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Investigating the Effect of Azotobacter and Bio-phosphate fertilizers on Yield and Yield Components of *Phaseolous Vulgaris*

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ABSTRACT: To evaluate the effect of Azotobacter and Bio-phosphate fertilizers on yield and yield components of *Phaseolous*, an experiment was conducted during 2012-13 in Lordegan city at Chahar Mahal-va-Bakhtiari province, Iran. Factorial testing was carried out in a randomized complete block design (RCBD) in three replications. First factor included Azotobacter treatment and the second factor Bio-phosphate was in the form of seed inoculation at a rate of 100 g per 70 kg of seed. Measured traits include the number of nodes on the main stem, number of lateral branches, number of seeds per pod, bush height, seed weight, seed yield, biological yield, protein percentage in the shoot. The results of the comparison showed that the factor of Azotobacter and Bio-phosphate biofertilizers alone or in combination had a significant effect on grain yield, its biological yield and bean harvest index at 5% than the control treatment. The results of the mean comparison indicated the interaction of Azotobacter and Bio-phosphate had significant and increasing effect on the number of side branches, bush height, protein percentage, number of seeds per pod, seed weight mentioned traits than the control treatment. Maximum biological yield and grain yield related to the interaction of Azotobacter and Bio-phosphate were which 4829 and 2505 kg per hectare, respectively. According to the obtained results in order to increase biological yield and grain yield interaction treatment of Azotobacter and Bio-phosphate is recommended.

Keywords: *Azotobacter*, Bio-phosphate, *Phaseolus vulgaris*, Yeild, Yield component

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). 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). 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 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 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). According to research conducted by Hamidi et al the highest yield in grain was observed in seed inoculated treatments with three bacteria Azotobacter, *Azospirillum* and *Pseudomonas* (Hamidi *et al*, 2009).

Grains, the second largest source of human food after cereals, can be considered as the most important source of vegetable protein that with having 18 to 23 percent protein compared with animal proteins particularly plays an important role in the nutrition of low-income people (Majnoon Hosseini, 2008; Noumavo *et al*, 2013).

Among the grains in terms of acreage and cost bean holds first place (Guarda *et al*, 2004). The complete scientific name of bean is (*Phaseolous vulgaris* L.) of herbaceous annual plants belonging to the family Fabaceae, with 20 to 25 percent protein and 50-56 percent carbohydrates which compared with cereals 2 to 3 times and compared with starchy plants has 10 to 20 percent protein (Pirbalooti *et al*, 2003).

. Many studies should be done on organic and integrated farming to improve the yield of bean since it is one of the most important crops in the world and Iran, and considering its capabilities it is expected to have an acceptable yield and quality in this system. According to the vast cultivation of beans in the central zagros and excessive of fertilized to farmers in this region, we should acquaint farmers with disadvantage of chemical fertilizer. In addition, this study were introduced the advantages of biofertilizerer to farmers, that can be used replace with chemical fertilizers. With respect to necessity of investigate the effect of biofertilizers (Azotobacter and Bio-phosphate) and their interactions on yield and yield components of beans in central zagros and due to the insufficient consideration of application of biological fertilizers on crops in this region of our country and with respect to the growing importance of grains, developing research programs on nutrition and increasing bean production is important It is thus decided to evaluate effect of biofertilizers (Azotobacter and Bio-phosphate) and their interactions on yield and yield components of beans (Abdollahi and Rahimi, 2013).

MATERIALS AND METHODS

A. Plan Locality

The present research was conducted during 2012-13 in the Falard district of Lordegancity at Chahar Mahal and Bakhtiari province, Iran at an altitude of 1730 meters above sea level and was conducted in an area of 300 square meters.

B. The experimental method

The studied type of bean was *Phaseolous Vulgaris* which was bought from PakanBazr Company, Isfahan, Iran. 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 (Abdollahi and Rahimi, 2013). Crops were planted due to the climatic conditions and local meteorological statistics in the first half of May.

