LEAF COLOUR CHART (LCC) FOR NITROGEN MANAGEMENT IN CROPS

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Plants, just like any other living organism require certain elements for normal growth and development. These mineral nutrients together make up less than 4% of plant mass, yet plant growth is very sensitive to nutrient deficiency. Nitrogen (N) is an indispensable major nutrient and is the "mineral of life" for most of the crops including major cereals like rice, wheat and maize. It is the most critical input that limits crop productivity in irrigated ecosystem. There is no compromise on the need for the judicious use of N fertilizer for increasing crop production despite the fact that the cost of N fertilizers increases year by year. Phasing of N application at critical developmental stages is more important for efficient utilization of applied N. Monitoring of plant N status is important in improving the balance between crop N demand and N supply from soil and applied fertilizer (Shiga et al., 1977; Cassman et al., 1994). Because leaf nitrogen

content is closely related to photosynthetic rate (Peng et al., 1995) and biomass production (Kropff et al., 1993), it is a sensitive indicator of the dynamic changes in crop N demand within a growing season. The direct measure of leaf N concentration by laboratory procedures is time consuming and costly. Such procedures have limited use as a diagnostic tool for optimizing N topdressing because of the extensive time delay between sampling and obtaining results. Farmers generally use leaf colour as a visual and subjective indicator for the crop's nitrogen status and need for N fertilizer application (Wells and Tuner, 1984). Simple diagnostic tools as leaf colour chart (LCC) and the SPAD (Soil and Plant Analysis Development) meter have been developed to monitor plant N status for fine tuning of N management. They allow farmers to adjust N applications in real time i.e., based on the present plant N status, which is closely related to the indigenous N supply and season specific climatic conditions that affect crop growth. The high price of SPAD meter limits its use by poor farmers. A very simple, quick and non destructive method of estimating leaf N status is by LCC, which has been tested for real time N management in the farmers' fields in several countries (Balasubramanian et al., 1999).

LEAF COLOUR CHART (LCC)

It is an inexpensive, simple, easy to use tool for measuring the leaf greenness for Nitrogen management. It is a 12-15 inch long chart. It had originally eight shades of unnamed green. Leaf colour is compared with the standard colour charts under the same environmental condition. The colour scale is made of plastic resistant to sunshine damage. It is less light reflectable and consists of many strip colour lines arranged like leaf veins. The lightest, more yellowish shade is labeled -1 and the deepest, darkest green shade is labeled 8. Later a colour chart with seven shades of greenness was developed by Furuya (1987) and the present form of the colour chart has five / six shades of green colour (IRRI, 1996). It has been calibrated with the chlorophyll meter and is used to guide nitrogen top dressing for rice. A simple construction sheet in the local language accompanies the chart and explains the farmers how to determine the correct time of N application. The colour chart is an ideal tool to optimize N use in rice cropping, irrespective of the nitrogen source applied- inorganic, organic or biofertilizers. LCC is used to assess the canopy green as well as green colour of a single leaf.

CRITICAL COLOUR GRADES OR LCC VALUES

Based on the leaf colour chart, nitrogen application could be skipped off, if a reading of 4 or above is obtained at panicle initiation. The critical leaf colour reading for N top dressing ranges from 3 for varieties with light green foliage (ex. scented to aromatic rice varieties) to 4 for other varieties and hybrids. Similarly the critical LCC grade is 4 for transplanted rice and 3 for direct wet seeded rice. Crops showing a leaf colour below the critical values suffer from N deficiency and require immediate N fertilizer application to prevent yield losses. For locally important varieties and crop establishment methods, the critical LCC values can be redefined after one or two test seasons.

