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Precision nitrogen management through Leaf Colour Chart for improved yield attributes and yield of transplanted rice

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Abstract
A field experiment was carried out during *kharif*, 2018 on sandy loam soil at college farm, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, with an objective to optimize nitrogen level and to determine LCC critical value for short duration transplanted rice. There were 9 treatments with 3 replications laid out in RBD which included two doses of nitrogen (120 and 150 kg ha^{-1}) applied on basis of two critical LCC values- 3 and 4. In turn N was applied in 3 equal splits incase of 120 kg N ha^{-1} and with 150 kg N ha^{-1} it was applied in 3 and 4 splits with half as basal. These LCC based treatments were evaluated against control with no nitrogen, recommended method and farmers practice with (120-60-40), (180-80-40) RDF respectively applied at fixed time intervals. Results revealed that, N application based on LCC value-4 was more beneficial than LCC-3 in improving yield attributes and yield of rice. N application at 150 kg ha^{-1} at LCC-4 (T_9) produced significantly (p=0.05) highest panicles m^{-2} (279), length of panicle (22.9 cm), spikelets panicle^{-1}(108), filled grains panicle^{-1} (98), test weight (24.71 g) and grain yield (6,533 kg ha^{-1}). Thus LCC-4 based N applicaton is considered as suitable nitrogen management technique in transplanted rice.

Keywords: crop need; LCC; nitrogen; short duration rice; yield attributes; yield

1. Introduction
Rice (*Oryza sativa* L.) is a major crop of 89 countries in the world and is the stable food for half of the world population [9]. In transplanted rice, poor management practices, especially the fertilizer management is key factor for its poor productivity in our country. Development and promotion of more efficient practices for N fertilizer management in rice consequently remain a high priority for increasing profitability of rice farming while protecting the environment [2]. Extensive adaption of modern varieties and improved production technology has accelerated the use of chemical fertilizers especially of nitrogen. Farmers generally apply excess nitrogen (and little Phosphorus, potassium and other nutrients) which will eventually result in high pest and disease incidence due to excess vegetative growth and also leads to serious lodging. Moreover, in India, most research works have so far been focused on the rate and timing of N application without considering the initial soil nitrogen and crop demand. So, a study is needed on crop-demand based N management through LCC.

Observing the plant N status is important in improving balance between crop N demand and N supply from soil and applied fertilizer [3]. LCC (Leaf colour chart) serves as an important guide for applying nitrogen fertilizer based on the crop need. LCC provides an indirect assessment of leaf nitrogen status, which is related to photosynthetic rate and biomass production [5]. The LCC used in Asia is typically a durable plastic strip about 7 cm wide and 13 to 20 cm long, containing four to six panels that range in colour from yellowish green to dark green. With this real-time based N management, farmers monitor the colour of leaves at 7 to 10 days intervals and apply N fertilizer whenever leaves become more yellowish green than the critical colour on the LCC. Results of on-farm experiments on productivity of an intensive rice based system through site specific nutrient management revealed that, Leaf color chart based N management gave 0.3 t ha^{-1} more yield over three split nitrogen applications of SSNM dose [6]. Similarly, by using LCC-5 with 35 kg N ha^{-1} each time with a total of 210 kg N ha^{-1} has recorded 87% higher grain yield (5104 kg ha^{-1}) over control (2723 kg ha^{-1}) [9]. Even, real-time N management with LCC has been under evaluation in Asia since late 1990s [8] and only limited information is available on the accuracy of LCC in estimating leaf N status of rice plant [9]. Considering all these aspects, the present investigation was carried out to standardize critical value of LCC for Short duration transplanted Rice variety, KNM-118.

2. Materials and Methods
A field experiment was conducted during *Kharif*, 2018 to study the effect of LCC based nitrogen management on growth, yield and nitrogen use efficiency of short duration transplanted rice at College farm, College of Agriculture, Rajendranagar, Telangana (17°19' N and 78°24' E). The soil was moderately alkaline in pH (7.8), non-saline in EC (0.32 dSm^{-1}), low in organic carbon (0.42 %), low in available N (210 kg ha^{-1}), medium in available P (44.3 kg ha^{-1}) and high in available K (351 kg ha^{-1}). The experiment was laid out in RBD with three replications. Treatments included two doses of nitrogen (120 and 150 kg ha^{-1}) applied on basis of two critical LCC values- 3 and 4. In turn N was applied in 3 equal

splits incase of 120 kg N ha^{-1} and with 150 kg N ha^{-1} it was applied in 3 and 4 splits with half as basal. These LCC based treatments were evaluated against control with no nitrogen, recommended method and Farmers practice with (120-60-40), (180-80-40) RDF respectively applied at fixed time intervals. KNM-118 (Kunaram sannalu) was the variety selected for the study. All agronomic practices were carried out as per the recommendations.

