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Phosphorus fertilizers effect on the yield and yield components of faba bean (*Vicia faba* L.)

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ABSTRACT

Effect of four levels of phosphorus (0, 40, 80, 120 kg ha^{-1} P_2O_5) from two sources [Triple Super Phosphate (TSP) and Diamonium Phosphate (DAP)] on autumn-sawn faba bean (Vicia faba L.) native bulk was studied. This trial was done in factorial experiment based on complete randomized block design with three replications. Total yield, branch number, fresh weight, seed dry matter percent, seed protein percent, weight of 100 seeds and node number in plants were measured. The kind of fertilizer source had significant effect ($p \leq 0.05$) on total yield, pods number, dry matter percent, pod seed number, plant length, weight of 100 seeds, branch number and plant dry matter. However, effect of fertilizer amounts was significant ($p \leq 0.05$) on plant length, fresh weight and pod number. The best treatment between fertilizers was TSP with 13.36 t ha^{-1} green pods and the best one of phosphate amount was 80 kg ha^{-1} P_2O_5 with 13.00 t ha^{-1} green pods.

Key words: broad bean, fertilizer, yield, phosphorus

INTRODUCTION

Broad bean (*Vicia faba* L.) is consumed worldwide as protein sources by humans. Faba bean grains have about 23% protein based on dry matter, which is considerable among vegetables [5]. *Vicia faba* L., Fabaceae, is able to fix nitrogen and it is used in crop rotation. Like the other members of Fabaceae, *Vicia faba* also increases humus of soil [9]. Depending on the plant density and the field management, this plant is able to fix nitrogen up to 40 kg ha^{-1} annually [4]. Abou-Salama and Dawood [2] believed that increasing of phosphorus until 90 kg ha^{-1} produces the most yield but it is unable to alter grain protein. Salem and El-seessy [12] revealed that 240 kg ha^{-1} calcium superphosphate has less effect on grain yield, but 360 kg ha^{-1} of this fertilizer decreased grain yield. Salem and El-Nakhlawi [11] found that increasing of phosphorus fertilizer had not any effect on yield component of broad bean and it just affected the branch number. In an experiment on *Zea mays* L. was proved that increasing of phosphorus until 80 kg ha^{-1} increased significantly yield, weight of 100 seeds and percent of seed protein [3]. Majumdar et al. [6] found that increasing of sulfur, phosphorus and zinc caused the significant increase on seed yield, nitrogen concentration, sulfur and phosphorus in seeds, stem and leaves of broad bean. The aim of our study was evaluation of different amount of phosphorus fertilizer on the faba bean yield and identification of the best one of phosphorus fertilizers.

MATERIALS AND METHODS

The study was conducted at the experimental field in Rasht, Guilan Province, Iran. The soil characteristics of the site included a pH 6.3, organic carbon 0.56%, total nitrogen 0.074% and available phosphorus 9.8 mg l^{-1}. This experiment was carried out in order to evaluate the effect of different levels of phosphorus (0, 40, 80, 120 kg ha^{-1} P_2O_5) and two type of phosphorus fertilizer [Triple Super Phosphate (TSP) and Diamonium Phosphate (DAP)] on autumn – sawn faba bean (*Vicia faba* L.) 'Native bulk'. The experiment was set up in "Factorial" with completely randomized block design, with three replications. The seeds were sown in 20 m^2 plots. 25 kg ha^{-1} nitrogen and 100 kg ha^{-1} K_2O was applied in all plots as base dose. Seeds are soaked about 24 hours before planting and these soaked seeds

sown in 4-5 cm depth at 1 Nov. Weeding out and pest management especially *Doralise faba* were done in all plots throughout of growth season. First harvesting is done at on 22 May. Second harvesting was about a week interval. At maturity, grain and straw samples were separately harvested and analyzed. Sum of two harvesting considered as total yield. Ten plants of each plot were harvested to measure of traits. Dry matter of seeds obtained in 105 ºC oven in 24 hours. To obtain protein percent of seeds, firstly nitrogen percent of grains was measured and then result multiplies by 6.25.

