2004 BELTWIDE COTTON CONFERENCES, SAN ANTONIO, TX – JANUARY 5-9

# EVALUATING CORON® BASED NUTRITIONAL SYSTEMS FOR COTTON PRODUCTION

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## Introduction

Nutrient management plans (NMP) continue to be discussed at many levels within state and federal agencies. Row crop producers will soon be mandated to implement NMPs on their farms. Some states already have implemented NMP for producers in certain watersheds. The cost of implementation of a NMP plus the increased cost of cotton (*Gossypium hirsutum* L.) production due to increased costs of inputs, especially nitrogen (N), necessitates efficient nutrient management for production. To stay profitable cotton producers may need to change from the traditional soil fertility program to an integrated system consisting of soil and foliar applied nutrients.

Producers and researchers have questioned increased cotton yields from supplemental foliar fertilization of N and K. This skepticism is justified since yield responses in certain areas have been either non-existent or very small. Several factors may be listed that may restrict yields from foliar applications. These factors include, source of foliar materials applied, poor growth conditions following application, late application timing (several weeks after flowering), the deficiency of plant N or K levels were not determined, and/or a deficiency of other nutrients. Howard et al. (1998) showed a yield response to foliar applying K to no-till with no response to foliar N on a low extractable K soil. In other research, Howard et al. (1997) reported a yield increase to foliar N when K was not a yield-limiting factor. Oosterhuis (1999) reported that although foliar N and/or K have been widely used to supplement soil applied fertilizer in cotton the major disadvantage is relative to the physical properties rather than the ineffectiveness of the foliar fertilizer product. Kenty et al. (2002) showed higher lint yields from foliar applying N and K on certain locations relative to only foliar N.

Nutrient monitoring paired with plant mapping allows producers and crop advisors to make sound decisions regarding the nutrient status and subsequent yield potential of the crop. The ability to monitor nitrogen (N) and potassium (K) levels throughout the growing season allows deficiencies to be detected and corrected, improving the possibility of achieving optimal yields. Petiole analysis is available to the producer through university and independent labs as a tool to monitor crop nutrient levels during the growing season. A common problem of traditional lab analysis is the time lag between submitting the materials to the lab and receiving the results which in many instances may have a negative impact on yield potential. Kenty et al (2003) determined the Cardy portable electrode-based $NO_3$-N and K ion meters (Horiba, Ltd., Kyoto, Japan) were an effective tool for producers and crop advisors to quickly evaluate crop N and K levels relative to growing conditions.

The objectives of this study were to evaluate the impact of HM9754 (an organic acid) and CoRoN (10-0-10, 0.5% B) on cotton production when fertilized at two N rates for cotton produced throughout the cotton belt.

## Materials and Methods

Field investigations were conducted at selected locations throughout the cotton belt states in 2003, with more than one location in certain states. States, and site number (number in parenthesis) were North Carolina, South Carolina, Georgia, Alabama, Mississippi, Louisiana, Tennessee, Arkansas (2), Missouri, Texas, Oklahoma, and California. The research was conducted in cooperation with University personal and private consultants.

The experimental design was a randomized complete block with treatments replicated four to six times. Row lengths ranged from 30 feet (small plots) to 300 feet (producer fields) with a minimum width of four rows. Treatments included two soil N rates; the recommended rate for the area and 2/3 the recommended rate; HM9754, a soil applied organic acid; and CoRoN 10-0-10 0.5% B. The treatment combinations are presented in Table 1. All treatments received a blanket application of foliar B at pinhead by applying CoRoN 12-0-0 5% B @ 1qt/acre. Ele-Max Phos-Cal (foliar P and Ca) was applied at mid-bloom at 2 qt/acre as a blanket application to all treatments.

Foliar treatments were to be applied in 10 gal/A water providing adequate coverage with the material remaining on the plant. Nozzles were oriented over the row and foliar materials applied at a pressure of 20 to 40 psi.

Soil P and K applications were determined by soil test. These nutrients were applied prior to or at planting. The soil N treatments were applied at planting or as a side-dress in accordance with local practices. Recommended fungicides and insecticides for cotton production applied when needed.

