Asian Journal of Plant Sciences

ISSN 1682-3974

science alert

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Asian Journal of Plant Sciences 6 (3): 477-483, 2007
ISSN 1682-3974

Relationship Between Index Leaf Nitrogen and Leaf Colour Chart (LCC) Values in Direct Wet Seeded Rice (*Oryza sativa* L.)

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Abstract: Field experiment was conducted at the wetlands, Tamil Nadu Agricultural University, Coimbatore in deep clay soil (*Vertic ustochrept*) to study the relationship between Leaf Colour Chart critical value (LCC cv.) and index leaf nitrogen in CO 47 rice variety. The study was conducted in factorial randomized block design with three replications. The treatments included three levels of LCC cv. (LCC cv. 3, 4 and 5) with different rates of nitrogen (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). LCC readings were measured every week from 21 Days After Sowing (DAS) to 84 DAS and nitrogen fertilizer was applied as per treatment schedule. Index leaf N content was measured from 35 DAS to 84 DAS. There exist a positive correlation between index leaf N and LCC values. The higher leaf N content monitored at 49, 56, 63 and 70 DAS had its positive implications on the LCC values for atleast another two succeeding weeks of observation. The LCC values and index leaf N recorded in control plot during 35-84 DAS indicated that the native N supply of the experimental field itself was sufficient to maintain LCC cv. 3 after 35 DAS. However N fertiliser application is essential to maintain cv. 4 to increase the index leaf N and achieve crop performance similar to blanket N. Thus LCC values give an indirect measurement of index leaf N and serve as a tool for plant based fertiliser application.

Key words: Leaf colour chart, rice, index leaf N, relationship

INTRODUCTION

Rice is the staple food for half of the world population. World wide, rice is harvested in 150.2 million hectare. In the global rice scenario, there is a total production of 606.3 million tonnes of unmilled, rough rice with an average productivity of 4.03 tonnes ha^{-1} (FAO, 2004). Rice is grown under varied environments such as upland, irrigated lowland, rainfed lowland, deep-water and floating situations (De Datta, 1981). This results in the production unpredictability. Besides, rice is the maximum consumer of nitrogen (N) fertilizer constituting one third of the total nitrogen consumption of the world (Saravana and Perumal, 2002). Rice crop usually take half of the applied N to yield above ground biomass. The other half of the N is dissipated in the wider environment causing a number of environmental and ecological problems (Balasubramanian, 2004). The efficient N use is critical to produce sufficient food for feeding the burgeoning population and avoid large scale degradation caused by excess N (Tilman *et al*., 2001). Adoption of blanket dose of N fertilizer recommendation alone causes improper usage in some cases leading to wastage through leaching, volatilization, run off and denitrification and in other cases it may prove insufficient if the soils are poor in N fertility (Balasubramanian *et al*., 1999). In this connection, nitrogen fertilizer has received due attention in order to obtain the required yield targets through rational fertilizer use with the aid of portable diagnostic tools such as chlorophyll meter (SPAD 502) and leaf colour chart that can measure crop N *in situ* (Alam *et al*., 2005).

Farmers use rice leaf colour as a visual and subjective indicator of the crops need for N fertilizer. The relationship between leaf N concentration and leaf photosynthetic rate (Yoshida and Coronel, 1976) laid foundation to some of the recent N management approaches viz., leaf greenness based N application (Takebe and Yoneyama, 1989), N application based on time course sufficiency of leaf N concentration

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(Thiyagarajan, 2002) and using chlorophyll meter and leaf colour chart to determine leaf N status and N application (Bindhu, 2002; Zaman, 1999; Velu *et al*., 2002). Optimal nitrogen management strategies seek to match crop N demand with fertilizer N supply, thus reducing losses and maximizing crop N utilization. Adequate leaf N should be maintained throughout the growing period of rice, which is critical for achieving high yield (Olfs *et al*., 2005). Assessing the leaf N concentration is one of the techniques to decide this and maintaining particular N concentration of different physiological stages is one way of increasing the rice yield. This is essentially because N concentration in leaves is highly correlated with the concentration of CO_2 fixing enzyme in photosynthesis and hence, the potential maximum rate of photosynthesis could be linearly related to the N concentration in the leaf (Black, 1993).

