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RESEARCH PAPER

Nutrient management option for maximizing productivity and profitability of rice – rice system

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Abstract : Field experiments conducted consecutively for three years during *Kharif* and *Rabi* seasons on Godavari alluvial soils revealed that during *Kharif*, application of 75 per cent recommended NPK coupled with 25 per cent recommended N through green manure recorded the higher grain yield. During *Rabi*, substitution of 50 per cent N through any of the organic sources to *Kharif* followed by application 100 per cent RDF to *Rabi* resulted in significantly higher grain yield. Substitution of 50 per cent rec. N through green manure during *Kharif* and application of 100 per cent RDF to *Rabi* crop recorded higher system grain yield (12315 kg/ha) as well as protein yield(862 kg/ha) and gross returns (Rs 73890/- per ha), Where as the net returns and B:C ratio of the system were higher with substitution of 25 per cent rec. N through green manure during *Kharif* and application of 75 per cent RDF to *Rabi* and was closely followed by 100 per cent RDF during both the seasons.

Key Words : Rice, Nutrient management, Grain yield, Economics

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INTRODUCTION

Rice (*Oryza sativa* L.) is the main staple food crop of India. In modern agriculture, efficient nutrient management has emerged as one of the most important factors in sustaining high production levels, besides conserving soil fertility of intensive cropping systems. Intensive cultivation of land without conservation of soil fertility would lead to springing up of deserts (Swaminathan, 1987). Continuous use of high level of chemical fertilizers had led to soil degradation problems causing serious stagnation and declining productivity of various rice ecosystems. Integrated nutrient management being an information intensive and location specific, achieves a better synchronization of nutrient release with the crop needs, which is a key step in realizing the production targets on sustainable basis. Keeping the above points in view, the present study was undertaken to find out an effective nutrient management option for rice-rice system.

MATERIALS AND METHODS

Field experiments were conducted on rice (*Oryza sativa* L.) consecutively for three years during *Kharif* and *Rabi* seasons of 2005-06, 2006-07 and 2007-08 on Godavari alluvials (Vertic chromusters) at Andhra Pradesh Rice Research Institute, Maruteru, A.P. India (26.38^0 N, 84. 44^0 E and 5 m above mean sea level). The soil was clay loam having pH 7.1, organic carbon 0.9 per cent, available P_2O_5 38 kg/ha and K_2O 344 kg/ha. The trial consisted of twelve treatments (Table A) replicated thrice in Randomised Block Design.

MTU 1001 (135 days duration) during *Kharif* and MTU 1010 (120 days duration) during *Rabi* were the test varieties planted 24 to 26 days old seedlings at a spacing of 20 cm x 15 cm during *Kharif* 15 x 15 cm during *Rabi* with 2-3 seedlings per hill. Weeds were controlled by application of pre emergence herbicide pretilachlore @ 0.75 kg a.i per hectare followed by one hand weeding at 40 days after transplanting. Water was maintained at a depth of 2 cm up to panicle initiation and 5 cm thereafter up to one week before harvest. The field was drained before application of fertilizers and one week before harvest. Manures and fertilizers were applied as per the treatmental requirement through urea, SSP, MOP. Entire P and K and 1/3 recommended N was applied as basal, remaining

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Table a : Treatments

Treatment	*Kharif*	*Rabi*
T_1	No fertilizer, no organic manure	No fertilizer, no organic manure
T_2	50% Rec. NPK dose through fertilizers	50% Rec. NPK through fertilizers
T_3	50% Rec. NPK dose through fertilizers	100% Rec. NPK through fertilizers
T_4	75% Rec. NPK dose through fertilizers	75% Rec. NPK through fertilizers
T_5	100% Rec. NPK dose through fertilizers (60-40-40 N P K)	100% Rec. NPK dose through fertilizers (120-60-40 N P K)
T_6	50% Rec. NPK through fertilizers + 50% Rec. N through FYM	100% Rec. NPK through fertilizers
T_7	75% Rec. NPK through fertilizers + 25% Rec. N through FYM	75% Rec. NPK through fertilizers
T_8	50% Rec. NPK through fertilizers + 50% Rec. N through paddy straw	100% Rec. NPK through fertilizers
T_9	75% Rec. NPK through fertilizers + 25% Rec. N through paddy straw	75% Rec. NPK through fertilizers
T_{10}	50% Rec. NPK through fertilizers + 50% Rec. N through green manure.	100% Rec. NPK through fertilizers
T_{11}	75% Rec. NPK through fertilizers + 25% Rec. N through green manure.	75% Rec. NPK through fertilizers
T_{12}	Conventional farmer's practice (60-40-0 NPK)	Conventional farmer's practice (120-40-0 NPK)

N was applied in two splits at active tillering and panicle initiation. Organic manures were applied based on their nutrient content and incorporated two weeks before planting.The experiments received uniform plant protection and cultural management practices throughout the period of crop growth.

