New Methods for Managing Midseason Nitrogen in Rice

By Gene Stevens and David Dunn

Managing N fertilization in rice production is a challenge throughout the world. In the USA, a simple method is needed to aid farmers with midseason N decisions in dry-seeded, delayed flood rice. A fast, inexpensive technique called the "yardstick method" looks promising.

A standard rice N fertilization program in the North Mississippi River Delta area is 70 to 120 lb N/A as urea applied preflood at first tiller, followed by aerial application of 30 lb N/A at 0.5 in. internode elongation and 30 lb N/A applied one week later (Dunn and Stevens, 2006). Potential N losses from urea volatilization before flooding and denitrification after flooding may or may not occur. Depending on well pump capacity and land area, fields often take several days to flood after urea is broadcast. Extension recommendations for preflood N rates in rice are usually based on field calibration tests with adjustments for specific cultivars, crop rotation, and soil texture. In recent years, many farmers have begun using a single application of 100 to 150 lb N/A preflood to avoid the expense of aerial applications of N at midseason.

With these uncertainties and higher N fertilizer prices, rice producers have been looking for ways to more closely predict the need for applying N midseason. Traditionally, rice leaf color, tissue N content, and plant area measurements have been used to determine whether midseason N is needed on a rice field.

Currently, only a small number of rice farmers and crop consultants in the USA are using Minolta® SPAD chlorophyll meters for managing midseason N because of the purchase cost (>US$1,300 per SPAD meter) and the need to establish high N reference strips early in the season. By comparing readings to reference strips, farmers can avoid trying to "green up" rice that has other problems besides N deficiency. Scientists at the International Rice Research Institute (IRRI) in the Philippines developed a leaf color chart, which is a less costly method of detecting rice leaf green color intensity (Shukla et al., 2004). This tool is being used with good results around the world. However, the need to use high N reference strips also applies to this method. And for color blind individuals, matching a rice leaf to green color plates on a chart is not possible.

Plant area measurements with a rice gauge have also been used to predict midseason N need. Research showed that plant area values are a more reliable estimator of total plant N than leaf N concentrations and chlorophyll readings (Ntanatungiro et al., 1999). Although rice gauges have been widely promoted by extension specialists, very few consultants use them because of the labor required. A person must carry a clipboard and pencil to record numbers, slide and lock the trapezoid in place, prevent the vertical shaft from falling over in the mud while backing away to estimate height and width, and then move to another sample location in a field.

The "Yardstick Method"

To help farmers be sure that no additional midseason N is needed, we developed a fast, inexpensive field test called the "yardstick method". Experiments at Qulin and Portageville, Missouri (USA) showed that the method did a good job of predicting yield response to midseason N. Leaf canopy is estimated by counting the inch numerals visible on a yardstick floating between rice row drills. Yardsticks can be purchased for less than $5 and no calculations are needed to decide whether more N is needed.

Here is how a yardstick reading is collected:
- At green ring rice growth (R1) stage, float a wood or plastic yardstick between two 7.5-in. rice drill rows.
- Standing between adjacent rows and leaning over the sampling rows, count the inch numbers showing on the yardstick (not hidden by rice leaves) out of 36 numbers possible (**Figure 1**).
- When a rice leaf obstructs the view of one digit in a two-digit number to the point that the whole number is not recognized, do not count that number.
- Keep both eyes open during the readings. Stand straight and avoid looking around leaves by rotating your head to read numbers on the yardstick.

The number of sample locations in a rice field where measurements need to be taken depends on the uniformity of

Figure 1. Rice leaves blocking the overhead view of inch numbers on a yardstick floating in floodwater between rice drill rows. The count on this example would be 16 numbers showing.

Figure 2. Example digital images. Left to right: low preflood N to high preflood N, collected at R1 growth stage with a digital camera in rice plots. Values in the lower right corner of photos were the proportion of green pixels in images.

