Real Time Nitrogen Management in Rice using Leaf Colour Chart under Rainfed Condition of Western Hills of Nepal

Sidda lal Bohara[1], Krishna Lamsal[2*], Dillu Nath Yogi[3], Ganga Ram Chaudhary[4]

[1]Asst. Prof. Campus of live sciences, department of agronomy IAAS T.U.
[*2]District coordinator Renewable energy for Change Project in Sundar Nepal Sanstha
[3]Agriculture instructors at Shree Nepal Rastrya Secondary School
[4]Agriculture Technician at Agriculture Section
*Corresponding Author: Krishna Lamsal

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Abstract— *A field experimentation to determine the response of real time nitrogen management in rice using leaf colour chart on yield of rice under rainfed condition of western hills of Baitadi district of Nepal during rainy season of 2015. The variety for the field experimentation was carried in the variety "Rato Basmati". This variety was tested at five LCC based nitrogen management practices (N omission + recommended dose of P and K, recommended dose 100:30:30 kg NPK ha^{-1}, 30 kg N ha^{-1} + LCC < 4 @ 30 kg N ha^{-1}, No basal + LCC<4 @30 kg N ha^{-1} and 30 kg N ha^{-1} 15 DAT + LCC<4 @ 30 kg N ha^{-1}) in simple RCBD with three replication. The soil of experimental site was sandy loam in texture with pH 5.93. The data showed that there was saving of 10 Kg N ha^{-1} as compared to recommended N practice (100 Kg N ha^{-1}) in that LCC management practices where the basal application is omitted. Real time nitrogen management in rice using leaf colour chart significantly influenced the growth, yield attributes and yield over control. The highest plant height (122.90 cm), grain/panicle (103), grain yield (3890.83 kg/ha), harvest index (57.58) was obtained with no basal nitrogen plus LCC based nitrogen application. Maximum effective tiller (283.75) obtained from N2 application at 15 DAT+LCC based N application. The application of nitrogen only using the LCC or omitting the basal application further improve the efficiency of applied nitrogen and increase the yield by 75.53% and 25% respectively over the control and recommended practice.*

Keywords— Real Time Nitrogen Management, Leaf Colour, Western Hills of Nepal, rice management.

I. INTRODUCTION

Rice is the most important staple food crops in Nepal occupying hectares of land producing 5045045 tomes of grains with national productivity of 3.39 t ha^{-1} (ABPSD, 2014). Rice is the major cereal crop of the terai and inner terai occupying 67.87% of total area (ABPSD, 2013) but can be grown throughout all agro-ecological regions from terai plains to the high hills up to 3000 m above sea level (NARC, 2007) including valleys and foothills (Dhital *et al.*, 1995). Rice provides 50% of total calories requirement to Nepalese population and contributes 20% to the agriculture gross development product (NARC, 2007).

The national yields (ABPSD, 2014) of rice (3.39 t ha^{-1}) is far below the attainable yield of 5.00 t ha^{-1} (Dey and Hossain, 1995) and yield obtained in other major rice growing countries in the world. Furthermore this present yield of rice is not sufficient to meet the national demand. It is estimated that about 1259 thousand tons of additional rice need to be produced by 2030, which is equivalent to an overall increase of 27.96% in the next 17 years (Prasad *et al*., 2011; ABPSD, 2014). But the possibility of expanding the area in future is very limited. Therefore, the required extra production has to come only through increase in productivity with less water, labor, and chemicals and ensuring long-term sustainability. Agronomic management and technological innovations are needed to address these issues at present.

Among various reasons for this low productivity, inefficient utilization of nitrogen in considered to be the most critical one especially in south Asia including Nepal (Shukla *et al*., 2004; Witt *et al*., 2005). Nitrogen fertilizer must be applied only when necessary and must be based on the crops' nitrogen status. However, most farmers rely on the age (days after transplanting) of rice and not on nitrogen status of crop (Alam *et al*., 2005). They generally apply nitrogen fertilizer in fixed time recommended nitrogen split schedule and ratio at basal, maximum tillering and panicle initiation stages, without taking into account whether the plant really requires nitrogen at that time. The number of splits, amount of nitrogen applied per split and the time of applications vary greatly among the farmers (Witt *et al*., 2005; Regmi, 2003). This, consequently, caused inefficiency levels of nitrogen in terms of growth, development, and yield. Moreover, there are several farmers applying nitrogen fertilizer even if the crop does not need. As a result, there is an insignificant addition to the production cost and undesired effects on the growth of rice.

