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Enriched sources of plant nutrients and different levels of phosphorus on sustained cowpea production in *Typic Haplusterts* soil

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Abstract
To optimize the level of P_2O_5 and to find out the best source, a pot experiment was conducted with thirteen treatments and three replications in CRD. The treatments included were control, 50, 75 and 100% P_2O_5 enriched FYM, Enriched pressmud and incubated rock phosphate. The results revealed that addition of 100% P_2O_5 enriched pressmud (EPM) significantly improved the pod yield P uptake and soil health interms of soil available phosphorus and organic carbon content. The best treatments were screened, selected and imposed into the second pot experiment with further levels. This study included seven treatments and three replication conducted in CRD. The treatments were 100, 125 and 150 % P_2O_5 enriched pressmud (EPM), incubated rock phosphate (IRP). Cowpea cv. VBN 1 grown as test crop for both the pot experiments. Finally the study concluded that though 150% P_2O_5 enriched pressmud (EPM) resulted in higher pod yield, P uptake, soil available P and organic carbon content, application of 125% P_2O_5 enriched pressmud (EPM) was sufficient to obtain significantly highest pod yield of cowpea under sustained soil health in clay loam soil.

Keywords: Cowpea, SSP, EFYM, EPM, IRP, Pod yield, P uptake, soil available P.

Introduction
Phosphorus is one of essential nutrients for plant growth. Its function cannot be performed by any other nutrient and an adequate supply of P is required for optimum growth and reproduction. It is commonly present as inorganic forms such as compounds of Ca, Fe, Al etc. and as organic forms such as compounds of phytins, phosphoilipids and nucleic acids in soil (Subba Rao, 1993) [5]. Application of FYM improves soil health by improving nutrient availability, soil physical properties and microbial activity (Tanwar *et al*., 2003) [6]. The presence of protein in pressmud would be a source of sustained release of amino acids. In addition, it facilitates chlorophyll synthesis, increases the availability of photo assimilates and growth rate. The use of rock phosphate (RP) as fertilizer is becoming increasing in India. Rock phosphate is a cheap source and it contains 20-40% phosphorus. Enriched composts is more concentrated manure compared to compost thereby it reduces the bulk to be handled per unit of nutrient. Cowpea is one of the most important food legume crops originated in Africa and widely grown in semi-arid tropics covering Asia, Africa, Southern Europe and central South America. It has ability to fix atmospheric N through its root nodules. The study aimed to optimize the level of P_2O_5 and find out the best source of enriched phosphorus for improving cowpea yield in clay loam soil.

Materials and Methods
The pot experiments were carried out at the pot culture yard of the Department of Soil Science & Agricultural Chemistry, Faculty of Agriculture, Annamalai University. The soil used in the study belongs to black colour, Kondal series, Vertisols in order and the taxonomic classification of *Typic Haplusterts*. Single super phosphate to supply 25, 37.5 and 50 kg ha^{-1} were mixed with 10 t ha^{-1} FYM each. The contents were incubated in each earthen pit with the size of 1'x 1'x1'. The whole quantity of farm yard manure was divided into five portions. One portion was spread in the pit. Over this 500g pleurotus *sp*. culture was added. Above this, portion of SSP was added. In this way, five layers were made and the top was smeared with cowdung slurry. The pit was allowed to decompose and enrichment for 45 days. Similarly, enriched pressmud was prepared. Rock phosphates to supply 25, 37.5 and 50 $kgha^{-1}$ were taken in each pit. It was incubated with 10 t FYM each. A portion FYM was spread out as layer of pit. Over which *pleurotus sp.* (500g) was applied uniformly and then a portion of rock phosphates were added. In such a way, 4 - 5 layers were made in each pit and the top was

covered with cow dung slurry. These pits were moistened periodically and allowed for incubation for about 45 days. To optimize the level of P_2O_5 and to find out the best source, a first pot experiment was conducted with thirteen treatments and three replications in CRD. The treatments included were control, 50, 75 and 100% P_2O_5 enriched FYM, enriched pressmud and incubated rock phosphate. The prepared EFYM, EPM and IRP were applied to cowpea cv. VBN1 as per the treatments. The test crop was grown with standard procedures. The best treatments were screened, selected and imposed with further levels in the second pot experiment. This study included seven treatments and three replication conducted in CRD. The treatments were 100, 125 and 150 % P_2O_5 enriched pressmud (EPM) and incubated rock phosphate (IRP).The pod yield, P uptake, soil available P, organic carbon content were recorded from each treatment of each replication.

