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Characterization of enriched phosphatic sludge and effect of its application on microbial population after harvest of field bean and finger millet

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Abstract

Phosphatic sludge is a byproduct from the phosphoric acid industry. Enriched phosphatic sludge (EPS) was developed as soil conditioner with substantial quantity of organic matter (~15%) by blending phosphatic sludge with press mud (containing 10 to 12 percent phosphorus in insoluble form) and also humic acid and sea weed extracts. It also contains substantial quantities of calcium, potassium, nitrogen and micro-nutrients. The sludge was moderately alkaline in reaction (pH 8.06) with medium EC (0.97 dS m^{-1}). The alkaline reaction of the EPS may be due to its mixing with press mud which was generally alkaline in reaction. The EPS had high quantity of phosphorus (6.88 %) and the total N (1.51 %), K (1.20 %), Ca (1.50 %), Mg (1.10 %) and S (1.50 %) content were also in appreciable amounts in the EPS. Similarly, the total Fe, Mn, Zn and Cu contents were 4800, 1200 and 2100 and 67 mg kg^{-1}, respectively. Field experiment was conducted at Zonal Agricultural Research Station, V. C. Farm, Mandya, University of Agricultural Sciences (UAS), Bengaluru during 2016. Results revealed that significantly higher microbial population (bacteria, fungal and actinomycetes) were noticed in treatment T_7 receiving RDF + EPS @1000 kg ha^{-1} (27.71 X10^6, 13.59 and 13.27 X10^3 cfu g^{-1} soil, respectively) and lower microbial population (bacteria, fungal and actinomycetes) was recorded in control (16.99 X10^6, 6.52 and 6.33 X10^3 cfu g^{-1} soil, respectively). With respect to finger millet higher microbial population was noticed in treatment T_7 which received RDF + EPS @ 1000 kg ha^{-1} and lower microbial population was noticed in control. Based on results it can be concluded that addition of higher amount of organic material with low C:N to soil enhance the microbial population.

Keywords: Enriched phosphatic sludge, press mud, field bean, finger millet

1. Introduction

Under the present trend of exploitative agriculture, inherent soil fertility can no longer be maintained on a sustainable basis. The nutrient supplying capacity of soil declines steadily under continuous and intensive cropping systems. The use of optimum levels of N, P and K has failed to maintain yield levels, probably due to increasing secondary and micronutrient deficiencies and also unfavorable alterations in the physical and chemical properties of soil. Apart from the fertility and productivity issues, use of chemical fertilizers is becoming difficult due to their high costs and scarcity during peak season. Hence, there is a need to look for additional or alternative means of providing nutrients to be explored. In this context, the byproducts and wastes of different industries which are rich in macro, secondary and micro nutrients and low in heavy metals are the most viable choice as the use of such materials in crop production solves their problem coincidently. The first one is their deprival problem and secondly to improve soil properties. The increasing cost of chemical fertilizers coupled with the concern for efficient utilization of energy and natural resources have generated interest in use of alternate nutrient sources such as urban compost, sewage sludge, industrial sludge, press mud and fly ash along with chemical fertilizers. Application of compost made from industrial or municipal wastes could be the most economical and attractive methods of solving twin problems of waste disposal and the necessity to increase the organic matter content of soils (Chen and Avnimelech, 1986) [4].

Applying organic amendments has been shown to increase soil microbial activity (Liu and Ristaino 2003) [13], microbial diversity (Girvan *et al.* 2004 Grayston *et al.* 2004) [7, 8], and bacterial densities (Van Bruggen and Semenov 2000) [19]. Gelsomino *et al.* (2004) [6] compared organic and conventional agricultural systems by examining their effects on soil microbial biomass, microbial activity, and substrate utilization and documented an enhancement of microbial biomass in the plots with organic amendments. The soil microbial biomass is fundamental to maintaining soil functions because it represents the main source of soil enzymes that regulate transformation processes of elements in soils (Bohme and Bohme 2006) [1].

Materials and methods
Experimental details
Analysis of enriched phosphatic sludge
Enriched phosphatic sludge was collected from Aditya Birla chemical fertilizers private limited and analysed for chemical composition and data are presented in Table 1 and heavy metals (data are not presented) content was below the permissible limit as per the standard given by FCO for phosphorus rich organic manures.

