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Organic Farming: Impact on Rice (*Oryza sativa* L.) Productivity and Soil Health

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Abstract: Investigations were carried out to study the effect of organic farming with various sources of organic manures and their combinations on the soil physical properties, nutrient availability and biological properties during July 2003 to October 2004. The recommended dose of NPK fertilizer was 90: 40: 40 kg ha^{-1} for Kharif and Rabi rice (ADT 36). 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. Application of FYM+NC at the rate of 90 kg N ha^{-1} showed significantly reduced bulk density and increased hydraulic conductivity, water holding capacity and percent pore space during Kharif' 04 and Rabi' 04. The biological properties like bacteria, fungi and actinomycetes also higher in the same treatment. FYM+NC (T_6) gave significantly higher grain yield (5675 kg ha^{-1} during Kharif and in Rabi was 5175 kg ha^{-1}. Higher straw yield (6520 kg ha^{-1}) in Kharif and in Rabi was 6020 kg ha^{-1} in the same treatment.

Key words: Physical, biological properties, grain, straw yield

INTRODUCTION

Organic farming, which is responsible for material circulation in agricultural ecosystem and enhanced crop production with a minimal environmental load with keeping ecological balance, contains the general meaning of the holistic production and management system for enhancing health of agricultural ecosystem[1]. Continuous use of inorganic fertilizers, lead to accumulation of injurious heavy metal ions, polluting the soil with precipitates of hydroxides, carbonates, sulphides and sulphates. These necessitate organic amendments to soil for environmental safety and soil health. The organic farming was more beneficial for the improvement of soil properties and green manure was more effective considering in two points of view i.e. maintenance of crop yield and enhancement of soil properties[2]. Investigations were carried out to study the effect of organic farming with various sources of organic manures (FYM, Sesbania and their combinations on soil fertility, yield and quality of ADT 36 rice (*Oryza sativa* L.) during July 2003 to October 2004.

MATERIALS AND METHODS

The experimental field soil comes under Anaiyur soil series (Entic Haplustert). The soil analyzed for pH (7.9), EC (0.4 dS m^{-1}), coarse sand, fine sand, silt and clay (27.25, 40.70, 10.50 and 21.15%), respectively and bulk density 1.24 Mg m^{-3}. It had water holding capacity of 38.4%, organic carbon 0.59%, 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 experiments were laid out in Randomized Completely Block Design with fourteen treatments, comprising twelve treatment combinations of organic manures Farmyard manure ((T_3), *Sesbania rostrata* ((T_4), Composted coirpith ((T_5), FYM+NC (T_6), FYM+NC+Azolla (T_7), SR+NC (T_8), SR+NC+Azolla (T_9), CCP+NC (T_{10}), CCP+NC+Azolla (T_{11}), FYM+Azolla (T_{12}), SR+Azolla (T_{13}) and CCP+Azolla (T_{14}) one treatment with recommended dose of chemical fertilizer (T_2) and other one was absolute control (T_1) which were replicated three times. The recommended dose of NPK fertilizer was 90: 40: 40 kg ha^{-1} for Kharif and Rabi rice. The recommended dose of 90 kg N ha^{-1} was substituted through organics viz., FYM, *S. rostrata*, composted coirpith alone and in combination with neem cake and Azolla.

RESULTS AND DISCUSSION

Application of FYM+NC at the rate of 90 kg N ha^{-1} (T_6) showed significantly reduced bulk density and

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Table 1a: Physical properties of soil-Kharif'04

