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Eresha
Central Institute of Aromatic and Medicinal plants, Bengaluru, Karnataka, India

Prakash SS
Prof& Head, Dept. of Soil Science and Agril. Chemistry, V. C. Farm, Mandya, Karnataka, India

Harsitha M
Dept. of Soil Science and Agril. Chemistry, UAS, GKVK, Bengaluru, Karnataka, India

Correspondence
Eresha
Central Institute of Aromatic and Medicinal plants, Bengaluru, Karnataka, India

Effect of enriched phosphatic sludge application on soil microbial population under field capacity (Maize) and flooded condition (Rice) of soil

Eresha, Prakash SS and Harsitha M

Abstract
The field experiment was conducted during the kharif of 2016 at "B" block, Zonal Agricultural research Station, V. C. Farm, Mandya, Karnataka to evaluate the effect of enriched phosphatic sludge (EPS) application on soil microbial population under maize and rice crops. Experiments were laid out in Randomized Complete Block Design with twelve treatments and replicate trice. The results revealed that application of enriched phosphatic sludge at 1000 kg ha^{-1} + RDF recorded higher microbial population *viz.*, bacteria, fungi and actinomycetes in maize soil than the rice soil. Significantly higher bacteria (25.30 and 8.32 X 10^6 cfu g^{-1} soil, respectively), fungi (12.30 and 6.25 X 10^3 cfu g^{-1} soil, respectively) and actinomycetes (7.00 and 2.51 X 10^3 cfu g^{-1} soil, respectively) were recorded in maize and paddy soils in treatment T_7 which received 1000 kg ha^{-1} + RDF. Based on present investigation it can be concluded that optimum aerobic condition with good amount of organic matter are suitable for faster growth of microorganisms.

Keywords: EPS, RDF, microbes, aerobic and flooded condition etc.

Introduction

Soil fertility, or its capacity to enrich natural and agricultural plants, is dependent upon three interacting and mutually dependent components: physical fertility, chemical fertility and biological fertility. Physical fertility refers to the physical properties of the soil, including its structure, texture and water absorption and holding capacity, and root penetration. Chemical fertility involves nutrient levels and the presence of chemical conditions such as acidity, alkalinity and salinity that may be harmful or toxic to the plant. Biological fertility refers to the organisms that live in the soil and interact with the other components. These organisms live on soil, organic matter or other soil organisms and perform many vital processes in the soil. Some of them perform critical functions in the nutrient and carbon cycles.

Of the three fertility components, it is the microbiological element, the rich diversity of organisms such as bacteria, viruses, fungi and algae that form interactive microbial communities that are the most complex and paradoxically, the least well-understood. Soil provides the medium for root development and with the exception of carbon, hydrogen, oxygen and some nitrogen, plants depend on soil for all other nutrients and water. Soils develop by the disintegration of rocks, and minerals therein, through biotic actions of the microbes and the fauna sustained by them. Earlier, only the physical and chemical properties of soil were considered important. However, the role of soil microorganisms in maintaining fertility and the interdependence of soil biological activities with physical and chemical characteristics is well recognized now (Abbott and Murphy 2003; Fitter 2005; Madsen 2005; Manlay *et al.*, 2007) [1, 9, 12, 14]. Physical properties and the amount of soil organic matter (SOM) determine the microbial diversity that varies with depth, and soil fertility. SOM adds to soil enhances the soil fertility, water retention and has a great influence on the growth of the above ground vegetation. Biological indicators such as microbial biomass, soil respiration, enzyme activities and microbial diversity indicate soil health. Significance of soil biodiversity for sustainability of the farming systems has been discussed at length (Brussard *et al.*, 2007) [3]. Microbial diversity is an excellent indicator of soil health (Nielsen and Winding 2002) [17]. They report that variation in microbial population or activities precede changes that can be noticed in some cases as early signs of soil degradation or amelioration. Water and nutrient supply from soil, particularly N and P, determine the plant growth both in natural and agro-ecosystems. The above ground vegetation is the ultimate source of C for the microbes in the rhizosphere that, in turn, support the macro-fauna. Thus, the above ground vegetation influences the below ground microbial community structure and soil properties (Orwin and Wardale 2005) [18]. The soil microbes that include bacteria, fungi, actinomycetes, protozoa and

