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Effect of different sources of organic matter on the yield of rice and soil health in red and lateritic zone of West Bengal, India

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Abstract: Field experiment was conducted to study effect of different sources of organic matter on the yield of rice and soil at Rice Research Station, Bankura, West Bengal, India during *kharif* season of 2009, 2010 and 2011. Average of three years data revealed that inclusion of vermi-compost in the fertilizers schedule of rice cultivation [variety: Swarna (MTU 7029)] increased the grain yield (30.26%) as well as straw yield (32.70%). However higher pH was observed in treatments receiving paddy straw application and organic carbon (%) was also higher in the respective plots where vermi-compost and paddy straw was applied. Regarding available P_2O_5, there was an increasing trend up to 13-20 kg ha^{-1} in vermi-compost and green manure applied plots. In case of available K_2O, there was a decrease value in all treatments were observed. So there was a positive balance of P and negative balance of K .

Keywords: Chemical fertilizers, Physico-chemical properties, Organic matter, Rice, Red and lateritic zone

INTRODUCTION

In India, during the past three decades intensive agriculture involving high yielding varieties of rice has lead to heaving withdraw of nutrients from the soil. Further more, imbalance use of chemical fertilizers by farmers has deteriorated soil health and declines soil organic carbon content, which is the threat to sustainability. Therefore, it is time to look for measures to stimulate sustainability in production of rice on long term basis (Mandal and Adhikary, 2005).Organic Manures like farm yard manure, green manure, vermi-compost and rice straw are improve the soil health and yield of rice. Songmuang *et al.* (1989) reported that an application of Farm Yard Manure (FYM) @ 3.1t ha^{-1} gave similar rice yields as a chemical fertilizer application @ 18.7, 6.5 and 6 kg ha^{-1} of N, P and K. However, farmers usually have access to relatively small amount of FYM. At the best FYM can be used to improve the soil fertility of a small area of the farm with little impact on overall rice production.

The application of green manure in transplanted rice field to improved the soil physico-chemical properties and water holding capacity. *Sesbania rostrata* and *Aeschynomene afraspera* two nitrogen fixing legumes, appear to be suitable sources of organic matter in north-east paddy fields [Ragland *et al.*(1986)]. Herrera *et al.* (1989). *Sesbania rostrata* has resulted in long-term improvement in soil fertility in general, and soil organic matter in particular. The application of vermi-compost in paddy field improves the physical, chemical and biological properties of soil. There is a good evidence that vermi-compost promotes growth of plants and it has been found to have a favourable influence on all yield parameters of crops like wheat, rice, sugarcane and vegetables (Ismail, 1997 and Ansari, 2007).

Long-term straw incorporation has improved soil fertility and productivity of the area. Increase in rice yield of up to 30% to application up to 25 t ha^{-1} of rice straw has been observed (Naklang and Rojanakusol, 1992). The main objective of this study was to investigate both the changes of soil physico-chemical properties and crop productivity of both organic and inorganically managed transplanted paddy soil and thereafter to manage soil fertility status in a proper way for long term rice cultivation using organic with inorganic fertilizers. Previously several early (Mallick *et al.,* 2013a) and late (Mallick *et al.,* 2013b) rice genotypes have been screened for red and lateritic areas of West Bengal. Jana and Mallick (2012) studied on best management practices for highest realizable yields in transplanted rice under red and lateritic zones of West Bengal. Not only had the influence of temperature on yield of rice also studied in red and lateritic areas of West Bengal (Jana *et al.,* 2013).However, less work has been done to investigate the effect of different sources of organic matter on grain yield in rice and soil health status in red and lateritic zones of West Bengal. So on the basis of this fact this study was conducted.

