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Production potentiality of rice in rice-rapeseed-greengram cropping sequence under system based nutrient management

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ABSTRACT

Field experiment was conducted with an objective to formulate optimum system based nutrient management of rice in rice-rapeseed-greengram sequence. The results revealed that recommended NPK at 60:30:30 produced maximum grain and straw yield but integrated use of NPK (50%) + FYM at 10 t ha^{-1} produced higher yield of rice which was statistically at par with recommended NPK, moreover integrated use of NPK increased soil fertility status. With the increase in the dose of FYM, significant increase of organic carbon, total N and available phosphorus in soil after harvest of rice was observed. Organic carbon and available phosphorus was found lowest with 100% NPK to rice as compared to other treatments. The maximum organic carbon and total nitrogen content was recorded with integrated use of NPK whereas FYM at 5 t ha^{-1} + neem cake at 0.2 t ha^{-1} recorded maximum available P_2O_5 after rice. The maximum available K_2O was observed in recommended NPK followed by integrated use of NPK. With the increase of FYM, available K_2O was increased and found maximum in FYM at 10 t ha^{-1} to rice.

Key words: *Rice, INM, soil status*

Traditional use of FYM has proven essential for protecting nutrient loss through leaching and better soil health in rainfed lowland rice (Wade and Ladha, 1995). However, neither the chemical fertilizer alone nor the organic sources exclusively is capable to achieve the production sustainability to the present level. The integrated use of organic manure with chemical fertilizer was found to be essential to achieve maximum yield and good soil health (Tripathi and Choubey, 1996). Hence, the present investigation was carried out to study the effect of different system based nutrient management on productivity, economics and soil fertility status under rice-rapeseed-greengram cropping sequence.

MATERIALS AND METHODS

Field experiment was conducted during 1998-1999 and 1999-2000 in the alluvial soils of lower gangetic plain of West Bengal with eleven system based nutrient managements *i.e.* T_1- FYM at 10 t ha^{-1} to rice, T_2- FYM at 5 t ha^{-1} to rice + neem cake at 0.2 t ha^{-1} to rice, T_3- FYM at 5 t ha^{-1} to rice + neem cake at 0.1 t ha^{-1} to rice, T_4- recommended doses of NPK to rice at 60:30:30 kg ha^{-1} of N: P_2O_5: K_2O, T_5- FYM at 10 t ha^{-1} + 50% NPK to rice, T_6- FYM at 5 t ha^{-1} to rice, T_7- FYM at 8 t ha^{-1} to rice + FYM 2 t ha^{-1} to rapeseed, T_8 – FYM at 5 t ha^{-1} + neem cake at 0.2 t ha^{-1} to rapeseed, T_9 – FYM at 5 t ha^{-1} to rice + neem cake at 0.1 t ha^{-1} to rapeseed, T_{10} – recommended doses of NPK to rice along with rapeseed at 80 : 40 : 40 kg ha^{-1} of N : P_2O_5 : K_2O, T_{11} – recommended doses of NPK to rice and rapeseed along with greengram at 20 : 40 : 0 kg ha^{-1} of N : P_2O_5 : K_2O. The experiment was laid out in a randomized block design where each nutrient management treatment was randomly allocated in three replications. Observation on grain, straw yield and different yield attributing characters were recorded at harvest. The soil samples under each treatment were analysed by standard methods (Jackson, 1973) in respect of pH, organic carbon, total nitrogen, available phosphorus and available potassium (Muhr *et al*., 1965). The plant samples of both grain and straw from each treatment were analysed for total N, P and K (Bhargava and Raghupati, 1995). Economic analysis of each nutrient management treatment was calculated component wise.

RESULTS AND DISCUSSION

Highest grain yield of rice was recorded in recommended doses of N,P and K treatment (T_{11}, T_{10} and T_4) with no significant differences whereas they differed significantly as compared to integrated use of FYM and N,P,K treatment (T_5) (Table 1). Straw yield was also found highest in T_{11} and T_{10} treatment followed by T_5 but they did not differed significantly. Among the organic sources, a combination of FYM and neem cake (T_2) showed better result in respect of grain yield, straw yield, number of filled grain panicle^{-1} and number of panicle m^{-2} followed by only FYM application to rice (T_1).