RESULTS AND DISCUSSION

Three years pooled data reveal that during *Kharif,* application of 75 per cent recommended NPK coupled with 25 per cent N through green manure recorded the higher grain yield (5731 kg/ha) which was 6 per cent higher than 100 per cent RDF (Table 1). Subashchandra *et al*. (2001) also reported similar findings *i.e.* application of 25 per cent N through GM + 75 per cent NPK through fertilizer recorded comparable yield of rice with that of 100 per cent recommended NPK. The increase in yield was mainly due to more number of panicles (362 /m^2), higher number of filled grains (143 grains/panicle) and higher panicle weight (3.6 g). Application of 25 or 50 per cent N through green manure + remaining N through urea significantly increased panicles m^{-2}, grains per panicle, 1000 grain weight over 100 per cent N through fertilizer (Prasad, 2000). Mineralization of green manures ensured a continuous supply of NH_4^+-N, which was preferred and readily absorbed by the low land rice crop, resulting in better growth, yield structure and yield was reported by Siddeswaran (1992). However, substitution of 25 and 50 per cent recommended N through sesbania green manure produced grain yield at par to substitution of 25 rec. N through FYM and100 per cent RDF. Pandey *et al*. (2001) reported that green manuring combined with prilled urea proved better than prilled urea alone increasing grain, straw yields and the yields were comparable with that of received with FYM. Substitution of 50 rec. N through FYM

Table 1 : Effect of nutrient management on yield attributes and yield of *Kharif* rice (Pooled data three years)

Treatments	Grain yield (kg/ha)	No of panicles /m^2	Filled grains /panicle	Panicle weight (g)
T_1- No fertilizer (Control)	2194	204	88	2.27
T_2-50% RDF	4088	280	108	2.70
T_3.50% RDF	4132	296	110	2.93
T_4.75% RDF	4799	316	122	3.12
T_5-100% RDF(60-40-40 NPK)	5385	344	133	3.34
T_6-50% RDF + 50% FYM- N	5050	345	132	3.52
T_7-50% RDF + 25% FYM- N	5530	352	135	3.60
T_8-50% RDF + 50% P.S- N	4484	309	120	3.17
T_9-50% RDF + 25% P.S- N*	4744	321	123	3.27
T_{10}-50% RDF + 50% GM- N*	5463	319	136	3.60
T_{11}-50% RDF + 25% GM- N	5731	362	143	3.60
T_{12}-Farmers practice(60-40-0 NPK)	4506	296	113	2.90
S.E. ±	131	14.3	3.3	0.13
C.D. (P=0.05)	370	42	8.0	0.39

*PS-N = Nitrogen through paddy straw ; GM-N = Nitrogen through green manure

recorded significantly lower grain yield compared to substitution of 25 rec. N through FYM, green manure and100 per cent RDF. Substitution of 25 and 50 per cent recommended N through paddy straw showed significantly poor performance as compared to green manure/FYM or 100 per cent RDF. It shows the possibility to substitute 25 per cent of the fertilizer needs of *Kharif* rice thorough organic sources of N particularly green manuring or FYM. Paddy straw integration was found ineffective in sustaining the production levels of rainy season rice. Wider C:N ratio and higher cellulo-lignin content of paddy straw results in immobilization of N might be the reason behind this. Increasing doses of NPK fertilizers from 0 to 50 per cent, 50 to75 per cent and 75 to100 per cent significantly increased the grain yield by each increment and the increase was 86 per cent, 33 per cent and 26 per cent, respectively indicating the need of 100 per cent fertilizer application.

During *Rabi,* substitution of 50 per cent N through any of the organic sources to *Kharif* crop followed by application 100 per cent RDF to *Rabi* crop resulted significantly higher grain yield as compared to substitution of 25 per cent N through any of the organic sources to *Kharif* crop followed by application 75 per cent RDF to *Rabi* crop (Table 2). It was possible to substitute 25 to 50 per cent needs of *Kharif* rice by FYM without any adverse effect on the total productivity of a rice based cropping system (Hegde, 1996). (Blaise and Prasad, 1996) explained the reason for this as rice crop supplied with adequate N produces more number of tillers, leaf area, dry

Table 2 : Effect of nutrient management on yield attributes and yield of *Rabi* rice (Pooled data three years)

Treatments	Grain yield (kg/ha)	No. of panicles /m^2	Filled grains /panicle	Panicle weight (g)
T_1- No fertilizer (Control)	1850	186	63	1.66
T_2-50% RDF *	3758	317	93	2.10
T_3.100% RDF	6010	393	111	2.53
T_4.75% RDF	5486	362	113	2.37
T_5-100% RDF (120-60-40 NPK)	6576	395	132	2.57
T_6-100% RDF	6848	412	155	2.78
T_7.75% RDF	6368	391	132	2.42
T_8-100% RDF	6853	409	150	2.69
T_9.75% RDF	6373	383	133	2.44
T_{10}-100% RDF	6852	404	146	2.68
T_{11}.75% RDF	6306	383	128	2.34
T_{12}- Farmers Practice(12-60-0 NPK)	5491	370	99	2.05
S.E. ±	117	21.7	6.6	0.08
C.D. (P=0.05)	331	63	19	0.24

