Journal of Crop and Weed 4(1) : 31-37 (2008)

Efficacy of different organic residues and inorganic fertilisers on growth and yield of two varieties of rice in red and laterite zone of West Bengal

[1]P. K. PATRA AND [2]C. BHATTACHARYYA

[1] Department of Agricultural Chemistry and Soil Science, Bidhan Chandra Krishi Viswavidyalaya, P.O.- Krishi Viswavidyalaya, Mohanpur- 741252, Nadia, West Bengal, India.
[2] Department of Plant Breeding, Bidhan Chandra Krishi Viswavidyalaya, Regional Research Station, Red and Laterite Zone, Jhargram-721507, West Midnapore, West Bengal, India.

Abstract

A field experiment was conducted for two consecutive years in the Red and Laterite Zone of West Bengal to evaluate the efficacy of three sources of organic manure viz., rice straw, sesbania top and gliricidia leaves, with and without nitrogenous fertilizer on growth and yield of two varieties of rice viz., IR-36 and CN-907-6-2.Gliricidia leaves alone and in combination with fertilizer N produced the highest rice grain yield. For sustainable rice productivity, application of organic residues will play a very significant role in the Red and Laterite zone soil of West Bengal where the inherent soil organic matter content of the soil is very low. Gliricidia plants could be very well grown on the bunds of the rice fields and the green leaves collected from these plants may be directly applied to the rice fields 2-3 weeks before transplanting of seedlings.

Key Words : Organic residues, rice straw, sesbania, gliricidia, rice

Introduction of high yielding varieties, intensive tillage system with high dose of chemical fertilisers and pesticides, undoubtedly enhanced food and fiber production (Lal and Mathur, 1989), but inadequacy of organic manures for the last 3-4 decades, deteriorated the soil physical, chemical, biochemical and microbial environment of the soil (Reganold, 1995). Soils have been constantly degraded and destroyed and about 70% of the soils are now deficient in organic carbon (<1.0%) which, in turn, resulted in imbalance of plant nutrients through out the country. Incorporation of organic residues and green manures are known to improve soil health by mitigating these adverse impacts by promoting soil aggregation, root development; improving water holding capacity and augmenting water use efficiency; improving soil microbial biomass pool, carbon and nitrogen mineralization and improving microbial activities and enhance crop yield per unit of applied nutrients (Meelu and Morris, 1984). Nutrient management integrating organic manure and inorganic chemical fertilisers improves rice crop growth by maintaining proper ecology of the rhizosphere and ultimately lead to higher production on a sustainable basis (Hussain *et al.*, 1991; Hedge, 1998). Red and Laterite agro-climatic zone of West Bengal, lying between 22°20′ N to 22°25′ N latitude and 87° E to 87° 05′ E longitude and spreading over 85 development blocks, occupies 28% of the total geographical area of the state. Rice is the main crop of the zone and cultivated in 3 out of 4 agro-ecological situations during *kharif* (rainy) season. The zone has a tropical sub-humid climate and receives between 1300-1500 mm rainfalls annually. Soils of the zone are light, porous, having acidic reaction, poor organic matter, nitrogen, phosphorus, potassium and base contents and result in poor rice yield. The present investigation was undertaken to study the effect of different organic additives in combination with inorganic chemical fertilisers on growth and yield of two rice varieties in this zone of West Bengal.

MATERIALS AND METHODS

The field experiment was laid out in triplicate factorial randomized complete block design in a typic haplustalf soil at the Sub-Divisional Adoptive Research Farm, Jhargram, West Midnapore, West Bengal. The soil of the experimental plot had a sandy loam (sand-77.2%, silt-8.0% and clay- 14.8%) texture with near neutral soil reaction (pH-6.9), low CEC [9.40c mol (p^+) kg^{-1}], medium low organic carbon (0.45%), medium low available P (31.5 kg ha^{-1} Olsen P) and medium low available K (222 kg ha^{-1}). Three levels of organic amendments viz., 0 (OM_0), 0.5 (OM_1) and 1.0 ((OM_2) tons ha^{-1} from three sources viz., Three levels of organic

