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# COMPARISON OF SPAD 502 CHLOROPHYLL METER AND CARDY NO3 METER WITH TRADITIONAL METHODS OF DETERMINING PLANT NITROGEN STATUS

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## Abstract

A nitrogen rate evaluation was conducted at sites in Missouri and Mississippi in 2002. Four methods of midseason N monitoring were compared for two different growth stages, first flower plus 3 weeks and cut out. No method for either growth stage was well correlated to cotton lint yields. All monitoring methods were more predictive of yields at first flower + 3 weeks than at cut out. Dry petiole N% at first flower + 3 weeks had the greatest correlation ($R^2$ = 0.46) followed by the Cardy $NO_3$ meter ($R^2$ = 0.34).

## Introduction

Cotton often requires supplemental nitrogen (N) fertilization to achieve maximum lint yields. Proper N rates are critical as lower rates may limit yields while higher rates promote excessive vegetative growth. This may delay the harvest and reduce fiber quality. Higher than optimal N rates may also contribute to increased disease and insect pressure. Optimizing N rates also reduces environmental impacts by limiting the potential for run off or leaching. Midseason management of nitrogen fertility is dependent on obtaining reliable and timely data about the plants nitrogen status. Several methods are available to cotton producers to determine crop nitrogen status. Traditional methods relied on petiole analysis for nitrate ($NO_3$) or total N % of the leaf blade. These methods while reliable have a built in time lag. Samples must be transported to a laboratory for drying, grinding and analysis. This process may take to up to two weeks for results to be available to producers. Two new methods for determining "infield" N status are the Cardy $NO_3$ meter and the Spad-502 chlorophyll meter. The Cardy $NO_3$ meter (Horiba, Ltd., Kyoto, Japan) uses ion selective electrode (ISE) technology to quantify $NO_3$ levels in liquids. In this system the electro potential of the $NO_3$ ion in an unknown sample is compared to standards of known concentrations. For midseason N monitoring, sap is mechanically extracted from cotton petioles. The SPAD-502 chlorophyll meter (Minolta Camera Co., Ltd., Japan) estimates the chlorophyll content of leaves by measuring the differences in light transmission at 430 and 750 nm. This is a non-destructive, instantaneous method. A potential weakness of the SPAD-502 is that differences in chlorophyll content among cultivars have not been studied. Use of well fertilized reference strips have been suggested to overcome this potential problem.

The objective of this study is to compare Cardy $NO_3$and SPAD-502 meters as tools for determining midseason N status and predicting cotton lint yields.

## Methods and Materials

A cotton evaluation was conducted in 2002. Sites in Missouri (MO) and Mississippi (MS) were used in this evaluation. The MO site was located near Portageville MO. Here the soil type was a Tiptonville Silt-loam and the cotton variety was PM 1218 BR. The MS site was located near Senatobia, MS. Here the soil type was a Memphis Silt-loam and the cotton variety was DPL 451 Bt/RR. A randomized complete block design was used. The MO site had 4 replications while the MS site had 5 replications. At both sites research plots were established. Each of these plots received one of three N treatments. Ammonium nitrate was applied at the following rates: 1: 0 lbs N/a, 2: 50 lbs N/a, and 3: 100 lbs N/a. All other methods of fertilization, weed and insect control were the standard cultural practices for cultivating irrigated cotton in MO and dry land cotton in MS. During the growing season plant N status was measured two times, first flower plus 3 weeks (ff+3) and cut out. The methods used at both sites were Cardy meter and SPAD-502 meter. Petioles were randomly collected from each plot. For both sampling times 25 to 30 petioles and associated leaves were collected from the center two rows of each plot. These samples represent the fourth node below the uppermost fully expanded leaf. Prior to each sampling the Cardy and SPAD-502 meters were calibrated according to the manufactures instructions. SPAD-502 meter readings were conducted on each col-

lected leaf. The petioles were then separated from the leaves and Cardy meter determinations were conducted on sap extracted from the petioles using a garlic press. For the MO site the remaining petiole was dried and ground. $NO_3$ levels were obtained using an Aluminum sulfate extraction and an ISE determination. Total N percentage levels were obtained using an $H_2SO_4$-$H_2O_2$ digestion and an Indophenol Blue determination. The results were recorded for each plot.