2.1 Nutrient management using LCC

The recommended dose of fertilizer @ (120-60-40) and (180-80-40) N, P_2O_5 and K_2O kg ha^{-1} were applied to T_2 and T_3 treatments respectively. NPK were applied through urea, single super phosphate and Muriate of potash (single super phosphate for control) sources respectively. Half of the recommended dose of N was applied as basal for all treatments except for T_4 and T_7. Entire dose of P as basal and K applied in 2 splits (basal + at 1st top dressing of Nitrogen) for all treatments. RDN was applied at 0, 18, 35 DAT for T_2 and T_3. For treatments T_4 to T_9, nitrogen was applied based on their respective LCC critical values using RDN of 120 kg ha^{-1} for T_4 and T_7 and RDN of 150 for T_5, T_6, T_8 and T_9 treatments.

2.2 LCC usage

The topmost fully expanded leaf from each hill was selected and leaf colour was compared to the panel colour of LCC. Whenever the green colour of more than 5 out of 10 leaves were observed equal to or below a set critical limit of LCC score, nitrogen was applied as per the treatment. The average LCC reading were determined for each treatment. Readings were taken in the morning (8-10 AM) under the shade of body in order to avoid the influence of sun light as it may reflect the LCC colour.

Observations on yield attributes i.e., panicles m^{-2}, length of panicle, spikelets panicle^{-1}, filled grains panicle^{-1} and test weight (g) were recorded at harvest stage. Observations were recorded from five randomly selected plants in each plot and then readings were averaged. After proper drying, threshing and winnowing, the produce from each plot at 14 per cent moisture level was weighed separately.

3. Results and Discussion

3.1 Effect of LCC based N management on yield attributes

Number of panicles is the most important component of yield. The number of grains per unit area is determined by panicle density and grains per plant, which is the sum of the grains number on each panicle. Highest no. of panicles m^{-2} (279) was recorded with T_9 {150 kg RDN at LCC 4 - RDN applied as1 basal + 3 equal splits (½ basal + 25 kg + 25 kg + 25kg)} and was on par with all other treatments except T_1, T_4 and T_5. While lowest (193) was recorded with T_1 (No Nitrogen) which was significantly inferior to all other treatments (Table 1). Supply of nitrogen at higher levels might have favoured structural and functional activities of the crop, resulting in production of more number of effective tillers. The lowest number of panicles m^{-2} with T_1 might be due to insufficient supply of nitrogen for better growth and development of crop [10].

Panicle length gives total number of grains present in panicle and expected grain yield from that area thus contributing to yield. An overview of the data indicated that, Length of panicle did not differ significantly by LCC based Nitrogen management. It was observed that, T_9 recorded higher length of panicle (22.9 cm). While lowest (19.3 cm) was recorded with T_1 (Table 1). It might be due to higher availability and uptake of N which is a substrate for synthesis of organic compounds, which constitute protoplasm and chlorophyll that resulted to increase in cell division and enlargement at higher doses of nitrogen [1].

Highest spikelets panicle^{-1} (108) were recorded with T_9 {150 kg RDN at LCC 4 - RDN applied as1 basal + 3 equal splits (½ basal + 25 kg + 25 kg + 25 kg)} which was on par with all other treatments except T_1, T_4, T_5 and T_6. While lowest spikelets panicle^{-1} (76) was recorded with T_1 (No Nitrogen) (Table 1). This might be due to timely nitrogen application and supply during panicle initiation stage that have increased the number of spikelets panicle^{-1} [4]. Moreover increased levels of N application in splits helped in synchronizing the nutritional demand of rice at all the stages.

Filled grains panicle^{-1} gives us the information about conversion ratio of the source to sink in plants. This is the most important factor that determines the grain yield of crop. Highest filled grains panicle^{-1} (98) was recorded with T_9 which was on par with T_3 {Farmers practice} T_7 and T_8. While lowest filled grains panicle^{-1} (58) was recorded with T_1 (Table 1). Among LCC scores, LCC-4 have recorded more filled grains panicle^{-1}. This might be due to timely availability of nitrogen for synthesis of photosynthates and grain filling. Treatments with 150 kg N ha^{-1} resulted in more filled grains panicle^{-1}. Higher uptake and recovery of applied nitrogen at higher levels (150 kg ha^{-1}) must have improved the filled grains panicle^{-1} [11].

