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Response of Rice (*Oryza sativa* L.) varieties to Nutrient Management in *kharif* Season under Lateritic Soil of West Bengal

Avinash B., Mahua Banerjee, Sarath Kumar Duvvada*, Sujay Kumar Paul and Ganesh Chandra Malik
Department of Agronomy, Palli Siksha Bhavana (Institute of Agriculture),
Visva Bharati, Sriniketan (West Bengal), India.

(Corresponding author: Sarath Kumar Duvvada)*
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ABSTRACT: In the twenty-first century, the major challenge in modern agriculture is to increase nutrient use efficiency, with a particular focus on nitrogen in fields of cereals. As soil test based nutrient recommendation is long process and to overcome this site specific nutrient management plays a major role in nutrient dosage decision making. Keeping this in view, a field experiment was carried out in 2017 at the farmer's field in Chella Kamarpada village of Chella G.P., Chella Mouza in Illambazar Block of Birbhum, West Bengal. The experiment consisted of two levels of varieties and six levels of nutrient management, which were replicated thrice and laid out in factorial randomized block design (FRBD). Among the two high-yielding types, Rajendra masuri proved significantly superior over Pratiksha concerning grain and straw yield, N, P, and K uptake by grain and straw and net return, which may be the combined effect of better growth potential. Different schedules of fertilizer application of nutrients based on recommendations from the decision support system like "Nutrient expert" and LCC-based application proved superior over farmer's practice and blanket application and was statistically at par with the state recommendation on growth, productivity, and economics of rice crop.

Keywords: LCC, Nutrient Expert, Nutrient management, Rice, Yield.

INTRODUCTION

Rice is one of the most important staple crops feeding more than half the global population. Ninety percent of the world's rice is grown and consumed in Asia. Rice provides 30–75% of the total calories to more than 3 billion Asians (Singh and Banjara 2021). It accounts for more than 40% of the food grain production in India. Annually, rice is cultivated in a 46.3 million ha area, producing 118.8 million tonnes (Anonymous, 2020). Rice is the maximum consumer of nitrogenous fertilizers as nitrogen is the most limiting nutrient in crop production. Also, it plays an immense role in increasing the productivity of rice. Worldwide, nitrogen use efficiency (NUE) for cereals, including rice, is as low as 30-33%. Low use efficiency of nitrogen fertilizers in agriculture contributes to different environmental impacts like eutrophication of surface water bodies, acidification of agricultural soil, and increased concentration of nitrous oxides in the atmosphere contributing to global warming. N loss from the soil-plant system occurs through gaseous emission, surface run-off, leaching beyond the effective rhizosphere of various crops, denitrification, and volatilization. Indian soil is deficient in nitrogen almost universally (Patra *et al*., 2019). As a result, farmers use massive amounts of nitrogenous fertilizer even in particular areas and go for more than blanket recommendation doses. Current N fertilizer recommendation dose typically consists of a fixed rate and is fixed concerning its time of application for more extensive tracts.

Nevertheless, following such recommendations, we cannot increase Nitrogen Use Efficiency (NUE) beyond a specific limit (Singh *et al*., 2012). The nitrogenous fertilizer recommendation must be according to crop demand. As plant growth reflects the total N supply from all sources, plant N status at any given time should better indicate the N availability to the plant (Midya *et al*., 2021; Raddy *et al*., 2022). In this context, the leaf N status of rice crops, which is directly related to photosynthesis and biomass production, indicates crop demand for N during the growing season (Pampolino *et al*., 2012). The International Rice Research Institute (IRRI) created the fixed time N management (FTNM) to improve fertilizer-N use effectiveness. The leaf N content can be estimated non-destructively with a leaf colour chart (LCC) (Mahajana *et al*., 2014; Archana *et al*., 2022). The computer-based decision support tool Nutrient Expert (NE) leverages the SSNM principles to create fertilizer recommendations suited to a particular field or growth environment. The outcome of the field evaluation demonstrated that NE is prosperous in offering suggestions that can boost yields and revenues compared to farmers' current practices (Avini-e Nakhro *et al*., 2023). The present study focused on the response of two different rice varieties concerning the use of LCC and NE recommendations in combination and in the sole precision N management approach for improving rice yield and NUE in the lateritic soil of Eastern India.