amendments viz., 0 (OM_0), 0.5 (OM_1) and 1.0 ((OM_2) tons ha^{-1} from three sources viz., rice straw (0.42% N, 0.066% P_2O_5 and 0.066% K_2O), sesbania tops (3.50% N, 0.60% P_2O_5 and 1.20% K_2O) and gliricidia leaves (2.76% N, 0.28% P_2O_5 and 0.066% K_2O) with two levels of fertilizer N viz., 0 (N_0) and 60 (N_{60}) kg ha^{-1} were applied in factorial combination and kept submerged for 21 days. All the plots were treated with fertilizer P and K @ 30 kg P_2O_5 and 30 kg K_2O ha^{-1} through Single Super Phosphate and Muriate of Potash, respectively and one half of nitrogen through urea, were applied during puddling. Healthy seedlings of two varieties of rice viz., IR-36 (V_1) and CN 907-6-2(V_2), were transplanted at 20 cm x 15 cm spacing during *kharif* season 1999. The other one half of the nitrogen was applied 21 days after transplanting of rice. Intercultural operations including irrigation were done as and when necessary. The crop was harvested at maturity and plant height, number of tillers and panicles $hill^{-1}$, panicle length, number of filled and unfilled grains $panicle^{-1}$ and grain and straw yields were recorded. The same experiment was repeated next year (kharif, 2000). The data generated were analyzed following standard statistical procedures.

RESULTS AND DISCUSSIONS

Two years' pooled mean data for different parameters are presented in table 1 , 2 and 3. The results revealed significant effect of organic sources, fertilizer N levels and varieties on the growth attributes of rice.

Plant height at harvest

Plants of the fertilizer N treated plots (N_{60}) of both the varieties were significantly taller compared to the plants of unfertilized plots (N_0) (table 1). Application of organic residues, irrespective of fertilizer N application, resulted in taller plants of both the varieties. Application of glyricidia leaves resulted in the highest plant height while the increase in height was the lowest through the incorporation of rice straw. The increase in height ranged from 2.25% to 9.93% with a mean of 5.08% under no fertilizer N and from 0.86% to 2.08% with a mean of 1.61% under integrated use of fertilizer N and organic residues. The plants of variety CN –907-6-2 were taller than IR-36 (table 3).

Number of tillers per hill

Application of fertilizer N resulted in a significant increase in tiller number in both the varieties (table 1). Application of organic residues irrespective of fertilizer N application resulted in significantly higher number of tillers. In both the varieties, integrated use of organic residues and fertilisers N resulted in higher number of tillers as compared to use of organic residues alone. Application of glyricidia leaves resulted in the highest number of tillers while the number of tillers was the lowest through the incorporation of rice straw. The increase in tiller number ranged from 2.7% to 37.3% with a mean of 19.3% under application of organic residues and between 2.1% to 10.5% with a mean of 6.5% under integrated use of fertilizer N and organic residues. The highest increase of 37.3% was observed under application of glyricidia leaves @1.0 t ha^{-1}. The plants of variety CN –907-6-2 produced lower number of tillers compared to IR – 36 (table 3).

Number of panicles per hill

Like tiller number, panicle number of plants were also significantly influenced by application of organic residues as well as fertilizer N (table 1). Fertiliser N treated plants resulted in higher panicle number as compared to no fertilizer N treated plants. In both the varieties, irrespective of fertiliser N, application of organic residues resulted in significant increase in the number of panicles per hill (table 3). In both the varieties, integrated use of organic residues and fertilisers N resulted in higher number of panicles as compared to use of organic residues alone. Application of glyricidia leaves resulted in the highest number of panicles while the number of panicles was the lowest when rice straw was applied. The increase in panicle number due to application of organic residues ranged from 4.2% to 42.0% with a mean value of 20.5% and from 1.1% to 10.0% with a mean of 5.9% under integrated use of fertilizer N

Table 1: Effect of organic residues on different growth parameters of two varieties of rice (Pooled mean of two years)

