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Effect of different levels of phosphorus and biofertilizers on growth and yield of soybean in Paktia, Afghanistan

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ABSTRACT

A field research was conducted during spring season in 2017 at Paktia province, Afghanistan to find out the effect of different levels of phosphorus and biofertilizers on growth and yield of soybean in Paktia, Afghanistan. The treatments consisted of T_1= recommended K only, T_2 = recommended FYM only, T_3 = recommended NPK only, T_4 = recommended NPK + FYM + PSB and Rhizobium, T_5 = recommended FYM+ PSB and Rhizobium, T_6 = recommended NPK + PSB and Rhizobium, T_7 = 0 % recommended NP + recommended K+ FYM + PSB and Rhizobium, T_8 = 50 % P and N + recommended K + FYM + PSB and Rhizobium. The experiment was laid out in randomized complete block design with three replications. The results of experiment showed that T_4 = recommended NPK + FYM + PSB and Rhizobium recorded significantly higher plant height (40 cm at 60 DAS and 51.47 cm at harvest), number of branches (6.57 at 60 DAS and 8.40 at harvest), number of root nodules (34 at 60 DAS and 58.43 at harvest), number of pods per plant (66.03), number of seeds per pod (2.57), 100 seeds weight (20.33 g), seed yield per plant (20.13 g), seed yield (2490 kg ha^{-1}) and straw yield (4109 kg ha^{-1}) and it was recorded non-significantly higher harvest index (38.20) and significantly higher gross return (1929 US$ ha^{-1}), net return (1067 US$ ha^{-1}) and net benefit cost of ratio (1.36). Based on the result of experiment it is recommended that for the higher yield of soybean the farmer should apply recommended NPK + FYM + PSB and Rhizobium.

Key words: Biofertilizers, phosphorus, soybean growth, yield

INTRODUCTION

Pulses are important food crops as they provide vital proteins and vitamins in an average Afghan diet (Noorzai et al., 2017 a, b). Afghanistan probably is the lowest producer of pulses and imports pulses from neighboring countries. Thus, there is a need to increase the production of pulses to meet the protein and oil requirements of growing population by appropriately manipulating the pulse production technologies.

Soybean (*Glycine max* (L.) Merill) a grain legume is considered as a wonder crop due to its dual qualities viz., high protein (40-43%) and oil content (20%). Soybean being the "Golden Bean" of the 20th century is a species of legume, native to East Asia, widely grown for its edible bean which has numerous uses. The plant is classed as an oilseed rather than a pulse by the Food and Agricultural Organization (FAO). It grows in varied agro-climatic conditions (Rana et al., 2014). It has emerged as one of the important commercial crops in many countries. Due to its worldwide popularity, the international trade of soybean has spreaded globally. Several countries such as Japan, China, Indonesia, Philippines, and European countries are importing soybean to supplement their domestic requirement for human consumption and cattle feed (Geetha and Radder, 2015).

Although, the climate of the country is reasonable for soybean cultivation, but the major

problems are inappropriate cultural practices of the application of phosphorous and biofertilizers, which lead to low yield of soybean.

To solve this problem we tried to find out the proper dose of P and biofertilizers. This crop is recently introduced to country and the country soils are varying from province to province because of heterogeneity nature. In Paktia province, the Nutrition and Education International (NEI) distributed soybean for cultivation to deprive the hunger from the province. While the total amount of P is high in some soils, available P is often limited because soil P not only forms insoluble precipitates with metals such as iron and aluminum in acid soils, and calcium in alkaline soils (Sharpley et al., 1984; Sanyal and De Datta, 1991), but also 50 to 80 percent of the soil P can exist as organic P which is not directly available to plants (Alexander, 1977; Iyamuremye et al., 1996).

MATERIALS AND METHODS

The field experiment was conducted during spring 2017 to study the effect of different levels of phosphorus and biofertilizers on growth and yield of soybean in Syedan village, Gardiz, Paktia, Afghanistan under irrigated condition. The geographical co-ordinates are 37° 16' N latitude and 49° 55' E longitudes with an altitude of 2350 m above mean sea level. It comes under South-eastern Zone of Afghanistan. The soil was clay with pH above 7.0 and low available nitrogen and phosphorous content, but high in available potassium.

