

Original Research Article

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Judicious Nitrogen Management using Leaf Colour Chart for Enhancing Growth and Yield of Short Duration Transplanted Rice (*Oryza sativa* L)

B. Bhavana^{1*}, P. Laxminarayana¹, A. Madhavi Latha¹ and T. Anjaiah²

¹Department of Agronomy, ²Department of Soil Science & Agricultural Chemistry,
College of Agriculture, PJTSAU, Rajendranagar, Hyderabad, Telangana -500030, India

*Corresponding author

ABSTRACT

Field investigation was carried out during *Khariif*, 2018 with an objective to study the possibility of effect of LCC based nitrogen management on growth of transplanted rice. Treatments included two doses of nitrogen (120 and 150 kg ha⁻¹) applied on basis of LCC- 3 and 4. In turn Nitrogen was applied in 3 equal splits @ 120 kg N ha⁻¹ and (3 and 4) splits with half as basal, remaining @ 150 Kg ha⁻¹. These treatments were evaluated against control, 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 enhancing the growth and yield of rice. LCC-4 at 150 kg N ha⁻¹ (T₀) produced significantly higher plant height (107.9 cm) at maturity, number of tillers (339 m⁻²), leaf area index (2.17), SPAD readings (34.3), dry matter (11,246 kg ha⁻¹) and grain yield (6,533 kg ha⁻¹). With respect to dose of nitrogen 150 kg N ha⁻¹ resulted in more yield than 120 kg N ha⁻¹. The results of the study implied that LCC-4 was found to be effective as a decision tool for optimum N application in rice.

Keywords

LCC, Nitrogen,
Short duration rice,
Oryza sativa L,
Growth, SPAD

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Introduction

Rice (*Oryza sativa* L.) is the most important source of staple food in India, occupying 43.5 m ha of area producing 104.41 m tonnes with productivity of 3.60 t ha⁻¹ (Directorate of Economics and Statistics 2016-17). Telangana contributes 2.09 m ha area with a production of 6.62 m tonnes, with an average productivity of 3.295 t ha⁻¹ during 2016-17 (Season and Crop report Telangana, 2016-17).

About 90 % of total rice produced is consumed in Asian countries, but the productivity of rice in India is comparatively very low than other major rice growing countries in the world (6.71 t ha⁻¹ - china).

Among all the reasons for lower productivity, inefficient utilisation of nitrogen is considered as an important one. Extensive adaption of modern varieties and improved production technology has accelerated the use of

chemical fertilizers especially of nitrogen. Nitrogen is the most important nutrient that limits the high yield potential of rice cultivars (Shreshta and Maskey, 2005). 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.

For most soils of the country, nitrogen use efficiency in rice is only about 30 to 40% and about 1/3 rd of applied nitrogen is lost by different losses (Abrol *et al.*, 2007). Optimum use of nitrogen can be achieved by matching nitrogen supply with crop demand. Precise application of nitrogen fertilizer based on plant need and location in the field will greatly help in improving the fertilizer use efficiency in rice.

A simple, quick and non-destructive method for estimating the plant nitrogen demand is LCC (leaf colour chart) and Soil Plant Analysis Development (SPAD)- chlorophyll meter. Leaf Colour Chart will provide indirect assessment of leaf nitrogen status, which is closely related to photosynthetic rate and biomass production (Kropff *et al.*, 1993). Direct measurement of leaf nitrogen content by laboratory methods are time taking, laborious and expensive. Because of delay in time between the sampling and results, the laboratory methods are limited in use.

Among the non-destructive methods of leaf nitrogen content estimation, LCC is more simple and quick tool. High price of SPAD limits its use by the farmers and hence LCC can be better option for farmers in estimating the leaf nitrogen status easily.

Due to shift (delay) in monsoons from 2nd week of June to last week of June/ 1st week of July, farmers choice of varieties changes from long duration varieties to short duration

varieties. This short duration varieties unlike medium/long duration varieties require less quantity of nitrogen fertilizer. Farmers instead apply same dose of nitrogen fertilizer in same manner as required by medium/long duration varieties which leads to application of nitrogen even after panicle initiation stage. This results in heavy lodging, pest and disease incidence due to excess vegetative growth eventually resulting in low yields. Hence there is a need to work out on quantity & time of application of nitrogen in short duration rice varieties.

Materials and Methods

A field experiment was conducted during *Kharif*, 2017 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, Hyderabad (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 P₂O₅ (44.3 kg ha⁻¹) and high in available K₂O (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 in case 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. Rice variety selected for the study was KNM-118 (Kunaram sannalu). All agronomic practices were carried out as per the recommendations.

Nutrient management

The recommended dose of fertilizer @ (120-60-40) and (180-80-40) N, P₂O₅ and K₂O kg ha⁻¹ were applied to T₂ and T₃ 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 T₄ and T₇.

