Indian Journal of Agronomy **51** (3) : 157–159 (September 2006)

Integrated nutrient management under hybrid rice-(*Oryza sativa*) hybrid rice cropping sequence

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Received : July, 2005

ABSTRACT

A field experiment was conducted during both rainy (*kharif*) (2002 and 2003) and summer (boro) seasons (2003 and 2004) at the Regional Research Station, New Alluvial Zone, to study the effect of organic and inorganic sources of plant nutrients applied singly and in combination on rainy season hybrid rice (*Oryza sativa* L.) and their residual effect on the succeeding summer season hybrid rice, receiving recommended doses of fertilizers. Growth attributes, yield components and grain yields increased with the increase in doses of chemical fertilizers alone as well as in combination with 5 tonnes FYM/ha in both the rainy seasons. Similar trend of result was observed in *boro* also. In hybrid rice-hybrid rice cropping system, the application of 125% recommended doses of fertilizer along with 5 tonnes FYM/ha during rainy season followed by 100% recommended doses of fertilizer during summer season gave higher grain yield (12.0 tonnes/ha), net return (Rs 15,848/ha) and return/Re investment (Rs 1.34) compared with that of 100% recommended doses of fertilizer in both the seasons (10.45 tonnes/ha) grain yield, Rs 10,004/ha net return and Rs 1.23 return/Re investment. The status of organic carbon, nitrogen, phosphorus and potassium in the soil increased over the initial values after four consecutive croppings where FYM was applied in the rainy season.

Key words : Organic, Inorganic, Growth, Yield, Uptake, Hybrid rice

Rice (*Oryza sativa* L.)–rice cropping system occupies the second highest area next to rice-wheat cropping system in India, and is the most important system prevailing in West Bengal. Hybrid rice responds to judicious application of fertilizer, especially N, P and K, and gives higher yield than high-yielding varieties (HYVs) at a particular level (Singh and Virmani, 1990). Integrated nutrient management (INM) aims at efficient and judicious use of all the sources of plant nutrients in an integrated manner, to attain sustainable crop production with minimum deleterious effect of chemical fertilizers on soil health and least disturbance to the plant-soil-environment (Pillai, 1996). In view of these, the present investigation was undertaken to find out or develop a suitable integrated nutrient-supply system in a hybrid rice-hybrid rice cropping system involving both organic and inorganic fertilizer nutrients for 2 consecutive years.

MATERIALS AND METHODS

A field experiment was conducted during the rainy season (*kharif*) of 2002 and 2003 and summer season (*boro*) of 2003 and 2004 at Regional Research Station, situated at 23° 53' N latitude and 83° 53' E longitude, with an elevation of 9.75 m above mean sea-level, to study the effect of integrated nutrient manuring on the productivity of rice ('Proagro 6444') under hybrid rice-hybrid rice cropping system in West Bengal. The experiment was laid out in randomized block design having 9 treatments in *kharif* (T_1, Control, no fertilizer and manure in *kharif* and *boro;* T_2 to T_4, 75%, 100 and 125% recommended doses of fertilizer respectively; T_5, 5 tonnes FYM/ha only; T_6 to T_8, 75, 100 and 125% recommended doses of fertilizer respectively along with 5 tonnes FYM/ha; T_9, no fertilizer in *kharif* only), and 9 treatments in *boro* (T_1, Control, no fertilizer in both the seasons; T_2 to T_9= 100% recommended doses of fertilizers), and it was replicated thrice. The soil was sandy clay-loam, having 36.71% sand, 27.67% silt and 35.62% clay with almost neutral pH (7.1), 0.60% organic carbon, 0.059% total nitrogen, 10.65 kg/ha available P and 126.2 kg/ha available K. Rice was transplanted on 4 August 2002 and 10 August 2003 during *kharif* and on 1 February 2003 and 3 February 2004 during *boro*, at a spacing of 20 cm × 10 cm and 20 cm × 15 cm in *boro* and *kharif* respectively, @ 1 seedling/hill. The *kharif* crops received 60 kg N, 30 kg P_2O_5 and 30 kg K_2O ($N_{60}P_{30}K_{30}$), and *boro* crop received 120 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha ($N_{120}P_{60}K_{60}$) respectively as 100% recommended doses of fertilizer. Plant-protection

measures were taken as and when required. The crop was harvested on 15 April 2003 and 20 April 2004, and 10 November 2002 and 15 November 2003 in *boro* and *kharif* respectively.

RESULTS AND DISCUSSION

Effect of manuring in rainy season rice

Plant height, dry-matter accumulation, number of panicles/m^2, filled grains/panicle, test weight, and the grain and straw yields of rice and uptake of nutrients increased with the increase in doses of chemical fertilizer from 0 to 125% RDF (Table 1).

