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Agronomic Efficiency of Phosphate rock Enriched FYM in Soybean (*Glycine max* (l.) Merrill) Production

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ABSTRACT

Field experiment was carried out at the Agricultural College Farm, Bapatla, Andhra Pradesh during *rabi* 2005-06 to study the efficiency of phosphate rock enriched organic manure in soybean. The treatments consisted of six phosphate rich organic manure (PROM) treatments of incubated rock phosphate (34/74) of recommended dose (RD) and double the recommended dose (DRD) of P_2O_5 for soybean with FYM in three ratios (1:2, 1:3 and 1:4), a normal practice of phosphorus application through SSP and a control. These were arranged in RBD and replicated thrice. Application of PROM made of DRD of P_2O_5 in 1:4 ratio recorded the maximum plant height and produced significantly higher drymatter compared to that of PROM made of RD of P_2O_5. The maximum number of nodules per plant was observed with RD of P_2O_5 through SSP closely followed by the treatments of PROM with higher proportions of FYM. Nodule dry weight was maximum with the application of PROM made of DRD of P_2O_5 in 1:4 ratio. The number of days taken to maturity was significantly reduced by phosphorus application through PROM and SSP over no phosphorus application. Yield parameters like number of pods per plant, number of seeds per pod and grain yield were significantly higher with PROM made either with RD or DRD of P_2O_5 in 1:4 over those of lower proportions of phosphate rock and FYM. Overall the results of the study indicated that PROM made of RD of P_2O_5 for soybean with FYM in 1:4 proportion is as effective as application of RD of P_2O_5 through SSP.

Key words : FYM, Growth, Phosphate rock, PROM, Soybean,Yield.

Fixation of phosphorus by soils has been considered the important reason for the low recovery of applied phosphatic fertilizer, which calls for more efficient management of phosphorus fertilizers. Besides, the escalation of prices of conventional phosphatic fertilizers is necessitating the farmers' to go for alternative non-conventional cheaper sources of phosphorus like rock phosphate. Enhancing solubility of phosphate rock by composting with organic manures, called PROM (Phosphate Rich Organic Manure), has been gaining popularity in recent years (Manna *et al* 2001 and Rasal *et al* 1996). The use of PROM will reduce the cost of fertilization to the farmers and will also result into the conservation of phosphate mineral a non renewable resource due to the high residual effect (Sekhar and Aery 2001). Exploring agronomic efficiency of cheaper sources of phosphorus like phosphate rock, particularly in crops that demand for high phosphorus application like soybean, is considered important in view of the increased cost of water soluble phosphatic fertilizers.

MATERIAL AND METHODS

A field study was conducted on clay loam soils of the Agricultural College Farm, Bapatla, during *rabi* 2005-06.The study comprised of eight treatments including six PROM treatments replicated three times in a randomized block design. The PROM treatments consisted of incubation of rock phosphate (34/74) of recommended dose (RD) and double the recommended dose (DRD) of P_2O_5 to soybean with FYM in three different ratios (1:2, 1:3 and 1:4), a normal practice of phosphorus application through SSP and a control wherein no phosphorus application was taken up. The experimental site was slightly alkaline in reaction (p^H:7.8), low in organic carbon (0.5%), medium in available phosphorus (43 kg P_2O_5 ha^{-1}) and high in available potassium (623 kg K_2O ha^{-1}). Nitrogen and potassium were applied as per the recommendation @ 30 kg N and 40 kg K_2O ha^{-1} through urea and murate of potash, respectively, at the time of sowing. The recommended dose of phosphorus @ 60 kg P_2O_5 ha^{-1} was applied through PROM and SSP at the time of sowing as per the treatments. The PROM was prepared by mixing rock phosphate @ 60 kg P_2O_5 ha^{-1} (RD) with FYM in three different ratios i.e., 1:2, 1:3 and 1:4. The rock phosphate and FYM mixture was kept separately in three different heaps and required quantity of water was sprinkled on for every two days to maintain moist conditions (50%

