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# EFFECT OF REAL TIME NITROGEN MANAGEMENT ON YIELD ATTRIBUTES AND YIELD OF RICE IN CENTRAL PLAIN ZONE OF UTTAR PRADESH

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***Abstract:*** *A field experiment was conducted during Kharif season 2010-11 and 2011-12 at Farm of C.S. Azad University of Agriculture and Technology, Kanpur, to study the effect of FYM and Urea as basal source, along with leaf colour Chart (LCC) based nitrogen (N) top dressing in three different rice cultivars. Yield attributes viz., number of panicle ($m^{-2}$), panicle length (cm) number of grains per panicle differed significantly by different rice cultivars and LCC scores. Among rice cultivars PA-6444 recorded significantly highest number of panicle (307.62 $m^{-2}$) over PHB-71 (291.17 $m^{-2}$) and NDR-359 (275.38 $m^{-2}$). Although, panicle length (28.80 cm) and number of grains per panicle (229.97) was recorded significantly higher in NDR-359, over both the remaining cultivars. Among rice cultivars significantly maximum grain yield (59.21 q $ha^{-1}$), and biological yield (140.10 q $ha^{-1}$) recorded by PA-6444. With grain (53.98 q $ha^{-1}$), biological yield (127.91 q $ha^{-1}$), PHB-71 found superior over grain (50.40 q $ha^{-1}$) biological yield (119.21 q $ha^{-1}$) of NDR-359. Among LCC scores, LCC<5+25%N as basal through urea, recorded highest grain and biological yield 62.80, and 148.59 q $ha^{-1}$ respectively and was significantly higher over rest of the LCC scores except LCC<5+25%N as basal through FYM. From this experiment it has been concluded that LCC<5+25% N as basal through FYM with cultivars PA-6444 can be used as a low cost technology for maximum production per unit area.*

***Keywords:*** *Leaf colour Chart, FYM, Nitrogen, Rice.*

**Introduction:** Rice (*Oryza sativa* L.), is the prince among cereals and the premier food crop not only in India even in the world too. Our national food security system largely depends on the productivity of rice. India is the second largest producer of rice only after China and its production in India has increased from 20 million tonnes during 1950-51 to 106.4 million tonnes during 2013-2014 **[1].** Rice occupies a pivotal place in Indian agriculture and is the staple food for more than 70 per cent of population and a source of livelihood for about 120-150 million rural households. At the accelerating current population growth rate of 1.64 per cent, rice requirement by 2020 is estimated to be around 140 million tonnes. However, the current average production is 2.37 t $ha^{-1}$, which is for below than the global average of 4.2 t $ha^{-1}$ [2]**.** Since, there is no scope for horizontal expansion of cultivable area, therefore, productivity and production of rice have to be increased to meet the need of future demand. Among the various strategies proposed to increase rice productivity, nitrogen management is of great importance. Nitrogen (N) is the nutrient that most often limits crop production [3] and the cost of mineral nitrogen fertilizer accounts for a major portion of the total cost of rice production [4]. Globally, the value of apparent recovery of fertilizer nitrogen is 55 per cent, while true recovery efficiency of nitrogen (TREn) is 44%. Hence, external nitrogen application is critical for intensive rice production. Therefore, its management strategies must be developed such that it should be responsive to temporal variations in crop N demands and soil N supply in order to achieve supply-demand synchrony for minimizing nitrogen losses. When N application is not synchronized with crop N demand, N losses from the soil plant system will be higher, that leads to low N fertilizer use efficiency. In many field situations, more than 60% of applied N is lost because of the lack of synchrony of plant demand with N supply [5]. Demonstrated that RE (Recovery efficiency) of top dressed urea during panicle initiation stage could be as high as 78% [6]. Hence, plant need-based application of N is important for achieving high yield and high N use efficiency. Predicting plant N requirements through plant tissue analysis takes 10–14 days from tissue sampling to receiving a fertilizer recommendation and does not seem to be a practical proposition. Since, farmers have always used leaf colour as a visual and subjective indicator of the need for N fertilization [7-8] and generally prefer to keep leaves of the crop dark green, which leads to over application of N fertilizers, resulting low nitrogen use efficiency. Hence, indirect measurement of N content through greenness by a chlorophyll meter (SPAD; Soil and Plant Analysis Division, Minolta Co.) and leaf color chart (LCC) provides a simple, quick, and non-destructive methods for estimating the N content of rice leaves and, thus, for determining the right time of N top dressing [9].

