Studies on nutrient management practice in rice-rice crop sequence under new alluvial zone of West Bengal

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ABSTRACT

Comparative effect of manuring on yield, under farmers' practice, recommended practice and practice on the basis of soil test under rice-rice cropping system was studied at Regional Research Sub-Station, Bidhan Chandra Krishi Viswavidyalaya, West Bengal. The results revealed that the highest growth, yield attributes, grain and straw yield (4.15 and 4.61 t ha^{-1} during wet season and 5.90 and 6.10 t ha^{-1}during boro season) as well as system productivity (10.05 t ha^{-1}) were recorded when the crop received 100 % recommended doses of NPK on the basis of soil test along with Zn @ 20 kg $ZnSO_4$ ha^{-1} during both the seasons resulting in 53.90 % yield increase over control. This treatment also gave the highest value of net return (Rs. 25730 ha^{-1}) and return per rupee investment (1.70). Thus a nutrient management system can be adopted for sustained crop production, which involved nutrient application on the basis of soil test along with micronutrient application in the deficient soil.

Key words: *Primary nutrients, micronutrients, growth, yield, uptake, economics, rice*

In India rice (*Oryza sativa* L.) – rice cropping system occupies the second highest area next to rice – wheat system, while it is the most predominant system in West Bengal. In many areas of this state water-logging is a very serious problem where the farmers have no other option but to go for rice-rice cropping system (Pal and Banerjee, 2006). Taking cognition of the fact that bulk of total food grain production in India (42.79 %) is contributed by rice (Chaturvedi and Ali, 2002), proper technology should be developed to boost up its production substantially. It, therefore, necessitates adoption of advance agro-techniques for narrowing the yield gap and adopting new eco-friendly technology, which can boost the present rice yield as well as break the ceiling on yield. This calls for balanced use of fertilizers according to the soil requirements along with application of different secondary and micronutrients. The combined use of primary, secondary and micronutrients help in maintaining yield stability through correction of marginal deficiencies of these nutrients enhancing efficiencies of applied nutrients and providing favourable soil physical condition (Banerjee *et al.*, 2006.). The pre sent investigation was planned to develop a suitable integrated nutrient supply system in a rice-rice crop sequence.

MATERIALS AND METHODS

Field experiments were conducted during wet season and *boro* seasons of 2004-05 and 2005-06 in new alluvial zone of West Bengal at Regional Research Sub-Station, Bidhan Chandra Krishi Viswavidyalaya, Chakdaha, Nadia. The farm where the experiment was conducted is situated at new alluvial zone (NAZ) of West Bengal at 23^0 5.32 N latitude and 83^0 5.32 E longitudes and at an elevation of 9.75 m above the mean sea level. The land topographically is referred to as medium land and medium in fertility with good drainage facility. The soil was sandy clay loam in texture (Entisol) having pH 7.10, EC 6.60 ds m^{-1}, organic carbon 0.67%, available P_2O_5 16.00 kg ha^{-1} and available K_2O 125.00 kg ha^{-1}. The experiment was laid out in a randomized block design with 6 treatments viz. T_1, Farmers' practice i.e. 40 : 36 : 44 kg N, P_2O_5 and K_2O ha^{-1} during wet season and 153 : 54 : 113 kg N, P_2O_5 and K_2O ha^{-1} during *boro* season, T_2, Farmers' practice + Zn @ 20 kg $ZnSO_4$ ha^{-1}, T_3, Recommended dose (RD) of NPK i.e.

60 : 30 : 30 kg N, P_2O_5 and K_2O ha^{-1} during wet season and 100 : 50 : 50 kg N, P_2O_5 and K_2O ha^{-1} during *boro* season, T_4, RD of NPK + Zn @ 20 kg $ZnSO_4$ ha^{-1}, T_5, Soil test based recommendation i.e. 80 : 40 : 40 kg N, P_2O_5 and K_2O ha^{-1} during wet season and 120 : 60 : 50 kg N, P_2O_5 and K_2O ha^{-1} during *boro* season + Zn @ 20 kg $ZnSO_4$ ha^{-1} in each season and T_6, Control i.e. no fertilization) each with 4 replications. 21 and 40 days old seedlings of rice var. IET 4094 (Khitish) were transplanted with 3-4 seedlings $hill^{-1}$) during 4th week of July and 4th week of January at a spacing of 20 cm × 15 cm and 20 cm × 10 cm during wet and *boro* season, respectively. Half dose of N in the form of Urea, full dose of P_2O_5 (Single Super Phosphate), K_2O (Muriate of Potash) and Zn ($ZnSO_4$) were applied as basal during final land preparation as per treatment. The rest half of N was topdressed in two equal splits; one at active tillering and the other at panicle initiation stage. All the plant protection measures were taken as and when required. The rice plant were harvested on 14.10.2004 and 30.10.2005 during wet season and 05.05.2005 and 09.05.2006 during *boro* season, respectively.

