RESEARCH PAPER | Science | Volume : 5 | Issue : 2 | Feb 2015 | ISSN - 2249-555X

Nitrogen management using Leaf Color chart (LCC) and nitrogen level in Kharif rice

KEYWORDS: LCC, Nitrogen, Rice, NUE

S.B. Satpute
Palli Siksha Bhavana, Visva-Bharati, Sriniketan, West Bengal-731236, India

T. Das
U.B.K.V ,Pundibari, CoochBehar, W.B

D.T. Surje
U.B.K.V ,Pundibari, CoochBehar, W.B

S. K. Maity
Palli Siksha Bhavana, Visva-Bharati, Sriniketan, West Bengal-731236, India

ABSTRACT *Experiment on rice (cv. MTU 7029) was conducted at the Institute of Agriculture, Visva-Bharati during rainy season of 2009. The experiment consisted of treatments such as fifteen factorial combinations of four LCC values (3, 4 and 5) and five N rates at each time of application (10, 15, 20, 25 and 30 kg N ha-1) and). The treatments also included one blanket split application of N and one control. The grain yield at LCC 5 was 46.2% and 19.9% more respectively over grain yield at LCC 3 and LCC 4, whereas grain yield at LCC 4 was 22.0% more over grain yield at LCC 3. Straw yield also increase gradually with higher LCC values. Grain yields at all the higher level of N application each time i.e. 15, 20, 25 and 30 kg N ha-1 were comparable with each other and significantly higher than grain yield recorded at 10 kg N ha-1. application of N at the rate of 15 or 20 kg N ha-1 each at LCC value 5 receiving 143 and 153 kg N ha-1 respectively recorded 16.5% and 18.3% increased grain yields. The higher values of LCC-N application both agronomic efficiency and physiological efficiency were improved*

INTRODUCTION

Nitrogen (N) is most important nutrient element required by rice plant throughout its growth stages. Substantial increase in the yield of paddy, by the application of N has been widely reported under different soil and climatic condition (Sethi *et al*, 1952, Abhichandani and Patnaik, 1959). Applying N in splits as per need of the crop can considerably increase the N-use efficiency of crop (Sharif, 1994) and improve the quality and productivity of rice. The LCC-based N management studies on rice under different cultures and methods of establishment done at different South Asian countries and in different parts of India almost univocally came out with the facts that LCC-based N management improves grain yield of rice, saves N, increases net return and B/C ratio and even the maximum achievable yield of a rice cultivar can be improved under LCC-based N management. The LCC is an easy-to-use and inexpensive diagnostic tool for monitoring the relative greenness of a rice leaf as an indicator of the plant N status (Alam *et al*, 2005). Maintaining adequate leaf N concentration throughout the critical stages of crop growth was important to achieve higher NUE in terms of growth, yield and photosynthetic rate as reported by several scientists from rice growing countries (Thiyagarajan *et al*, 1993). Because Leaf N content is closely related to photosynthetic rate (Peng *et al*, 1995) and biomass production (Kropff *et al*, 1933), it is a sensitive indicator of the dynamic changes in crop N demand within a growing season.

The LCC can be used to guide the application of fertilizer N to maintain an optimal leaf N content for achieving high rice yield with effective N management. Optimization of nitrogen level as well as split doses to different crop growth stages is more important to produce higher grain yield.

Materials and Methods

Pot experiment on rice (cv. MTU 7029) was conducted at the Institute of Agriculture (Palli Siksha Bhavana), Visva-Bharati, Sriniketan, West Bengal. The experiment was conducted in the kharif season during 2009.The experimental soil was sandy loam in texture with pH 5.8 and was analyzed to be medium in available nitrogen (338.7 kg N ha^{-1}), medium phosphorus (36.5 kg P_2O_5 ha^{-1}) and medium potassium (142.5 kg K_2O ha^{-1}). The experiment was laid out in randomized block design with three replications consisted of treatments such as fifteen factorial combinations of four LCC values (3, 4 and 5) and five N rates at each time of application (10, 15, 20, 25 and 30 kg N ha^{-1}). The treatments also included one blanket split application of N and one control. The LCC used was a plastic, ruler-shaped strip containing six panels that ranged in color from yellowish green to dark green. LCC readings were taken at weekly intervals from 14 days after transplanting (DAT) till panicle emergence. Agronomic Efficiency, Physiological Efficiency (PE) and Apparent Recovery of N for the treatment were computed using following equation given by (Cassman *et al,* 1998).

