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EFFECT OF VARIOUS SULPHUR LEVELS ON DRY MATTER, YIELD AND YIELD ATTRIBUTES OF SOYBEAN [*GLYCINE MAX* (L.)] VARIETIES

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ABSTRACT

A pot experiment was carried out using factorial CRD with four replications during *Kharif* 2012 to investigate the effect of varieties and sulphur levels on dry matter, yield and yield attributes and quality of soybean (*Glycine max* L.). The experiment consisted of four levels of sulphur (S_1 : 0 , S_2 : 5 S_3: 10 S_4: 15) and five level of varieties (V_1: GS–1,V_2 :GS – 2,V_3: JS – 335, V_4 :PK – 472 and V_5 :GJS – 3). Among the different tested varieties, variety V_5(GJS-3) produced significantly nodules per plant (5.19), pods per plant (25.39) and seed yield (6.78 g plant^{-1}) than other varieties, it was also remaining at par with varietyV_4(PK-472) with value of (6.6 g plant^{-1}) for seed yield. Significantly higher values of nodules per plant (4.63), pods per plant (23.52) and seed yield (6.78) were recorded under application of sulphur @15 mg kg^{-1}, which was remain at par with S_3 (10 mg kg^{-1}) for nodules per plant and seed yield. Based on the result, it can be concluded that the variety GJS-3 was found the high yielding soybean cultivar responding to sulphur @10 mg kg^{-1} in the medium black calcareous soil of Saurashtra region of Gujarat.

KEY WORDS
soybean , sulphur levels, yield and yield attributes

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INTRODUCTION

Soybean (*Glycine max* L.) is important oil and protein crop belongs to family Fabaceae, it contains about high quality protein (40-42 %), oil (18-20%) and other nutrients like calcium, iron and glycine (Devi *et al.*, 2012). Soybean is preferable for human nutrition due to its high protein content. It is a good source of is flavones and therefore it helps in preventing heart diseases, cancer and HIVs (Kumar, 2007). In India, The annual soybean production in India was 12.21 million tonnes (2011-12) with its area under cultivation was 10.1 million hectares. Madhya Pradesh is known as the soybean bowl of India, contributing 59% of the country's soybean production, followed by Maharashtra with 29% contribution and Rajasthan with a 6% contribution. Andhra Pradesh, Karnataka, Chhattisgadh and other parts of India also produce the bean in small quantities (Anonymous, 2013). The most important constraints to crop growth are those caused by shortage of plant nutrients. Sulphur is an essential macronutrient in plant growth and development. It is increasingly being recognized as the fourth major plant nutrient after nitrogen, phosphorus and potassium. Among the fertilizer elements sulphur requirement of oilseed crops is quite high as compared to other crops (Das and Das, 1994). In Gujarat, about a 30 % soils are deficient and 31 % soil are marginal in respect of available sulphur . The range of available sulphur was recorded 2.8-105.1 with average of 14.5 ppm in different soils of Saurashtra (Jetpara *et al*. 2009). Recently, widespread deficiency of S in the soil of crop fields has been noticed in many parts of India (Jamal *et al.,* 2005).

The role of sulphur in the seed production of soybean has been reported by several investigators. Bhuiyan *et al*. (1998) found that application of sulphur at 20 kg per hectare produced the highest seed yield in soybean, but Mohanti *et al*. (2004) reported sulphur at 30 kg per hectare produced the highest seed yield and found that sulphur was involved in the synthesis of fatty acids and also increases protein quality through the synthesis of certain amino acids such as cysteine, cysteine and methionine. Srivastava *et al*. (2000) observed that among the fertilizer elements, sulphur requirement of oilseed crops is quite high as compared to other crops. Prasad and Prasad (2003) revealed that sulphur at 30 kg per hectare treated pea plants had higher number of grains per plant which was 24.18% higher than the control one. The objectives of this study were to examine the effects of S applications and their interactions on soybean (*Glycine max* L.) yield, their yield attributing traits and quality parameters

MATERIALS AND METHODS

A pot experiments was conducted in CRD design during *kharif* - 2012, at the Department of Agricultural Chemistry and Soil Science, Junagadh Agricultural

University, Junagadh. The experiment consisted of four levels of sulphur (S_1 : 0, S_2 : 5, S_3: 10, S_4: 15 mg kg^{-1}) and five varieties (V_1: GS–1, V_2: GS–2, V_3: JS–335, V_4: PK–472 and V_5: GJS–3). There were 20 treatment combinations, each replicated for four times. Eighty pots were filled in with each soil bulk of 12 kg and sulphur applied in source of Cosavet Fertis sulphur (90%).

