EFFECT OF LEVELS OF SULPHUR AND PHOSPHORUS ON YIELD AND QUALITY OF SOYBEAN GROWN IN INCEPTISOL

Abstract

The field experiment was conducted during *Kharif* 2017 at Post Graduate Research Farm,Rajarshee Chhatrapati Shahu Maharaj, College of Agriculture Kolhapur with the view to study the effect of levels of sulphur and phosphorus on yield and quality of soybean grown in inceptisol.The soil of experimental site was slightly alkaline in reaction,very low in available nitrogen, medium in available phosphorus and medium in available potassium and deficient in available sulphur. The field experiment was carried out inFactorial Randomized Block Design with three replications and sixteen treatments comprising four levels of sulphur (0, 20, 40 and 60 kg ha^{-1}) through elemental sulphur and four levels of phosphorus (0, 75, 100 and 125 kg ha^{-1}) through DAP. Result indicated that the application of 60 kg ha^{-1} S and 100 kg ha^{-1} P recorded highest grain and straw yield of soybean and quality parameter of soybean .

Keywords: Soybean, DAP, Phosphorus.

1. Introduction

Soybean (*Glycine max* L. Merril) is leguminous crop and belongs to family papillionaceae, sub family of leguminoaceae, originally a crop of China. Soybean was introduced in India some times in 1800 A.D and largely grown in Madhya Pradesh, Rajasthan and Maharashtra. Soybean is natures versatile plant, it supplies abundant amount of protein (35-45 %) and oil (18-24 %), across a wide range of environmental condition. It gives 2-3 times more protein yield per hectare than the other legumes or oil seed crop.

Dhage et al. (2014) indicated that grain and straw yield, uptake of phosphorus and sulphur increased with increase in the rate of application of P and S individually as well as in various combinations. Applied various levels of P and S also influenced the quality parameters of soybean (protein content and test weight). Available P in soil increased with increasing levels of phosphorus. Similarly available S in the soil increased with increasing levels of sulphur. Sulphur is recognized as 4^{th} major nutrient after N P K. Sulphur plays an important role in many physiological function. Soybean is a source of sulphur containing amino acids *viz*; cystein, cystine, methonine, synthesis of protein and also promote oil and chlorophyll synthesis. Soybean seed yield was increased by sulphur application. Pasricha and Aulakh (1991) reported that, oil percent increased by 2 % and 3.8 %, with the application of sulphur to soybean. Sulphur improves the nutrient use efficiency of other plant nutrient particularly N and P. Sulphur provided direct nutritive value.

Phosphorus is essential for growth and development of root nodules and multiplication and effectiveness of root nodules bacteria. Phosphorus is one of the second major plant nutrient, it is an indispensible element play and unique role in several plant metabolic and energy transformation process. Phosphorus act as energy source (ATP) for plants. It hasten maturity and improves quality of grain.

2. Material and methods

The experiment was conducted with sixteen treatments and three replication laid out in a factorial randomized block design using soybean crop atPost Graduate Research Farm,Rajarshee Chhatrapati Shahu Maharaj, College of Agriculture, Kolhapur, Maharashtra,

India. The soil of the experiment site was medium deep soil (inceptisol) which was deficient in available sulphur (7.42 kg ha^{-1}). The soil was alkaline in reaction,very low in available nitrogen (137.98kg ha^{-1}), medium in available phosphorus (15.33kg ha^{-1}) and medium in available potassium (181.30 kg ha^{-1}). The Sixteen treatments consisting of four levels of sulphur (0, 20, 40, 60 kg S ha^{-1}) and four levels of phosphorus (0, 75, 100, 125 kg P ha^{-1}) sulphur and phosphorus applied through elemental sulphur and diammonium phosphate (DAP). The plot wise soil samples were collected and analyzed as per standard procedure also treatment wise plant sample were prepared and analyzed as per the standard procedure.

3. Results and discussion

Grain yield-

The data in relation to effect of levels of Sulphur and Phosphorus on grainyield is presented in table1. Sulphur application of soybean up to the 60 kg S ha^{-1} increases the grain yield of soybean. Phosphorus application also successively and significantly increased grain yield of crop over preceding levels up to 100 kg P ha^{-1}, however the response at higher level 125 kg P $ha^{-1}$was found to be almost at par with 100 kg P ha^{-1}.The significantly highest grain yield (27.20 q ha^{-1}) was recorded by application of sulphur @ of 60 kg ha^{-1} (S_4) than rest of the sulphur levels. The different levels of phosphorus application did not showed much more variation in grain yield. The application of phosphorus significantly highest grain yield @ 100 kg ha^{-1} (P_3) (25.04 q ha^{-1}). Decrease in yield (24.51 q ha^{-1}) in P_4 level might be due to the higher concentration of phosphorus which may cause toxic effect and imbalance of nutrients.