Harvest index, number of panicle m^{-2} and number of filled grain panicle^{-1} were also influenced significantly with different nutrient management (Table 1) where higher values were recorded in T_4, T_{10} and T_4 treatments, respectively, vindicating supremacy of recommended doses of N, P and K.

Total uptake of N,P and K in rice were influenced significantly with the nutrient management (Table 2). Significantly higher N uptake was recorded in recommended NPK (T_{11},T_{10},T_4) followed by 50 % NPK + FYM (T_5). With the increase in doses of FYM from FYM at 5 t ha^{-1} (T_6, T_8 and T_9) to FYM at 10 t ha^{-1} (T_1) total N uptake was also increased significantly. Sharma and Mitra (1990) also observed similar result.

In regard to soil fertility status, except pH, the organic C, total N, available P and K were affected significantly by the different nutrient management (Table 3). The increasing levels of FYM recorded increasing content of organic C in soil after rice in which T_1 (FYM at 10 t ha^{-1}) was found superior followed by T_7 (FYM at 8 t ha^{-1}). Swarup and Yaduvanshi (2000) also reported similar result with FYM. Integrated use of NPK (50%) and FYM at 10 t ha^{-1} (T_5) showed higher organic C content after T_1. The recommended NPK (T_{11},T_{10}, T_4) doses recorded lowest organic C content. The total N content was found highest in integrated nutrient use (T_5) followed by T_1 (FYM at 10 t ha^{-1}) and T_2 (FYM + neem cake). With the increase in application of FYM, the total N content also increased significantly where T_1 showed superiority over T_7, T_6, T_8 and T_9. The microbial biomass N was found higher in fertilizer + FYM followed by only FYM resulting in higher total N content (Ghosal and Singh, 1995).

The available P content was recorded highest in T_2 followed by T_5 (integrated nutrient use) with no significant difference. Among the varying doses of FYM, FYM at 10 t ha^{-1} (T_1) recorded higher available P followed by FYM at 8 t ha^{-1} (T_7) and FYM at 5 t ha^{-1} (T_6, T_8, T_9). The numbers of fungi, ammonifying bacteria and phosphate solubilizing bacteria increased with neem cake in water logged rice soil (Das and Mukherjee, 1990). However, higher available K content was found in recommended NPK (T_{11}, T_4, T_{10}) followed by T_5 (integrated nutrient use).

Table 1. Effect of different nutrient managements on yield and yield components of rice in rice-rapeseed-greengram cropping sequence (Pooled data of two years)

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)	No. of panicle m^{-2}	No. of filled grain panicle^{-1}	Test weight (g)
T_1	25.5	47.7	34.8	342.0	55.9	21.72
T_2	27.2	51.8	34.4	345.4	64.3	21.29
T_3	26.5	49.0	35.1	331.2	60.1	22.46
T_4	30.9	54.2	36.3	369.4	73.9	22.00
T_5	29.1	56.5	33.9	373.8	67.1	21.79
T_6	22.3	43.8	33.7	270.8	50.9	20.64
T_7	24.5	46.7	34.4	306.5	56.4	21.55
T_8	23.1	44.0	34.4	276.8	49.1	21.16
T_9	21.9	44.7	33.0	285.7	52.8	22.15
T_{10}	30.9	57.8	34.8	391.7	71.5	23.11
T_{11}	31.8	59.9	34.6	388.2	72.2	24.03
S.Em(±)	0.8	1.1	0.8	5.9	1.8	0.91
CD (P=0.05)	2.4	3.2	2.4	17.4	5.3	NS

Table 2. Effect of different nutrient managements on total uptake (kg ha^{-1}) of nutrients by rice in rice-rapeseed-greengram cropping sequence (Pooled data of two years)

