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Effect of Organic Farming on Quality of Soil under Rice Cultivation

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Abstract—*Organic farming is one of desired methods of sustainable agriculture production due to its crucial role in ecological protection. The demand for organically grown foods is increasing globally and organic rice finds a special mention. The combined input of agricultural residues, composted manures and N-specific bio-fertilizers (N-fixers) can be exploited to meet the nutritional needs of organically grown rice. With the hypothesis that whether the input of organic matter through vermicompost (VC) and farm yard manure (FYM) improves the properties of paddy grown soil and rice grain yield or not, a field experiment was conducted during 2010 and 2011 following a split plot design. Three fertilization practices included organic farming (OF), integrated nutrient management (INM) and chemical fertilization (CF). After two years of rice cultivation, organic matter content of paddy grown soil recorded a value of 4.8 %, significantly higher than the valuesin INM and CF soil. Plant available water content and water retention capacity showed increased values in OF soil, compared with CF soil. The rice grain yield was found to be highest (4.72 t/ha) under OF practices (cyanobacteria +Azolla+ VC + FYM) followed by INM (VC+1/2 recommended dose of N, P, K) and CF ($N_{120}P_{60}K_{60}$) practices (4.36 t/ha). Economical statistics showed that though, organically produced basmati rice grain yield was higher compared with their INM and CF counterparts, but organic farming practice is beneficial when the produce is sold at a premium price of 25 %. Integrated farming practices were more beneficial and could save up to 50 % of synthetic fertilizer without compromising with the yield.Key words: CF, INM, organic fertilization, paddy*

1. INTRODUCTION

The soils of tropical region are most affected due to intensive cultivation and are under consistent threat of low soil fertility (Sharma et al. 2005). Being an important regulator of numerous environmental constraints, organic matter has direct relation to crop productivity. A global shift towards sustainable agriculture production systems that has low reliance on chemical fertilizer needs to be adopted. Exploitation of natural resources in the form of farm and animal waste, decomposed organic matter and crop specific microbial inoculants may replenish the soil by returning its lost share of organic matter and reverse the process of yield stagnation. The modern farming practices such as crop rotation and organic amendments positively affect the soil fertility parameters, thereby influencing the soil productivity (Gaind and Lata, 2010, Jha et al. 2012).

Rice being a staple crop is widely consumed by Indian community. Its production needs to be increased by another 40 % to provide food security to the growing population by 2030. Being a high nutrient consumption crop, its fertilizer requirements are also very high and add a financial constraint to marginal farmers. Strategies need to be adopted to enhance the use of natural and existing resources that can substitute chemical fertilizers. In order to improve soil organic carbon content and crop productivity using agricultural wastes, the present investigation was undertaken by combining FYM +Vermicompost + cyanobacteria + Azolla for organic fertilization and comparing it with INM and NPK at the recommended dose to select the best fertilization practices for sustainable rice cultivation. The effect of three fertilization practices was evaluated on selected chemical properties (pH, EC), soil organic matter, organic carbon status, water retention capacity and crop yield for two consecutive years The study will help in selecting the most suitable and economical fertilization practices for soil quality and carbon sequestration with sustainable rice cultivation.

2. METHODOLOGY

.The experiment started in 2010 was laid out in a split plot design on the soil that was under rice- wheat crop rotation using organic farming practices since 2003. The three nutrient regimes included (i) Organic fertilizer- farm yard manure at 5000 kg ha^{-1}+ vermicompost at 5000 kg ha^{-1}+ Azolla at 1000 kg ha^{-1} + Cyanobacteria at 1.5 kg ha^{-1}during summer for rice cultivation. (ii) INM- integration of chemical fertilizers N_{60} P_{30} K_{30} and vermicompost at 5000 kg ha^{-1} (iii) CF- recommended dose of chemical fertilizers- N_{120} P_{60} $K_{60.}$ All the treatments were replicated thrice. Nitrogen applied as urea was added in two split doses. Half the dose of chemical nitrogen (60 kg N ha^{-1}) was applied as a basal dose at transplanting and other at tillering stage. Phosphorus and potassium were applied as superphosphate and muriate of potash. The rice var. Pusa 1401 was sown at recommended seed rate. The control plots received no experimental

treatments. The experiment was repeated in 2011 with the same treatments. Harvesting of rice crop was done during October of each growing season.

Soil sampling and analysis

Finely ground and sieved soil samples drawn at 0-15cm were oven dried prior to estimation of soil organic matter. Soil organic matter was estimated by calculating the loss in weight after burning the above sample in a muffle furnace at 550^{o}C for 4 h. Total soil organic carbon (TOC) was determined by dividing the organic matter by 1.724. Soil pH and electrical conductivity (EC) was measured using digital pH meter and TDS scanner with soil water ratio of 1:5 and bulk density was also measured. The samples drawn at 0-15cm and 15-30cm were used for estimation of water holding capacity and plant available water capacity. The biomass and grain yield were recorded after harvest of the crop. All the determinations were performed in triplicate and results were expressed on dry weight basis.