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, which is important in improving the balance between crop N demand and N supply from soil and applied fertilizer [10-11]. However, critical LCC values vary considerably among different rice genotypes having different genetic background, plant type and leaf colour [12], because leaf N status of rice is closely related to photosynthetic rate [13] and biomass production [14]. The LCC can be used to rapidly assess leaf N status from tillering to panicle initiation, thereby, guide the application of fertilizer N to maintain an optimal leaf N content, which can be vital for achieving high rice yield. The purpose of using LCC is to apply adequate amount of nitrogen and avoid application of fertilizer more than required. A leaf colour chart (LCC) developed by a Japanese scientist [8], will help the farmers to measure the leaf colour intensity. Keeping above in view, the present study entitled "Studies on leaf colour Chart Based Nitrogen Management in Rice Cultivars in Central Plain Zone of Uttar Pradesh" was undertaken to find out the suitable rice cultivars and LCC guided nitrogen management stategies and to standardize the LCC value for different rice cultivars.

**Materials and Methods**

A field experiment was conducted during the two consecutive *kharif* seasons of 2010-11 and 2011-12 at Farm of C.S. Azad University of Agriculture and Technology, Kanpur, (26°23'35''N latitude, 80°18′25''E longitude and at an altitude of 125.90 m above mean sea level) situated in the Central Plain Zone of Uttar Pradesh. The climate of Kanpur is semiarid subtropical with dry hot summer and cold winter. The average annual rainfall is 893 mm, major part of which is received during the later part of June to mid September. The experimental soil was sandy clay loam in texture having medium organic carbon and low in available nitrogen (215 kg $ha^{-1}$), medium in available phosphorus (20.5 kg $ha^{-1}$), and medium in available potassium (201 kg $ha^{-1}$), and neutral in reaction (pH 7.1). The experiment was laid out in a split plot design with three replications. Three rice genotypes, PA-6444 (semi tall, medium duration variety, developed in 2001 by Bayer Bio-Science and released by Central Variety Release Committee (CVRC) with a yield potential of 6-8 t/ha), PHB-71 (tall, medium duration 130-135 days duration variety) NDR 359 (a medium duration high yielding variety released from NDUAT, Faizabad with a yield potential of 4-5 t $ha^{-1}$), were grown in the main plots while the six fertilizer N management treatments (with the help of LCC <3, <4 and <5 in combination with 25% N as basal through FYM and Urea with every LCC score) were allotted to sub-plots and were compared with fixed time recommended N rate of 150 kg $ha^{-1}$. In the recommended N dose treatment, nitrogen was applied in 1:2:1 ratio at the time of sowing, maximum tillering and panicle initiation stages respectively. Phosphorous and potassium @ 60 kg and @ 40 kg $ha^{-1}$ and Zn @ 5 kg $ha^{-1}$ were applied to all the plots as basal. The experimental field was prepared by one deep ploughing followed by two cross harrowing and leveling. After preparing the field 25 days old seedlings were transplanted on 1th July, 2010-11 and 28th June 2011-12 at a spacing of 20x15 cm with 2 seedlings per hill of PA-6444 and PHB-71 while, 3-4 seedling of NDR-359. After the establishment of seedlings a constant water level of 5±2 cm was maintained during the entire crop growth period till early dough stage. For the management of weeds two hand weeding were done at 25 and 45 days after transplanting (DAT) respectively. The crop was harvested manually at maturity. Grain (at 13% moisture content) and straw yield on sun dry weight basis were reported in q $ha^{-1}$.