Treatments	Nitrogen	Phosphorus kg ha^{-1}	Potassium
T_1	76.8	15.4	180.4
T_2	85.5	17.7	201.2
T_3	76.9	15.9	183.4
T_4	99.4	26.3	237.7
T_5	94.2	26.5	227.0
T_6	59.5	12.3	140.1
T_7	70.2	14.9	166.1
T_8	62.2	12.7	145.3
T_9	60.7	12.6	144.0
T_{10}	104.8	27.2	251.8
T_{11}	108.0	28.4	263.9
S.Em(±)	1.6	0.7	3.4
CD (P=0.05)	4.7	2.1	10.0

Table 4. Economic analysis of different nutrient management in rice under rice-rapeseed-greengram sequence (pooled data of two years)

Treatments	Gross Return (Rs.ha^{-1})	Net Return (Rs.ha^{-1})	Benefit Cost ratio
T_1	26098	13828	1.12
T_2	27919	14299	1.05
T_3	27126	15056	1.24
T_4	31398	21065	2.03
T_5	29900	16849	1.29
T_6	22791	12271	1.16
T_7	25182	13612	1.17
T_8	23668	13148	1.25
T_9	22604	12084	1.15
T_{10}	31582	21249	2.05
T_{11}	32477	22144	2.14
S.Em(±)	705	705	0.06
CD (P=0.05)	2080	2080	0.18

Higher gross return, net return and benefit cost ratio were recorded in treatments receiving 100% recommended doses of NPK (T_{11}, T_{10}, T_4) followed by integrated use of NPK (50%) and FYM but there was no significant difference among treatments receiving recommended NPK (Table 4). Singh *et al.* (1998) also found maximum net return with application of 100% NPK (60: 30:30 kg ha^{-1} of N: P_2O_5: K_2O).

Hence it can be concluded that application of recommended doses of N, P and K either to all three crops (T_{11}) or in rice and rapeseed (T_{10}) or in only to rice (T_4) in rice-rapeseed-greengram sequence showed

Table 3. Effect of different nutrient managements on soil fertility status after rice in rice-rapeseed-greengram cropping sequence (Pooled data of two years)

Treatments	Soil pH		Organic C (%)		Total N (%)		Available P_2O_5 (kg ha^{-1})		Available K_2O (kg ha^{-1})	
	A	B	A	B	A	B	A	B	A	B
T_1	7.45	7.23	0.56	0.608	0.06	0.077	18.5	31.8	178.5	233.5
T_2	7.45	7.27	0.56	0.597	0.06	0.073	18.5	33.1	178.5	223.8
T_3	7.45	7.28	0.56	0.590	0.06	0.070	18.5	30.6	178.5	219.3
T_4	7.45	7.37	0.56	0.451	0.06	0.065	18.5	25.5	178.5	248.4
T_5	7.45	7.29	0.56	0.606	0.06	0.079	18.5	32.5	178.5	234.2
T_6	7.45	7.30	0.56	0.555	0.06	0.066	18.5	30.2	178.5	209.8
T_7	7.45	7.26	0.56	0.573	0.06	0.070	18.5	30.7	178.5	217.8
T_8	7.45	7.26	0.56	0.557	0.06	0.064	18.5	29.3	178.5	210.6
T_9	7.45	7.26	0.56	0.566	0.06	0.064	18.5	29.5	178.5	211.2
T_{10}	7.45	7.39	0.56	0.450	0.06	0.067	18.5	24.5	178.5	246.6
T_{11}	7.45	7.40	0.56	0.443	0.06	0.067	18.5	25.1	178.5	248.9
S.Em(±)		0.17		0.015		0.001		0.5		1.4
CD(P=0.05)		NS		0.044		0.003		1.5		4.1

* A – initial B- after rice

higher productivity but in respect of both productivity and soil health, application of FYM at10 t ha^{-1} and 50% of recommended NPK (T_5) found promising.

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