Development of a Leaf Color Chart for California Rice Varieties

FREP Contract # 01-0510

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Introduction

Proper nitrogen management in rice influences yields and grain quality. Excessive nitrogen and its application at an inappropriate growth stage can reduce yields, reduce market value of some varieties, and increase disease incidence. In contrast, suboptimal nitrogen levels in rice at discrete growth stages may substantially reduce plant productivity. The nitrogen status of rice at specific growth stages may be used for estimating supplemental nitrogen requirements and yield potential. Nitrogen status in the 'Y' leaf varies throughout the life cycle of rice and the rice plant transitions through the most nitrogen sensitive growth stages within a few days (Figure 1). Thus, it is essential that plants be sampled at a consistent growth stage for nitrogen management. Furthermore, time of sampling must be based on the actual plant growth stage, not days after planting. Days after planting to panicle initiation, for example, may vary between years due to weather. Estimating tissue N status at critical points of the plant's life cycle can greatly improve the economics of rice production. Therefore, fertility management decisions must frequently be made for numerous large fields in a short period of time. Tissue sampling and subsequent lab analysis may not provide the needed information in a time effective manner. Moreover, rice is grown under anaerobic soil conditions, thus rendering in-field tissue nitrate tests inapplicable. Hand held chlorophyll meters (e.g., Model SPAD-1504, Minolta Ltd.) are used to estimate leaf nitrogen in rice, but these instruments are costly and require extensive sampling and tissue analysis to accurate calibration.

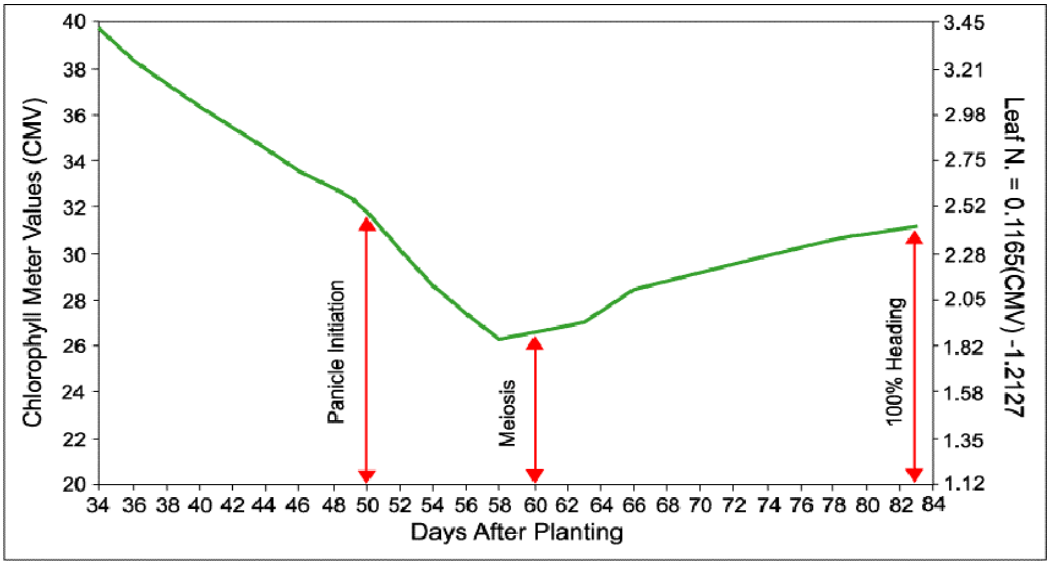
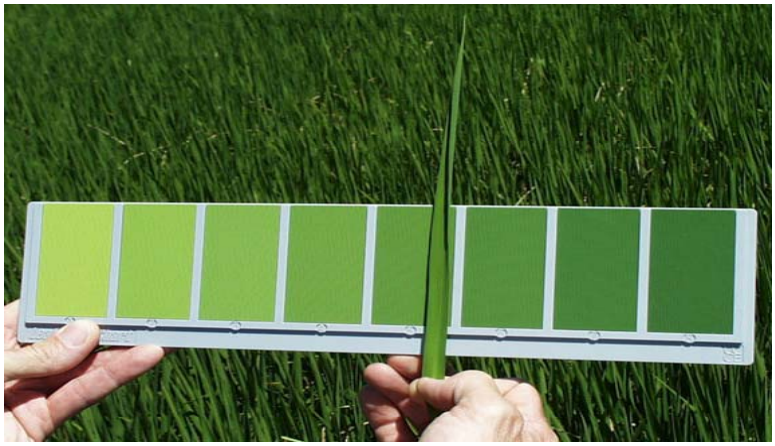


