Oryza Vol. 49. No. 2, 2012 (108-111)

Response of hybrid rice to nutrient management during wet season

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ABSTRACT

An integrated nutrient management programme on hybrid rice was conducted for two consecutive years (2005 and 2006) during wet season for sustained crop production at Research Farm of BCKV under new alluvial zone of West Bengal. The experiment was laid out in a randomized complete block design with 11 treatments. The results of the study demonstrated that plant height, dry matter production, leaf area index and crop growth rate of hybrid rice cultivar was increased with increasing doses of N, P and K fertilizers. All these growth attributes showed their maximum values with 100% recommended dose of fertilizers (RDF) NPK @ 80:40:40 kg ha^{-1}. Both both years maximum number of panicles m^{-2} (267 and 327), filled grain panicle^{-1} (116 and 158), 1000- grain weight (20.4 and 22.4g), grain yield (5.3 and 5.5 t ha^{-1}) and biological yield (11.13 and 11.75 t ha^{-1}) was recorded with 100% RDF. The second highest figures of all the above characters were observed with 75% RDF and 25% RD of N through GLM. The net return and B:C ratio were ₹ 13,425 ha^{-1} and ₹ 0.61 with 100% RDF closely followed by 75% RDF + 25% RDN through green leaf manuring.

Key words: *hybrid rice, nutrient management, organic manures, soil fertility, yield*

Rice is grown in several states of India and West Bengal contributes maximum (16%) in the domestic production of over 94 MT of rice (ASSOCHAM, 2008). Yield growth, which remained the major driving force behind the production growth of rice, has slowed down due to saturation in adaptation of high yielding varieties, lack of expansion in acreage and depleting soil fertility in some major rice producing regions. Given the limited scope to increase the acreage under paddy cultivation, there is a need to boost yields. Secondly, the ceiling on yield can be broken by adopting hybrid rice technology which can boost the present rice yield by about 15-20% with present level of input use. It is apparent that the hybrid rice cultivation is confined only to most favourable irrigated areas where plateauing of yield of HYVs has already been reached, particularly in *boro* season. Any attempt to boost the rice production in West Bengal depends mainly on large-scale adoption of hybrid rice varieties during wet season, availing the advantages of monsoon rain and large cultivated area. Further, soil fertility decline is now-a-days more alarming in intensively rice cultivated regions. Nutrient withdrawal by rice crop is high and replenishment is not only inadequate. Therefore, maintaining soil fertility at high levels through careful appraisal and soil-test based judicious nutrient use is an assured way to attain and sustain maximum economic growth (ASSOCHAM, 2008). This calls for balanced use of fertilizers according to soil requirements, use of organic manures including green manuring and adoption of appropriate agronomic practices. Therefore, the present investigation was undertaken with specific objectives viz. to evaluate the effect of integrated nutrient management (INM) on the growth and productivity of hybrid rice and to find out the profitability of INM.

MATERIALS AND METHODS

A field experiment was conducted in 2005 and 2006 during wet season at Regional Research Sub-Station, BCKV in Chakdaha, West Bengal. The climate of the experimental site is humid subtropical with mild short winter and hot humid long summer. The experiment was conducted under irrigated shallow low land situation, having medium fertility status with good drainage facility. The soil of the experimental field was sandy clay loam in texture (Entisol) with pH 7.5, EC 0.61 ds m^{-1}, organic carbon 0.68%, available N 110 kg ha^{-1}, available P 16 kg ha^{-1} and

available K 126 kg ha^{-1}. The experiment was laid out in a randomized complete block design with 11 treatments and 3 replications. The treatments were Control, 50% recommended dose of fertilizer (RDF, 80-40-40 kg N-P-K ha^{-1}), 75% RDF, 100% RDF, 50% RDF + 50% RD of N as farm yard manure (FYM), 75% RDF + 25% RD of N as FYM, 50% RDF + 50% RD of N as crop residue (CR), 75% RDF + 25% RD of N as CR, 50% RDF + 50% RD of N as green leaf manuring of Sesbania aculeata (GLM), 75% RDF + 25% RD of N as GLM and farmer's practice (60-30 kg N-P ha^{-1}). Individual plots were 3m x 5m. Well germinated seeds of hybrid rice (var. Proagro 6444) @ 20 g m^{-2} were sown on 1st July and 24 days old seedlings were transplanted on 25 July @ 1 seedling $hill^{-1}$ at a spacing of 20cm x 10cm in both the years. Nitrogen, phosphorus and potash in the form of urea, single super phosphate and muriate of potash were applied as per treatment. Based on soil test recommendations provided by the Rice Research Station, Chinsurah, Hooghly, West Bengal recommended dose of N, P and K fertilizers (RDF) were applied at 80 : 40 : 40 kg ha^{-1}, respectively. One fourth of total N, entire amount of P and three fourths of K were applied as basal after draining out the standing water but before final puddling. Remaining N was top dressed in three equal splits, each at three weeks after transplanting, panicle initiation and panicle emergence stages. Remaining one fourth of K was also applied at panicle initiation. Organic manures (Table 1) were applied 7 days before transplanting just to substitute a part of recommended dose of N.