Abbreviations and notes for this article: N = nitrogen;

the field. Generally, it is best to take at least 10 measurements in a field.

Yardstick numbers showing are indicators of crop leaf canopy closure and can be influenced by leaf orientation. The rice varieties commonly grown in the North Mississippi River Delta region have been selected for vertical leaf orientation for the uppermost leaves. This change in leaf orientation improves light penetration into the canopy compared to the more horizontal leaf position of older cultivars. Yields are maximized in these rice varieties when leaf interception of available sunlight is maximized.

Table 1. Average rice yield response to midseason N applications (30 lb N/A at growth stage R1 followed by another 30 lb N/A 7d later) relative to visual number showing on yardstick at R1 growth stage for Francis and Cheniere varieties on Sharkey clay and Dewitt silt loam soils.

Yardstick numbers showing	Change in rice yield, lb/A
10	-392
12	-134
14	90
16	291
18	470
20	622
22	750
24	874
26	930
28	974
30	1008

Results

The yardstick method was evaluated with two rice varieties (Cheniere and Francis) over 3 years on clay and silt loam soils. No yield response was produced from midseason N (30 lb N/A at growth stage R1 followed by another 30 lb N/A 7d later) when fewer than 14 numbers were showing at green ring growth stage on a yardstick floating between drill rows (**Table 1**). The results showed that applying midseason N to rice that does not need it is not only wasteful, but often reduces yield.

We also evaluated the use of digital cameras to estimate rice plant area for making midseason N decisions. The major disadvantage of this method is the cost of the digital camera

Figure 3. Collecting a digital photo for percentage green pixel analysis.

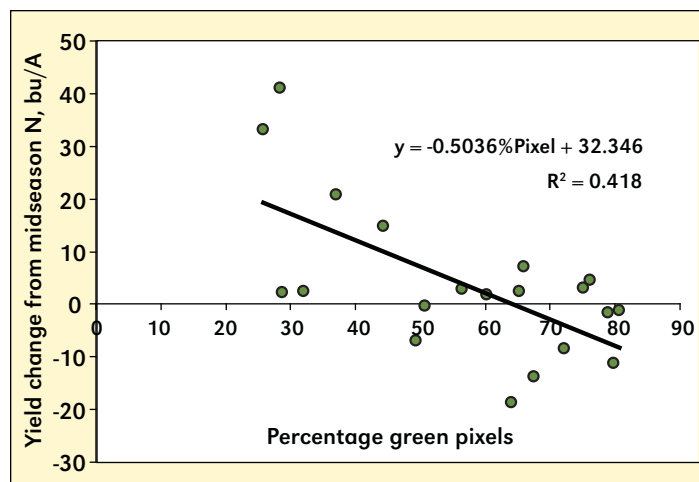$$y = -0.5036\%Pixel + 32.346$$
$$R^2 = 0.418$$

Figure 4. Rice yield response to midseason N applications relative to percentage of green pixels in digital images recorded at R1 stage from Francis and Cheniere varieties in 2005 and 2006 on Sharkey clay and 2006 on Dewitt silt loam soil.

and computer software for scanning images. In our tests, a camera was mounted on a 5-foot rod held above the plot (**Figure 3**). The camera was positioned level with the soil surface and recorded a plot area of 30 by 45 in. A computer macro program developed at the University of Arkansas was used with Sigma Scan™ Pro 5.0 image software (Aspire Software International, Asburn, Virginia) to determine the percentage of green pixels in each photo (**Figure 2**).

No yield response was produced from midseason N when greater than 64% of the pixels were green color in digital images (**Figure 4**)

Both the yardstick and digital image methods of estimating yield response to mid-season N are specific to drill-seeded rice. It may be possible to use these methods in other rice production systems. However, before agronomic recommendations are considered, field evaluations should be conducted. For example, field calibrations would be required to determine critical levels for recommending midseason N on transplanted rice based on numbers showing on a meter stick or yardstick. BC

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