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Response of Rice Crop to Organic Manuring in High pH Soil

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Abstract: Field experiments were conducted during August-December 2002 (Kharif) and January-April (Summer season) 2003 to study the effect of incorporation of biocompost on lowland rice with four treatments viz., M_1-Control, M_2-FYM at the rate of 12.5 t ha $^{-1}$, M_3-GLM at the rate of 6.25 t ha^{-1} and M_4-Biocompost at the rate of 3 t ha^{-1}. Rice varieties Co 43 and IR 50 were used as test crops. Among the different organic manures used, application of biocompost at the rate of 3 t ha^{-1} registered higher yields and favourably improved the soil chemical and biological properties than the other treatments. Thus, the conversion of by-products like pressmud and distillery spentwash into a value added eco-friendly organic manure can be considered as a commercially viable, environmentally acceptable and practically enforceable option for improving the crop productivity and soil fertility status of the soil.

Key words: Rice, pH, soil, organic manuring

INTRODUCTION

The use of inorganic amendments like gypsum, phosphogypsum, iron pyrites or elemental S for the reclamation of sodic soils has been in vogue for the past several years. Continuous use of inorganic fertilizers, pesticides and fungicides cause environmental pollution thereby affecting the soil fertility on a long-term basis. For maintaining optimum productivity of the land and building up of soil fertility, the use of organic manures needs no emphasis. Due to non-availability of organic manures like farm manures, green and green leaf manures in sufficient quantities, the recycling of organic wastes and industrial by-products plays a vital role in improving soil fertility. Considering the importance of organic additives in sustainable agriculture, the sugar industry byproducts like pressmud and distillery spentwash that are rich in organic and inorganic nutrients can serve as suitable raw materials for the production of organic manure viz., biocompost. Preparation of biocompost based on the principles of solid-state fermentation ensures complete abatement of pollution through zero discharge. The present investigation was conducted to study the effect of biocompost on fertility status of the soil and yield of rice crop.

MATERIALS AND METHODS

Field experiments were conducted during August-December 2002 and January-April 2003 to study the effect of incorporation of biocompost on lowland rice. The experimental soil was clayey loam with pH 9.3, EC 0.82 d Sm^{-1} and 218, 14 and 315 kg of available N, P and K ha^{-1}, respectively. The experiments were carried out in Randomized Block Design with four treatments viz., M_1-Control, M_2-FYM at the rate of 12.5 t ha^{-1}, M_3-GLM at the rate of 6.25 t ha^{-1} and M_4-Biocompost at the rate of 3 t ha^{-1}. Each treatment was replicated four times. Rice varieties Co 43 and IR 50 were used as test crops in 2002 and 2003, respectively.

The different sources of organic manures were incorporated in the respective plots and allowed for decomposition keeping 1 cm of water column 15 days before planting of rice seedlings. The recommended fertilizer schedule of 150:50:50 kg N, P_2O_5, K_2O ha^{-1} and 120 : 38 : 38 kg N, P_2O_5, K_2O ha^{-1} were kept constant for all the treatments for the long and short duration varieties, respectively. The characteristics of biocompost used in this study is presented in Table 1. Soil samples drawn

Table 1: Characteristics of organic manure (biocompost)

Parameters	Values (%)
Moisture	30
Total organic mater	40-45
Organic carbon	23-26
Total nitrogen	1.7-2.5
Total phosphorus	1.0-1.5
Calcium (Ca)	2.0-4.0
Magnesium (Mg)	1.5-2.0
Sulphur (as SO_4)	2.0-3.0
Iron	0.1-0.5
Zinc	50-100 ppm
Manganese	150-500 ppm
Copper	30-50 ppm
Boron	3-5 ppm
C : N ration	Between 10:1 and 20:1
pH	7.0-8.0

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from each plot after harvest were analyzed for available N, P and K by using standard procedures[1]. Microbial assay was done adopting plate dilution technique[2]. Yield attributes of rice crop viz., panicles m^{-2}, filled grains $panicle^{-1}$, 1000 grain weight were recorded for the corresponding treatments. The yield of grain and straw were recorded individually from the net harvested area and the results were expressed on dry weight basis in kg ha^{-1}.

RESULTS AND DISCUSSION

Biocompost application at the rate of 3 t ha^{-1} recorded the highest values of soil available N of 230.20 and 215.10 kg ha^{-1}, available P of 27.35 and 22.01 kg ha^{-1} and available K of 335.25 and 315.65 kg ha^{-1} in 2002 and 2003, respectively (Table 2). Biocompost as an organic manure contain plant nutrients which are released into soil solution upon its decomposition. By virtue of its higher N analysis, biocompost contributes a higher quantity of N supplement thus increasing the available N content of the soil. The increase in available P status was due to appreciable P content of biocompost and also due to the solubilisation effect of organic acids on insoluble form of phosphates. Potassium was supplied directly in large quantities by the compost thus enhancing the availability of K in soil[3]. The overall improvement in soil physical, chemical and biological environment through biocompost application had favoured the release of more nutrients from the native forms of the soil thus increasing the soil fertility status.