The highest grain yield was recorded by treatment T_{15} (S_4P_3) (29.65 q ha^{-1}). Yield attributes of plant due to S application is well known keeping in view the physiological role of S in plant body. As sulphur enhances cell multiplication, elongation and expansion, imparts a deep green colour to leaves due to better chlorophyll synthesis resulting in increased food supply, essential replacement of amino acids, and relatively greater amount of dry matter accumulation. The supply of phosphorus to soil might have accelerated cell division and enlargement, carbohydrate, fat metaboilism and respiration in plant favouring increased growth and yield. The similar results were also recorded by Dhage *et al*. (2014) and Mahmoodi *et al*. (2013).

Straw yield-

The result indicated that, the increase in levels of 'S' significantly increased the straw yield of soybean. The application of S @ 60 kg ha^{-1} (S_4) showed significantly highest straw yield (38.85 q ha^{-1}) than rest of the sulphur levels. The different levels of phosphorus highest straw yield P_3i.e 100 kg P ha^{-1} 35.50 q ha^{-1}.

Considering the interaction effects of levels of S & P it was observed that straw yield of soybean was significantly influenced due to interaction effect of S & P levels. Treatment T_{15} (S_4P_3) and T_{14} (S_4P_2) recorded highest straw yield (42.00 and 41.96 q ha^{-1} respectively) and found statistically at par with each other and significantly superior over rest of the treatments. Application of sulphur might have increased the availability of nutrient to soybean plant due to improved nutritional environment, which in turn, favourably influenced the energy transformation activation of enzymes, chlorophyll synthesis as well as increased carbohydrate metabolism. Similar results were also obtained by Dhage *et al*. (2014) and Mahmoodi *et al*. (2013).

Table 1 : Effect of sulphur and phosphorus and their interaction on yield of soybean (q ha^{-1}).

Levels of sulphur (kg ha $^{-1}$)	Levels of phosphorus (kg ha^{-1})				Treatments			
	P_1 (0)	P_2 (75)	P_3 (100)	P_4 (125)	Mean		S.E±	C.D. at 5%
Grain								
S_1 (0)	15.68	18.09	17.73	18.27	**17.44**			
S_2 (20)	16.97	24.50	25.09	24.66	**22.81**	**S**	0.37	1.07
S_3 (40)	20.24	27.26	27.68	27.24	**25.61**	**P**	0.37	1.07
S_4 (60)	22.67	28.60	29.65	27.87	**27.20**	**SxP**	0.74	2.14
Mean	**18.89**	**24.61**	**25.04**	**24.51**	**23.26**			
Straw								
S_1 (0)	18.90	24.10	25.00	26.32	**23.58**			
S_2 (20)	24.13	35.96	36.00	35.27	**32.84**	**S**	0.49	1.43
S_3 (40)	27.73	36.99	39.00	36.62	**35.09**	**P**	0.49	1.43
S_4 (60)	32.32	41.96	42.00	39.11	**38.85**	**SxP**	0.99	2.87
Mean	**25.77**	**34.75**	**35.50**	**34.33**	**32.59**			

Effect of S and P on quality parameters of soybean

1. 1000 Grain Weight

The different levels of S & P and their interaction showed significant effect on thousand grain weight. Application of sulphur @ of 60 kg ha^{-1} recorded highest thousand grain weight (150.58 g) and it was found significantly superior over rest of the S levels. The application of different levels of phosphorus i.e. P_2, (146.12g) P_3 (147.54g) and P_4 (145.84g) did not showed much more variation in thousand grain weight and found statistically at par with each other and significantly superior over P_1 (140.64g) i.e. 0 k ha^{-1} P.

The interaction effect of sulphur and phosphorus indicated that, the highest thousand grain weight of soybean was observed in treatment T_{15} (S_4P_3) (155.00g) which was significantly superior over rest of the treatment except T_{14} (S_4P_2) and T_{16} (S_4P_4) 151.51 and 153.08 g respectively. Sulphur plays important role in growth attributing metabolic and synthesis activities of oil, starch and protein. Increase in thousand grain weight is may be due to the result of these activities. Similar finding were reported by Bhosale (2012) and Mahmoodi *et al*. (2013) and Dhage *et al*. (2014).

2. Oil Per cent

The oil per cent in soybean grain was increased with increased levels of sulphur. However, the highest oil per cent was observed in S_4 level (21.10%) i.e. application of sulphur @ of 60 kg ha^{-1} and it was significantly superior over rest of the sulphur levels. The application of phosphorus @ of 100 kg ha^{-1} (P_3) recorded highest oil per cent (19.96 %) in soybean and found significantly superior over control (P_1) (19.10 %) i.e. 0 kg ha^{-1} P. But, P_2 (19.85 %) and P_4 (19.79 %) levels are statistically at par with P_3 level. Further, oil per cent decreased beyond 100 kg ha^{-1} P application i.e. in P_4 level, 125 kg ha^{-1} P (19.79 %).