A leaf colour chart developed in Japan (Furuya, 1987) is used to measure the green colour intensity of rice leaves, serves as a cheaper tool to assess the nitrogen requirements by non destructive method (Shukla *et al*., 2004). The use of LCC in rice aims at need based nitrogen application to crop based on soil N supply and crop demand, there by increasing the nitrogen use efficiency in rice. Even though LCC has been tested for real time N management in the farmers' fields in several countries (Balasubramanian *et al*., 1999), very limited information is available on the accuracy of LCC in estimating leaf N status of rice plants. The use of LCC for scheduling N application may not be uniformly applicable to all varieties that differ in inherent leaf colour, thereby necessitating individual or group standardization (Sheoran *et al*., 2004). Hence, the present investigation was focused on investigating the relationship between the Leaf Colour Chart critical value (LCC cv.) and index leaf N in direct seeded rice. It is hypothesised that the LCC cv is directly related to the measured index leaf nitrogen.

MATERIALS AND METHODS

Experimental site and initial soil characteristics: Field experiment was conducted at wetlands, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during *kuruvai* (August-November) 2002, to study the relationship between Leaf Colour Chart critical value (LCC cv.) and index leaf N in CO 47 rice variety (115 days duration). 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 (68.7% clay, 18.1% silt, 7.3% coarse sand and 5.9% fine sand) 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, high in Olsen-P and NH_4OAc-K.

Experimental design, sowing and fertiliser schedule: The study was conducted in factorial randomized block design 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 (Table 2). 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.

Table 1: Treatment details of the field experiment

Tr. No.	Notation	Treatment details
T_1	C	Control (zero-N)
T_2	BN	Blanket N (120 kg N ha^{-1} in four equal splits from 21 DAS)
T_3	MN	Manage N practice (120 kg N ha^{-1} in four splits - 1/6, 1/3, 1/3 and 1/6 from 21 DAS)
T_4	L_3N_{20}	LCC cv. 3 with 20 kg N ha^{-1} each time
T_5	L_3N_{25}	LCC cv. 3 with 25 kg N ha^{-1} each time
T_6	L_3N_{30}	LCC cv. 3 with 30 kg N ha^{-1} each time
T_7	L_3N_{35}	LCC cv. 3 with 35 kg N ha^{-1} each time
T_8	L_4N_{20}	LCC cv. 4 with 20 kg N ha^{-1} each time
T_9	L_4N_{25}	LCC cv. 4 with 25 kg N ha^{-1} each time
T_{10}	L_4N_{30}	LCC cv. 4 with 30 kg N ha^{-1} each time
T_{11}	L_4N_{35}	LCC cv. 4 with 35 kg N ha^{-1} each time
T_{12}	L_5N_{20}	LCC cv. 5 with 20 kg N ha^{-1} each time
T_{13}	L_5N_{25}	LCC cv. 5 with 25 kg N ha^{-1} each time
T_{14}	L_5N_{30}	LCC cv. 5 with 30 kg N ha^{-1} each time
T_{15}	L_5N_{35}	LCC cv. 5 with 35 kg N ha^{-1} each time

Table 2: LCC values recorded at weekly interval from 21 DAS as influenced by different N regimes (values in the parentheses indicate the quantity of N applied in kg ha^{-1})

