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Effect of customised leaf colour chart (CLCC) based real time N management on agronomic attributes and protein content of rice (*Oryza sativa* L.)

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ABSTRACT

We conducted a field experiment at the Crop Research Farm, SHIATS, Allahabad (U.P.) during the kharif season of 2015 to evaluate the effect of customised leaf colour chart (CLCC) on yield and N content of rice. The experiment consisted of four level of nitrogen treatments 70, 80, 90 and 100% of recommended dose of nitrogen (RDN). Neem coated urea was applied based on CLCC and conventional method. The experiment was laid out in randomised block design with three replications. Significantly higher grain yield (5.93 t ha^{-1}) and grain protein content (8.23%) were recorded under 100% RDN application based on CLCC. Real time N application based on CLCC, synchronised N supply and demand and hence partial factor productivity (PFP_N) was 11% higher as compared to 100% RDN application based onconventional method. Highest net income (Rs.47034 ha^{-1}) and B:C ratio (1.90) were also recorded under 100% RDN application based on CLCC.

Key words: *Neem coated urea, customized leaf colour chart, rice*

INTRODUCTION

Rice is the principal cereal crop of Asia, which ensures food and nutritional security to the major population. It accounts for about 43% of total food grain production and 46% of total cereal production in the country.For sustaining rice production, apart from adoption of recent scientificcropping sequences (Roy et al., 2011; Kumar et al., 2016), fertilizer nitrogen (N) is one of the key input. Urea is the major N providing fertilizer today; it contributes about 80% to the total fertilizer consumption in India (FAI, 2008). Fertilizer N is relatively inexpensive, but deficiencies can result in substantial yield reduction. Farmers are inclined to indiscriminate use of fertilizer N to minimize the risk of deficiency, which leads to excessive fertilizer application. Excessive N application causes nutrient imbalances and produces plants which are susceptible to diseases and pests. The residual N from the rice crop does not improve the inherent capacity of the soil to supply N to the succeeding crops and is lost from the soil-plant system (Ladha et al., 2005). Low recovery of N is not only responsible for higher cost of crop production, but also for environmental pollution (Fageria and Baligar, 2005; Bhatia et al., 2011). About one-third of the applied fertilizer N is lost to the atmosphere or leached down to the groundwater. Thus, as the N consumption increases, its contribution to environmental pollution with ammonia and nitrous oxide and groundwater contamination with nitrates will also increase. Fertilizer N is being increasingly recognized as the source of nitrate contamination in the groundwater of the Indo-Gangetic plains as also reported by Singh and Singh (2004). The recovery efficiency of N fertilizer achieved by rice farmers ranges between 30 to 40% (Singh et al., 2003).

Singh et al. (2014) opined that blanket recommendations based on fixed-time application of fertilizer N doses at specified growth stages do not consider the dynamic soil N supply and crop N requirements, and lead to untimely application of fertilizer N. The soil C and N supply varies from field to field and even in the same field from year to year (Cassman et al., 1996; Dobermann et al., 2003; Nayak et al., 2012). Therefore, demand driven need-based fertilizer N applications can help improve N recovery efficiency in cereals. In-season crop N requirement can be known following tissue testing procedures, but its practical implication is limited as it is time consuming. The farmers generally use leaf colour as a visual and subjective indicator of the need for N fertilizer (Furuya, 1987). Since farmers generally prefer to keep leaves of the crop dark green, it leads to over application of fertilizer N resulting in low recovery efficiency. Thus, the spectral properties of leaves should be used in a more rational manner to guide need-based fertilizer N applications. To support decision-making on the timing of N application in rice, National Rice Research Institute (ICAR-NRRI) introduced the use of relatively inexpensive customised leaf colour chart (CLCC), a simple and portable tool. Alam et al., (2005) observed a linear relationship between a CLCC reading and leaf N content. The CLCC management approach may be a valuable tool for on-farm decision making.