Test weight did not differ significantly by LCC based Nitrogen management. It was observed that, highest (24.71) test weight (1000 grain weight) was recorded with T_9. While lowest test weight (24.01) was recorded with T_1 (Table 1). Higher test weight was observed with treatments imposed based on LCC-4 rather than recommended and farmers practice. This might be due to more nitrogen absorption after flowering stage in grain which lead to more no. of filled grains panicle^{-1} that ultimately resulted in more test weight [7]. With regard to nitrogen doses 150 kg N ha^{-1} resulted in more test weight.

3.2 Effect of LCC based N management on grain yield (kg ha^{-1})

Highest grain yield (6,533 kg ha^{-1}) was recorded with T_9 {150 kg RDN at LCC 4 - RDN applied as 1 basal+ 3 equal splits (½ basal + 25 kg + 25 kg + 25kg)} which was on par with T_3 { Farmers practice }, T_7 and T_8. While lowest grain yield (2,474.1 kg ha^{-1}) was recorded with T_1 (No Nitrogen) which was significantly inferior to all other treatments (Table 1). Maximum yield of 6,533 kg ha^{-1} was recorded in T_9 which is based on LCC value-4, but it was statistically on par with T_3 (Farmers practice). The percentage of 'N' saving was about 16.7 % and recorded about 4 % more yield. Application of N @ 120 kg ha^{-1} under LCC guidance resulted lower values of the grain yield which could be attributed to inadequate N to meet the crop needs but have saved 20 % of nitrogen over 150 kg N ha^{-1}. Among nitrogen doses 150 kg N ha^{-1} produced more grain yield than 120 kg ha^{-1} which might be attributed to synchronization of nitrogen supply with demand of crop lead to better growth, biomass production and higher photosynthetic rate which reflected in better reproductive growth too [12].

Table 1: Yield attributes and yield as influenced by LCC based nitrogen management in rice

Treatments		Yield attributes					Grain yield (kg ha^{-1})
		Panicles m^{-2}	Length of panicle (cm)	Spikelets panicle^{-1}	Filled grains panicle^{-1}	Test weight (g)	
T_1	No Nitrogen	193	19.3	76	58	24.01	2474
T_2	RDF (120-60-40 Kg N, P_2O_5, K_2O ha^{-1}) - RDN applied as 1 basal+ 2 equal splits (½ basal + 1/4th + 1/4th)	258	20.9	98	85	24.39	5499
T_3	Farmers practice (180-80-40 Kg N, P_2O_5, K_2O ha^{-1}) - RDN applied as 1 basal + 2 equal splits (½ basal + 1/4th + 1/4th)	271	20.5	107	94	24.70	6224
T_4	120 kg RDN at LCC 3 – RDN applied as 3 equal splits (1/3rd basal + 1/3rd + 1/3rd)	225	21.0	87	73	24.18	3814
T_5	150 kg RDN at LCC 3 - RDN applied as 1 basal + 2 equal splits (½ basal + 1/4th + 1/4th)	228	21.0	91	81	24.22	4342
T_6	150 kg RDN at LCC 3 - RDN applied as 1 basal+ 3 equal splits (½ basal + 25 kg + 25 kg + 25 kg)	252	21.0	93	82	24.33	4954
T_7	120 kg RDN at LCC 4 – RDN applied as 3 equal splits (1/3rd basal + 1/3rd + 1/3rd)	266	22.2	102	92	24.45	5891
T_8	150 kg RDN at LCC 4 - RDN applied as 1 basal+ 2 equal splits (½ basal + 1/4th + 1/4th)	267	22.3	104	92	24.65	5893
T_9	150 kg RDN at LCC 4 - RDN applied as1 basal + 3 equal splits (½ basal + 25 kg + 25 kg + 25kg)	279	22.9	108	98	24.71	6533
	SE(m) ±	9.0	0.74	4.5	3.05	1.02	309.8
	CD (*P*=0.05)	28	NS	13	9	NS	929

5. Conclusion

With increase in nitrogen dose from 120 to 180 kg ha^{-1} yield attributes like panicle m^{-2}, spikelets panicle^{-1}, filled grains panicle^{-1}, test weight and yield were also increased. Moreover LCC-4 based treatments (T_7, T_8 and T_9) showed higher yield attributes and yield advantage to a tune of 7-18 % over recommended practice with saving of 30 kg N ha^{-1} over farmers practice. Thus LCC based nitrogen application helps in preventing the farmers from excess nitrogen application in turn can save the capital invested on N- fertilizer.

6. References

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