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Microbial Population and Enzymatic Activity as Influenced by Organic Farming

S. Krishnakumar, A. Saravanan, S.K. Natarajan, V. Veerabadran and S. Mani

Water technology centre, Tamil Nadu agricultural university,
Coimbatore – 641 003, Tamil Nadu, India.

Abstract: The effect of organic farming with various sources of organic manures and their combinations on soil biological fertility the experiment was conducted during July to October 2003. The recommended dose of NPK fertilizer was 90: 40: 40 kg ha^{-1} and recommended dose of 90 kg N ha^{-1} substituted through organics viz., FYM, *Sesbania rostrata*, composted coirpith alone and in combination with neem cake and Azolla. The microbial population viz., bacteria, fungi and actinomycetes conspicuously increased with application of different organic N sources compared to the control. Among the organic N sources, application of FYM + neem cake registered maximum population of bacteria (38.6 CFU g^{-1}), fungi (15.2 CFU g^{-1}) and actinomycetes (12.2 CFU g^{-1}). Higher urease and dehydrogenase activities were observed with the application of FYM + neem cake. The value in*Kharif* 0.65, 6.1and *Rabi* was 0.76, 6.4 respectively whereas the phosphatase activity was more in FYM + neem cake + Azolla during *Kharif* was 7.4 and *Rabi* season it was 7.7 over control treatment.

Key words: Organic manures, Microbial populations, Enzymatic activity

INTRODUCTION

Soil is an eco system with complex biochemical reactions going on continuously. Several enzymes in soil catalyse these biochemical reactions, which are responsible for nutrient cycling in soils. Organic farming is an eco-friendly system of farming which can maintain the soil health in terms of soil biological fertility and productivity besides producing quality produce which can fetch high price in the market. The favourable effect of various components of organic farming over conventional farming or integrated nutrient management practice is to be considered holistically rather than looking for short term benefits. Most studies describe the effect of inorganics alone or combination of one organic source and inorganic fertilizer under various rates of substitution usually not exceeding 50 per cent of inorganic nutrient level. But studies on exclusive use of organic sources in combinations of different organic source in various proportions are very few. The effect of complete exclusion of inorganic nutrient sources in rice nutrition needs to be studied in depth to make meaningful recommendation for organic farming.

MATERIALS AND METHODS

The experiments were laid out in randomized block design (RBD) with fourteen treatments, comprising twelve treatment combinations of organic manures, one treatment with recommended dose of chemical fertilizer and other one was absolute control which were replicated three times. The recommended dose of NPK fertilizer was 90: 40: 40 kg ha^{-1} for *Kharif* rice. The recommended dose of 90 kg N ha^{-1} was substituted through organics viz., FYM, *Sesbania rostrata*, composted coirpith alone and in combination with neem cake and Azolla. The soil analyzed for pH (7.9), EC (0.4 dSm^{-1}), coarse sand, fine sand, silt and clay (27.25, 40.70, 10.50 and 21.15 per cent) respectively and bulk density 1.24 Mgm^{-3}. It had water holding capacity of 38.4 percent, organic carbon 0.59 percent, available nitrogen, phosphorus and potassium 285, 15 and 380 kg ha^{-1} respectively and available Zn, Cu, Mn and Fe 1.46, 1.25, 19.5 and 10.5 ppm respectively and CEC of 20.1 C mol (p^{+}) kg ha^{-1}. The soil samples collected during the different growth stages (active tillering, panicle initiation and post harvest stages) rice crop were analysed for biological properties of soil.

RESULTS AND DISCUSSIONS

Microbial Populations:

A. Bacteria population: Among all the treatments, FYM + NC (T_6) showed significantly higher bacteria population (38.6 CFU g^{-1}) than absolute control treatment (15.9 CFU g^{-1}) followed by SR + NC treatment (37.8 CFU g^{-1}) was given in Table 1. The recommended NPK fertilizer

Corresponding author: S. Krishnakumar, Water technology centre, Tamil Nadu agricultural university, Coimbatore – 641 003, Tamil Nadu, India.

Table 1: Bacterial population (CFU g^{-1}) of rice grown soil

Treatments (T)	Active tillering (S_1)	Panicle initiation (S_2)	Post harvest (S_3)	Mean
T_1 Control	7.0	15.7	25.0	15.9
T_2 Rec. NPK fertilizer	6.7	19.3	26.7	17.6
T_3 FYM	9.0	37.7	47.0	31.2
T_4 SR	11.3	41.7	52.7	35.2
T_5 CCP	10.3	40.0	50.0	33.4
T_6 FYM + NC	14.3	44.7	56.7	38.6
T_7 FYM + NC + Azolla	10.3	40.7	51.0	34.0
T_8 SR + NC	16.7	42.7	54.0	37.8
T_9 SR + NC + Azolla	11.0	41.7	51.7	34.8
T_{10} CCP + NC	12.0	41.0	53.0	35.3
T_{11} CCP + NC + Azolla	12.3	42.0	52.7	35.7
T_{12} FYM + Azolla	10.3	39.3	48.3	32.6
T_{13} SR + Azolla	11.0	40.7	51.7	34.5
T_{14} CCP + Azolla	9.0	39.3	50.0	32.8
Mean	10.8	37.6	47.9	-