In view of the facts, a field experiment was carried out at Crop Research Farm, SHIATS, Allahabad (U.P.) during *kharif* season of 2015, to evaluate the effect of CLCC based real time N management through neem coated urea on agronomic performance of rice.

MATERIALS AND METHODS

Experimental site

The field experiment was conducted during rainy (*kharif*) season of 2015 at Crop Research Farm, SHIATS, Allahabad (U.P.) which is located at 25^0 24' 42" N latitude, 81^0 50' 56" E longitude at 98 m altitude above the mean sea level and lies in Indo-Gangetic plains. The soil (0 to 15 cm depth) of the experimental site was of sandy loam textural class having pH 7.79, EC 0.18 dS m^{-1}, organic carbon 0.52 %, available N;126.3, P; 28.3and K;185.0 kg ha^{-1}.

Allahabad comes under sub-tropical and semi-arid climatic zone with sub-humid summer and cool winter. Generally, south-west monsoon sets in during the first fortnight of July and continues up to the end of September. The rainfall is unevenly distributed, apart from this, a few winter and summer showers are also received. During the crop period a total of 477.5 mm were obtained through 21 rainy days.

Experimental design

The experiment was conducted in randomised block design consisting of sixteen treatment combinations with three replications. Out of the 16 treatments the results of the 8 treatments are presented in this manuscript.The rice crop variety used was SHIATS Dhan 1, which is a medium duration variety and matures in 120 to 130 days and suitable for *kharif* season irrigated ecology with a yield potential varying from 5 to 6 t ha^{-1} under optimum condition of crop management. Twenty five days old rice seedlings were carefully uprooted and two seedlings per hill with spacing of 20 × 15 cm were transplanted in the experimental field.

Nutrient management was done through the straight fertilizers, *viz.,* neem coated urea (NCU), SSP and MOP to supply the required NPK respectively. Recommended dose of P_2O_5 and K_2O @ 60 kg ha^{-1} was applied to all the treatments as basal dressing. The nitrogen application varied between treatments. Micronutrient zinc as $ZnSO_4$ at 25 kg ha^{-1} was also applied to all the treatments as basal dressing. The details of N fertiliser dose and time of application adopted in the experiment was as follows:- T_1= 70% RDN based on CLCC, T_2= 80% RDN based on CLCC, T_3= 90% RDN based on CLCC, T_4= 100% RDN based on CLCC, T_5= 70% RDN based onconventional, T_6= 80% RDN based on conventional, T_7= 90% RDN based on conventional, T_8= 100% RDN based on conventional.

The CLCC consisted of five green shades from yellowest green (number 1) to dark green (number 5). The methodology adopted for measuring leaf colour was as follows:- Ten disease free plants were randomly selected in the field. The top most fully expanded healthy leaves were randomly selected for CLCC reading. Leaf colour was measured under the shade of the body by placing the middle part of leaf on the top of the colour strip for comparison; precaution was taken to avoid interception of direct sun light. The colour of leaf and CLCC was visually compared and if more than 6 out of 10 leaves had a reading less than the critical value i.e., less than 3, nitrogenous fertilizer was top dressed as per the treatment (Nayak et al., 2013). The CLCC reading was recorded in the afternoon between 2 and 4 PM from 21 DAT, at weekly intervals up to 1 week after panicle initiation.

Gaps caused by mortality were filled immideatly. This operation was done for maintaining a proper hill to hill distance and standard plant population. Weeding was done two times, first at 21 DAT and the second at 42 DAT. The experimental field was maintained in a moist condition and for this, eight irrigations were provided, as insufficient and scanty rainfall was received during the cropping period. As prophylactic measure, seedling root dip treatment for about a minute with Chlorpyriphos 20 EC before transplanting was done.

The crop was harvested at 106 DAT, when the plants were fully dried and grains when pressed between teeth were found to be brittle. Crop was harvested separately from each plot taking 1 m^2 area and allowed to sun dry for 4 days. Then, carefully bundled, tagged and shifted to threshing floor.