On the recent world-wide evaluation of fertilizer, its recovery efficiency has been found to be around 30% in rice (Krupnik *et al*., 2004). It has been observed that more than 60% of applied nitrogen is lost from the soil plant system due to lack of synchronization between the nitrogen demand and nitrogen supply (Yadav *et al*., 2004). The optimum use of nitrogen can be achieved by matching nitrogen supply with crop demand (Bijay *et al*., 2002) and caused greater yield responses to nitrogen application compared to farmer practice (Witt *et al*., 2005).

Viewing the scenario of low yield of rice in the hills of western Nepal, the experiment was conducted for sustainable improvement of the yield through the most economic and ecological prospective by effective nutrient management. The main objective of this study was to find out the effective nitrogen management practices through the use of LCC on rice production and to access the effect of different nitrogen management on growth, yield and yield attributes of rice under western mid hills of Nepal.

II. MATERIALS AND METHODS

The details of methods adopted and materials used during the course of study have been described in this chapter under following headings.

2.1 Description of the field experiment

2.1.1 Location

The experiment was carried out from June 2015 to October 2015 in the Agronomy farm of GAASC, Baitadi, Nepal which is located at Gokuleshwor, VDC of Baitadi District. The elevation of the sites, i.e. GAASC is at 700 masl with $24^{0}75'$ N latitude and $80^{0}50'$ E longitude. The research was conducted in the GAASC agronomy farm during rainy season of 2015.

FIGURE 1: Map showing research station (Gokuleshwor) of the Baitadi district

2.2 Physico-chemical characteristics of experimental soil

Composite soil sample were randomly taken from different spots from 0 – 15 cm depth using auger to record the initial soil physico-chemical properties of the experimental site. Soil sample was air dried, grounded and sieved through 2 mm sieve and tested for their properties.

The total nitrogen was determined by Kjeldhal distillation unit (Jackwson, 1967), available phosphorus by spectrophotometer (Olsen *et al.*, 1954) and available potassium by Ammonium acetate method (Black, 1965). Organic matter was determined by Walkey and Black method (1934), pH (1:2 soil: water suspensions) by Beckman Glass Electrode pH meter (Wright, 1939) and soil texture by hydrometer method. Physico-chemical properties of the soil of the experimental site are presented in Table 2. From the analysis, sand was found to be dominated in the physical properties of soil than silt and clay, possessing the sandy loam texture (Table 2).

On the chemical properties of soil, organic matter, total nitrogen, available phosphorus and potassium were observed. The average soil pH was found slightly acidic (pH 5.93) in the experimental field. The available nitrogen in the field represented medium (Khatri Chhetri, 1991), phosphorus in medium and high potassium in lower range whereas organic matter of soil (Jaishy, 2000) indicated the low soil fertility status (Appendix 2).

TABLE 1
PHYSICO-CHEMICAL PROPERTIES OF THE SOIL OF THE EXPERIMENTAL SITE AT GAASC, BAITADI

S.N.	Properties	Average content	Scale
1.	**Physical properties**		
	Sand (%)	30	
	Silt (%)	40	
	Clay (%)	20	
2.	**Chemical properties**		
	Soil pH	5.93	Slightly acidic
	Soil organic matter (%)	3.2	Medium
	Total nitrogen (%)	0.17	Medium
	Available phosphorus (Kg ha^{-1})	74.23	Medium
	Available potassium (Kg ha^{-1})	79.2	High
3.	**Texture/Rating**	Silt loam	

Source: NARC (Soil testing lab), Khajura, Banke district

2.3 Climatic condition during experimentation

The experimental site lies in the subtropical humid climate belt of Nepal. The area has sub-humid type of weather condition with cool winters, hot summers and distinct rainy season with annual rainfall of about 1919.5 mm. The metrological data for cropping season was recorded from NASA Power and presented Figure 2.

