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Effect of Sulphur Levels and Poultry Manure on Crop Performance of Soybean (*Glycine max* L.)

G. Venugopal[1*], S.H.K. Sharma[1], Abdul Aziz Qureshi[2], G.E.Ch. Vidya Sagar[3] and M.H.V. Bhave[4]

[1]Department of Soil Science and Agricultural Chemistry, College of Cgriculture, PJTSAU, Rajendranagar, Hyd-500030, Telangana, India

[2]ICAR-Indian Institute of Oilseeds Research, Rajendranagar, Hyd-500030, Telangana, India

[3]Deparment of Agronomy, College of Agriculture, PJTSAU, Rajendranagar Hyd-500030, Telangana, India

[4]Deparment of Statistics and Mathematics, College of Agriculture, PJTSAU, Rajendranagar Hyd-500030, Telangana, India

*Corresponding Author E-mail: venugopalguttikonda@gmail.com

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ABSTRACT

A field experiment was conducted at the College Farm, College of Agriculture Rajendranagar, Hyderabad, Telangana. The experiment was laid out in factorial combination of Sulphur and poultry manure following randomized complet block design, each plot measuring 7.5 m x 6 m and three replications. JSS 335 a high yielding variety of soybean was used as the test crop in this experiment. The soil was red sandy loam in texture and slightly alkaline (pH 7.51) in reaction, non-saline in nature (EC 0.29 dS m^{-1}) and medium in organic carbon content (2.5 g kg^{-1}). The experiment consisted of 2 factors viz. 4 levels of sulphur 0, 20, 40 and 60kg ha^{-1} through elemental sulphur with and without poultry manure (0 and 2.5 t ha^{-1}). Even though the highest grain yield 1489 was recorded with application of 60 kg S ha^{-1} along with poultry manure but this was statistically on par with 40 kg S ha^{-1}. The S content in soybean seeds ranged from 0.31% in control to 0.40% in 60 kg S ha^{-1}. The highest total sulphur uptake was 11.46 kg ha^{-1} in 60 kg S ha^{-1} followed by 10.41 kg ha^{-1} in 40 kg ha^{-1a}. The highest Protein and oil content was 35.1 and 23.5 with application of 60 kg S ha^{-1}. The average available sulphur content in soil was at flowering stage (16.2 mg kg^{-1}) when compared to the vegetative (15.1 mg kg^{-1}) and harvesting (14.3 mg kg^{-1}).

Key words: *Soybean, Sulphur, Poultry manure, Agriculture.*

INTRODUCTION

Soybean (*Glycine max L.*) is an important and weel recognized oil and protein containing crop belongs to family Fabaceae, it contains about high quality protein (40-42%), oil (18-20%) and other nutrients like calcium, iron and glycine[4].soybean is preferable for human nutrition due to its high protein content and it is a good source of isoflavones and therefore it helps in preventing heart diseases, cancer[12]. Soybean oil is the leading vegetable oil in the world and is used in many industrial applications including biodiesel. Because of its high nutritional value and myriad form of uses, it is recognized as "Golden Bean" in India

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Sulphur is one of the essential nutrient required for the plant growth. It is now assuming importance next to the major nutrients *i.e.,* nitrogen, phosphorus and potassium. Intensive cultivation with high yielding varieties, use of high analysis NPK fertilizers and limited manuring have resulted in emergence of secondary and micronutrient deficiencies in soils. Among secondary nutrients, deficiency of sulphur (S) was reported (Tiwari[17]). Sulphur deficiency in soils of Indian states varies from 5 to 83 per cent with overall mean of 33 to 41 per cent[16].

Soybean was grown in a small way for the past many decades in India, but since 1972 the area sown to the crop has increased substantially. Currently, in India area under soybeans is grown in 11.60 m ha with a production of 10.91 million tones and productivity of 738 kg ha^{-1} (Directorate of Economics and Statistics[5], 2015-16).

Sulphur is essential for physiological and metabolic activities of the plants. It is an integral part of certain vitamins and enzymes which are important to life cycle of the plants. Being vitally important to life cycle of plants, its presence in adequate quantities in the soil and in the form available to plants is vert essential. In the absence of sufficient sulphur, several essential enzymatic activities and physiological functions are inhibited. Thus, maintenance of an optimum level of sulphur in the soil in relation to other nutrients is essential for maximum crop production and best quality aspects.