**Yield Attributes:** Grain yield of rice can only be improved to a limited degree by increasing grain size, because, grain growth is restricted by the size of hull. If the nitrogen status of the plant is adequate it is not the rate of photosynthesis that restricts growth but rather the physiological sink which is the limiting factor of rice yields. The strength of the physiological sink is depending on the number of grains per unit area. This can be raised either by increasing the plant density or by increasing the number of grain per panicle. Experimental results of the study showed that the number of panicles $m^{-2}$ differed significantly among the rice cultivars. PA-6444 recorded maximum number of panicles (307.62 $m^{-2}$) which was 5.65 % higher over PHB-71 and 11.70 % over NDR-359. It might be due to the profuse tillering ability and less mortality of shoots in PA-6444 and PHB-71. Among LCC scores, LCC<5+25% N as basal through urea recorded highest number of panicles $m^{-2}$ (311.94) followed by LCC<5+25% N as basal through FYM (307.65) and these both the treatment were statistically at par and recorded 5.45 % and 4.02 % higher number of panicles respectively over RDN. LCC<4+25% N as basal through urea, LCC<4+25% N as basal through FYM and recommended N dose were found statistically at par during both the year of study. The improvement in the yield attributes of rice is might be due to the adequate supply of photosynthates to sink under higher levels of nitrogen. The results are in close conformity with the finding [15-16]. Among the rice cultivars NDR-359 recorded significantly longest panicle (28.80 cm) which significantly longer over PA-6444 (27.31cm) and PHB-71 (27.37cm) respectively. Among nitrogen levels LCC<5+25% N as basal through urea recorded longest panicle (28.71cm) which significantly longer than RDN but were at par with, LCC<5+25% N as basal through FYM, LCC<4+25% N as basal through urea and LCC<4+25% N as basal through FYM. The results are in close conformity [17]. Rice cultivars, NDR-359 recorded highest number of grain per panicle (229.97) which was significantly higher over PA-6444 and PHB-71, while, PA-6444 was at par with PHB-71. Among nitrogen levels through LCC scores, LCC<5+25% N as basal through urea recorded highest number of grains per panicle (241.56) over rest of the nitrogen levels. Similarly, LCC<5+25% N as basal through FYM (235.77) also found significantly superior over rest of the nitrogen levels, but was at par with LCC<5+25% N as basal through urea. LCC<4+25% N as basal through urea, LCC<4+25% N as basal through FYM and RDN was found at par with each other. NDR-359 recorded highest test weight which was significantly higher over PA-6444 and PHB-71. While, PA-6444 and PHB-71 were found at par to each other during both the year of experimentation. Among nitrogen levels, LCC<5+25% N as basal through urea recorded highest test weight which was significantly higher over rest of the nitrogen levels.

