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Effect of ammonium polyphosphate on the yield of soybean (*Glycine max*)

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ABSTRACT

A field experiment was conducted during the rainy seasons of 1987 and 1988 at Indore to determine the effect of ammonium polyphosphate and orthophosphate sources on soybean [*Glycine max* (L.) Merr.]. Liquid fertilizer ammonium polyphosphate showed an edge over the conventional P sources, single superphosphate, diammonium phosphate and NPK complex, as increase in soybean yield was 9.6–13.0%. The enhancement in yield due to ammonium polyphosphate was accompanied by a conspicuous improvement in pod-bearing and seed quality of soybean. Increase in level of P_2O_5 application increased in the soybean production in both years under rainfed conditions.

Phosphorus fertilization has attained greater significance than any other plant nutrient for higher tonnage of oilseed production, particularly in a crop like soybean [*Glycine max* (L.) Merr.]. Singh and Bajapi (1990) and Reddy *et al.* (1990) reported significant increase in soybean yield with the increasing levels of P up to 60 kg P_2O_5/ha. Besides being high analysis and greater solubility, ammonium polyphosphate serves as a sequestering agent, offering availability of micronutrients like Al, Fe, Ca (Fleming, 1969). Due to paucity of work on the effect of ammonium polyphosphate and other P sources on the growth and yield of soybean the present field study was undertaken.

MATERIALS AND METHODS

The field experiment was conducted at Indore during the rainy seasons of 1987 and 1988. The soil of the experimental site was well-drained, medium black with pH 7.8. It had electrical conductivity 0.40 millimhos/cm, organic carbon 0.55% and available N, P_2O_5, K_2O 202, 9.0, 680 kg/ha respectively. The experiment was laid out in split-plot design with 3 replications. The treatments comprised 2 varieties of soybean ('JS 71-05 and 'JS 76-44') and 2 levels of P_2O_5 (40 and 80 kg/ha) in the main plot, and 4 sources of phosphorus (single superphosphate, diammonium phosphate, NPK complex 12 : 32 : 16 and ammonium polyphosphate containing 16 : 32 : 10 NPK) in the subplots. A uniform dose of 30 kg N and 20 kg K/ha was applied to all the plots. Ammonium polyphosphate being the liquid fertilizer was applied mixed with 3 times of Narmada sand. The total rainfall during 1987 was relatively lower (706 mm) than that during 1988 (1,029 mm). The crop was raised

rainfed in both the years.

RESULTS AND DISCUSSION

In both the years the differences due to genotypes, levels of P_2O_5 and sources of phosphorus fertilizers were significant in case of yield, indicating thereby the effect of the 3 components.

Yield attribute

Pod-bearing capacity of 'JS 76-44' soybean was significantly superior to 'JS 71-05' soybean, but the trend reversed was observed for seed weight/plant and pods/plant invariably in both the years (Table 1). The differential response in 2 varieties of soybean to the P fertilizers may be attributed to their genetical difference and potentiality to utilize the plant nutrients. The precipitation received at the flowering and pod-formation stage of early variety 'JS 71-05' perhaps contributed to increase pod and seed weight. Contrary to this, late-maturing 'JS 72-44' had to pass through a moisture stress and high temperature at the critical stage of fruiting phase, which might have ultimately affected pod and seed development adversely.

A significant rise in each parameter of yield attributes was noted due to the increase in level of P_2O_5 from 40 kg P/ha to 80 kg P/ha. Data revealed a significant contribution of P application to the enhancement in pods/plant and seed size, as indicated by the statistically marked difference between the 40 kg and 80 kg P_2O_5/ha. The response to P in improving the seed quality may be attributed to its significant role in regulating the photosynthesis, root enlargement and better microbial activities (Prasad and Sanoria, 1981).

Data presented in Table 1 further revealed

Table 1. Effect of P_2O_5 level and its source on the yield attributes of soybean genotypes

