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RESEARCH PAPER

Effect of phosphorus and sulphur on growth and yield of summer soybean

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Abstract : A field experiment was conducted during summer season of 2010 at the Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh to Effect of phosphorus and sulphur on growth and yield of summer soybean. Result of the experiment revealed that an application of phosphours @ 60 kg ha^{-1} recorded significantly higher plant height (49.56 cm), branch/plant (5.83), plant spread (36.78 cm), pods/plant (58.78), seed/pod (3.04), test weight (149.22 g), seed yield (2675 kg ha^{-1}), and stover yield (2980 kg ha^{-1}) over control. Similarly sulphur levels also recorded significant effect in increasing all these growth and yield attributes. The highest seed yield (2882 kg ha^{-1}) stover (2940 kg ha^{-1}) was obtained under the application @ 30kg ha^{-1} followed by application of sulphur 15 kg ha^{-1}. The interaction effect between phosphorus and sulphur were observed significant in respects seed yield and stover yield Significantly highest seed yield (3104 kg ha^{-1}) and stover yield (3408 kg ha^{-1}) was observed with combined application of 75 kg P_2O_5 ha^{-1} + 30 kg S ha^{-1} (P_3S_2).

Key Words : Growth, Yield, Soybean, Phosphorus, Sulphur

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INTRODUCTION

Soybean [*Glycine max* (L.) Merrill] is considered to be a miracle crop because of its dual qualities *viz.*, high protein content and oil. It has high yield potential, wide adaptability, and short duration, very high nutritional value, having a vast multiplicity of uses as food and industrial products. Moreover, being a legume, the crop fix large amount of atmospheric nitrogen in soil. Therefore, soybean crop is known as Golden Bean, Miracle Crop, Wonder Crop and Gold of Soil. From nutritional point of view soybean contains 43.2 per cent protein and 20.0 per cent edible oil. Soybean protein is also rich in valuable amino acid lysine (5%) which is deficient in most of the cereals. In addition, it contains good amount of minerals, salts and vitamins (thiamine and riboflavin) and its sprouting grains contain considerable amount of vitamin C . Soybean contains less starch, thus, it is good for diabetic patients. Symbiotically soybean fixes 125-150 kg N ha^{-1}. Therefore, it not only maintains the soil fertility by fixing the atmospheric nitrogen, but also reduces nitrogen requirement of plants.

Phosphorus is a key element in process of photosynthesis, root nodulation and for growth, yield and quality. It is known to be associated with several vital functions in the plant body such as utilization of sugar and starch, photosynthesis, nucleus formation, cell division, fat and albumin formation, cell organization and transfer of the heredity. The availability of phosphorus form soil to plants depends on the equilibrium adjustment around the root zone.

It plays an important role in carbohydrate metabolism and formation of chlorophyll, glycosides, oils and many other compounds that are involved in N-fixation and photosynthesis of plants. It lowers the HCN content of certain crops, promotes nodulation in legumes and produces heavier grains of oilseeds. Sulphur improves carbohydrate metabolism and formation of

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chlorophyll, glycosides, oils and many other compounds that are involved in N-fixation and photosynthesis of plants.

MATERIALS AND METHODS

A field experiment was conducted during summer season of 2010 at the Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh to know the effect of phosphorus and sulphur on growth and yield of summer soybean [*Glycine max* (L.) merrill]. The soil of the experiment field was clayey in texture, medium in available nitrogen (261.5 kg ha^{-1}) medium in available phosphorus (38.3 kg ha^{-1}), available sulphur (228.4 kg ha^{-1}) with 7.8 pH. Twelve treatment combinations comprised of four levels of phosphorus *viz.*, control (P_0), phosphorus @ 45 kg P_2O_5 ha^{-1} (P_1), phosphorus @ 60 kg P_2O_5 ha^{-1} (P_2) and phosphorus @ 75 kg P_2O_5 ha^{-1} (P_3) and three levels of sulphur *i.e.* control (S_0), 15 kg S ha^{-1}(S_1)and 30 kg S ha^{-1}(S_2) were tried in Factorial Randomized Block Design with three replications. The soybean variety GS-2 was sown 25th February 2010 keeping 45 cm inter-row spacing and intra-row spacing of 10 cm was maintained by thinning operation. Recommended dose of 25:25:00 kg NPK ha^{-1} and other cultural practices were also adopted as per need of crop.

