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Impact of phosphorus levels on growth and productivity of soybean in calcareous vertisols

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Abstract
An field experiment was conducted in vertisols during *kharif* season of 2016 at AICRP on cropping system, college of agriculture, Indore (M.P.) to study the impact of phosphorus levels on growth and productivity of soybean in calcareous vertisols. The area has almost uniform topography with light to medium black vertisols, formed from basaltic parent material. The growth and yield attributes such as seed yield and dry matter yield of soybean was not affected significantly by different levels of applied P in calcareous vertisols. The highest plant height (36.78 cm), no. of branches (6.80), fresh weight/plant (36.59 g), dry weight/plant (8.2), number of pods (8.96), seed yield (2124 kg ha^{-1}) and total dry mater yield (3652 kg ha^{-1}) was obtained under P_{180} and the lowest (2029 kg ha^{-1}) under P_0 soybean in calcareous vertisols.

Keywords: phosphorous, soybean, calcareous vertisols

Introduction
Phosphorus (P) is not only a major nutrient in crop production, but is also a major constraint due to its low bioavailability in soils. Phosphorus is the vital component of DNA, RNA, ATP and photosynthetic system and catalyses a number of biochemical reactions from the beginning of seedling growth to the formation of grain and maturity. Many factors influence soil P availability like type of parent material from which the soil is derived, degree of weathering and climatic conditions. In addition to this, erosion, crop removal and phosphorus fertilization and soil phosphorus levels also affect P availability in soil. Rock phosphate is the key raw material used for manufacturing phosphatic fertilizers on which the food production depend. By calculating RP reserve longevity using current reserve and production, Steven *et al*. (2013) predicted P reserves to exhaust over 300 years. With increasing population pressure, global food production will need to increase by 70% by 2050. Thus good agronomic management requires the efficient use of fertilizer P for optimum crop production whereas excess soil P can be detrimental for water quality. Phosphorus thus plays a key role in sustainable crop production as well as environmental quality. The low recovery of P by crops, high retention by soil and residual fertilizer P in different P pools necessitates understanding P dynamics in soil and crop management for efficient use of P resources in Indian agriculture. Therefore proper P management is necessary to meet crop demand, to improve P use efficiency and to protect the environment in a given cropping system and landscape.

Material and Methods
An experiment was conducted at AICRP on Cropping System and Salt Affected Soils, College of Agriculture, Indore (M.P.) during kharif season of 2016. The area has typically semi-arid, subtropical having mild winter and summer with uncertain winter rains. The total rainfall received during the crop growth period was 1079.9 mm during 2016 with fairly good distribution. The maximum and minimum temperature during the crop-growth period ranged between 24.9 °C to 35.3 °C and 22.6 °C to 26.4 °C during 2016. The soil was clay (56% clay) in texture and slightly alkaline in reaction (pH 8.2) with electric conductivity 0.14dS/m, high in available N (334 kg/ha) and available K (425 kg/ha), medium in available P (16.9 kg/ ha). A combination of 8 treatments T1: 0, T2: 0+ S, T3: 30, T4: 60,T5: 90, T6: 120, T7: 150, and T8: 180 kg P2O5 $ha^{-1}$with three replication and gross plot size was 6.5 m x 5 m and after leaving non-experimental margin on both sides, the net experimental plot size was 1.0m x 0.5 m. soybean (*Glycine max* (L.) Merrill) crop (cv. JS-335) was sown on June 24, 2016 and harvested on October 17, 2016.

Soybean seed at the rate of 80 kg per hectare were sown at row-to-row distance of 45 cm. The recommended dose of fertilizers was applied before sowing in the seed row zone. Nitrogen and P2O5 were applied through urea and single superphosphate, respectively.

Results and Discussion

Effect on growth parameters

The results presented revealed that growth parameters were non-significantly influenced due to different P level (Table 1). Even though 180 kg/ha level of phosphorus treatment, was found to give significantly highest increase in growth attributes over 0 level of phosphorus (Table 1). It is evident from the Table 1 that the plant height, no. of branches, fresh and dry weight/plant was not affected by different P-levels as the differences are statistically at par with each other. This trend was maintained at all the growth stages. In general the plant height, no. of branches, fresh and dry weight/plant increased with increasing levels of phosphorus from P0 to P180.

Table 1: Effect of P-levels on growth parameters of soybean in calcareous vertisols.

Treatment	Growth parameters			
	Plant height (cm)	No. of branches	Fresh weight/plant	Dry weight/plant
P_0	34.93	5.58	32.50	8.0
P_{0+S}	35.43	5.90	33.40	7.9
P_{30}	35.55	6.06	34.07	8.0
P_{60}	36.23	6.06	35.89	8.1
P_{90}	36.33	6.13	35.95	8.2
P_{120}	36.56	6.24	36.52	8.2
P_{150}	36.67	6.70	35.98	8.2
P_{180}	36.78	6.80	36.59	8.2
SEm±	1.76	0.27	5.42	0.32
CD $_{5\%}$	NS	NS	NS	NS

Effect on yield and yield attributing parameters

The results presented revealed that yield and yield attributing parameters were non-significantly influenced due to different P level (Table 1). Even though 180 kg/ha level of phosphorus treatment, was found to give significantly highest increase in yield attributes over 0 level of phosphorus (Table 2). The highest seed yield (2124 kg ha^{-1}) was obtained under P180 and the lowest (2029 kg ha^{-1}) under P0. However, there were non-significant differences obtained in soybean yield by the application of various doses of phosphorus in Vertisols. Similar trend was recorded in case of total dry matter yield of soybean (Table 2). The TDM yield ranged from 3386-3652 $kgha^{-1}$. The highest TDM yield was recorded under P180 and the lowest in case of control i.e. P0. Overall results suggest that the various levels of P ranged from P0 to P180 when applied to soybean crop grown in calcareous Vertisols did not influenced the soybean productivity.

Table 2: Effect of P-levels on yield attributing characters of soybean in calcareous vertisols.

Treatment	Yield parameters at harvest		
	No. of pods/plant	Seed Yield ($kgha^{-1}$)	Total dry matter yield ($Kgha^{-1}$)
P_0	38.92	2029	3386
P_{0+S}	38.45	2032	3434
P_{30}	39.45	2060	3476
P_{60}	39.95	2073	3579
P_{90}	40.25	2081	3638
P_{120}	40.21	2100	3640
P_{150}	40.88	2120	3646
P_{180}	40.96	2124	3652
SEm±	2.89	38.20	98
CD $_{5\%}$	NS	NS	NS

Conclusion

Based on the results of one year experiment application of recommended doses of P may be applied once in two years in chickpea- soybean sequence to sustain soil P status and economize the P application without sacrificing the crop yields (AICRP on Cropping System Research). The highest seed yield (2124 kg ha^{-1}) was obtained under P_{180} and the lowest (2029 kg ha^{-1}) under P_0 soybean in calcareous vertisols. Seed yield and dry matter yield of soybean was not affected significantly by different levels of applied P.

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