Results and Discussion

The data on pod yield, P uptake, post-harvest soil available P and organic carbon content in the pot experiment – I with cowpea cv. VBN 1 as influenced by different levels of P_2O_5 enriched composts are given in table 1.

Table 1: Effect of different levels of P_2O_5 enriched composts on pod yield, P uptake, post-harvest soil available P and organic carbon content in the pot experiment – I with cowpea cv. VBN 1.

Treatment No.	Treatments	Pod yield (g pot^{-1})	P Uptake (g pot^{-1})	Post-harvest soil available P (mg kg^{-1})	Post-harvest soil Organic carbon content (g kg^{-1})
T_1	Control (No P_2O_5)	7.1	0.15	4.14	4.7
T_2	50% P_2O_5 (SSP)	8.0	0.18	4.56	4.9
T_3	75% P_2O_5(SSP)	10.6	0.28	5.21	4.9
T_4	100 % P_2O_5 (SSP)	12.9	0.32	5.50	5.0
T_5	50% P_2O_5 (EFYM)	8.9	0.21	4.65	5.1
T_6	75% P_2O_5(EFYM)	13.0	0.38	5.30	5.1
T_7	100 % P_2O_5 (EFYM)	14.0	0.45	7.52	5.6
T_8	50% P_2O_5 (EPM)	11.9	0.37	6.63	5.4
T_9	75% P_2O_5(EPM)	13.1	0.42	7.05	5.9
T_{10}	100 % P_2O_5 (EPM)	16.4	0.57	8.71	6.5
T_{11}	50% P_2O_5 (IRP)	10.4	0.25	4.63	5.1
T_{12}	75% P_2O_5(IRP)	12.1	0.32	6.10	5.2
T_{13}	100 % P_2O_5 (IRP)	15.0	0.51	8.00	5.7
	SEd	0.30	0.02	0.13	0.07
	CD (p=0.05)	0.63	0.05	0.27	0.14

Pot-experiment –I (cowpea cv. VBN 1)

Pod yield (g pot^{-1})

The pod yield significantly differed due different levels of P_2O_5 enriched composts. It was significantly highest with the application of 100% enriched pressmud (16.4 g pot^{-1}) (T_{10}). It was significantly superior over 100% incubated rock phosphate (15.0 g pot^{-1}), 100% enriched farmyard manure (14.0 g pot^{-1}). Whereas control recorded significantly lower pod yield (7.1 g pot^{-1}). Application 50% SSP registered the pod yield of 8.0 g pot^{-1}.

P uptake (g pot^{-1})

The data on phosphorus uptake by cowpea under various treatments was furnished in table 2. The higher and significant P uptake was observed in 100% EPM (0.57g pot^{-1}) followed by 100% IRP (0.51 g pot^{-1}) and 100% EFYM (0.45 g pot^{-1}). The lowest phosphorus uptake was observed with control (T_1) (0.15 g pot^{-1}).

Table 2: Effect of different levels of P_2O_5 enriched composts on pod yield, P uptake, post-harvest soil available P and organic carbon content in the pot experiment – II with cowpea cv. VBN 1.

Treatment No.	Treatments	Pod yield (g pot^{-1})	P Uptake (g pot^{-1})	Post-harvest soil available P (mg kg^{-1})	Post-harvest soil Organic carbon content (g kg^{-1})
T_1	100 % P_2O_5 (SSP)	14.28	0.17	10.74	5.1
T_2	100 % P_2O_5 (SSP) EPM	18.24	0.30	15.49	5.9
T_3	125 % P_2O_5 (SSP) EPM	23.85	0.42	18.10	6.6
T_4	150 % P_2O_5 (SSP) EPM	24.11	0.43	18.46	6.7
T_5	100 % P_2O_5 (SSP) IRP	15.71	0.21	12.83	5.4
T_6	125 % P_2O_5 (SSP) IRP	16.95	0.26	14.26	5.6
T_7	150 % P_2O_5 (SSP) IRP	20.39	0.33	16.87	6.1
	SEd	0.41	0.010	0.33	0.05
	CD (p=0.05)	0.89	0.021	0.71	0.12

Post-harvest soil available P (mg kg^{-1})

The available phosphorus in the post harvest soil differed significantly due to different treatments. The available phosphorus content in control was (4.14 mg kg^{-1}) significant and higher available phosphorus content of 8.71 mg kg^{-1} was recorded in the treatment at 100 % enriched pressmud (T_{10}) followed by 100%IRP (8.00 mg kg^{-1}) and 100 % EFYM (7.52 mg kg^{-1}) and T_9- 75%EPM (7.05 mg kg^{-1}). Among the different treatments, T_9-75%EPM and T_4-100%SSP were onpar.