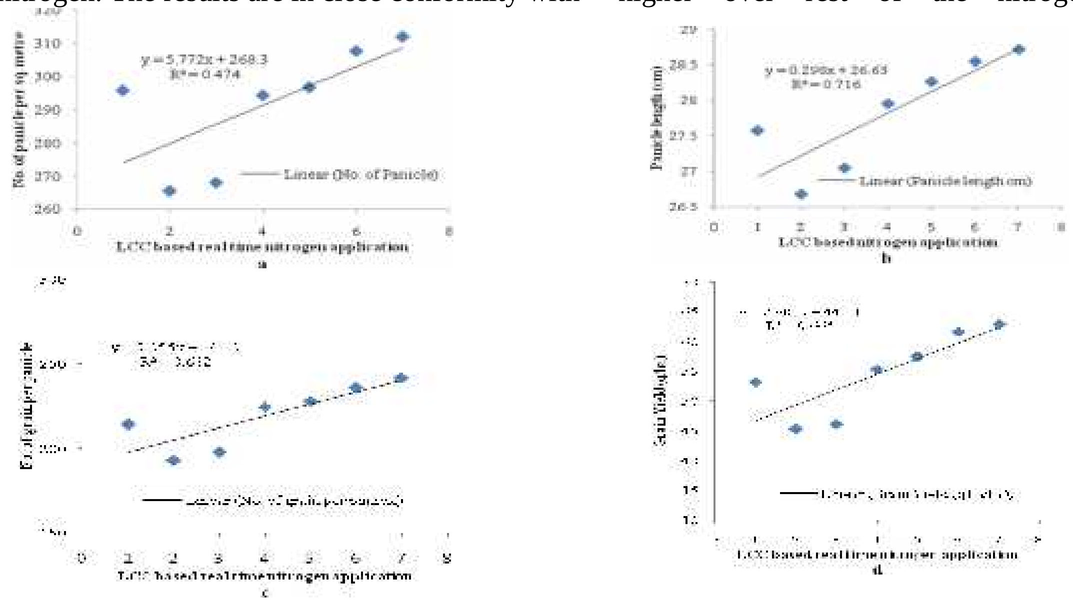


**Fig. 1 Relationship between yield attributes, yield (a. No. of panicle $m^2$), (b. panicle length, cm) (c. number of grains per panicle) and (d. grain yield q $ha^{-1}$) with (LCC based real time nitrogen application.**

There was highly significant and positive correlation existed between yield attributes, yield and LCC based real time nitrogen application.