MATERIAL AND METHODS

During the 2017 *kharif* season, a field experiment was carried out in a farmer's field in the village of Chella Kamarpada. The location is 230 62' N latitude, 870 62' E longitude, and 60 m above mean sea level. The soil used for the experiment has a clay loam texture and a pH of 6.10. The amounts of nitrogen, phosphorus, and potassium readily available in the experiment field were 165.32 kg ha^{-1}, 32.45 kg ha^{-1}, and 168.0 kg ha^{-1}, respectively. The experiment was laid out in a factorial randomized full-block design with two components (varieties and fertilizer application) containing twelve treatments replicated three times. Factor A consisted of two levels of varieties *viz*., V_1= Pratiksha, V_2= Rajendra masuri, and factor B consisted of six levels of nutrient management i.e. N_1= Blanket application (80-40-40 N-P_2O_5-K_2O kg ha^{-1}), N_2= State recommendation with LCC (80-40-40 N-P_2O_5-K_2O kg ha^{-1}), N_3= Nutrient expert recommendation (132-42-67 N-P_2O_5-K_2O kg ha^{-1}), N_4= Nutrient expert based recommendation with LCC based N split, N_5=Farmers practices (75.5-40-40 N-P_2O_5-K_2O kg ha^{-1}) and N6= control. The gross size of each plot was 15 m^2 (5m×3 m). In the nursery, seeds were sown at a rate of 50 kg ha^{-1}, and before planting, the seeds were treated with bavistin @ 2g kg^{-1} seed. About one-month-old seedlings were transplanted in each plot with a spacing of 25 cm × 20 cm. The basal dose of N application was done according to the treatments. Both P and K were applied @40 kg ha^{-1} each of P_2O_5 and K_2O, respectively to the treatments like blanket application, state recommendation based on LCC, and farmer's practice as basal dose. In the case of treatments like NE-based recommendation and NE-based recommendation with split application based on LCC, both P and K were applied @ 42 kg ha^{-1} SSP and 67 kg ha^{-1} MOP as basal dose. The N has been applied in splits according to the schedule of LCC threshold value in two types of treated plots: state recommendation based on LCC and NE recommendation based on split dose according to LCC reading. In NE recommendation treatment, N was applied in 3 equal splits during basal, active tillering, and panicle initiation. The plant height, leaf area index, accumulation of dry matter, and crop growth rate were all recorded with standard protocols. The grain yield and yield attributes were recorded at harvest, while the yield of sun-dried straw was recorded 15 days following harvest. By Jackson's (1973) recommendations, total nitrogen was calculated using the Kjeldahl method from acid digestion, total phosphorus using the Vanado molybdate yellow colour method from diacid extract, and total potassium using the flame photometric method from diacid extract. By dividing crop production by the corresponding percent composition of nitrogen, phosphorus, and potassium, plants' uptake of nitrogen, phosphorous, and potassium was calculated. Based on the current market price in the area, a standard formula was used to compute the cost of cultivation, the net return, and the benefit-cost (B: C) ratio. The crucial difference was determined to compare the treatment means, and statistical significance was evaluated by computing the F value at the 5% probability level.

RESULTS AND DISCUSSION

Growth attributes. From the field trial, growth parameters like plant height, leaf area index, dry matter accumulation, and crop growth rate were recorded and presented in Table 1.

Plant height. The variety of Rajendra masuri proved superior regarding plant height compared to Pratiksha. The height of Rajendra masuri was higher than that of Pratiksha at 90 DAT, though they did not differ significantly. Fertilizer levels differed significantly concerning plant height at 90 DAT. Nutrient expert-based recommendation and N-split according to LCC value produced significantly higher plant height than the Nutrient expert-based fertilizer application, state recommendation based on LCC, and farmer practices treatment at 90 DAT. All the levels of fertilizer application were found to increase the plant height significantly over control (no fertilizer application). The timely supply of the desired amount of nutrients helped the plant to uptake more nutrients, which effectively move from source to sink organs that help increase cell division and enhancement of internodal length, leading to increased plant height. Similar results were also obtained by Hou *et al*. (2013); Gupta *et al.* (2016) with maize crops. No significant difference was observed in plant height concerning their interaction between varieties and nutrient management.