Post-harvest soil organic carbon content (g kg^{-1})

The organic carbon content of soil differed significantly among the treatments. Higher organic carbon (6.5 g kg^{-1}) was recorded in 100 % P_2O_5 (SSP) enriched pressmud followed by 100 % IRP (5.7 g kg^{-1}) and 100 % EFYM (5.6 g kg^{-1}). The

treatments T_{10} and T_{13} significantly differed with other treatments. However, the lowest organic carbon content was recorded in control (4.7 g kg^{-1}).

Pot-experiment –II (cowpea cv. VBN 1) (Table 2)

Pod yield (g pot^{-1})

The highest pod yield of 24.11 g pot^{-1} was recorded with application of 150% P_2O_5 enriched pressmud (T_4). Which was on par with 125% P_2O_5 enriched pressmud (EPM) (T_3) (23.85 g pot^{-1}). This was followed by 150% P_2O_5 incubated rock phosphate (IRP) (T_7) (20.39 g pot^{-1}). Application of 100% P_2O_5 (SSP) registered the lowest pod yield of 14.28 g pot^{-1}.

This might be due to greater response of cowpea to phosphorus nutrition. Similar results are also reported by Selva anbarasu (2011) [4]. Since the P is involved in the growth, development, photosynthesis and utilization of carbohydrate, its role in increasing the growth and yield need not be over emphasized. Further, the phosphorus helps in the production of deeper and root proliferation which enables the plants to feed on bigger soil volume for water and nutrients (Anitha, 2002) [1].

P uptake (g pot^{-1})

Application of different levels of P_2O_5 enriched pressmud, incubated rock phosphate significantly increased phosphorus uptake by cowpea. The P uptake under various treatments ranged from 0.17 to 0.42 g pot^{-1}. The highest P uptake of 0.43 g pot^{-1} was recorded with 150% P_2O_5 enriched pressmud (T_4). Which was statistically onpar with 125% P_2O_5 enriched pressmud (EPM) (T_3) (0.42 g pot^{-1}). This might be due to fact that better plant growth leading to higher uptake of nutrients. Similar results are also indicated by Santhosh (2008) [3]. The increased uptake of P by cowpea might also be ascribed to more availability of the nutrient from added enriched fertilizers and the solubility action of organic acids produced during decomposition of organic materials.

Post-harvest soil available P (mg kg^{-1})

With respect to available phosphorus in the post-harvest soil of cowpea, application of 150% P_2O_5 enriched pressmud recorded the highest available P of 18.46 mg kg^{-1} than 100 % P_2O_5 (SSP)(control)(10.74 mg kg^{-1}). The buildup of available phosphorus in enriched composts treated pots might be due to the release of organic acids during microbial decomposition of organic matter, which might have helped in the solubility of native phosphorus thus increasing the available phosphorus content in soil (Santhosh, 2008) [3]. Further, the organic anions compete with phosphate ions for the bindings sites on the soil particles and these organic anions chelate with Al^{3+}, Fe^{2+} and Ca^{2+} and thus decrease the phosphate precipitating power of these cations there by increase the phosphorus desorption. Similar results were reported by Babhulkar *et al.* (2000).

Post-harvest soil organic carbon content (g kg^{-1})

It was found that the highest soil organic carbon content of 6.7 g kg^{-1} was recorded with 150% P_2O_5 enriched pressmud (T_4). It was followed by 125% P_2O_5 enriched pressmud (T_3) (6.6 g kg^{-1}) and 150% P_2O_5 incubated rock phosphate (IRP) (T_7) (6.1 g kg^{-1}). However the lowest organic carbon content of 5.1 g kg^{-1} was registered in control (T1) which was received 100 % P_2O_5 (SSP). This could be attributed to addition of enriched pressmud composts and also due to better root growth and their subsequent decomposition and their influence on the physical – chemical characteristics of the soil. These observations are in conformity with the findings of Babhulkar *et al*. (2000).

Conclusion

From the pot experiment –I and II with cowpea cv. VBN 1 under different levels of P_2O_5 enriched composts, it is concluded that application of 150% P_2O_5 enriched pressmud recorded the highest pod yield, P uptake and soil available phosphorus and organic carbon content. However, application of 125% P_2O_5 enriched pressmud (T_3) was sufficient to obtain significantly highest pod yield of cowpea and sustained soil health interms of higher soil available phosphorus and organic carbon content.

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