The Cardy nutrient meter was used to evaluate petiole N and K levels. Analysis was initiated prior to first bloom and continued on a seven-day interval until plant cutout. Approximately 30 petioles were collected from the top-most mature leaf, generally the third or forth leaf from the top. Leaves were detached and the petioles cut into ¼ to ½ inch lengths placed in a garlic press with the sap either squeezed into a beaker or onto the N and K Cardy Meters. The recorded values were an average of several readings. These data were collected to evaluate plant N and K concentrations as a function of days after emergence (DAE). Subsequent to the first application of CoRoN 10-0-10 0.5%B at first bloom, additional applications @ 1gal/A were applied when the meter readings were lower than the critical level. The 2003 critical N and K levels were established from correlations conducted in 2001 and 2002 of N and K Cardy meter readings and determinations by the Arkansas soil test lab in Marianna (Kenty et al., 2003).

Statistical analyses of treatment effect on yields was conducted utilizing SAS Mixed Model procedure (SAS Ins., 1997). The Mixed Model procedure provides Type III F values but does not provide mean square values for each element within the analysis or the error terms. Mean separation was accomplished through a series of protected pair-wise contrasts among all treatments (Saxton, 1998). Regression analyses of the Cardy meter N analysis as a function of days after emergence (DAE) were evaluated using SAS.

Treatment yields were averaged across replications for each location and treated as a replication for the statistical analyses. Two yield analyses was conducted, the first to evaluate lint yields from each location and the second to evaluated relative yields to normalize data due to weather, soil, or cultivar variations. Relative yields were calculated as a percent based on the highest treatment mean for each location.

## Results and Discussion

The ANOVA data reported in Table 2 shows a highly significant effect of treatment on both yields and relative yields of cotton produced on the 13 locations. Previous ANOVA analyses of the yield data that was not averaged across the replications indicated that there was not a significant interaction, P = 0.05, between location and treatment indicating that the yield effects were consistent across locations (data not presented).

### Yields

Yield data reported in Table 3 indicates treatment differences for the 13 locations. Applying the recommended N rate resulted in yields (1267 lbs) significantly higher than applying the 2/3 N rate (1222 lbs). Yield differences due to applying the recommended N rate and 2/3 N rate have been reported by Kenty et al (2003b). The recommended N rate at each of the 13 locations was not consistent but varied with the rate varying upwards from 80 lbs N/acre. In some instances, data from each state (not reported), there were no yield differences between the recommended and 2/3 recommended rate indicating the possibility that growing conditions may have limited the response or that the recommended rate for that area may be too high.

There is no significant difference in the organic acid and CoRoN treatments either applied separately or as a combination when applied to cotton fertilized at the recommended N rate plots, treatments 1, 2, 3, and 4. Likewise, there is no significant difference in these same treatments when the N rate was reduced to 2/3 the recommended rate, treatments 5, 6, 7, and 8. Applying the organic acid (HM9754, treatment 2) to the full N rate did not significantly increase yields but the average mean increase was 26 lbs. Applying the combination of the organic acid and CoRoN 10-0-10 0.5%B to the full N rate did not significantly increase yield above the full N rate yield but the average mean increase was 23 lbs which is similar to that for treatment 2. Based on this observation applying the 10-0-10 did not have a positive affect on yields produced at the recommended N rate.

However this was not observed for the cotton fertilized with the 2/3 N rate. Again there is no significant difference in the yields for the four treatments receiving the 2/3 N rate. The average mean yield for applying the organic acid at the 2/3 N rate was 15 lbs higher than the 2/3 N rate mean yield. The average mean yield for applying the CoRoN 10-0-10 0.5%B was 16 lbs higher than mean yield for the 2/3 N rate. However, the average mean yield for applying the combination of the organic acid and CoRoN 10-0-10 0.5%B was 34 lbs higher than the 2/3 N rate. This suggests that the individual effects of the two treatments, HM9754 and the CoRoN 10-0-10 0.5%B, were both effective in increasing the average mean yield whereas this was not observed when the full N rate was applied. In fact, the yield resulting from the 2/3 N rate plus the organic acid and the CoRoN 10-0-10 0.5%B was not significantly different from any yields produced by applying the full N rate.

The relative yield data shows the same effect of the treatments indicating that variations due to climatic and soil conditions were not as great as has been observed in other years (Thomas et al, 2002; Kenty et al, 2003b).