Leaf Area Index (LAI). Regarding LAI, no significant difference was noticed among the varieties at 60 DAT. The Pratiksha variety recorded higher LAI than the Rajendra masuri at 60 DAT. Nutrient expert-based recommendation along with N-split according to LCC value resulted in higher LAI compared to the Nutrient expert based application of fertilizer, state recommendation based on LCC, and farmer practices treatment at 90 DAT, but Nutrient expert recommendation and Nutrient expert based recommendation with LCC-based N split were statistically at par. All the fertilizer application levels were found to enhance LAI over control significantly. Supply of the required amount of fertilizer to crop leads to increased plant height and number of leaves per plant with good canopy cover, facilitating the higher LAI. A similar beneficial effect of split N application was also reported by Vikram *et al*. (2015) with maize crops. No significant difference was observed in LAI concerning their interaction between varieties and nutrient management.

Dry Matter Accumulation (DMA). Rajendra masuri recorded a higher DMA with no significant difference within varieties, while Pratiksha recorded a lower DMA at 90 DAT. Nutrient management treatments exhibited a significant difference in dry matter accumulation. The maximum DMA was recorded when the crop supplied nutrients to the nutrient expert with LCC, which was at par with the recommendation based on the nutrient expert. The rice crop accumulated dry matter in a positive linear relationship with plant height, with a coefficient of determination of 0.922 (Fig. 1). The gradual increase in the growth parameters increases the dry matter accumulation. The increased nitrogen level significantly increased the number of tiller hill^{-1} and the weight of tillers, which might have resulted in higher dry matter accumulation in the plots where higher doses of nitrogen were applied in more splits. The lowest DMA was recorded in the no fertilized plot. No significant difference was observed in DMA regarding their interaction between varieties and nutrient management. These results were in conformed with Mandal *et al*. (2015); Sridhar *et al*. (2022).

Crop Growth Rate (CGR). Regarding CGR, no significant difference was recorded among the rice varieties. At 60-90 DAT, Pratiksha and Rajendra masuri showed CGR values of 1.9, and 1.95 g m^{-1} day^{-1}, respectively. The crop growth rate showed a similar trend as dry matter accumulation. Among all nutrient management treatments, the performance of both N_3 and N_4 were at par during 60-90 DAT, and they performed significantly higher than rest treatments. An ample supply of nutrients at the correct times increases dry matter production and, in turn, increases CGR. Compared to other treatments, a lower CGR value was recorded in an unfertilized plot. The interaction between varieties and nutrient management practices was observed as non-significant. These results were in the pipeline with Qureshi *et al.* (2016).

Yield attributes. Yield attributes such as the number of hills m^{-2}, number of effective tillers m^{-2}, panicle length, number of grains per panicle, number of filled grains per panicle, and test weight were recorded, and related data are presented in Table 2. All parameters exhibited non-significant among the varieties except for the number of filled grains per panicle. However, among different nutrient management practices, a significant difference was exhibited among all the yield attributes.

Effective tillers per m^2. Rajendra masuri and Pratiksha recorded 238.61 and 235.28 effective tillers m^{-2}, respectively. Regarding effective tiller m^{-2}, NE with LCC produced significantly higher effective tillers m^{-2} than other nutrient management treatments. It showed that balanced nutrition like N_3 resulted in significantly lower no. of effective tillers m^{-2} than balanced nutrition and natural time nitrogen management, i.e., N_4. Though nitrogen dose was identical in both N_1 and N_2, still in N_2, nitrogen was applied in splits based on LCC value apart from the basal application. However, it seems that LCC-based nitrogen application did not significantly affect no. of effective panicles m^{-2}. When the mean value of such parameters of all treatments was compared with the control plot, they all produced a significantly higher number of effective tillers m^{-2}. In terms of effective tillers m^{-2}, varietal interactions with nutrient management practices were non-significant in this experiment. A similar result was in accordance with Singh *et al.* (2017).