Observations recorded

For the purpose of data generation and subsequent analysis, appropriate sampling techniques were adopted as per Gomez, 1972. Five sample hills were randomly selected in a zig-zag pattern avoiding the harvest zone and border rows within the plots. These tagged hills were used for the collection of growth and yield parameter at different successive stages of the crop, while the requisite five hills were obtained for recording data through destructive sampling (Kumar et al., 2016, 2017).

Five hills were selected randomly from each plot and tagged. The height of these plants was measured from the ground up to the tip of the growing point of topmost fully opened leaf (Kumar et al., 2016, 2017). Plant height and number of tillers $hill^{-1}$ was recorded at 15, 30, 45, 60, 75, 90 and 106 DAT from five tagged hills in each plot. Plants were randomly uprooted from each plot on the above mentioned dates and were air dried and then kept in oven for 72 hours at 70°C. After drying their dry weight was determined and the average dry weight per hill was calculated.

It represents dry weight gained by a unit area of crop in a unit time expressed as g m^{-2} day^{-1} (Fisher, 1921; Kumar et al., 2017). The values of plant dry weight at 1 to 15, 16 to 30, 31 to 45, 46 to 60, 61 to 75, 76 to 90 and 91 to 106 DAT (at harvest) intervals were used for calculating the CGR.

$$\text{Crop growth rate} = \frac{W_1 - W_2}{t_1 - t_2}$$

Relative growth rate (RGR)

It was described by Fisher (1921) which indicates the increase in dry weight per unit dry matter over any specific time interval and it was calculated by the following equation:

$$\text{Relative growth rate (RGR)} = \frac{\text{In}W_2 - \text{In}W_1}{t_2 - t_1}$$

This parameter was calculated for the time intervals, *viz.,* 15 to 30, 30 to 45, 45 to 60, 60 to 75, 75 to 90 and 90 to 106 DAT using the data obtained from dry weight of plants.

Grains and chaff from ten panicles were counted separately which were obtained randomly from five tagged hills and their averages were recorded as number of grains per panicle. The fertility (%) of the total grains per panicle was worked out by using following formula.

$$\text{Fertility (\%) of grain} = \frac{\text{Filled grains}}{\text{Filled grains} + \text{Unfilled grains}} \text{X } 100$$

The partial factor productivity of nitrogen was worked out by using following formula:

$$PFP_N = Y/N \text{ (kg grain / kg N applied)}$$

The benefit cost ratio was worked out on the basis of gross return (Rs.) per unit cost of cultivation (Rs.).

$$\text{Benifit cost ratio} = \frac{\text{Gross return (Rs. } h^{-1})}{\text{Cost of cultivation (Rs. } h^{-1})}$$

Protein content in grain was worked out by multiplying the total N content in grain with factor (5.95). The nitrogen content of grains was analyzed by Micro-Kjeldahl's method as described by Bremner and Mulvancy (1982).

Protein (%) = N (%) x 5.95. (Anon,1980).

The data were subjected to statistical analysis "Analysis of variance" technique (Fisher and Yates, 1938) for drawing conclusion. The significant and non-significant effect of the treatments was judged with the help of 'F' (variance ratio) value between the means. The critical differences at 5% level of significance were used for testing of hypothesis.

RESULTS AND DISCUSSION

Growth parameters

The significant and higher plant height and dry weight was observed under T_4 at all growth stages, which was statistically at par with T_8 at most of the observation days (Table 1 and 2). The plant height increased as the plant growth stage increased, however after 90 DAT, the increase was not significantly higher as compared to 106 DAT. There was an increasing trend in plant dry weight from 15 DAT till maturity for all the treatments. The tiller count per hill increased up to 60 DAT, but thereafter it declined regardless of the treatments (Table 3). This may be due to the erratic weather pattern and extended dry spell leading to higher tiller mortality rate.