Soil having pH-8.0, EC-0.58 dSm^{-1}, CEC-36.2 cmol kg^{-1}, organic carbon-6.6 g kg^{-1}, available N-242 kg ha^{-1}, available P-39.20 kg ha^{-1}, available K-320 kg ha^{-1}, available S-9.59 mg kg^{-1}. The yield and yield attributes were recorded at 45 DAS and harvest. Subsequently average of each five plants was worked out and recorded the yield and yield attributes.

RESULTS AND DISCUSSION

Effect of variety

The dry weight of leaves, shoot and total plant was significantly influenced by the varieties of soybean (Table 1) with different levels of sulphur. The dry weight of leaves, shoot and total plant was recorded significantly higher with variety V_5(GJS-3) with values of (2.763, 2.601 and 5.730 g $plant^{-1}$) at 45 DAS and (3.063, 5.601 and 9.095 g $plant^{-1}$) at harvest, respectively. It was also remained at par with variety V_4 (PK-472), V_3(GJ-335) and V_2(GS-2) for dry weight of leaves, shoot and total plant, while the dry weight of the root was registered significantly higher with variety V_2(GS-2) with value of (0.419 g $plant^{-1}$) at 45 DAS and (0.484 g $plant^{-1}$) at harvest. Significantly the highest plant height and number of branches per plant were recorded with variety V_2(GS-2) at 45 DAS (37.10 cm and 4.88 cm) and at harvest (49.54 cm and 6.13 cm), respectively as compared to remaining varieties. It was also remained at par with V_5(GJS-3) and V_4(PK-472) at both stages of soybean. Among the different tested varieties, variety V_5(GJS-3) produced significantly higher nodules per plant(5.19), pods per plant (25.39) and seed yield (6.78 g $plant^{-1}$) than other varieties, it was also remaining at par with varietyV_4(PK-472) with value of (6.6 g $plant^{-1}$) for seed yield. The dry matter accumulation in plant influenced by genotypes, age of crop and fertilization (Makhdum *et al.,* 2007). This results are already in agreement with the reported of Billore *et al.* (2005), Reddy and Reddy (2010) and Layek *et al.* (2014) for different varieties of soybean for yield and yield attributing character of crop.

Effect of sulphur

The dry weight of leaves, shoot and total plant was significantly influenced by the different sulphur levels at both stages except dry weight of root at 45 DAS (Table-1). Application of sulphur @ 15 mg kg^{-1} gave significantly higher dry weight of leaves (2.749 g $plant^{-1}$), shoot (2.694 g $plant^{-1}$) and total plant (5.789 g $plant^{-1}$) at 45 DAS and leaves (3.165 g $plant^{-1}$), shoot (5.767 g $plant^{-1}$), root (0.476 g $plant^{-1}$) and total plant (9.408 g $plant^{-1}$) at harvest. It was remain at par with sulphur applied at 10 mg kg^{-1} for dry weight of plant parts. The dry matter yield of leaves, stems and total plant at flowering stage leaves, stems, seed and total plant at maturing stage significantly influenced by sulphur levels (Girish and Ready, 2005). These observations are also in agreement with that of Mohanti *et al.* (2004), Tomar *et al.* (2004), Najar *et al.* (2011) and Choudhary *et al.* (2014) who also reported that dry matter of soybean was influenced significantly by sulphur rate.

The application of sulphur at various doses produced significant effect on nodules per plant, pod per plant, and seed yield of soybean (Table-2), while plant height and branch per plant at 45 DAS and at harvest were remain unaffected. Significantly higher values of nodules per plant (4.63), pods per plant (23.52) and seed yield (6.78) were recorded under application of sulphur @15 mg kg^{-1}, which was remain at par with S_3 (10 mg kg^{-1}) for nodules per plant and seed yield. Similar finding were also reported elsewhere by Karmakar and Bhatnagar (1995), Ramana and satyanarayana (2006) for yield and yield attributes of soybean.

Interaction effect of variety and sulphur

The data (Table 3) on combined effect of variety and sulphur was found non-significant in terms of dry weight of leaves,

Table 1: Effect of varieties and sulphur on dry matter yield (g $plant^{-1}$) of soybean