### Petiole N and K Concentrations

The petiole N concentrations of treatments 4 and 8 as a function of time (DAE) indicates petiole N to decrease between flowering and cutout (Figure 1). As expected treatment 4 (the recommended N rate) petiole N concentrations were higher relative to treatment 8 (2/3 recommended N rate) the first 75 DAE after which the N concentration of treatment 8 surpassed and remained above treatment 4 until cutout. The higher initial petiole N level would be expected since treatment 4 had 1/3 higher N rate applied at planting but the petiole N concentrations of the two being similar was not expected. The fit of the regressed equation with the N concentrations for the locations varied considerably as indicated by the low $R^2$ values, 0.0714 and 0.1194, for the two respective treatments. This variation may be attributed to several physical factors including weather, soil differences, ambient temperatures, etc. during the growing season.

Petiole K concentrations for the two treatments (4 and 8) as a function of time show a reverse relationship to the N levels in that they increased over time (Figure1). However, unlike the N levels the petiole K concentrations of treatment 8 tended to be higher throughout the 80 days between 50 - 130 DAE. This difference appears to be greater later in the growing season. As with the N concentrations the K concentration $R^2$ values for treatments 4 and 8, 0.0041 and 0.0114, respectively, varying considerably between locations.

These data points out that N and K petioles of the two treatments were sufficient to provide comparable yields even though the initial N application to treatment 4 was 1/3 higher than that of treatment 8.

### Simple Economics

Simple economic calculations for $0.70 cotton plus the 2003 average cost of HM9754 and two applications of CoRoN 10-0-10, 0.5B indicate that return to the producer for treatment 8 is a profitable situation. However, these calculations do not consider the cost of the N nor application costs which in some instances may be applied in conjunction with other crop treatments. These calculations indicate that treatment 5 would return $855.40/A (0.70 * 1222) while treatments 6, 7and 8 would return \$859.90 \$858.70, and \$864.30, respectively. These data are further indication that the profitability of cotton production can be maintained while applying reduced N levels conforming to NMP systems.

## Conclusions

With the implementation of a NMP program, cotton producers may have to reduce nutrient application rates at planting, particularly N, in order to minimize the effects on the environment. These data suggest an alternative program for maintaining high cotton yields at a significantly reduced N rate. Cotton yields were maintained when the initial recommended N rates were reduced by 1/3 utilizing HM9754, an organic acid, plus CoRoN 10-0-10 0.5% B.

The petiole N and K data showed N and K concentrations for the treatments 4 and 8 to be similar with small variations during the growing season. The simple economic data indicates profitability of producing cotton using this proposed program remained relatively high.

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Table 1. Treatment description, rates, and application timings.

| Trt. No. | Treatment Name | Rate | Grow Stage |
|---|---|---|---|
| 1 | Recommended soil (NPK) | Recommended[1] | Preplant |
| 2 | Recommended soil (NPK) + HM9754 | Recommended + 1 gal/A | Preplant |
| 3 | Recommended soil (NPK) | Recommended | Preplant |
| | CoRoN 10-0-10 0.5% B | 1 gal/A | First Bloom |
| | fb CoRoN 10-0-10 0.5% B | 1 gal/A | Post Bloom[2] |
| 4 | Recommended soil (NPK) + HM9754 | Recommended + 1 gal/A | Preplant |
| | CoRoN 10-0-10 0.5% B | 1 gal/A | First Bloom |
| | fb CoRoN 10-0-10 0.5% B | 1 gal/A | Post Bloom |
| 5 | 2/3 Recommended soil (NPK) | 2/3 Recommended | Preplant |
| 6 | 2/3 Recommended soil (NPK) + HM9754 | 2/3 Recommended + 1 gal/A | Preplant |
| 7 | 2/3 Recommended soil (NPK) | 2/3 Recommended | Preplant |
| | CoRoN 10-0-10 0.5% B | 1 gal/A | First Bloom |
| | fb CoRoN 10-0-10 0.5% B | 1 gal/A | Post Bloom |
| 8 | 2/3 Recommended soil (NPK) + HM9754 | 2/3 Recommended + 1 gal/A | Preplant |
| | CoRoN 10-0-10 0.5% B | 1 gal/A | First Bloom |
| | fb CoRoN 10-0-10 0.5% B | 1 gal/A | Post Bloom |

1. Recommended rate determined by soil analysis and subsequent recommendation for yield goal.
2. Post Bloom applications triggered in response to Cardy Meter readings as compared to critical levels.