The reason for the production of more tillers in NCU might be due to the continuous and steady supply of nutrient N which promoted the initiation of more number of tillers. Similar results were also reported by Reddy (1988).The increase in the plant height might be due to gradual release of Nfrom the NCU which might be exerted a beneficial effect on plant growth. The result is in conformity with the finding of Umashankar et al. (2005) and Raj et al. (2014). Real time N management with the help of CLCC positively influenced plant growth. Significantly higher plant height was obtained with NCU application based on LCC were also reported by Sathiya and Ramesh (2009).

For all the treatments there was an increase in CGR from 15 DAT to 60 DAT and there after it showed

Table 1. Effect of nitrogen management on plant height of rice at periodic intervals.

	Treatment	Plant height (cm)						
		15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	106 DAT
T_1	70% RDN, NCU + CLCC	36.80	55.58	66.21	87.20	102.87	108.53	112.00
T_2	80% RDN, NCU + CLCC	39.70	57.71	74.31	90.00	106.33	116.83	118.27
T_3	90% RDN, NCU + CLCC	40.81	59.10	80.11	91.89	109.80	118.60	120.53
T_4	100% RDN, NCU + CLCC	43.17	61.27	83.16	95.14	112.87	120.60	122.40
T_5	70% RDN, NCU + Conventional	36.60	55.35	66.95	85.93	101.73	110.87	112.40
T_6	80% RDN, NCU + Conventional	37.87	57.63	73.89	88.07	106.13	113.73	115.13
T_7	90% RDN, NCU + Conventional	39.50	58.46	76.83	91.89	107.47	117.13	118.70
T_8	100% RDN, NCU + Conventional	42.45	60.55	80.97	93.04	110.27	118.67	119.90
	CD(P=0.05)	1.03	1.14	3.04	2.11	1.48	4.18	2.37

RDN: Recommended dose of nitrogen (120 kg ha^{-1}), NCU: Neem coated urea, CLCC: Customized Leaf Colour Chart.

Table 2. Effect ofnitrogen management on plant dry weight of rice at periodic intervals.

	Treatment	Plant dry weight (g $hill^{-1}$)						
		15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	106 DAT
T_1	70% RDN, NCU + CLCC	0.92	3.76	9.41	18.87	29.99	36.47	41.75
T_2	80% RDN, NCU + CLCC	1.08	4.10	12.53	26.17	33.05	40.20	46.03
T_3	90% RDN, NCU + CLCC	1.25	4.41	14.14	26.57	35.96	42.05	48.15
T_4	100% RDN, NCU + CLCC	1.34	4.69	14.71	30.19	42.97	53.67	55.45
T_5	70% RDN, NCU + Conventional	0.93	3.17	9.50	18.73	28.32	29.66	37.28
T_6	80% RDN, NCU + Conventional	1.03	3.47	10.53	24.17	32.71	34.31	39.28
T_7	90% RDN, NCU + Conventional	1.23	4.08	12.25	24.48	35.47	39.79	45.56
T_8	100% RDN, NCU + Conventional	1.32	4.47	13.12	28.25	41.65	44.61	50.77
	CD (*P*=0.05)	0.11	0.32	1.47	2.15	3.08	4.06	3.58

RDN: Recommended dose of nitrogen (120 kg ha^{-1}), NCU: Neem coated urea, CLCC: Customized Leaf Colour Chart

Table 3. Effect of nitrogen management on number of tillers of rice at periodic intervals.

	Treatment	Tiller hill^{-1}					
		15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT
T_1	70% RDN, NCU + CLCC	5.60	9.07	9.47	9.33	8.33	6.67
T_2	80% RDN, NCU + CLCC	5.93	9.73	10.73	9.67	8.67	7.27
T_3	90% RDN, NCU + CLCC	6.60	10.27	11.53	10.13	9.20	7.73
T_4	100% RDN, NCU + CLCC	7.53	11.60	12.53	10.67	9.53	8.60
T_5	70%RDN, NCU + Conventional	5.67	8.53	9.20	9.20	8.13	6.27
T_6	80% RDN, NCU + Conventional	6.07	9.53	10.60	9.53	8.47	6.93
T_7	90% RDN, NCU + Conventional	6.40	10.13	11.00	9.80	8.73	7.60
T_8	100% RDN, NCU + Conventional	6.93	10.80	11.53	10.07	9.33	8.00
	CD (*P*=0.05)	0.27	0.41	0.38	0.64	0.15	0.11