A known weight of enriched phosphatic sludge sample was taken in a 250 ml conical flask and was predigested by adding 10 ml of HNO_3 and kept it overnight. Di acid mixture (10 ml) in 9:4 proportion (HNO_3:$HClO_4$) was added and heated on sand bath until a snow white residue was obtained. The residue was cooled and diluted to a known volume with distilled water, filtered and made up to 100 ml using distilled water. Further, it was used for estimation of all other elements. The chemical composition of the enriched phosphatic sludge was given in the Table 1. The methods adopted for macro, secondary, micro and heavy metal analysis of sludge samples are presented in Table 2.

Table 1: Characterization of enriched phosphatic sludge

Parameter	Value
MWHC (%)	38.10
Bulk density (Mg m^{-3})	1.06
pH (1:10)	8.06
EC (1:100) dS m^{-1}	0.97
OC (g kg^{-1})	11.50
N (%)	1.51
P (%)	6.88
K (%)	1.20
Ca (%)	1.50
Mg (%)	1.10
S (%)	1.50
Zn(mg kg^{-1})	2100
Mn (mg kg^{-1})	1200
Cu (mg kg^{-1})	67
Fe (mg kg^{-1})	4800
Pb (mg kg^{-1})	28
Ni (mg kg^{-1})	16
Cr (mg kg^{-1})	12
Cd (mg kg^{-1})	ND

ND- Not detected

Table 2: Methods adopted for the analysis of enriched phosphatic sludge samples.

Parameter	Method	Reference
MWHC (%)	Keen's Cup	Piper (1966)
Ph	Potentiometry	Jackson (1973)
EC (dS m^{-1})	Conductometry	Jackson (1973)
Organic carbon (%)	Dry combustion	Jackson (1973)
Total nitrogen (%)	Micro kjeldahl digestion and distillation	Piper (1966)
Total phosphorus (%)	Vanadomolybdic yellow colour spectrophotometry	Piper (1966)
Total potassium (%)	Flame photometry	Piper (1966)
Total calcium (%)	Versenate titrimetry	Piper (1966)
Total magnesium (%)	Versenate titrimetry	Piper (1966)
Total sulphur (%)	Turbidimetry	Bradsley and Lancester (1965)
Total Fe, Mn, Zn and Cu	Atomic absorption spectrophotometry	Lindsay and Norvell (1978)
Heavy metal content (Pb, Ni, Cr, Cd)	Atomic absorption spectrophotometry	Lindsay and Norvell (1978)

Field experiment details
Field experiment was conducted at Zonal Agricultural Research Station, V. C. Farm, Mandya, University of Agricultural Sciences (UAS), Bengaluru during 2016 to the Characterization of enriched phosphatic sludge and effect of its application on microbial population after harvest of field bean and finger millet. Field experiments were laid out in Randomized Complete Block Design with twelve treatments (for both crops) *viz*., T_1 : Control, T_2 : RDF + FYM @ 10 t ha^{-1}, T_3: RDF + 125 kg EPS ha^{-1}, T_4: RDF + 250 kg EPS ha^{-1}, T_5: RDF + 500 kg EPS ha^{-1}, T_6: RDF + 750 kg EPS ha^{-1}, T_7: RDF + 1000 kg EPS ha^{-1}, T_8: Balanced RDF + 125 kg EPS ha^{-1}, T_9: Balanced RDF + 250 kg EPS ha^{-1}, T_{10}: Balanced RDF + 500 kg EPS ha^{-1}, T_{11}: Balanced RDF + 750 kg EPS ha^{-1} and T_{12}: Balanced RDF + 1000 kg EPS ha^{-1} replicated with trice.

Soil sampling and analysis
Soil sample were collected after immediate harvest of field bean and finger millet crops. Soil samples were collected from each treatments individually at the depth of 0-15 cm. Soil samples were air dried and processed for further analysis by adopting standard protocol.