Panicle length. Both varieties, Pratiksha and Rajendra masuri, gave a nearly equal response regarding panicle length, i.e., Rajendra masuri showed non-significantly higher panicle length than Pratiksha. Among all nutrient management treatments, a Nutrient Expert with N-split based on LCC, i.e., N_4, showed significantly longer panicle length than all other treatments. It showed that higher N and plant need-based applications resulted in a longer panicle. All the treatments showed significantly higher panicle lengths than the control plot, where no fertilizers were applied. The varietal interaction with nutrient management practices came statistically non-significant. These results agreed with those obtained previously by Goudra *et al*. (2019).

Number of grains per panicle. The variety Rajendra masuri proved to be non-significantly higher than Pratiksha concerning the total no. of grains per panicle. Among all nutrient management treatments, N_4 proved significantly superior over all other treatments for total no. of grains per panicle. Shrestha *et al*. (2018) also reported that the increase in N fertilization enhanced grains per panicle, total florets per plant, and, ultimately, the grain yield. All the treatments showed a significantly higher number of grains per panicle than the control treatment, but the difference was non-significant among them. The interaction of varieties and nutrient management was found to be non-significant.

Numbers of filled grains per panicle. The variety Rajendra masuri had a significantly higher number of filled grains per panicle than Pratiksha. The nutrient management treatment N_4 was found to have a significantly higher no. of filled grains per panicle than all other treatments, except N_3, which was at par with N_4. Farmers' practice produced comparatively higher filled grains per panicle than blanket application, but the difference was insignificant. All the treatments gave significantly higher results regarding filled grains per panicle than the control treatments. The interaction between the varieties and nutrient management treatments was recorded as non-significant.

Test weight. The performance of both varieties was non-significantly different regarding test weight. Rajendra masuri produced a higher test weight than the Pratiksha. Nutrient expert-based recommendation with LCC recorded the highest test weight, statistically at par with all other nutrient management treatments except the control, where no nutrients were applied. Kandel *et al*. (2018) reported that LCC critical value 4, in contrast with the blanket application, produced a higher test weight, also recorded in this experiment. The varietal interaction with nutrient management regarding the test weight of rice grain was observed as non-significant.

Yield. The rice grain and straw yield was recorded as t ha^{-1}, and the data is presented in Table 3 and Fig. 2.

Grain yield. Regarding grain yield, Rajendra masuri has achieved a significantly higher yield than Pratiksha. It might be due to its significantly higher leaf area and no. of filled grain per panicle, which resulted in higher net photosynthesis, then ultimately higher grain yield, due to its higher-yielding potential. Among all nutrient management treatments, Nutrient expert-based recommendation with LCC-based split of nitrogen N4 recorded significantly higher grain yield than other treatments and 80.37% higher yield over farmers' practice. It reflected that balanced nutrition and real-time nitrogen management outscored only balanced nutrition and only real-time nitrogen management, i.e., state recommendation with LCC-based N-split regarding grain yield. The balanced and need-based nutrient application might have favorably affected the growth in terms of LAI and dry matter accumulation in plants. It might have resulted in better photosynthate accumulation and its assimilation. All these effects collectively may have resulted in higher grain yield. A similar result was also opined by Sapkota *et al*. (2021). The rest of the nutrient management treatments also recorded significantly higher grain yields than the control treatment.

Regarding grain yield, the interaction of varieties and nutrient management treatments became significant. The combination of Rajendra masuri with the balanced nutrition with LCC recorded significantly higher grain yield than the variety Pratiksha in combination with similar nutrient management treatment, i.e., N_4. The response of Rajendra masuri towards nutrient management was significantly higher than that of Pratiksha. A similar differential response of varieties toward nutrient management was also reported by Patel *et al*. (2017) with varieties of maize (*Zea mays* L.).

Straw yield of rice. Among two varieties, Rajendra masuri was reported to have a significantly higher yield of straw than Pratiksha. Nutrient management treatment NE-based recommendation with LCC-based N split, i.e., N_4, recorded significantly higher straw yield than other treatments, except N_3, which was statistically at par with N_4 and 32.29% higher straw yield over farmers' practice. Higher straw yield at LCC value four had also been reported by Chou *et al.* (2020). The straw yield in balanced fertilization, i.e., NE-based recommendation, was significantly higher than that of fixed-time nitrogen management, i.e., blanket application and farmers' practice. The rest of the treatments recorded significantly higher straw yields over the control plot.