Tr. No.	Tr.	Periods of observation (days after sowing) 21	28*	35	42	49	56**	63	70	77	84	Mean	Applied N (kg ha^{-1})
T_1	C	2.20	2.16	3.15	3.26	3.96	4.20	4.23	4.17	3.55	3.76	3.46	0
T_2	BN	2.43 (30)	2.70	3.30 (30)	3.83	4.43	4.33	4.70 (30)	4.77	4.27	4.25 (30)	3.90	120
T_3	MN	2.23 (20)	2.43	3.00 (40)	3.90	4.30	4.13	4.70 (40)	4.53	4.55	4.53 (20)	3.83	120
T_4	L_3N_{20}	2.23 (20)	2.36	2.83 (20)	4.03	4.20	4.30	4.63	4.38	4.22	4.02	3.72	40
T_5	L_3N_{25}	2.10 (25)	2.56	3.56	3.90	4.40	4.30	4.27	4.18	3.92	3.92	3.71	25
T_6	L_3N_{30}	2.16 (30)	2.26	3.20	3.60	4.13	4.00	4.00	4.06	4.02	3.87	3.53	30
T_7	L_3N_{35}	2.30 (35)	2.40	3.23	3.96	4.13	4.16	4.77	4.62	4.05	3.92	3.75	35
T_8	L_4N_{20}	2.43 (20)	2.70	3.13 (20)	3.93 (20)	4.60	4.50	4.77	4.70	4.25	3.97	3.90	60
T_9	L_4N_{25}	2.30 (25)	2.43	3.20 (25)	4.06	4.06	4.40	4.37	4.43	4.00	3.88	3.71	50
T_{10}	L_4N_{30}	2.20 (30)	2.16	3.06 (30)	4.00	4.10	4.10	4.47	4.15	3.93	3.92	3.61	60
T_{11}	L_4N_{35}	2.13 (35)	2.30	3.13 (35)	4.06	4.36	4.53	4.63	4.50	4.10	3.95	3.77	70
T_{12}	L_5N_{20}	2.33 (20)	2.50	3.57 (20)	4.33 (20)	4.50 (20)	4.73	4.63 (20)	4.93 (20)	4.22	3.98	3.97	120
T_{13}	L_5N_{25}	2.26 (25)	2.26	3.10 (25)	4.13 (25)	4.20 (25)	4.36	4.93 (25)	4.57 (25)	4.27	3.97	3.81	150
T_{14}	L_5N_{30}	2.30 (30)	2.33	3.06 (30)	3.66 (30)	4.40 (30)	4.97	5.00	4.90 (30)	4.50	4.25	3.94	150
T_{15}	L_5N_{35}	2.53 (35)	2.53	3.36 (35)	4.00 (35)	4.70 (35)	4.90	4.66 (35)	4.93 (35)	4.08	3.97	3.97	210
Mean		2.28	2.41	3.19	3.91	4.30	4.39	4.58	4.52	4.13	4.01	3.77	

(data not subjected to statistical analysis) *: Since the crop was at very early stage of tillering and the application of N was done at just the previous week, N application at the specified rates was not taken up, though the LCC critical values were below the target level.** : N application as per treatment schedule was not taken up though the measured LCC values were below the target level, due to cloudy and rainy weather

Leaf Colour Chart (LCC) value and index leaf N measurement: The LCC was developed from a Japanese prototype by the Crop and Resource Management Network (CREMNET) at IRRI and the Philippine Rice Research Institute, Philippines (Philrice). LCC is made of high quality plastic material. It consists of six colour shades ranging from light yellowish green (No. 1) to dark green (No. 6) colour strips fabricated with veins resembling those of rice leaves. LCC readings were taken at weekly intervals from 21 DAS. At least 10 disease free healthy rice plants were selected at random for each plot. The colour of the index leaf (fully opened third leaf from top upto panicle emergence and boot leaf after panicle emergence) of selected plants was compared with the colour strips of the chart. If six or more leaves read below the set critical value, fertilizer N was applied in the form of urea as per treatment schedule. LCC readings were measured under the body shade in the morning time. LCC readings were taken upto 84 DAS.

Separate area was demarked for plant sampling at different growth stages. Index leaves (fully opened third leaf from 35 DAS to panicle emergence and flag leaf after panicle emergence to 84 DAS) were collected every seven days from 35 DAS for analysis of leaf N. Leaf N is measured using Kjeldahl digestion and distillation (Humphries, 1956).

Statistical analysis: The observations collected from the field experiment and the data on the results of analysis of soil and plant samples were subjected to statistical scrutiny as per the procedure of Gomez and Gomez (1984). The treatments T_4 to T_{15} were treated as factorial randomised block design along with three checks (control, blanket N and manage N) and statistically analysed.

RESULTS

Leaf colour chart values: The LCC values measured at weekly intervals from 21 DAS ranged from 2.10 to 5.00 as recorded by L_3N_{25} on 21 DAS and L_4N_{30} on 63 DAS, respectively. Irrespective of the treatments, the LCC values were found below the threshold level on 21 and 28 DAS (Table 2). The LCC values were below three in all the treatments until 28 DAS. A curvilinear relationship was observed in LCC values with the advancement of crop growth (Fig. 1). The LCC value of control plot ranged from 2.16 to 4.23 on 28 and 63 DAS, respectively. LCC critical value of blanket N plot ranged from 2.43 to 4.77 and that of manage N plot ranged from 2.23 to 4.70 on 21 and 63 DAS, respectively.