RESULTS AND DISCUSSION

A significant response was obtained from different treatments towards growth attributes of rice during wet and *boro* seasons. The highest plant height (92.83 and 98.45 cm during wet and *boro* season, respectively) and dry matter accumulation (790.76 and 1198.28 g m^{-2} during wet and *boro* seasons, respectively) were recorded when the crop was fertilized with 100 % RD of NPK on the basis of soil test values in combination with Zn @ 20 kg $ZnSO_4$ ha^{-1} (Table 1). This was closely followed by the treatment having application of 100 % RD of NPK without soil test along with 20 kg $ZnSO_4$ ha^{-1} towards plant height but significantly higher in dry matter accumulation. The trend of variation of the leaf area index and crop growth rate at different stages were similar to that of dry matter production i.e. the highest LAI (4.65 and 5.19 during wet and *boro* season, respectively) and CGR (13.36 and 23.72 g m^{-2} day^{-1} during wetand *boro* season, respectively) were obtained due to application of 100 % RD of NPK on the basis of soil test along with 20 kg $ZnSO_4$ ha^{-1}. Khanda *et al.* (1997) also reported similar results. Both control and farmers' practice, i.e. unbalanced application of nutrients showed poor results with respect to all the growth attributing characters of rice.

During both kharif and boro season the highest number of panicles m^{-2} (401 and 485, respectively), filled grains $panicle^{-1}$ (130.1 and 146.9, respectively), 1000-grain weight (18.46 and 21.70 g, respectively), grain yield (4.15 and 5.90 t ha^{-1}, respectively), straw yield (4.61 and 6.10 t ha^{-1}, respectively) and system productivity (10.05 t ha^{-1}) were recorded when the crop received 100 % RD of NPK on the basis of soil test along with 20 kg $ZnSO_4$ ha^{-1} (Table 2). This treatment

Table 1. Effect of different nutrient management practices on growth attributing characters of rice during wet and boro season (Pooled data of two years)

Treatment	Plant height (cm) at harvest		Dry Matter accumulation (g m^{-2}) at harvest		Leaf area index (LAI) at 60 DAT		CGR (g m^{-2} day^{-1}) during 60-75 DAT	
	Wet	Boro	Wet	Boro	Wet	Boro	Wet	Boro
T_1=Farmers' practice 40:30:44 kg N, P_2O_5 and K_2O ha^{-1}	80.70	90.99	629.35	840.28	3.97	4.88	12.58	16.27
T_2=Farmers' practice + Zn @20 kg $ZnSO_4$ ha^{-1}	90.99	91.41	706.20	875.26	4.03	4.95	12.69	16.34
T_3=Recomended dose + 60:30:30 kg P_2O_5 and K_2O ha^{-1}	91.29	96.28	752.35	888.90	4.20	5.07	12.81	16.77
T_4=Recomended dose + Zn @20 kg $ZnSO_4$ ha^{-1}	92.58	97.04	754.71	931.25	4.60	5.17	13.12	17.95
T_5= Soil test based dose 80:40:40 kg NP_2O_5 and K_2O ha^{-1}	92.83	98.45	790.76	1198.28	4.65	5.19	13.36	23.72
T_6=Control (no fertilizer)	80.12	84.70	518.05	702.15	2.81	3.72	9.64	11.29
S.Em (±)	1.35	1.50	17.25	21.01	0.14	0.06	0.90	2.01
CD (P=0.05)	3.93	4.37	50.20	61.15	0.43	0.18	2.63	5.86

DAT=days after transplanting

Table 2. Effect of nutrient management practices on yield components and yield of rice during both wet and boro season (Pooled data of two years)

Treatment	Number of panicles m^{-2}		Filled grains panicle^{-1}		1000-grain weight (g)		Grain yield (t ha^{-1})		Straw yield (t ha^{-1})		System productivity (t ha^{-1})
	Wet	Boro	Wet	Boro	Wet	Boro	Wet	Boro	Wet	Boro	
T_1	350	452	101.8	113.2	17.12	20.67	3.00	5.35	3.85	5.75	8.35
T_2	355	458	113.8	120.6	17.19	20.96	3.64	5.40	3.95	6.10	9.04
T_3	385	465	124.3	128.8	17.34	20.98	3.86	5.45	4.15	6.20	9.31
T_4	395	475	125.5	137.8	17.99	21.60	3.93	5.64	4.50	6.45	9.57
T_5	401	485	130.1	146.9	18.46	21.70	4.15	5.90	4.61	6.10	10.05
T_6	250	330	60.1	70.51	15.06	18.00	2.60	3.93	2.75	5.45	6.53
S.Em (±)	3.24	3.47	2.51	2.97	0.12	0.15	0.08	0.10	0.07	0.11	-
CD (P=0.05)	9.45	10.11	7.31	8.66	0.37	0.45	0.24	0.31	0.21	0.34	-

T_1=Farmers' practice 40:30:44 kg N, P_2O_5 and K_2O ha^{-1}; T_2= Farmers' practice + Zn @20 kg $ZnSO_4$ ha^{-1}; T_3= Recomended dose + 60:30:30 kg, P_2O_5 and K_2O ha^{-1}; T_4= Recomended dose + Zn @20 kg $ZnSO_4$ ha^{-1}; T_5= Soil test based dose 80:40:40 kg NP_2O_5 and K_2O ha^{-1}; T_5= Control (no fertilizer)

had 53.90 % increase in grain yield over control. On the other hand farmers' practice and control treatment showed very poor results. These results corroborated with the findings of Channabasavanna *et al*. (2001). The next highest production was recorded when the crop was fertilized with 100 % RD of NPK without soil test along with 20 kg $ZnSO_4$ ha^{-1} during both kharif and boro seasons (46.55 % increase over control). However, these two treatments were at par with each other. The farmers' practice of avoiding application of micronutrients without soil test showed very poor system productivity (8.35 t ha^{-1}) due to unbalanced nutrition of the crop.

