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Growth and productivity of lowland rice (*Oryza sativa*) as influenced by substitution of nitrogen fertilizer by organic sources

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ABSTRACT

Field experiment was conducted during *rabi* and *kharif* seasons of 2011 and 2012 at research farm of ICAR–RC for NEH Region, Tripura centre, to assess the competence of different organic sources for substituting the 50% N fertilizer in integrated nutrient management system of rice (*Oryza sativa* L.) production. Data reveals that the substitution of 50% recommended dose of N fertilizer with either FYM@11.2 tonnes/ha or *Glyricidia* leaves @ 11.6 tonnes/ha significantly improved the growth and yield attributes of both *rabi* and *kharif* rice as compared to 100% recommended N fertilizer dose (80 kg N/ha). The maximum values of growth attributes (plant height, tillers/hill and total dry matter accumulation/hill), yield attributes (productive tillers/hill, panicle length, filled grains/panicle and 1 000 grain weight) and grain yields of rice was obtained with 50% recommended N fertilizer dose along with either FYM@11.2 tonnes/ha or *Glyricidia* leaves @ 11.6 tonnes/ha during both the seasons. Therefore, study suggested that the *Glyricidia* leaves has the competence for substituting the 50% recommended dose of N fertilizers and a suitable option for improving the productivity of lowland rice in Tripura region of North-East India.

Key words: FYM, Glyricidia leaf, Grain yield, Panicle length, Productive tillers

Rice (*Oryza sativa* L.) is the chief staple food of the North-Eastern region of India. It accounts more than 80% of the total cultivated area of the region and 7.8% of the total rice area in India, whereas its share in national rice production is meagre. The average productivity of rice in the region is very low (1.6 tonnes/ha) as compared to national average, leading to about 1.77 million tonnes deficit of rice (Tomar and Das 2011). Among the various reasons for low productivity of rice in the region, one finds the role of balance nutrition in plant growth of paramount importance. The importance of adequate supply of plant nutrients for higher yields of rice has long been recognized. Among the nutrients, nitrogen is a crucial nutrient for rice growth; its deficiency is major constraint in rice production. So, proper supply of nitrogen is very much essential for harvesting sustainable yield. Fertilizers particularly N fertilizers are costlier inputs in crop production. Since, the farmers of the region are resource poor, which are unable to buy fertilizers. So there is a need for complete or partial substitution of fertilizers, especially nitrogenous fertilizers by locally available organic sources of nitrogen for sustaining rice production. Organic sources of nitrogen are the best alternatives for NE region, but the availability of the suitable organic nitrogen sources at lower prices is scarce. Integrated approach provides an adequate and efficient use of plant nutrients and proper soil health too. The superiority of integrated nutrient management in enhancing grain yield of rice has been reported by several researchers (Azad and Lehiri 2001, Bastia 2002). The farmers of this region applied low level of manure (5 tonnes/ha) due to non-availability of required quantities. However, the region has huge resources of biomass like weeds, litter, leaves and twigs from pruning and lopping of trees on bunds or around the fields, which are very rich in essential nutrients (Das 2006, Ghosh *et al.* 2010). It can be hypothesized that the uses of proper combination of these organic sources of nitrogen with the inorganic nitrogen fertilizer not only improving the rice productivity but also curtail the environmental problems associated with inorganic nitrogen fertilizers. Recycling of this biomass for replacement of N fertilizer in rice production systems could give a good alternative of conventional organic manure and inorganic fertilizers. Effort is needed to formulate an input package with the combination of these organic sources and inorganic fertilizers, so that it will be technically

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effective, feasible and environmentally acceptable. Therefore, the present study was undertaken to evaluate the effect of replacement of chemical fertilizer by different organic N sources on growth and productivity of low land rice.