Algae play a significant role in the nutrient cycling. Though it is widely accepted that soil biodiversity is vital for maintaining productivity in natural and managed agro ecosystems, the understanding of the microbial communities, soil fauna and their diversity is extremely limited (Buckley and Schmidt 2003; Nannipieri *et al.,* 2003; Lynch *et al.*, 2004) [4, 11, 16].

Raw sludge generated from the ortho-phosphoric acid manufacturing plant, located at Karwar, Karnataka and it was further enriched with press mud, sea weed extract and plant growth promoting substance to improve its physical and chemical properties. Enriched phosphatic sludge have alkaline in reaction with low soluble salts and high organic matter and phosphorus content and it also contain moderate amount of N, K and micronutrients. Thus, enriched phosphatic sludge can be used in crop production as a source of nutrients and / or as soil conditioner along with chemical fertilizers. Further, the compost prepared from industrial sludge or enriched waste containing high organic carbon provides labile organic matter in sufficient quantities to stimulate soil microorganisms. On this context our study in mainly concern about effect of enriched phosphatic sludge application on microbial population under field and submerged condition with an objective to study the effect of varied levels of enriched phosphatic sludge application on biological properties of soil.

Materials and methods

Location of experiment

Field experiment was conducted at "B" block, Zonal Agricultural research Station, V. C. Farm, Mandya. Experimental area lies between $76^0$82'01" to $76^0$82'08" E longitude and $12^0$57'03" to $12^0$57'05" N latitude with an average elevation of 699-715 m above SML. This area under canal irrigation.

Experimental Details

Enriched phosphatic sludge was collected from Aditya Birla chemical fertilizers private limited and analyzed 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.

Field experiment was conducted at Zonal Agricultural Research Station, V. C. Farm, Mandya, University of Agricultural Sciences (UAS), and Bengaluru during 2016 to investigate the effect of enriched phosphatic sludge application on soil microbial population under field capacity (Maize) and flooded condition (Rice) of soil. Field experiments were laid out in Randomized Complete Block Design with twelve treatments *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-with three replication.

Table 1: Characterization of enriched phosphatic sludge

Parameter	Value
MWHC (%)	38.10
pH (1:10)	8.03
EC (1:100) d S m^{-1}	0.97
OC (g kg^{-1})	11.30
N (%)	1.51
P (%)	6.88
K (%)	1.20
Ca (%)	1.50
Mg (%)	1.10
Sulphur (%)	1.56

Collection of soil samples and analysis

After immediate harvest of maize and paddy 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

Estimation of soil microbial population

The general microbial population in different treatments of the experimental soil was estimated at harvest 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.

Result and discussion

Microbial population of soil after harvest of maize (under field capacity).

In agricultural ecosystems microbial population has been found to be strongly related to soil organic carbon (Booth *et al.,* 2005; Cleveland and Liptzin, 2007; Fierer *et al.,* 2009; Kallenbach and Grandy, 2011) [2, 5, 8, 10]. This close relationship suggests that the fertilizer and organic source rich amendments induced increase in soil organic carbon which was observed in our results was mainly due to the higher carbon in fields receiving mineral fertilizers along with EPS. In both the fields, the concentrations of the fungal, bacterial, and total microbial biomass were higher in the soils amended with organic material than in control soils amended only with inorganic fertilizer.