Among the different rates of applied N to maintain LCC cv.3, the lowest rate of applied N viz., L_3N_{20} reached the threshold level on 42 DAS with two applications on 21 and 35 DAS, whereas the other treatments viz., L_3N_{25}, L_3N_{30} and L_3N_{35} had reached the threshold level on 35 DAS with a single application on 21 DAS. Among the different rates of applied N to maintain LCC cv. 4, the lowest rate of N application viz., L_4N_{20} reached the threshold level on 49 DAS with three applications on 21, 35 and 42 DAS; but all the other treatments viz., L_4N_{25} L_4N_{30} and L_4N_{35} reached the threshold level on 42 DAS with 2 applications on 21 and 35 DAS. Among the different rates of applied N to maintain LCC cv. 5, the treatments L_5N_{20}, L_5N_{25} and L_5N_{35} had never attained the threshold level even after 6 applications on almost all weeks from 21 DAS except on 28 and 56 DAS. Perversely, the treatment L_5N_{30} had attained the threshold level on 63 DAS with 4 applications on 21, 35, 42 and 49 DAS. However, the LCC threshold level could not be maintained as this treatment also followed the curvilinear relationship with the age of the crop (Fig. 1). Considering the over all mean values of LCC under individual treatments, the control plot recorded the lowest LCC value of 3.46 whereas L_5N_{20} and L_5N_{35} recorded the highest LCC value of 3.97 (Table 2).

Index leaf N: The index leaf N content varied between 1.69 to 4.52% as recorded at 84 DAS in control plot and 56 DAS in L_5N_{30} treatment. In general, a linear decreasing trend was observed in the index leaf N content with the advancement in crop growth (Fig. 2). Index leaf N content of control plot ranged from 1.69% on 84 DAS to 3.16% on 42 DAS with a mean value of 2.50%. Blanket N and manage N were on a par among themselves from 21 to 84 DAS, inspite of the differences in the N split. Pooled analysis of the data over the crop growth period revealed that all the treatments were superior to control in recording higher index leaf N. A concomitant increase in the index leaf N content was observed with the increase in LCC values and the trend of results were similar at almost all the weeks except on 42 DAS. The rates of applied N failed to influence on index leaf N except at 56 DAS. Though the main effect of rate of N application failed to influence the index leaf N at the rest of the periods of observation, their interaction with LCC levels had a marked influence on 49, 56, 77 and 84 DAS wherein, increasing rates of N application favoured increased N content in leaf under L_5 and L_3 while the reverse was the case in L_4 (Table 3).

Relationship between Index leaf N and LCC values: The leaf N content was found to have a significant and positive correlation with the LCC value at the respective

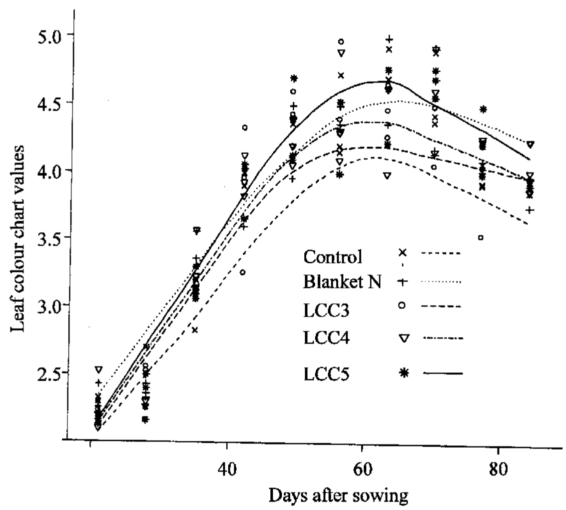

Fig. 1: Leaf colour chart values of rice variety (CO 47) at different period of observation for different N regimes

Table 3: Index leaf nitrogen content (%) at various growth stages of rice as influenced by different nitrogen regimes