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 T₂ and T₃. For treatments T₄ to T₉, nitrogen was applied based on their respective LCC critical values using RDN of 120 kg ha⁻¹ for T₄ and T₇ and RDN of 150 for T₅, T₆, T₈ and T₉ treatments.

LCC observation

The topmost fully expanded leaf from each hill was selected and leaf colour was compared by placing the middle part of the leaf on LCC and the leaf colour was observed. 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 leaf was not detached or destroyed. 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 plant height, Leaf area, Leaf Area Index, tillers, dry matter production, SPAD readings, Days to 50% flowering and grain yield during maturity stage were done. Five hills per plot were randomly marked with wooden sticks and tagged with luggage labels for recording various observations pertaining to the growth parameters.

Results and Discussion

Effect of LCC based N management on growth parameters of rice

The data depicted in the Table.1 showed significant variation in growth components of rice Viz., plant height, Leaf area, Leaf Area Index, Dry matter production and Tillers m⁻². The plant height increased progressively with the growth of crop. At harvest highest plant height (111.3 cm) was recorded with T₃ {Farmers practice (180-80-40 Kg N, P₂O₅, K₂O ha⁻¹) - RDN applied as 1 basal + 2 equal splits (½ basal + 1/4th + 1/4th)} and was on par with treatments T₇, T₈, T₉ and T₂. The lowest plant height (75.4 cm) was recorded in treatment which received No nitrogen. It was also observed that treatments imposed at LCC critical value 4 (T₇ to T₉) recorded more plant height over LCC-3 treatments (T₄ to T₆).

As nitrogen is directly associated with plant metabolism and vegetative growth. Hence application of more nitrogen results in increased vegetative growth due to meristematic growth, cell division and cell elongation of internodes thus contributing to higher growth rate of stem. Similar results were reported by Ali *et al.*, 2012. Leaf area and Leaf area index (LAI) increased rapidly upto panicle initiation but decreased at harvest.

This could be due to senescence of leaves after the reproductive phase. Highest Leaf area and LAI (372.2 cm² and 2.48) was recorded with T₃- Farmers practice (180-80-40 Kg N, P₂O₅, K₂O ha⁻¹) which might be due to sufficient availability of nitrogen for producing larger cells with thinner cell walls thereby resulting in efficient cell division and elongation, ultimately producing higher photosynthetic area (Patel *et al.*, 2018). Lowest (188.1 cm² and 1.25) was recorded with T₁ (No Nitrogen).

Table.1 Effect of LCC based nitrogen management on growth parameters of rice

Treatments		Plant height (cm)	Leaf area (cm ²)	Leaf Area Index	Dry matter accumulation (kg ha ⁻¹)	Tillers m ⁻²
T ₁	No Nitrogen	75.4	188.1	1.25	5208	242
T ₂	RDF (120-60-40 Kg N, P ₂ O ₅ , K ₂ O ha ⁻¹) - RDN applied as 1 basal+ 2 equal splits (½ basal + 1/4 th + 1/4 th)	103.0	308.3	2.06	10469	316
T ₃	Farmers practice (180-80-40 Kg N, P ₂ O ₅ , K ₂ O ha ⁻¹) - RDN applied as 1 basal + 2 equal splits (½ basal + 1/4 th + 1/4 th)	111.3	372.2	2.48	11130	328
T ₄	120 kg RDN at LCC 3 – RDN applied as 3 equal splits (1/3 rd basal + 1/3 rd + 1/3 rd)	92.0	278.9	1.86	8214	281
T ₅	150 kg RDN at LCC 3 - RDN applied as 1 basal + 2 equal splits (½ basal + 1/4 th + 1/4 th)	94.7	279.7	1.86	8863	295
T ₆	150 kg RDN at LCC 3 - RDN applied as 1 basal+ 3 equal splits (½ basal + 25 kg + 25 kg + 25 kg)	100.2	283.1	1.89	8923	300
T ₇	120 kg RDN at LCC 4 – RDN applied as 3 equal splits (1/3 rd basal + 1/3 rd + 1/3 rd)	102.1	311.4	2.08	10565	317
T ₈	150 kg RDN at LCC 4 - RDN applied as 1 basal+ 2 equal splits (½ basal + 1/4 th + 1/4 th)	104.2	321.9	2.15	10870	320
T ₉	150 kg RDN at LCC 4 - RDN applied as 1 basal + 3 equal splits (½ basal + 25 kg + 25 kg + 25kg)	107.9	325.7	2.17	11246	339
	SE(m) ±	2.6	9.8	0.07	515.3	10.39
	CD (p=0.05)	7.9	29.5	0.20	1544.7	31.15
	CV %	4.6	5.8	5.8	9.4	5.9

Table.2 Effect of LCC based nitrogen management on Days to 50 % flowering, SPAD readings, and Grain Yield of rice