Significantly higher (Table 2) microbial population (bacteria, fungi and actinomycetes) was noticed in treatment T_7 (25.30 X 10^6, 12.30 and 7.00 X 10^3 cfug^{-1} soil, respectively) which received 1000 kg EPS ha^{-1} as compared to control (15.46 X 10^6, 5.97 and 3.84 X 10^3 cfu g^{-1} soil, respectively). This increase might be due to increased organic matter content in The soil and higher availability of nutrients to the crop. Addition of EPS and RDF increased the activity of microorganisms as compared to EPS and balanced RDF applied treatments. Soil bacteria were the dominant species among the microbes.

Wherever EPS was applied with full dose of RDF enhances the microbial population it clearly indicates the role of essential nutrients (NP and K) in faster growth and multiplication of microbes. With respect to balanced RDF was not so, it might be due to insufficient supply of essential nutrient to microbes may be hinder the higher and faster growth of microbial population. Microbial population under field capacity was much higher than the flooded soil it clearly shows. The increases in microbial population in maize soil after harvest of maize might be attributed to the improvement in Physico-chemical properties of the rhizosphere soil for microbial growth due to addition of organics along with chemical fertilizers. The higher organic carbon and supply of essential nutrients through the direct addition of chemical fertilizers or EPS or FYM or root biomass might be the reason for higher microbial population. Similar results were reported by Das and Dkhar (2011) [6] reported an increase in the microbial populations due to the addition of organic and inorganic manures and Rangaraj *et al.* (2007) [19] reported an increase in microbial population due to addition of organics (urban compost, press mud and vermicomposting) along with chemical fertilizers to neutral soil.

Table 3: Effect of different levels of enriched phosphatic sludge application on microbial population soil after harvest of maize

Treatments	pH	Bacteria	Fungal	Actinomycetes
		X 10^6 cfu g^{-1} soil	X 10^3 cfu g^{-1} soil	
T_1: Control	7.15	15.46	5.97	3.84
T_2: RDF + FYM @ 10 t ha^{-1}	7.50	22.35	12.89	6.67
T_3: RDF + 125 kg EPS ha^{-1}	7.42	17.57	9.38	4.00
T_4: RDF + 250 kg EPS ha^{-1}	7.55	18.87	9.77	4.67
T_5: RDF + 500 kg EPS ha^{-1}	7.55	19.34	10.89	5.00
T_6: RDF + 750 kg EPS ha^{-1}	7.62	21.79	11.56	6.50
T_7: RDF + 1000 kg EPS ha^{-1}	7.67	25.30	12.30	7.00
T_8: Balanced RDF + 125 kg EPS ha^{-1}	7.39	16.85	9.23	4.50
T_9: Balanced RDF + 250 kg EPS ha^{-1}	7.38	18.28	9.71	5.00
T_{10}: Balanced RDF + 500 kg EPS ha^{-1}	7.56	19.22	10.30	5.84
T_{11}: Balanced RDF + 750 kg EPS ha^{-1}	7.49	20.74	10.89	6.17
T_{12}: Balanced RDF + 1000 kg EPS ha^{-1}	7.57	21.89	12.20	6.17
S.Em±	0.18	0.61	0.32	0.36
CD @5%	0.52	1.80	0.95	1.05

Microbial population of soil after harvest of paddy (under submergence).

Compare to maize soil (aerobic condition) lowest microbial population was notice under submerged condition even though same quantity of EPS was applied. Significantly lower number of microbes (bacteria, fungal and actinomycetes) was noticed in control (3.35 X 10^6, 2.96 and 1.70 X 10^3 cfu g^{-1} soil, respectively) but application of enriched phosphatic sludge increased the microbial population (bacteria, fungi and actinomycetes). Higher microbial population was noticed in treatment T_7 (8.32 X 10^3, 6.25 and 2.51 X 10^3cfu g^{-1}soil, respectively) which received RDF + 1000 kg EPS ha^{-1} and it was on par with treatments T_2 (7.67 X 10^6, 5.69 and 2.36 X 10^3 cfu g^{-1} soil, respectively) and T_{12} (7.59 X 10^6, 5.78 and 2.12 X 10^3 cfu g^{-1} soil, respectively) which received RDF + FYM and balanced RDF + 1000 kg EPS ha^{-1}, respectively.