Treatments	Bulk density (Mg m^{-3})	Hydraulic conductivity (cm h^{-1})	Water holding capacity (%)	Pore space (%)
T_1	1.40	4.40	38.40	52.70
T_2	1.40	4.50	38.30	52.70
T_3	1.30	5.40	45.70	55.30
T_4	1.36	5.10	45.00	55.80
T_5	1.32	5.20	45.20	55.90
T_6	1.24	6.30	51.20	56.90
T_7	1.36	5.10	44.80	54.60
T_8	1.27	5.80	47.50	56.80
T_9	1.29	4.70	42.70	54.40
T_{10}	1.27	6.10	47.10	56.30
T_{11}	1.32	4.90	42.80	54.90
T_{12}	1.32	4.90	39.50	53.30
T_{13}	1.30	4.70	39.00	53.40
T_{14}	1.30	4.70	39.40	53.40
Mean	1.32	5.13	43.33	54.74
SED	0.01	0.01	0.65	0.24
CD (p = 0.05)	0.02	0.02	1.30	0.50

FYM : Farmyard manure, SR : *Sesbania rostrata*,
CCP : Composted coirpith, NC : Neem cake

Table 1b: Physical properties of soil-Rabi'04

Treatments	Bulk density (Mg m^{-3})	Hydraulic conductivity (cm h^{-1})	Water holding capacity (%)	Pore space (%)
T_1	1.400	4.40	38.400	52.70
T_2	1.400	4.60	38.200	52.80
T_3	1.290	5.60	45.800	55.50
T_4	1.320	5.20	45.200	55.80
T_5	1.300	5.40	45.500	56.10
T_6	1.220	6.60	51.400	57.00
T_7	1.320	5.40	45.100	54.80
T_8	1.240	6.30	47.600	56.90
T_9	1.270	4.90	43.300	54.60
T_{10}	1.260	6.40	48.000	56.90
T_{11}	1.300	5.10	43.200	55.00
T_{12}	1.290	5.20	40.000	53.40
T_{13}	1.290	4.80	39.500	53.60
T_{14}	1.270	4.90	39.800	53.70
Mean	1.300	5.30	5.340	54.91
SEd	0.008	0.11	0.008	0.25
CD (p = 0.05)	0.020	0.20	0.020	0.50

increased hydraulic conductivity, water holding capacity and percent pore space during Kharif'04 and Rabi'04 (Table 1a and 1b).

FYM+NC (T_6) treatment showed significantly lower bulk density value (1.24 Mg m^{-3}) during Kharif and during Rabi it was 1.22 Mg m^{-3} than all other treatments. The bulk density in the treatment that received FYM @ 12.5 t ha^{-1} was significantly lower than that which received green manure or urban compost at the rate of 12.5 t ha^{-1}[3]. The beneficial effect of FYM as was observed in the present study[4,5].

FYM+NC (T_6) showed significantly higher hydraulic conductivity (6.3 cm h^{-1}) than other treatments and also absolute control treatment (4.4 cm h^{-1}). The percent increase over control was 43 in Kharif. FYM+NC (T_6) gave significantly higher value (6.6 cm h^{-1}) than absolute control (4.4 cm h^{-1}) treatment in Rabi. The increase over control was 50 in Rabi, but on par with CCP+NC (6.4 cm h^{-1}) treatment.

Table 2: Bacteria, fungi and actinomycetes population (CFU g^{-1}) of rice soil

Treatments (T)	Bacteria		Fungi		Actinomycetes	
	Kharif'05	Rabi'05	Kharif'05	Rabi'05	Kharif'05	Rabi'05
T_1	15.9	18.30	6.50	8.80	4.40	6.70
T_2	17.6	20.80	7.60	10.50	5.90	8.10
T_3	31.2	33.70	8.70	12.80	7.70	10.70
T_4	35.2	36.90	10.20	16.50	8.80	13.60
T_5	33.4	36.60	10.80	12.80	8.20	10.40
T_6	38.6	43.00	15.20	19.80	12.20	17.00
T_7	34.0	36.40	10.00	14.70	9.20	12.90
T_8	37.8	40.90	12.10	17.40	10.30	12.50
T_9	34.8	37.50	13.20	16.60	8.60	10.80
T_{10}	35.3	38.00	12.60	14.70	8.10	11.80
T_{11}	35.7	38.00	12.00	14.60	8.20	12.50
T_{12}	32.6	34.80	13.00	16.30	11.60	14.30
T_{13}	34.5	37.50	14.50	14.30	10.90	14.20
T_{14}	32.8	35.20	12.00	13.30	8.30	12.70
Mean	32.1	34.80	11.30	14.50	8.70	12.00
SEd	10.5	10.00	2.15	2.69	2.17	2.36
CD (p = 0.05)	NS	NS	NS	NS	NS	NS