After land preparation, it was plot out in the dimensions of 3 × 3m with a distance of 1m between plots; the distances of blocks were 2m.

The first irrigation was done before planting and after ploughing. Beans were planted manually and bio-fertilizers (Azotobacter and Bio-phosphate) in the form of seed inoculation at a rate of 100 g per 70 kg of seed. Beans were planted in rows, to a depth of 6-8 cm of soil and 20-25 cm row spacing and the bush spacing on the planted rows was 10 cm. The flood irrigation was done 20 to 25 days after planting and irrigation interval was considered 4 to 5 days and every 3 days during the flowering.

C. Traits of Experiment

In this experiment biological yield, grain yield, Bush height, the numbers of lateral branches, number of seed per pod, Protein percentage, Weight of one hundred seeds were studied

The number of lateral branches: In each plot through observing the marginal effect, the number of lateral branches was measured randomly from among 5 bushes.

Bush height: Height in cm was measured randomly from ground level to the last node among 10bushesby observing the marginal effect.

Grain yield: 5 bushes were randomly selected from each plot and all the seeds of five plants were removed from the pods and weighted. Then the average yield of a bush was calculated. At the end, the yield was extended to the hectare in kilograms per hectare.

Biological yield: To obtain biological yield5 bushes were randomly selected from each plot and weighed. Then their average was taken out and the biological yield of one bush was obtained. At the end, the biological yield was extended to the hectare in kilograms per hectare.

The number of seeds per pod: The number of seeds per pod was obtained through counting the number of seeds per 100 pods out of 10 bushes randomly.

Weight of one hundred seeds: To calculate the weight of one hundred seeds per plot, one hundred seeds were taken randomly then weighed.

Seed protein: 2 bushes and 20 seeds from each plot were randomly selected and assessed for protein content through Kjeldahl method.

D. Statistical analysis

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

A. Bush height

The results of the mean comparison showed that the factors of Azotobacter and Bio-phosphate fertilizers solely had no significant effect on the Bush height but in intraction together had a significant effect than the control treatment (P≤0.05). It was observed that interactive treatment of fertilizers had the highest Bush height (37.67 Cm) and the least Bush height (29.67 Cm) belonged to the control treatment (Fig. 1).

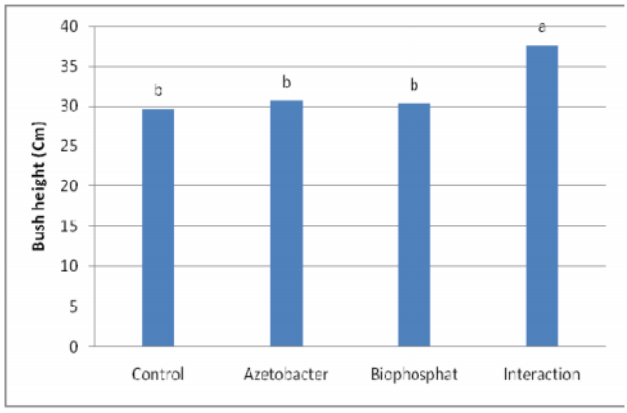

Fig. 1. Effect of Treatments on Bush height.

B. The number of lateral branches

The results of the mean comparison showed that the factors of Azotobacter and Bio-phosphate fertilizers solely had no significant effect on the lateral branches but in intraction had a significant and increased effect than the control treatment at 5% level. It was observed that interactive treatment of fertilizers had the highest number of branches (7.67) and the least number of lateral branches (6) belonged to the control treatment and Bio-phosphate (Fig. 2).

