



Precision Nitrogen Management Using SPAD Meter and Leaf Colour Chart for Enhancing Nitrogen-Use Efficiency, Productivity and Grain Quality of Direct-Seeded Basmati Rice

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Precision management of nitrogen is vital not only for boosting productivity but also enhancing the efficiency of nitrogen utilization and the quality of rice grains in direct-seeded Basmati rice. Excess nitrogen application and poor timing of nitrogen applications can lead to unnecessary costs and loss of nutrient items added to the cost of inputs. On the other hand, a lack of nitrogen may result in inadequate crop growth and yield. The use of SPAD meter and Leaf Colour Chart (LCC) allows farmers to assess nitrogen status of the crops and use nitrogen in accordance with their real needs. SPAD analysis gives fast, non-destructive result about chlorophyll content in leaves, while LCC is an easy and inexpensive means to assess leaf greenness in the field. Using both methods will improve utilization of nitrogen as well as yield characteristics and quality of grain. Also, such indicators as nitrogen uptake and agronomic and recovery efficiencies and productivity as well as grain yield and protein content of rice that can assess the efficiency of nitrogen management.

Keywords: Precision Management, Nitrogen, SPAD, LCC, Nitrogen Use Efficiency, Productivity, Nitrogen Management

Introduction

The high price of Basmati rice is due to its aroma, long grains, cooking methods, and costs. The increasing popularity of DSR or Direct Dry-seeded Rice techniques made it possible for farmers to cut down the labor and avoid many processes connected to the traditional transplantation method. At the same time, with these techniques, it becomes even more necessary to control the nutrients since different conditions in terms of organic substance and nitrogen (N) are essential to the development of the plants. Lack of nitrogen could cause light green leaves and poor plant production while too much of it could initiate too much plant construction and risk loss of nutrients. As such, the main concept of "proper amount of nitrogen at an appropriate time" is important for precision nitrogen management. India has made examples of the use of the Leaf Colour Chart (LCC) for nitrogen management, but also the use of the SPAD method to check the nitrogen status in plants.

What are SPAD and LCC?

SPAD meter: The SPAD meter is a handheld optical instrument that measures the chlorophyll content of a live leaf without damaging it. Since leaf chlorophyll is linked to the plant's nitrogen level, the readings from the SPAD meter can be used to know whether additional nitrogen is needed.

Leaf Colour Chart (LCC): LCC is a cheap and easy-to-use plastic bar that offers standardized shades of green. The colour of a rice leaf is visually compared with the chart. When leaf colour becomes lighter than the locally validated threshold, nitrogen application can be considered. ICAR describes LCC as a simple and rapid tool for efficient N management in rice.



Important Technical Terms

Technical term	Definition
Nitrogen-Use Efficiency (NUE)	A metric on N utilization for crops.
N uptake	The amount of nitrogen absorbed as well as accumulated by the crop.
Agronomic efficiency	Quantity of grain produced per unit of N input.
Recovery efficiency	The percentage of applied N that is recovered through crop production.
Partial Factor Productivity (PFP)	The amount of grain produced per unit of N input.
SPAD value	The measure of chlorophyll contained in the leaves.
LCC score	Amount of leaf greenness measured visually using an LCC.
DSR	Direct sowing of seeds instead of transplanting seedlings.
Grain quality	The grain characteristics including size, milling quality, head-rice recovery, and protein content.

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Precision Nitrogen Management System