RDN: Recommended dose of nitrogen (120 kg ha^{-1}), NCU: Neem coated urea, CLCC: Customized Leaf Colour Chart.

decrease till 106 DAT. Highest CGR value was obtained at 60 DAT. Among all the treatments highest CGR was obtained under T_4 which was statistically at par with T_8 at most of the observation days. The RGR was found maximum between 15 to 30 days DAT interval, but thereafter it declined up to 91 to 106 DAT interval, regardless of treatments.

The increase in the CGR might be due to the gradual release of N from the NCU, which exerted a beneficial effect on plant growth. The result is in conformity with the finding of Umashanker et al. (2005). Real time N management with the help of CLCC may have positively influenced the plant growth and yield attributes (Thind et al., 2010).

Yield, yield attributes and economic analysis

Application of NCU at100% RDN resulted in highest number of effective tillers m^{-2} and panicle length (Table 7). However, the application of NCU as per CLCC (T_4) schedule resulted in significantly higher number of effective tillers m^{-2}. Total number of grains per panicle and % fertility (Table 6) increased as the dose of NCU fertilizer increased and highest value was obtained at 100% RDN in both conventional and CLCC based methods. For total number of grains per panicle, CLCC and conventional methods did not differed significantly, whereas grain fertility under CLCC was significantly higher as compared to conventional at 100% RDN. There was no significant effect of fertilizer dose and application schedule on test weight.

There was a significant increase in grain yield as the dose of NCU increased from 70 to 100% RDN. The increase in grain and straw yield was 26 and 16% under CLCC based application, whereas under conventional method the increase was 31 and 20% respectively under 100% RDN as NCU as compared to 70% RDN as NCU. Use of CLCC increased both grain and straw yield by 11% as compared to conventional method under 100% RDN as NCU.

Real time application of NCU on the basis of CLCC increased the PFP_N by 11% under conventional application method for 100% RDN. Highest grain

Table 4. Effect of nitrogen management on crop growth rate of rice.

	Treatment	Crop growth rate (g m^{-2} day^{-1})						
		1-15 DAT	16-30DAT	31-45DAT	46-60 DAT	61-75 DAT	76-90 DAT	91-106DAT
T_1	70% RDN, NCU + CLCC	8.36	6.32	12.55	21.03	24.69	14.41	11.73
T_2	80% RDN, NCU + CLCC	9.12	6.71	18.72	30.31	15.29	15.89	12.95
T_3	90% RDN, NCU + CLCC	9.80	7.02	21.62	27.63	20.86	13.52	13.56
T_4	100% RDN, NCU + CLCC	10.42	7.44	22.26	34.41	28.38	18.59	13.89
T_5	70% RDN, NCU + Conventional	7.04	4.96	14.07	20.52	21.30	10.28	9.63
T_6	80% RDN, NCU + Conventional	7.70	5.42	15.69	30.32	18.96	7.41	8.82
T_7	90% RDN, NCU + Conventional	9.06	6.32	18.17	27.17	24.41	9.60	12.83
T_8	100% RDN, NCU + Conventional	9.93	6.99	19.22	33.63	29.76	6.58	13.69
	CD (*P*=0.05)	1.05	1.01	3.11	5.48	NS	NS	5.06

RDN: Recommended dose of nitrogen (120 kg ha^{-1}), NCU: Neem coated urea, CLCC: Customized Leaf Colour Chart.

Table 5. Effect of nitrogen management on relative growth rate of rice.