The interaction between varieties and nutrient management practices was found to be significant. The combination of V_2 with N_4 recorded the highest straw yield among various combinations of varieties and nutrient management practices. Also, the combinations like V_2N_3 and V_2N_2 were at par with the highest value.

Uptake of N, P, and K. Total NPK were analyzed by following standard methods and reported in Table 4.

Total N uptake. Rajendra masuri recorded a significantly highest uptake of N than Pratiksha both in grain and straw. It clearly showed that V_2 was more responsive toward nitrogen uptake than V_1. The data revealed that, among different nutrient management treatments, the balanced nutrition along with RTNM (N_4) and only balanced nutrition (N_3) were found to have significantly higher nitrogen uptake in grain and straw than other treatments. In between RTNM, i.e., state recommendation with LCC and blanket application, N uptake was significantly higher in the former one than the latter one through both grain and straw because there might be chances of losses of nitrogen in blanket application due to the bulk application of N-fertilizer at a single time over that of the split application. Hou *et al*. (2013) reported a similar kind of N uptake. All the nutrient management treatments were reported to have significantly higher N uptake over the control plot, where no nitrogenous fertilizers were added. The interaction of varieties and nutrient management w.r.t. N uptake was recorded as non-significant.

Total P uptake. Rajendra masuri gave significantly higher P uptake over Pratiksha in terms of grain P uptake, but both were statistically at par regarding straw P uptake. Overall, Rajendra masuri was found to be more responsive to P fertilization. In the case of grain P uptake, balanced nutrition with RTNM, i.e., NE with LCC treatment recorded significantly higher values over other treatments and was statistically at par with balanced nutrition, i.e., NE-based treatment, with the value 4.35 kg ha^{-1}. Though in N_1, N_2, and N_5, P-doses were the same, in N_2 treatments, P uptake through grain and straw was significantly higher over the other two, i.e., N_1 and N_5. It might be due to better plant growth and yield in plant need-based application of N in N_2 treatment. The interaction between the varieties and the nutrient management treatments was recorded as non-significant.

K uptake. Rajendra masurigave significantly higher K uptake over Pratiksha regarding grain and straw K uptake. Overall, Rajendra masuri was found to be more responsive to K fertilization. In the case of grain P uptake, balanced nutrition, i.e., NE-based treatment recorded a significantly higher value over other treatments and was statistically at par with balanced nutrition with RTNM, i.e., NE with LCC, with the value 3.71 kg ha^{-1}. N_1, N_2 and N_5, though their K-doses were the same, and the time of application was the same, i.e., at basal. Still, there was an increase in K uptake in grain and straw recorded in N_2, where N was applied in split according to LCC, which might be a reason behind its higher uptake due to plant need-based N application. It might be due to better plant growth and yield in plant need-based application of N in N_2 treatment, and there may be a synergistic effect between N and K uptake, which probably resulted in this effect. Results conform to the findings of Hou *et al*. (2013). The interaction between the varieties and the nutrient management treatments was recorded as non-significant.

Economics. As in N_3 and N_4, balanced fertilization was carried out along with RTNM options, i.e., LCC. Comparatively, its cost of cultivation was higher than all other treatments (Table 5). Though fertilizer dose was identical in both N_1 and N_2, due to the incorporation of LCC management in the latter one, i.e., N_2, its cost of cultivation came slightly higher than N_1. Expectedly the cost of cultivation for the rest of the treatments was higher than the control, where no fertilization was done. In between the two varieties, Rajendra masuri gave significantly higher gross, net return, and return per rupee invested over Pratiksha. Also, NE-based dose with LCC management gave significantly higher gross, net return, and return per rupee invested return over other treatments. Similar results were opined by Qureshi *et al*. (2016).

Table 1: Effect of nutrient management practices on plant height (cm), leaf area index, dry matter accumulation (g m^{-2}), crop growth rate (g m^{-2} day^{-1}) of different rice varieties.

