F، E and R, the grain yield (kg/Hec), number of Shrub per square meter, number of Spike per Shrub, number of grains per spike and Thousand grain weight (gr) were respectively in this equation.ld were measured by using a digital scale.

Statistical analysis

Factorial testing was carried out in a randomized complete block design (RCBD) in three replications. The experimental factors included Azotobacter and Bio-phosphate in the form of seed inoculation each at a rate of 100 g per 70 kg of seed and their interaction was done.

Data were analyzed using SAS statistical software. Comparison of treatment means was performed using Duncan's multiple range test and Excel software was used to prepare plot graphs.

Results and discussion

Stem Height

Based on the results of variance analysis, effect of Azotobacter and Bio-Phosphat lonely and interaction of their factors on Stem height mean were significant at 1% level (table2).

Table 1. Results of Soil analysis.

pH	Conductivity (ds/m)	Saturation	Percent of Self-neutralizing materials	Percent of Organic carbon	Percent of Total nitrogen	Phosphor p.p.m	Potassium p.p.m	Culture
7.3	0.31	44	19.2	3.21	0.28	8.04	119	Clay loam

Table 2. The variance analysis of mean square for interaction effects of Azetobacter1 and Phosphat barvar2 on yield and yield components of Wheat.

Alteration sources	Degree of freedom	Mean square						
		Stem Height	Tillering	Spike number per square	number seed per spike	of weight of thousand seeds	one Yield	Biological Yield
Block	3	2.97^{ns}	0.063^{ns}	38.73^{ns}	0.44^{ns}	0.46^{ns}	1.42^{ns}	79.4^{ns}
Azetobacter1	1	315.95**	0.562^{ns}	430.56**	189.06**	0.03ns	956.35**	222.01*
Phosphat barvar2	1	546.4**	0.063^{ns}	2997.6**	126.56**	0.05ns	1484.2**	2525.06**
Azetobacter1× Phosphat barvar2	1	155.62**	0.063^{ns}	612.56**	10.56**	0.14ns	278.06**	165.12*
Eror	6	4.35	0.23	24.4	0.56	0.185	5.4	25.27
Coefficient of variation		2.39	11.43	2.62	4.07	11.26	2.06	11.71

** :Significant at % 1

*: Significant at the 5% level.

NS: no significant.

Results from comparing the mean of data showed that the interaction of factors of Azetobacter and Bio-Phosphat had a significant effect on the Stem height (Figure 1). The maximum Stem height (100.6 Cm) was observed in the treatment of the interaction of Azetobacter and Phosphat barvar2 (N2P2) and occupied class a, while its minimum (80Cm) was in the treatment control (N1P1) and occupied class c, (table 3). The results of this study were consistent with studies conducted by (Hassan panah, 2010; Gerami, 2003).

Table3. The results for interaction effects of Azetobacter1 and Phosphat barvar2 on yield and yield components of Wheat.

Examined factors				Characteristics						
Azeto bacter1	Unit ml	Phosphat barvar2	Unit ml	Stem Height (Cm)		Spike number per square	number seed spike	of weight of one thousand seeds (gr)	Yield (gr/m²)	Biological Yield (gr/m²)
N1	0	P1	0	80c	3.25ab	173.5c	13c	34.35a	99.6c	274.4c
N1	0	P1	2	85.47b	3.75ab	190.5b	17b	34.05a	110.55b	305.9a
N2	2	P2	0	82.7bc	4.75a	175.5c	18.25b	34.25a	106.8b	288.25b
N2	2	P2	2	100.6a	4.25a	212.25a	25.5a	34.32a	134.35a	306.95a

Means scores of each column with at least one shared letter, are not significantly different.

Number of tillers on per shrub

Based on the results of variance analysis, Azetobacter and Bio-Phosphat lonely and interaction of their factors had no significant effect on number of tillers on per shrub (table2).

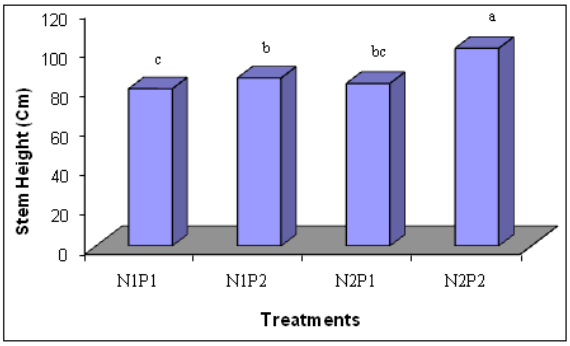

Fig. 1. The interaction effect of Azotobacter and Bio-Phosphat on Stem Height.