Figure 1. Seasonal variation in N content of the 'Y' leaf in rice.

To address the need for a real time nitrogen management tool, the project leader began a project in 1998 to develop a leaf color chart (LCC) to estimate leaf nitrogen content in rice based on leaf color. In a controlled experiment, the leaf reflectance characteristics of eight public rice varieties were measured with a spectrophotometer. Leaf color was described in L*, a*, b* three-dimensional color space with designations of lightness, red to green scale, and blue to yellow scale, respectively. Spectral data were used to fabricate a color chart consisting of eight acrylic plates (color cells) that accurately represents actual leaf color (Figure 2). Under experimental conditions, regression analysis relating leaf nitrogen to color revealed correlation coefficients ranging from 0.91 to 0.96 for the tested varieties (Figure 3). The University of California and a commodity board funded the development and initial production costs.



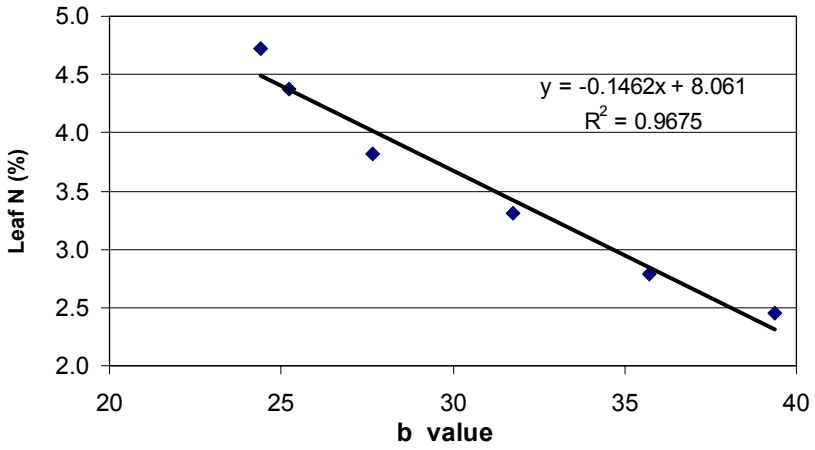


Figure 2. University of California leaf color chart.

Figure 3. Relationship between leaf color and leaf N (%).

Objectives

The overall objective is to introduce and promote the adoption of a real time nitrogen tool for rice, to improve fertilizer use efficiency, reduce production costs, and minimize off-farm movement of nitrogen. Specific objectives are to:

1.) Refine the chart calibration algorithms for multiple varieties across location;
2.) Improve the use and sampling techniques for single leaf and whole field nitrogen determination;
3.) Promote the adoption and proper use of the LCC through a series of field meetings and workshops to train growers and PCA's.

Project Description

1.) The LCC was distributed to 170 rice growers and numerous PCA's sent along with detailed instructions for use throughout the Sacramento Valley.
2.) Two training session/field days were held, one in Sutter County and the other in Butte County. In total over 50 growers attended.
3.) Conducted individual on- farm training with over 25 growers.
4.) Informed growers about the LCC four winter grower meetings (2002) and at the Rice Experiment Station Annual field day attended by over 600 people.
5.) Leaf samples were collected from multiple locations and varieties at different stages of growth. Leaf N was estimated with the LCC and subsequently chemically analyzed for comparison and regression analysis.

6.) Controlled nitrogen by rice variety experiments were conducted in participating growers fields. Extensive leaf sampling was conducted for developing single leaf and whole field calibration of the LCC.

Results

Data analysis for the first field season is in progress.