MATERIALS AND METHODS

The present study was conducted during *kharif* 2016 at College Farm, College of Agriculture Rajendranagar, Hyderabad, Telangana. The soil was red sandy loam in texture and slightly alkaline (pH 7.51) in reaction, non-saline in nature (EC 0.29 dS m^{-1}) and medium in organic carbon content (2.5 g kg^{-1}) these soil samples were analyzed for pH, EC and organic carbon by standard procedures[10]. The available Nitrogen 269 Kg ha^{-1}, Phosphorus 18 Kg ha^{-1}, Potassium 350 Kg ha^{-1} and available Sulphur 8.7 mg kg^{-1}.The experiment was laid out in factorial combination of Sulphur and poultry manure following randomized complet block design, Each plot measuring 7.5 m x 6 m and three replications.

The experiment consisted of 2 factors *viz*. 4 levels of sulphur 0, 20, 40 and 60 kg ha^{-1} through elemental sulphur and 2 levels of poultry manure 0 and 2.5 t ha^{-1}(on dry basis). Recommended dose of N, P and K (30 kg N from urea, 60 kg P from DAP and 40 kg K from MOP). Poultry manure and elemental sulphur were applied two weeks before sowing to the respective plots as per treatmental requirement. The hole of the DAP and half of the urea fertilizer were applied as basal dose, remaining urea fertilizer were applied after 30 days of sowing. JSS 335 a high yielding variety of soybean was used as the test crop in this experiment. The experimental field was ploughed with tractor-drawn plough twice and finally with cultivator followed by rotovator to get fine tilth. Later the stubbles were removed and the field was uniformly leveled and layout was implemented for *kharif* soybean. The crop was harvested each plot wise and the yields were expressed in kg ha^{-1}. Plant samples were collected from every individual plot for chemical analysis. Grain and stover yields were recorded separately for each plot. Plot-wise grain and stover samples collected were analysed for nutrient content following standard procedures[15]. The uptake of sulphur was calculated using the sulphur content and yield of grain and stover. Protein was calculated by percent total N X 6.25 (Morrison 1956). Oil content was determined by NMR method.

RESULTS AND DISCUSSION

Grain and Stover yield

The data pertaining to effect of sulphur and poultry manure has been presented in Table 1. The grain yield of soybean increased

significantly with increasing levels of sulphur over the control. The highest grain yield 1489 and 1436 kg ha^{-1} was found at @ 60 and 40 kg S ha^{-1} application. However, both the treatments were statistically at par. The percentage increase in grain yields due to 20, 40 and 60 kg S over the control was 21.1, 34.7 and 39.6. Similarly, Ganeshamurty[9] reported that @application of 40 kg S ha^{-1} through gypsum significantly increased the grain yield (1820 kg ha^{-1}) of soybean[2] Also reported that application of 40 kg S ha^{-1} increased yield of soybean over control.It was observed in the results that with application of poultry manure the grain yield of soybean increased significantly over non application. Percent increase of grain yield over without application of poultry manure was 13.1. The interaction effect of sulphur and poultry manure application was significant increased over the control. The highest grain yield of soybean 1571 kg ha^{-1} was found with application of 40 kg S ha^{-1} along with @ 2.5 t of poultry manure and this was found at par with combined application of S @60 kg and poultry manure. The percent increase of grain yields with graded levels of sulphur and poultry manure over the only application of poultry manure was 29.2, 46.5 and 48.3. These results support the findings of Premanandarajah and Shanika[14] in groundnut. Similarly, Fahmina[6] that 40 kg S ha^{-1} resulted in highest soybean yield (2910 kg ha^{-1}).The Stover yield of soybean increased significantly over the control with increasing levels of sulphur. The highest stover yield (1819 kg ha^{-1}) was recorded at @ 40 kg S $ha^{-1}$and this was statistically at par with super optimal dose of sulphur (@ 60 kg S ha^{-1}). The percentage increase in Stover yield over the control due to application of graded levels of S (@ 20, 40 and 60 kg ha^{-1} was 5.9, 15.8 and 18.5. These findings are in agreement with the results obtained by[6, 18.] Application of poultry manure @ 2.5 t ha^{-1} had produced 10.8 percent higher stover yield of soybean over without application. The combined application of sulphur along with poultry manure significantly increased the stover yield of soybean. The highest stover yield (1953 kg ha^{-1}) was obtained with @40 kg S ha^{-1} along with poultry manure @2.5 t ha^{-1}which was found to be at par with the yield obtained due to 60 kg S ha^{-1} + poultry manure application. Similar findings were reported by Khaim[11].The results also indicated that total biological yield of soybean was significant over the control. The highest total biological yield (3255 kg ha^{-1}) was obtained due to S application @ 40 kg ha^{-1} and same was which was statistically at par with higher level of sulphur at 60 kg ha^{-1}. Combined effect of sulphur and poultry manure also improved the total biological yield which was significant over the control. The increases in total yield due to combined application of sulphur @ 20, 40 and 60 kgha^{-1} and poultry manure @ 2.5t ha^{-1} over the control was 13.9, 25.5 and 29.19 percent, respectively. Similar results were showed[8].