Table 2. ANOVA of yield and relative yield as affected by treatments[1] when averaged for each location.

| | | Yield | | Relative Yield | |
|---|---|---|---|---|---|
| Source | df | "F" | Pr > F | "F" | Pr > F |
| Treatment | 7 | 2.76 | 0.0124 | 3.14 | 0.005 |
| Error | 84 | | | | |

[1] Treatments means were averaged and used as replications in this analysis.

Table 3. Treatment effects on both yields and relative yields averaged across each location.

| Treatments | Yields[1] | Relative Yields |
|---|---|---|
| 1 | 1267 ab [2] | 0.955 ab |
| 2 | 1293 a | 0.972 a |
| 3 | 1278 ab | 0.959 ab |
| 4 | 1290 a | 0.970 a |
| 5 | 1222 c | 0.917 c |
| 6 | 1237 bc | 0.927 bc |
| 7 | 1238 bc | 0.931 bc |
| 8 | 1256 abc | 0.943 abc |

1. Reps were not used in this analysis. The reps were locations.
2. Means within the same year, followed by the same letter are not significantly different at P= 0.05.

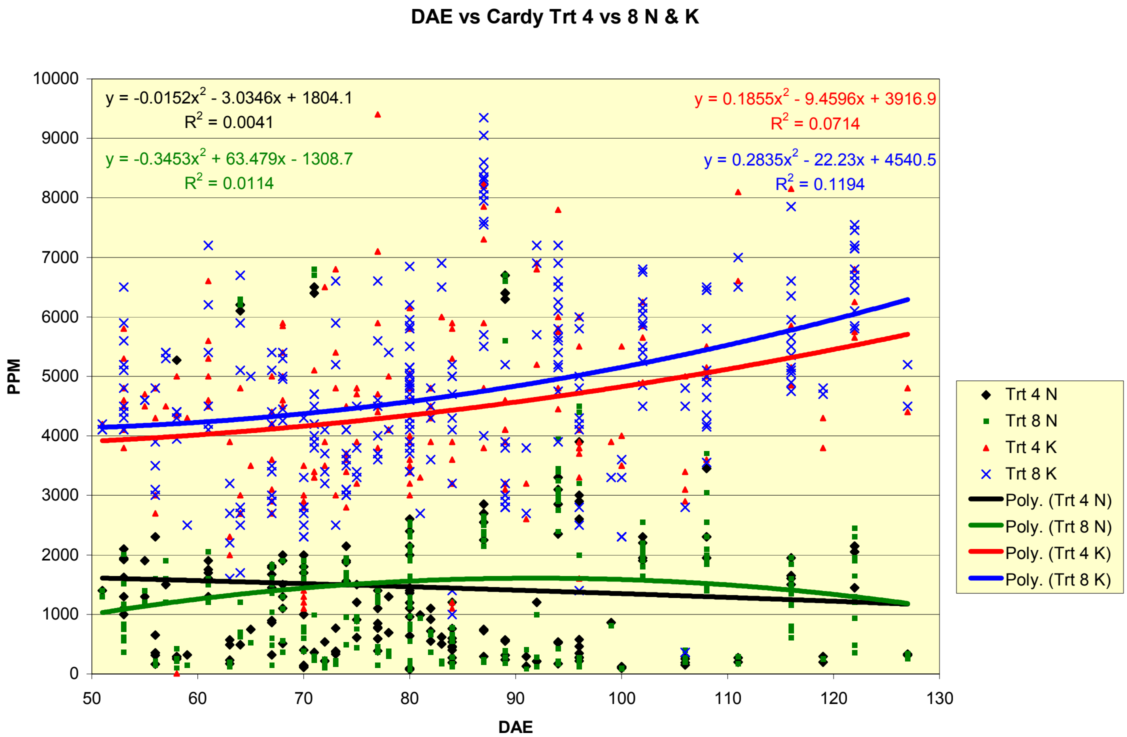


Figure 1. Regression for treatments 4 and 8 across locations for Cardy meter $NO_3$-N (ppm) and Cardy meter K (ppm) vs. days after emergence (DAE).