$$\text{Agronomic Efficiency (AE)} = \frac{\text{Increase in grain yield (g/pot) due to N}}{\text{Applied N level (g/pot)}}$$

$$\text{Physiological Efficiency (PE)} = \frac{\text{Increase in grain yield (g/pot) due to N}}{\text{Increase in Plant N uptake (g/pot) due to N}}$$

$$\text{Recovery efficiency (AR)} = \frac{\text{Increase in plant N uptake yield (g/pot) due to N}}{\text{Applied N level (g/pot)}}$$

RESULT AND DISCUSSION

Effect on Growth Attributes

Higher LCC values i.e. LCC 4 and LCC 5 showed superiority over LCC 3 in terms of growth attributes like plant height, leaf number and tiller/hill. At 80 DAT, plant height at LCC 4 was significantly higher than both LCC 3 and 5. Budhar (2005) explained that the increased plant height and more number of tillers at LCC 4 and 5 might be due to steady supply of N applied at seedling stage helped to produce favorable effect on growth attributes. In case of tiller production at 80 DAT there had been gradual and significant increase in tiller production with higher LCC values of N application ranging from 3 to 5. Among the LCC values adopted for N application LCC 5 turned out to be superior with respect to the production of tillers per hill particularly at latter stages of growth at 60 and 80 DAT when tiller count at LCC 5 was the highest and significantly higher than LCC 3 and 4. Sathiya and Ramesh (2009) while evaluating two values of LCC (i.e. 3 and 4) in aerobic rice found that tiller production and higher plant height was significantly higher under LCC 4 over LCC 3.

Effect on yield attributes

Yield attributes such as effective tillers/hill, panicle length, spikelet's/panicle, percent filled grain, grain weight/panicle and test weights were studied. Adopting nitrogen application with LCC values 3, 4 and 5 had resulted significant successive increase in number of panicle bearing tillers per hill(Table 1.). However, Budhar (2005) on direct seeded puddle rice recorded no significant increase in effective tillers under different LCC values in the first year, but in the second year LCC 5 recorded significantly higher number of effective tillers over LCC 3 only.

Table 1: Yield attributes of rice as influenced by N application at different LCC value and N dose at each time

Treatments	Effective tillers/hill (number)	Panicle length (cm)	Spikelets/ Panicle	Per cent filled grain	Grain weight / panicle (g)	Test weight (g)
LCC value						
3	7.2	19.9	124.3	87.2	2.0	18.5
4	7.6	20.6	134.8	92.0	2.4	19.3
5	9.2	20.6	139.3	87.5	2.3	19.2
Sem (±)	0.1	0.2	3.3	0.9	0.1	0.4
$CD_{0.05}$	0.4	0.5	9.5	2.5	0.2	NS
N- application (kg ha^{-1})						
10	7.6	20.2	130.9	88.3	2.2	19.0
15	8.3	20.5	135.4	87.2	2.2	18.8
20	8.1	20.4	131.4	89.2	2.2	18.8
25	8.1	20.5	132.3	89.4	2.3	19.3
30	7.9	20.3	134.0	90.4	2.3	19.2
Sem (±)	0.2	0.2	4.3	1.1	0.1	0.5
$CD_{0.05}$	NS	NS	NS	NS	NS	NS
LCC-N application	8.0	20.4	132.8	88.9	2.3	19.0
Blanket split N	8.2	21.6	146.6	91.4	2.7	19.9
Control	6.7	16.2	79.3	90.0	1.3	16.1
$CD_{0.05}$	1.0	1.2	21.7	NS	0.4	2.6

The higher rate of nitrogen i.e. 15, 20, 25 and 30 kg N ha^{-1} at each time of nitrogen application though produced slightly higher number of effective tillers per hill over 10 kg N ha^{-1} but the effect was not significant. Panicle length at LCC 4 and 5 was equal and significantly more than LCC 3.Among the LCC values of N application, spikelets per panicle at LCC 5 was maximum but it was on a par with that of LCC 4, both of them being significantly more than LCC 3. Applying N at LCC 4 recorded significantly higher percent filled grains (92.0) over LCC value 3 and LCC 5, the latter to being statistically on a par with each other. Different levels of N application at each time did not record any significant effect on percent filled grains of rice. Though different LCC values had no significant effect on 1000-grain weight of rice. Test weight of rice under different levels of Among LCC values of N application LCC 4 and LCC 5 recorded significantly higher weight than LCC 3, the former two being statistically on a par with each other (Table1.). Different rate of N application at each time did not result any significant influence on grain weight per panicle. N at each time of application remained statistically on a par with each other. Baba (1961) reported that the weight of 1000 perfect grains showed no definite relation to N supply.