3. RESULTS AND DISCUSSION

The silt loam calcareous soil of experimental field had an initial pH- 8.7, EC- 0.46 dS m^{-2}, soil organic carbon- 0.68 %, Total Kjeldahl's nitrogen (TKN) - 0.05 %, available P-17.58 kg ha^{-1}, available K-256 kg ha^{-1}, available Fe-11.7 mg g^{-1}. Organic matter content of soil showed an improvement of 70 % in OF soil compared to CF soil at the end of two years. The values for CF, INM and OF treatments ranged from 2.8-4.8 %. Application of VC and FYM, Azolla and Cyanobacteria used as bio-fertilizer for two consecutive years added the organic matter to soil and resulted in elevated values (Fig. 1). The trend was similar for soil organic carbon. The OF and INM treated soils had significantly higher content of organic carbon while CF treatment recorded the lowest value (Fig. 2). Though, the test soil has been under cultivation for the last so many years but the organically fertilized soil was receiving organic matter in the form of VC and FYM since 2003, therefore had much higher content of total carbon respectively compared to CF treatments

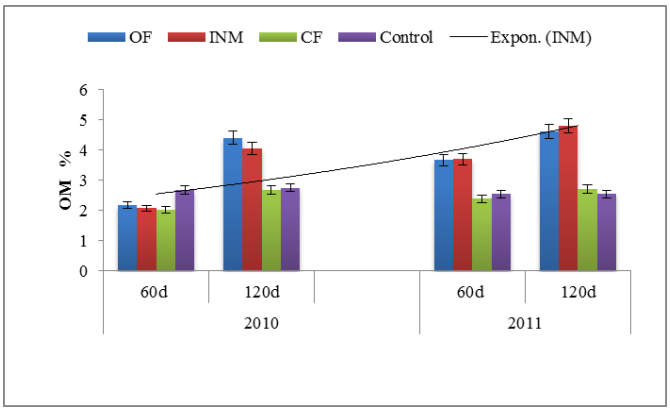

Fig. 1: Organic matter content of paddy grown soil

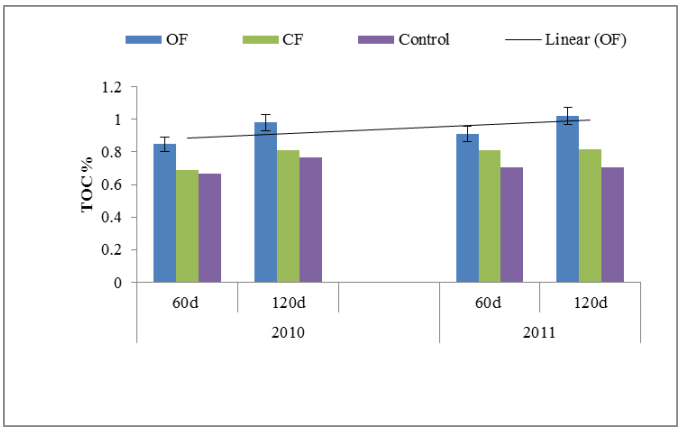

Fig. 2: Organic carbon content of paddy soil

OF- organic fertilization, INM- integrated nutrient management, CF- recommended dose of chemical fertilizer

Water holding capacity (WHC) and plant available water capacity (PAWC) improved with organic amendments that added carbon in soil. Effect was more pronounced at 0-15 cm compared to 15-30 cm depth (Table 1).

Table 1: WHC and PAWC of paddy soil at two depths

Treatments	WHC (%) 0-15cm	WHC (%) 15-30 cm	PAWC volumetric water content) 0-15cm	PAWC 15-30cm
OF	69	69	0.18	0.15
INM	63	62	0.18	0.15
CF	58	57	0.16	0.17

Amendment of soil with different fertilizer for prolonged period reduced the soil pH from its initial value of 8.72 to 7.6 and also affected the electrical conductivity values (Table 2). Carbon input did not show any significant difference in bulk density because most of the soil had been under cultivation since long.

Table 2: Physico-chemical properties of paddy grown soil

Treatments	pH	EC	Bulk density (g cm^{-3})
OF	8.23	0.20	1.20
INM	8.20	0.27	1.24
CF	8.26	0.17	1.28

The data on grain yield of rice crops for 2010 and 2011 is given in Fig.3. Grain yield of rice was at par in both OF and INM practices. These results indicate that combined application of NPK at half their recommended dose and VC at 5000 kg ha^{-1} sustain higher yield under rice in alkaline soils of IARI farm.

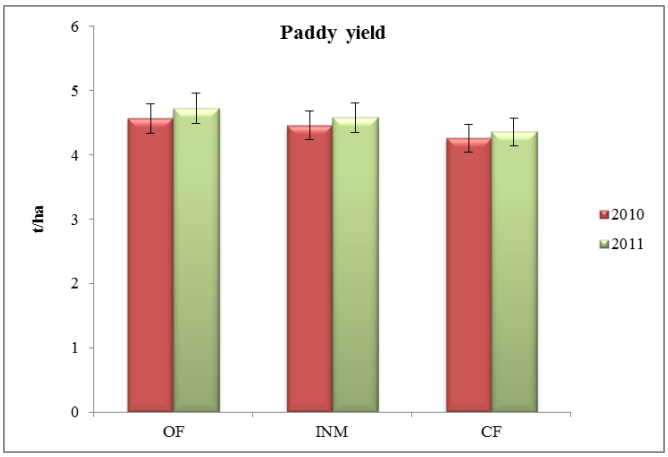

Fig. 3: Paddy yield under different fertilization practices

The economics calculated for rice crops showed that INM fertilization is more economical. As the cost of cultivation is more in organic farming, this practice is beneficial when the produce is sold at a premium price of 20-25 %. Due to its better quality, the net return improves in the long run.

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