The increased proportion of labile carbon and nitrogen directly stimulate the activity of the microorganisms. The higher microbial population *viz.*, bacteria, fungi and actinomycetes were recorded in treatment T_7 which received RDF + EPS @1000 kg ha^{-1} might be due to increased organic matter content in the soil and higher availability of essential nutrients to the microbes might be the reason for higher microbial population. Nanda *et al.* (1988) [15] reported that addition of organic nutrient source increased the bacterial population as compared to fungi and actinomycetes and this results also supported by findings of Maheswarappa *et al.* (1999) [13] revealed that application of organic fertilizer along with inorganic fertilizers increases the population and activity of microorganisms than the inorganic fertilizer alone.

Comparison of microbial population under different moisture condition and pH

Aeration, soil temperature and soil reaction plays a vital role in growth and development of particular microorganisms in soil. Many studies carried out in a number of ecosystems have shown that pH exerts a strong influence on the composition of soil microbial communities. Bacteria, fungi and actinomycetes populations under field capacity of moisture having pH of (7.67) neutral recorded significantly higher population in all treatments as compare to flooded soil having pH (8.11) alkaline. In maize soil significantly higher bacteria, fungi and actinomycetes populations was recorded in treatment RDF + 1000 kg EPS ha^{-1} (25.30 X 10^6 cfu g^{-1} soil, 12.30 and 7.00 X 10^3 cfu g^{-1} soil, respectively) than the treatment same RDF + 1000 kg EPS ha^{-1} (8.32 X 10^6 cfu g^{-1} soil, 6.25 and 2.51 X 10^3 cfu g^{-1} soil, respectively) under flooded condition.

Table 4 Effect of different levels of enriched phosphatic sludge application on microbial population soil after harvest of paddy

Treatments	pH	Bacteria	Fungi	Actinomycetes
		X 10^6 cfu g^{-1} soil	X 10^3 cfu g^{-1} soil	
T_1: Control	7.63	3.35	2.96	1.70
T_2: RDF + FYM @ 10 t ha^{-1}	7.77	7.67	5.69	2.36
T_3: RDF + 125 kg EPS ha^{-1}	7.67	6.02	3.89	1.84
T_4: RDF + 250 kg EPS ha^{-1}	7.90	6.23	4.26	1.88
T_5: RDF + 500 kg EPS ha^{-1}	7.93	6.65	4.69	1.99
T_6: RDF + 750 kg EPS ha^{-1}	8.00	7.37	5.42	2.06
T_7: RDF + 1000 kg EPS ha^{-1}	8.11	8.32	6.25	2.51
T_8: Balanced RDF + 125 kg EPS ha^{-1}	7.63	5.88	3.82	1.66
T_9: Balanced RDF + 250 kg EPS ha^{-1}	7.72	6.00	3.97	1.83
T_{10}: Balanced RDF + 500 kg EPS ha^{-1}	7.74	6.02	4.76	1.91
T_{11}: Balanced RDF + 750 kg EPS ha^{-1}	7.95	6.53	5.66	2.02
T_{12}: Balanced RDF + 1000 kg EPS ha^{-1}	8.09	7.59	5.78	2.12
S.Em±	0.09	0.28	0.24	0.07
CD @5%	0.26	0.82	0.70	0.21

Similar results were recorded in North and South America, 98 soil samples collected from different ecosystems by Fierer and Jackson (2006) [7] found that the diversity and richness of soil bacterial communities differed substantially across ecosystem types and that differences in soil pH largely explained the variation. Differences in bacterial community composition were most pronounced in soils with a pH below 5. Bacterial diversity was highest in neutral soils and lower in acidic soils. Total number of microbial population was observed at field capacity was much higher than the submerged condition.

