COMPARISON OF TWO METHODS FOR DETERMINING PETIOLE N AND K LEVELS

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Introduction

The increased cost of cotton (*Gossypium hirsutum* L.) production paired with low commodity prices necessitates better in-season nutrient management for the crop. The ability to monitor nitrogen (N) and potassium (K) levels throughout the growing season and respond to any detected deficiencies can improve possibilities of achieving optimal yields. Petiole analysis is available through university and independent labs to the producer as a tool to monitor NO_3-N and K levels of a crop during the growing season. A common problem of traditional lab analysis is the lack of timely results to the crop advisor.

Sampling and conducting the petiole analysis the same day can eliminate this time lag. The problem of time efficiency can be overcome by utilizing Cardy portable electrode-based ion meters (Horiba, Ltd., Kyoto, Japan). The Cardy NO_3-N and K ion meters offer crop advisors the ability to quickly evaluate crop N and K levels relative to growing conditions. Cardy meters have been widely used in vegetable production with NO_3-N and K thresholds established for several crops (Maynard and Hochmuth, 1997). During the past decade several researchers (Burmester and Mullins, 1994; Hodges and Baker, 1993; and Smith, et al. 1997) have investigated the utility of Cardy meters as diagnostic tools in cotton.

Hodges and Baker (1993) found that routine lab analysis and the Cardy meter measurements were strongly correlated (r=0.88) although a change in the slope of the correlations was noted with increasing time. As the cotton crop advanced through the bloom stage, it became more difficult to extract sap from the petioles. They suggested that the meters would be useful for early season measurements and for evaluating problem areas in fields. Burmester and Mullins (1994) obtained similar results when evaluating the K meter for in-field measurements. Contradictory to the earlier study the correlations of lab analysis K to Cardy meter K were poor (R^2=0.08 or less) in all but the first sampling period (bloom +1 week) which had an R^2=0.53. These poor correlations were due to the difficulty in obtaining sap extract as the plant matured. Burmester and Mullins concluded that the best use for the Cardy meters would be early season before the petioles hardened.

As with any diagnostic tool there are potential problems associated with the Cardy meter. In addition to improper calibration, environmental conditions, and maintenance issues Hodges and Baker (1993) determined that the meters were highly sensitive to temperature and sunlight. Smith, et al. (1997) conducted a trial to analyze the accuracy of the Cardy meter to effectively measure NO_3-N in irrigated cotton. As with previous experiments, petioles were randomly sampled and divided into two samples, one for Cardy meter analysis and one for the standard lab analysis. Correlation and linear regression analysis were conducted on NO_3-N concentrations as measured by the Cardy Meter versus the standard lab analysis. The two NO_3-N petiole analysis methods were highly correlated (Pearson correlation coefficient = 0.96, $P<0.0001$) throughout the growing season. A highly significant ($P< 0.0001$) linear regression equation was derived: $Y = 9.96X – 1170.86$ (n = 279, R^2=0.92), where X and Y are NO_3-N concentrations (ppm) for Cardy meters and standard lab analysis, respectively. Their results suggest that the Cardy meters can be a valuable diagnostic tool to monitor NO_3-N levels in cotton.

All of the previous trials have been conducted within one state or area of the state. The objective of this study was to evaluate both the NO_3-N and K Cardy meters in several locations across the cotton belt.

Material and Methods

Five strategic locations, based on soil type, were selected from sixteen locations of a regional fertility trial consisting of four treatments. The locations were selected in an attempt to encompass the annual fluctuations in environmental conditions where production cotton is grown annually. Agronomic data by location is reported in Table 1.

Petioles were randomly sampled weekly from the two center plot rows from each treatment starting at pinhead square and continuing through cutout. From each plot, approximately 20-30 petioles were sampled from the fourth node below the uppermost fully expanded leaf throughout the season. At each sampling date an extra 20-30 petioles were sampled from one replication (which was rotated weekly) and sent to the University of Arkansas Soil Test Laboratory for a standard NO_3-N and K determination, Procedures PL-0002 and PL-0001, respectively.