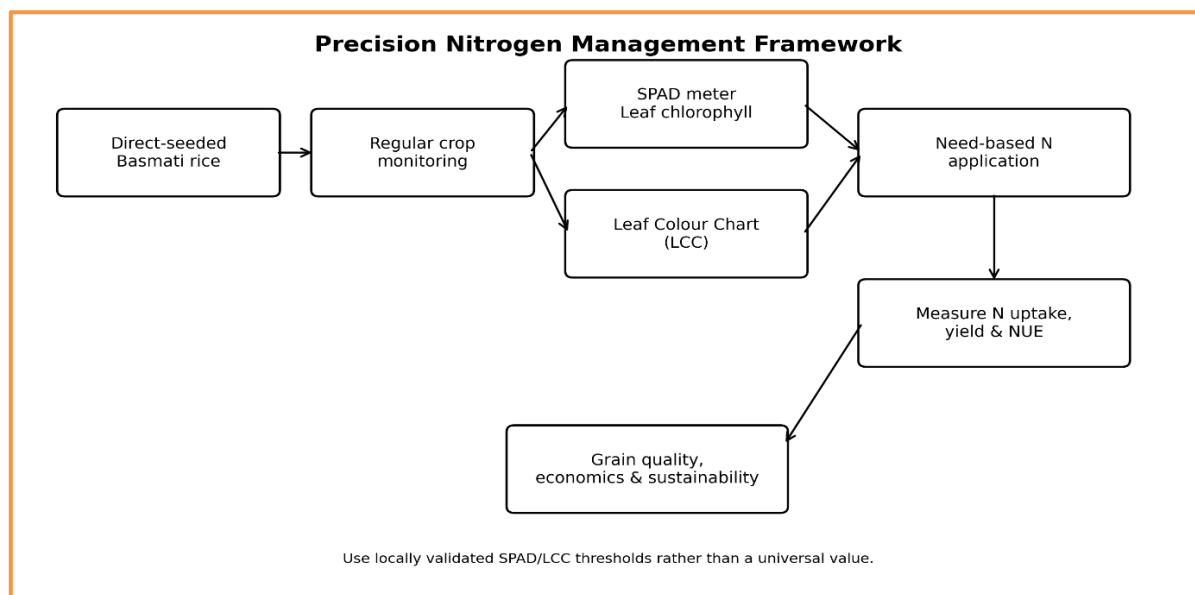
This method is about constant monitoring of crops with focus on their actual nitrogen status so that fertilizer requirements can be calculated instead of following preset fertilizer schemes.

Direct Seeding Basmati → Crop monitoring → SPAD/LCC analysis → Conditional N application → Measuring nitrogen uptake & NUE → Grain yield & quality

Measurements of SPAD and LCC must be taken at the appropriate stage of crop growth and therefore recorded in an orderly fashion. It must be noted that there isn't any universally applicable threshold for SPAD or LCC across all Basmati cultivars and supply chain conditions and that threshold values must be validated taking into account the specific variety, soil type, season and other local growing conditions.

Parameters to be Measured

Category	Parameters
Crop growth	Plant height, tiller number and biomass
Nitrogen status	SPAD value and LCC score
Yield	Grain yield, straw yield and harvest index
Nitrogen efficiency	N uptake, agronomic NUE, recovery efficiency and PFP
Grain quality	Kernel length, breadth, milling recovery, head-rice recovery and protein
Economics	Fertilizer cost, gross return, net return and benefit-cost ratio



Several N-control techniques can be compared, including standard recommended N applications, SPAD-based N management, LCC-based N management, and SPAD + LCC management combined. The purpose of this comparison is to demonstrate the great efficiency of nitrogen in producing crops by real time monitoring.

Three relevant indicators are:

Agronomic NUE

$$\text{Agronomic NUE} = \frac{\text{Grain yield with N} - \text{Grain yield without N}}{\text{Applied N}}$$

Recovery Efficiency (%)

$$\text{RE} = \frac{\text{N uptake with N} - \text{N uptake without N}}{\text{Applied N}} \times 100$$

Partial Factor Productivity

$$\text{PFP} = \frac{\text{Grain yield}}{\text{Applied N}}$$

Unlike just solely relying on grain yield, these indicators give a wider view of whether the excess fertilizer is converting to crop yield.

Why Grain Quality is Important for Basmati Rice?

In the case of Basmati rice, crop productivity is not enough. Kernel length, grain slenderness, milling recovery, head rice recovery, protein content, and other quality parameters have a big impact on the market price of the product. Therefore, the precision nitrogen management should try to create the right balance between the yield, nitrogen efficiency, and grain quality. ICAR agro-advisories also emphasize judicious N application based on soil testing and LCC-based management in rice. Earlier ICAR research has demonstrated the potential of LCC-based N management to improve nitrogen-use efficiency and avoid unnecessary N application in rice.

Conclusion

Utilizing precision in nitrogen applications with the use of SPAD meter and Leaf Colour Chart brings us a practical way of making nitrogen application more efficient in relation to the actual crop needs. The combination of undertaken monitoring practices and/or measurements of nitrogen uptake, N efficiency, grain yield, grain quality and economic figures will help make a scientifically based and farmer-friendly nitrogen management scheme for direct-seeded Basmati rice cultivation. The final goal is not just to raise the

amount of nitrogen applied but to produce high-quality Basmati rice with effective nitrogen application and stable yields with minimal losses of inputs, which will enable farmers to increase their income.

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