Treatment	No. of pods/plant		Pod weight/plant (g)		Seed weight/plant (g)		1,000-seed weight (g)	
	1987	1988	1987	1988	1987	1988	1987	1988
Genotype								
'JS 76-44'	25.8	32.9	5.6	8.5	2.9	3.1	107.3	114.2
'JS 71-05'	23.6	27.8	6.4	10.6	3.3	4.1	124.5	158.7
CD (P = 0.05)	1.88	1.63	0.72	0.96	NS	0.10	2.13	1.97
P_2O_5 (kg/ha)								
40	20.6	28.8	5.7	8.9	3.0	3.4	110.2	134.1
80	24.3	31.9	6.8	10.1	3.5	3.8	118.4	138.8
CD (P = 0.05)	1.88	1.63	0.72	0.96	0.45	0.10	2.13	1.97
P_2O_5 source								
SSP	18.7	23.8	5.4	8.3	2.3	3.4	104.6	130.5
DAP	20.4	28.7	5.8	9.0	2.6	3.5	105.2	134.9
IFFCO complex	21.6	32.5	6.2	9.6	2.5	3.5	103.8	138.5
APP	25.8	36.5	7.5	11.2	3.2	3.9	110.4	141.8
CD (P = 0.05)	2.49	3.62	0.99	0.90	0.61	0.19	3.87	3.51

SSP, Single superphosphate; DAP, diammonium phosphate; APP, ammonium polyphosphate

that different sources of P also affected pod-bearing capacity and seed size. The yield attributes were least affected by the application of superphosphate, whereas a significant rise was noted with the ammonium polyphosphate, irrespective of the pod or seed characters. Among the orthophosphate sources, IFFCO complex (12 : 32 : 16) proved marginally superior to diammonium phosphate and single superphosphate but none of the 3 could reach to the level of significance with ammonium polyphosphate in respect to pod number, pod weight, seed weight/plant or 1,000-seed weight. The value of polyphosphate fertilizers as a superior source of P for plants soon after their application appears to be largely dependent on its hydrolysis to orthophosphate and tissue accumulation of Mn and Zn in the tops of soybean (Hossner and Rechards, 1968). Compared to diammonium phosphate and similar other orthosphosphate sources, ammonium polyphosphate established its superiority at statistical level for yield attributes. This may primarily be due to its sequestering action serving as an agent to improve the availability of cations like Al, Fe and Ca (Fleming, 1969).

Soybean yield and harvest index

Early-maturing genotype 'JS 71-05' showed significant increase of 24.5% in yield over 'JS 76-44' (Table 2). The harvest index also varied accordingly. The yield increase in the former variety may be attributed to its higher pods and seed weight/plant as well as the 1,000-seed weight in 2 years.

Soybean yields improved significantly with the increasing levels of P_2O_5. Each kg of applied P_2O_5 @ 80 kg P_2O_5/ha increased

Table 2. Effect of P_2O_5 level and source on the soybean yield and harvest index

Treatment	Seed yield (kg/ha)		Straw yield (kg/ha)		Biological yield	Harvest index (%)
	1987	1988	1987	1988	1987	1988
Genotype						
'JS 76-44'	1,254	2,085	2,585	4,549	5,236	31.87
'JS 71-05'	1,465	2,692	2,236	4,029	5,210	29.69
CD (P = 0.05)	187	79	203	217		
P_2O_5 (kg/ha)						
40	1,258	2,255	2,645	4,596	5,376	32.66
80	1,455	2,523	2,860	4,782	5,810	34.20
CD (P = 0.05)	187	79	203	217		
P_2O_5 source						
SSP	1,460	2,271	2,385	4,561	5,338	34.94
DAP	1,500	2,344	2,450	4,635	5,774	35.11
IFFCO complex	1,485	2,302	2,235	4,578	5,299	35.27
APP	1,575	2,638	2,670	4,962	5,922	35.56
CD (P = 0.05)	105	134	219	295		

SSP, Single superphosphate; DAP, diammonium phosphate; APP, ammonium polyphosphate

the seed production by 11.65 kg over 2 years, indicating thereby a substantial role of phosphorus nutrition in soybean. These findings are in conformity with those reported by Prasad and Sanoria (1981). Stover yield of soybean was also affected accordingly.

There was a significant difference among the orthophosphate and polyphosphate formulations used in the study. The mean values recorded over 2 years are indicative of significant superiority of ammonium polyphosphate to rest of the P sources. Application of ammonium polyphosphate enhanced the soybean production from 9.6 to 13.0% over the single superphosphate, diammonium phosphate and NPK complex. This may be attributed mainly to the high-analysis, high-water solubility and sequestering ability of polyphosphates in general (Terman, 1976). Ammonium polyphosphate gave the highest harvest index compared with the other P sources. However, this difference was non-significant among the 3 orthophosphate sources.

It was concluded that the soybean yields with 'JS 71-05' could be enhanced by 11.65 kg with each kg P_2O_5 applied at 80 kg P_2O_5/ha. Among the sources of P, ammonium polyphosphate was most efficient as compared to either single superphosphate, diammonium phosphate or IFFCO complex.

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