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Impact of different organic manures in enhancing the growth and productivity of rice (*Oryza sativa*) under coastal saline tract of West Bengal

R. KUNDU, K. BRAHMACHARI AND S. KARMAKAR[1]

Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya
Mohanpur -741 252, Nadia, West Bengal.
[1]National Institute of Technology, Durgapur - 731 209, West Bengal.

ABSTRACT

An experiment was conducted during 2007 and 2008 following Randomized Block Design (RBD) with 9 different nutritional treatments each replicated thrice, to evaluate the growth, productivity and economics of growing rice under such management practices. The growth parameters, yield components and seed yield of rice were maximum when organic manure was applied along with inorganic fertilizer at 75% of the recommended dose (RDF). The effect of well decomposed fishmeal (WDFM) was as good as farm yard manure (FYM) vis-a-vis vermicompost and sometimes it showed better result over FYM and vermicompost.

Key words: Coastal saline tract, FYM, nutrient management, vermicompost, WDFM

Application of inorganic fertilizers even in balanced amount can not sustain the soil fertility and crop productivity under diversified continuous cropping or mono-cropping and as a result agriculture is now facing a lot of stresses. Integrated nutrient management involving conjunctive use of organic and inorganic sources of nutrients may improve the soil productivity (Patra *et al.*, 2000), and system productivity becomes sustainable (Raju and Reddy, 2000), rather to say, the soil-water-plant-animal-human continuum is maintained, i.e. the agriculture can thus be conserved to a large extent. It is fact that in the village cowdung is becoming scarce day-by-day. A large part of the available amount of it is used for preparing cowdung cakes for fuel purpose. So, emphasis should be given to use alternative sources (specifically different for different areas) for organic manures. In the coastal saline zone of West Bengal, farmers are habituated in applying raw fishmeal in the vegetables and some other crops, but it causes problems of disease and insect occurrence. Preparation of well-decomposed fishmeal (WDFM) from dried fish, easily and amply available at low cost in this zone and application can increases the yield of crops (Pal *et. al.*, 2010) without causing any pest problem and improves soil fertility simultaneously. In this context, with a broader objective of utilizing the different organic resources for substituting the chemical fertilizer partly, and augmenting the soil health for sustainability in agricultural production this study was undertaken.

MATERIALS AND METHODS

The experiment was carried out at Regional Research Station, Bidhan Chandra Krishi Viswavidyalaya during rainy season (*kharif*) of 2007 and 2008 under coastal saline soil of Kakdwip (Latitude-21^{0}90$'$N, longitude-88^{0}10$'$E and altitude-5.5m), 24 Parganas (South), West Bengal. The experimental soil is silty clay loam in texture having pH 7.8, BD 1.48 gm.cm^{-3}, EC 1.78 dsm^{-1}, organic carbon 0.56%, total nitrogen 1187 kg ha^{-1}, available phosphorus 26.70 kg ha^{-1} and available potassium 174.52 kg ha^{-1} respectively. The experimental site was subtropical humid climate with an average rainfall ranging between 1365 mm and 2250 mm and means maximum, minimum temperature of 22 to 37^{0}c respectively. The experiment was laid out in Randomized Block Design (RBD) with 9 different nutritional treatments each replicated thrice. The different nutritional treatments of rice were T_1-100% Recommended Dose of Fertilizer (RDF); T_2-75% RDF; T_3-50% RDF; T_4-75% RDF +10 t farm yard manure (FYM) ha^{-1}; T_5-50% RDF +10 t FYM ha^{-1}; T_6-75% RDF +2 t well decomposed fishmeal (WDFM) ha^{-1}; T_7-50% RDF +2 t WDFM ha^{-1}; T_8-75% RDF +5 t vermicompost ha^{-1}; and T_9-50% RDF +5 t vermicompost ha^{-1}. FYM, WDFM and vermicompost were used for assessing the impact of different organic sources of nutrient, as cowdung is becoming scarce day by day, so, vermicompost and WDFM may be used in lieu of FYM if they show better or same result over or as good as FYM. Moreover, dry fish is a locally available low-cost input of this zone.