The corresponding growth attributes, yield components and yield of rice increased further when 5 tonnes FYM/ha was added to these doses of chemical fertilizers. Addition of 5 tonnes FYM/ha without chemical fertilizer did not show any increase over the chemical fertilizer. The trend of variation among the treatments was similar in both the years. Maximum plant height (101.25 cm), dry-matter accumulation (891.3 g/m^2) leaf-area index (5.13), uptake of nutrients (98.9, 29.4 and 52.9 kg N, P_2O_5 and K_2O/ha respectively), number of panicles/m^2 (245.0), number of filled grains/panicle (165.4), 1,000-grain weight (23.4 g), grain (5.32 tonnes/ha) and straw yields (5.33 tonnes/ha) were recorded when the crop received 125% recommended doses of fertilizers along with 5 tonnes FYM/ha (Table 1). Acharya *et al.* (1998) opined that application of N, P, and K fertilizers along with FYM increased the growth attributes, yield components and grain yield of rice compared with that of N, P and K fertilizers alone.

Effect of manuring in summer season rice

The performance of *boro* rice was better than that of *kharif* rice in all the respect (Table 2). Plant height (92.2 cm), dry-matter accumulation (1,000.4 g/m^2), leaf-area index (4.92), uptake of nutrients (97.31, 36.3 and 55.3 kg N, P_2O_5 and K_2O/ha respectively), number of panicles (350), filled grains/panicle (172.1), test weight (23.89 g), grain (6.68 tonnes/ha) and straw yields (7.43 tonnes/ha) were maximum when the crop was fertilized with 100%

Table 1. Growth attributes, yield components, yield and uptake of nutrients of rainy season rice crop (mean data of 2002 and 2003)

Treatment	Plant height (cm)	Dry-matter accumulation (g/m^2)	Leaf-area index	Panicles/ m^2	Filled grains/ panicle	1,000-grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Uptake of nutrients (kg/ha)		
									N	P	K
T_1, Control	93.3	694.8	3.20	196.5	132.3	20.86	3.09	3.22	50.2	14.7	28.9
T_2, 75% RDF	94.3	785.6	4.56	226.5	137.3	21.01	4.28	4.34	78.2	21.5	41.3
T_3, 100% RDF	97.0	827.2	4.78	230.0	139.4	21.66	4.63	4.80	88.6	22.8	46.7
T_4, 125% RDF	100.6	850.6	5.13	243.0	143.3	21.90	4.86	4.93	96.4	26.7	50.2
T_5, 5 t FYM/ha	94.7	725.1	4.60	196.5	140.0	21.00	3.61	3.80	68.4	18.9	34.3
T_6, 75% RDF + 5t FYM/ha	96.0	802.3	4.95	231.5	145.0	22.10	3.99	4.73	85.8	25.4	47.6
T_7, 100% RDF + 5 t FYM/ha	98.6	860.2	5.01	240.0	155.4	22.26	4.96	5.77	90.0	27.3	50.1
T_8, 125% RDF + 5 t FYM/ha	101.3	891.3	5.13	245.0	165.4	23.40	5.32	5.33	98.9	29.4	52.9
T_9, Control (no fertilizer in *kharif*)	94.0	690.1	3.80	175.0	132.4	20.55	3.14	3.29	53.5	15.5	26.8
CD (P=0.05)	2.4	29.3	NS	35.3	3.9	1.2	0.32	0.14	13.4	4.5	9.1

100% RDF, $N_{60}P_{30}K_{30}$ in summer and $N_{120}P_{60}K_{60}$ in rainy season

Table 2. Growth attributes, yield components, yield and uptake of nutrients of summer season rice crop (mean data of 2002–03 and 2003–04)

Treatment	Plant height (cm)	Dry-matter accumulation (g/m^2)	Leaf-area index	Panicles/ m^2	Filled grains/ panicle	1,000-grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Uptake of nutrients (kg/ha)		
									N	P	K
T_1, Control	71.4	702.5	3.61	320	138.6	20.50	3.17	4.60	58.3	19.6	32.5
T_2, 100% RDF	83.5	848.6	4.20	328	142.4	20.81	5.45	6.54	82.1	27.4	50.7
T_3, 100% RDF	84.3	900.3	4.31	338	147.8	21.79	5.86	6.32	91.4	29.8	51.3
T_4, 100% RDF	88.1	936.1	4.30	341	153.7	22.15	6.15	7.23	93.6	35.1	52.5
T_5, 100% RDF	73.7	790.0	4.05	325	146.9	20.88	4.64	5.21	78.5	26.3	46.3
T_6, 100% RDF	85.2	807.2	4.42	332	155.0	22.14	5.47	6.74	85.6	28.1	50.1
T_7, 100% RDF	90.1	958.4	4.53	344	160.8	22.64	6.14	7.40	88.9	32.3	50.3
T_8, 100% RDF	92.2	1,000.4	4.92	350	172.1	23.89	6.68	7.43	97.3	36.3	55.3
T_9, 100% RDF	72.3	765.4	4.12	324	144.6	20.68	5.28	6.42	64.8	25.1	44.3
CD (P=0.05)	8.5	60.0	0.69	NS	5.5	0.52	0.48	0.47	14.2	5.0	11.8

