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User Friendly Tools Suitable for Efficient Nitrogen Management in Field Crops

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Nitrogen is the most yield limiting nu trient for crop growth worldwide and its efficient management is important for economic sustainability. About 50% of the applied nitrogen to the soil remains unavailable to crop because of combination of various losses like leaching, volatilization and de-nitrification. Recovery of nitrogen under irrigated and submerged condition is hardly 35% because effectiveness of nitrogen supply to the crop is poor, due to the lack of synchrony between nitrogen supply and demand. Both excess and insufficient nitrogen applications may cause either yield reduction or some physiological disorders like hollow stem and pathological problems. Hence, effective management strategies for nitrogen fertilizer are important to ensure optimum seed yield and seed quality of field crops. Optimal nitrogen management strategies aim at matching nitrogen requirement with actual crop demand, thus maximizing plant nitrogen uptake and reducing its losses to the surroundings. The timing of nitrogen application is used to match the nitrogen demand by crop plants with supply. Leaf nitrogen content of crops is directly associated with photosynthetic rate and dry matter production, greenness of first fully opened leaf from the top which gives an indication of nitrogen demand and has, therefore, used as guide for application of nitrogen at different crop growth stages. Now a day, many non-invasive tools are available to quantitatively measure leaf chlorophyll content by using leaves greenness, absorbance/reflectance of light by intact leaf. Among these diagnostic tools LCC, Soil Plant Analysis Development (SPAD) meter, and hand-held Green Seeker optical sensor are used widely in cereals to enhance nitrogen use efficiency in South Asia and elsewhere, when crop is already growing in the field to assess real-time nitrogen requirements. The details of these fertilizer saving tools with their using procedures are described.

1. Leaf Colour Chart (LCC)

First LCC was developed in Japan. An improved version of six panel LCC (IRRI-LCC, Six panel) was developed with collaboration of International Rice Research Institute (IRRI) with agricultural research system of several Asian countries. Recently, IRRI developed four panel of IRRI-LCC (Four green colour shades from number 2 to 5) to best match the spectral reflectance of plant leaves. Now a days, use of LCC for nitrogen application in many crops like rice, maize, wheat, sugarcane, potato, cotton, cassava and vegetables is a common practice. Leaf nitrogen status of crop is closely related to photosynthetic

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rate and biomass production, and it is a sensitive indicator of changes in crop nitrogen demand within a growing season. A tool to rapidly assess leaf nitrogen status and thereby guide the application of fertilizer nitrogen to maintain optimal leaf nitrogen content can consequently be vital for achieving high crop yield with effective nitrogen management.

The leaf color chart is an easy-to-use and inexpensive diagnostic tool for monitoring the relative greenness of a leaf as an indicator of the plant nitrogen status. It's a high quality plastic, ruler-shaped strip with different shades of green colour ranging from light yellowish green to dark green. The LCC is used to monitor leaf nitrogen status from tillering to panicle initiation or later (in rice) by either of two equally effective options. The decision on which option to be used can be based on farmers' preferences and location specific factors, such as frequency of visits by farmers to their fields and their knowledge of critical growth stages for nitrogen application. The fixed-time/adjustable-dose option saves time, and is thus preferred by farmers who have gainful alternative activities. The real-time option is generally preferred when farmers lack sufficient understanding of the critical stages for optimal timing of nitrogen fertilizer.

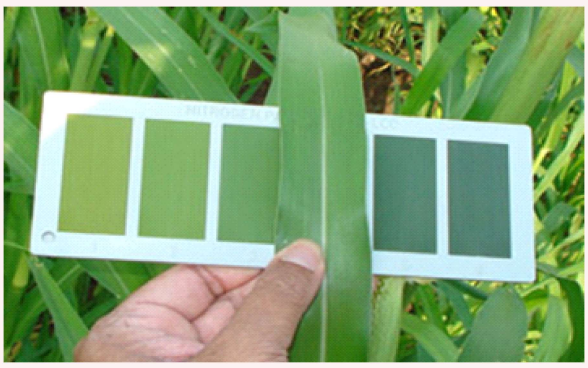
Real-Time Nitrogen Management Option

Farmers monitor the leaf color at 7 to 10 days interval from tillering to about 5-10 days after panicle initiation. Farmers apply nitrogen whenever the leaves become more yellowish-green than a critical threshold value indicated on the LCC.