Yield of rice and Harvest Index

There was gradual significant increase in grain yield of rice with higher LCC values of N application ranging from 3 to 5. The grain yield at LCC 5 was 46.2% and 19.9% more respectively over grain yield at LCC 3 and LCC 4, whereas grain yield at LCC 4 was 22.0% more over grain yield at LCC 3(Table 2.). A gradual increase in grain yield of direct wet seeded rice with N application at higher levels of LCC values from 3 to 5 had also been recorded by Nachimuthu *et al* (2007). However, several other experimenter reported higher grain yield of rice at LCC 4 and suggested for adoption of LCC 4 to be optimum value for real time N management considering higher grain yield and N saving (Budhar, 2005; Balaji and Jawahar, 2007 and Sathiya and Ramesh, 2009).All the higher dose of N except 20 kg N ha^{-1} recorded significantly higher straw yields over 10 kg N ha^{-1}. Highest harvest index (51.4%) among LCC value was recorded at LCC 4. However, Balaji and Jawahar (2007) found decreasing trend of harvest index with the increasing values of LCC.

Table 2: Yield and harvest index of rice as influenced by N application at different LCC value and N dose at each time

Treatments	Grain yield (g/pot)	Straw yield (g/pot)	Harvest Index (%)
LCC value LCC value			
3	26.4	26.4	49.5
4	32.2	30.6	51.4
5	38.6	40.4	49.0
Sem (±)	0.66	1.0	0.9
$CD_{0.05}$	1.88	3.0	NS
N- application (kg ha^{-1})			
10	30.0	28.7	50.3
15	33.3	32.3	50.9
20	33.6	31.9	51.3
25	32.3	34.5	48.6
30	32.9	34.9	48.8
Sem (±)	0.85	1.3	1.1

$CD_{0.05}$	2.43	3.6	NS
LCC-N application	32.4	32.5	50.0
Blanket split N	35.0	33.5	51.1
Control	24.3	20.4	54.4
$CD_{0.05}$	4.28	6.7	NS

Nitrogen Use Efficiency

Nitrogen at higher value of LCC proved to be better in terms of agronomic efficiency which was 32 g grain/g N applied at LCC 5. This was in contradictory of the findings by Nachimuthu (2007) who found decreasing trend in agronomic efficiency with increasing LCC values (3 to 5) of N application in direct wet seeded rice. Among different rates of N at each time of application appreciably high value of agronomic efficiency (32.9 g grain/ g N) applied was recorded with 15 kg N ha^{-1}(Table 3). The highest physiologically efficiency (82.1 g grain/g N uptake) was achieved by LCC 5.Among the different N doses at each time of application the highest physiologically efficiency (68.2g grain/g N uptake) was found 15 kg N ha^{-1} application (Table 3).

Table 3: Nitrogen use efficiency of rice as influenced by N application at different LCC value and N dose at each time

Treatments	Nitrogen use efficiency		
	Agronomic Efficiency	Physiological Efficiency	Recovery Efficiency
LCC value LCC value			
3	17.6	32.5	49.4
4	27.8	67.8	44.4
5	32.0	82.1	39.8
N- application (kg ha^{-1})			
10	25.1	54.2	54.6
15	32.9	68.2	48.9
20	23.3	64.1	33.0
25	20.8	55.6	35.3
30	26.8	61.8	50.8
LCC-N application	25.8	61.8	44.5
Blanket split N	42.7	96.4	44.2

Recovery efficiency of N under LCC-N application and blanket split N application was almost similar. With the increased values of LCC, there was a decreasing trend of percent recovery efficiency of nitrogen

CONCLUSION:

Most of the times, the higher LCC values of N application had resulted better growth attributes. This might be due to higher amount of N application at higher LCC values. Dose of N at each time of application did not result any significant effect on growth as well as yield attributes. The grain yield at LCC 5 was 46.2% and 19.9% more respectively over grain yield at LCC 3 and LCC 4, whereas grain yield at LCC 4 was 22.0% more over grain yield at LCC 3. With the higher values of LCC N application both agronomic efficiency and physiological efficiency were improved. However, recovery efficiency of nitrogen was declined gradually with the gradual increase in LCC values.

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