Treatments	Plant height at harvest (cm)			No. of tillers per hill			No. of panicles per hill		
	IR-36	CN-907-6-2	Mean	IR-36	CN-907-6-2	Mean	IR-36	CN-907-6-2	Mean
$OM_0 + F_0$	68.9	82.0	75.5	7.8	7.2	7.5	7.4	6.4	6.9
Straw (0.5) + F_0	70.0	84.3	77.2	8.2	7.2	7.7	7.5	6.8	7.2
Straw (1.0) + F_0	70.1	85.1	77.6	9.1	8.5	8.8	8.0	7.3	7.7
Sesbania (0.5) + F_0	70.3	85.0	77.7	8.5	8.7	8.6	7.6	7.6	7.6
Sesbania (1.0) + F_0	72.8	86.0	79.4	11.0	9.1	10.1	8.1	8.8	8.5
Glyricidia (0.5) + F_0	73.1	89.0	81.1	9.2	7.2	8.2	9.9	8.3	9.1
Glyricidia (1.0) + F_0	76.7	89.2	83.0	11.3	9.2	10.3	10.5	9.0	9.8
$OM_0 + F_{60}$	74.9	88.3	81.6	9.5	9.5	9.5	8.9	9.0	9.0
Straw (0.5) + F_{60}	76.0	88.6	82.2	9.7	9.6	9.7	9.0	9.1	9.1
Straw (1.0) + F_{60}	76.5	89.2	82.9	10.0	10.0	10.0	9.4	9.5	9.5
Sesbania (0.5) + F_{60}	76.5	89.2	82.9	9.8	10.0	9.9	9.1	9.6	9.4
Sesbania (1.0) + F_{60}	76.9	89.6	83.3	10.2	10.3	10.3	9.5	9.8	9.7
Glyricidia (0.5) + F_{60}	76.3	89.4	82.9	10.2	10.3	10.3	9.4	9.7	9.6
Glyricidia (1.0) + F_{60}	76.5	89.9	83.2	10.6	10.4	10.5	9.9	9.8	9.9
Mean	73.9	87.5		9.7	9.1		8.9	8.6	
Year – 1999	78.1	93.5	85.8	11.0	10.8	10.9	10.1	10.3	10.2
Year – 2000	69.8	81.5	75.7	8.3	7.3	7.8	7.6	7.0	7.3
	S.Em (±)	LSD (p=0.05)		S.Em(±)	LSD (p=0.05)		S.Em(±)	LSD (p=0.05)	
Year	0.2065	0.42		0.0508	0.10		0.0520	0.10	
Variety	0.1402	0.28		0.0635	0.13		0.0654	0.13	
Organics	0.5463	1.10		0.1345	0.27		0.1377	0.28	

Table 2: Effect of organic residues on different yield attributes of two varieties of rice (Pooled mean of two years)

Treatments	Length of panicle (cm)			No. of grains panicle^{-1}			Grain yield (t ha^{-1})			Straw yield (t ha^{-1})		
	IR-36	CN-907-6-2	Mean	IR-36	CN-907-6-2	Mean	IR-36	CN-907-6-2	Mean	IR-36	CN-907-6-2	Mean
$OM_0 + F_0$	1.63	18.1	17.2	49.2	76.6	63.0	2.82	2.24	2.53	2.76	3.45	3.11
Straw (0.5) + F_0	17.1	18.7	17.9	52.3	77.7	65.0	2.90	2.83	2.87	2.84	3.84	3.34
Straw (1.0) + F_0	17.5	20.0	18.8	56.3	83.8	70.1	3.03	3.06	3.05	3.21	4.19	3.70
Sesbania (0.5) + F_0	18.0	18.7	18.4	54.4	77.8	66.1	3.46	3.41	3.44	3.27	3.97	3.62
Sesbania (1.0) + F_0	20.7	21.0	20.9	62.5	100.0	81.3	3.68	4.00	3.84	3.47	4.74	4.11
Glyricidia (0.5) + F_0	19.7	20.3	20.0	54.8	94.0	74.4	3.75	3.41	3.58	3.29	3.99	3.64
Glyricidia (1.0) + F_0	20.6	21.3	21.0	80.5	104.6	92.6	4.80	4.08	4.44	5.03	5.14	5.09
$OM_0 + F_{60}$	20.6	21.0	20.8	65.6	82.5	74.1	3.44	3.65	3.55	3.66	4.77	4.22
Straw (0.5) + F_{60}	21.0	21.1	21.1	76.5	83.6	80.1	3.83	4.08	3.96	3.68	4.89	4.29
Straw (1.0) + F_{60}	22.1	22.0	22.1	82.2	90.1	86.2	4.34	4.15	4.25	3.76	5.02	4.39
Sesbania (0.5) + F_{60}	21.2	21.3	21.3	77.2	94.3	85.8	3.86	4.18	4.02	3.83	4.96	4.40
Sesbania (1.0) + F_{60}	22.2	22.0	22.1	84.6	96.4	90.5	4.37	4.51	4.44	4.07	5.35	4.71
Glyricidia (0.5) + F_{60}	21.1	22.4	22.3	83.0	96.3	89.7	3.76	4.21	3.99	3.91	4.97	4.44
Glyricidia (1.0) + F_{60}	22.2	22.7	22.5	87.1	102.1	94.6	4.40	4.57	4.49	4.09	5.61	4.85
Mean	20.0	20.8		68.9	90.0		3.75	3.98		3.63	4.74	
Year – 1999	20.0	20.8		68.9	90.0		4.02	3.94		3.39	4.72	
Year – 2000	ND	ND		-	-		3.47	3.54		3.63	4.55	
	S.Em (±)	LSD (p=0.05)		S.Em (±)	LSD (p=0.05)		S.Em (±)	LSD (p=0.05)		S.Em (±)	LSD (p=0.05)	
Year	-	-		-	-		0.019	0.04		0.024	0.05	
Variety	0.134	0.27		0.99	2.07		NS	NS		0.027	0.05	
Organics	0.301	0.62		3.16	6.48		0.050	0.01		0.064	0.13	