Sulphur content and uptake

The data on sulphur content and uptake in soybean as influenced by application of different levels of sulphur and poultry manure are presented in Table 2 to 2b. The S content in soybean seeds range from 0.31% in control to 0.40% in 60 kg S ha^{-1}. The sulphur content due to 40 kg S ha^{-1} (0.39%) was found statistically at par with 60 kg S ha^{-1}.The percent increase in S uptake due to increasing levels of sulphur @ 20, 40 and 60 kg S ha^{-1} was 16.1, 25.8 and 29.0 respectively. Combined application of poultry manure along with sulphur levels the content of sulphur was significantly increased over the without application. The percent increase was 21.2. Similar results were found in stover of soybean. The range of sulphur content in stover was 0.17% in control to 0.30% in 60 kg S ha^{-1}.

The total uptake of sulphur by soybean (grain+stover) ranged from 6.22 kg ha^{-1} in control to 11.46 kg ha^{-1} in 60 kg S ha^{-1}. The

highest sulphur uptake was 11.46 kg ha^{-1} in 60 kg S ha^{-1} followed by 10.41 kg ha^{-1} in 40 kg ha^{-1}. Increasing levels of sulphur @ 20, 40 and 60 the uptake also increased significantly over the control and the corresponding percent increases were 36.4%, 73.2 and 90.6 respectively. Application of poultry manure improved the sulphur uptake significantly over its non application and the percent increased was 38.1. The combined application of sulphur and poultry manure had significant effect on uptake of sulphur. The highest uptake was 12.5 kg ha^{-1} in 40 kg S ha^{-1} + poultry manure and this was statistically at par with 12.94 kg ha^{-1} in 60 kg S ha^{-1} + poultry manure. The sulphur uptake in soybean increased due to application of incremental doses of sulphur @ 20, 40 and 60 kg ha^{-1} along with poultry manure over the manure control and the corresponding increases were 41.9, 85.3 and 91.1 percentages, respectively.

Oil content.

Oil content increased linearly with increasing of sulphur and poultry manure doses. The highest oil content of 23.1% was observed due to application of 40 kg S ha^{-1} and which was statistically at par with higher dose of sulphur @ 60 kg ha^{-1} and the lowest was in control. The increase in oil content with addition of sulphur might be associated with increase in the acetyl-CoA enzyme activity[3]. Many workers have reported the increase in oil content with addition of sulphur[19, 13, 15]. The combined application of sulphur and poultry manure on oil content was not so promising as the interaction effect was found non significant.

The oil yield of soybean varied significantly due to different levels of sulphur and poultry manure application. The highest oil yield 334 kg $ha^{-1}$was observed in 40 kg S ha^{-1} and this was statistically on par with sulphur @60 kg ha^{-1} and the lowest was observed in control. Increasing the levels of sulphur along with poultry manure had significant effect on oil yield of soybean. The per cent increase in oil yield due to sulphur @ 20, 40 and 60 kg ha^{-1} over the control was 38.7, 63.7 and 71.5 respectively.

Available sulphur content at different growth stages in soil

The data pertaining to effect of deferent levels of sulphur and poultry manure on available sulphur at different growth stages of soybean has been presented in Table 4 the available sulphur in soil was highest at flowering stage when compared to the vegetative and harvesting. Over and above, in all the three crop stages, the highest available sulphur of 18.5 mg kg^{-1} soil was noticed with application of 40 kg S ha^{-1} at flowering stage and which was also at par with higher dose of sulphur (60 kg ha^{-1}). Increasing the levels of sulphur the available sulphur content was increased linearly in all three crop stages[1]. Increasing levels of sulphur the available sulphur content was increased[20]. Application of poultry manure along with sulphur improved the available S and the percentage increase over non application at vegetative, flowering and harvesting was 31.1, 33.8 and 41.1 respectively. This findings are agreement with Nader *et al.,* (2011) who had reported that the integrated role of applied organic manure is more pronounced for availability of sulphur in the soil, may be the released active organic acids during microbial activity that enhanced the oxidation of sulphur (S^0) from the native and added sources to sulphate form (SO^{2-}_4).

The combined application of sulphur along with poultry manure, the available content of sulphur in soil significantly increased. Super optimal doses of sulphur (40 and 60 kg S ha^{-1}) increased the available sulphur content over the optimal dose (20 kg S ha^{-1}) at all the growth stages of crop. The percentage increase with application of above super optimal doses over optimal dose at harvesting stage was 23.3 and 36.8 respectively.