MATERIALS AND METHODS

Field experiment was conducted during the *rabi* and *kharif* seasons of 2011 and 2012 at research farm of ICAR Research Complex for NEH Region, Tripura centre, Lembucherra, West Tripura, it is situated at a latitude of $23^0$54'24.02" N and $91^0$18'58.35"E and altitude of 48 m from the above mean sea level. The annual rainfall of Lembucherra is 2000 mm. However, cumulative rainfall during the period of investigation in the year 2011-12 (December-November) was 1980 mm. The soil of the experimental field was sandy clay loam and its initial soil sample had 7.6 g/kg organic C, 112.4 mg/kg available N, 5.3 mg/kg available P and 54.6 mg/kg available K. The pH of soil was 5.1 (soil and water ratio).The experiment was laid out in simple randomized block design (RBD) with five treatments, viz. T_1- control (no manure and fertilizers); T_2- 100% recommended N fertilizer dose (80 kg N/ha); T_3- 50% N through fertilizer + 50% N through FYM; T_4 –50% N through fertilizer + 50% N through *Glyricidia* leaves and T_5 –50% N through fertilizer + 50% N through weed biomass. All the treatments replicated four times during both the seasons. Treatments description and nutrient content in different organic manure are given in Table 1 and 2.Well-decomposed farmyard manure, partially dry *Glyricidia* leaves and weed biomass were applied in rice field as per treatment during final land preparation. The recommended dose of NPK fertilizers (80:18:33 kg/ha) were applied during both the seasons. One third quantity of nitrogen, full amount of phosphorus and potassium is supplied through urea; single superphosphate and muriate of potash, respectively as a basal application before transplanting. Remaining 2/3 quantity of nitrogen was top dressed in two equal splits; one at active tillering stage and second at panicle initiation stage. The amount of P and K supplied through organic manure was adjusted at the time of application. Rice nursery was grown as per recommended agro techniques. Twenty one day- old seedlings of Gomati variety of rice was transplanted in the last week of January for *rabi* rice and second week of July for *kharif* rice with a spacing of 20 cm × 20 cm. Recommended plant protection measure has taken up for the control of insect pest during both seasons. Both *rabi* and *kharif* rice were grown as per recommended package of practices and harvested in second week of June and third week of November, respectively. The observations for growth attributes were recorded at 30, 60, 90 and 120 days after transplanting from the earmarked area of 4 m × 3m in each plot and yield attributes and yield data were recorded at harvest. After harvesting, threshing, cleaning and drying the grain yield was recorded at 14% moisture and expressed in tonnes/ha. All the data obtained from rice for consecutive two seasons were statistically analyzed using the *F*-test as per the procedure given by Gomez and Gomez (1984). LSD values at $P = 0.05$ were used to determine the significance of difference between treatment means.

RESULTS AND DISCUSSION

Growth parameters

Growth attributes like plant height, number of tillers/hill and dry matter accumulation in rice was significantly influenced by the treatments under study during both the seasons (Fig 1). Among the various growth stages, maximum plant height and dry matter accumulation were observed at 120 days after transplanting (DAT). However, higher number of tillers/hill was recorded at 60 DAT and a decreasing trend was noticed thereafter. Similar findings were also reported by Barik *et al*. (2006).The decrease in tiller numbers on aging resulted from death of the last tillers due to their failure to compete for light and nutrients. Increase in plant height and dry matter accumulation were caused by an improvement in tiller numbers and cumulative growth rate of plant. Application of 50% recommended N fertilizer dose along with FYM @11.2 tonnes/ha (T_3) was recorded significantly maximum plant height, number of tillers/hill and dry matter accumulation at all the growth stages of rice (30, 60, 90 and 120 DAT) closely followed by 50% recommended N fertilizer dose along with *Glyricidia* leaves@11.6 tonnes/ha and 100% recommended dose of N fertilizer, respectively during both the seasons.

Similar results were also reported by Karmakar *et al*.

