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EFFECT OF ROCK PHOSPHATE ENRICHED ORGANIC SOURCES OF PHOSPHORUS ON WHEAT IN TYPIC HAPLUSTEPT

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ABSTRACT

Effect of rock phosphate enriched press mud (RPEPMC), biogas slurry (RPEBGS) and FYM applied alone or in combination with DAP was evaluated in a field experiment with wheat cv. WR-544 (Pusa Gold) at the Institute farm at New Delhi on a sandy loam soil during rabi season 2007-08 in relation to P use efficiency and yield of wheat crop. Results showed that there was considerable effect of P application on response of wheat, the effect being more pronounced at higher levels of P. The effect of P 40 and 80 kg ha^{-1} P_2O_5 on grain and straw yield varied from 37.12 to 43.62 qha^{-1} and 48.81 to 56.27 kg ha^{-1}, respectively. The application of 80 kg P_2O_5 ha^{-1} through DAP increased P uptake from 12.7 to 20.2 kg ha^{-1}. RPEBGS emerged as the best treatments in relation to grain yield and P uptake by the crop. Effect of RPEPMC + DAP (3:1 ratio) built up higher available P in soil after harvest of wheat.

Keywords: Enriched organic sources, phosphorus, use efficiency, phosphorus uptake, wheat

INTRODUCTION

Phosphorus (P) is the second most limiting nutrient in majority of soils for crop production. Nearly 80% of Indian soils are low to medium in available P (Prasad, 2008). In most situations, P balance is negative even with the recommended rate of P fertilizer use. Rock phosphate enriched organic manures as a potential source of plant available P is important both from agronomic and environmental stand points. It is estimated that about 300 million tonnes of rock phosphate (RP) containing on an average 18-20% P_2O_5 in insoluble form are available in India. Most of the rock phosphates are reasonably suitable for direct use in acid soils, but have not given satisfactory results in neutral to alkaline soils. This urgently calls for an improvement in the effectiveness of RP and efficient utilization of P by the crops in neutral and alkaline soils. Composting of organic wastes with rock phosphate has been reported to enhance the dissolution of RP and thus enrichment of P can be achieved (Biswas and Narayanasamy, 2006). So the vast potential of this native RP can be exploited in order to reduce the dependence of farmers entirely on water soluble P-fertilizer. Pressmud, a by product of sugar industry and biogas slurry are a cheap alternative to modify the rock phosphate. Thereby, this can be used as a composting material for preparation of phosphate enriched pressmud compost (RPEPMC) and biogas slurry compost (RPEBGS) for an alternative to diammonium phosphate (DAP) in integrated P nutrition of crops. Hence, the contribution of P from these sources towards P uptake by the crop needs to be quantified. The present research was formulated to assess the impact of organic sources alone or in combination with DAP towards P nutrition of crop.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* 2007-2008 with wheat cv. WR-544 (Pusa Gold) at the research farm of Indian Agricultural Research Institute, New Delhi. The soil belongs to Maharuli series, member of coarse loamy, non-acid mixed hyperthermic family of Typic Haplustepts. The physico-chemical properties of the experimental soil as were texture sandy loam; pH 7.7; EC 0.34 dSm^{-1}; organic C 3.4g kg^{-1}; CEC 8.55 cmol(p^{+}) kg^{-1} and available N, P and K were 224, 17 and 236 kg ha^{-1}, respectively. The treatments were T_1, Absolute control, T_2, 40 kg P_2O_5 ha^{-1} as DAP, T_3, 80 kg P_2O_5 ha^{-1} as DAP, T_4, 80 kg P_2O_5 ha^{-1} as FYM, T_5, 80 kg P_2O_5 ha^{-1} as RPEPMC, T_6, 80 kg P_2O_5 ha^{-1} as RPEBGS, T_7, 20 kg P_2O_5 as DAP + 60 kg P_2O_5 ha^{-1} as FYM, T_8, 20 kg P_2O_5 as DAP+60 kg P_2O_5 ha^{-1} as RPEPMC, T_9, 20 kg P_2O_5 as DAP + 60 kg P_2O_5 ha^{-1} as RPEBGS. The rock phosphate enriched pressmud compost (RPEPMC) was prepared by composting a mixture of fresh pressmud and powdered low grade rock phosphate in 20:1 ratio on weight basis in plastic drum for 90 days with use of microbial culture. Similarly rock phosphate enriched biogas slurry compost (RPEBGS) was prepared by using a slurry mixture of powdered rock phosphate and fresh cattle dung in 1:40 ratio. The slurry mixture was used as a feed stock for digestion in biogas plant. The dried RPEBGS, RPEPMC and FYM was analyzed for total P_2O_5 and used as P source in wheat crop. The organic manures viz. RPEPMC, RPEBGS and FYM had total P_2O_5 of 2.11, 3.50 and 0.47%, respectively.