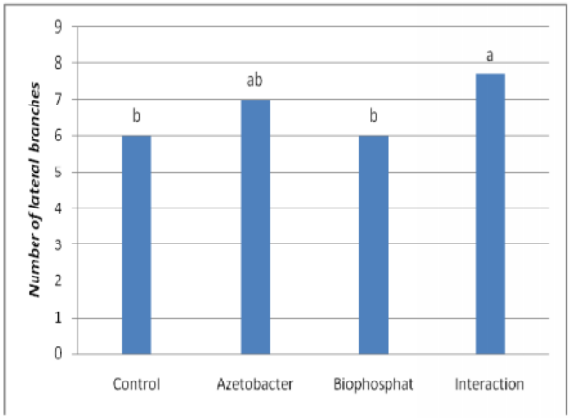

Fig. 2. Effect of Treatments on number of lateral.

C. The number of seeds per pod

The results of the mean comparison showed that the factors of Azotobacter and Bio-phosphate fertilizers solely had no significant effect on the number of seeds per pod (P≤0.05) but in combination had a significant and increased effect than the control treatment (P≤0.05). It was observed that interactive treatment of fertilizers with 4.3 and control treatment with 2.56 respectively had the highest and lowest numbers of seeds (Fig. 3) late July that seeds have reached full maturity. The mature seeds begin to fall; the stems dry and are cracked in early September (Fig. 3).

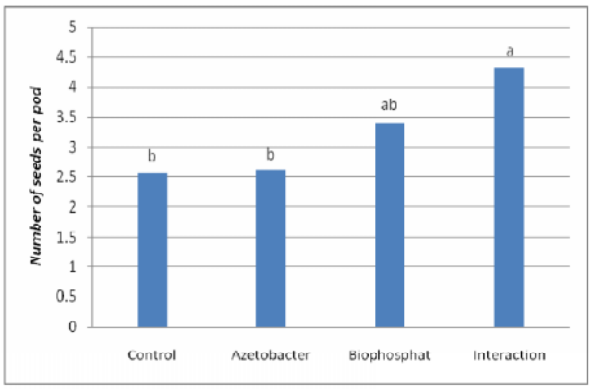

Fig. 3. Effect of Treatments on number of Seed per pod.

D. Protein percentage

The mean comparison of results showed that Azotobacter and Bio-phosphate treatments in the form of interaction 5% had significant effect on the protein percentage of bean (P≤0.05). It should be noted that Azotobacter and Bio-phosphate treatments solely, had no significant effect on bean protein at the level of 5%. Also it was observed that interactive treatment of fertilizers treatments. at a rate of 21.87% and control treatment with 18.332% respectively had the highest and lowest protein content (Fig. 4).

E. Grain yield

The results presented had revealed that different levels of treatments had significant effects on the grain yield (P≤0.05). The mean comparison of data in different treatments showed that the highest Grain yield (2505 $kg.ha^{-1}$) was achieved by interactive treatment of fertilizers treatments. The lowest biological yield (1190 $kg.ha^{-1}$) was obtained in control (non-fertilizer application) (Fig. 5).

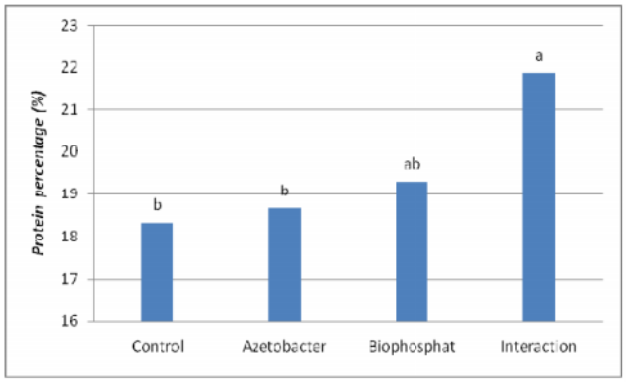

Fig. 4. Effect of Treatments on Protein percentage.