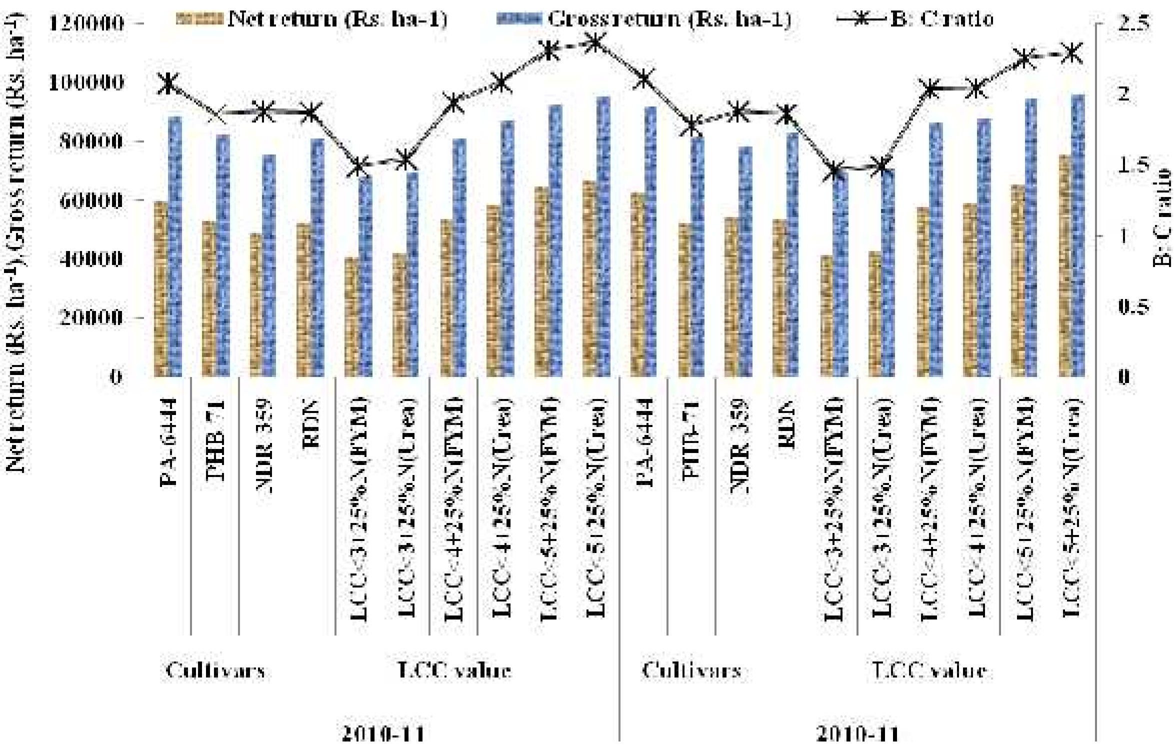


**Fig. Economics as influenced by Rice cultivars and LCC based nitrogen application.**

**Yield:** Grain yield, straw and biological yield, straw: grain ratio of rice, as influenced by rice cultivars and different LCC based nitrogen levels differed significantly during both the years. PA-6444 recorded higher grain yield (59.21 q ha$^{-1}$) over PHB-71 (53.98 q ha$^{-1}$) and NDR-359 (50.4 q ha$^{-1}$) which was 9.68% and 17.48% higher over PHB-71 and NDR-359 respectively. In case of nitrogen levels, LCC<5+25% N as basal through Urea recorded significantly higher grain yield (62.8 q ha$^{-1}$) over all the nitrogen levels except LCC <5+25% N as basal through FYM (61.61 q ha$^{-1}$). This result might be similar [19-20]. Straw yield as influenced by different rice cultivars and LCC scores differ significantly and PA-6444 recorded significantly higher straw yield (80.90 q ha$^{-1}$) over PHB-71 (73.91 q ha$^{-1}$) and NDR-359 (68.77q ha$^{-1}$). PHB-71 also recorded significantly higher straw yield over NDR-359. It may be due to plant height and more number of plants per unit area. In case of nitrogen levels through LCC scores, LCC <5+25% N as basal through Urea recorded significantly higher straw yield over all the nitrogen levels except LCC<5+25% N as basal through FYM during both the year of study. LCC<4+25% N as basal through urea also recorded significantly higher straw yield over rest of the lower nitrogen levels including RDN. Among rice cultivars, PA-6444 recorded highest biological yield (140.10 q ha$^{-1}$) and was significantly higher over PHB-71 (127.91 q ha$^{-1}$) and NDR-359 (119.21 q ha$^{-1}$). PHB-71 also recorded significantly higher biological yield over NDR-359 during both the year of experimentation. In case of nitrogen levels through LCC scores, LCC <5+25% N as basal through Urea recorded significantly higher biological yield (148.6 q ha$^{-1}$) over all the nitrogen levels except LCC <5+25% N as basal through FYM. LCC <4+25% N as basal through urea also recorded significantly higher biological yield over rest of the lower nitrogen levels. Recommended N dose was found at par with LCC <4+25% N as basal through FYM. LCC <3+25% N as basal through FYM recorded lowest biological yield. Regarding straw: grain ratio result showed that rice cultivars didn't differ significantly. All the rice cultivars recorded statistically similar straw: grain ratio and found at par with each other. Nitrogen levels through LCC scores, showed significant difference regarding straw: grain ratio. Among all the nitrogen levels, recommended N dose, recorded significantly higher ratio over LCC <3+25% N as basal through FYM and LCC <3+25% N as basal through urea, while rest nitrogen levels were found at par to RDN. Harvest index didn't differ significantly among rice cultivars. NDR-359 recorded highest harvest index followed by PA-6444 and PHB-71. It is obvious from the data that nitrogen levels through LCC scores didn't showed significant difference regarding harvest index.

Among rice cultivars (Table 1, Fig. 2), PA-6444 recorded highest gross return (Rs.90.37 thousands) net return (Rs.61.2 thousand) and benefit: cost ratio (2.09) which was significantly higher over PHB-71 and NDR-359 during both the years. Likewise, PHB-71 also recorded significantly higher gross and net return over NDR-359. LCC<5 + 25% N as basal through urea recorded highest gross return, net return and benefit: cost ratio followed by LCC<5 + 25% N as basal through FYM. Higher gross return, net return and benefit: cost ratio in these both treatments might be due to higher dose of nitrogen that impart more biomass production which ultimately contributes more grain and straw yield per unit area. Similar reports were also presented [19 & 21]. LCC<3 + 25% N as basal through FYM recorded lowest gross return, net return and benefit: cost ratio followed by LCC<3 + 25% N as basal through urea during both the years.