RESULTS AND DISCUSSION

The experimental findings obtained from the present study have been discussed in following heads:

Effect on growth parameters :

Application of phosphorus @ 75 kg ha^{-1} (P_3) produced significantly highest plant height (49.56 cm), number of branches per plant (5.83) and plant spread (36.78 cm), which was 23.90, 45.75 and 24.42 per cent higher over control (P_0), respectively (Table 1). The improvement in these parameters with phosphorus application might be due of, phosphorus has long been considered as an essential constituent of all living organisms, which plays an important role in conservation and transfer of energy in metabolic reactions of living cells including biological energy transformations. Application of sulphur @ 30 kg ha^{-1} (S_2) recorded significantly plant height (47.75 cm) with higher number of branches per plant (5.67) and plant spread (36.00 cm), which were 15.75, 40.69 and 20.84 per cent higher over control (S_0), respectively. This might be due to the role of sulphur in stimulation of cell division, photosynthetic process as well as formation of chlorophyll. It also promotes the root nodules in legumes, which cause the more sulphur available during vegetative

Table 1: Effect of phosphorus and sulphur on growth and yield attributes in soybean

Treatments	Plant height (cm)	Branch/plant	Plant spread (cm)	Pods/plant	Seeds/ pod	Test weight (g)	Seed yield (kg ha-1)	Stover yield (kg ha-1)
Phosphorus levels(kg P_2O_5 ha^{-1})								
P_0	40.00	4.00	29.56	47.44	2.42	137.11	2082	2392
P_1	43.00	4.59	31.78	51.78	2.56	142.11	2322	2623
P_2	46.00	5.33	34.17	54.11	2.76	144.44	2515	2821
P_3	49.56	5.83	36.78	58.78	3.04	149.22	2675	2980
S.E.±	1.06	0.13	33.07	1.22	0.11	2.49	51	50.59
C.D. at 5%	3.10	0.38	3.14	3.58	0.32	7.29	150	148
Sulphur levels (kg S ha-1)								
S_0	41.25	4.03	29.79	47.83	2.53	137.42	2080	2443
S_1	44.92	5.13	33.42	53.42	2.68	143.42	2426	2728
S_2	47.75	5.67	36.00	57.83	2.88	148.83	2882	2940
S.E.±	0.92	0.11	0.93	1.06	0.09	2.15	44	44
C.D. at 5%	2.69	0.33	2.72	3.10	NS	6.32	130	129

Table 2 : Interaction effect of phosphorus and sulphur on seed and stover yield (kg ha^{-1}) of soybean

Sulphur levels / Phosphorus levels	Grain yield (kg ha-1)			Stover yield (kg ha-1)		
	S_0	S_{15}	S_{30}	S_0	S_{15}	S_{30}
P_0	1913	2120	2200	2231	2426	2520
P_{45}	2126	2326	2513	2430	2630	2810
P_{60}	2303	2530	2713	2615	2824	3023
P_{75}	2189	2731	3104	2499	3033	3408
S.E.±		88.70			87.63	
C.D. at 5%		260.16			257.03	
C.V. %		6.4			5.61	

growth period and development of plant occurs. This ultimately reflected in increased plant height, number of branches per plant and plant spread. Similar view was presented by Fazal and Sisodia (1989), Agrawal and Mishra (1994), Dubey and Billore (1995), Gupta *et al.* (2003), Mohanti *et al.* (2004) and Tomar *et al.* (2004) in soybean.