Prior to each sampling both the NO_3-N and K Cardy meters were calibrated in accordance with the procedures and standards provided with each meter. The fresh petioles were cut approximately ½" in length and placed in a garlic press for sap extraction. As the crop matured, it was necessary to place the petioles in a freezer for approximately 20 minutes to rupture the cell walls, which facilitated sap extraction. The sap extract was placed directly on the sensor pad of each Cardy meter and the readings were recorded. Generally, 3 – 5 readings were recorded and averaged for each plot.

Regression and correlation analysis between the Cardy meter and Arkansas lab analysis were performed for both the NO_3-N and K concentrations in accordance with procedures outlined by the SAS Institute (SAS, 1997).

Results and Discussion

Correlation analyses were performed by location and across locations by sampling date but are not reported in this paper. Linear regression analyses were performed on NO_3-N concentrations (ppm) of cotton petiole sap, as measured by the Cardy meter, versus the NO_3-N ppm as measured by the University of Arkansas Procedure PL-0002. The linear regression equation for each location and levels of significance are reported in Table 2 where N refers to the Cardy meter NO_3-N ppm levels, and AN refers to the Arkansas lab NO_3-N ppm levels. Similar to Smith et al. (1997) the Cardy meter NO_3-N ppm levels showed a positive linear relationship with the Arkansas lab NO_3-N ppm levels for each location and across locations (Fig. 1). All of the locations except Arkansas had very similar regression equations (Table 2 and Figure 1). This effect could be due to a difference in the sampling technique used in Arkansas, which was to dry the samples for the Arkansas lab analysis prior to submission. All samples were stored until the end of the season, then submitted for analysis. This delay could have resulted in a degradation of the tissue from earlier sampling dates. Samples were submitted by the other locations on a seven-day interval. Linear regression analyses were also performed on the K concentrations (ppm and %) as measured by the Cardy meter and the University of Arkansas Procedure PL-0001, respectively. The linear regression equations and levels of significance for each location are reported in Table 3 where K refers to the Cardy meter K ppm levels, and AK refers to the Arkansas lab K % levels. As was seen with the NO_3-N data the Cardy meter K ppm levels showed a consistent, positive linear relationship with the Arkansas lab K % levels (Fig. 2). The MS and MO data very nearly matched the linear equation for all locations.

The differences exhibited in the linear relationships for both the NO_3-N and K concentrations among the five locations may be due to differences in sampling technique. These sampling differences may be due to weather conditions and/or to time of day the samples were taken; or the handling of the petioles prior to determining either N or K concentration by the two methods.

Conclusion

The results demonstrate that the cotton petiole NO_3-N and K concentrations (ppm) as measured by the respective Cardy meters show a positive linear relationship with the University of Arkansas concentrations. These linear relationships indicate that the Cardy meters can be used as a tool for weekly or daily monitoring of a cotton crops N and K levels. Therefore, with some minor refinement in the sampling and assaying procedure the Cardy meter can be a useful diagnostic tool for crop advisors.

Literature Cited

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Table 1. Locations and agronomic information.

Location	Reps	Variety	Planting Date
Rowher, AR	5	STV747	6/05/01
Portageville, MO	6	BXN 47	5/25/01
Verona, MS	4	SG501BR	5/09/01
Florence, SC	4	DPL458BR	4/24/01
Lubbock, TX	5	PM 2326RR	5/17/01

Table 2. NO_3-N linear regression equations and test of significance for all locations.

Location	Equation	R^2	n	Intercept	Slope
AR	N = 0.196 AN + 2896.79	0.35	148	P<0.0001	P<0.0001
MO	N = 0.116 AN + 371.21	0.81	108	P<0.0001	P<0.0001
MS	N = 0.060 AN + 1130.59	0.28	60	P<0.0001	P<0.0005
SC	N = 0.043 AN + 925.90	0.51	28	P<0.0001	P<0.0001
TX	N = 0.066 AN + 1711.18	0.13	40	P<0.0001	P<0.0221

Table 3. K linear regression equations and test of significance for all locations.