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Recommended dose of 120 kg N ha^{-1} and 40 kg K_2O ha^{-1} were applied as urea and muriate of potash, respectively. The crop was harvested at physiological maturity. The other crop-management practices were followed as per standard recommendation. Phosphorus uptake was calculated multiplying the yield data with P content. The surface soil samples (0-15 cm depth) from each plot were collected after the harvest of wheat and were analysed for available P (Olsen *et al.,* 1954). The P content in plant samples was determined in diacid mixture digestion by adopting standard method (Jackson, 1973).

RESULTS AND DISCUSSION

Yield

The data on grain and straw yield of wheat as affected by P applied through DAP and organic manures (FYM, RPEMC and RPEBGS) have been presented in Table 1. The increasing doses of P (0 to 80 kg P_2O_5 ha^{-1}) had significant effect on the grain yield of wheat. The grain yield of wheat increased from 37.12 q ha^{-1} at control to 43.62 q ha^{-1} at 80 kg P_2O_5 ha^{-1}. The effect of organic manures on grain yield of wheat was significant over control. Among organic manures, the effect of RPEBGS (42.73 q ha^{-1}) on wheat was significantly higher than that of FYM (39.6 q ha^{-1}) and comparable to RPEPMC (41.44 q ha^{-1}). Among the combined use of DAP with organic manures, maximum grain yield of wheat (41.65 q ha^{-1}) was obtained under the DAP + RPEPMC treatment. Increasing doses of P significantly increased the straw yield over control. The straw yield ranged from 48.81 q ha^{-1} at control to 56.27 q ha^{-1} with 80 kg P_2O_5 ha^{-1} as DAP. Application of various organic manures alone also improved the straw yield of wheat over control. Among these organic manures, RPEBGS at 80 kg P_2O_5 ha^{-1} gave higher straw yield (55.55 q ha^{-1}) followed by RPEPMS (53.66 q ha^{-1}) and FYM (51.97 q ha^{-1}). The straw yield was further improved when DAP was combined with organic manures. Reza *et al.* (2012) also reported significance response of pearl millet crop to applied P through rock phosphate enriched press mud compost.

Table 1: Residual effect of levels and sources of P on grain and stover yield and P content in wheat

Treatment	Yield (q ha^{-1})		P content in (%)	
	Grain	Straw	Grain	Stover
Control	37.12	48.81	0.21	0.10
DAP (40 kg P_2O_5 ha^{-1})	40.09	51.88	0.25	0.12
DAP (80 kg P_2O_5 ha^{-1})	43.62	56.27	0.28	0.14
FYM (80 kg P_2O_5 ha^{-1})	39.69	51.97	0.26	0.13
RPEPMC (80 kg P_2O_5 ha^{-1})	41.44	53.66	0.27	0.13
RPEBGS (80 kg P_2O_5 ha^{-1})	42.73	55.55	0.27	0.13
DAP+FYM (20+60 kg P_2O_5 ha^{-1})	40.77	52.84	0.28	0.14
DAP+RPEPMC (20+60 kg P_2O_5 ha^{-1})	41.65	54.06	0.29	0.15
DAP+RPEBGS (20+60 kg P_2O_5 ha^{-1})	40.85	53.09	0.29	0.15
CD (P=0.05)	2.27	2.95	0.01	0.01

Phosphorus content

The increasing levels of P_2O_5 showed significant effect on P content of wheat. The P content in wheat grain ranged from 0.21% at control to 0.28% at 80 kg P_2O_5 ha^{-1} as DAP, which was significantly greater over control (Table 1). The effect of organic manures on P content in wheat grain was significant over control but did not differ significantly among themselves in respect of P content in wheat grain as well as straw. Among the treatments, combined use of DAP with organic manures (ratio 1:3) gave the highest P content in wheat grain (0.28 - 0.29%) followed by organic manures alone (0.26-0.27%). The P content increased significantly from 0.10 % at control to 0.14 % at 80 kg P_2O_5 ha^{-1} in wheat straw. All the organic manures improved the P content in wheat straw significantly over control but these were at par among themselves in respect of P content. The P content in straw was further improved with combined application of inorganic and organic sources of P.