Estimation of soil microbial population after harvest of field bean and finger millet
The general microbial population in different treatments of the experimental soil was estimated after harvest of the crops by serial dilution plate count technique. Soil samples from each treatment were collected separately and used for microbial population estimation following the procedure detailed below:

Ten grams of homogenized soil (treatment wise) was mixed in 90 ml sterile water blank to give 10^{-1} dilution. Subsequent dilutions up to 10^{-5} were made by transferring serially 1 ml of the dilution to 9 ml sterile water blanks. The populations of bacteria, fungi and actinomycetes were estimated by transferring 1ml of 10^3, 10^3 and 10^5 dilutions, respectively to a sterile petridish and approximately 20 ml of media *viz*., Soil Extract Agar, Martins Rose Bengal Agar and Kusters Agar for soil bacteria, fungi and actinomycetes, respectively was poured into the plates and the count was done based on the respective cfu formed by bacteria, fungi and actinomycetes.

Results and discussion
Physico - chemical properties of enriched phosphatic sludge
Phosphatic sludge (EPS) was obtained from ortho phosphoric acid manufacturing industry owned by Aditya Birla Chemical and Fertilizers Limited, located at Karwar, Karnataka. It was enriched with press mud, sea weed extract and plant growth hormones. The EPS was characterized in order to ascertain its suitability in crop production.

Perusal of the data presented in the Table 1 revealed that the BD of EPS was low (1.06 Mg m^{-3}) and moderate in MWHC

(38.10 %) due to higher organic carbon (11.50 %) content in it as it was enriched with press mud and sea weed extract at the site of production and storage. The sludge was moderately alkaline in reaction (pH 8.06) with medium EC (0.97 dS m^{-1}). The alkaline reaction of the EPS may be due to its mixing with press mud which was generally alkaline in reaction. The EPS had high quantity of phosphorus (6.88 %) and the total N (1.51 %), K (1.20 %), Ca (1.50 %), Mg (1.10 %) and S (1.50 %) content were also in appreciable amounts in the EPS. Similarly, the total Fe, Mn, Zn and Cu contents were 4800, 1200 and 2100 and 67 mg kg^{-1}, respectively. The above values for nutrient content clearly indicate that it can be used in crop production as source of nutrients. The higher nutrients content in the EPS might be due to its enrichment with press mud and sea weed extract.

The sample was analyzed for heavy metal contents. The results indicated that it contains heavy metals *viz.*, Cr, Pb and Ni to an extent of 12, 28 and 16 mg kg^{-1} respectively. However, Cd was not detected in the EPS. All the heavy metals recorded in the EPS were below the permissible limits as per the Indian standards. The alkaline nature of the EPS might be due to the enrichment of sludge with press mud which was alkaline in nature and contained 11.50 percent of organic matter. These values were similar to the values reported by Muhammed and Khaliq (1975) [15] and Khattak and Khan (2004) [10] who recorded up to 15 percent organic matter and 70 percent lime in press mud.

Effect of EPS application on microbial population of soil after harvest of field bean and finger millet

Enriched phosphatic sludge rich in organic matter content as well as phosphorus and it also have very narrow C:N all these factors resulted in enhancing microbial population in soil after harvest of crops.

With respect to microbial dynamics *viz.*, bacteria, fungal and actinomycetes (Table 3) after harvest of field been was significantly increases (bacteria, fungal and actinomycetes) in treatment T_7 receiving RDF + EPS @1000 kg ha^{-1} (27.71 X10^6, 13.59 and 13.27 X10^3 cfu g^{-1} soil, respectively) and lower microbial population (bacteria, fungal and actinomycetes) was recorded in control (16.99 X10^6, 6.52 and 6.33 X10^3 cfu g^{-1} soil, respectively). Due to neutral soil pH, Nitrogen fixation by pulse crop and addition of organic rich and narrow C: N materials to soil have positive influence on faster growth of microbes.

Organic matter introduced to soil stimulates soil microbial populations and soil biological activity (Brady and Weil 1999) [3], which is in accordance with the present study where organically treated plots showed an increase in fungal and bacterial population compared to the control plot, where no fertilizer was applied. Fungal, bacterial and actinomycetes population was significantly higher in EPS treated plots compared to control and this might be due to the direct addition of organic carbon to the soil through EPS. Similar findings were reported by Das and Dkhar (2012) [5] who recited that increase in the microbial populations in post-harvest soil of soybean due to the addition of organic manures and their population was more in organic manure treated plots compared to fertilizer treated plots. Sharma and Guled (2012) [18] also reported that increase in the microbial population might be due to decomposing root tissues and root nodules also provide carbon and energy to the soil microbes resulting in multiplication of microbial population in the pigeon pea and green gram cropping system. It has been reported that addition of organic manure would have resulted in increased secondary and micronutrients in the soil, which might have helped to increase the microbial population (Krishnakumar *et al.* 2005) [11].