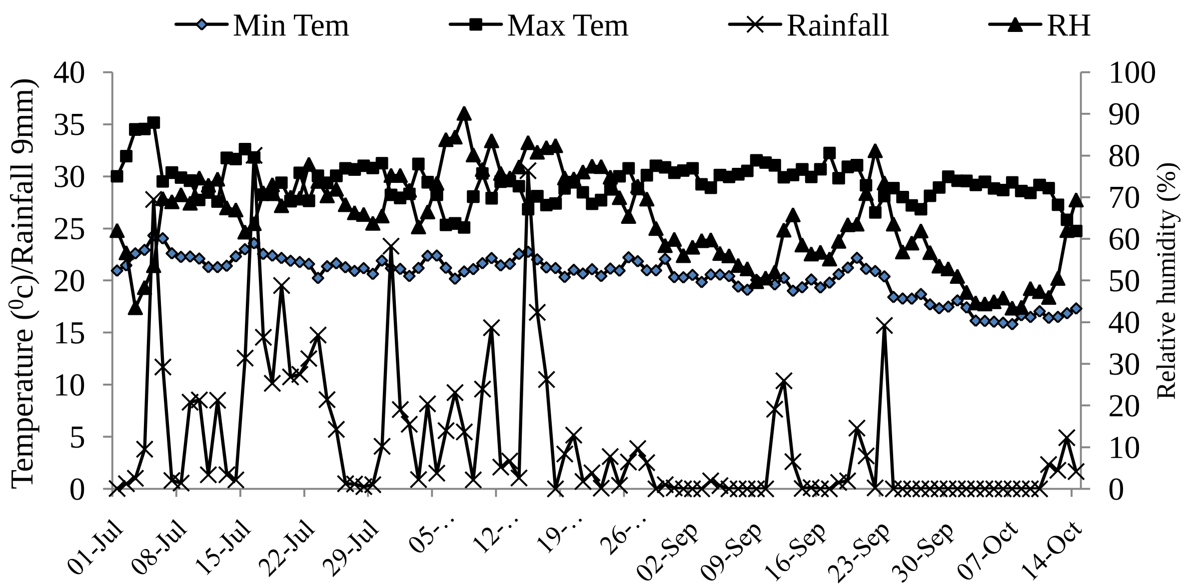

FIGURE 2: Weather condition during the experimentation period at GAASC, Baitadi
(Source: NASA power 2015)

The total rainfall of 472.8 mm was received during the entire period of experimentation whereas 300.00 mm of rainfall was recorded in the rice transplanting. The highest rainfall was recorded during July (256.05 mm) and lowest in October (10.67 mm).

The temperature regime in the experimental field was 15.81^{0}C -35.15^{0}C with average of 25.48^{0}C. The average relative humidity during the experimentation period was 64.70%.

2.4 Experimental details

2.4.1 Field layout

The experiment was laid out in one factors randomized complete block design with three replications having five treatments (Figure 2). The treatments consisted of combination of different levels and methods of nitrogen management namely control (nitrogen omission and recommended P and K), recommended NPK (100:30:30 kg NPK ha^{-1}), 30 kg N ha^{-1} basal+ LCC at <4 @ 30 kg N ha^{-1}, No basal N + LCC at <4 @ 30 kg N ha^{-1} and 30 kg N ha^{-1} at 15 DAS+ LCC at < 4 @ 30 kg N ha^{-1} detailing in Table 3. The variety used in experiment is Rato Basmati, a long duration variety. The size of individual plot was 3 m × 2 m (6.0 m^2). There was a bund of 0.5 m width between two experimental plots and each replication was separated by bund of 1 m width. The crop geometry of rice was maintained at 20 cm × 20 cm (hill to hill and row to row spacing) with two-three to four seeding per hill with 10 rows in each plot. The five central rows were treated as net plot rows for harvesting and remaining five rows in each side were used for biometrical observation.

2.4.2 Treatment details

TABLE 2
TREATMENT DETAIL OF THE EXPERIMENT REAL TIME NITROGEN MANAGEMENT IN RICE USING LEAF COLOUR CHART ONRICE DURING RAINY SEASON OF 2015 AT GOKULESHWOR, VDC OF BAITADI DISTRICT, NEPAL

S.N.	Treatment combination	Treatment code
1	Nitrogen omission + Recommended P and K	T1
2	Recommended 100:30:30 kg NPK ha^{-1}	T2
3	30 kg N/ha basal+ LCC at <4 @ 30 kg N ha^{-1}	T3
4	No basal N + LCC at <4 @ 30 kg N ha^{-1}	T4
5	30 kg N/ha at 15 DAT+ LCC at < 4 @ 30 kg N ha^{-1}	T5

2.4.3 Cultivation practices

Rice was transplanted on 20 July by using 24 day old seedling in main field. Fertilizer was applied according to treatment combination, no basal nitrogen were applied in basal dose skip plot. Gap filling was done one week after rice transplantation. Two manual weeding were carried at 24 and 45 days after transplanting. Crop form net plot area was harvested and dried in-situ for 3 days then threshed and yield measurements were recorded.

