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RESEARCH PAPER

Effect of phosphorus and sulphur on content, uptake and quality 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 know effect of phosphorus and sulphur on content, uptake and quality of summer soybean. Result of the experiment revealed that an application of phosphours @ 60 kg ha^{-1} recorded significantly higher content and uptake of N, P, K and S in grain and stover. Similarly, the levels of sulphur @ 30 kg ha^{-1} showed significantly highest content and uptake in grain and stover. Phosphorus @ 60 kg ha^{-1} and sulphur @ 30 kg ha^{-1} gave significantly highest oil and protein in soybean.

Key Words : Phosphorus, Sulphur, Uptake, Soybean

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

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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. 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:

Nutrient content in grain and stover :

Application of phosphorus @ 75 kg ha^{-1} recorded significantly higher content of N (6.12 and 0.62%), P (0.76 and 0.39%), K (1.12 and 1.31%) and S (0.56 and 0.29%) in seed and stover over control, respectively (Table 1). Application of phosphorus might have improved the nutritional environment in rhizosphere as well as in plant system leading to absorption uptake and translocation of nutrients, especially of N, P, K and S in reproductive structures which led to higher content and uptake. Application of sulphur @ 30 kg ha^{-1} recorded significantly higher content of N (5.83 and 0.60%), P (0.73 and

Table1: Effect of phosphorus and sulphur on grain and stover content in soybean

Treatments	Grain content (%)				Stover content (%)			
	N	P	K	S	N	P	K	S
Phosphorus levels(kg P_2O_5 ha^{-1})								
P_0	4.09	0.56	0.92	0.36	0.42	0.27	1.12	0.17
P_1	4.70	0.62	0.99	0.42	0.49	0.31	1.19	0.21
P_2	5.44	0.63	1.07	0.45	0.57	0.33	1.27	0.23
P_3	6.12	0.76	1.12	0.56	0.62	0.39	1.31	0.29
S.E.±	0.13	0.02	0.02	0.02	0.02	0.01	0.02	0.01
C.D. at 5%	0.40	0.05	0.05	0.05	0.05	0.03	0.05	0.03
Sulphur levels (kg S ha^{-1})								
S_0	4.22	0.57	0.94	0.37	0.44	0.29	1.14	0.19
S_1	5.23	0.65	1.04	0.45	0.54	0.32	1.24	0.22
S_2	5.83	0.73	1.10	0.53	0.60	0.37	1.29	0.27
S.E.±	0.12	0.01	0.01	0.01	0.01	0.01	0.02	0.01
C.D at 5%	0.34	0.04	0.04	0.04	0.04	0.03	0.05	0.03

Table 2 : Effect of phosphorus and sulphur grain and stover uptake in soybean

Treatments	Grain uptake (kg ha^{-1})				Stover content (kg ha^{-1})			
	N	P	K	S	N	P	K	S
Phosphorus levels(kg P_2O_5 ha^{-1})								
P_0	112.22	11.26	21.26	8.09	17.33	4.00	27.33	8.26
P_1	119.00	12.00	22.00	8.70	20.78	4.79	30.78	8.91
P_2	126.56	12.66	22.63	9.44	23.44	5.44	33.44	9.64
P_3	130.89	13.86	23.61	10.62	27.33	6.40	37.56	10.82
S.E.±	1.87	0.17	0.36	0.16	1.19	0.12	1.20	0.16
C.D. at 5%	5.48	0.51	1.07	0.48	3.49	0.36	3.52	0.48
Sulphur levels (kg S ha^{-1})								
S_0	113.58	11.43	21.43	8.22	19.17	4.22	29.17	8.39
S_1	124.25	12.45	22.45	9.23	21.92	5.23	31.92	9.43
S_2	128.67	13.44	23.25	10.20	25.58	6.03	35.75	10.40
S.E.±	1.62	0.15	0.32	0.14	1.03	0.11	1.04	0.14
C.D. at 5%	4.75	0.44	0.93	0.41	3.02	0.31	3.05	0.41

Table 3: Effect of phosphorus and sulphur on oil and protein content in soybean

Treatments	Oil content (%)	Protein content (%)
Phosphorus levels(kg P_2O_5 ha^{-1})		
P_0	17.00	36.00
P_1	18.56	38.44
P_2	19.12	40.78
P_3	21.22	41.56
S.E.±	0.71	0.91
C.D. at 5%	2.09	2.68
Sulphur levels (kg S ha^{-1})		
S_0	17.83	37.25
S_1	18.75	38.67
S_2	20.92	41.67
S.E.±	0.62	0.79
C.D. at 5%	1.81	2.32

0.37%), K (1.10 and 1.29%) and S (0.53 and 0.27%) in seed and stover over control, respectively. The probable reason for higher uptake of S under higher application of sulphur might have increased their concentration in soil solution, which increased the availability and absorption by plant. More over increasing trend of seed and stover yield increased in S uptake by seed and stover was noticed with sulphur application. The results are in conformity with the work of 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.

Nutrient uptake in grain and stover :

Application of phosphorus @ 75 kg ha^{-1} resulted in significantly higher uptake of nitrogen (130.89 and 27.33 kg ha^{-1}), phosphorus (13.86 and 6.40 kg ha^{-1}), potassium (23.61 and 37.56 kg ha^{-1}) and sulphur (10.62 and 10.82 kg ha^{-1}) by the seed and stover over the control, respectively. Application of 30 kg S ha^{-1} resulted in significantly higher uptake of nitrogen (128.67 and 25.58 kg ha^{-1}), phosphorus (13.44 and 6.03 kg ha^{-1}), potassium (23.25 and 35.75 kg ha^{-1}) and sulphur (10.20 and 10.40 kg ha^{-1}) by the seed and stover over the control, respectively. The increase in uptake of nitrogen, phosphorus and potassium in seed and stover of soybean due to application of sulphur up to 30 kg S ha^{-1} could be attributed to favorable effect of sulphur application on growth and yield attributes which resulted in higher seed and stover yield (Table 2). Similar results were found by Sharma *et al.* (2002), Ramesh *et al.*, (2003), Kausadikar *et al.* (2003), Kanojia and Sharma (2008), Ijgude and Kadam (2008) in soybean.

Effect on quality :

Oil and protein content (Table 3) of seed affected significantly due to application of sulphur. Application of sulphur @ 30 kg ha^{-1} (S_2) significantly improved oil content (20.92 %) and protein content (41.67%), which was 17.33 and 11.86 per cent higher over control (S_0), respectively. Sulphur plays an important role in synthesis of essential amino acids and certain vitamins and in formation of ferodoxin an iron-containing plant protein that acts as an electron carrier in the photosynthetic process and chlorophyll which is required for the production of protein.

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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