Table 1 Treatments description

Treatment	Organic sources
T_1–Control (no manure and no fertilizer)	Nil
T_2–RDN (Recommended dose of nitrogen)	Nil
T_3–50% N through fertilizer+50% N through FYM	11.2 FYM tonnes/ha
T_4–50% N through fertilizer+50% N through *Glyricidia* leaves	11.6 *Glyricidia* leaf tonnes/ha
T_5–50% N through fertilizer + 50% N through weed biomass	13.4 weed biomass tonnes/ha

Table 2 Nutrient content in different organic sources

Organic sources	Nutrients content (%) on dry weight basis			Moisture (%)
	N	P	K	
FYM	0.52	0.22	0.56	31.5
Glyricidia leaves	1.26	0.31	0.65	72.6
Weed biomass*	0.95	0.25	0.70	68.5

* Mixture of broadleaved and grassy weeds

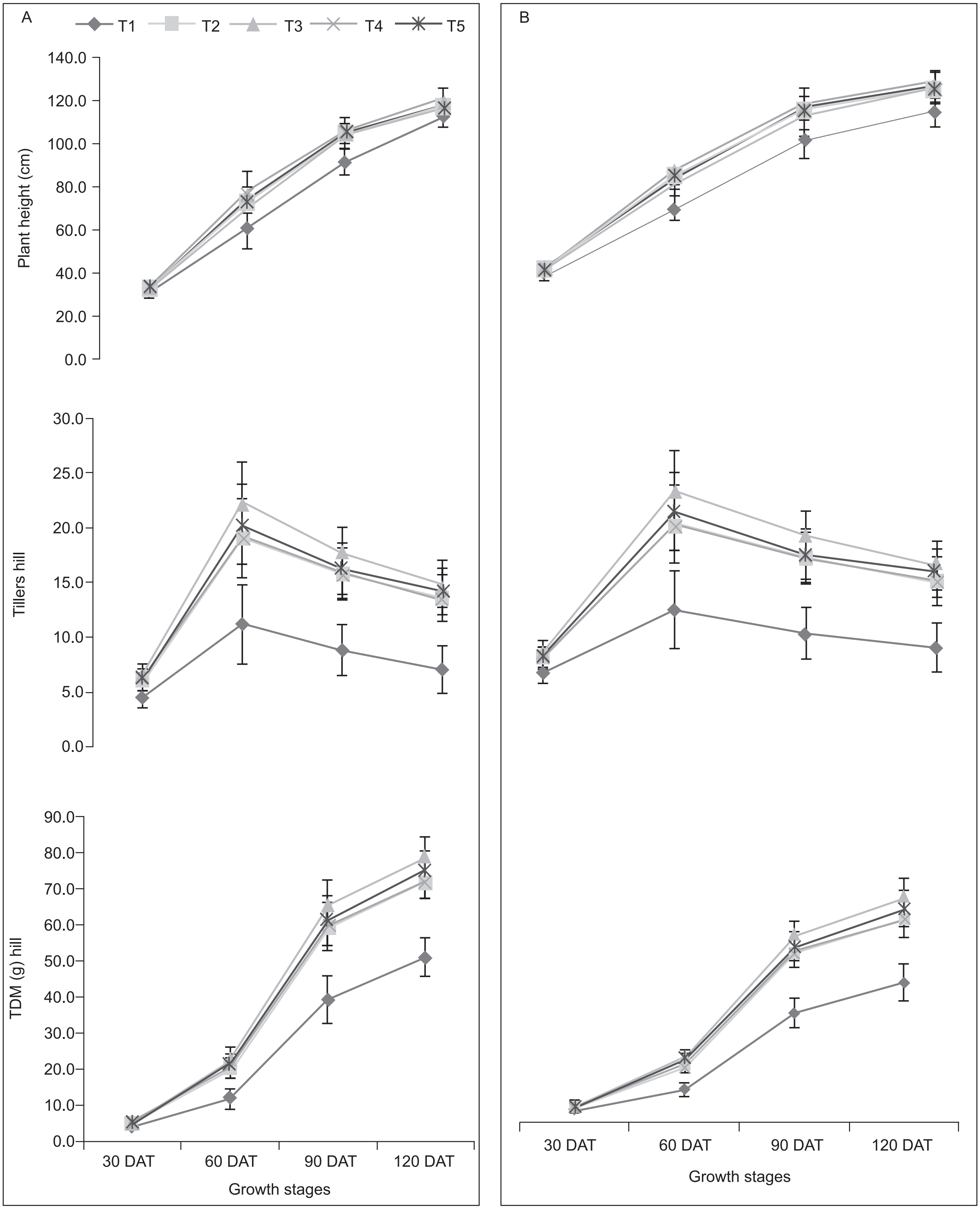

Fig 1 Effect of N fertilizer substitution through organic sources on plant height, tillers/hill and TDM accumulation of *rabi* rice (A) and *kharif* rice (B). The standard error bar indicated the LSD value.