Table 1. Influence of different treatments of PROM on growth of soybean

Treatments	Plant height (cm)	Drymatter production at maturity(g m^{-2})	No of nodules at 60 DAS	Dryweight of nodules at 60 DAS (mg per plant)	Days to 50% flowering	Days to maturity
T_1- Control(No phosphorus)	38.9	312.7	12.0	42.4	33.3	86.3
T_2- RD of P_2O_5 through SSP	42.8	408.5	14.0	48.9	31.0	82.0
T_3- PROM made of RD of P_2O_5 (PR and FYM - 1:2)	41.1	368.7	12.3	43.2	33.3	84.3
T_4- PROM made of RD of P_2O_5 (PR and FYM - 1:3)	41.2	370.2	13.0	44.8	33.0	83.7
T_5- PROM made of RD of P_2O_5 (PR and FYM - 1:4)	42.2	377.4	13.7	46.2	32.7	82.7
T_6- PROM made of DRD of P_2O_5 (PR and FYM - 1:2)	42.3	398.7	14.0	48.4	32.7	83.7
T_7- PROM made of DRD of P_2O_5 (PR and FYM - 1:3)	44.0	411.6	14.7	50.1	32.7	81.3
T_8- PROM made of DRD of P_2O_5 (PR and FYM - 1:4)	44.4	433.8	15.3	52.8	31.3	81.0
SEm ±	1.04	14.95	0.79	1.58	0.77	0.72
CD (p=0.05)	3.2	45.4	NS	4.8	NS	2.2
CV (%)	4.3	6.7	10.0	5.8	4.1	1.8

PROM - Phosphate rich organic manure
PR - Phosphate rock
DAS - Days after sowing
FYM - Farmyard manure
RD - Recommended dose
DRD - Double the recommended dose
SSP - Single Super Phosphate

of maximum water retention capacity of manure). These heaps were kept for a period of 30 days with intermittent mixing of the contents to maintain uniform moisture level and for proper incubation. The quantity of PROM made of RD of P_2O_5 was doubled while applying to arrive at PROM made of DRD of P_2O_5 in different ratios.

RESULTS AND DISCUSSION

Application of PROM showed significant effect on growth parameters. In general, with increase in the proportion of FYM in PROM made either with RD or DRD from 1:2 to 1: 4 ratio, increased plant height and drymatter production was observed during all growth stages of crop. The application of PROM made of DRD of P_2O_5 in 1:4 ratio followed by 1:2 and 1:3 ratios produced the tallest plants (Table 1). These treatments, however, were not differed significantly with PROM made of RD of P_2O_5 in 1:4 ratio and application of 60 kg P_2O_5 through SSP. Whereas, in case of drymatter production, PROM of DRD of P_2O_5 (1:4) differed significantly from PROM made of RD of P_2O_5 at different ratios. The increased plant height and drymatter production by application of PROM made of 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 double the recommended dose of phosphate rock which might have produced luxuriant vegetative growth and plant height. The increase in drymatter production with all the treatments of PROM made either with RD or DRD of P_2O_5 were comparable with the application of RD of P_2O_5 through SSP. This indicates the utility of FYM as a good composting material in releasing phosphorus from phosphate rock in alkaline soils. These results are in conformity with the findings of Rastogi *et al*. (1976) and Manna *et al*. (2001). The maximum number of nodules per plant was observed with RD of P_2O_5 through SSP closely followed by the treatments of PROM with higher proportions of FYM (T_8, T_7 and T_5). Whereas at 60 DAS the maximum weight of nodule per plant

Table 2. Influence of different treatments of PROM on yield of soybean.