The experimental design involved was randomized complete block design with three replications and eight treatments (T_1 = recommended K only, T_2 = recommended FYM only, T_3 = recommended NPK only, T_4 = recommended NPK + FYM + PSB and Rhizobium, T_5 = recommended FYM+ PSB and Rhizobium, T_6 = recommended NPK + PSB and Rhizobium, T_7 = 0 % recommended NP + recommended K+ FYM + PSB and Rhizobium, and T_8 = 50 % P and N + recommended K + FYM.+ PSB and Rhizobium). The recommended fertilizer dose 40:80:25 kg N, P_2O_5 and K_2O kg ha^{-1} in the form of Urea, DAP and MOP and FYM 5 t ha^{-1} was applied. Seeds were treated using Rhizobium and PSB (*Pseudomonas striata*) at the rate of 6 g kg^{-1} of seed. Entire dose of N, P and K as basal were applied at the time of sowing and FYM was applied 10 days before sowing of the crop.

There were 24 experimental plots and each plot was with dimension of 3 m × 5 m. Soybean cultivar 'Stine 3300' was sown on 20 April, 2017 using 60 kg seeds per ha. Two seeds per hill were dibbled 5 cm deep at a spacing 40 cm × 5 cm. The crop was harvested at its physiological maturity. In the experiment all plant samples were taken by randomized uprooting of five plants in both sides of the border rows from each plot. After harvesting the border rows, yield per plot was recorded by taking the weight of the seeds from net plot. The seed yield of net plots is converted to seed yield per hectare and expressed in kg per hectare, in the order to evaluate effect of treatments on growth parameters, yield attributes and yield.

The economic ratio (returns per US dollars invested) was worked out on the basis of existing rates inputs and outputs. The methods outlined by Panse and Sukhatme (1985) was used for the statistical analysis of the data for drawing conclusions on the effect of various treatments on different parameters studied.

RESULTS AND DISCUSSION

Plant height was recorded significantly higher (40 and 51.47 cm at 60 DAS and harvest, respectively) with the application of treatment T_4= RDF + FYM + PSB + Rhizobium (Table 1). It was on par with all the treatments at harvest except T_1 recommended K, but at harvest it was on par with all treatments except of T_1 = recommended K only), at 60 DAS it was recorded non-significantly higher number of branches per plant (6.57). However, at harvest it was recorded significantly higher number of branches per plant (8.40) which was comparable with T_1 = recommended K only. Significantly higher number of nodules was recorded by application of T_4 = recommended NPK + FYM + PSB and Rhizobium (34 at 60 DAS and 66.03 at harvest, but at 60 DAS it was on par with

T_8 = 50% recommended NP + recommended K + FYM + PSB and Rhizobium). Rana et al. (2014) was reported that inoculation of the soybean seeds with rhizobium and PSB resulted in a significant increase in the growth parameters (plant height, dry matter production and number of nodules). Abd-Alla et al. (2001) and Son et al. (2006) found that inoculated soybean seed with *Bradyrhizobium japonicum* and phosphate solubilizing bacteria significantly increased nodulation, seed and biomass yield, nutrient uptake and symbiotic N fixation.

The application of recommended NPK + FYM + PSB and Rhizobium (T_4) was superior to other treatments in yield attributes and yield (Table 2). It had higher number of pods per plant (66.03), number of seeds per pod (2.57), 100 seeds weight (20.33 g), seed yield per plant (20.13 g), seed yield (2490 kg ha^{-1}), straw yield (4109 kg ha^{-1}) and non-significant increase in harvest index (38.20), which agree with Geetha and Radder (2015). Afzal and Bano (2008) also reported a favourable effect of integration of chemical fertilizers, rhizobium and PSB on growth and yield parameters. Integrated nutrient management of inorganic chemical fertilizers along with application of FYM and inoculation with biofertilizers (rhizobium and PSB) produced higher yield (Kumpawat, 2010). Singh and Rai (2004) reported that the highest pods per plant, seeds per pods and 100 seed weight of soybean through the combination of recommended dose of NPK + FYM @ 5 t ha^{-1} + bio-fertilizers.

The experiment revealed that the significant highest gross return (1929 US$ ha^{-1}), net return (1067 US$ ha^{-1}) and net benefit: cost ratio (1.36) was registered due to T_4 = recommended NPK+ FYM + PSB and Rhizobium (Table 3). Rana et al. (2014) also reported that inoculation of the soybean seeds with rhizobium and PSB resulted in a significant increase in the benefit to cost ratio.