Email: rajibagro2007@gmail.com

The experiment was conducted during monsoon season of two consecutive years in the same piece of land without any change in the layout. The rice crop (cv. *Shatabdi* i.e. IET-4786), was transplanted in the end of July in both the years with recommended dose of fertilizers (60,30,30 kg NPK ha^{-1} Reddy, 2004). The sources of NPK were urea, SSP and MOP. Organic manure like FYM, WDFM (Dried fish, amply available in this zone, but erratically used in raw condition causing various insect and diseases problems in crops, was decomposed properly in "heap method" Sahai, 2004) and vermicompost were incorporated into the soil at the time of final land preparation. Well decomposed fishmeal contained 6.73% N, 4.51% P_2O_5 and 1.33% K_2O whereas FYM contained 0.47% N, 0.29% P_2O_5 and 0.71% K_2O and vermicompost 1.37% N, 0.45% P_2O_5 and 1.09% K_2O. Total nitrogen, available phosphorus and available potassium were estimated by modified Macro- Kjeldahl's method, Olsen's method and flame photometric method respectively (Jackson, 1967). The growth parameters like leaf area index (LAI), dry matter accumulation (DMA), crop growth rate (CGR) were studied at 30, 60 and 90 days after transplanting (DAT) and plant height and number of tillers m^{-2} were studied at the time of harvest. Crop growth rate, defined as the increase in dry weight of plant material $unit^{-1}$ area of land $unit^{-1}$ change of time (Watson, 1947), was calculated with the following formula:

$$CGR = \frac{W_2 - W_1}{t_2 - t_1} \text{ g m}^{-2} \text{ day}^{-1}$$

Where, W_1 = initial dry matter weight $unit^{-1}$ area, W_2 = Final dry matter weight $unit^{-1}$ area and $(t_1 - t_2)$ = time interval. Analysis of variance method (Gomez and Gomez, 1976) was used for statistical analysis. The significance of different sources of variation was tested by error mean square with the help of Fisher's 'F' test at probability level of 0.05. For comparison of 'F' value and computation of critical different (CD) at 5% level of significance, Fisher and Yates, table were consulted. The costs of cultivation of rice under different treatments were taken into consideration. The variable costs included the cost of fertilizers, manures depending upon the particulars of treatments. The total cost of cultivation, thus, consisted of the cost of cultivation plus cost of fertilizers. Profit was calculated by deducting total cost of cultivation from total product value. The net production value (NPV) was, thus, calculated by dividing net profit with total cost of cultivation.

RESULTS AND DISCUSSION

Growth parameters

The pooled data in the table-1 depicts that the growth parameter of rice *i.e.,* leaf area index (LAI), drymatter accumulation (DMA), crop growth rate (CGR), plant height and number of tillers m^{-2} differed significantly with different nutritional management treatments at different stages. The maximum LAI (2.82, 5.41 and 1.12 at 30, 60 and 90 days after transplanting respectively) were recorded when the rice crop was fertilized with 75% RDF along with 2 t WDFM ha^{-1} (T_6) which was statistically at par with T_4 and T_8 at 30 DAT, and at par with T_1 and T_8 at 90 DAT. The significantly lowest value of LAI (2.04, 3.51 and 0.53 at 30, 60 and 90 DAT respectively) was obtained under the treatment where the rice crop was fertilized with only 50% RDF (T_3). At all the stages, the highest value of dry matter accumulation (DMA) was observed in the treatment T_6 (75% RDF+2 t WDFM ha^{-1}) which has no significant difference with T_8 and the lowest DMA was recorded in the treatment T_3 (50% RDF). In case of CGR (crop growth rate), the maximum value (13.01 and 6.88 g m^{-2} day^{-1}) was found in the treatment T_6 and it was closely followed by the treatment T_8 (75% RDF+5 t vermicompost ha^{-1}). The maximum plant height (92.7 cm) was recorded in treatment T_1 (100% RDF) and the significantly highest number of tillers m^{-2} (327.1 m^{-2}) was obtained in the crop receiving 75% RDF along with 2 t WDFM ha^{-1} (T_6) where as the treatment T_3 showed the significantly lowest value of CGR, plant height and number of tillers m^{-2} (8.36 and 3.85 g m^{-2} day^{-1}, 76.8 cm and 262.9 m^{-2} respectively). Similar result also reported Brahmachari *et al.*, (2010).