The economics of different treatments in both wet and *boro* season under rice-rice cropping sequence were worked out and the data have been depicted in the Table 3. In this cropping sequence the highest gross return (Rs. 62451 ha^{-1}), net return (Rs. 25730 ha^{-1}) and return per rupee investment (1.70) were obtained when the crop received 100 % RD of NPK on the basis of

Table 3. Economic analysis of the rice-rice crop sequence (Pooled data of two years)

Treatment	Cost of cultivation except cost of fertilizer (Rs. ha^{-1})	Cost of fertilizer	Total cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1}) (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Return rupee^{-1} investment
T_1=Farmers' practice 40:30:44 kg N, P_2O_5 and K_2O ha^{-1}	30561	4946	35507	51994	16487	1.46
T_2=Farmers' practice + Zn @20 kg $ZnSO_4$ ha^{-1}	32126	5410	37536	55296	18390	1.47
T_3=Recomended dose + 60:30:30 kg, P_2O_5 and K_2O ha^{-1}	32126	4229	36355	56947	20592	1.56
T_4=Recomended dose + Zn @20 kg $ZnSO_4$ ha^{-1}	32126	4317	36443	59438	22996	1.63
T_5= Soil test based dose 80:40:40 kg NP_2O_5 and K_2O ha^{-1}	32126	4595	36721	62451	25730	1.70
T_6=Control (no fertilizer)	32126	0	32126	42667	10541	1.32
S.Em (±)	-	-	-	704	704	0.03
CD (P=0.05)	-	-	-	2049	2049	0.08

Prices : Urea – Rs. 5.00 kg^{-1}, SSP – Rs. 4.00 kg^{-1}, MOP – Rs. 4.50 kg^{-1} and $ZnSO_4$ – Rs. 30.00 kg^{-1}, Paddy – Rs. 6000.00 Ton^{-1} and Straw – Rs. 500.00 Ton^{-1}

Table 4. Nutrient uptake after rice harvest during kharif and boro season (Mean data of two years)

Treatment	Uptake of N (kg ha^{-1})		Uptake of P (kg ha^{-1})		Uptake of K (kg ha^{-1})	
	Wet	Boro	Wet	Boro	Wet	Boro
T_1=Farmers' practice 40:30:44 kg N, P_2O_5 and K_2O ha^{-1}	78.1	79.6	17.2	20.8	30.3	42.4
T_2=Farmers' practice + Zn @20 kg $ZnSO_4$ ha^{-1}	80.6	83.6	18.7	22.4	34.4	44.3
T_3=Recomended dose + 60:30:30 kg, P_2O_5 and K_2O ha^{-1}	82.3	85.2	19.4	23.7	40.5	51.7
T_4=Recomended dose + Zn @20 kg $ZnSO_4$ ha^{-1}	83.9	87.7	21.7	24.5	42.3	49.5
T_5= Soil test based dose 80:40:40 kg, NP_2O_5 and K_2O ha^{-1}	84.4	89.4	21.8	29.5	48.2	58.6
T_6=Control (no fertilizer)	42.9	50.1	10.2	15.4	20.5	27.3

soil test in combination with micronutrient i.e. Zn @ 20 kg $ZnSO_4$ ha^{-1} during both wet and *boro* season. Application of 100 % RD of fertilizers without soil test along with 20 kg $ZnSO_4$ ha^{-1} in both wet and *boro* season also gave satisfactory gross return (Rs. 59438 ha^{-1}), net return (Rs. 22996 ha^{-1}) and return per rupee investment (1.63).

Uptake of N, P and K in rice was highest (84.4, 21.8 & 48.2 kg ha^{-1}, respectively during wet season and 89.4, 29.5 and 58.6 kg ha^{-1}, respectively during boro season) when the crop was fertilized with 100 % RD of NPK on the basis of soil test values along with 20 kg $ZnSO_4$ ha^{-1} during both the season (Table 4). This was closely followed by the treatment having application of 100 % RD of nutrients through chemical fertilizers (without soil test) along with 20 kg $ZnSO_4$ ha^{-1} in respect of nitrogen and phosphorus. Khanda *et al.* (1997) supported these results.

Considering the system productivity and economics of production under rice-rice cropping sequence it may be concluded that a nutrient management system can be developed for sustained crop production that involves soil test based recommendation of NPK fertilizers along with micronutrient application in the deficient soil.

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