Treatments	Pods per plant	Seeds per pod	Test weight (g)	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})
T_1- Control(No phosphorus)	21.4	2.6	10.1	1188	1624
T_2- RD of P_2O_5 through SSP	30.5	2.9	10.9	1529	2195
T_3- PROM made of RD of P_2O_5 (PR and FYM - 1:2)	24.1	2.6	10.3	1278	1714
T_4- PROM made of RD of P_2O_5 (PR and FYM - 1:3)	24.3	2.6	10.4	1410	1903
T_5- PROM made of RD of P_2O_5 (PR and FYM - 1:4)	27.4	2.7	10.6	1511	2146
T_6- PROM made of DRD of P_2O_5 (PR and FYM - 1:2)	27.9	2.8	10.4	1521	2239
T_7- PROM made of DRD of P_2O_5 (PR and FYM - 1:3)	28.6	2.8	10.5	1526	2270
T_8- PROM made of DRD of P_2O_5 (PR and FYM - 1:4)	30.7	2.9	10.5	1531	2379
SEm ±	1.00	0.05	0.49	38.7	108.6
CD (p=0.05)	3.5	0.2	NS	117	329
CV (%)	7.3	0.4	8.1	4.7	9.1

PROM - Phosphate rich organic manure
FYM - Farmyard manure
DRD - Double the recommended dose
PR - Phosphate rock
RD - Recommended dose
SSP - Single Super Phosphate

was recorded with PROM made of DRD of P_2O_5 at 1:4 ratio followed by 1:2 and 1:3 ratios with DRD and application of 60 Kg P_2O_5 through SSP. It appears that at later days of crop growth weight of nodules was affected more by phosphorus than its number. More phosphorus availability due to application of DRD of P_2O_5 might have produced more drymatter and supplied better carbohydrates and increased higher photosynthetic activity. Similar results were also reported by Rasal *et al*. (1996) and Namdeo *et al*. (2003). The number of days taken to maturity was significantly reduced by phosphorous application through PROM and SSP over no phosphorus application. In general, the increase in phosphate rock and FYM ratio of PROM from 1:2 and 1:4, decrease in number of days to maturity was observed.

Yield attributes

All the yield attributes except test weight (Table 2) were significantly influenced by various treatments of PROM. A significant increase in pods per plant and seeds per pod were observed with increase in proportion of FYM from 1:2 to 1:4 in PROM made either with RD or DRD. The PROM of RD with FYM and phosphate rock in 1:4 ratio was significantly superior to PROM of RD with 1:2 and 1:3 ratios. However, similar difference among ratios of PROM made of DRD of P_2O_5 was not significant in increasing pods per plant and seeds per pod. It is also evident from the data the superiority in increasing in yield attributes with application of 60 kg P_2O_5 through SSP and PROM made of DRD of P_2O_5 (T_6, T_7 and T_8) was comparable with that of PROM made of RD in 1:4 ratio (T_5). It appears that PROM made of RD of P_2O_5 with higher phosphate rock and FYM ratio (1:4) might be the just sufficient dose of phosphorus to soybean because, with higher rates of phosphorus application the yield attributes were not increased significantly. It is also clear from the data that the application of PROM of RD in 1:4 ratio (T_5) was equally effective with that of PROM made of DRD of (T_6, T_7 and T_8) in influencing the yield of soybean. The phosphorus use efficiency (kg grain kg^{-1} fertilizer P) of 3.7 and 5.8 with treatment receiving RD of P_2O_5 (T_4 and T_5) were comparatively higher than that of treatments (T_7 and T_8) received DRD of P_2O_5 of 2.8 and 2.9 respectively. Increasing availability of phosphorus with increasing dissolution of rock phosphate due to increasing proportion of FYM in PROM might have enhanced the phosphorus use efficiency.

However, the application of PROM made of DRD of P_2O_5 in 1:4 ratio produced the highest grain yield. Stover yield also followed the same trend as the grain yield. The highest stover yield was observed with the application of PROM made of DRD of P_2O_5 in 1:4 ratio. Overall, it can be concluded from the study that the phosphate rock can be effectively used to replace the use of single superphosphate as a source of phosphorus if applied in the form of PROM made of phosphate rock and FYM in 1:4 ratio.

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