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INFLUENCE OF PHOSPHORUS AND SULPHUR ON RESIDUAL NUTRIENT AVAILABILITY AND DRY MATTER YIELD OF SOYBEAN IN ACID ALFISOL OF MEGHALAYA

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ABSTRACT

In a field experiment on acid Alfisol, phosphorus and sulphur individually and in combination improved dry matter yield of soybean in kharif (rainy) seasons of 1998 and 1999. The soil pH, organic carbon, exchangeable Na, K, Ca and Mg, total and available P, K, S contents of soil increased significantly with increasing levels of phosphorus and sulphur application. A positive significant interaction was found between P and S for all these soil properties and $P_{60}S_{40}$ treatment combination was found best suited for dry matter yield of soybean and residual nutrient build up in acid soil.

INTRODUCTION

Soybean (*Glycine max),* being a good source of proteins, fats, vitamins and minerals is a valuable legume crop. Legumes and oil seed crops have been reported to respond to phosphorus and sulphur application (Sacchidanand *et al.* 1980). Application of these nutrients together affects the availability of each other and thereby growth and yield of crops (Sindhe *et al.* 1979). Soils of Meghalaya are deficient in available P and S (Prasad 1981). The information regarding P and S nutrition of soybean and their effect on residual nutrient availability in acid soil of Meghalaya is scanty. The present study was therefor undertaken to find out the effect of P and S application on yield of soybean and residual nutrient availability in an acid Hapludalf.

MATERIALS AND METHODS

Field experiments were conducted in an Ultic Hapludalf soil at the research farm of Soil Science division, ICAR Research Complex for NEH Region, Umiam, The surface soil (0-15 cm) had 1.62% organic C, pH 4.26, 116 ppm available N, 93.3 ppm available K, 5.98 ppm available P and 5.58 ppm available S. The treatment consisting of four levels of P_2O_5 (0,20,40 and 60 kg/ha) through DAP and three levels of S (0,20 and 40 kg/ha) through elemental suphur was tried in factorial randomized block design with three replications. Elemental S was applied 15 days before sowing. A basal dose of 25-kg/ha of N as urea and 30-kg/ha of K_2O as muriate of potash was also applied. Lime@ 2t/ha was applied to all plots 15 days prior to sowing during 1st year. Soybean cv. Ankur was the test crop. Soil samples were collected after harvest for both the seasons. Collected soil samples were dried, processed and analysed

for available P (Bray and Kurtuz 1945), S (Chesnin and Yien 1951) and K by flame photometer. For total nutrients, soil samples were digested with di-acid mixutre (HNO_3: $HClO_4$) in 5 : 2 ratio and P and S were analysed colorimetrically and K by flame photometer. Soil samples were extracted with 1N ammonium acetate solution for exchangeable Na, K, Ca and Mg.

RESULTS AND DISCUSSION

Dry matter yield : There was a significant increase in total dry matter yield (grain + straw) of soybean at harvest over control ($P_0 S_0$) by the application of phosphorus and sulphur (Table 1). The dry matter yield increased by 72 and 15% over control respectively with 60 kg P_2O_2 and 40-kg/ha of S application. The interaction between P and S was significant, thereby indicating a more beneficial effect of the two in combination. Sacchidanand *et al.* (1980) and Bapat *et al.* (1986) also reported similar results. The dry matter yield was maximum at 60 kg P_2O_5 and 40-kg/ha of S application.

Soil pH and organic carbon : A significant increase in both soil pH and organic carbon content was observed by the application of phosphorus and sulphur (Table 2). Increase in organic carbon content may be because of increased biomass production as a result of biological nitrogen fixation by soybean which might have enhanced by P and S application as both of these nutrients are involved in root growth and nodulation (Nayak and Dwivedi 1990). Increase in soil pH is understandable from the fact that there was an increase in exchangeable basic cations in the soil because of P and S application. The interaction between P and S was significant for pH and organic carbon content of soil.

Exchangeable Cations : Exchangeable Na, K, Ca, and Mg content of soil increased with higher doses of P and S significantly over control (Table 2). The exchangeable cation contents of soil increased at each P level with increasing levels of S, indicating synergistic relationship between P and S. This increase in exchangeable cation contents may be attributed to higher biomass addition in the soil as a result of P and S application. Maximum exchangeable Na, K, Ca and Mg contents were recorded with $P_{60}S_{40}$ treatment combination.

Nutrient status : The residual availbale phosphorus and sulphur content increased significantly with their respective application in the soil (Table 3). This result was in agreement with the findings of Dwivedi (1985) and Choudhury *et al.* (1987). The available P content increased with S application and vice versa suggesting synergism between P and S. The increase in soil sulphur due to phosphorus application may be because of release of sulphate ions from exchange complex of soil. Moreover, as both of these nutrients are absorbed by plants as anions, if one is available in higher amounts, the available pool for other will also increase. Similar positive interaction between P and S was also reported by Joshi and Seth (1975) and Nayak and Dwivedi (1990).

