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Economic Evaluation of Real Time N Management Technology in Direct Wet (Drum) Seeded Rice

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Abstract: A field experiment was conducted in clay soil (*Vertic ustochrept*), to standardize the leaf colour chart critical value (LCC cv.) and the rate of nitrogen application in CO 47 rice variety. The treatments included three levels of LCC cv. (LCC cv. 3, 4 and 5) with different rates of N application (20, 25, 30 and 35 kg ha^{-1} at a time) along with three checks [(control, blanket N (150 kg N ha^{-1} in four equal splits) and manage N practices (150 kg N ha^{-1} in four unequal splits)] arranged in factorial randomized design with three replications. LCC readings were measured every week from 21 Days After Sowing (DAS) to 84 DAS and nitrogen fertilizer was applied as per treatment schedule. Besides, measuring grain yield, straw yield and nutrient use efficiency, economic indices such as harvest index, net income and benefit cost ratio were worked out. The results indicate that maintaining LCC cv.4 at the rate of 20 kg N ha^{-1} each time could be adopted to get similar benefits as that of blanket N with 50% N saving and LCC cv.5 at the rate of 30 kg N ha^{-1} each time could be adopted to get higher net income over blanket N. The study also stresses the need for standardisation of LCC based N management for different varieties under the specific location of cultivation.

Key words: Leaf color chart, N management, rice variety, direct wet (drum)

INTRODUCTION

Increasing the efficiency of applied N with high productivity has been the prime objective for larger group of resource management rice workers during the last few decades in many rice growing countries and the interest continues to dominate even now. In the process, several new approaches, theories, concepts and tools have been employed. A new concept of time course sufficiency of leaf nitrogen concentration (TCSNL) has also been developed (Thiyagarajan, 2002). Leaf N status is seen as an indicator of N sufficiency or deficiency and tools that assess the leaf N status by non-destructive methods have become useful in this endeavour. The Leaf Colour Chart (LCC) is being employed for N management in rice in recent times (Alam *et al*., 2005; Sheoran *et al*., 2004; Shukla *et al*., 2004). Even though LCC has been tested for real time N management in the farmers field in several countries (Balasubramanian *et al*., 1999), very limited information is available on the accuracy of LCC in N management. Economic evaluation of a new technology is a must to evaluate the profitability of the same over the existing methods. The parameters like biomass production, grain and straw yields indicated the response of the crop to applied N and the related management technology. At the same time, the technology should be economically viable and profitable. Several economic indices are available to evaluate the profitability of a technology in a research experiment. Cost of cultivation, benefit-cost ratio, net income and harvest index are few of the indices to calculate the economics and

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identify the best treatment. No single index is capable of giving a good comparison of different treatments and hence the indices such as B:C ratio, HI and net income were used to assess the economics of N application.

In this view, this research discusses the net income, benefit cost ratio and harvest index worked out to identify the best performing treatment.

MATERIALS AND METHODS

A field experiment was conducted at wetlands, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during kuruvai (August-November) 2002, to standardize the Leaf colour chart critical value (LCC cv.) and the rate of nitrogen application in CO 47 (115 days duration) rice. The farm is situated in Western agro-climatic zone of Tamil Nadu at 11°N latitude and 77° E longitudes at an elevation of 426.7 m above the mean sea level. The soil of the experimental site was clay textured belonging to Noyyal series (*Vertic ustochrept*). The initial analysis of the soil of the experimental site revealed that soil was neutral (pH-7.87) with low soluble salts (EC-0.79 dS m^{-1}), medium organic carbon content (0.72%), medium in $KMnO_4$-N (290 kg ha^{-1}), high in Olsen-P (41 kg ha^{-1}) and NH_4OAc-K (796 kg ha^{-1}).