Table 3: Effect of organic amendments on different growth parameters of two rice varieties over two years

Treatments	Plant Height (cm)	No.of tillers hill $^{-1}$	No. of panicles hill^{-1}	Length of panicle (cm)	No. of filled grains panicle^{-1}	No. of unfilled grains panicle $^{-1}$	Grain yield (tons hectare ^{1})	Straw yield (tons hectare^{-1})
$OM_0 + N_0$	76.2	8.5	8.1	20.5	79.1	23.7	3.12	3.34
$OM_0 + N_{60}$	82.9	10.3	9.6	21.0	74.6	23.5	4.24	4.40
Straw (0.5) + N_0	76.6	10.1	9.7	18.8	65.7	16.9	2.57	3.63
Straw (0.5) + N_{60}	82.7	9.6	9.0	22.5	82.3	32.7	3.55	4.36
Straw (1.0) + N_0	82.8	8.2	7.2	17.4	78.3	10.2	4.40	4.88
Straw (1.0) + N_{60}	81.6	10.2	9.6	20.9	91.8	20.3	4.19	4.71
Sesbania(0.5)+ N_0	79.0	8.6	8.2	18.4	70.0	8.7	3.05	3.36
Sesbania (0.5) + N_{60}	83.0	9.8	9.2	22.1	93.4	21.7	3.98	4.28
Sesbania (1.0) + N_0	79.6	9.3	8.1	17.6	65.1	9.0	3.92	4.30
Sesbania (1.0) + N_{60}	82.3	10.0	9.5	21.2	86.7	22.4	4.27	4.56
Glyricidia (0.5) + N_0	78.0	8.8	7.8	21.0	74.6	18.9	3.44	3.70
Glyricidia (0.5) +N_{60}	83.2	9.9	9.4	22.3	83.3	30.8	3.95	4.21
Glyricidia (1.0) + N_0	79.1	7.7	7.4	20.4	79.0	14.4	3.26	3.37
Glyricidia (1.0) +N_{60}	83.1	10.1	9.5	21.6	88.6	23.7	4.48	4.76
Year Mean :								
1999	85.8	10.9	10.2	20.4	79.5	19.8	3.98	4.30
2000	75.7	7.8	7.3	ND	ND	ND	3.50	3.97
Variety Mean :								
IR – 36	73.9	9.6	8.9	20.0	68.9	14.9	3.75	3.63
CN –907-6-2	87.5	9.1	8.6	20.8	90.0	24.7	3.74	4.64
Amendment Mean :								
Rice Straw	81.0	9.6	8.9	19.9	79.5	20.1	3.68	4.40
Sesbania	81.0	9.5	8.8	19.9	78.9	15.5	3.81	4.13
Glyricidia	80.9	9.2	8.6	21.4	81.4	22.0	3.79	4.02
LSD (P= 0.05)								
Amendments	1.20	0.27	0.28	0.62	6.48	2.80	0.10	0.13
Variety	0.28	0.13	0.13	0.27	2.03	0.79	NS	0.05
Year	0.41	0.10	0.10	ND	ND	ND	0.04	0.05

and organic residues. The highest increase of 42.0% was observed under application of glyricidia leaves @1.0 t ha^{-1}. The plants of variety IR – 36 produced lower number of panicles compared to CN –907-6-2.

Length of panicle

Irrespective of organic residues, fertiliser N resulted in longer panicles in both the varieties (table 1). Organic residues, alone or in combination with fertiliser N, increased the length of rice panicles. Irrespective of variety, integrated application of organic residues and fertiliser N resulted in longer panicles compared to the use of organic residues alone. Highest increase in the panicle length was observed with application of glyricidia leaves @ 1.0 t ha^{-1} while the lowest was seen with application of rice straw. The increase in the length of panicle ranged from 4.1% to 22.1% with a mean value of 13.4% under no fertiliser N and from 1.4% to 8.2% with a mean value of 5.3% under integrated use of organics and fertiliser N. The panicles of variety CN-907-6-2 were longer than those of variety IR- 36 (table 3).