Conclusion

Aeration and soil pH play a major role in growth and development of soil microorganisms significantly higher microbial population (bacteria, fungi and actinomycetes) after harvest of maize under field capacity was noticed in treatment T_7 which received 1000 kg EPS ha^{-1} + RDF as compared to treatment T_7 which received same amount of EPS and RDF under flooded condition. Among the microorganism's soil bacteria was the dominant species in both the sol.

References

1. Abbott LK, Murphy DV. Soil biological fertility: a key to sustainable land use in agriculture. Springer, Berlin Heidelberg New York, 2003, 276.
2. Booth MS, Stark JM, Rastetter E. Controls on nitrogen cycling in terrestrial ecosystems: a synthetic analysis of literature data. Ecological Monographs. 2005; 75:139-157.
3. Brussard L, Ruiter PC, Brown GC, soil biodiversity for agricultural sustainability. Agric Ecosyst Environ. 2007; 121:233-244.
4. Buckley DH, Schmidt TM. Diversity and dynamics of microbial communities in soils from agro-ecosystems. Environ Microbiol. 2003; 5:441-452.
5. Cleveland CC, Liptzin D. C: N: P stoichiometry in soil: is there a Redfield ratio for the microbial biomass? Bio geochemistry. 2007; 85:235-252.
6. Das BB, Dkhar MS. Rhizosphere Microbial Populations and Physico Chemical Properties as Affected by Organic and Inorganic Farming Practices. J Agric. & Environ. Sci. 2011; 10(2):140-150
7. Fierer N, Jackson RB. The diversity and biogeography of soil bacterial communities. Proceedings of the National Academy of Sciences of the USA. 2006; 103:626-631.
8. Fierer N, Strickland MS, Liptzin D, Bradford MA, Cleveland CC, Global patterns in belowground communities. Ecology Letters. 2009; 12:1238-1249.
9. Fitter AH, Darkness visible: reflections on underground ecology. J Ecol. 2005; 93:231-243.
10. Kallenbach C, Grandy AS. Controls over soil microbial biomass responses to carbon amendments in agricultural systems: a meta-analysis. Agric, Eco & Environment. 2011; 144:241-252.
11. Lynch JM, Benedetti A, Insam H, Nuti MP, Smalla K, Torsvik V, Nannipieri P. Microbial divesity in soil: ecological theories, the contribution of molecular techniques and the impact of transgenic plants and transgenic organisms. Biol Fertil Soils. 2004; 40:363-385.
12. Madsen EL. Identifying microorganisms responsible for ecologically significant bio geo-chemical processes. Nat Rev Microbiol. 2005; 3:439-446.
13. 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.
14. Manlay RJ, Feller C, Swift MJ. Historical evolution of soil organic matter concepts and their relationships with the fertility and sustainability of cropping systems. Agric Ecosyst Environ. 2007; 119:217-233.
15. Nanda SK, Das PK, Behera B. effect of continuous manuring on microbial populations, ammonification and CO_2 evolution in rice soil. Oryza. 1988; 25:413-416.
16. Nannipieri P, Ascher J, Ceccherini MT, Landi L, Pietramellara G, Renella G. Microbial diversity and soil functions. Eur J Soil Sci. 2003; 54:655-670.
17. Nielsen MN, Winding A. microorganisms as indicators of soil health. NERI Technical Report No. 388. National Environmental Research Institute, Ministry of the Environment, Denmark. 2002.
18. Orwin KH, Wardle DA. Plant species composition effects on belowground properties and the resistance and resilience of the soil micro flora to a drying disturbance. Plant Soil. 2005; 278:205-221.
19. Rangaraj T, Somasundaram E, Mohamed Amanullah M, Thirumurugan V, Ramesh S, Ravi S. Effect of agro industrial wastes on soil properties and yield of irrigated finger millet (*Eleusine coracana* (L).*Gaertn*) in coastal soil. Res. J Agric. Biol. Sci. 2007; 3(3):153-156.