MATERIALS AND METHODS

This field experiment on 'Effect of different source of organic matter on yield of rice and soil health in red and lateritic zone of West Bengal, India' was conducted at Rice Research Station, Bankura, West Bengal, India during *kharif* season of 2009, 2010 and 2011. Objectives

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were to study the effect of supplied organic matter on yield, nutrient uptake and physico-chemical properties of soil. This field experiment was laid out in randomised block design (RBD) with four Replications on sandy loam soil in acidic in nature. The status of organic carbon (%), available P_2O_5 and available K_2O are medium. There were six different treatments: T_1- No organic matter (Control plot), T_2 - FYM (@ 5 t ha^{-1}), T_3 -Vermicompost (@ 2.5 t ha^{-1}), T_4 - Green manure (@ 5 t ha^{-1}) incorporation (*Dhaincha* applied externally) at 20 days before planting (DBP), T_5 - Paddy straw (@ 5 t ha^{-1}) incorporation (applied externally) at 20 DBP and T_6 - Paddy straw (@ 5 t ha^{-1}) incorporation (applied externally) along with 25% of recommended dose of N (Urea) [Remaining 75% N applied as usual] at 20 DBP. Rice variety was Swarna (MTU-7029). Observed the yield data and statistical analysis was done. Regarding physico-chemical analysis, to determine the soil physical and chemical properties, the soil sample were collected before and after the experiment from soil depth of 15cm.The recommended fertilizers dose N, P_2O, K_2O @ 80, 40, 40 were applied through urea and 10:26:26, respectively. 1/3 of recommended dose of N, full P_2O_5 and K_2O were applied as basal and rest amount of N was applied in two equal split doses at tillering and panicle initiation stages, respectively. The plot size was 5m ×5m. Spacing was 20 cm ×15 cm. The physic-chemical properties of the experimental soil were as follows: pH- 4.9, EC- 0.12 dsm^{-1}, organic carbon-0.59 (%), available P_2O_5- 35 kg/ha and available K_2O- 289 kg/ ha.

RESULTS AND DISCUSSION

The experimental results revealed that the highest rice grain yield (4.95 t ha^{-1}) and straw yield (5.64 t ha^{-1}) was obtained from the treatment T_3, where vermi-compost was applied @ 2.5 t ha^{-1} followed by rice straw application along with urea as booster dose (T_6). It was differs significantly with control plot (T_1). The lowest grain yield (3.80 t ha^{-1}) was recorded from the treatment T_1 (no organic matter) and it was significantly lower than other treatments of this experiment (Table 1). Average of three years data also revealed that inclusion of vermi-compost in the fertilizers schedule of rice cultivation [variety: Swarna (MTU 7029)] increased the grain yield (30.26%) as well as straw yield (32.70%) (Table1). Ansari (2007) reported that application of vermicompost improved the yield attributes of rice and this results was confirmed the findings of Ansari. Treatment T_6 where, paddy straw (@ 5 t ha^{-1}) incorporation (applied externally) along with 25% of recommended dose of N (Urea) [Remaining 75% N applied as usual] at 20 DBP was done and it also increased the grain yield (24.47%) and straw yield (28.70%). Similar results were reported by Naklang and Rojanakusol (1992) and they reported that rice straw management improved the moisture status of soil and suppress the weed growth as well as increased the grain yield of rice. Regarding post harvest soil analysis (Table 2), the pH was observed in lower value after three years of experimentation in the plots, where paddy straw was applied. In case of available P_2O_5, there was an increasing value in T_6, where paddy Straw (@ 5t ha^{-1}) incorporation (applied extremely) along with 25% recommended dose of N (as urea) at 20 DBP. Regarding organic carbon (%), there was an increasing trend and higher value was obtained in the plots, where vermicompost and straw was applied. In case of available P_2O_5, there is an increasing trend upto 13-20 kg ha^{-1} after three years of the experimentation were observed in the treatments T_3 and T_4, respectively. Mandal and Adhikary (2005) also found that grain yield of rice was significantly higher with the treatment receiving 50% N through chemical fertilizer and 50% N through FYM and application of organic matter improved the rice soil health status and obtained similar findings. On the other hand in case of available K_2O, there is decreasing value in all the treatments were observed. So, there was a positive

Table1. Yield of rice influenced by the integrated use of organic matter and inorganic fertilizers.