How to use LCC

LCC determines greenness of the leaf which indicates its nitrogen content. For this purpose, randomly select at least 10 disease-free plants in a field with uniform plant population. Always select the topmost fully expanded leaf from each plant. Place middle part of the leaf on a chart and compare leaf color with color panels of the LCC. Do not detach or destroy the leaf. Measure leaf color under the shade of your body, because of direct sunlight affects leaf color readings. If possible, the same person should take LCC readings at the same time of day every time. Determine average LCC reading for the selected leaves. If the color of a leaf (e.g. rice) is in between two shades, take the average of the two values of the reading. For example, if the color is in between 3 and 4, the reading should be 3.5. Take reading of 10 leaves and determine the average. If the color is more or less than 3, top dressing of nitrogen is needed. Use the LCC once every 7-10 days starting from the beginning of tillering (14 DAT). Continue this process up to 5-10 days after panicle initiation.

Plants deficient in nitrogen are yellowish in colour. Nitrogen deficiency is confirmed when the LCC reading is between panels 2 and 3. At lower nitrogen application rates, plants look better, but low LCC reading still indicates N deficiency. At higher nitrogen application rates, the plants look well developed and the canopy is closed. The LCC reading between panels 3 and 4 is critical range



LCC use in maize and rice

for most of the transplanted rice. In plants with high nitrogen application rate, leaves are dark green. Leaf color darker than the LCC panel no. 4 indicates a surplus of nitrogen fertilizer.

Advantages of Using LCC

- It is cost effective, cheaper and easy to use as it does not require any technical skills to assess the foliar nitrogen status. It saves excess use of nitrogen besides synchronizing nutrient supply and crop demand those results into higher nitrogen use efficiency.
- Larger area can be easily managed by using this practice.
- Using LCC reduces the nitrogen losses occurred during conventional methods (broadcasting/split application of nitrogen fertilizers).
- Studies reported that about 26-29% saving of applied nitrogen over recommended practices besides increasing partial factor productivity, agronomic efficiency and yield.

2. Soil Plant Analysis Development (SPAD) Meter

The SPAD meter is a hand-held device that is widely used for rapid, accurate and non-destructive measurement of leaf chlorophyll concentrations. It has been employed extensively in both research and agricultural applications for wide range of plant species. The SPAD chlorophyll meter instantly measures chlorophyll content or greenness of plants to reduce the risk of yield-limiting deficiencies or costly over fertilization. The SPAD quantifies subtle changes or trends in plant health long before they are visible to the human eye. Non-invasive measurement includes simply clamping the meter over leafy tissue and an indexed chlorophyll content reading (-9.9 to 199.9) is received in less than 2 seconds. It assesses nitrogen needs by comparing in-field SPAD readings to university guidelines or to adequately fertilized reference strips. Research shows a strong correlation between SPAD measurements and leaf nitrogen content.

How to measure SPAD readings

- The fully expanded leaf of youngest plant is used for the purpose. Readings are taken from the midrib of the leaf blade.

- Average of 10-15 readings per plot/field to be taken. If the average value of SPAD falls below a critical value, then immediate nitrogen to be applied to circumvent the yield losses.
- The practice to assess the leaf nitrogen status should be repeated regularly at 10-15 days' time interval up to pre-flowering stage or initial 10% flowering.

Advantages

- Instantly measures chlorophyll content or greenness of plants on a scale of -9.9 to 199.9.
- Non-invasive, non-destructive measurement, waterproof design.
- Trend graph stores and displays up to 30 measurements.
- Compares in-field SPAD readings to university guidelines.
- Available with or without a built-in data logger.
- Use of SPAD does not require any technical skills, anyone can use it at any time.