	Treatment	Relative growth rate (g g^{-1} day^{-1})					
		15-30 DAT	31-45 DAT	46-60 DAT	61-75 DAT	76-90 DAT	91-106 DAT
T_1	70% RDN, NCU + CLCC	0.094	0.061	0.046	0.031	0.013	0.008
T_2	80% RDN, NCU + CLCC	0.089	0.074	0.050	0.016	0.013	0.008
T_3	90% RDN, NCU + CLCC	0.084	0.078	0.042	0.020	0.010	0.008
T_4	100% RDN, NCU + CLCC	0.084	0.076	0.048	0.024	0.012	0.008
T_5	70% RDN, NCU + Conventional	0.081	0.073	0.045	0.028	0.010	0.008
T_6	80% RDN, NCU + Conventional	0.081	0.074	0.055	0.020	0.007	0.007
T_7	90% RDN, NCU + Conventional	0.080	0.073	0.046	0.025	0.008	0.008
T_8	100% RDN, NCU + Conventional	0.081	0.072	0.051	0.026	0.005	0.008
	CD (*P*=0.05)	NS	NS	NS	NS	NS	NS

RDN: Recommended dose of nitrogen (120 kg ha^{-1}), NCU: Neem coated urea, CLCC: Customized Leaf Colour Chart.

Table 6. Effect of nitrogen management onyield, yield attributes and harvest index of rice.

	Treatment	No. of Grains $Panicle^{-1}$	Grain Fertility (%)	Test weight (g)	Grain Yield (t ha^{-1})	Straw Yield (t ha^{-1})	Harvest index (%)
T_1	70% RDN, NCU + CLCC	148.60	83.22	15.63	4.72	5.17	47.73
T_2	80% RDN, NCU + CLCC	153.52	87.75	16.16	4.80	6.13	43.93
T_3	90% RDN, NCU + CLCC	155.59	89.42	17.08	5.33	6.47	45.19
T_4	100% RDN, NCU + CLCC	159.54	92.50	17.47	5.93	6.76	48.63
T_5	70% RDN, NCU + Conventional	147.15	81.79	15.44	4.60	5.06	47.62
T_6	80% RDN, NCU + Conventional	152.08	86.29	16.06	4.91	5.29	48.15
T_7	90% RDN, NCU + Conventional	154.01	88.83	16.14	5.11	5.82	46.76
T_8	100% RDN, NCU + Conventional	155.62	89.05	16.31	5.35	6.07	46.85
	CD (*P*=0.05)	9.25	2.05	NS	0.17	0.25	1.24

RDN: Recommended dose of nitrogen (120 kg ha^{-1}), NCU: Neem coated urea, CLCC: Customized Leaf Colour Chart.

protein content was recorded under T_4. The use of CLCC increased the grain protein content by 2.5, 6, 4 and 5% respectively, under 70, 80, 90 and 100% RDN as compared to conventional method.

The net return per ha was Rs. 47034 and 37290, respectively under T_4 and T_8. It is evident that use of CLCC increased net return per ha by 26%. Highest B:C ratio was recorded under T_4.

The reason for the production of more number of effective tillers and panicle length in CLCC treated plots might be due to the real time supply of nutrient N, which promoted the initiation of more number of tillers. Similar results were also reported by Reddy (1988). Use of CLCC may have led to greater N supply resulting in adequate N content in rice plant thereby stimulating profuse tillering also observed by Raj et al. (2014). The increase in panicle length with CLCC based nitrogen management was also reported by Mathukia et al. (2014)

Real time application may have provided continuous and steady supply of nutrient N into the soil solution to match the required absorption pattern of rice to meet the physiological process which in turn produced higher number of total grain per panicle, increased quantum of fertile grain per panicle and higher grain yield (Raj et al., 2014). Further, it might also have positively influenced in maintaining the optimal leaf N of rice plant throughout the growing period, with the resultant improvement in the yield attribute (Mathukia et al., 2014; Kumar et al., 2010).

The increase in NUE (PFP_N) through the use of CLCC resulted from better synchronization of timing of fertilizer N applications and the crops need for N fertilizer (Singh et al., 2007; Thind et al., 2010).