RESULTS AND DISCUSSION

Experimental results revealed that the biometrical parameters like plant height, dry matter (DM) accumulation, leaf area index (LAI) and crop growth rate (CGR) responded significantly upto 100% RDF (either through chemical means or combination of organic and inorganic source) during both the years (Table 2). This could be attributed to the fact that higher dose of nitrogen, being constituent of enzyme and protein, enhanced cell expansion and various metabolic processes (Dwivedi *et al.,* 2006). It is also evident that during 2005 maximum plant height at harvest (103cm) was achieved with 100% RDF which was statistically at par with 25 or 50% replacement of inorganic fertilizer with different organic manures. Significantly lower plant height was observed with control treatment and farmers' practice. During second year similar type of results were obtained. There was a sharp increase of DM accumulation throughout crop growth from 30 to 90 DAT. Rice crop with 100% RDF produced maximum DM (42.13 and 48.19% increment over control in 2005 and 2006, respectively), which had no significant difference with treatments having partial substitution of chemical fertilizer with organic manures. In all the treatment combinations, LAI increased gradually upto 60 DAT and thereafter it declined upto harvesting of the crop. At 60 DAT hybrid rice maintained higher LAI which indicated delayed senescence of leaves and superior activity of leaves of hybrid rice. Maximum LAI was obtained with 100% RDF (57 and 33.9% increment over control in 2005 and 2006, respectively) closely followed by the treatment receiving 75% RDF + 25% RD of N as GLM. In both the year control treatment gave minimum LAI. Crop growth rate increased gradually upto 75 DAT and then decreased till harvesting of the crop. Banerjee *et al.* (2006) opined that additional dry matter produced from developing panicles and grains during flowering to 15 days after flowering might be the cause of higher CGR during 60-75 DAT. There was no significant difference among the treatments with respect to CGR at 60-75 DAT during 2005 and 2006 except control treatment and farmers' practice.

Table 1. Chemical composition of organic manures applied (on dry-weight basis)

Manure	Mineral composition (%)			C : N ratio
	N	P_2O_5	K_2O	
Farm yard manure	0.5	0.2	0.45	10:1
Paddy straw	0.5	0.15	1.60	80:1
Sesbania aculeata green leaf	0.65	0.35	1.30	12:1

The treatment receiving 100% RDF produced maximum number of panicle closely followed with 75% RDF + 25% RD of N as GLM during first year, whereas minimum number of panicles m^{-2} was obtained under control (Table 2). In the second year similar trend was observed, but number of panicles m^{-2} was higher as compared to first year. During 2005, application of 100% RDF produced maximum number of filled grains $panicle^{-1}$ which was statistically at par with 75% RDF + 25% RD of N as GLM. Significantly lowest filled

Table 2. Effect of nutrient management on growth and yield attributes of hybrid rice

Treatment	Plant height (cm)		DMA (g m^{-2})		LAI at 60 DAT		CGR at 60-75 DAT (gm^{-2}day^{-1})		Panicles m^{-2}		Filled grains panicle^{-1}		1000-grain weight (g)	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Control	95.8	105.5	651.1	615.1	3.5	4.1	6.2	23.8	187	242	73	92	19.1	19.1
50% RDF (40-20-20 kg N-P-K ha^{-1})	97.3	103.3	737.1	690.0	3.7	4.7	22.5	29.9	200	258	73	105	19.3	20.1
75% RDF (60-30-30 kg N-P-K ha^{-1})	99.0	103.5	809.4	756.6	4.9	5.0	22.1	30.7	208	275	79	110	19.5	20.7
100% RDF (80-40-40 kg N-P-K ha^{-1})	103.0	107.3	925.4	911.5	5.5	5.5	27.7	32.5	267	327	116	158	20.4	22.4
50% RDF + 50% RD of N as FYM	99.2	103.7	821.7	813.5	5.0	4.9	22.3	29.4	217	292	80	111	22.3	22.4
75% RDF + 25% RD of N as FYM	100.1	103.8	846.2	857.3	5.0	5.1	23.5	30.4	225	300	83	112	22.1	19.0
50% RDF + 50% RD of N as CR	100.3	104.3	850.0	880.3	5.1	5.2	24.1	31.8	225	300	91	118	22.0	21.5
75% RDF + 25% RD of N as CR	100.6	104.8	870.0	881.1	5.3	5.4	23.7	31.5	233	308	93	120	20.2	20.3
50% RDF + 50% RD of N as GLM	100.6	105.3	890.6	892.3	5.3	5.4	25.7	31.5	233	308	96	121	22.1	20.1
75% RDF + 25% RD of N as GLM	101.8	105.8	901.6	900.2	5.5	5.4	25.9	34.0	242	325	110	132	21.6	21.7
Farmers' practice (60-30 kg N-P ha^{-1})	97.3	102.7	709.9	671.0	3.3	4.5	20.7	21.9	200	275	73	102	21.7	22.2
S.Em±	1.52	1.40	39.39	31.09	0.52	0.54	3.22	2.36	15.1	21.3	6.7	8.3	0.85	0.72
CD (P=0.05)	4.45	4.13	115.52	91.19	1.54	1.59	9.43	6.91	44.2	62.2	19.7	24.4	2.5	2.1

DMA=Dry matter accumulation; LAI=Leaf area index; CGR=Crop growth rate

grains panicle^{-1} was obtained with control in both the years. During 2006 100% RDF gave maximum number of filled grains panicle^{-1} which differ significantly from all other treatments. During both the years, application of 100% RDF and farmers' practice gave maximum and minimum 1000-grain weight, respectively.