		Periods of observation (days after sowing)								
*Tr. No.	*Tr.	35	42	49	56	63	70	77	84	Mean
T1	C	2.89	3.16	3.08	3.02	2.35	2.13	1.70	1.69	2.50
T2	BN	3.42	3.81	3.27	3.46	3.42	3.01	2.87	2.46	3.21
T3	MN	3.36	4.07	3.70	3.53	3.21	3.20	3.12	2.71	3.36
T4	L_3N_{20}	3.34	3.75	3.15	3.10	2.91	2.84	2.45	2.26	2.97
T5	L_3N_{25}	3.32	4.14	2.86	2.80	2.74	2.74	2.93	2.63	3.02
T6	L_3N_{30}	3.45	3.83	3.29	3.53	2.84	3.06	3.02	2.87	3.24
T7	L_3N_{35}	3.73	3.45	3.36	3.60	2.73	2.87	2.74	2.48	3.12
T8	L_4N_{20}	3.60	3.81	4.35	3.63	3.15	2.99	3.01	2.71	3.41
T9	L_4N_{25}	3.60	4.07	3.64	3.08	3.02	2.97	2.97	2.84	3.27
T10	L_4N_{30}	3.70	4.03	3.58	3.24	3.06	2.74	2.59	2.28	3.15
T11	L_4N_{35}	3.71	3.98	3.14	3.51	3.15	2.58	2.41	2.37	3.11
T12	L_5N_{20}	3.77	3.85	3.58	4.41	3.55	3.05	2.92	2.80	3.49
T13	L_5N_{25}	3.46	4.22	3.60	4.44	3.99	3.56	3.01	2.86	3.64
T14	L_5N_{30}	3.73	4.00	3.92	4.52	3.86	3.42	3.11	2.98	3.69
T15	L_5N_{35}	3.73	4.36	4.11	4.14	3.49	3.18	3.15	3.15	3.66
Mean		3.52	3.90	3.51	3.60	3.16	2.96	2.80	2.61	3.26
*Tr. LSD		0.35	0.56	0.47	0.39	0.39	0.38	0.32	0.28	0.25
LSD for L		0.18	NS	0.23	0.19	0.19	0.19	0.16	0.14	0.13
LSD for N		NS	NS	NS	0.22	NS	NS	NS	NS	NS
LSD for LxN		NS	NS	0.47	0.39	NS	NS	0.32	0.28	NS

*Tr- Treatment; NS = Non Significant

Table 4: Relationship between LCC values and Index leaf N of rice variety (CO 47) at different period of observation

	Index leaf N							
LCC values	35 DAS	42 DAS	49 DAS	56 DAS	63 DAS	70 DAS	77 DAS	84 DAS
35 DAS	0.175^{NS}	0.135^{NS}	0.121^{NS}	0.102^{NS}	0.010^{NS}	0.039^{NS}	0.239^{NS}	0.283^{NS}
42 DAS	0.650**	0.546*	0.218^{NS}	0.300^{NS}	0.466^{NS}	0.399^{NS}	0.436^{NS}	0.421^{NS}
49 DAS	0.453^{NS}	0.485^{NS}	0.515*	0.464^{NS}	0.511^{NS}	0.390^{NS}	0.546*	0.562*
56 DAS	0.506^{NS}	0.377^{NS}	0.517*	0.651**	0.630*	0.366^{NS}	0.319^{NS}	0.506^{NS}
63 DAS	0.451^{NS}	0.237^{NS}	0.515*	0.658**	0.725**	0.572*	0.330^{NS}	0.294^{NS}
70 DAS	0.557*	0.248^{NS}	0.604*	0.749**	0.707**	0.543*	0.465^{NS}	0.518*
77 DAS	0.414^{NS}	0.448^{NS}	0.471^{NS}	0.571*	0.721**	0.786**	0.680**	0.575*
84 DAS	0.079^{NS}	0.295^{NS}	0.256^{NS}	0.271^{NS}	0.458^{NS}	0.509^{NS}	0.462^{NS}	0.283^{NS}

(n = 15; ** r >= Value significance at 1% = 0.641; *Significance at 5 % = 0.514); NS = Non significant

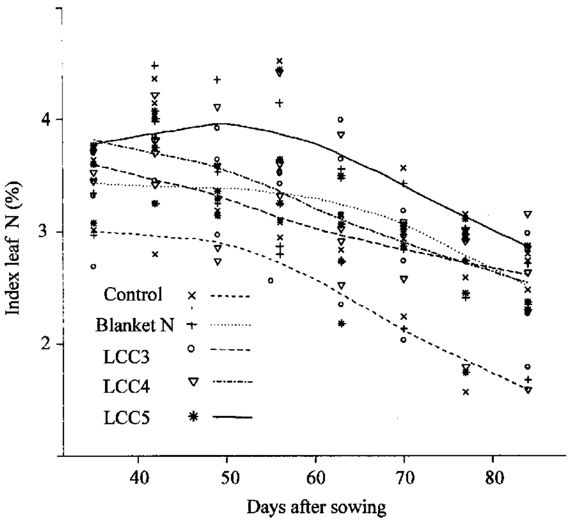

Fig. 2: Index leaf N of rice variety (CO 47) at different period of observation for different N regimes

period of observation at all the weeks except during 35th and 84th DAS (Table 4). The higher leaf N content monitored at 49, 56, 63 and 70 DAS had its positive impact on the LCC values for atleast another two succeeding weeks of observation. The relationship of LCC values at 35th and 84th DAS with that of N content monitored at different periods of observation was found to be non significant.