Treatments	45 DAS				At harvest			
	Leaves	Shoot	Root	Total plant	Leaves	Shoot	Root	Total plant
Variety (V)								
V_1 (GS-1)	1.905	2.127	0.304	4.335	2.230	5.127	0.369	7.727
V_2 (GS-2)	2.600	2.553	0.419	5.571	2.886	5.553	0.484	8.923
V_3 (JS-335)	2.439	2.329	0.348	5.074	2.702	5.324	0.413	8.439
V_4 (PK-472)	2.457	2.316	0.362	5.134	2.757	5.316	0.427	8.499
V_5 (GJS-3)	2.763	2.601	0.366	5.730	3.063	5.601	0.431	9.095
S.Em.+	0.164	0.117	0.024	0.286	0.147	0.097	0.021	0.247
C.D. (P=0.05)	0.467	0.334	0.067	0.813	0.420	0.276	0.059	0.704
Sulphur level (S)								
S_1-0 mg kg^{-1}	2.151	2.179	0.348	4.678	2.366	5.102	0.380	7.848
S_2-5 mg kg^{-1}	2.267	2.229	0.337	4.834	2.569	5.221	0.412	8.201
S_3-10 mg kg^{-1}	2.562	2.438	0.379	5.375	2.810	5.446	0.433	8.689
S_4-15 mg kg^{-1}	2.749	2.694	0.376	5.789	3.165	5.767	0.476	9.408
S.Em.+	0.147	0.105	0.021	0.255	0.132	0.087	0.019	0.221
C.D. (P=0.05)	0.418	0.299	NS	0.727	0.375	0.247	0.053	0.630
VxS Interaction								
S.Em.+	0.328	0.235	0.047	0.571	0.295	0.194	0.041	0.495
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
C.V.%	19.08	13.91	18.52	15.63	15.29	8.09	13.78	8.20

Table 2: Effect of varieties and sulphur on yield and yield attributing characters of soybean

Treatments	Yield Attributing character Plant heightat 45 DAS(cm)	Plant heightat harvest(cm)	No. of branch/ plant at 45 DAS	No. of branch/ plant at harvest	Nodules/ plant at harvest	No. of pods/ plant	Seed yield (g plant-1)
Variety (V)							
V_1 (GS-1)	29.25	40.54	3.82	5.20	3.30	20.30	3.39
V_2 (GS-2)	37.10	49.54	4.88	6.13	4.18	20.47	3.72
V_3 (JS-335)	33.25	41.54	3.96	5.35	4.41	21.77	4.32
V_4 (PK-472)	25.36	34.54	4.63	5.40	4.61	23.72	6.61
V_5 (GJS-3)	29.37	38.54	4.56	6.06	5.19	25.39	6.78
S.Em.+	0.62	1.39	0.18	0.26	0.16	0.75	0.14
C.D. (P=0.05)	1.75	3.94	0.50	0.74	0.44	2.13	0.40
Sulphur level (S)							
S_1-0 mg kg^{-1}	30.80	40.20	4.32	5.28	4.06	20.73	4.72
S_2-5 mg kg^{-1}	30.65	40.40	4.39	5.50	4.20	22.69	4.82
S_3-10 mg kg^{-1}	31.20	42.30	4.41	5.69	4.46	22.38	5.08
S_4-15 mg kg^{-1}	30.82	40.85	4.36	6.03	4.63	23.52	5.24
S.Em.+	0.55	1.24	0.16	0.23	0.14	0.67	0.13
C.D. (P=0.05)	NS	NS	NS	NS	0.39	1.90	0.36
VxS Interaction							
S.Em.+	1.23	2.77	0.36	0.52	0.31	1.49	0.28
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	0.81
C.V.%	5.64	9.57	11.34	13.14	10.11	9.46	8.08

Table 3: Interaction effect of varieties and sulphur on seed yield (g $plant^{-1}$) of soybean

	V_1 (GS-1)	V_2 (GS-2)	V_3 (JS-335)	V_4 (PK-472)	V_5 (GJS-3)	Mean
S_1-0 mg kg^{-1}	3.32	3.72	3.78	6.47	6.29	4.72
S_2-5 mg kg^{-1}	3.41	3.45	4.28	6.39	6.57	4.82
S_3-10 mg kg^{-1}	3.40	3.07	4.65	6.79	7.51	5.08
S_4-15 mg kg^{-1}	3.43	4.65	4.59	6.78	6.74	5.24
Mean	3.39	3.72	4.32	6.61	6.78	
S.Em.±	0.28		C.D. (P=0.05)		0.81	

shoot, root, plant height branches per plant, nodules per plant, and pod per plant. But, the seed yield significantly influent by interaction effect of variety and sulphur level. Significantly higher seed yield (7.51 g $plant^{-1}$) with variety GJS-3 at 10 mg S kg^{-1}. It was also found at par with S_4V_5, S_3V_4 and S_4V_5. This finding are in agreement with those by Allen *et al*. (1979), Patra *et al*. (1995), Raghuwansi *et al*. (1997) and Thakur *et al*. (2001).

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