Table 3. Economics and soil-fertility status after 2 years of rice-rice cropping sequence

Treatment		System productivity (t/ha)	Total cost of cultivation (Rs/ha)	Net return (Rs/ha)	Return/Re investment (Rs/ha)	Organic C (%)	Total N (%)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
Kharif	*Boro*								
T_1 : Control	Control	6.26	36,220	3,827	0.89	0.36	0.035	13.50	117.0
T_2 : 75% RDF	100% RDF	9.37	41,369	7,037	1.17	0.46	0.045	14.62	124.25
T_3 : 100% RDF	100% RDF	10.45	43,284	10,004	1.23	0.51	0.052	16.00	127.8
T_4 : 125% RDF	100% RDF	11.01	44,641	11,534	1.26	0.56	0.055	17.21	129.75
T_5 : 5t FYM/ha	100% RDF	8.25	40,033	2,009	1.05	0.61	0.061	17.90	131.92
T_6 : 75% RDF + 5 t FYM/ha	100% RDF	9.46	42,369	7,714	1.19	0.62	0.062	17.20	132.20
T_7, 100% RDF + 5 t FYM/ha	100% RDF	11.10	44,283	12,807	1.28	0.65	0.064	18.65	134.06
T_8, 125% RDF + 5 t FYM/ha	100% RDF	12.00	45,632	15,848	1.34	0.66	0.065	19.21	134.12
T_9, No fertilizer	100% RDF	8.42	39,042	663	1.02	0.45	0.046	15.31	126.00
CD (P=0.05)		0.73		2,081	0.04	0.02	0.001	0.89	2.01
Initial value						0.60	0.059	16.05	126.20

Price : Urea, Rs 4.30/kg; single superphosphate, Rs 3.20/kg; muriate of potash, Rs 5.00/kg; farmyard manure, Rs 100/tonne
Price of rice calculated on the basis of minimum support price

RDF during *boro* and the previous *kharif* crop received 125% RDF + 5 tonnes FYM/ha (Table 2). Maiti *et al.* (2003) reported that in hybrid rice cultivars the growth parameters and yield components increase due to increased in level of N, P and K.

Effect of manuring on rice-rice crop sequence

Both grain and straw yields increased with the increase in doses of nutrients. Maximum grain (5.32 and 6.68 tonnes/ha) and straw yields (5.33 and 7.43 tonnes/ha) were recorded in the system when the crop received 125% RDF along with 5 tonnes FYM/ha during rainy season and 100% RDF during summer season (Table 3). The grain yield under this treatment increased (Table 3) by 91.69% over the control. Use of FYM along with RDF in *kharif* and 100% RDF in *boro* had positive effect on system productivity. The result corroborates the findings of Katyal and Gangwar (2000).

Nutrient status of soil

After 2 years of continuous rice–rice cropping, organic carbon, total nitrogen, available phosphorus and available potassium increased by 10.0, 10.17, 19.68 and 6.27% respectively over the initial value in the treatment where crop was supplied with 125% RDF along with 5 tonnes FYM/ha in *kharif* rice and 100% RDF in *boro* rice. The application of FYM in *kharif* along with mineral fertilizer substantially increased the soil-nutrient status (NPK) at the end of rice–rice cropping system over the initial value. The results are in line with those of Raju and Reddy (2000).

Economics

Where the *kharif* crop received 125% recommended doses of chemical fertilizers along with 5 tonnes FYM/ha and *boro* crop 100% RDF, net return (Rs 15,848) and return/Re investment (Rs 1.34) were maximum.

Considering the productivity, economics and nutrient content of the soil, it may be concluded that maximum grain yield, net return and return/Re investment were maximum where the *kharif* crop received 125% recommended doses of mineral fertilizer along with 5 tonnes FYM/ha, followed by *boro* crop fertilized with 100% recommended doses of fertilizers.

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