Location	Equation	R^2	n	Intercept	Slope
AR	K = 2363.38 AK + 283.20	0.14	148	P<0.0001	P<0.0001
MO	K = 1087.57 AK+ 543.01	0.60	99	P<0.0001	P<0.0001
MS	K = 1330.31 AK + 475.92	0.61	60	P<0.0001	P<0.0001
SC	K = 3776.52 AK + 206.61	0.21	28	P<0.0001	P<0.0140
TX	K = 447.77 AK + 1669.65	0.27	40	P<0.0218	P<0.0006

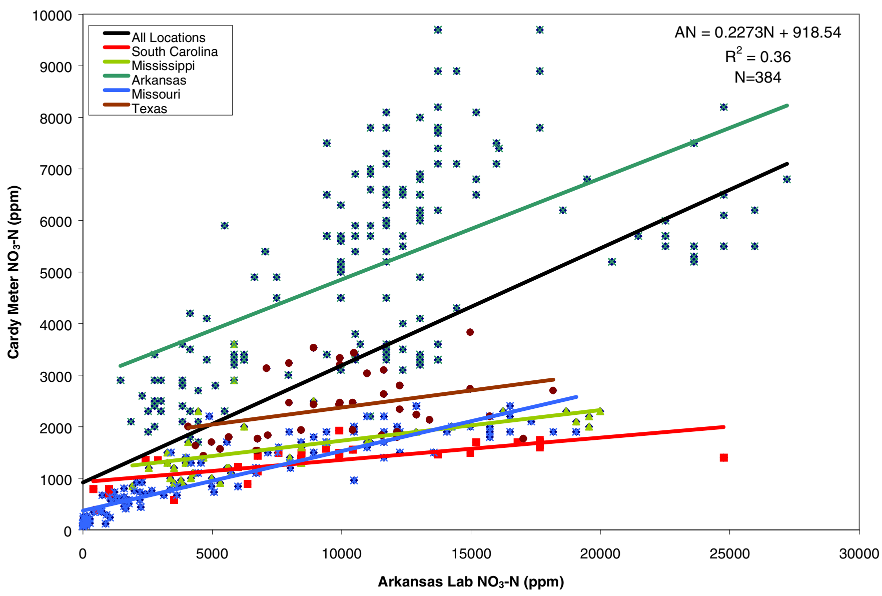

Figure 1. Linear regressions for each location and across locations for Cardy meter NO_3-N (ppm) vs. Arkansas Lab NO_3-N (ppm).

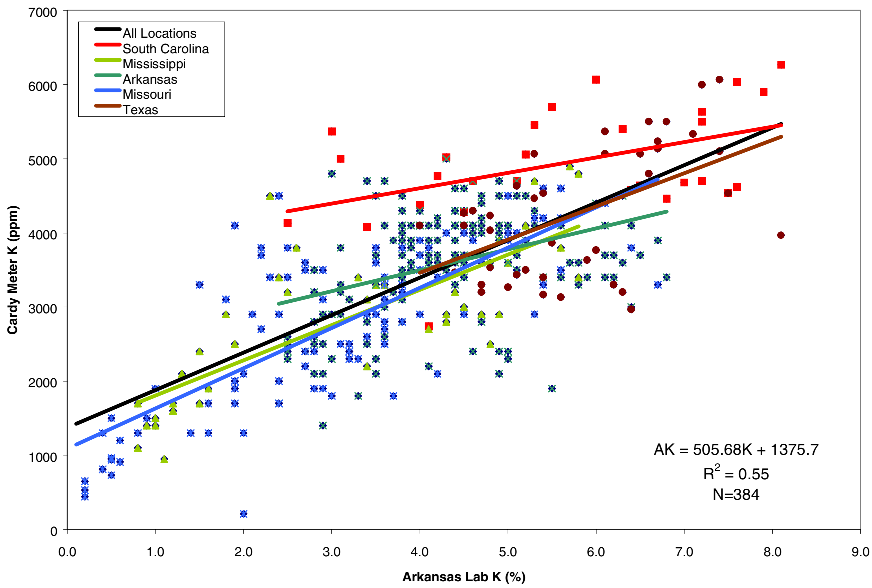

Figure 2. Linear regressions for each location and across locations for Cardy meter K (ppm) vs. Arkansas Lab K (%).