Yield components

The yield components of rice i.e., number of panicle m^{-2}, number of filled grains $panicle^{-1}$ and percentage of filled grain varied significantly with the variation in nutritional management treatments (Table 2). The maximum number of panicles m^{-2} (309.1 m^{-2}) was recorded in the T_6 and it was statistically at par with treatment T_8. Conjunctive use of chemical fertilizer along with organic manure in general showed higher number of panicles m^{-2} as compared to use of inorganic fertilizer alone to the crop. This result is an agreement with the findings of Pal *et al.,* (2003). The highest value of filled grains $panicle^{-1}$ (82.7) was obtained from T_6 and it has no significant difference with the treatment T_8. The percentage of grain filling was maximum (76.7%) under the treatment T_6 and it was statistically at par with T_8 and T_4. The treatment, received only 50% RDF (T_3) produced the significantly lowest value of number of panicles m^{-2}, filled grains $panicle^{-1}$ and percentage of grain filling (243.0 m^{-2}, 67.1 and 64.5% respectively) among the all treatments. The 1000 grain weight of rice did not differ significantly with different nutritional management treatment.

Table: 1. Effect of different nutritional treatments on growth parameters of rice (pooled of two years)

Treatments	LAI			DMA			CGR		Plant height (cm)	No. of tillers m^{-2}
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30-60 DAT	60-90 DAT		
T_1	2.63	5.13	1.07	188.9	521.9	689.5	11.10	5.59	92.7	309.7
T_2	2.31	4.22	0.75	173.1	477.1	598.7	10.13	4.05	82.0	279.5
T_3	2.04	3.51	0.53	141.0	391.7	507.1	8.36	3.85	76.8	262.9
T_4	2.77	4.69	0.99	195.8	545.0	729.5	11.64	6.15	86.9	310.4
T_5	2.61	4.15	0.81	182.6	472.0	651.8	9.65	5.99	82.3	290.3
T_6	2.82	5.41	1.12	201.0	591.2	797.7	13.01	6.88	89.6	327.1
T_7	2.68	4.87	0.97	195.7	503.7	699.4	10.27	6.52	84.5	302.2
T_8	2.77	5.18	1.08	197.5	577.8	779.7	12.68	6.73	88.9	313.5
T_9	2.62	4.53	0.96	183.8	497.1	693.8	10.44	6.56	84.3	297.7
SEm(±)	**0.039**	**0.065**	**0.029**	**3.06**	**12.57**	**14.87**	**0.121**	**0.063**	**0.96**	**4.13**
LSD (0.05)	**0.111**	**0.185**	**0.082**	**8.70**	**35.75**	**42.29**	**0.344**	**0.173**	**2.73**	**11.75**

Note: *1) LAI- Leaf Area Index (%), DMA- Dry Matter Accumulation (g m^{-2}), CGR- Crop Growth Rate (g m^{-2} day^{-1}), DAT- Days After Transplanting*

2) Treatment: T_1-100% Recommended Dose of Fertilizer (RDF) of NPK; T_2-75% RDF; T_3-50% RDF; T_4-75% RDF +10 t farm yard manure (FYM) ha^{-1}; T_5-50% RDF +10 t FYM ha^{-1}; T_6-75% RDF +2 t well decomposed fishmeal (WDFM) ha^{-1}; T_7-50% RDF +2 t WDFM ha^{-1}; T_8-75% RDF +5 t vermicompost ha^{-1}; and T_9-50% RDF +5 t vermicompost ha^{-1}.

Yield

Maximum grain yield (3541 kg ha^{-1}) of rice was recorded in the treatment T_6 where rice crop was fertilized with 75% RDF along with 2 t WDFM ha^{-1} and it has no significant difference with the treatment T_8 whereas significantly lowest grain yield of rice (2481 kg ha^{-1}) was found from the treatment T_3 (50% RDF) among all the treatments (Table 2). This result is in agreement with the findings of Patil *et al.,* (2000). They opined that application of 1, 2 and 3 t fishmeal ha^{-1} increased the grain yield of rice by 0.75, 1.86 and 2.93 t ha^{-1} respectively over no application of fishmeal. The maximum straw yield (4619 kg ha^{-1}) was obtained when the crop was fertilized with 75% RDF along with 10 t FYM ha^{-1} (T_4) and this treatment was closely followed by the treatment T_6 and T_8. Significantly lowest straw yield (3508 kg ha^{-1}) was found under the treatment T_3. Similar result was found by Pal *et al.,* (2005). Harvest index of rice was maximum (43.77 %) where crop received with 75% RDF along with 2 t WDFM ha^{-1} (T_6) followed by the treatment T_8 and T_4. Maximum and minimum percentage of yield increased over 100% RDF was found from the treatment T_6 (10.31 %) and T_3 (-28.01 %) among all the treatments. This result is in agreement with the findings of Brahmachari *et al.,* (2009).