Quality of food grains is a complex phenomenon and may be influenced by both genetic and/or environmental factors (Kumar et al., 2011; Singh and Singh, 1991). The increase in grain protein content might be due to better availability of N in the crop root zone and enhanced N uptake and consequent increase in photosynthetic and metabolic activities. Thus, resulting in better partitioning of photosynthates to sink, this got reflected in quality enhancement in terms of grain protein content and protein yield also reported by

Table 7. Number of effective tillers and panicle length under different nitrogen treatment.

	Treatment	Effective tillers no. m^{-2}	Panicle length (cm)
T_1	70% RDN, NCU + CLCC	204.4	24.10
T_2	80% RDN, NCU + CLCC	227.7	24.74
T_3	90% RDN, NCU + CLCC	236.0	25.70
T_4	100% RDN, NCU + CLCC	239.7	26.97
T_5	70% RDN, NCU + Conventional	193.6	23.90
T_6	80% RDN, NCU + Conventional	202.7	24.09
T_7	90% RDN, NCU + Conventional	224.6	24.73
T_8	100% RDN, NCU + Conventional	226.5	26.17
	CD (*P*=0.05)	10.26	1.03

RDN: Recommended dose of nitrogen (120 kg ha $^{-1}$), NCU: Neem coated urea, CLCC: Customized Leaf Colour Chart.

Table 8. Effect of nitrogen management on partial factor productivity and grain protein content of rice.

	Treatment	PFP_N (kg grain-kg N^{-1} applied)	Grain protein (%)
T_1	70% RDN, NCU + CLCC	56.23	6.24
T_2	80% RDN, NCU + CLCC	50.00	6.90
T_3	90% RDN, NCU + CLCC	49.38	7.63
T_4	100% RDN, NCU + CLCC	49.42	8.23
T_5	70% RDN, NCU + Conventional	54.80	6.09
T_6	80% RDN, NCU + Conventional	51.15	6.50
T_7	90% RDN, NCU + Conventional	47.31	7.35
T_8	100% RDN, NCU + Conventional	44.58	7.84
	CD (*P*=0.05)	2.15	0.25

RDN: Recommended dose of nitrogen (120 kg ha $^{-1}$), NCU: Neem coated urea, CLCC: Customized Leaf Colour Chart.

Table 9. Economic analysis of rice crop as influenced by NCU and LCC.

	Treatment	Gross return (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
T_1	70% RDN, NCU + CLCC	78555	51394	27161	1.53
T_2	80% RDN, NCU + CLCC	81189	51616	29573	1.57
T_3	90% RDN, NCU + CLCC	89655	51837	37818	1.73
T_4	100% RDN, NCU + CLCC	99092	52058	47034	1.90
T_5	70% RDN, NCU + Conventional	76591	51394	25197	1.49
T_6	80% RDN, NCU + Conventional	81582	51616	29966	1.58
T_7	90% RDN, NCU + Conventional	85378	51837	33541	1.65
T_8	100% RDN, NCU + Conventional	89348	52058	37290	1.72

RDN: Recommended dose of nitrogen (120 kg ha $^{-1}$), NCU :Neem coated urea, CLCC: Customized Leaf Colour Chart.

Mathukia et al. (2014).

The remarkable increase inthe economic returns is due to the 11% increase in grain yield under need based N management strategy based on CLCC with 120 kg N per hectare through theneem coated urea in three split doses. These results are in conformity with Gupta et al. (2011) and Maiti et al. (2007).

CONCLUSION

We conclude that the recommended dose of nitrogen, application of 120 kg N ha^{-1} through NCU with the help of CLCC resulted in highest grain yield (5.93 t ha^{-1}), grain protein content (8.23%), 11% increase in PFPNover the conventional method of fertilizer application.This treatment also resulted in highest net income (Rs. 47034 ha^{-1}) and B:C ratio (1.90). Since the findings are based on the research done in one season, hence further studies are needed for confirmation.

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