Influence of EPS application on microbial population viz., bacterial, fungal and actinomycetes in finger millet were presented in Table 4. Higher microbial population (bacteria, fungal and actinomycetes) were noticed in treatment T_7 which received RDF + EPS @1000 kg ha^{-1} (26.60 x 106, 12.93 and 12.55 x 103 cfu g^{-1} soil, respectively) and lower microbial population (bacteria, fungal and actinomycetes) was recorded in control (16.16 x 106 and 6.24 and 5.81 x 103 cfu g^{-1} soil, respectively).

The higher microbial population viz., bacteria, fungi and actinomycetes (Table.4) was recorded in treatment T_7 receiving RDF + EPS @ 1000 kg ha^{-1} after harvest of the finger millet crop as compared to control soil microbial population. The increased proportion of labile carbon and nitrogen directly stimulate the activity of the microorganisms. It might be due to increased organic matter content in the soil and higher availability of nutrients to the crop. Nanda *et al.* (1988) [16] stated that application of FYM along with RDF to wheat enhanced the bacterial population as compared to fungi and actinomycetes. As compared to inorganic fertilizers, addition of FYM increased the activity of microorganisms (Maheswarappa *et al.*, 1999) [14]. Results provide support to the present study that application of enriched phosphatic sludge increased the soil microbial population compared to control

Table 3: Effect of different levels of enriched phosphatic sludge on total microbial population of soil after harvest of field bean

Treatment	**Bacteria (10^6 cfu g^{-1} soil)**	**Fungi (10^3 cfu g^{-1} soil)**	**Actinomycetes (10^3 cfu g^{-1} soil)**
T_1 - Absolute Control	16.99	6.52	6.33
T_2 - RDF+FYM	24.56	14.08	12.68
T_3 - RDF+ EPS @125 kg ha^{-1}	19.31	10.25	6.86
T_4 -RDF + EPS @ 250 kg ha^{-1}	20.73	10.67	8.38
T_5 – RDF + EPS @500 kg ha^{-1}	21.24	11.90	8.97
T_6 – RDF + EPS @750 kg ha^{-1}	23.86	12.71	12.17
T_7 – RDF + EPS @1000 kg ha^{-1}	27.71	13.59	13.27
T_8 - Balanced RDF + EPS @125 kg ha^{-1}	18.44	10.10	7.82
T_9 - Balanced RDF + EPS @250 kg ha^{-1}	20.00	10.63	8.94
T_{10} - Balanced RDF + EPS @ 500 kg ha^{-1}	21.04	11.27	10.59
T_{11} - Balanced RDF + EPS @750 kg ha^{-1}	22.69	11.92	11.48
T_{12} - Balanced RDF + EPS @1000 kg ha^{-1}	23.96	13.35	11.34
S.Em±	1.42	0.80	0.26
CD @ 5 %	4.17	2.34	0.76

Table 4: Effect of different levels of enriched phosphatic sludge on total microbial population of soil after harvest of finger millet

Treatment	Bacteria (10^6 cfu g^{-1} soil)	Fungi (10^3 cfu g^{-1} soil)	Actinomycetes (10^3 cfu g^{-1} soil)
T_1 - Absolute Control	16.16	6.24	5.81
T_2 - RDF+FYM	23.36	13.47	11.81
T_3 - RDF+ EPS @125 kg ha^{-1}	18.36	9.80	6.24
T_4 -RDF + EPS @ 250 kg ha^{-1}	19.72	10.21	7.66
T_5 – RDF + EPS @500 kg ha^{-1}	20.20	11.38	8.29
T_6 – RDF + EPS @750 kg ha^{-1}	22.90	12.15	11.39
T_7 – RDF + EPS @1000 kg ha^{-1}	26.60	12.93	12.55
T_8 - Balanced RDF + EPS @125 kg ha^{-1}	17.71	9.70	7.28
T_9 - Balanced RDF + EPS @250 kg ha^{-1}	19.21	10.21	8.35
T_{10} - Balanced RDF + EPS @ 500 kg ha^{-1}	20.20	10.82	10.07
T_{11} - Balanced RDF + EPS @750 kg ha^{-1}	21.79	11.45	10.76
T_{12} - Balanced RDF + EPS @1000 kg ha^{-1}	23.01	12.82	10.76
S.Em±	1.38	0.72	0.25
CD @ 5 %	4.04	2.13	0.74