FYM+NC (T_6) treatment registered higher water holding capacity value (51.2%) than absolute control treatments (38.4%) and also other treatments in Kharif. FYM+NC treatment showed significantly higher water holding capacity (51.4%) than absolute control (T_1) treatment (38.4%) but on par with CCP+NC (48.0%) in Rabi.

Among the treatments T_6 (FYM+NC) having significantly higher value of pore space (56.9%) than absolute control treatment (52.7%) in Kharif. The percent increase over control was 8. But T_6 was on par with SR+NC (56.8%) treatment. Among all the treatments FYM+NC (T_6) in Rabi, registered higher pore space value (57.0%) than absolute control treatment (52.7%). The percent increase other control was 8, but T_6 was on par with T_8 and T_{10} treatments.

Application of Azolla decreased the bulk density and improved other physical parameters like HC, WHC and pore space[6,7]. The organic residues that are added to the soil undergo microbial decomposition and in this process, various organic products of decay like polysaccharides are released which act as strong binding agents in the formation of large and stable aggregates[8] which helps to improve the physical properties of the soil. Application of coirpith reduced the BD, increased the HC and WHC as observed in the study[9,10]. Combined use of organic manures improved the physical properties of the soil rather than single organic manure application. The recommended NPK fertilizer treatment showed higher bulk density and reduced hydraulic conductivity, water holding capacity and pore space. This is quite expected with the application of inorganic fertilizer alone.

FYM+NC (T_6) showed significantly higher bacteria population (38.6 CFU g^{-1}) in Kharif and in Rabi it was 43.0 CFU g^{-1} (Table 2). The higher fungi population of 15.2 CFU g^{-1} in Kharif and 19.8 CFU g^{-1} in Rabi was noted in the same treatment. FYM+NC) registered

Table 3: Grain and straw yield (kg ha^{-1})-Kharif'04

	Grain yield		Straw yield	
Treatments	Kharif'05	Rabi'05	Kharif'05	Rabi'05
T_1	2997	2507	3215	2715
T_2	4995	4494	5900	5400
T_3	4520	4006	5010	4510
T_4	4016	3524	5515	5015
T_5	4002	3500	5720	5220
T_6	5675	5175	6520	6020
T_7	4620	4118	4900	4400
T_8	4327	3822	5710	5210
T_9	4130	3622	5720	5220
T_{10}	5300	4797	6200	5700
T_{11}	4116	3620	5820	5320
T_{12}	4711	4209	5130	4630
T_{13}	4121	3612	5710	5210
T_{14}	4226	3722	5930	5430
Mean	4411	3909	5500	5000
SED	106	106	129	129
CD (p = 0.05)	218	218	265	265

significantly higher value (12.2 CFU g^{-1}) in Kharif and in Rabi was 17.0 CFU g^{-1} (Table 2). 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[11].

FYM+NC (T_6) gave significantly higher grain yield (5675 kg ha^{-1} during Kharif and in Rabi was 5175 kg ha^{-1} (Table 3). Higher straw yield (6520 kg ha^{-1}) in Kharif and in Rabi was 6020 kg ha^{-1} in the same treatment (Table 3). Under submerged conditions mineralization of organic nitrogen was more than that under aerobic conditions indicating less immobilization under anaerobic conditions[12]. FYM was often superior to inorganic fertilizer as it exerts dual benefits on improving the physical environment of soil and also supply the plant nutrients, which might have contributed to the increased nutrient uptake and ultimately the higher grain yield[13]. The superiority of FYM is due to the release of aliphatic and aromatic hydroxyl acids, humates and lignin[14]. FYM worked as soil conditioner and supplying plant nutrients which resulted in improvement in grain yield[15].

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