2.5 Observation recorded in rice

2.5.1 Leaf color chart reading

For N top dressing under LCC based treatments, LCC reading was taken at an interval of 10 days on randomly selected 10 plants from 14 days after transplanting (DAT) to the beginning of flowering. Readings were taken on the top most fully expanded leaf of randomly selected fixed 10 disease free plants by placing its middle part on top of the color strips in the chart. If six or more leaves read bellow a set critical value (4), predetermined rate of N was applied immediately. N top dressing through LCC was 30 Kg N ha^{-1}.

- **Plant height**

Randomly selected entire two rows' 10 hills were used for the measurement of plant height at an interval of around 15 days from 15^{th} day, after transplanting and ending with 48 DAT. It was measured from base to tip of the upper leaves of the main stem.

- **Yield and yield attributing characters**:

Effective tiller/m^2 was counted from net harvested area. No of grain/panicle from 20 randomly selected panicle, thousand grain weight form threshed seed, adjusted straw yield and grain yield and harvest index were recorded in kg /ha.

2.6 Statistical analysis

Dependent variables were subjected to analysis of variance using GenStat for simple RCBD. Repeated measure analysis was performed to account for the measurements over time on plant height. All the recorded data were subjected to analysis of variance and Duncan's multiple range test (DMRT) for mean separations from the reference of Gomez and Gomez (1984). Treatments differences were considered statistically significant at 0.05 levels of significance. A simple correlation and regression analysis was run between selected parameters. And SPSS was used for the regression analysis was used for the graphical analysis.

III. RESULTS AND DISCUSSION

The results obtained during the experiment are analyzed and presented in this chapter with the help of the tables and figures wherever necessary. The results obtained are discussed with possible reasons and literature support.

3.1 Effect of LCC readings on N fertilization in rice

Nitrogen fertilizer, while essential for high yield and profit in rice farming, is often managed inefficiently by farmers (Alam *et al.*, 2005). To avoid the underutilization and over utilization of N to the rice crop, IRRI introduced the leaf color chart (LCC) to help farmers measure leaf color intensity, an indicator of the crop's need for N (Budhar and Tamilselvan, 2003). Thus LCC is a simple tool for improving the time and rate of N fertilizer in rice.

TABLE 3
TOTAL AMOUNT OF NITROGEN FERTILIZER APPLIED IN DIFFERENT TREATMENTS COMBINATIONS DURING 2015 AT GOKULESHWOR, VDC OF BAITADI DISTRICT, NEPAL

S.N.	Treatment detail	Nitrogen applied (kg ha^{-1})
1	T1 = N omission + Recommended dose of P and K	0
2	T2 = Recommended 100:30:30 kg NPK ha^{-1}	100
3	T3 = 30 kg N/ha basal+ LCC at <4 @ 30 kg N ha^{-1}	120
4	T4 = No basal N + LCC at <4 @ 30 kg N ha^{-1}	90
5	T5 = 30 kg N/ha at 15 DAT+ LCC at < 4 @ 30 kg N ha^{-1}	90

Note: LCC, Leaf color chart, DAT days after transplanting

The data on the amount of nitrogen applied either through the use of LCC or through other ways of nitrogen management is presented in Table 5. The data showed that there was saving of 10 Kg N ha^{-1} as compared to recommended N practice (100 Kg N ha^{-1}) in that LCC management practices where the basal application is omitted. Saving might be due to application of N fertilizer when crop demands, thus enhancing the efficiency of applied nitrogen by reducing losses.

3.2 Effect of nutrient management on plant height

The plant height of rice was increased up to 48 DAT and recorded maximum (117.07 cm). The different nutrient management practices significantly influenced the plant height at all dates of observation (Table 2).