Results from comparing the mean of data indicated the interaction of factors of Azotobacter and Bio-Phosphat had no significant effect on number of tillers on per shrub (Figure 2). The maximum tillers of shrub (4.75) was observed in the treatment of the interaction of Azotobacter and Bio-Phosphat (N_2P_2) and occupied class a, while its minimum (3.25) was in the treatment control (N_1P_1) and occupied class ab Fig (2). Finding obtained was consistent with results of the (safayi, 2009).

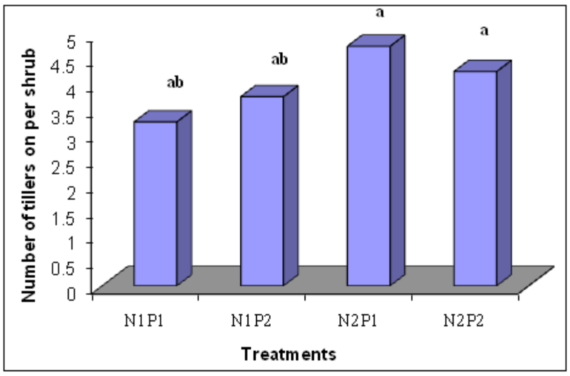

Fig. 2. The interaction effect of Azotobacter and Bio-Phosphat on number of tillers on per shrub.

Number of Spike on per Square

Based on the results of variance analysis, effect of Azotobacter and Bio-Phosphat lonely and interaction of their factors were significant on Spike number per square at 1% level (table2).

The results of the mean comparison indicated that interaction of factors of Azotobacter and Bio-Phosphat had significant effect on Spike number per square (Figure 3). The maximum Spike number per square (213.25) was observed in treatment of the interaction of Azotobacter and Bio-Phosphat (N_2P_2) and occupied class a, while its minimum (173.5) was in the treatment control (N_1P_1) and occupied class c (table 3). Finding obtained were consistent with results of the (safayi, 2009; khalil *et al.*, 2014).

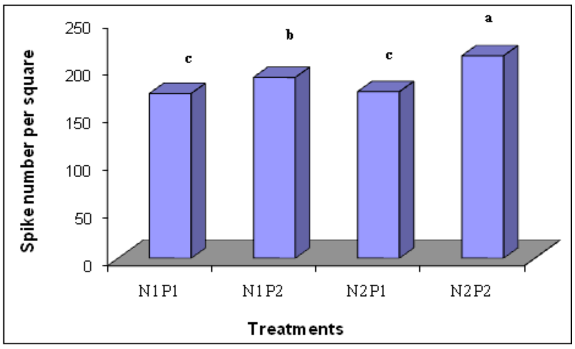

Fig. 3. The interaction effect of Azotobacter and Bio-Phosphat on Spike number per square.

Number of seed per Spike

Analysis of variance indicated effect of Azotobacter and Bio-Phosphat lonely and interaction of factors on number of seed per spike were significant at 1% level (table2).

The results of the mean comparison indicated that interaction of factors of Azotobacter and Bio-Phosphat had significant different on mean number of seed per spike (Figure 4). The maximum number of seed per spike (25.5) was observed in treatment of the interaction of Azotobacter and Bio-Phosphat (N_2P_2) and occupied class a, while its minimum (13) was in the treatment control (N_1P_1) and occupied class c (table3). Finding obtained were consistent with results of the (sahami and bagheri, 2006; Hassan panah, 2010).

Thousand seeds Weight

Analysis of variance indicated effect of Azotobacter and Bio-Phosphat lonely and interaction of factors had no significant effect on weight of one thousand seeds (table2).

The results of the mean comparison indicated the maximum weight of one thousand seeds (34.35 gr) was observed in treatment of the interaction of none Azotobacter and none Bio-Phosphat (N_1P_1) and occupied class a, and its minimum (34.05gr) was in the treatment interaction none azetobacter and Bio-phosphate (N_1P_2) and occupied class a, (Fig 5). Based on the finding of our results, all means belong to one class (table3).

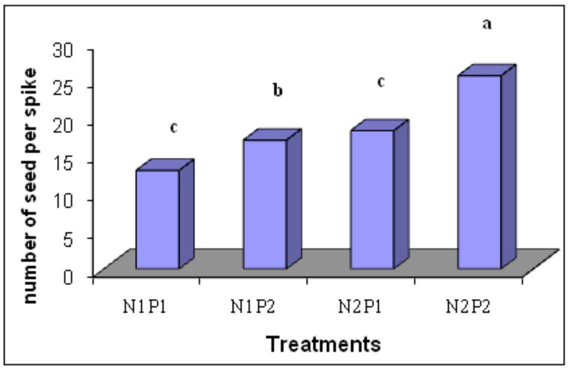

Fig. 4. The interaction effect of Azotobacter and Bio-Phosphat on number of seed per spike.