Statistical analysis of nitrogen treatment effect on yields was conducted utilizing SAS Mixed Model procedure (SAS Ins. 1997). Regression and correlation analysis between the midseason N status methods and yields were preformed in accordance with procedures outlined by the SAS Institute.

## Results and Discussion

A typical response to nitrogen fertilization was observed at both locations. In each case both the 50 and 100 lbs., N/acre rates produced cotton lint yields significantly greater than the unfertilized check (Table 1). These yield differences were not well correlated to any of the midseason N status monitoring methods for either sampling date (Table 2). The best correlations were obtained at the ff +3 date. For this time dry petiole N% had the greatest R2 value (0.46) followed by the Cardy NO3 meter (0.34). N status monitoring at cut out was not predictive of yield. A positive linear relationship between Cardy and SPAD-502 meters was observed at both locations and for both sampling dates (Figures 1 and 2). For both dates the MO SPAD-502 readings were approximately 5 units greater than the MS readings. This may be reflective of chlorophyll content differences between the two varieties. The slopes of each regression line were similar for each site. The slope for the ff +3 was greater than cut out sampling at both locations. A greater correlation between the Cardy and SPAD-502 meters was observed for the cut out sampling date than the ff +3. Cardy NO3 readings were strongly correlated, R2 = 0.78, to dry petiole ISE readings (Figure 2a). There was also a strong correlation (R2 = 0.60) between Cardy NO3 meter readings and petiole dry N% (figure 3a). SPAD-502 readings were poorly correlated to both dry petiole NO3 and N% levels.

## Conclusions

All sampling methods were better correlated to yields at ff +3 than at cut out. Methods that directly measured N or NO3 content were better at predicting yields than the SPAD-502 meter. Differences between varieties in chlorophyll content may limit the SPAD-502 meters effectiveness with out the use of well-fertilized reference strips.

## Acknowledgement

This research was made possible by the generous and continuing support of the Helena Chemical Company.

Table 1. Average cotton lint yields for N treatments. Yields followed by the same letter are not significantly different at the alpha = 0.05 level.

| N Treatment | MO Cotton lint yield (lbs./acre) | MS Cotton lint yield (lbs./acre) |
|---|---|---|
| 0 N | 743 b | 835 a |
| 50 lbs N/acre | 889 a | 1141 b |
| 100lbs N/acre | 907 a | 972 ab |

Table 2. Correlation between cotton lint yields and midseason N monitoring methods, 2002.

| | $R^2$ ff+3 | | $R^2$ cut out | |
|---|---|---|---|---|
| **Measurement** | **MO** | **MS** | **MO** | **MS** |
| SPAD 502 | 0.15 | <0.01 | 0.01 | 0.01 |
| Cardy NO3 | 0.34 | 0.13 | 0.02 | 0.01 |
| Dry petiole NO3 | 0.26 | --- | 0.09 | --- |
| Dry petiole N% | 0.46 | --- | 0.03 | --- |

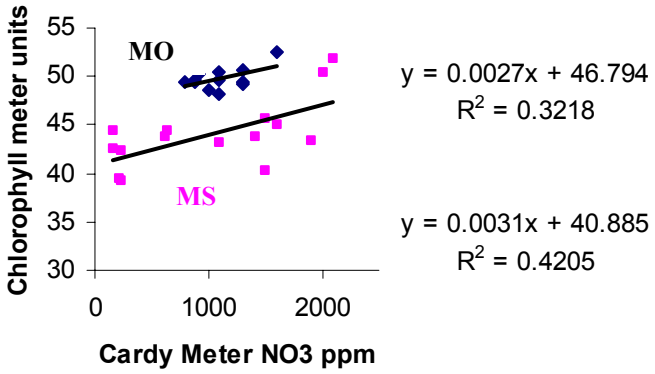


Figure 1. Correlation between Cardy NO3 meter and SPAD-502 meter for the growth stage ff +3.