TABLE 4
EFFECT OF REAL TIME NITROGEN MANAGEMENT IN RICE USING LEAF COLOUR CHART ON PLANT HEIGHT (CM) OF RICE DURING RAINY SEASON OF 2015 AT GOKULESHWOR, VDC OF BAITADI DISTRICT, NEPAL

Treatments	Plant height (cm)		
	15 DAT	33 DAT	48 DAT
T1 = N omission + recommended P and K	61.10^{c}	80.70^{c}	100.90^{b}
T2 = Recommended 100:30:30 kg NPK ha^{-1}	70.60^{b}	81.55^{c}	119.05^{a}
T3 = 30 kg N ha^{-1} basal+ LCC at <4 @ 30 kg N ha^{-1}	72.05^{ab}	101.35^{a}	119.90^{a}
T4 = No basal N + LCC at <4 @ 30 kg N ha^{-1}	74.10^{a}	96.15^{b}	122.90^{a}
T5 = 30 kg N ha^{-1} at 15 DAT+ LCC at < 4 @ 30 kg N ha^{-1}	70.80^{b}	101.35^{a}	122.60^{a}
SEm (±)	0.82	1.45	1.52
LSD (=0.05)	2.78**	4.74**	4.95*
CV, %	2.10	2.70	2.20
Grand mean	69.73	92.22	117.07

Note: DAT, Days after transplanting; LCC, leaf color chart. Same letter(s) with in the column are not significant, **highly significant * significant

At 15 DAT, The average plant height was 69.73 cm and significantly varied among the treatments. The maximum plant height (74.10 cm) was recorded under treatment 4 (No basal N + LCC <4 @ 30 kg N ha^{-1}) and it was statistically similar to T3 (30 kg N ha^{-1} basal + LCC <4 @ 30 kg N ha^{-1}) but higher than other treatments. There was no significant difference among T3 (30 kg N ha^{-1}basal+ LCC at <4 @ 30 kg N ha^{-1}), T2 (Recommended 100:30:30 kg NPK ha^{-1}), and T5 (30 kg N ha⁻

^{1} at 15 DAS+ LCC at < 4 @ 30 kg N ha^{-1}). The shortest plant height (61.10 cm) was recorded for treatment (N omission + recommended dose of P & K) and it was statistically lower as compared to rest treatments.

The average plant height at 33 DAT was recorded 92.22 cm and significantly varied among the treatments. The maximum plant height (101.35 cm) was recorded under T3 (30 kg N/ha basal+ LCC at <4 @ 30 kg N ha^{-1}) and T5 (30 kg N ha^{-1} at 15 DAS + LCC at < 4 @ 30 kg N ha^{-1}) and they were significantly taller than other treatments. The lowest plant height (80.70 cm) was recorded on T1 (N omission + recommended dose of P and K) which is statistically at par with T2 (Recommended 100:30:30 kg NPK ha^{-1}). The treatment 4 (No basal N + LCC <4 @ 30 kg N ha^{-1}) was intermediate in height (96.15 cm).

At 48 DAT, the average plant height was recorded 117.07 cm and which is significantly varied among other treatments. The maximum plant height (122.9 cm) was recorded under treatment 4 (No basal N + LCC <4 @ 30 kg N ha-1) and it was statistically similar to T2 (Recommended 100:30:30 kg NPK ha^{-1}), T 3 (30 kg N/ha basal+ LCC at <4 @ 30 kg N ha^{-1}) and T5 (30 kg N ha-1 at 15 DAS+ LCC at < 4 @ 30 kg N ha^{-1}). The lowest plant height (100.90 cm) was recorded for T1 (N omission + recommended dose of P & K) and it was statistically lower as compared to treatments.

3.3 Effect of nutrient management on yield attributes

The average effective tiller was (260.75) per square meter and significantly varied among the treatments. The highest effective tiller (283.75) was recorded in T5 (30 kg N ha^{-1} @ 15 DAT + LCC < 4 @ 30 kg N ha^{-1}) and it was significantly different from rest of treatments. T2 (Recommended 100:30:30 kg NPK ha^{-1}) and T3 (30 kg N ha^{-1}basal+ LCC at <4 @ 30 kg N ha^{-1}) had statistically similar effective tiller per square meter and the lowest effect number of tiller per square meter (240.00 was recorded in T1 (N omission + recommended dose of P and K) and statistically lower as compared to rest treatments.