Table 1: Effect of sulphur levels on soybean grain, stover and total yields (kg ha^{-1})

S levels (kg S ha^{-1}) / Manure (t ha^{-1})	Grain yield (kg ha^{-1})					Stover yield (kg ha^{-1})					Total yield (kg ha^{-1})				
	0	20	40	60	Mean	0	20	40	60	Mean	0	20	40	60	Mean
0	1063	1197	1301	1384	1239	1530	1635	1686	1706	1639	2593	2832	2987	3090	2878
2.5	1208	1385	1571	1590	1402	1610	1692	1958	2015	1817	2818	3077	3524	3605	3219
Mean	1135	1291	1436	1489		1570	1664	1819	1861		2705	2955	3255	3350	
Factors	SEM (±)	C.D. (5%)				SEM (±)	C.D. (5%)				SEM (±)	C.D. (5%)			
S levels	29	85				35	104				48	143			
Manures	20	60				24	73				34	101			
Interaction	41	123				49	146				67	202			
CV (%)	5.8					5					6				

Table 2: Sulphur content (% S) of soybean seed and stover

S levels (kg S ha^{-1}) / Manure (t ha^{-1})	Seed					Stover				
	0	20	40	60	Mean	0	20	40	60	Mean
0	0.28	0.32	0.35	0.38	0.33	0.15	0.18	0.22	0.28	0.21
2.5	0.34	0.42	0.40	0.42	0.40	0.19	0.22	0.32	0.31	0.26
Mean	0.31	0.37	0.38	0.40		0.17	0.20	0.27	0.30	
Factors	**SEM (±)**	**C.D. (5%)**				**SEM (±)**	**C.D. (5%)**			
Manures	0.01	0.02				0.01	0.02			
S levels	0.01	0.02				0.00	0.01			
Interaction	0.01	NS				0.01	0.03			
CV (%)	4.84					7.30				

Table 2a: Sulphur uptake (kg ha^{-1}) by soybean seed and stover

S levels (kg S ha^{-1}) / Manure (t ha^{-1})	Seed					Stover				
	0	20	40	60	Mean	0	20	40	60	Mean
0	3.0	3.9	4.6	5.2	4.2	2.3	2.9	3.7	4.8	3.4
2.5	4.1	5.8	6.3	6.6	5.6	3.1	3.8	6.2	6.3	4.9
Mean	3.5	4.9	5.5	5.9		2.7	3.4	4.9	5.5	
Factors	**SEM (±)**	**C.D. (5%)**				**SEM (±)**	**C.D. (5%)**			
Manures	0.1	0.3				0.1	0.3			
S levels	0.1	0.4				0.2	0.5			
Interaction	0.2	0.6				0.2	0.7			
CV (%)	7.5					9.3				

Table 2b: Total sulphur uptake (kg ha^{-1}) by sobean

S levels (kg S ha^{-1}) / Manure (t ha^{-1})	0	20	40	60	Mean
0	5.25	6.83	8.28	9.98	7.58
2.5	7.20	9.61	12.55	12.94	10.47
Mean	6.22	8.22	10.41	11.46	
Factors	**SEM (±)**	**C.D. (5%)**			
Manures	0.2	0.5			
S levels	0.2	0.7			
Interaction	0.3	1.0			
CV (%)	6.5				

Table 3: Oil and protein content of soybean

S levels (kg S ha^{-1}) / Manures (t ha^{-1})	Oil content (%)				
	0	20	40	60	Mean
0	17.9	21.1	22.0	22.5	20.9
2.5	20.3	22.6	24.2	24.4	22.9
Mean	19.1	21.9	23.1	23.5	
Factors	**SEM (±)**	**C.D. (5%)**			
S levels	0.39	1.17			
Manures	0.27	0.83			
Interaction	0.55	NS			
CV (%)	4.3				

Table 4: Available sulphur content (mg ka^{-1}) of soil at different growth stages of soybean

S levels (kg S ha^{-1}) / Manure (t ha^{-1})	Vegetative stage					Flowering stage					Harvesting stage				
	0	20	40	60	Mean	0	20	40	60	Mean	0	20	40	60	Mean
0	10.1	13.4	14.7	15.9	13.5	10.3	13.8	15.3	16.2	13.9	9.0	10.6	13.5	14.5	11.9
2.5	9.9	17.5	20.6	22.8	17.7	10.7	17.9	21.6	24.1	18.6	9.9	16.0	19.4	21.9	16.8
Mean	10.0	15.4	17.6	19.3		10.5	15.9	18.5	20.2		9.5	13.3	16.4	18.2	
Factors	SEM (±)	C.D. (5%)				SEM (±)	C.D. (5%)				SEM (±)	C.D. (5%)			
S levels	0.6	1.7				0.7	2.1				0.6	1.7			
Manures	0.4	1.2				0.5	1.5				0.8	2.4			
Interaction	0.8	2.3				1.0	3.0				1.1	3.4			
CV (%)	8.6					10.7					13.7				

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