Phosphorus uptake

Phosphorus uptake was significantly increased with increasing levels of P as applied to wheat crop. Total P uptake ranged from 16.2 kg ha^{-1} in DAP (40 kg P_2O_5 ha^{-1}) to 20.1 kg ha^{-1} in DAP (80 kg P_2O_5 ha^{-1}) (Table 2). All the values of total P uptake were significantly greater than that in control (12.7 kg ha^{-1}). Among the manures, RPEPMC and RPEBGS were at par in the P uptake in wheat grain (11.19 and 11.54 kg ha^{-1} respectively), but FYM had low value of 10.32 kg ha^{-1} of P uptake as compared to

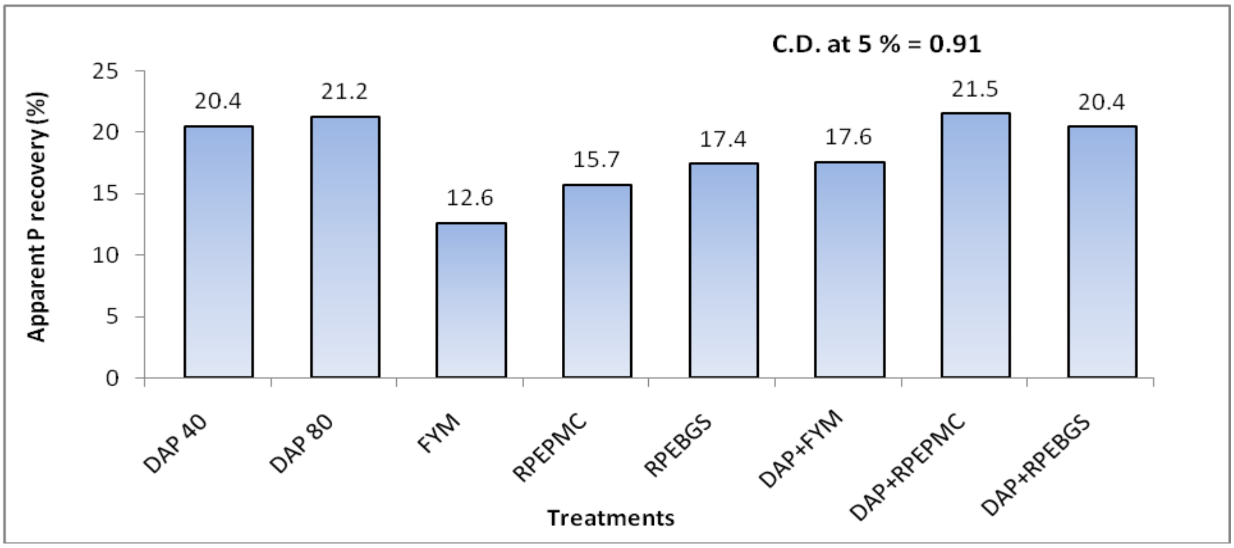

Fig. 1: Effect of levels and sources of phosphorus on apparent P recovery (%)

other manures treatments. Phosphorus uptake in grain of wheat was increased significantly under all the combined use of organic n\manures with DAP followed by use of organic manure alone treatments. Results showed that increasing levels of P from 0 to 80 kg P_2O_5 ha^{-1} applied through DAP had significant effect on the P uptake in wheat straw. Phosphorus uptake varied from 6.23 kg ha^{-1} at 40 kg P_2O_5 ha^{-1} to 7.88 kg ha^{-1} at 80 kg P_2O_5 ha^{-1} treatment. Similar trend was observed with the application of FYM and RPEPMC manures at 80 kg P_2O_5 ha^{-1}. The combined ratios as compared to control and DAP (40 kg ha^{-1}) treatments. Higher P uptake was observed with the application of DAP and organic manures had beneficial effect on the utilization of P by wheat straw as compared to DAP or organic manures alone. The maximum P uptake (7.40 to 8.11 kg ha^{-1}) by wheat straw was recorded under combined use of organic manure with DAP. The total P uptake also improved significantly with organic manures alone and combined use of organic manures with DAP treatments over control.

Table 2: Effect of levels and sources of phosphorus on its uptake by wheat and available P in post harvest soil

Treatments	P uptake (kg ha^{-1})			Available P (kg ha^{-1})
	Grain	Straw	Total	
Control	7.80	4.88	12.7	13.5
DAP (40 kg P_2O_5 ha^{-1})	10.02	6.23	16.2	15.5
DAP (80 kg P_2O_5 ha^{-1})	12.21	7.88	20.1	18.0
FYM (80 kg P_2O_5 ha^{-1})	10.32	6.76	17.1	16.1
RPEPMC (80 kg P_2O_5 ha^{-1})	11.19	6.98	18.2	18.0
RPEBGS (80 kg P_2O_5 ha^{-1})	11.54	7.22	18.8	18.7
DAP+FYM (20+60 kg P_2O_5 ha^{-1})	11.42	7.40	18.8	17.6
DAP+RPEPMC (20+60 kg P_2O_5 ha^{-1})	12.08	8.11	20.2	19.1
DAP+RPEBGS (20+60 kg P_2O_5 ha^{-1})	11.85	7.96	19.8	18.7
CD (P= 0.05)	0.61	0.39	1.00	0.98