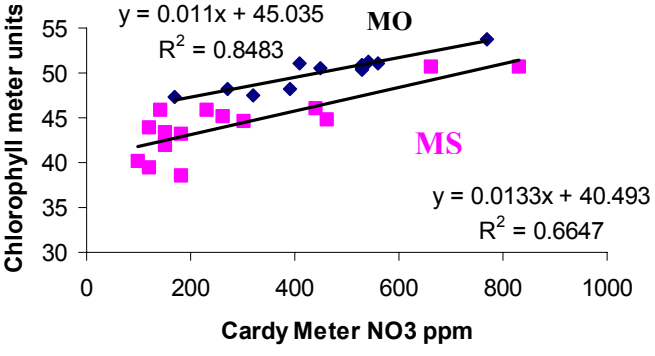


Figure 2. Correlation between Cardy $NO_3$ meter and SPAD-502 meter for the growth stage cut out.

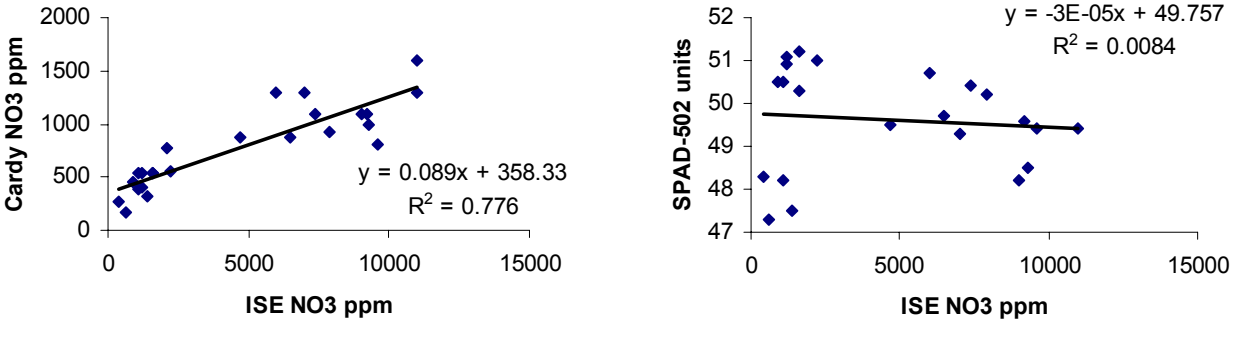


Figure 3. Correlation's between dry petiole $NO_3$, Cardy $NO_3$ meter and SPAD-502 readings from MO, 2002.

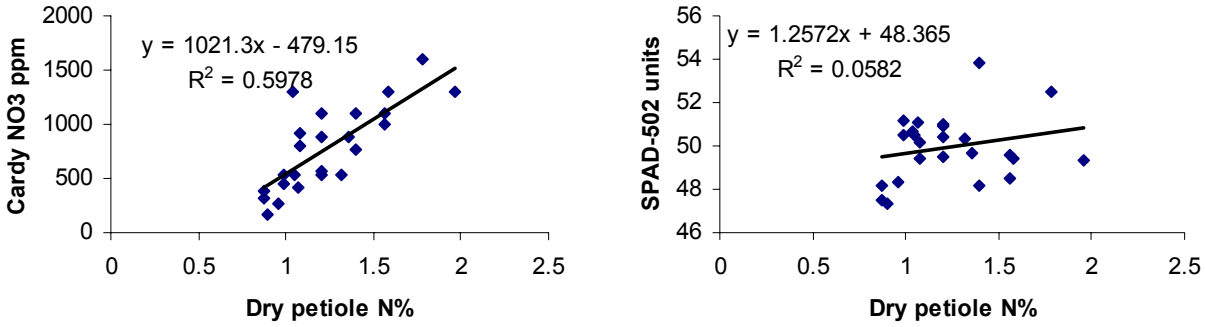


Figure 4. Correlation's between dry petiole N%, Cardy $NO_3$ meter and SPAD-502 readings from MO, 2002.