Conclusion

Higher microbial population (bacteria, fungi and actinomycetes) after harvest of field bean and finger millet was noticed in treatment T_7 which received EPS @ 1000 kg ha^{-1} as compared to control. Microbial population was increases with increasing the levels of EPS but significantly higher population was noticed in treatment T_7

References

1. Bohme L, Bohme F. Soil microbiological and biochemical properties affected by plant growth and different long-term fertilization. European J Soil Biology. 2006; 42:1-12.
2. Bradsley CE, Lancester JD. Sulphur. In: Methods of Soil Analysis, Part 2. Eds. Black, C.A., Evans, D.D., White, J.L., Jusminger, L.E. and Clark, F.E. Madison, American Soc. Agron., 1965, 1102-1116.
3. Brady NC, Weil RR. Soil organic matter. In The nature and properties of soils, Upper Saddle River, N.J.: Prentice Hall, 1999, 446-490.
4. Chen Y, Avnimelech Y. The role of organic matter in modern agriculture. Developments Plant and Soil Sciences, 1986; 25:456-482.
5. Das, Dkhar. Organic amendment effects on microbial population and microbial biomass carbon in the rhizosphere soil of soybean. Communications Soil Sci. and Plant Analysis. 2012; 43:14.
6. Gelsomino A, Cacco G. Compositional shifts of bacterial groups in a solarized and amended soil as determined by denaturing gradient gel electrophoresis. Soil Biology Biochemistry. 2004; 38:91-102.
7. Girvan MS, Bullimore J, Ball AS, Pretty JN, Osborn AM. Responses of active bacterial and fungal communities in soil under winter wheat to different fertilizer and pesticide regimens. Applied Environ Microbiology. 2004; 70:2692-2701.
8. Grayston SJ, Campbell CD, Bardgett RD, Mawdsley JL, Clegg CD, Ritz K, *et al*. Assessing shifts in microbial community structure across a range of grasslands of differing management intensity using CLPP, PLFA, and community DNA techniques. Applied Soil Ecology. 2004; 25:63-84.
9. Jackson ML. Soil Chemical Analysis, Prentice Hall of India Private Limited, New Delhi. 1973, 485.
10. Khattak RA, Khan MJ. Evaluation, reclamation and management of saline sodic soils in Kohat division. Final Report. Department of Soil and Environmental Sciences, NWFP Agriculture University Peshawar. National Drainage Programme (NDP), Govt. of Pakistan, 2004.
11. Krishnakumar S, Saravanan A, Natarajan SK, Veerabadram V, Mani S. Microbial population and enzymatic activity as influenced by organic farming. Res J Agril Biological Sci. 2005; 1:85-88.
12. Lindsay WL, Norvell WA. Development of DTPA soil test for zinc, iron, manganese and copper. Soil Sci. Soc. America J. 1978; 42:421-428.
13. Liu B, Ristaino JB. Microbial community structure in soils from organic and conventional agro- ecosystems. Phytopathology. 2003; 96:53.
14. Maheswarappa HP, Nanjappa HV, Hegde MR. Influence of organic manures on yield of arrow root, soil physico-chemical and biological properties when grown as intercrop in coconut garden. Ann. Agric. Res. 1999; 20:318- 323.
15. Muhammed S, Khaliq A. Comparison of various chemical and organic amendments for reclamation of saline-sodic soil. Bulletin Irrigation, Drainage and Flood Control Research Council of Pakistan. 1975; 5:50-54.
16. Nanda SK, Das PK, Behera B. Effect of continuous manuring on microbial populations, ammonification and CO2 evolution in rice soil. Oryza, 1988; 25:413-416
17. Piper CS. Soil and Plant Analysis, Hans Publishers Bombay, 1966, 368.
18. Sharma A, Guled MB. Effect of set-furrow method of cultivation in pigeon pea + green gram intercropping system in medium deep black soil under rainfed conditions. Karnataka J Agricl. Sci. 2012; 25(1):18-24.
19. Van Bruggen AHC, Semenov AM. In search of biological indicators for plant health and disease suppression. Applied Soil Ecology. 2000; 15:13-24.