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Effect of Phosphate Rich Organic Manure on Growth, Nutrient Uptake, Quality and Economics in Soybean [*Glycine max* (L.)Merrill]

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ABSTRACT

A field experiment was conducted on clay loam soils of the Agricultural College Farm, Bapatla, to study the effect of phosphate rich organic manure (PROM) on growth, nutrient uptake, quality and economics of soybean [*Glycine max* (L.)Merrill] during *rabi* 2005-06. Phosphate rich organic manure (PROM) made of double the recommended dose (DRD) of P_2O_5 in 1:4 ratio recorded the maximum drymatter production at maturity and found significantly superior to all other treatments of PROM made of recommended dose (RD) of P_2O_5. The highest P uptake by both grain and stover was observed by PROM with DRD of P_2O_5 in 1:4 ratio. However, it was comparable to PROM of DRD of P_2O_5 in 1:2 and 1:3 ratios, RD of P_2O_5 in 1:4 ratio and 60 kg P_2O_5 through SSP. The highest protein content was recorded with the application of PROM made of double the recommended dose of P_2O_5 in 1:4 ratio. The increase in available phosphorus status in soil was recorded with the treatment PROM made of DRD of P_2O_5 over the treatments of PROM with RD of phosphorus. The highest benefit cost ratio was obtained with the application of PROM made of RD of P_2O_5 in 1:4 ratio followed by PROM made of DRD of P_2O_5 in 1:4 ratio.

Key words : Economics, Growth, Nutrient Uptake,PROM, PR, FYM, Quality, Soybean

Soybean [*Glycine max* (L.)Merrill] is a highly nutrient exhaustive legume and requires higher amount of nutrients, particularly phosphorus for its optimum production. Unlike other crops, soybean takes up phosphorus throughout the growing period. However, phosphorus is very critical at flowering and pod formation stages of soybean.

PROM comprises composting of high grade phosphate rock with organic manures like FYM, pressmud, karanj cake, wheat or rice straw and other agricultural wastes. Composting of high grade phosphate rock with natural organic manures like FYM and other sources is found effective in releasing phosphorus from phosphate rock in neutral and slightly calcarious soils.

Keeping this in view, for increasing the efficacy of rock phosphate by composting with organic wastes like FYM, the present investigation was carried out.

MATERIAL AND METHODS

A field experiment was conducted during *rabi* 2005-06 at the Agricultural College Farm, Bapatla. The soil of experimental field was clay loam with P^H 7.8, low in available nitrogen, medium in phosphorus and high in available potassium. The mean maximum and minimum temperatures during crop growth period ranged from 21.5 ^{0}C to 33.0 ^{0}C and 15.4 ^{0}C to 19.9 ^{0}C, respectively with a total rainfall of 7.4 mm. The experiment comprised eight treatments including six PROM treatments, a normal practice of phosphorus application through SSP and a control wherein, no phosphorus application was taken up. The PROM treatments consisted of incubation of rock phosphate of recommended dose (RD) and double the recommended dose (DRD) of P_2O_5 with FYM in three different ratios (1:2,1:3 and 1:4). The treatments were arranged in randomized block design and replicated thrice. The variety JS 335 of soybean was sown with inter-and intra-row spacing of 30 X 10 cm. The crop was sown on 26th November 2005 and harvested in February 2006.

RESULTS AND DISCUSSION

Drymatter production

In general, with increase in proportion of FYM in PROM made either with RD or DRD of 1:2 to1: 4 ratio, there was an increase in drymatter during all growth stages of crop. Increased availability of phosphorus due to higher quantity of FYM in PROM might have contributed for higher growth parameters irrespective of the level of P_2O_5. The maximum increase in growth parameters with combined application of FYM or vermicompost in 1:2 ratio over 1:1 ratio was also observed by Manjunath *et al.* (2006).

Application of PROM with DRD of P_2O_5 in 1:4 ratio (T_8) differed significantly with PROM made of RD of P_2O_5 (T_3, T_4 and T_5) in increasing drymatter. The increase in drymatter by application of PROM with DRD of P_2O_5 over PROM made of RD of P_2O_5 may be attributed to increased availability and uptake of phosphorus due to solubility of the phosphate rock which might have produced luxuriant vegetative growth, is in conformity with Manna *et al. (*2001).

Nutrient uptake

The differences in phosphorus uptake noticed with increase in FYM proportion in PR (Phosphate Rock) and FYM ratio in phosphate rich organic manure made of RD of P_2O_5 were not significant at 30 DAS. However, the maximum phosphorus uptake was recorded with PROM made of DRD of P_2O_5 in 1:4 ratio (T_8) followed by PROM of PR and FYM in 1:3 ratio (T_7) and 60 kg P_2O_5 through SSP (T_2). Similar trend in nutrient uptake as that of 30 DAS was observed at 60 DAS also. The phosphorus uptake with PROM of DRD of P_2O_5 at 1:4 ratio was found significantly superior to the treatments of PROM of RD of P_2O_5 except with 1:4 ratio (T_5) of PR and FYM.