Apparent P recovery and response ration

The data on apparent P recovery of various P sources ranged from 12.6% in FYM (80 kg ha^{-1}) alone to 21.5% in DAP+RPEPMC (20+60 kg P_2O_5 ha^{-1}) treatment (Fig.1). Among the organic manures, difference was significant in respect of apparent P recovery. Combind use of various organic sources with DAP also recorded significnt diffrence with each other and these treatments proved significantly superior over the use of organic manure alone at 80 kg ha^{-1} treatments. The DAP (80 kg ha^{-1}) and DAP+RPEPMC (20+60 kg P_2O_5 ha^{-1}) treatments were statistically at par with each other and significanty higher over the other treatmets except DAP (80 kg ha^{-1}) and DAP + RPEBGS (20+60 kg P_2O_5 ha^{-1}) treatments. The response ratio (grain) ranged from 3.2 at FYM alone (80 kg P_2O_5 ha^{-1}) to 8.1 at DAP (80 kg P_2O_5 ha^{-1}) (Fig. 2). Among the manures (FYM, RPEPMC and RPEBGS) applied at 80 kg P_2O_5 ha^{-1}, RPEBGS had the highest response ratio (7.0) followed by RPEPMC (5.4) and FYM (3.2). The application of DAP with RPEPMC (20+60 kg P_2O_5 ha^{-1}) recorded higher response ration (5.7) in caparison to FYM and RPEBGS along with DAP treatments. Among the all treatments, DAP @ 80 kg P_2O_5 ha^{-1} gave the significantly higher response ratio (8.1). Mahala *et al.* (2006) and Reza *et al.* (2012) also reported significant response of mustard crop to applied P.

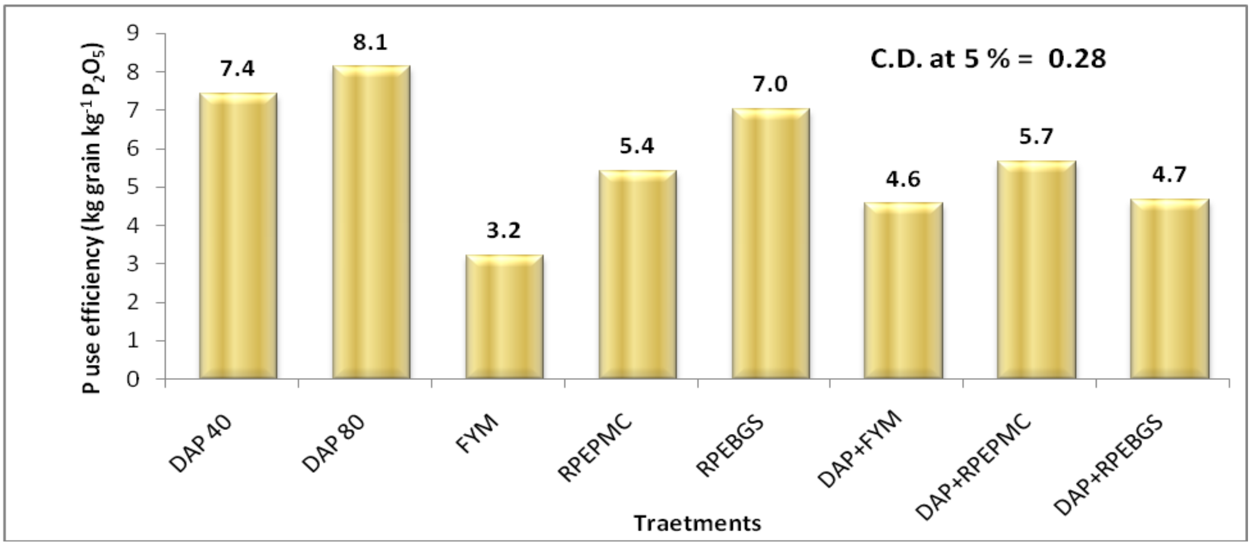

Fig. 2: Effect of levels and sources of phosphorus on P use efficiency

Available phosphorus

Olsen's extractable available P in soil increased consistently with increasing doses of P applied through DAP and all the levels proved significantly superior to control (13.5 kg ha^{-1}). The 80 kg P_2O_5 ha^{-1} applied through FYM (16.1 kg ha^{-1}), RPEPMC (18.0 kg ha^{-1}) and RPEBGS (18.7 kg ha^{-1}) showed significant increase in available P content over control. The RPEPMC was at par with RPEBGS in respect of available P content in soil. The crop could make use of existing available P without supply from any source, other than soil. This may be ascribed to slow and gradual solubilization of P in manures. This may possibly be due to the enrichment of available P pools of soil from different inorganic and organic P forms in addition to the availability from higher levels of applied P. Tripathi *et al.* (2013) reported similar results.

It is concluded from the present study that P application had significant beneficial effect on yield of wheat, the effect being more pronounced when DAP was applied with manures.

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