Effect on yield attributes and yields :

Significantly highest number of pods per plant (58.78), number of seeds per pod (3.04) and test weight (149.22 g) were recorded under application of phosphorus @ 75 kg ha^{-1} (P_3), which was 23.90, 25.61, and 8.83 per cent higher over control (P_0), respectively (Table 1). Application of phosphorus @ 60 kg ha^{-1} (P_2) was also found statistically identical to phosphorus @ 75 kg ha^{-1} in respect of number of seeds per pod and test weight, which increased number of seeds per pod and test weight to the extent of 10.15 and 3.31 per cent over control (P_0), respectively. This can be attributes to better growth as well as higher uptake of nutrients under these levels. The maximum seed yield (2675 kg ha^{-1}) and stover yield (2980 kg ha^{-1}) were recorded with application of @ 75 kg P_2O_5 ha^{-1} (P_3), which was 28.48 and 24.58 per cent higher over control (P_0), respectively. This might be due to the concomitant increase in number of pods per plant and weight of 100 seeds under this treatment. This might be the fact that excess assimilates stored in the leaves and later translocated into seeds at the time of senescence, ultimately led to higher seed yield. A significant increase in stover yield was also noticed due to application of phosphorus upto 75 kg P_2O_5 ha^{-1} as compared to lower levels and control. This might be due to increased growth and development in terms of plant height and branches as a result of improved nutritional environment in rhizosphere and plant system. The results are substantiated with the studies conducted by Sharma *et al.* (2002), Ramesh *et al.* (2003), Kausadikar *et al.* (2003), Kanojia and Sharma (2008), Ijgude and Kadam (2008) in soybean.

Application of sulphur at 30 kg ha^{-1} remarkably increased number of pods per plant (57.83), number of seed per pod (2.88) and test weight (148.83 g) to the tune of 20.90, 13.83 and 8.30 per cent higher over control (S_0), respectively. Increase in different yield attributing characters might be due to more availability of sulphur during vegetative and reproductive stages of the crop. Sulphur helps in chlorophyll formation, photosynthetic process, and activation of enzymes and grain formation. Application of sulphur brought significant variation in seed and stover yields of soybean . However, the significant response in seed (2882 kg ha^{-1}) and stover (2940 kg ha^{-1}) yields of soybean were obtained under application of 30 kg S ha^{-1}, which was 38.55 and 20.34 per cent more as compared to control (S_0). The higher yields with sulphur application over control (S_0) could be ascribed to accelerated nutrients uptake helped the plant to put optimum growth. As these growth and yield attributes as well as nutrients uptake showed significantly increased seed yield evidently resulted in higher yields with sulphur fertilization. Similar findings were also reported by Hari Ram and Dwivedi (1992) in respect of chick pea, Khanpara *et al.* (1993) in respect of mustard, Jat and Rathroe (1994) in respect of green gram and Bansal (1991), Nagar *et al.* (1993), Agrawal and Mishra (1994), Ramamoorthy *et al.* (1997) and Mohanti *et al.* (2004), in respect of soybean.

Interaction effect of grin and stover yield :

The interaction effect between phosphorus and sulphur were observed significant in respects seed yield and stover yield.

Interaction of phosphorus and sulphur exerted significant influence on seed and stover yield (Table 2). Significantly highest seed yield (3104 kg ha^{-1}) and stover yield (3408 kg ha^{-1}) was observed with combined application of 75 kg P_2O_5 ha^{-1} + 30 kg S ha^{-1} (P_3S_2) while, significantly the lowest seed yield (1913 kg ha^{-1})and stover yield (2231.66 kg ha^{-1}) was observed under control (P_0S_0).This indicates that the synergistic effects of phosphorus and sulphur application in improving yield parameters. The results are in conformity with the work of Datta and Sharma (2001), Majumdar *et al.* (2001) and Ijude and kadam (2008) in soybean .

Conclusion :

Based on the results of one year experimentation, it seems quite logical to conclude that soybean crop grown in summer season should be fertilized 75 kg P_2O_5 ha^{-1} and 30 kg S ha^{-1} along with recommended dose of N (30 kg N ha^{-1}) on medium black soil for getting maximum production and net realization under South Saurashtra Agro-climatic conditions.

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