Variety	Plant height (cm)	Leaf area index	Dry matter accumulation (g m^{-2})	Crop growth rate (g m^{-2} day^{-1})
	90 DAT	**60 DAT**	**90 DAT**	**60-90 DAT**
V_1: Pratiksha	111.51	6.62	397.55	1.90
V_2: Rajendra masuri	111.99	6.48	408.53	1.95
SEm (±)	0.18	0.057	5.26	0.03
CD (at 5%)	**NS**	**NS**	**NS**	**NS**
Nutrient management				
N_1: Blanket application	109.9	5.56	321.85	1.90
N_2: State recommendation with LCC	110.6	6.66	379.32	2.07
N_3: NE based recommendation	115.7	7.05	527.37	2.32
N_4: NE with LCC	118.43	7.1	535.68	2.45
N_5: Farmers' practices	111.17	5.69	402.97	1.78
N_6: Control	104.7	5.35	251.05	1.04
SEm(±)	0.31	0.0987	9.10	0.051
CD(at 5%)	**0.91**	**0.289**	**26.72**	**0.15**
CV(%)	**6.80**	**3.69**	**5.54**	**6.43**
V*N Interaction	**NS**	**NS**	**NS**	**NS**

Table 2: Effect of nutrient management practices on yield attributes of different rice varieties.

Variety	Effective tillers m^{-2}	Panicle length (cm)	No. of grains per panicle	No. of filled grains per panicle	Test weight (g)
V_1: Pratiksha	235.28	15.21	96.72	76.78	23.62
V_2: Rajendra masuri	238.61	15.34	97.83	79.11	23.74
SEm(±)	1.96	0.093	0.89	0.69	0.19
CD(at 5%)	**5.76 (NS)**	**0.27 (NS)**	**2.6 (NS)**	**2.02**	**0.56 (NS)**
Nutrient management					
N_1: Blanket application	219	13.93	99.67	74	23.76
N_2: State recommendation with LCC	219	14.5	103.33	83	23.8
N_3: NE based recommendation	283	18.83	111	99.2	24.08
N_4: NE with LCC	297	21.07	116.17	102.5	24.58
N_5: Farmers' practices	217	13.17	87.83	70.83	23.7
N_6: Control	187	11.27	65.67	39.33	20.22
SEm(±)	3.40	0.16	1.54	1.2	0.33
CD(at 5%)	**9.98**	**0.47**	**4.50**	**3.5**	**0.97**
CV(%)	**3.52**	**2.59**	**3.87**	**3.75**	**3.58**
V*N Interaction	**NS**	**NS**	**NS**	**NS**	**NS**

Table 3: Grain and Straw yield (t ha^{-1}) as influenced by interaction effect of rice varieties and nutrient management practices in rice.

	Grain Yield (t ha^{-1})			Straw Yield (t ha^{-1})		
Treatments	**Pratiksha (V_1)**	**Rajendra masuri (V_2)**	**Mean**	**Pratiksha (V_1)**	**Rajendra masuri (V_2)**	**Mean**
N_1: Blanket application	3.45	3.66	3.56	4.46	4.87	4.67
N_2: State recommendation with LCC	4.38	5.25	4.82	5.14	6.08	5.61
N_3: NE based recommendation	4.63	5.63	5.13	5.36	6.06	5.71
N_4: NE with LCC	5.03	5.85	5.44	5.48	6.39	5.94
N_5: Farmers' practices	2.87	3.16	3.01	4.38	4.60	4.49
N_6: Control	2.03	2.11	2.07	3.72	3.64	3.68
Mean	3.73	4.28		4.76	5.27	
SE(m)±	0.074			0.142		
CD (at 5%)	**0.22**			**0.42**		
CV(%)	**8.18**			**7.90**		

Table 4: Effect of nutrient management practices on NPK uptake by grain and straw (ka ha^{-1}) of different rice varieties.