Table 3 Effect of different N sources on yield attributes and grain yields of rice

Treatment	Productive tillers/ hill		Filled grains/ panicle		Panicle length (cm)		1000 grain wt (g)		Grain yield (tonnes/ha)	
	Rabi	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*
T_1	6.1	5.8	112.0	107.5	25.4	24.9	23.72	23.02	3.20	2.78
T_2	10.1	9.8	124.6	117.4	29.4	28.6	24.49	23.74	4.53	4.08
T_3	12.7	12.5	147.5	141.5	31.0	28.9	27.32	26.44	5.05	4.63
T_4	12.2	11.8	146.9	137.0	30.0	28.3	26.01	24.23	4.80	4.20
T_5	10.3	9.5	127.0	117.5	29.8	28.4	25.22	23.75	4.53	4.03
SEm±	0.65	0.64	3.01	5.06	1.11	0.89	0.94	0.91	0.15	0.18
LSD (*P=0.05*)	2.00	1.97	9.26	15.58	3.43	2.75	2.89	2.80	0.47	0.54

T_1-Control (no manure and fertilizers); T_2-100% recommended N fertilizer dose (80 kg N/ha); T_3- 50% N through fertilizer + 50% N through FYM; T_4 – 50% N through fertilizer + 50% N through *Glyricidia* leaves and T_5 – 50% N through fertilizer + 50% N through weed biomass

(2011) and Hussain *et al*. (2012). The higher growth attributes in integrated nutrient management plots may be ascribed to higher availability of NPK and other nutrients, elevated population of beneficial micro-organisms, production of growth promoting hormones, antibiotics, enzymes etc which helps in improvement of soil health as compared to recommended dose of N fertilizer and control. Umashanker *et al*. (2005) in his study also reported that the integrated nutrient management improved the growth attributes of direct seeded rice.

Productivity

Yield attributing characters like productive tillers/hill**,** filled grains/panicle, panicle length (cm), 1 000 grain weight (g), and grain yield (tonnes/ha) of rice were significantly influenced by different N sources over control during both the seasons (Table 3). Among the N sources, application of FYM @11.2 tonnes/ha along with 50% recommended doses of N fertilizers recorded maximum number of productive tillers/hill (12.7 and 12.5), filled grains/panicle (147.5 and 141.5) and grain yield (5.05 and 4.63 tonnes/ha) during both the seasons, respectively followed by the combination of 50% recommended N fertilizer dose and *Glyricidia* leaves @11.6 tonnes/ha (T_4). However, both the treatments remained statistically at par to each other but significantly superior over the other N sources.

With regards to panicle length and test weight, different N sources dose not had significant effect on panicle length during both the seasons and test weight only during *kharif* season. Although, maximum values of panicle length (31 and 28.9 cm) and test weight (27.3 and 26.4 g) were recorded with the application of FYM@ 11.2 tonnes/ha along with 50% recommended doses of N fertilizers during both the seasons, respectively followed by 50% recommended N fertilizer dose and *Glyricidia* leaves @ 11.6 tonnes/ha (T_4). Similar results were also reported by Acharya and Mondal (2010) and Chaudhary *et al*. (2011). The increase in grain yield might be due to build-up in available nutrient and organic carbon through integrated use of organics and in organics (Sepehya *et al*. 2012). Tomar and Das (2011) also reported that the application of tree leaf along with inorganic fertilizer increased the yield of lowland rice.

An overall analysis of data showed that application of FYM@ 11.2 tonnes/ha along with 50% of recommended N fertilizer dose and combined application of 50% recommended N fertilizer dose along with *Glyricidia* leaves @11.6 tonnes/ha gave the statistically similar values of grain yield. But the availability of FYM is scarce in that region. Therefore, application of *Glyricidia* leaves may be recommended as a substitute of other organic manures like FYM and 50% recommended dose of N fertilizer for enhancing the productivity of rice in Tripura region of North-East India.

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