RESULTS AND DISCUSSION

Between two phosphorus fertilizers, the effect of TSP was significant ($p \leq 0.05$) on yield and this increasing of yield was 16% compared to control (Table 1). The effect of TSP on some characteristics was better than DAP (Table 2). Application of TSP was significant at 0.05 on weight of 100 seeds, branches number and percent of plant dry matter. Besides, TSP application caused to increase fresh weight of plants, but this increasing was not statistically significant. Besides, TSP application caused to increase fresh weight of plants, but this increasing was not statistically significant. In this study, amount of 80 kg ha^{-1} P_2O_5 was the best treatment among deferent level of P fertilizers in broad bean fertilizing. The effect of this treatment was significant on the plant length, fresh weight and pod number and in comparison with other treatments (0, 40 and 120 kg ha^{-1}) was better ($p \leq 0.05$). Application of 80 kg ha^{-1} P_2O_5 increased yield production, but this increasing was not statistically significant. Salem and El-Nakhlawy [11] found that further amount of the soil phosphorus did not affect on yield components. In a field experiment on broad bean, Abou-Salama and Dawood [2] found that increasing in phosphorus up to 90 kg ha^{-1} could increase yield production. This result is in accord with our result. The studies of Selim and El-Seessy [12] on broad bean showed that the effect of 240 kg ha^{-1} calcium super phosphate using was less than controls on yield, whilst 360 kg ha^{-1} from this fertilizer reduced the yield. In present study, no significant difference found between the levels of phosphorus on the yield. In conclusion, phosphorus fertilizer application up to certain amount can increase yield of faba bean, but further P fertilizer using not only cannot increase yield, but also decrease it. Al-Farhan and Al-Rawi [3] in experiment on *Zea mays*, found that increasing in phosphorus up to 80 kg ha^{-1} caused to increase yield. Nayak and Dwivedi [8] also demonstrated that among 0, 40 and 80 kg ha^{-1} phosphorus, 80 kg ha^{-1} produced the highest yield. Majumdar et al. [6] revealed that application of sulphur, phosphorus and zinc have significant effect on the yield and the best treatment was 80 kg ha^{-1} phosphorus, 20 kg ha^{-1} sulphur and 20 kg ha^{-1} zinc. Totally, one of the most important reasons for non- significant effect of phosphorus on the yield of faba bean is its low efficiency in soil due to low solubility and absorption. For improvement of solubility and absorption, the best P-resource should be identify and apply [14, 15]. The results show that TSP had more effect than DAP on the faba bean yield. It is believed that reason of non-significant effect of P on the yield is antagonistic interaction between P and microelements [13]. Hence, P fertilizers decreased solubility of zinc [10]. In study with N, P and K treatments on autumnal lentil, 60 kg ha^{-1} N, 80 kg ha^{-1} P and 60 kg ha^{-1} K produced the most yields [7]. The plant node number, plant length and the yield in 80 kg ha^{-1} TSP application were more than other treatments. This shows that these recent three traits have close correlation. Since the flowers of broad bean produced on the nodes, thus the presence of more node and length in plants result in more yield [4]. The seed dry matter and the grain protein was not affected by amounts and type of P fertilizers, but plant dry matter in TSP treatment was better than it's amount in DAP apllication ($p \leq 0.05$). Abou- Salama and Dawood [2] found that increasing of P up to 90 kg ha^{-1} has not positive effect on the grain protein, while Abdel-Aziz et al. [1] believed that increasing of P caused to boost of total protein and carbohydrates in the plant leaves. 80 kg ha^{-1} P was better than other treatments ($p \leq 0.05$) on the pod number. Al-Farhan and Al-Rawi [3] found that application of P up to 80 kg ha^{-1} increased the weight of 100 seeds in maize.