FYM -Farmyard manure; SR - *Sesbania rostrata*; CCP - Composted coirpith;
NC - Neem cake

	SEd	CD (p = 0.05)
T	6.0	12.0
S	2.8	5.6
T × S	10.5	NS

Table 2: Fungi population (CFU g^{-1}) of rice grown soil

Treatments (T)	Active tillering (S_1)	Panicle initiation (S_2)	Post harvest (S_3)	Mean
T_1 Control	3.7	7.0	8.7	6.5
T_2 Rec. NPK fertilizer	4.0	7.7	11.0	7.6
T_3 FYM	5.7	9.0	11.3	8.7
T_4 SR	8.0	10.3	12.3	10.2
T_5 CCP	7.3	10.7	14.3	10.8
T_6 FYM + NC	12.0	16.0	17.7	15.2
T_7 FYM + NC + Azolla	10.3	8.7	11.0	10.0
T_8 SR + NC	12.0	12.0	12.3	12.1
T_9 SR + NC + Azolla	10.7	14.0	15.0	13.2
T_{10} CCP + NC	11.0	13.0	13.7	12.6
T_{11} CCP + NC + Azolla	9.0	12.0	15.0	12.0
T_{12} FYM + Azolla	10.0	13.0	16.0	13.0
T_{13} SR + Azolla	11.3	15.3	17.0	14.5
T_{14} CCP + Azolla	9.3	12.0	14.7	12.0
Mean	8.9	11.5	13.6	-

FYM -Farmyard manure; SR - *Sesbania rostrata*; CCP - Composted coirpith;
NC - Neem cake

	SEd	CD (p = 0.05)
T	1.24	2.5
S	0.57	1.1
T × S	2.15	NS

treatment (T_2) showed significantly lower value (17.6 CFU g^{-1}) than all other organic manure treatments, but significantly higher than control treatment (15.9 CFU g^{-1}).Among different plant growth stages post harvest (S_3) soil sample registered higher value (47.9 CFU g^{-1}) than panicle initiation stage (37.6 CFU g^{-1}). S_3 and S_2 on par with each other, but significantly higher than active tillering stage (10.8 CFU g^{-1}).

B. Fungi population: Among all the treatments, FYM + NC (T_6) registered higher fungi population (15.2 CFU g^{-1}) than absolute control (6.5 CFU g^{-1}) treatment (Table 2). The per cent increase over control was 133 followed by SR + Azolla (14.5 CFU g^{-1}) and SR + NC + Azolla (13.2 CFU g^{-1}) treatment. But T_6, T_9 and T_{13} treatments were on par with each other.

Among different plant growth stages, post harvest (S_3) stage soil sample registered significantly higher value (13.6 CFU g^{-1}) than panicle initiation stage (11.5 CFU g^{-1}) and active tillering stage (8.9 CFU g^{-1}). But S_2 was significantly higher to S_1 stage. The treatment NPK fertilizer treatment (T_2) registered significantly lower fungal population (7.6 CFU g^{-1}) than all other organic manure treatments except T_3. But it was on par with each other.

C. Actinomycetes population: Among the treatments, T_6 treatment (FYM + NC) registered significantly higher

Table 3: Actinomycetes population (CFU g^{-1}) of rice grown soil

Treatments (T)	Active tillering (S_1)	Panicle initiation (S_2)	Post harvest (S_3)	Mean
T_1 Control	1.7	4.7	6.7	4.4
T_2 Rec. NPK fertilizer	3.0	5.7	9.0	5.9
T_3 FYM	5.0	7.0	11.0	7.7
T_4 SR	5.3	8.3	12.7	8.8
T_5 CCP	4.3	8.0	12.3	8.2
T_6 FYM + NC	8.0	11.7	17.0	12.2
T_7 FYM + NC + Azolla	6.0	9.0	12.7	9.2
T_8 SR + NC	7.0	10.0	14.0	10.3
T_9 SR + NC + Azolla	5.3	8.3	12.3	8.6
T_{10} CCP + NC	6.7	6.7	11.0	8.1
T_{11} CCP + NC + Azolla	4.0	9.0	11.7	8.2
T_{12} FYM + Azolla	7.7	11.0	16.0	11.6
T_{13} SR + Azolla	7.0	9.3	16.3	10.9
T_{14} CCP + Azolla	5.0	7.0	13.0	8.3
Mean	5.4	8.3	12.6	-

FYM -Farmyard manure; SR - *Sesbania rostrata*; CCP - Composted coirpith;
NC - Neem cake