It might be due to the higher concentration of P may cause imbalance nutrients. Application of 60 kg S and 100 kg P ha^{-1} recorded significantly highest oil per cent (21.41%) over rest of all treatments except treatment T_{14} i.e. (21.35 %) i.e. application of 60 kg S and 75 kg P ha^{-1}. There was improvement of quality parameters due to S and P application. Similar finding were reported by Harendra, Kumar and Das, (2007).

3. Oil Yield

The oil yield of soybean enhanced due to different levels of sulphur and phosphorus. The highest oil yield (574.66 kg ha^{-1}) was obtained at 60 kg sulphur per hectare and it was found significantly superior than rest of the sulphur levels (0, 20, and 40 levels), the application of phosphorus at 100 kg ha^{-1} showed highest oil yield (504.69 kg ha^{-1}) and it was significantly superior over control i.e. P_1 (365.79 kg ha^{-1}) 0 kg P ha^{-1}. However, application of phosphorus @ of 75 kg ha^{-1} (P_2) (493.27 kg ha^{-1}) and 125 kg ha^{-1} (P_4) (487.59 kg ha^{-1}) found statistically at par with 100 kg ha^{-1} phosphorus (P_3). The interaction effect of different sulphur and phosphorus levels found to be significant amongst different treatment combinations, the treatment T_{15} i.e. application of sulphur @ of 60 kg ha^{-1} with 100 kg ha^{-1} phosphorus recorded highest oil yield (634.80 kg ha^{-1}) followed by treatment T_{14} (S_4P_2) i.e. 60 kg S ha^{-1} with 75 kg ha^{-1} P (610.60 kg ha^{-1}) and found statistically at par with each other and significantly superior over rest of treatments.

It is due to the improvement in quality parameters (1000 grain weight, protein and oil content) by application of sulphur and phosphorus. The improvement of sulphur and phosphorus through growing media to the soybean crop. Besides this , an enzyme acetic thiokinase is involved in the conversion of acetyl Co-A to malonyl Co-A and this activity of thiokinase is governed by sulphur which might have resulted in increased oil yield. Similar finding were reported by Harendra Kumar and Das, (2007)

4. Protein Content (%)

The different levels of sulphur, phosphorus and their interactions did not showed much more variation in protein content and were found non significant in protein per cent. Similar results were obtained by Dhage *et al*. (2014).

5. Total Chlorophyll Content.

The different levels of S and P and their interaction showed significant effect on chlorophyll content. The level of S_3 i.e. application of sulphur @ of 40 kg ha^{-1} recorded highest chlorophyll content (0.210 mg g^{-1}) and it was found significantly superior over rest of sulphur levels. The application of phosphorus (P_4) @ of 125 kg ha^{-1} showed highest chlorophyll content (0.191 mg g^{-1}) and found statistically at par with P_3 (0.180 mg g^{-1}) and significantly superior over control i.e. P_1 0 kg P ha^{-1}.

The interaction effect of sulphur and phosphorus indicated that, the highest chlorophyll content of soybean was observed in treatment T_{12} (S_3P_4) (0.236 mg g^{-1}) which was significantly superior over rest of the treatments. The chlorophyll content of leaf is influenced by both N and S nutrition of the crop. Application of 40 kg S ha^{-1} significantly increased the chlorophyll content of the leaves. Higher rates of applied sulphur did not further increase the chlorophyll content of the leaves. Similar results were obtained by Reddy and Ganeshamurthy (2000).

6. Germination Per cent

The different levels of sulphur, phosphorus and their interactions were found non significant in germination per cent.

Treatment	1000 grain weight	Oil Per- cent	Oil yield	Protein content	Chlorophyll content	Germination count
	(g)	%	Kg ha^{-1}	%	mg g^{-1}	%
S_1	140.52	17.79	310.99	39.91	0.133	97.17
S_2	143.58	19.62	448.15	40.02	0.170	97.67
S_3	145.47	20.19	517.53	40.05	.0210	97.25
S_4	150.58	21.10	574.66	40.57	0.195	96.92
SE ±	0.62	0.08	8.17	0.20	0.002	0.8
CD at 5%	1.81	0.23	23.61	NS	0.005	NS
P_1	140.64	19.10	365.79	40.27	0.168	97.33
P_2	146.12	19.85	493.27	40.11	0.169	97.25
P_3	147.54	19.96	504.69	40.33	0.180	97.08
P_4	145.84	19.79	487.59	39.85	0.191	97.33
SE ±	0.62	0.08	8.17	0.20	0.002	0.8
CD at 5%	1.81	0.23	23.61	NS	0.005	NS

Table. 2 Effect of sulphur and phosphorus on quality parameter of soybean.

Conclusion

The application of sulphur @ 60 kg ha^{-1} and application of phosphorus @ 75, 100, 125 kg ha^{-1} showed significant effect and increasing grain and straw yield of soybean. The thousand grain weight, oil content significantly increased due to application of the increasing levels of sulphur @ 60 kg $ha^{-1}$and phosphorus @ 100 kg ha^{-1} and improved the quality of soybean.

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