TABLE 5
EFFECT OF REAL TIME NITROGEN MANAGEMENT IN RICE USING LEAF COLOUR CHART ON YIELD ATTRIBUTES OF RICE DURING RAINY SEASON OF 2015 AT GOKULESHWOR, VDC OF BAITADI DISTRICT, NEPAL

Treatments	Yield attributes		
	Effective tillers per square meter	Grains per panicle	Thousand grain weight (g)
T1 = N omission + recommended P and K	240.00^{d}	58.03^{c}	17.00^{a}
T2 = Recommended 100:30:30 kg NPK ha^{-1}	258.75^{c}	82.12^{b}	15.50^{a}
T3 = 30 kg N ha^{-1} basal+ LCC at <4 @ 30 kg N ha^{-1}	267.50^{b}	76.50^{bc}	17.00^{a}
T4 = No basal N + LCC at <4 @ 30 kg N ha^{-1}	253.75^{c}	103.08^{a}	16.50^{a}
T5 = 30 kg N ha^{-1} at 15 DAT+ LCC at < 4 @ 30 kg N ha^{-1}	283.75^{a}	78.08^{bc}	16.50^{a}
SEm (±)	1.69	5.95	0.63
LSD (=0.05)	5.52	19.41	Ns
CV, %	1.10	13.00	6.60
Grand mean	260.75	79.56	16.50

LCC, leaf color chart, Common letter(s) with in the column are not significantly different at 0.05 level of significance by DMRT, Same letter (s) with in the column are not significant, **highly significant * significant

The average grain per panicle was 79.56 and maximum grain per panicle (103.08) recorded in T4 (No basal + LCC< 4 @30 kg N ha^{-1}) and it was statistically different rest of treatments. The treatment T2 (Recommended 100:30:30 kg NPK ha^{-1}) was statistically similar to T3 (30 kg N ha^{-1}basal+ LCC at <4 @ 30 kg N ha^{-1}) and T5 (30 kg N ha^{-1} @ 15 DAT + LCC < 4 @ 30 kg N ha^{-1}). The minimum grain per panicle (58.03) was recorded in T1 (N omission + recommended dose of P and K) and it was statically similar to T3 (30 kg N ha^{-1}basal+ LCC at <4 @ 30 kg N ha^{-1}) and T5 (30 kg N ha^{-1} @ 15 DAT + LCC < 4 @ 30 kg N ha^{-1}).

The average value of TGW was 16.50 g and highest TGW (17 g) was recorded in T1 (N omission + recommended dose of P and K) and T3 (30 kg N ha^{-1} basal+ LCC at <4 @ 30 kg N ha^{-1}). All treatment had not significantly influenced the TGW.

3.4 Effect of LCC based nitrogen management yield and harvest index

The average grain yield was 3114.83 kg ha^{-1} and was significantly varied among the treatments. The maximum grain yield 3890.83 kg ha^{-1} was recorded in T4 (No basal + LCC< 4 @30 kg N ha^{-1}) and it was statistically similar to T2 (Recommended

100:30:30 kg NPK ha^{-1}), T3 (30 kg N ha^{-1} basal+ LCC at <4 @ 30 kg N ha^{-1}) and T5(30 kg N ha^{-1} @ 15 DAT + LCC < 4 @ 30 kg N ha^{-1}). The minimum grain yield 2216.67 kg ha^{-1} was recorded in T1 (N omission + recommended dose of P & K) and it was statistically differ among rest treatments. It showed that grain yield was 28.78 % more in T2 (Recommended 100:30:30 kg NPK ha^{-1}) over T1 (N omission + recommended dose of P and K). The grain yield of T3 (30 kg N ha^{-1} basal+ LCC at <4 @ 30 kg N ha^{-1}), T4 (No basal + LCC< 4 @30 kg N ha^{-1}) and T5 (30 kg N ha^{-1} @ 15 DAT + LCC < 4 @ 30 kg N ha^{-1}) was 44.36%, 75.52% and 42.29% respectively more than that of T1 (N omission + recommended dose of P and K). Also, the grain yield of T3 (30 kg N ha^{-1} basal+ LCC at <4 @ 30 kg N ha^{-1}), T4 (No basal + LCC< 4 @30 kg N ha^{-1}) and T5 (30 kg N ha^{-1} @ 15 DAT + LCC < 4 @ 30 kg N ha^{-1}) was increased by 2.734%, 20.004% and 1.33% respectively as compared to T2(Recommended 100:30:30 kg NPK ha^{-1}). The per kg of nitrogen applied in recommended NPK resulted in 31.13 kg grain, while T3 (30 kg N ha^{-1} basal+ LCC at <4 @ 30 kg N ha^{-1}), T4 (No basal + LCC< 4 @30 kg N ha^{-1}), T5 (30 kg N ha^{-1} @ 15 DAT + LCC < 4 @ 30 kg N ha^{-1}) resulted in 26.67 kg, 43.23 kg and 35.05 kg.