Net production values (NPV)

From table-2 it may be concluded that the maximum net production value (1.39) was obtained where the rice crop received 75% RDF along with 2 t WDFM ha^{-1} (T_6) and it was closely followed by that (1.36 and 1.31) recorded in the treatment T_8 (75% RDF along with 5 t vermicompost ha^{-1} and 75% of RDF along with 10 t FYM respectively). Among all the treatments, T_3 (50% RDF) showed the minimum net production value (0.81). Application of fishmeal at 2 t ha^{-1} along with 75% RDF showed the best result (Pal and Brahmachari., 2005) and Pal *et. al.,* (2010).

Thus, it may be concluded that utilization of some organic resources of the coastal saline zone for partial substitution of chemical fertilizers not only offers the higher crop yields but also sustains agricultural production *vis-à-vis* recycling of different organic matter or waste. The growth parameters, yield components and yield of crop were maximum when organic manure was applied along with inorganic fertilizer at 75% of the recommended dose. The effect of well decomposed fishmeal was as good as farm yard manure (FYM) vis-a-vis vermicompost and sometimes it showed better result over FYM and vermicompost. This may be due to the fact that all of these organic manures supply the major plant nutrients along with various micronutrients to the crop. Above that a improve soil physical characteristic as a whole. But as the WDFM was prepared from the dried fish, is a locally available low-cost input, so, its use will be more beneficial from the point of view of both crop yield and economics.

Table: 2. Effect of different nutritional treatments yield components and yield of rice (pooled of two years).

Treatments	Yield components				Yield		Harvest index (%)	Increase in yield % over 100% RDF	Net Production Value (NPV)
	No. of panicles m^{-2}	No. of filled grains $panicle^{-1}$	% filled grain $panicle^{-1}$	1000 grain weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})			
T_1	285.6	77.8	72.9	21.18	3146	4339	42.26	---	1.14
T_2	261.7	72.3	68.0	20.56	2938	4267	40.78	-8.10	1.03
T_3	243.0	67.1	64.5	19.67	2481	3508	41.43	-28.01	0.81
T_4	289.1	80.3	74.2	20.34	3382	4619	42.27	6.09	1.31
T_5	277.5	74.4	68.9	20.61	3149	4449	41.45	-0.86	1.17
T_6	309.1	82.7	76.7	21.27	3541	4549	43.77	10.31	1.39
T_7	281.8	76.1	71.0	21.36	3238	4411	42.33	1.91	1.23
T_8	297.5	82.3	75.8	20.83	3479	4538	43.40	8.71	1.36
T_9	282.9	74.9	71.5	20.47	3181	4319	42.41	0.16	1.21
SEm (±)	**4.12**	**0.65**	**1.17**	**0.618**	**29.8**	**32.7**	**---**	**---**	**---**
LSD (0.05)	**11.72**	**1.85**	**3.33**	**NS**	**84.75**	**93.00**	**---**	**---**	**---**

***Note:** 1) NS- Non Significant, RDF-Recommended Dose of Fertilizer 2) Treatment: T_1-100% Recommended Dose of Fertilizer (RDF) of NPK; T_2-75% RDF; T_3-50% RDF; T_4-75% RDF +10 t farm yard manure (FYM) ha^{-1}; T_5-50% RDF +10 t FYM ha^{-1}; T_6-75% RDF +2 t well decomposed fishmeal (WDFM) ha^{-1}; T_7-50% RDF +2 t WDFM ha^{-1}; T_8-75% RDF +5 t vermicompost ha^{-1}; and T_9-50% RDF +5 t vermicompost ha^{-1}.*

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