Grain yield as well as biological yield of hybrid rice increased significantly with increasing levels of nutrients (Table 3). Higher grain yield under high N level was due to adequate N supply, which contributed to increase dry matter production. Productivity of crop is collectively determined by vegetative growth and yield attributes. Better vegetative growth coupled with higher yield attributes resulted in higher grain and straw yield of hybrid rice (Dwidevi *et al.,* 2006). Though the highest grain yield (5.3 and 5.5 t ha^{-1} in 2005 and 2006, respectively) was achieved with 100% RDF but no significant difference was observed with other treatments having organic and inorganic combinations. Treatments including control, 50% RDF and farmers' practice produced very poor grain yield in both the years. Singh and Subbaiah (2007) reported that interaction of hybrids and increasing levels of NPK on grain yield was significant during wet season. Integration of GLM with chemical fertilizers brought down the C:N ratio to 10:1, consequently resulting in additional mineralization and availability of N to the crop, to give a higher rice yield (Mahavishnan *et al.,* 2003). Data on biological yield suggested that during 2005, though application of 100% RDF gave maximum biological yield but did not differ significantly from 75% RDF + 25% RD of N as GLM. In both the years of study, application of 50% RDF and 75% RDF produced minimum and maximum HI, respectively.

The hybrid rice gave highest net return (₹ 13,425 ha^{-1}) and B:C ratio (0.61) with 100% RDF (Table 3). This treatment was followed by the treatment having 75% RDF + 25% RD of N as GLM (₹ 11,725 ha^{-1}; 0.53). On the other hand farmers' practice gave lowest net return and B:C ratio (₹ 7,225 ha^{-1}, 0.33). Banerjee and Pal (2009) also opined that maximum net return and return per rupee investment was recorded with 50% recommended NPK through fertilizer along with 50% NPK through GLM during wet season. Singh and Subbaiah (2007) reported that green manure + 50% recommended NPK recorded higher net return and B:C ratio than 100% NPK application. Highest net return

Table 3. Effect of nutrient management on yield of hybrid rice and economics (Mean of two years)

Treatment	Grain yield (t ha^{-1})		Biological yield (tha^{-1})		Harvest Index (%)		Total cost (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
	2005	2006	2005	2006	2005	2006			
Control	4.2	4.3	8.8	9.2	47.7	46.7	20,500	7,375	0.36
50% RDF (40-20-20 kg N-P-K ha^{-1})	4.5	4.6	9.6	10.0	46.9	46.0	21,300	8,625	0.40
75% RDF (60-30-30 kg N-P-K ha^{-1})	4.9	5.0	10.0	10.5	49.0	47.6	21,700	10,650	0.50
100% RDF (80-40-40 kg N-P-K ha^{-1})	5.3	5.5	11.1	11.8	47.7	46.6	22,000	13,425	0.61
50% RDF + 50% RD of N as FYM	4.8	4.9	10.1	10.4	47.5	47.1	22,500	9,300	0.41
75% RDF + 25% RD of N as FYM	5.0	5.2	10.3	10.7	48.5	48.6	22,300	11,000	0.50
50% RDF + 50% RD of N as CR	4.9	5.0	10.2	10.8	48.0	47.6	21,000	11,400	0.54
75% RDF + 25% RD of N as CR	5.0	5.1	10.3	10.8	48.5	47.2	22,500	10,550	0.47
50% RDF + 50% RD of N as GLM	4.0	5.1	10.3	10.8	38.8	47.2	22,000	8,300	0.38
75% RDF + 25% RD of N as GLM	5.1	5.2	10.6	11.0	48.1	47.3	22,000	11,725	0.53
Farmers' practice (60-30 kg N-P ha^{-1})	4.3	4.5	9.0	9.5	47.8	47.4	21,600	7,225	0.33
CD (P=0.05)	0.5	0.7	0.6	0.8	-	-	-	1740.0	0.09

Urea– ₹ 4.50kg^{-1}, SSP–₹ 3.00kg^{-1} and MOP–₹ 5.00kg^{-1}; FYM–₹ 200 ton^{-1}, CR – ₹ 250 ton^{-1} and GLM–₹ 150kg^{-1}; Paddy–₹ 6,000 ton^{-1} and Straw – ₹ 500 ton^{-1}

could be possible through higher yields obtained with integration of cost effective organic sources of nutrients (Sathesh Kumar *et al.,* 2007).

Considering the cost of chemical fertilizer and environmental pollution, INM can be adopted for better performance of hybrid rice during wet season in West Bengal, which involves meeting a part of nutrient need of crop through green leaf manuring with *Sesbania* along with chemical fertilizers.

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