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Effect of different levels of phosphorus and bio-fertilizers on yield and yield attributes of *kharif* soybean (*Glycine max* L.)

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Abstract
A field research was conducted during spring season in 2019 at College of Agriculture, Baramati (Maharashtra) to find out the effect of different levels of phosphorus and biofertilizers on growth and yield of soybean. The experiment was laid out in split plot design with three replications. The main plot treatments comprised four phosphorus levels, *viz.*, T_1 (control), T_2 (25Kg P_2O_5 ha^{-1}), T_3 (75Kg P_2O_5 ha^{-1}) and T_4 (75Kg P_2O_5 ha^{-1}). The sub plot treatments comprised four bio fertilizer treatments *viz.*, control (B_1), Seed inoculation with Rhizobium and PSB bio fertilizers each @ 25 g kg^{-1} seeds (B_2) PSB, (B_3) Rhizobium and (B_4) Rhizobium + PSB thus, there were in all sixteen treatment combinations. Application of 50Kg P_2O_5 ha^{-1} with Rhizobium + PSB soybean seeds produced maximum and significantly higher grain and stover yield over rest of the treatment combinations.

Keywords: Spring, phosphorus, soybean and bio fertilizers

Introduction
Pulses are important food crops as they provide vital proteins and vitamins in an average Indian diet. Soybean (*Glycine max* L.) 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) [2]. 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) [1]. 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 bio fertilizers, 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.

Materials and Methods
The field experiment was conducted at Agronomy Department Farm, College of Agriculture, Baramati. Dist. Pune during spring season of 2019. The selection of the site was considered on the basis of suitability of the land for the cultivation of green gram. The soil analysis indicated that the experimental plot was sandy clay loam in texture, medium in available nitrogen and phosphorus, high in available potassium, very high in organic carbon and slightly acidic in reaction.

The quantity of fertilizer dose was calculated as per the treatments and applied in the plots as per the treatments and mixed thoroughly in to the soil after layout. Nitrogen and phosphorus were applied in the form of urea and single superphosphate as per the treatments. The whole quantity of fertilizers was applied as a basal dose before sowing. Required quantity of healthy, bold, unbroken and fully developed seeds of green gram was inoculated with Rhizobium and

PSB bio fertilizers @ 25gkg^{-1} seeds before sowing of the crop. Rows were marked on the field with the help of marker and bio fertilizers treated and untreated seeds were sown at the spacing of 30cm × 10cm as per the treatments. Two seeds were dibbled at each hill at about 3 cm depth. Seeds were properly covered with the soil to obtain uniform germination and plant stand. The experimental crop was harvested when pods were fully matured. Harvesting was carried out manually by cutting the crop at ground level with sharp sickle. Five observational plants were harvested separately for recording the yield contributing characters and yield were recorded.

Results and Discussions

Effect of phosphorus levels on yield and yield attributes of spring soybean

In the green gram crop, the growth contributing characters application of phosphorus level 50 kg P2O5 ha^{-1} recorded significantly more, yield contributing characters namely number of pods plant^{-1}, number of grains pod^{-1}, test weight of grain, length of pod, grain yield plant^{-1} and stover yield plant^{-1} were significantly more under phosphorus level (50 kg P2O5 ha^{-1}) and found at par with treatment (75 kg P2O5 ha^{-1}) than rest of the treatments. Application of phosphorus levels significantly influenced on grain and straw yield of soybean crop. Phosphorus level P_3 (50 kg P2O5 ha^{-1}) recorded significantly more grain and stover yield than rest of the treatment. Data further revealed that the magnitude of increase in grain yield recorded were 13.51%, 3.40% and 01.50% respectively.

Effect of biofertilizers on yield and yield attributes of spring soybean

Application of biofertilizers (Rhizobium + PSB) recorded highest yield contributing characters namely number of pods plant^{-1}, number of grains pod^{-1}, test weight of grain, length of pod, grain and stover yield plant^{-1} were significantly more under treatment (Rhizobium + PSB) and which is greater than the single inoculation of Rhizobium and PSB. It showed significant improvement due to application of bio fertilizers. The treatment (Rhizobium + PSB) was reported significantly more grain and stover yield than rest of the treatment.

Conclusion

On the basis of present investigation it can be concluded that for obtaining higher yield and yield attributes from soybean crop be grown during the spring season with application of 50kg P_2O_5 ha^{-1} along with seed inoculation of Rhizobium and PSB bio fertilizers each @ 25g Kg^{-1} seeds.

Table 1: Effect of different levels of phosphorus and bio-fertilizers on yield attributes of *kharif* soybean

Treatments	Total number of pods plant^{-1}	Length of pod (cm) plant^{-1}	Number of grains pod^{-1}	Test Weight (g)	Grain yield (g) plant^{-1}	Stover yield (g) plant^{-1}
A) Phosphorous levels						
T_1 : 00 Kg P_2O_5 ha^{-1}	9.97	7.10	9.21	46.33	2.77	4.38
T_2 : 25 Kg P_2O_5 ha^{-1}	11.70	7.26	10.71	47.66	3.08	4.51
T_3 : 50 Kg P_2O_5 ha^{-1}	13.35	8.13	11.33	51.12	3.88	4.93
T_4 : 75 Kg P_2O_5 ha^{-1}	12.80	8.07	11.05	48.23	3.61	4.83
F. test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
S. Em ±	0.61	0.11	0.55	0.91	0.05	0.06
C.D. at 5%	2.10	0.38	0.98	3.14	0.17	0.19
B) Biofertilizer						
B_1: No Biofertilizer	9.31	7.27	9.89	46.98	2.37	3.44
B_2: PSB	12.35	7.47	10.06	47.22	2.42	3.42
B_3: Rhizobium	12.75	7.60	10.77	49.08	2.46	3.51
B_4: PSB + Rhizobium	13.41	8.22	11.54	50.06	2.76	3.73
F. test	Sig.	Sig.	Sig.	Sig	Sig.	Sig.
S. Em ±	0.59	0.23	0.52	0.82	0.09	0.08
C.D. at 5%	1.71	0.66	1.51	2.40	0.25	0.22
C) Interaction effect						
F. test	NS	NS	NS	NS	NS	NS
S. Em ±	1.17	0.46	1.04	1.64	0.17	0.15
C.D. at 5%	-	-	-	-	-	-
General mean	11.95	7.64	10.43	48.34	2.50	3.60

Table 2: Effect of different levels of phosphorus and bio-fertilizers on grain and straw yield of *kharif* soybean (*Glycine max* L.)

Treatments	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})
A) Phosphorous Levels		
T_1: 00 Kg P_2O_5 ha^{-1}	9.22	14.61
T_2: 25 Kg P_2O_5 ha^{-1}	10.28	15.04
T_3: 50 Kg P_2O_5 ha^{-1}	12.68	16.44
T_4: 75 Kg P_2O_5 ha^{-1}	12.08	16.09
F. test	Sig.	Sig.
S. Em ±	0.13	0.17
C.D. at 5%	0.44	0.58
B) Bio-fertilizers		
B_1: No Biofertilizer	7.92	8.35
B_2: PSB	8.07	8.55
B_3: Rhizobium	8.19	8.77
B_4: PSB + Rhizobium	8.99	9.32
F. test	Sig.	Sig.
S. Em ±	0.27	0.25
C.D. at 5%	0.78	0.75
C) Interaction Effect		

F. test	NS	NS
S. Em ±	0.53	0.51
C.D. at 5%	-	-
General mean	8.29	11.66

References

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