The maximum phosphorus uptake recorded in grain and stover at maturity with application of PROM of DRD of P_2O_5 in 1:4 ratio (T_8) was significantly superior to that of application of PROM of RD of P_2O_5 in 1:2 and 1:3 (T_3 and T_4) and no phosphorus (T_1).

The positive influence of FYM in bringing about dissolution of rock phosphate by producing organic acids during the decomposition process and consequently enhancing the P availability to plants was reported by several workers in various crops. Increasing proportion of FYM in PROM to bring about dissolution effect on rock phosphate and increase in root proliferation might have resulted in high phosphorus uptake. Biju Joseph (1994) opined that the increase in uptake of phosphorus by combined application of organics and P solubilizer could be due to release of energy substrates from organic manure, which might stimulate the P- solubilizing organisms and inturn increase the phosphorus availability by solubilization of added rock phosphate as also reported by Mohan Singh (2004).

Oil content and protein content

Application of PROM made of DRD of P_2O_5 in 1:4 ratio (T_8) registered the highest protein content, but it was on par with all other PROM treatments except PROM made of RD of P_2O_5 in 1:2 ratio (T_3) and no phosphorus application. The increase in protein content due to higher availability of phosphorus in these treatments might have facilitated higher uptake of nitrogen and had positive influence on amino acid metabolism. Oil content was not significantly affected due to treatments of PROM.

Economics

Application of PROM made of DRD of P_2O_5 resulted in lower net returns compared to PROM made of RD of P_2O_5 in 1:4 ratio. This was due to double the dose of rock phosphate that was applied in these treatments that did not increase the yield proportionately with the increase in phosphorus application in comparison with that of PROM of RD of P_2O_5 in 1:4 ratio (T_5). The higher BCR obtained with PROM of RD of P_2O_5 in 1:4 ratio (T_5) compared to RD of P_2O_5 through SSP (T_2), clearly indicates that the high cost phosphatic fertilizers like SSP can be replaced with the application of recommended dose of incubated or composted rock phosphate with FYM in 1:4 ratio. The higher additional returns and more benefit-cost ratio with application of phosphate rock along with FYM were also reported by Aery *et al.* (2004).

Available phosphorus in soil at harvest

Phosphorous content in soil was improved after harvest with the treatments of PROM made of DRD of P_2O_5 when compared to that of the treatments of PROM with RD of phosphorus. The maximum amount of available phosphorus recorded in T_6 was 61 kg ha^{-1} which was significantly superior to PROM made of RD of P_2O_5 and RD of P_2O_5 through SSP. However, the treatments receiving 60 kg P_2O_5 ha^{-1} through SSP was noticed with low phosphorus status in soil after harvest over other treatments. This could be due to synergistic and complementary effect of FYM when applied along with rock phosphate in arresting fixation into insoluble form and keeping in available form for extended time as also reported by Subbarao *et al.* (1995).

Table Effect of phosphate rich organic manure on growth, nutrient uptake, quality and economics in soybean

Treatments	Drymatter production at maturity (g m^{-2})	Grain yield (kg ha^{-1})	Phosphorus uptake (kg ha^{-1})				Quality Parameters		Available P in soil (kg ha^{-1})	BCR
			30 DAS	60 DAS	Grain	Stover	Oil content (%)	Protein content (%)		
T_1 - Control (No phosphorus)	312.7	1188	1.0	7.5	7.4	3.2	19.0	36.5	23.9	0.62
T_2 - RD of P_2O_5 through SSP	408.5	1529	1.9	10.8	10.7	5.7	20.8	40.7	45.8	0.81
T_3 - PROM made of RD of P_2O_5 (PR and FYM - 1:2)	368.7	1278	1.1	8.8	8.6	3.7	21.3	36.8	49.6	0.67
T_4 - PROM made of RD of P_2O_5 (PR and FYM - 1:3)	370.2	1410	1.4	9.2	9.6	4.2	21.1	40.1	48.1	0.83
T_5 - PROM made of RD of P_2O_5 (PR and FYM - 1:4)	377.4	1511	1.4	9.6	10.5	5.2	21.4	40.2	47.3	0.96
T_6 - PROM made of DRD of P_2O_5 (PR and FYM - 1:2)	398.7	1521	1.5	10.0	10.2	5.9	21.5	40.4	61.8	0.89
T_7 - PROM made of DRD of P_2O_5 (PR and FYM - 1:3)	411.6	1526	1.8	10.6	11.0	6.2	21.2	41.4	58.0	0.88
T_8 - PROM made of DRD of P_2O_5 (PR and FYM - 1:4)	433.8	1531	2.0	11.2	11.5	7.2	21.7	42.3	58.0	0.87
SEm ±	14.95	38.70	0.13	0.58	0.32	0.37	0.69	0.90	1.43	-
CD (p=0.05)	45.4	11.7	0.4	1.8	1.0	1.1	NS	2.7	4.3	-
CV (%)	6.7	4.7	14.3	10.3	5.6	12.4	5.7	3.9	5.1	-

PROM - Phosphate rich organic manure
FYM - Farmyard manure
DRD - Double the recommended dose
PR - Phosphate rock
RD - Recommended dose
SSP - Single super phosphate
BCR - Benefit cost ratio
DAS - Days after sowing

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