TABLE 6
EFFECT OF REAL TIME NITROGEN MANAGEMENT IN RICE USING LEAF COLOR CHART ON GRAIN YIELD (kg ha^{-1}), STRAW YIELD (kg ha^{-1}) AND HARVEST INDEX (%) OF RICE DURING RAINY SEASON OF 2015 AT GOKULESHWOR, VDC OF BAITADI DISTRICT, NEPAL

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)
T1 = N omission + recommended P & K	2216.67^{b}	2104.17^{a}	50.97^{a}
T2 = Recommended 100:30:30 kg NPK ha^{-1}	3112.50^{a}	3091.67^{a}	50.72^{a}
T3 = 30 kg N ha^{-1} basal+ LCC at <4 @ 30 kg N ha^{-1}	3200.00^{a}	2487.50^{a}	56.17^{a}
T4 = No basal N + LCC at <4 @ 30 kg N ha^{-1}	3890.83^{a}	2850.00^{a}	57.58^{a}
T5 = 30 kg N ha^{-1} at 15 DAT+ LCC at < 4 @ 30 kg N ha^{-1}	3154.17^{a}	2579.17^{a}	54.90^{a}
SEm (±)	238.20	2.76.70	3.46
LSD (=0.05)	776.90	Ns	Ns
CV, %	13.20	18.20	11.10
Grand mean	3114.83	2622.50	54.07

LCC, leaf color chart, Common letter(s) with in the column are not significantly different at 0.05 level of significance by DMRT, Same letter (s) with in the column are not significant, **highly significant * significant

The average straw yield was 2622.50 kg ha^{-1} and maximum straw yield (3091.67 kg ha^{-1}) was recorded in T2 (Recommended 100:30:30 kg NPK ha^{-1}) and all the treatment had not significantly influenced the straw yield.

The average harvest index was 54.07 %. The maximum harvest index 57.58% was recorded in T4 (No basal + LCC< 4 @30 kg N ha^{-1}) and all the treatment had not significantly influenced the harvest index.

3.5 Correlation among yield attributes and yield parameters

Correlation among the yield attributes and yield was presented in Table 5. The grain yield was positively correlated with effective tillers per square meter (0.343) and number of grains per panicle (0.943**) and non-significant association with the thousand grain weight. The increase or decrease in the grain yield was greatly affected by the changed in effective tillers per square meter and grains per panicle. Similarly correlation among the harvest index and number of grains per panicle was also positive and highly significant.

TABLE 7
CORRELATION COEFFICIENTS FOR RELATIONSHIPS BETWEEN YIELD ATTRIBUTING CHARACTERS WITH YIELD OF RICE DURING RAINY SEASON OF 2015 AT GOKULESHWOR, VDC OF BAITADI DISTRICT, NEPAL

	GPP	TGW	GY	SY	HI
ET	0.177	-0.052	0.343	0.184	0.208
GPP		-0.229	0.943**	0.255	0.664**
TGW			-0.002	-0.038	0.044
GY				0.281	0.711**
SY					-0.466

Note: GPP, grains per panicle, ET, effective tillers per square meter, TGW, thousand grain weight, GY, grain yield; SY, straw yield and HI, harvest index; * Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed)

IV. CONCLUSIONS

The data showed that there was saving of 10 Kg N ha^{-1} as compared to recommended N practice (100 Kg N ha^{-1}) in that LCC management practices where the basal application is omitted. Real time nitrogen management in rice using leaf colour chart significantly influenced the growth, yield attributes and yield over control and at par with the recommended nitrogen application. The application of nitrogen only using the LCC or omitting the basal application further improve the efficiency of applied nitrogen and increase the yield by 75.53% and 25% respectively over the control and recommended practice.

REFERENCES

[1] ABPSD. 2013. Statistical information on Nepalese agriculture 2012/2013 (2069/070). Government of Nepal Ministry of Agricultural Development, Agri-Business Promotion and Statistics Division, Agri-statistics Section, Singha Durbar, Kathmandu Nepal

[2] ABPSD. 2014. Statistical information on Nepalese agriculture 2013/2014 (2070/071). Government of Nepal Ministry of Agricultural Development, Agri-Business Promotion and Statistics Division, Agri-statistics Section, Singha Durbar, Kathmandu Nepal.

[3] Alam, M. M., J. K. Ladha, S. R. Khan, Foyjunnessa, Harun-ur-Rashid, A. H. Khan and R. J. Buresh. 2005. Leaf color chart for managing nitrogen fertilizer in lowland rice in Bangladesh. Agron. J., 97: 949-959.