**Table 1. Yield attributing characters, yield and economics as influenced by rice cultivars and LCC based nitrogen management practices (pooled mean of 2 years data).**

| Treatments | No. of Panicle (m-2) | Panicle length (cm) | No. of grains /ear | Grain yield (q ha-1) | Straw yield (q ha-1) | Total yield (q ha-1) | Straw: Grain ratio | Harvest Index (%) | Test weight (g) | Gross return (Rs.000'ha-1) | Net return (Rs. 000' ha-1) | B: C ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rice cultivars** | | | | | | | | | | | | |
| PA-6444 | 307.62 | 27.31 | 216.405 | 59.21 | 80.90 | 140.10 | 1.37 | 42.26 | 25.22 | 90.37 | 61.22 | 2.09 |
| PHB-71 | 291.17 | 27.37 | 211.405 | 53.98 | 73.91 | 127.91 | 1.37 | 42.21 | 25.21 | 82.17 | 53.05 | 1.82 |
| NDR-359 | 275.38 | 28.80 | 229.975 | 50.40 | 68.77 | 119.21 | 1.37 | 42.27 | 26.36 | 76.67 | 51.89 | 1.88 |
| SE(d) | 0.87 | 0.40 | 2.284 | 0.47 | 0.60 | 1.06 | 0.01 | 0.09 | 0.02 | 0.70 | 0.75 | 0.02 |
| CD (P=0.05) | 2.40 | 1.09 | 6.343 | 1.31 | 1.66 | 2.94 | NS | NS | 0.06 | 1.94 | 2.10 | 0.07 |
| **Nitrogen levels** | | | | | | | | | | | | |
| Recommended N dose | 295.78 | 27.57 | 214.225 | 53.15 | 73.87 | 127.01 | 1.39 | 41.83 | 25.69 | 81.85 | 53.29 | 1.86 |
| 25% N(FYM)+LCC < 3 | 265.47 | 26.68 | 193.055 | 45.28 | 61.77 | 107.05 | 1.36 | 42.29 | 25.46 | 68.86 | 41.05 | 1.47 |
| 25% N(Urea)+LCC < 3 | 267.89 | 27.05 | 197.83 | 46.14 | 62.89 | 109.02 | 1.36 | 42.32 | 25.49 | 70.16 | 42.28 | 1.51 |
| 25% N(FYM)+LCC < 4 | 294.32 | 27.95 | 224.44 | 55.26 | 75.13 | 130.38 | 1.37 | 42.38 | 25.54 | 83.98 | 55.91 | 1.99 |
| 25% N(Urea)+LCC < 4 | 296.68 | 28.26 | 227.945 | 57.48 | 78.39 | 135.86 | 1.37 | 42.31 | 25.62 | 87.42 | 58.95 | 2.07 |
| 25% N(FYM)+LCC < 5 | 307.65 | 28.54 | 235.775 | 61.61 | 84.14 | 145.59 | 1.38 | 42.31 | 25.64 | 93.69 | 65.17 | 2.28 |
| 25% N(Urea)+LCC < 5 | 311.94 | 28.71 | 241.56 | 62.80 | 85.63 | 148.59 | 1.38 | 42.26 | 25.75 | 95.55 | 71.06 | 2.33 |
| SE(d) | 2.53 | 0.41 | 2.955 | 0.91 | 1.17 | 2.025 | 0.01 | 0.19 | 0.02 | 1.33 | 1.35 | 0.05 |
| CD (P=0.05) | 5.13 | 0.82 | 5.995 | 1.84 | 2.37 | 4.105 | 0.02 | NS | 0.04 | 2.71 | 2.75 | 0.09 |

**Conclusion:** It is concluded that rice cultivar PA-6444 recorded highest grain, straw and biological yield and gross return, net return and B:C ratio in combination with LCC<5 + 25% N as basal through urea but it was statistically at par with LCC<5 + 25% N as basal through FYM during both the years. Hence, LCC<5 + 25% N as basal through FYM with PA-6444 can be used as a low cost technology for maximum production per unit area.

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