Treatments	*Kharif* 2009		*Kharif* 2010		*Kharif* 2011		Average of 3years			
	Grain Yield (t ha^{-1})	Straw Yield (t ha^{-1})	Grain Yield (t ha^{-1})	Straw Yield (t ha^{-1})	Grain Yield (t ha^{-1})	Straw Yield (t ha^{-1})	Grain Yield (t ha^{-1})	%Yield advance over check	Straw Yield (t ha^{-1})	%Yield advance over check
T_1	3.75	4.04	3.81	4.12	3.85	4.60	3.80	-----	4.25	-----
T_2	4.37	4.60	4.43	4.63	4.52	5.92	4.44	16.84	5.05	18.58
T_3	**4.89**	**5.06**	**4.93**	**5.22**	**5.03**	**6.65**	**4.95**	**30.26**	**5.64**	**32.70**
T_4	4.35	4.56	4.41	4.57	4.55	5.72	4.43	16.57	4.65	09.41
T_5	4.25	4.77	4.32	4.78	4.43	5.88	4.33	13.94	5.14	20.94
T_6	4.72	4.98	4.71	5.07	4.75	6.37	4.73	24.47	5.47	28.70
S. Em(±)	0.285	0.268	0.27	0.12	0.43	0.56	----	-----	----	----
C.V.(%)	10.74	9.57	12.0	11.32	1.29	1.71	----	-----	----	----
C.D. (5%)	0.861	0.807	0.806	0.80	19.05	19.42	----	-----	----	----

T_1- No organic matter (Control plot), T_2 - FYM (@ 5 t ha^{-1}), T_3-Vermicompost (@ 2.5 t ha^{-1}), T_4 - Green manure (@ 5 t ha^{-1}) incorporation (*Dhaincha* applied externally) at 20 days before planting (DBP), T_5 - Paddy straw (@ 5 t ha^{-1}) incorporation (applied externally) at 20 DBP and T_6 - Paddy straw (@ 5 t ha^{-1}) incorporation (applied externally) along with 25% of recommended dose of N (Urea) [Remaining 75% N applied as usual] at 20 DBP.

Table 2. Post harvest soil status influenced by integrated use of organic matter and inorganic fertilizers.

Treatments	2009					2010					2011				
	pH	EC (dsm^{-1})	O/C (%)	available P_2O_5	available K_2O	pH	EC (dsm^{-1})	O/C (%)	avail-able P_2O_5	available K_2O	pH	EC (dsm^{-1})	O/C (%)	avail-able P_2O_5	available K_2O
T_1	4.6	0.09	0.53	39.0	215.0	4.6	0.11	0.60	41.0	201.0	4.8	0.19	0.59	44.0	191.0
T_2	4.7	0.11	0.56	41.0	224.0	4.8	0.09	0.65	46.0	222.0	4.9	0.15	0.70	49.0	193.0
T_3	4.5	0.11	0.60	45.0	252.0	4.7	0.11	0.64	48.0	225.0	4.8	0.14	0.70	51.0	183.0
T_4	4.7	0.12	0.58	45.0	243.0	4.8	0.12	0.61	49.0	231.0	4.9	0.12	0.68	55.0	186.0
T_5	4.9	0.12	0.65	38.0	223.0	5.0	0.13	0.62	42.0	206.0	5.1	0.15	0.67	41.0	196.0
T_6	4.5	0.11	0.67	36.0	245.0	4.8	0.15	0.60	44.0	215.0	5.1	0.22	0.74	48.0	190.0

T_1- No organic matter (Control plot), T_2 - FYM (@ 5 t ha^{-1}), T_3-Vermicompost (@ 2.5 t ha^{-1}), T_4 - Green manure (@ 5 t ha^{-1}) incorporation (*Dhaincha* applied externally) at 20 days before planting (DBP), T_5 - Paddy straw (@ 5 t ha^{-1}) incorporation (applied externally) at 20 DBP and T_6 - Paddy straw (@ 5 t ha^{-1}) incorporation (applied externally) along with 25% of recommended dose of N (Urea) [Remaining 75% N applied as usual] at 20 DBP

balance of Pand negative balances of K were found after three years of experimentation.

Conclusion

From the present study, it may be concluded that the integrated use of FYM, vermi-compost, green manure, paddy straw and other inorganic fertilizer significantly increased the grain and straw yield of rice. From organic matter point of view, use of vermi-compost, paddy straw along with N application (as urea) and FYM was very effective to increase the grain yield of rice with side by side soil fertility status, *i.e.* improved the physical, chemical and biological characteristics of soil.

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