DISCUSSION

In general, the LCC values showed a gradual and progressive increase from the lowest (2.20) recorded at 21 DAS to the highest (4.58) at 63 DAS and there after it declined gradually to 4.01 at 84 DAS. This trend of changes could be observed even in the control plots, with the highest LCC value of 4.23 recorded at 63 DAS. The overall mean value of control plot was 3.46 which indicated that the native soil N supply was also relatively high. This is also evident from the moderate level of initial soil available N observed in the experimental field. Thiyagarajan *et al.* (1997) reported that some of the soils in Tamil Nadu were able to supply N equal to the demand of a sufficiently fertilized crop during the initial crop growth period and suggested the skipping of basal N application in these soils. The highest soil N uptake rate of unfertilized crops during important growth period was around 1 kg ha^{-1} d^{-1} and occurrence of this peak varied with locations. The LCC values observed under LCC cv. 3 and 4 revealed that once after attaining the threshold level after 1-3 applications, the LCC values never fall below the threshold level, indicating that the nitrogen supply at the early growth stages could maintain leaf greenness even upto reproductive phase. This was in contradiction to Bindhu (2002) who observed that the LCC values were below the threshold level at alternate weeks from 14 days after transplanting in transplanted hybrid rice. The LCC values recorded under LCC cv. 5 at different rates of N application indicated that even the application of 35 kg N ha^{-1} each time had failed to maintain the threshold LCC value of 5. This suggests the moderate response of the CO 47 rice variety for the higher rates of N application.

The LCC values recorded had a direct influence on the index leaf N content. The concomitant increase in the index leaf N with increasing LCC levels (Fig. 3) revealed that leaf N concentration was directly related to leaf greenness. There existed a positive correlation between LCC values and index leaf N from 42 DAS to 77 DAS (r>0.510) which was in accordance with John *et al.* (2000). The LCC values from 42 DAS to 84 DAS had a direct influence on the Index leaf N from 42 DAS to 84 DAS (r>0.546). The N concentration in leaves has been reported to be highly correlated with the concentration of the CO_2 fixing enzymes in photosynthesis, ribulose 1, 5-biphosphates carboxylase/oxygenase (Greenwood *et al.*, 1991) and hence the potential maximum rate of photosynthesis would be linearly related to the nitrogen concentration in the leaf (Black, 1993). Besides, N is an essential constituent of chlorophyll and these could be the reason for the positive relationship of LCC levels and index leaf

N content. Index leaf N content of control plot (Fig. 2) was always lesser than those of the different N regimes from 35 to 84 DAS with LCC 5 ranking the top indicating that N application is a must to maintain leaf N concentration and thereby increased levels of chlorophyll, photosynthesis, carbohydrate accumulation and in turn yield of rice. The reason for the index leaf N content of the control plot may be due to high native N supply and also the potential of the variety to exploit the nitrogen from the soil.

LCC values and index leaf N had a positive correlation among themselves at all periods of observation (35 to 84 DAS). The LCC values and index leaf N in control plot recorded during 35-84 DAS indicated that the native N supply of the experimental field itself was sufficient to maintain LCC cv. 3 after 35 DAS (Fig. 1). However N fertiliser application is essential to maintain cv. 4 to increase the index leaf N similar to blanket N to achieve crop performance similar to blanket N. Earlier studies which reviewed plant based fertiliser recommendations has indicated that N level in the plants is the result of the interaction between N from soil N mineralisation, from pre-crop residues, water status, root growth, N uptake efficiency etc., that influence the N availability and uptake (Olfs *et al*., 2005). Thus LCC values gives indirect measurement of index leaf N and thus saving fertiliser nitrogen without affecting crop yield.

CONCLUSIONS

There exist a positive correlation between index leaf N and LCC values. The higher leaf N content monitored at 49, 56, 63 and 70 DAS had its positive impact on the LCC values for atleast another two succeeding weeks of observation. The LCC values and index leaf N in control plot during 35-84 DAS indicated that the native N supply of the experimental field itself was sufficient to maintain LCC cv. 3 after 35 DAS. However N fertiliser application is essential to maintain cv. 4 to increase the index leaf N similar to blanket N to achieve crop performance similar to blanket N. Thus LCC values gives indirect measurement of index leaf N and serve as a tool for plant based fertiliser application.

ACKNOWLEDGMENT

Authors particularly like to thank Mr. Ramesh, casual field assistant for helping in LCC reading measurement.

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