Yield of Wheat

Analysis of variance indicated effect of Azotobacter and Bio-Phosphat lonely and interaction of factors on yield were significant at 1% level (table2).

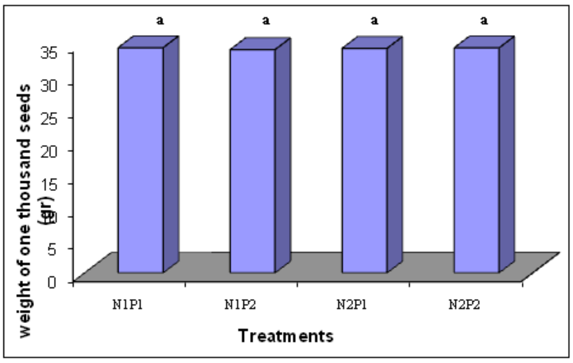

Fig. 5. The interaction effect of Azotobacter and Bio-Phosphat on Thousand seeds weight.

The results of the mean comparison indicated that interaction of factors of Azetobacter and Bio-Phosphat had significant effect on yield (Figure 6). The maximum yield (134.35gr) was observed in treatment of the interaction of Azetobacter and Bio-Phosphat (N_2P_2) and occupied class a, while its minimum (99.6gr) was in the treatment control (N_1P_1) and occupied class c (table3). Finding obtained were consistent with results of the (safayi, 2009, khalil *et al.*, 2010).

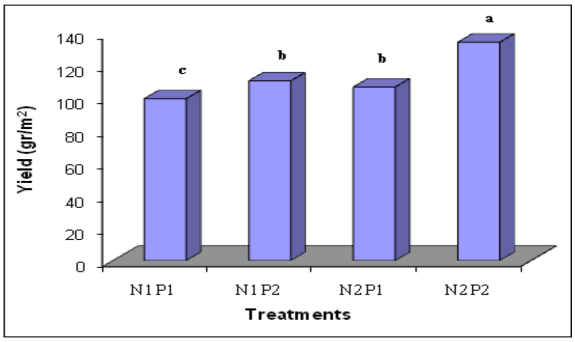

Fig. 6. The interaction effect of Azotobacter and Bio-Phosphat on Yield.

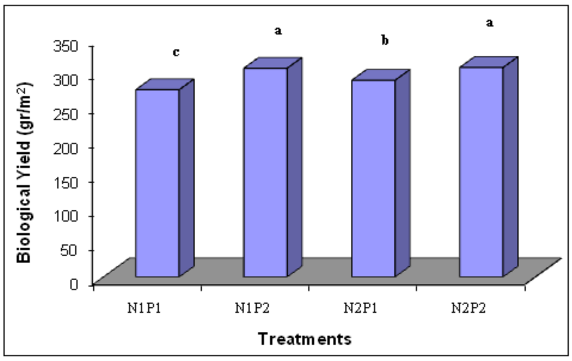

Fig. 7. The interaction effect of Azotobacter and Bio-Phosphat on Biological Yield.

Biological Yield

Analysis of variance indicated effect of Azotobacter and Bio-Phosphat lonely and interaction of factors on Biological yield were significant at 1% level (table2).

The results of the mean comparison indicated that interaction of factors of Azotobacter and Bio-Phosphat had significant effect on Biological yield (Figure 7). The maximum yield (306.95gr) was observed in treatment of the interaction of Azotobacter and Bio-Phosphat (N_2P_2) and occupied class a, while its minimum (288.25gr) was in the treatment control (N_1P_1) and occupied class c (table3). Finding obtained were consistent with results of the (safayi, 2009; khalil *et al.*, 2010; Gerami, 2003; Sahami and Bagheri, 2006.

Conclusion

Considering the Previous researches and results obtained of our experiment, using of biological fertilizers on the one hand reduced consumption of chemical fertilizers and the other hand reduced environmental pollution than caused effective step will be to move towards sustainable agriculture.

Therefore was concluded that Azotobacter and Bio-Phosphate are important roles in order to reduce nitrogen and phosphorus in farms. Moreover, in order to increase biological yield and grain yield of rain-fed wheat, using of Azotobacter and Bio-phosphate is recommended for cultivation in areas that climatic conditions similar to NurAbad.

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