The study was conducted in Factorial Randomized Block Design (FRBD) with three replications. The treatments (Table 1) included three levels of LCC (LCC cv. 3, 4 and 5) with different rates of N application (20, 25, 30 and 35 kg ha^{-1} at a time) along with three checks viz., control (zero-N), blanket N [120 kg ha^{-1} in four equal splits from 21 Days After Sowing (DAS)] and manage N practice (120 kg N ha^{-1} in four unequal splits -1/6, 1/3, 1/3 and 1/6 from 21 DAS). Sprouted seeds were sown at the rate of 80 kg ha^{-1} using a drum seeder at 20 cm row spacing. Nitrogen was applied in the form of urea as per treatment schedule based on the LCC cv. assessed at weekly intervals from 21 DAS as per treatment schedule. A uniform dose of 38 kg P_2O_5 ha^{-1} (all basal), 38 kg K_2O ha^{-1} in two equal splits at 21 and 56 DAS, 25 kg $ZnSO_4$ ha^{-1} (all basal) and 500 kg gypsum ha^{-1} (all basal) were applied to all the treatments. Sampling rows of all plots and the net plot area were harvested, thrashed and winnowed separately. The grain yield was recorded for each plot at 14% moisture content.

Agronomic Efficiency

Agronomic Efficiency (AE) was worked out for different N regimes. The response of rice (increase in grain yield per kg of fertilizer N applied) in different treatments were calculated from the formula:

$$AE = \frac{Y_t - Y_0}{X}$$

Where

Y_t = Grain yield kg ha^{-1} in treated plot

Y_0 = Grain yield kg ha^{-1} in control plot

X = Total N applied in kg ha^{-1}

Net Income

Net income was calculated by deducting the cost of cultivation from total income. The cost of cultivation and total income were worked out using the following parameters.

Basic cost of cultivation = Rs. 15000 (excluding nitrogen cost)

Unit price of nitrogen = Rs. 10.4 kg^{-1}

Unit price of grain = Rs. 5.75 kg^{-1}

Unit price of straw = Rs. 1.00 kg^{-1}

Benefit-Cost Ratio

Benefit-cost ratio was computed as:

$$\text{B:C ratio} = \frac{\text{Total income (Rs.)}}{\text{Total cost of cultivation (Rs.)}}$$

Harvest Index

Harvest index represents the ratio of quantity of economic produce to total biomass:

$$\text{HI} = \frac{\text{Grain yield (kg ha}^{-1}\text{)}}{\text{Total biomass at harvest (kg ha}^{-1}\text{)}}$$

The observations collected from the field experiment were subjected to statistical scrutiny as per the procedure of Gomez and Gomez (1984). Economic indices were not analyzed statistically.

RESULTS AND DISCUSSION

Net income and B:C ratio ranged from Rs. 4576/- to Rs. 21359/- and 1.31 to 2.24 as observed under control and L_5N_{35} treatments, respectively (Table 2). Increase in the B:C ratio as well as net income with increasing levels of LCC was considerable. LCC cv.5 gave Rs. 4526/- and Rs. 3067/-higher net income than LCC cv.3 and LCC cv.4, respectively. B:C ratio and net income did not vary much with N application rates. Harvest index of economic produce ranged from 0.35 to 0.42. Neither the LCC levels nor the different rates of N application had any profound influence on the HI of CO 47 rice.

The net income varied from Rs. 4,576/- to Rs. 21,359/- as recorded by control and L_5N_{35} treatments, respectively indicating that higher input of fertilizer N upto 150 kg N ha^{-1} could fetch more income (Table 1 and 2). The increase in net income with increasing LCC levels and increasing rate of applied N indicated the same. B:C ratio also followed a similar trend as that of net income. Budhar and Tamilselvan (2003) recorded higher net income and B:C ratio in LCC cv.4. Angadi *et al*. (2002) recorded higher net returns with LCC 5 and 3.5 for cultivars Abhilash and Intan, respectively

Table 1: Grain yield (kg ha^{-1}) and agronomic efficiency of rice under different N regimes