	SEd	CD (p = 0.05)
T	1.26	2.5
S	0.58	1.2
T × S	2.17	NS

Table 4. Soil Enzyme activity - *Kharif'* 04

Treatments	Urease[1]	Dehydrogenase[2]	Phosphatase[3]
T_1 Control	0.25	1.8	3.5
T_2 Rec. NPK fertilizer	0.26	2.3	3.9
T_3 FYM	0.30	3.3	4.3
T_4 SR	0.35	3.1	4.7
T_5 CCP	0.30	3.1	4.3
T_6 FYM + NC	0.65	6.1	6.3
T_7 FYM + NC + Azolla	0.45	4.9	7.4
T_8 SR + NC	0.55	5.4	6.3
T_9 SR + NC + Azolla	0.42	4.5	7.3
T_{10} CCP + NC	0.46	5.2	5.9
T_{11} CCP + NC + Azolla	0.35	4.3	6.5
T_{12} FYM + Azolla	0.40	4.0	5.5
T_{13} SR + Azolla	0.42	3.6	5.6
T_{14} CCP + Azolla	0.35	3.4	5.4
Mean	0.39	3.9	5.5
Sed	0.02	0.5	0.2
CD (p = 0.05)	0.04	1.0	0.4

FYM -Farmyard manure; SR - *Sesbania rostrata*; CCP - Composted coirpith;
NC - Neem cake
1. Urease – (mg NH_4^+ formed g^{-1} of soil h^{-1})
2. Dehydrogenase – (g of TPF released g^{-1} of soil h^{-1})
3. Phosphatase - (g of p-nitrophenol released g^{-1} h^{-1})

value (12.2 CFU g^{-1}) than absolute control (4.4 CFU g^{-1}) treatment followed by T_8, T_{12} and T_{13} treatments (Table 3). But all were on par with each other.

The recommended NPK fertilizer treatment (T_2) registered significantly lower number of actionomycetes (5.9 CFU g^{-1}) than organic manure treatments except T_3, T_5, T_{10} and T_{14} treatments. Among different plant growth stages, post harvest stage (S_3) had significantly higher actionomycetes (12.6 CFU g^{-1}) than panicle initiation stage (8.3 CFU g^{-1}) and active tillering stage (5.4 CFU g^{-1}). But S_2 was significantly higher to S_1 stage.

In the present study, the treatment FYM + NC had significantly more influence on the population of bacteria, fungi and actinomycetes than other organic manure treatments and recommended NPK fertilizer treatment in *Kharif'* 2004. The attributed reason could be the enhanced organic carbon content of the soil as a result of organic manure application as compared to inorganic fertilizers. Besides this, the organic manure addition viz., FYM + NC would have resulted in increased secondary and micronutrients in the soil which might have helped to increase the microbial population. Chicken manure used in organic farming treatment enhanced the bacteria and fungal population greater than conventional farming[1]. The soil microbial activity was always higher in organic plots than conventional plots[2]. Application of FYM to the soil stimulated actinomycetes and bacteria. Combined use of organic manures improved the microbial load of the soil rather than single organic manure application[3].

The microbial population viz., bacteria, fungi and actinomycetes conspicuously increased with application of different organic N sources than the control. Among the organic N sources, application of FYM + neem cake registered maximum population of bacteria, fungi and actinomycetes. The soil microbes continue to increase with the advancement of crop growth.

Enzymatic Activity:

A. Urease activity (mg NH_4^+ formed g^{-1} of soil h^{-1}): Among all the treatments, T_6 (FYM + NC) showed significantly higher urease activity (0.65) than all other organic manure treatments and absolute control (T_1) treatment (0.25) was given in table 4. The recommended NPK fertilizer (T_2) treatment showed significantly lower urease activity (0.26) than other organic treatments.

B. Dehydrogenase activity (g of TPF released g^{-1} of soil h^{-1}): Among all the treatments FYM + NC (T_6) showed higher dehydrogenase activity (6.1) than absolute control (T_1) treatment (1.8) followed by T_{10}, T_8 and T_7. But all were on par (table 4). The recommended NPK fertilizer (T_2) treatment have significantly lower value (2.3) than all other organic manure treatments except T_3, T_{14}, T_3, T_4 and T_5 treatments.

C. Phosphatase activity (g of p-nitrophenol released g^{-1} h^{-1}): Among all the treatments, T_7 (FYM + NC + Azolla) showed higher phosphatase activity (7.4) than absolute control (3.9) and other treatments and on par with SR + NC + Azolla (7.3) was given in table 4. The recommended NPK fertilizer (T_2) treatment showed significantly lower phosphatase activity than all other organic manure treatments except T_5 treatment.

The application of FYM + NC @ 90 kg N ha^{-1} showed highest urease, dehydrogenase activity in *Kharif*'04 season. The phosphatase activity was higher in the treatment receiving FYM +NC + Azolla *Kharif*'04. This might be due to higher organic manure application which would have favoured more microbial populations ultimately more enzyme activity. Similar strong relationship between organic manure and enzyme activities[4, 5 & 6]. The major contributors of soil enzyme pool are mainly microorganisms. In addition to soil microorganisms, soil microflora, plants roots and plant residues undergoing varying degree of decay also contribute to this pool. Soil enzyme originate from soil microorganisms[7] and soil enzyme help soil organisms in their efforts to satisfy their nutritional needs and in their function of degrading and humifying added organic material, mainly originating from plant polymers present in soil[8]. Combined use of organic manures improved the enzyme activity of the soil rather than single organic manure application.

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