Table 1. Effects of different levels of phosphorus and biofertilizers on growth parameters of soybean

Treatments	Plant height (cm)		Number of branches per plant		Number of root nodules per plant	
	At 60 DAS	At harvest	At 60 DAS	At harvest	At 60 DAS	At harvest
T_1= Recommended K only	30.37	47.47	4.87	6.98	13.33	19.67
T_2= Recommended FYM only	32.73	48.03	5.17	7.50	15.00	25.10
T_3= Recommended NPK only	35.67	48.30	5.10	7.70	18.83	30.47
T_4= Recommended NPK + FYM + PSB and Rhizobium	40.00	51.47	6.57	8.40	34.00	58.43
T_5= Recommended FYM + PSB and Rhizobium	35.83	48.57	5.40	7.80	25.17	44.63
T_6= Recommended NPK + PSB and Rhizobium	37.40	49.73	6.37	8.77	29.00	50.37
T_7= 0% Recommended NP + Recommended K + FYM + PSB and Rhizobium	36.10	49.40	5.83	7.83	27.90	46.17
T_8= 50% Recommended NP + Recommended K + FYM + PSB and Rhizobium	36.47	49.60	6.00	8.03	30.17	46.33
SEm±	0.55	1.24	0.37	0.43	1.62	1.64
CD (P=0.05)	1.66	3.76	1.12	1.30	4.91	4.99
CV	2.67	4.38	11.31	9.46	11.59	7.09

Table 2. Effects of different levels of phosphorus and biofertilizers on yield attributes and yields of soybean

Treatment	Number of pods per plant	Number of seeds per pod	Hundred seeds weight (g)	Seed yield per plant (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index
T_1= Recommended K only	35.7	2.2	16.3	9.9	1427	2731	34.4
T_2= Recommended FYM only	36.7	2.2	17.3	10.1	1600	2874	35.7
T_3= Recommended NPK only	38.5	2.3	17.7	10.4	1694	2914	36.9
T_4= Recommended NPK + FYM + PSB and Rhizobium	66.0	2.6	20.3	20.1	2490	4109	38.2
T_5= Recommended FYM + PSB and Rhizobium	47.3	2.4	18.3	10.6	1897	3273	37.0
T_6= Recommended NPK + PSB and Rhizobium	52.7	2.5	19.3	16.8	2212	3619	38.0
T_7= 0% Recommended NP + Recommended K + FYM + PSB and Rhizobium	50.9	2.5	18.7	13.2	2035	3433	37.4
T_8= 50% Recommended NP + Recommended K + FYM + PSB and Rhizobium	51.3	2.4	19.3	13.4	2082	3464	37.6
SEm±	0.5	0.1	1.3	0.4	50	283	2.0
CD (P=0.05)	1.55	0.29	3.90	1.06	152	858	5.98
CV	1.87	7.02	12.08	4.63	4.51	14.84	9.25

Table 3. Effects of different levels of phosphorus and biofertilizers on economics of soyabean

Treatment	Gross returns (US$ ha^{-1})	Net returns (US$ ha^{-1})	Net benefit: cost
T_1= Recommended K only	1154	523	0.83
T_2= Recommended FYM only	1270	688	1.18
T_3= Recommended NPK only	1327	566	0.74
T_4= Recommended NPK + FYM + PSB and Rhizobium	1929	1067	1.36
T_5= Recommended FYM + PSB and Rhizobium	1488	856	1.24
T_6= Recommended NPK + PSB and Rhizobium	1709	898	1.11
T_7= 0% Recommended NP + Recommended K + FYM + PSB and Rhizobium	1586	854	1.17
T_8= 50% Recommended NP + Recommended K + FYM + PSB and Rhizobium	1616	820	1.03
SEm±	46.5	46.5	0.06
CD (P=0.05)	141	141	0.19
CV	5.33	10.27	10.11

CONCLUSION

Based on the results obtained, it may be concluded that the application of recommended NPK + FYM + PSB + Rhizobium was recorded significantly higher growth and yield parameters. It was followed by the application of recommended NPK + PSB + Rhizobium and then 50% recommended NP + recommended K + FYM + PSB + Rhizobium during spring season under Paktia, Afghanistan conditions.

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