GUIDELINES FOR USING LCC

- The topmost fully expanded leaf is chosen for leaf colour measurement as it is highly correlated to the N status of rice plants. The colour of a single leaf is measured by holding the LCC vertically and placing the middle part of the leaf 1 cm in front of a colour strip for comparison. Tanno et al. (1982) reported that the reading by colour scale of canopy green was more closely correlated with average chlorophyll content of three topmost leaves than reading on a single leaf.
- The leaf should neither be detached nor destroyed.
- The leaf in which reading to be recorded is to be shielded with our body as the leaf colour chart reading is affected by sun's angle and sunlight intensity.
- Readings are taken between 8-10 am when there is not much glare from the sun. Readings should not be taken very early in the morning since dew drops can make reading difficult.
- Every time the same person should take colour measurement at the same time of the day.
- Readings are taken for ten leaves at random for each plot and then the average score is compared to determine the need for N top dressing.

- LCC readings are taken once in a week, starting from 14 days after transplanting for transplanted rice and 21 days after seeding for wet seeded rice. Readings are taken once every 7 -10 days until first flowering (figure 1).

Figure 1 Taking Leaf Colour Chart reading for the wheat crop

INTERPRETATION OF LCC VALUES

- The critical leaf colour reading for N top dressing may normally range from 3 to 5 depending upon the cultivar groups. If more than 6 leaves show reading below the critical value, nitrogenous fertilizer has to be applied. If the colour falls between two grades, the mean of the two values is taken for LCC readings. Ex., If the leaf colour lies between chart values 3 and 4, it is noted as 3.5.
- The critical readings are fixed locally for each cultivar group (No.3 to No. 5) and N is top dressed to the rice crop accordingly.
- During the final land preparation, at least 40 kg P_2O_5 /ha and 30 kg K_2O/ha should be incorporated. A basal application of 25 kg $ZnSO_4$ / ha should be done.
- The topmost fully expanded healthy leaves of 10 plants are measured if the area is homogenous (land with fairly uniform growth). If six or more of the leaves have LCC values below the threshold value, N to be top dressed.
- If the area is heterogeneous (with low or elevated areas with different soil nitrogen status), the area is divided into several plots of similar characteristics. Then LCC readings of 10 representative plants are taken from each plot. For each plot, if there are six or more leaves with LCC readings below the threshold value, then N to be top dressed.

LCC DEVELOPED FOR MAJOR CROPS

LCCs developed for major crops (Figure 2) in India are

Rice (CRRI Cuttack)

- Always take LCC reading in 10 leaves opposite to sun in shade in fully matured leaf after 21 DAT or 28 DAS upto panicle initiation
- If > 6 leaves show <4 reading, then apply 25 Kg urea under Irrigated
- If > 6 leaves show <3 reading, then apply 25 Kg urea under DSR
- If > 6 leaves show <3 reading, then apply 35 Kg urea under Boro
- Repeat LCC reading at 7-10 days interval for medium and 10-12 days for late duration varieties

Wheat (PAU Ludhiana)

- Apply DAP 55 kg (basal); 40 kg or 25 kg urea at 1st irrigation 21-28 DAS
- Always take LCC reading in 10 leaves opposite to sun in your shade in fully matured leaf (MRML) before 2nd irrigation
- If > 6 leaves show <4 reading at 55-60 DAS, then apply 40 or 25 Kg urea for normal or late sown
- If >/=4 reading then 25 or 15 kg urea for normal or late sown

Maize (PAU Ludhiana)

- Apply 25 kg urea (basal)
- If > 6 leaves show <5 reading at 21 DAS, then apply 25 Kg urea
- Repeat LCC at 10 days interval
- Stop applying fertilizer after silking