Available K content also increased with individual and combined application of P and S. Total P, S, and K contents also showed the similar trend as that of available nutrients. Maximum available and total P, S and K contents were recorded with $P_{60}S_{40}$ treatment combination.

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Table 1. Effect of phosphorus and sulphur application on dry matter yield (t/ha) of soybean (two years-mean data)

Phosphorus levels	Sulphur levels (kg/ha)			
(kg/ha)	0	20	40	Mean
0	3.00	3.46	4.22	3.56
20	4.44	4.66	4.91	4.67
40	5.20	5.49	5.65	5.44
60	5.85	6.12	6.39	6.12
Mean	4.62	4.93	5.29	
CD (0.05)	P = 0.16	S = 0.10	P × S = 0.18	

Table 2. Effect of Phosphorus and sulphur application on chemical properties of soil (two years mean data)

Phosphorus levels (kg/ha	Sulphur levels (kg/ha)			
	0	20	40	Mean
Soil pH				
0	4.55	4.65	4.84	4.68
20	4.68	4.82	4.82	4.77
40	4.75	4.85	4.92	4.84
60	4.81	4.94	5.13	4.96
Mean	4.69	4.81	4.92	
CD (0.05)	P = 0.04	S = 0.03	P × S = 0.08	
Organic carbon (%)				
0	2.03	2.10	2.15	2.09
20	2.08	2.12	2.18	2.12
40	2.11	2.18	2.23	2.17
60	2.18	2.33	2.41	2.30
Mean	2.10	2.18	2.24	
CD (0.05)	P = 0.01	S = 0.01	P × S = 0.02	
Exchangeable K (me/100g)				
0	0.194	0.213	0.243	0.216
20	0.198	0.217	0.244	0.219
40	0.202	0.223	0.251	0.225
60	0.210	0.243	0.263	0.238
Mean	0.201	0.224	0.250	
CD (0.05)	P = 0.001	S = 0.001	P × S = 0.002	
Exchangeable Na (me/100g)				
0	0.263	0.271	0.282	0.272
20	0.274	0.281	0.290	0.281
40	0.278	0.289	0.304	0.290
60	0.286	0.314	0.322	0.307
Mean	0.275	0.288	0.299	
CD (0.05)	P = 0.001	S = 0.001	P × S = 0.002	
Exchangeable Ca (me/100g)				
0	6.05	6.15	7.00	6.40
20	6.20	6.85	7.20	6.75
40	6.50	7.00	7.53	7.01

60	7.00	7.20	7.85	7.35
Mean	6.43	6.80	7.39	
CD (0.05)	P = 0.02	S = 0.01	P × S = 0.03	
	Exchangeable Mg (me/100g)			
0	1.30	1.55	1.70	1.51
20	1.34	1.60	1.80	1.58
40	1.40	1.65	1.90	1.65
60	1.65	1.80	2.06	1.83
Mean	1.42	1.65	1.86	
CD (0.05)	P = 0.01	S = 0.01	P × S = 0.02	

Table 3. Effect of phosphorus and sulphur application on residual nutrient status of soil (two years mean data)

Phosphorus levels	Sulphur levels (kg/ha)			
(kg/ha)	0	20	40	Mean
	Available P (kg/ha)			
0	3.58	3.95	5.18	4.23
20	7.50	8.45	9.20	8.38
40	10.80	12.50	13.20	12.16
60	14.00	15.60	17.12	15.57
Mean	8.97	10.12	11.17	
CD (0.05)	P = 0.22	S = 0.19	P × S = 0.37	
	Available S (kg/ha)			
0	3.30	4.50	8.50	5.43
20	4.20	8.00	11.20	7.80
40	5.80	10.50	14.50	10.26
60	6.50	14.00	17.50	12.66
Mean	4.95	9.25	12.92	
CD (0.05)	P = 0.16	S = 0.13	P × S = 0.36	
	Available K (kg/ha)			
0	169.9	186.6	212.8	189.8
20	173.6	190.2	214.0	192.6
40	177.3	195.3	220.0	197.5
60	184.2	212.8	230.0	209.0
Mean	176.2	196.2	219.2	
CD (0.05)	P = 0.50	S = 0.42	P × S = 0.85	

		Total P (ppm)		
0	400	435	485	440
20	500	560	620	560
40	639	675	720	678
60	750	782	795	775.6
Mean	572.2	613.0	655.0	
CD (0.05)	P = 7.07	S = 6.12	P × S = 12.24	
		Total S (ppm)		
0	145.0	160.0	181.0	162.0
20	165.0	180.0	210.0	185.0
40	195.0	230.0	256.0	227.0
60	230.0	265.0	275.0	256.6
Mean	183.7	208.7	230.5	
CD (0.05)	P = 4.64	S = 4.02	P × S = 8.04	
		Total K (%)		
0	0.175	0.195	0.222	0.197
20	0.215	0.265	0.280	0.253
40	0.245	0.285	0.330	0.286
60	0.260	0.325	0.380	0.321
Mean	0.224	0.267	0.303	
CD (0.05)	P = 0.004	S = 0.003	P × S = 0.007	