The population of bacteria, fungi and actinomycetes observed at maximum tillering stage of rice are presented in Table 3. The dominant microbial species found in the rice rhizosphere is chemoheterotrophs[4] and the addition of organic manures influenced these species of microbes thus contributing to an increase in microbial population over the control. Among the different sources of organic manures, biocompost application at the rate of 3 t ha^{-1} recorded the maximum bacteria, fungi and actinomycetes population of 21.62 and 21.75 x10^5, 4.35 and 4.46×10^4 and 3.47 and 3.62×10^4 g^{-1} of ovan dry soil in 2002 and 2003, respectively. Traces of reducing and non reducing sugars left in the spentwash and pressmud might have served as ready energy source for the growth and multiplication of microbes. The bacterial population was influenced to a greater extent than the fungi and actinomycetes.

All the treatments were found to significantly influence the yield attributes and yield over control in both the seasons. Biocompost at the rate of 3 t ha^{-1} (M_4) recorded the highest number of panicles m^{-2} (307.9 and 266.0 in 2002 and 2003, respectively), filled grains $panicle^{-1}$ (145.4 and 132.6) and maximum 1000 grain weight (24.9 and 23.0 g) in 2002 and 2003, respectively. Application of biocompost at the rate of 3 t ha^{-1} recorded the maximum grain yield of 5.30 and 5.15 t ha^{-1} in 2002 and 2003, respectively (Table 4). The grain yield of rice was increased by nearly 30% over control in both the seasons. Biocompost application resulted in increased mineralization of nitrogen by virtue of lower C : N ratio (12:1). During aerobic digestion a considerable amount of protein nitrogen must have been mineralized to ammoniacal form thus increasing the N uptake. This could have been the reason for significant increase in the yield attributes and yield of rice crop.

The pressmud based organic manure is rich in plant growth stimulants and enriched with beneficial microflora. These characteristics along with higher nutrient content, lower C : N ratio and well decomposed nature of biocompost contributed its superiority in rice grain yield compared to other sources. Similar results were also reported with bio-digested pressmud application in ADT 36 rice crop[5].

The results of the field experiments conducted during 2002-2003 indicated that among the different organic manures used, application of biocompost at the rate of 3 t ha^{-1} enhanced available nutrient contents and microbial population of the soil thus increasing the overall

Table 2: Effect of different organic sources on soil available N, P and K (kg ha^{-1})

Treatments/ Manures	Available N (kg ha^{-1})		Available P (kg ha^{-1})		Available K (kg ha^{-1})	
	2002	2003	2002	2003	2002	2003
M_1	181.50	170.25	18.50	16.63	295.60	277.50
M_2	210.65	193.00	24.60	20.80	321.80	293.65
M_3	215.00	210.60	24.15	21.15	315.00	295.00
M_4	230.20	215.10	27.35	22.00	335.25	315.65
CD (5%)	7.56	10.18	0.40	1.66	3.45	4.58

Table 3: Microbial population (g^{-1} of over dry soil) as influenced by organic manures

Treatments /Manures	Bacteria (10^5)		Fungi (10^4)		Actinomycetes (10^5)	
	2002	2003	2002	2003	2002	2003
M_1	16.70	16.15	1.50	1.45	1.90	1.75
M_2	20.15	19.89	3.66	3.50	2.84	2.58
M_3	19.75	19.50	3.10	3.21	2.63	2.50
M_4	21.62	21.75	4.35	4.46	3.47	3.62
CD (5%)	0.28	0.24	0.26	0.28	0.20	0.15

Table 4: Yield attributes of rice crop as influenced by various organic sources

Treatments /Manures	Panicles m^{-2}		Filled grains $panicle^{-1}$		1000 grain weight (g)		Grain yield t ha^{-1}	
	2002	2003	2002	2003	2002	2003	2002	2003
M_1	220.5	231.0	124.0	105.8	24.50	20.0	3.90	3.70
M_2	262.4	225.8	135.0	118.6	24.60	22.0	4.30	4.00
M_3	275.0	240.4	139.6	120.0	24.70	22.0	4.65	4.40
M_4	307.9	266.0	145.4	132.6	24.90	23.0	5.30	5.15
CD (5%)	0.52	0.68	0.32	0.14	0.28	0.33	0.29	0.26

soil fertility status. Under improved soil conditions, this treatment registered the highest values for yield attributes viz., number of panicles m^{-2}, number of filled grains $panicle^{-1}$, 1000 grain weight and grain yield. Thus the nutrient rich biocompost can be effectively introduced as an ecofriendly component in the integrated nutrient management systems to enhance the soil fertility status and achieve sustainability in crop production.

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