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Application of rock phosphate in composting improving the quality of compost

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Indian rock phosphate are of low grade and usually not suitable for the manufacture of phosphatic fertilizer (Manna *et al.*, 2003). Phosphocompost prepared by composting organic wastes with different graded dose of Missouri rock phosphate @ 1, 4 and 8 % of substrate, was reported to be comparable to single super phosphate in its effect on yield and phosphorus uptake in crops (Mishra *et al.* 1982, Banga *et al.* 1985). India has large deposit of rock phosphate but only 30% of it is in use. Direct application of rock phosphate has given good response in acid soil (Waigwa *et al.* 2003) but no effect in natural and alkaline soil (Hundal and Sekhon 1976, Rahman and Hajra, 2003). Mathur *et al.* (1980) observed that citrate soluble phosphorus content was increased on composting of Missouri rock. The P use efficiency is low as the water-soluble phosphate when applied to soil is quickly converted into unavailable forms by precipitation or adsorption with Al/ Fe in acidic (Chakravarti and Talibudeen 1962) and with Ca in alkaline condition. On the contrary organic forms of phosphorus immobilized in microbial cells are mineralized slowly (Dinesh *et al*, 2002) and made available to the plant regularly for a longer period increasing the P-use efficiency significantly. An attempt was made in the present study to quantify the quality improvement of compost by P enrichment through rock phosphate at different doses with decomposable organic matter during composting.

The experiment was conducted during 2000-01 and 2001-02 at the agriculture farm of Sheila Dhar Institute of Soil Science, Allahabad University, Allahabad. The detailed chemical analysis of compost and phosphocompost sample was carried out at Indian Institute of Vegetable Research, Varanasi during 2006-07. Composting pit of dimension 150 X 90 X 90 cm were made and filled with 750 kg raw material comprising 80 kg rice and wheat straw, 75 kg green water hyacinth and weeds and 595 kg cow dung and urine and decomposable farm waste. The decomposable substrate materials in each pit were moistening with 100 liters of water to maintain sufficient moisture. The mixture in pit on control, 1% P_2O_5 MPR, 4% P_2O_5 MPR, and 8% P_2O_5 MPR was added to study its effect on the efficiency of MPR solubilization and the change in chemical properties during composting. Nitrogen as urea @ 2% was added to the substrate to increase the C: N ratio, for quick decomposition. The contents of the pit were mixed after 4, 8, 15, 30, 60 and 90 days of composting and samples were drawn on these days for measurement of physico-chemical properties. The moisture content of the added substrate was maintained to the original level by sprinkling water. The loss in organic material during decomposition was measured by scaling the height and volume of the composting material in each pit at 30, 60, 90 and 120 days after composting and respective samples were taken out for chemical analysis. The sample were dried at room temperature, ground to pass through a 2 mm sieve and analyzed for pH, water soluble, organic and total phosphorus contents (Jackson, 1973). The percent solubilization of added rock phosphate was calculated at different time interval by the following equation: (Increased water soluble P + Increased organic P) - (water soluble P in control + organic P in control) / (total P- total P in control)* 100. Triplicate samples from the pits denoting different phosphorus enrichment levels were drawn by tube auger after specific days of incubation/ composting and analyzed for organic carbon, total nitrogen, total potassium and other micronutrients as described by Jackson (1973).

A steady decrease of substrate total biomass subjected to composting was noted with the progress of incubation days irrespective of phosphorus enrichment. The phosphorus enrichment up to 4 % P_2O_5 as phosphate rock with the substituted biomass significantly increased the rate of decomposition and lead to a faster loss of total substrate biomass. However at 8 % P_2O_5 enrichment the total biomass loss was less compared to phosphorus enrichment at 4 % P_2O_5 and recorded at par to 1 % enrichment (Table 1). The P enrichment level dependent biomass decomposition was in conformity with the earlier reports (Nazirkar *et al.*, 2004). A steady decrease in the pH value of the substrate biomass with the progress of decomposition was noted which eventually indicated the release of more acid forming ions particularly increase in H^+ concentration in the substrate biomass, corroborating the findings of Tian and Kolawole, 2004. A steady increase in total N % of decomposable substrate biomass was recorded with the progress of composing. The phosphorus enrichment @ 1 % P_2O_5 was more effective in increasing total N percentage of decomposable biomass as compared to 4 and 8 % enrichment (Table 1).

The enrichment of the compost with rock phosphate not only enhanced the availability of phosphorus

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from the insoluble source by its dissolution but also improved the quality of the final product. Mathur *et al.* 1980 observed similar phenomena during composting with varying phosphorus levels. The citrate soluble phosphorus content from charged compost of rock phosphate application had an increasing trend from 30 to120 days of incubation. The releases of phosphorus being slow at the initial stage and fast at later stage of composting. After 120 days of incubation the release of citrate soluble phosphorus was higher in compost treated with a higher amount of phosphorus enrichment compared to enrichment at a lower level (Vanden, 1996). There was a faster release of water-soluble phosphorus after 90 days of incubation. In all the stages of composting citrate soluble phosphorus was higher compared to water-soluble phosphorus in the compost mixture irrespective of level of enrichment with MPR compared to control (Table 2). Compost charged with either 1 % or 4% P_2O_5 and 8% P_2O_5 attained the highest level of citrate soluble phosphorus with the progress of composting at 120 DAI. Release of water-soluble phosphorus followed similar trend as citrate soluble phosphorus. The only difference was being lesser amount of phosphorus in water-soluble form than in citrate soluble form.