*RDF= Recommended dose of Fertilizer

Table 3 : Effect of nutrient management on system yield and economics of rice-rice system (Pooled data three years)

Treatments	System grain yield (kg/ha)	System protein yield (kg/ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
T_1	4044	283	24264	-3714	0.87
T_2	7846	549	47076	17888	1.61
T_3	10142	710	60852	31664	2.08
T_4	10285	720	61710	31737	2.06
T_5	11961	837	71766	41368	2.36
T_6	11898	833	71388	37226	2.09
T_7	11898	833	71388	38294	2.16
T_8	11337	794	68022	35584	2.10
T_9	11117	778	66702	36460	2.21
T_{10}	12315	862	73890	41218	2.26
T_{11}	12037	843	72222	41806	2.37
T_{12}	9997	700	59982	30284	2.02
S.E. ±	192	94	1567	1034	0.06
C.D. (P=0.05)	540	264	4574	3018	0.17

matter, yield attributes and there by higher yields. However it was at par to application of 100 per cent RDF during both the seasons. It shows that the yield attributes like panicles /$m^{2,}$ filled grains per panicle and 1000 grain weight were higher with substitution of 50 per cent N through any of the organic sources to *Kharif* crop followed by application 100 per cent RDF to *Rabi* crop. The performance of all the organic sources applied to *Kharif* crop were at par during *Rabi.* Increasing doses of NPK fertilizers from 0 to 50 per cent, 50 to75 per cent and 75 to100 per cent registered very significant increase in grain yield by each increment and the increase was 103 per cent, 94 per cent and 58 per cent, respectively. Which shows very high response to the fertilizer application during *Rabi* compared to *Kharif.*

Rice-rice system responded very well to different fertilizer treatments as all the fertilizer treatments were significantly superior over unfertilized control. Substitution of 50 per cent reccommended N by green manuring during *Kharif* and application of 100 per cent RDF to *Rabi* crop recorded higher system grain yield (12315 kg/ha) as well as protein yield (862 kg/ha) (Table 3). Organic materials might have modified and increased the soil physical conditions to enhance the grain yield of rice as suggested by Larsen and Clapp (1984). However, substitution of 25 or 50 per cent rec. N through green manure or FYM produced similar effect on system grain yield and were at par to 100 per cent RDF. Importance of supplying part of N requirement through farm available organic sources for realizing higher yield and economic returns was also reported by Abrol and Katyal, (1990). On the other hand substitution of either 25 per cent or 50 per cent reccommended N through paddy straw proved inferior as compared to green manuring/FYM and recorded significantly lower grain yield. Increasing doses of NPK fertilizers from 0 to 50 per cent, 75 per cent and to100 per cent increased grain yields by 94 per cent, 154 per cent and 196 per cent, respectively. Deleting of K from fertilizer schedule reduced the grain yield to an extent of 16.4 per cent. Similar findings of omission of K fertilisers resulted in reduction of grain yield to the tune of 15.3 per cent and 16.6 per cent during *Kharif* and *Rabi*, respectively was reported by Rao *et al*. (2007).

Economic analysis of the system reveals that substitution of 50 per cent reccommended N by green manuring during *Kharif* and application of 100 per cent RDF to *Rabi* crop recorded higher gross returns (Rs. 73890/- per ha), however, it was at par substitution of 25 or 50 per cent reccommended N through green manure or FYM during *Kharif* followed by 100 per cent RDF during *Rabi* and 100 per cent RDF during both the seasons. Where as the net returns and B:C ratio of the system were higher with substitution of 25 per cent reccommended N through green manuring during *Kharif* and application of 75 per cent RDF to *Rabi* and was closely followed by 100 per cent RDF during both the seasons and substitution of 50 per cent Rec. N by sesbania green manuring. Similar findings of higher gross returns with green manure integration and at par net returns with green manure integration and 100 per cent RDF to rice were reported by Rao *et al*. (2006). Since the cost of N supplied through chemical fertilizer was relatively cheaper than any other organic sources of N.

Thus the results reveal that substitution of 50 per cent reccommended N of *Kharif* rice through organic sources and 100 per cent fertilization to *Rabi* rice through minerals fertilisers was the best fertilisers option in rice-rice system in Godavari delta and significant yield reduction was observed with any reduction in fertiliser dose to either of the seasons. The study also indicates that rice –rice system in Godavari delta requires application of 100 per cent recommended dose of fertilisers during both seasons to double the system productivity as compared to no fertiliser application.The system productivity was declined by 29 per cent and 18 per cent when the recommended fertiliser dose was reduced to 50 per cent and 25 per cent, respectively.

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