Treatments		Days to 50 % Flowering	SPAD readings	Grain yield (kg ha ⁻¹)
T₁	No Nitrogen	60	23.2	2474
T₂	RDF (120-60-40 Kg N, P ₂ O ₅ , K ₂ O ha ⁻¹) - RDN applied as 1 basal+ 2 equal splits (½ basal + 1/4 th + 1/4 th)	67	29.9	5499
T₃	Farmers practice (180-80-40 Kg N, P ₂ O ₅ , K ₂ O ha ⁻¹) - RDN applied as 1 basal + 2 equal splits (½ basal + 1/4 th + 1/4 th)	70	36.0	6224
T₄	120 kg RDN at LCC 3 – RDN applied as 3 equal splits (1/3 rd basal + 1/3 rd + 1/3 rd)	66	28.4	3814
T₅	150 kg RDN at LCC 3 - RDN applied as 1 basal + 2 equal splits (½ basal + 1/4 th + 1/4 th)	67	28.9	4342
T₆	150 kg RDN at LCC 3 - RDN applied as 1 basal+ 3 equal splits (½ basal + 25 kg + 25 kg + 25 kg)	67	29.5	4954
T₇	120 kg RDN at LCC 4 – RDN applied as 3 equal splits (1/3 rd basal + 1/3 rd + 1/3 rd)	67	32.4	5891
T₈	150 kg RDN at LCC 4 - RDN applied as 1 basal+ 2 equal splits (½ basal + 1/4 th + 1/4 th)	68	33.6	5893
T₉	150 kg RDN at LCC 4 - RDN applied as 1 basal + 3 equal splits (½ basal + 25 kg + 25 kg + 25kg)	67	34.3	6533
	SE(m) ±	1.64	1.08	309.8
	CD (p=0.05)	4.93	3.23	928.5
	CV %	4.3	6.1	10.6

Highest dry matter (11246 kg ha⁻¹) of rice was recorded with T₉ and was on par with T₂. While lowest (5208 kg ha⁻¹) was recorded with T₁ (No Nitrogen). Treatments imposed based on LCC-4 resulted in higher dry matter than LCC-3. As nitrogen could enhance tillers production, leaf area development and its translocation to panicles at reproductive stage thereby total dry matter production also increased with increased level of nitrogen. Similar findings were reported by Malik *et al.*, (2014) and Lampayan *et al.*, (2010).

Increase in number of tillers varied in accordance with the quantity of N applied, higher value recorded in treatments receiving higher quantity of N application. At harvest the highest number of tillers m⁻² were noticed with T₉ (339). While lowest was recorded with (242) was recorded with T₁ (No Nitrogen). Tillers m⁻² in T₉ increased by 3 and 7 % over farmers and recommended practice respectively. Ahmed *et al.*, (2005) found higher number of tillers with higher dose of N application.

T₃ (Farmers practice with 180-80-40 Kg N, P₂O₅, K₂O ha⁻¹) took more time for 50 % flowering (70 DAT) {Table.2}. This might be due to availability of excess nitrogen that had led to prolonged vegetative growth, thus resulting in delayed flowering. While T₁ (No Nitrogen) registered earliness in days to 50 % flowering (60 DAT) due to inadequate nitrogen availability at all crop growth stages that had hastened flowering.

Highest SPAD meter reading (36.0) was observed with T₃ (Farmers practice with 180-80-40 Kg N, P₂O₅, K₂O ha⁻¹). While lowest (23.2) was recorded with T₁ (No nitrogen). This may be due to application of more quantity of nitrogen which enhanced production of leaf N concentration and chlorophyll content that ultimately resulted in more SPAD reading (Islam *et al.*, 2004).

Effect of LCC based N management on yield of rice

Highest grain yield (6,533 kg ha⁻¹) was recorded with T₉ {Table.2} which was on par with T₃. While lowest grain yield (2,474 kg ha⁻¹) was recorded with T₁ (No Nitrogen). The maximum yield was recorded in T₉ which is based on LCC, but it was statistically on par with the yield recorded in Farmers practice with saving of 16.7% nitrogen and gave 4% more yields than farmers practice.

The application of N @ 120 kg ha⁻¹ under LCC guidance accounted for lower values of 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. Farmers and recommended practice, though received a total of 180 and 120 kg N ha⁻¹ in three splits at fixed intervals, recorded on par values for yield parameters and yield than LCC based N application. This could be due to low availability of N at grain filling phase of the crop. Kenchaiah *et al.*, (2000) also found higher grain yield under LCC based N management than the blanket recommendation.

The present study concluded as more than 50% of applied N is lost due in part to the lack of synchrony of plant N demand with N supply. The LCC is simple and easy-to-use tool. The LCC based management in rice suggests that N application can be saved with no yield loss by appropriately revising the fertilizer recommendation. There is considerable opportunity to increase farmers yield through improved N management with the LCC.

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