Variety	N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw
V_1: Pratiksha	44.65	29.41	2.8	8.19	2.11	70.24
V_2: Rajendra masuri	49.1	31.27	2.9	8.92	2.53	76.97
SEm(±)	1.03	0.68	0.15	0.38	0.11	1.04
CD(at 5%)	**3.014**	**0.321**	**0.45 (NS)**	**1.12 (NS)**	**0.32 (NS)**	**3.06**
Nutrient management						
N_1: Blanket application	41.03	24.42	1.82	6.27	1.49	63.63
N_2: State recommendation with LCC	59.59	35.14	3.38	10.02	3.14	80.32
N_3: NE based recommendation	71.93	38.88	4.35	11.63	3.83	94.48
N_4: NE with LCC	73.64	39.37	4.96	12.84	3.72	98.87
N_5: Farmers' practices	29.77	27.8	1.85	6.72	1.35	60.91
N_6: Control	5.29	16.44	0.72	3.83	0.37	43.43
SEm(±)	1.78	1.18	0.263	0.662	0.19	1.80
CD(at 5%)	**5.22**	**3.47**	**0.77**	**1.95**	**0.56**	**5.30**
CV(%)	**9.30**	**9.54**	**22.61**	**18.97**	**20.01**	**6.02**
V*N Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 5: Effect of nutrient management on economics of rice cultivation.

Varieties	Nutrient management	Total cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	Return per rupees invested
Pratiksha (V_1)	N_1: Blanket application	32910	62889	29979	1.91
	N_2: State recommendation with LCC	33472	78953	45481	2.36
	N_3: NE based recommendation	34152	83324	49172	2.44
	N_4: NE with LCC	34152	89888	55736	2.63
	N_5: Farmers' practices	32856	53464	20608	1.63
	N_6: Control	29000	38914	9914	1.34
Rajendra masuri (V_2)	N_1: Blanket application	32910	66954	34044	2.03
	N_2: State recommendation with LCC	33472	94425	60953	2.82
	N_3: NE based recommendation	34152	100478	66326	2.94
	N_4: NE with LCC	34152	104523	70371	3.06
	N_5: Farmers' practices	32856	58465	25609	1.78
	N_6: Control	29000	40101	11101	1.38
	SEm(±)		1116.60	1116.60	0.03
	CD (5%)		**3205.78**	**3205.78**	**0.10**
	CV (%)		**2.66**	**4.84**	**2.70**

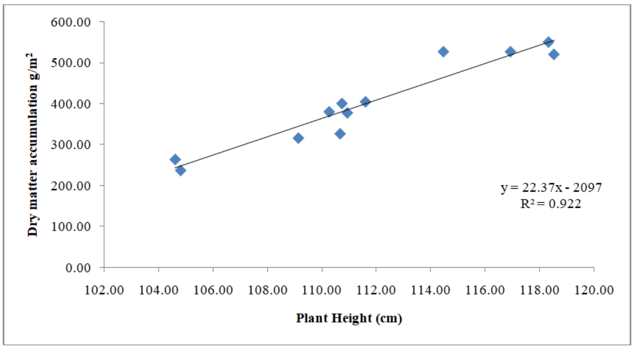

Fig. 1. Relationship between dry matter accumulation and plant height influenced by varieties and nutrient management by rice crop.

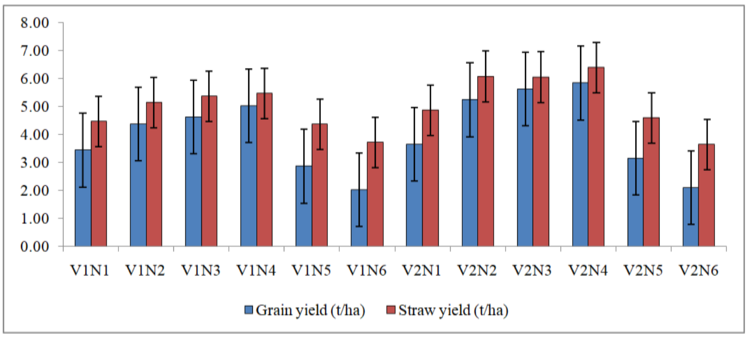

Fig. 2. Grain yield and straw yield of rice crop as influenced by varieties and nutrient management practices.

CONCLUSIONS

Cultivation of Rajendra masuri variety along with application of fertilizers on the basis of Nutrient expert based recommendation with N split according to LCC may be more productive and profitable for the Red and lateritic soil of West Bengal specially in Birbhum.

FUTURE SCOPE

This research will assist farmers in understanding the suitable variety and nitrogen management practices. Furthermore, advances in precise nitrogen management practices have a stronger impact on resource conservation usage.

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Conflict of Interest. None.

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