Tr. No.	Notation	Treatment details	N dose (kg ha^{-1})	No. of splits	Grain yield	AE#
T_1	C	Control (zero-N)	0	0	2723	
T_2	BN	Blanket N*	120	4	4926	18.4
T_3	MN	Manage N**	120	4	4702	16.5
T_4	L_3N_{20}	LCC cv. 3 with 20 kg N ha^{-1} each time	40	2	4315	39.8
T_5	L_3N_{25}	LCC cv. 3 with 25 kg N ha^{-1} each time	25	1	4182	58.3
T_6	L_3N_{30}	LCC cv. 3 with 30 kg N ha^{-1} each time	30	1	4315	53.1
T_7	L_3N_{35}	LCC cv. 3 with 35 kg N ha^{-1} each time	35	1	4077	38.7
T_8	L_4N_{20}	LCC cv. 4 with 20 kg N ha^{-1} each time	60	3	4703	36.5
T_9	L_4N_{25}	LCC cv. 4 with 25 kg N ha^{-1} each time	50	2	4405	33.6
T_{10}	L_4N_{30}	LCC cv. 4 with 30 kg N ha^{-1} each time	60	2	4226	25.1
T_{11}	L_4N_{35}	LCC cv. 4 with 35 kg N ha^{-1} each time	70	2	4568	26.4
T_{12}	L_5N_{20}	LCC cv. 5 with 20 kg N ha^{-1} each time	120	6	4702	16.5
T_{13}	L_5N_{25}	LCC cv. 5 with 25 kg N ha^{-1} each time	150	6	4688	13.1
T_{14}	L_5N_{30}	LCC cv. 5 with 30 kg N ha^{-1} each time	150	5	5045	15.5
T_{15}	L_5N_{35}	LCC cv. 5 with 35 kg N ha^{-1} each time	210	6	5104	11.3
			LSD	(0.05)	386	***

*120 kg N ha^{-1} in four equal splits from 21 DAS, **Practice (120 kg N ha^{-1} in four splits -1/6, 1/3, 1/3 and 1/6 from 21 DAS, # (kg grain kg^{-1} N applied); ***Data not subjected to statistical analysis

Table 2: Economic indices on LCC based N management in direct seeded rice

Tr. No.	Net income (Rs.)	B:C ratio	Harvest index
T_1	4576	1.31	0.41
T_2	19688	2.21	0.39
T_3	18893	2.16	0.37
T_4	15706	2.02	0.41
T_5	14590	1.96	0.42
T_6	15897	2.04	0.40
T_7	14255	1.93	0.40
T_8	18289	2.17	0.40
T_9	16223	2.05	0.41
T_{10}	14596	1.93	0.42
T_{11}	17150	2.09	0.41
T_{12}	17942	2.10	0.40
T_{13}	19098	2.15	0.35
T_{14}	20114	2.21	0.40
T_{15}	21359	2.24	0.36

Data not subject to statistical analysis

in similar clay soil. Earlier literatures and results of present study show that there is variation in terms of economic returns for each variety under LCC based N management. This stresses the need for standardisation of LCC based N management in each variety under specific sites.

Though L_5N_{35} was found comparable with L_5N_{30} with respect to the grain yield and recorded marginally higher net income and B:C ratio than L_5N_{30}, the harvest index and AE under L_5N_{35} were much lower (Table 1 and 2). The performance of L_5N_{35} deviated much from the predicted optimum N dose (139 kg N ha^{-1}) and yield (5350 kg ha^{-1}) whereas the L_5N_{30} being equal in B:C ratio and better in net income over blanket N, was found closer to the predicted optimum N dose and yield besides recorded higher AE and hence L_5N_{30} may be adopted to achieve higher yield in rice (Table 1 and 2).

Under LCC cv.4, L_4N_{20} though recorded marginally lower net income and B:C ratio over blanket N, the yields under the above two treatments were found statistically comparable. Besides, AE was much higher for L_4N_{20} (Table 1 and 2) and it also would serve as a better option suitable for farmers with low resource allocative efficiency. Hence, such resource poor farmers can adopt L_4N_{20} to achieve moderately higher rice yields comparable to the blanket N, with 50% saving in fertilizer N.

CONCLUSIONS

The results suggest, a farmer with high resource allocative efficiency can adopt LCC cv.5 at the rate of 30 kg N ha^{-1} each time and those of low resource allocative efficiency can adopt LCC cv.4 at the rate of 20 kg N ha^{-1} each time to achieve the desirable yield in direct wet (drum) seeded rice. The study also stresses the need for standardisation of LCC based N management for different varieties under the specific location.

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