Organic carbon content in the raw material was as high as 40 per cent in the beginning of incubation, which considerably reduced after 30 days, and steadily decreased with time till reached a minimum value of 6.3 per cent after 120 days. The stimulation to the decomposition process could be due to the presence of phosphate and other nutrients ions available in the rock phosphate (Dash *et al*, 1988). Phosphorus enrichment with rock phosphate during composting also increased the calcium and magnesium content of compost. Enriching the compost with rock phosphate during composting also enhanced the concentration of micronutrients particularly Fe and Mn (Table 3). This was primarily due to the presence of calcium carbonates and salts of Fe, Mg, Zn, Cu and Mn, present in the rock phosphate, which during decomposition released from adsorbed form to ionic form in solution. The rate of decomposition of organic matter is directly correlated with the populations of thermophilic microorganism and release of CO_2 from the substrate biomass. A part of released CO_2 dissolved in the water and produce carbonic acid which initially solubilized not only PO_4^{-3} from calcium but also Mg, Fe, Zn, Mn and Cu salts of the rock phosphate (Sreenivas and Narayanasamy, 2003). In the presence of these essential nutrients the mesosphilic organisms also come into the reactions with the substrate that continues the decomposition of the organic matter and produces the organic acid (Singh *et al.* 1982, Singh and Amberger, 1991). Released organic acid and aerobic micro flora further mobilize the more insoluble compounds of the rock phosphate that subsequently, enhanced the soluble phosphorus percentage of decomposable substrate biomass together with total Ca, Mg, Fe, and Zn content in phosphocompost compared to normal compost. A significant increase in 42.6% water soluble phosphorus, 16.7% organic carbon, 28.6% total Ca, 50% total Mg, 1.5 to 2.8 fold increase in micronutrient Zn, Cu, Mn and Fe content was noted when composting was done with phosphorus enrichment @ 1% by Missouri rock phosphate compared to ordinary compost.

Table 1 : Effect ofphosphorus enrichment on biomass decomposition, pH and total N % during composting

Treatment	Loss of substrate (%)			pH			Total N % of substrate		
	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI
Control	12.17	24.17	30.2	7.6	7.3	7.2	0.21	0.34	0.49
1% P_2O_5 as MPR	14.2	25.57	34.63	7.5	7.3	7.1	0.25	0.50	0.62
4% P_2O_5 as MPR	20.77	32.17	44.17	7.4	7.3	7.1	0.21	0.47	0.54
8% P_2O_5 as MPR	17.53	23.37	33.27	7.4	7.2	7.2	0.20	0.39	0.50
$LSD_{0.05}$	0.65	0.32	2.72	0.54	0.45	0.34	0.07	0.03	0.09

DAI, days after incubation

Table 2 : Effect ofMPR on phosphate ion concentration during composting

Treatment	Water soluble phosphate %			Citric acid soluble P %			Total phosphate %		
	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI
Control	0.027	0.034	0.054	0.2	0.31	0.42	0.22	0.31	0.39
1% P_2O_5 as MPR	0.046	0.059	0.068	0.25	0.39	0.73	0.46	0.74	0.96
4% P_2O_5 as MPR	0.034	0.041	0.049	0.85	1.13	1.9	0.72	1.16	2.9
8% P_2O_5 as MPR	0.031	0.036	0.39	0.92	1.46	2.35	1.24	2.6	3.1
$LSD_{0.05}$	0.05	0.06	0.046	0.08	0.07	0.1	0.12	0.21	0.18

DAI, days after incubation

Table 3 :Properties of compost and phosphocompost at different levels of P enrichment

Nutrient status	Control	1% P_2O_5 as MPR	4% P_2O_5 as MPR	8% P_2O_5 as MPR
Organic matter loss (%)	33.20	36.63	46.80	48.6.0
Total phosphorus (%)	0.63	1.28	3.12	5.71
Water-soluble P (%)	0.061	0.087	0.073	0.066
Citrate soluble P (%)	0.069	1.07	3.21	4.61
pH	6.70	7.10	7.00	7.2
Total N (%)	0.58	0.76	0.71	0.64
Total K (%)	0.89	0.76	0.86	0.92
Organic Carbon (%)	13.76	16.07	10.75	8.56
Total Ca (%)	1.78	2.29	4.29	5.21
Total Mg (%)	0.32	0.48	0.54	0.60
Fe (ppm)	5072.00	12700.00	12864.00	13822.00
Mn (ppm)	178.00	498.00	693.00	829.00
Zn (ppm)	56.00	86.00	132.00	157.00
Cu (ppm)	9.00	22.00	28.00	39.00

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