Table1: Analysis of variance of different treatments on measured characteristics

Source of variance	df	Node number	Plant length (cm)	Seed dry matter (%)	Seed protein (%)	Yield (t ha^{-1})	Pod seed number	Weight of 100 seeds (g)	Plant fresh weight (g)	Branches number	Plant pod number	Plant dry matter (%)
Replication	2	1.191$^{n.s}$	81.866$^{n.s}$	2.978 $^{n.s}$	1.266 $^{n.s}$	1.362 $^{n.s}$	0.052 $^{n.s}$	23.561 $^{n.s}$	4750.542 $^{n.s}$	2.731$^{n.s}$	0.729 $^{n.s}$	7.703 $^{n.s}$
P fertilizers (S)	1	0.886$^{n.s}$	5.424 $^{n.s}$	0.082 $^{n.s}$	2.618 $^{n.s}$	21.682*	0.001 $^{n.s}$	1225.510*	8437.5 $^{n.s}$	5.387 *	0.910 $^{n.s}$	34.082*
P amounts (P)	3	1.641$^{n.s}$	1040.086*	1.855 $^{n.s}$	0.278 $^{n.s}$	1.567 $^{n.s}$	0.028 $^{n.s}$	588.108 $^{n.s}$	12508.55*	0.360 $^{n.s}$	6.420*	8.796 $^{n.s}$
SP	3	0.173$^{n.s}$	21.463$^{n.s}$	0.073 $^{n.s}$	0.081 $^{n.s}$	2.877 $^{n.s}$	0.005 $^{n.s}$	74.643 $^{n.s}$	914.944$^{n.s}$	0.415 $^{n.s}$	0.471 $^{n.s}$	0.449 $^{n.s}$
Error	14	3.097	268.186	2.608	1.541	3.917	0.056	253.155	2403.304	1.023	1.978	4.581
CV (%)	-	8.22	13.53	5.84	4.30	15.94	9.60	7.06	22.77	19.7	19.29	7.82

*ns: Non significant; * : Significant at 5% ;** : Significant at 1%*

Table 2: Means comparison of treatments effect on traits

Treatments	Node No.	Plant length(cm)	Seed dry matter (%)	Seed protein (%)	Yield (t ha^{-1})	Pod seed No.	Weight of 100 seeds (g)	Plant fresh weight (g)	Branches No.	Plant pod No.	Plant dry matter (%)
S_1 (TSP)	21.597a*	121.49 a	21.58 a	29.21 a	13.36 a	2.48 a	232.44 a	234.08 a	5.61 a	7.49 a	28.55 a
S_2 (DAP)	21.212 a	120.54 a	27.70 a	28.55 a	11.46 b	2.47 a	218.15 b	196.85 b	4.66 b	7.10 a	26.17 b
P_1 (0 kg/ha)	20.808 a	108.57 b	26.87 a	28.63 a	12.31 a	2.42 a	212.03 a	176.50 b	5.05 a	6.23 b	28.35 a
P_2 (40kg/ha)	21.127 a	112.98 b	27.63 a	28.79 a	12.56 a	2.44 a	225.65 a	183.67 b	4.84 a	6.85 ab	28.02 a
P_3 (80kg/ha)	21.895 a	138.00 a	28.13 a	29.08 a	13.00 a	2.58 a	235.92 a	275.67 a	5.24 a	8.44 a	26.63 a
P_4(120kg/ha)	21.788 a	124.51 b	27.93 a	29.04 a	11.78 a	2.47 a	227.58 a	225.50 b	5.41 a	7.44 a	27.43 a

** Values fallowed by same letters are not significantly different according to DMRT ($p<0.05$)*

CONCLUSION

In conclusion, there isn't a direct relation between increasing of P in soil and enhancing of yield components in faba bean. Finally, application of the proper amount of P can cause to increase of yield.

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