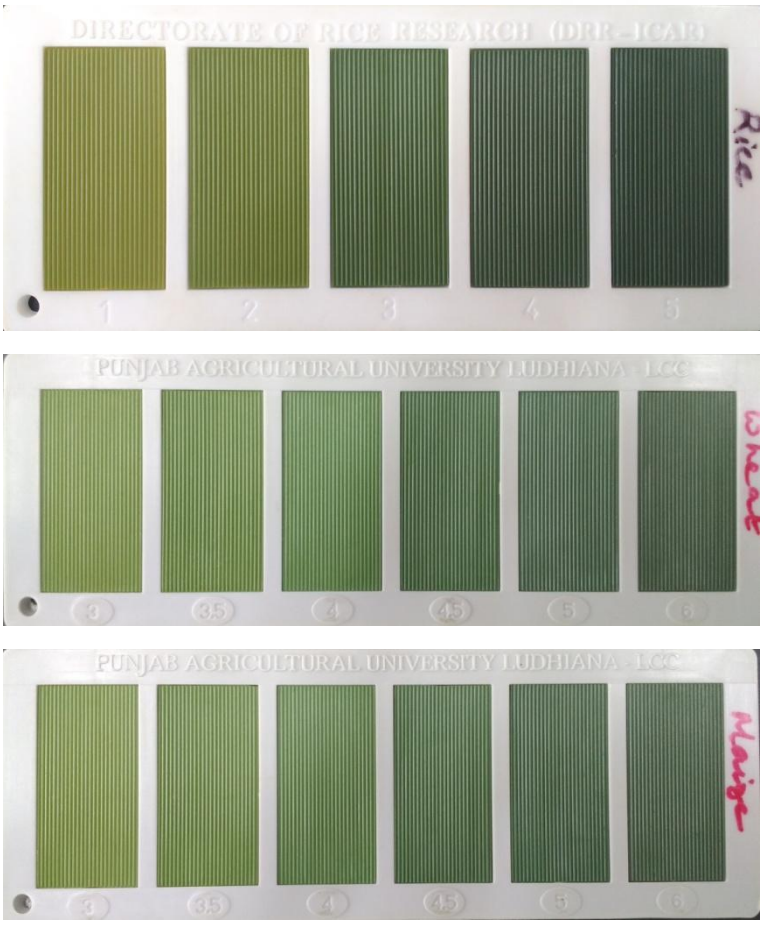

Figure 2 LCC developed by different institutions for rice, wheat and maize

MERITS OF LCC

- It is a simple and easy to use tool for farmers to assess the leaf nitrogen status and to determine the time of N top dressing to rice
- LCC is inexpensive than SPAD meter
- No samples need to be collected, processed and sent to a laboratory for analysis
- SPAD meter involves technical skill but LCC donot demand expertise in usage as it is only matching the colour scores of the leaf with standard chart.

DEMERITS OF LCC

- LCC cannot indicate smaller differences in leaf greenness as the colour shades fall in between two shades, the mean of the two scores is taken which may result in less accuracy
- The relative accuracy of LCC to assess the leaf N status can be determined only when it is compared and correlated with chlorophyll meter readings and calibrated with the cultivar groups (semi dwarf, local tall , hybrid)
- LCC is used only to fine tune the top dressed N but one cannot decide the basal nitrogen application by LCC.
- LCC can be more successful in integrated site-specific nutrient management strategy in which to achieve optimum response to N fertilizer, other nutrients (P, K, S, Zn) must not be limiting.
- P or K deficiencies may cause darker leaf colour which leads to erroneous LCC readings. Hence local calibration of LCC is always required. But SPAD meter is less affected by these deficiencies.
- LCC values are influenced by diurnal variations of the day, varieties and seasons, hence needs calibration.

CONCLUSION

Nitrogen is the kingpin in fertilizer management programme for a crop to realize its yield potential. Nitrogen is more imperative than other nutrients because timing of N application decides the efficiency. Blanket or package fertilizer recommendations over larger areas are not efficient because indigenous supply varies widely among crop fields in Asia. Leaf colour Chart based N management will significantly benefit the farmers in adjusting N input to actual crop conditions and nutrient requirements. Need based N management based on LCC aid in optimizing threshold levels without any yield loss. These tools are inevitable guidelines in deciding the top dressed N requirements and synchronize fertilizer N application with actual crop demand and adds more returns

to the farming community. Thus, LCC provides advantages over the conventional method of N estimation which is very tedious and time consuming and LCC emphasis on need based N application to the crops.

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