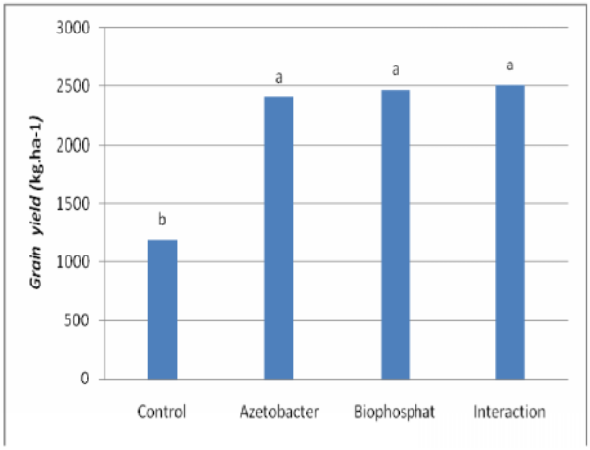

Fig. 5. Effect of Treatments on Grain yield.

F. Biological yield

The results presented had revealed that different levels of treatments had significant effects on the Biological yield (P≤0.05). The mean comparison of data in different treatments showed that the highest Biological yield (5022 kg.ha^{-1}) was achieved by interactive treatment of fertilizers treatments. The lowest biological yield (3283 kg.ha^{-1}) was obtained in control (non-fertilizer application) (Fig. 6).

G. Weight of one hundred seeds

The results of the mean comparison showed that the factors of Azotobacter and Bio-phosphate fertilizers solely had no significant effect on the Weight of one hundred seeds (P≤0.05) but in combination had a significant and increased effect than the control treatment (P≤0.05) (Fig. 7). The mean comparison of data in different treatments showed that the highest Weight of one hundred seeds (33.24 Gr) was achieved by interactive treatment of fertilizers treatments. The

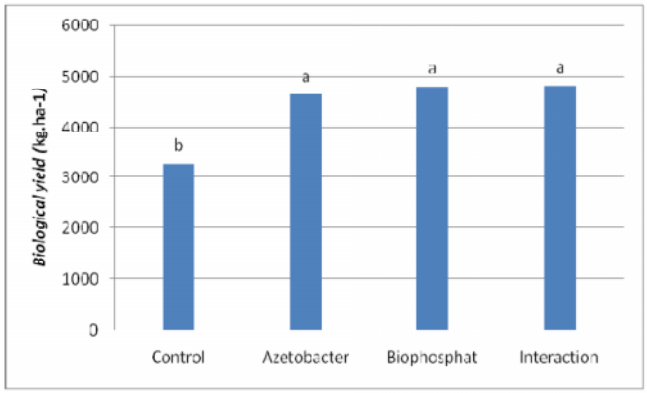

Fig. 6. Effect of Treatments on biological yield.

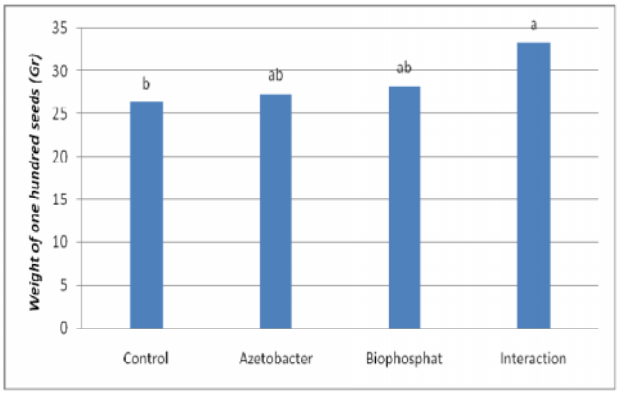

Fig. 7. Effect of Treatments on Weight of one hundred Seeds.

lowest biological yield (26.33 Gr) was obtained in control (non-fertilizer application) (Fig. 7).

CONCLUSION

The mean comparison of results showed that the use of Bio-phosphate and Azotobacter treatments alone or in combination can increase grain yield and biological yield at the 5% level compared to the control treatment which is highly economical. The interaction of biological fertilizers to increase efficiency, yield and yield components of beans is recommended. Since nowadays there is a reduced tendency toward the use of chemical fertilizers among the societies, the use of bio fertilizers can be a positive approach in this regard.

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