Number of grains per panicle

In both the varieties, application of fertiliser N, alone or in combination with organic residues resulted in significant increase in the number of grains per panicle (table 2). Application of organic residues, with or without fertiliser N, increased the per panicle number of grains. The increase in the number of grains per panicle ranged from 3.1% to 47.0% with a mean value of 18.9% under no fertiliser N and from 8.1% to 27.7% with a mean value of 18.5% under the integrated use of fertiliser N and organic residues. Highest increase in grain number was observed under application of glyricidia leaves @ 1.0 t ha^{-1} while the lowest increase was with the application of rice straw (table 3).

Grain yield

Both the varieties of rice responded positively to application of 60 kg fertiliser N ha^{-1} and organic residues (table 2). Irrespective of fertiliser N levels, both the varieties responded positively also to application of organic residues. The increase in grain yield due to addition of organics ranged from 13.4% to 75.5% with a mean value of 39.8% under organics alone and from 11.5% to 26.5% with an average value of 18.1% when organics were applied in combination with 60 kg ha^{-1} fertiliser N. Glyricidia leaves alone and in combination with fertiliser N effectuated the highest increase in grain yield over no organic residue application. Variety CN -907-6-2 produced significantly higher grain yield compared to variety IR- 36 (table 3).

Straw yield

Application of fertiliser N alone or in combination with organic residues, effectuated significant increase in rice straw yield compared to fertiliser N untreated control (table 2) in both the varieties. Application of organic residues, irrespective of fertiliser N application, resulted in higher straw yield compared to plots that did not receive organic residues. The increase in straw yield due to application of organics ranged from 7.4% to 63.7% with a mean value of 25.9% under no fertiliser N and from 1.6% to 14.9% with a mean value of 6.9% when fertiliser N application was integrated with organics. Straw yields were higher in variety CN - 907-6-2 than IR-36 (table 3).

Efficacy of different organic manures and residues on equal nutrient basis in soil test crop response studies and 25% substitution of complex fertilisers with FYM for increasing rice grain yield have been suggested by many workers (Ravisankar *et al.*, 2002; Suresh and Reddy, 2002). Significant changes in different enzyme activities due to application of organic manures in submerged rice soil have also been suggested (Srinivas *et al.*, 2003). Better crop growth in glyricidia leaves treated plots find supports in the research reports by Rautray *et al.*, (2003) who found fastest release of NH_4^+-N from green manure and delayed release in case of application of rice straw.

It may be concluded that for sustainable rice productivity, application of organic residues will play a very significant role in the Red and Laterite zone soil of West Bengal where the inherent soil organic

matter content of the soil is very low. Since the topography of the area is undulating and the rice fields are always bunded, glyricidia plants could be very well grown on these bunds. The green leaves collected from these plants may be directly applied to the rice fields 2-3 weeks before transplanting of rice seedlings.

REFERENCES

Hegde, D. H. 1998. Effect of integrated nutrient supply on crop productivity and soil fertility in rice (*Oryza sativa)*- wheat (*Triticum aestivum*) system in semi-arid and humid ecosystem. *Indian J. Agron.* **43**(1) : 7-12.

Hussain, T.; Zaki, Z. H. and Jilani, G. 1991. Comparison of various organic and inorganic fertilizer combination for economical rice production. *Pakistan J. Soil Sci.* **6** : 21-24.

Lal, S. and Mathur, B. S. 1989. Effect of long term fertilization, manuring and liming of an alfisol on maize, wheat and soil properties. II. Soil physical properties. *J. Indian Soc. Soil Sci.* 37 : 815-816.

Meelu, O. P. and Morris, R. A. 1984. Integrated management of plant nutrients in rice based cropping system. *Fert. News* **29**(12) : 65-69.

Rautaray, S. K.; Ghosh, B. C. and Mitra, B. N. 2003. Efficacy of organic materials on growth and yield of rice as influenced by time of application under integrated nutrient management. *Oryza* **40** : 18-21.

Ravisankar, N.; Arunachalam Alwar, A. and Veerabadran, V. 2002. Direct and residual effect of sugarcane trash compost and inorganic fertilisers on crop yield and nutrient uptake in rice-rice sequence. *Oryza* **39** : 60-63.

Reganold, J. P. 1995. Soil quality and profitability of biodynamics and conventional farming system, A Review, *Am. J. Altern Agric.* **10**(1) : 36-45.

Srinivas, D.; Raman Saroja and Rao Chandrasekhara, P. 2003. Effect of organic manures on activities of certain soil enzymes under submerged condition. *Oryza* **40** : 14-17.

Suresh, K. and Ramsubba Reddy, G. 2002. Effect of organic and inorganic sources of nutrients on growth and yield of rice. *Oryza* **39** : 57-59.