[4] Bijay, S., S. Yadvinder, J. K. Ladha, K. F. Bronson, V. Balasubramanian, S. Jagdeep and C. S. Khind. 2002. Chlorophyll meter and leaf color chart-based nitrogen management for rice and wheat in northwestern India. Agronomy J., 94(4): 821-829.

[5] Black, C. A. 1965. Method of soil analysis. Part II. American Society of Agronomy. INC publisher, Madison, Wisconsin, USA. pp 1372-1376.

[6] Budhar, M. N. 2005. Leaf colour chart with nitrogen management in direct seeded puddled rice (*Oryza sativa*L). Fertilizer News, 50(3): 41-44.

[7] Dey, M.M. and M. Hossain, M. 1995. Yield potentials of modern rice varieties: an assessment of technological constraints to increase rice production. In: Proceedings of the Final Workshop of the Projections and Policy Implications of Medium and Long Term Rice Supply and Demand Project. Beijing, China, April 23-26, 1995.

[8] Dhital, B. K., T. B. Gurung, R. P. Bhari and K. D. Subedi. 1995. Agronomic research in rice. LARC working paper 1995, Lumle Kashi, No. 96:51.

[9] Gomez, K. and A. Gomez. 1984. Statistical Procedures for Agricultural Reserch, 2nd edition. Two factor experiments. A wiley interscience publication. John Wiley and Sons, New York. p 108.

[10] Jakson, M. L. 1967. Soil chemical analysis. Prentices Hall of India. Pvt. Ltd., New Delhi.

[11] Joshi, K.D., R.B. Rana, and A. Subedi. 2001. Farmers and researchers contribution to the selection of landraces of Gaiya (Upland Rice) for Tar areas of Nepal. LIBIRD/SANFEC: Kathmandu / Dhaka.13:1-32.

[12] Khatri-Chhetri, T. B. 1991. Introduction to soils and soil fertility. Tribhuvan University, Institute of Agriculture and Animal Science, Rampur Chitwan, Nepal. pp. 164-198.

[13] Krupnik, T. J., J. Six, J. K. Ladha, M. J. Paine and C. van Kessel. 2004. An assessment of fertilizer nitrogen recovery efficiency by grain crops. *In*: Agriculture and the Nitrogen Cycle: Assessing the Impacts of Fertilizer Use on Food Production and the Environment, Scientific Committee on Problems of the Environment (SCOPE), A. R. Mosier, J. K. Syers and J. R. Freney (Eds.), Paris.

[14] NARC. 2007. Research highlights: 2002/03-2006/07. Communication, Publication and Documentation Division, Nepal Agricultural Research Council (NARC), Khumaltar, Lalitpur. 17 p.

[15] Olsen, S. R., C. V. Cole, F. S. Watanable and L. Dean. 1954. Estimation of available phosphorus in soil by extraction with Sodium carbonate. US Dept of Agric.

[16] Prasad, S. K., H. Pullabhotla and A. G. Kumar. 2011. Supply and Demand for Cereals in Nepal 2010-2030, In: IFPRI Discussion Paper 01120, Environment and Production Technology Division, New Delhi.

[17] Regmi, A. P. 2003. Improving the productivity of rice-wheat system through field specific nutrient management in Nepal. Thesis (Ph.D.) University of the Philippines at Los Banos (UPLB), Los Banos, Laguna, Philippines.

[18] Shukla, A. K., J. K. Ladha, V. K. Singh, B. S. Dwivedi, V. Balasubramanian, R. K. Gupta, S. K. Sharma, Y. Singh, H. Pathak, P. S. Pandey, A. T. Padre and R. L. Yadav. 2004. Calibrating the leaf color chart for nitrogen management in different genotypes of rice and wheat in a systems perspective. Agronomy Journal, 96: 1606–1621.

[19] Witt, C., J. M. C. A. Pasuquin, R. Mutters and R. J. Buresh. 2005. New leaf color chart for effective nitrogen management in rice. Better Crops, Vol. 89 (1): 36-39

[20] Wright, C. H. 1939. Soil analysis: A hand book of physical and chemicals. Thomas Murty and Co., London.

[21] Yadav, R. L., A. T. Padre, P. S. Pandey and S. K. Sharma. 2004. Calibrating the leaf color chart for nitrogen management in different genotypes of rice and wheat in a system. Agronomy J., 98: 1606-1621.