**BACKGROUND INFORMATION AND RESEARCH PROBLEM**

Nitrogen recovery efficiency (NCE) by cotton (*Gossypium hirsutum*, L.) has been shown to vary from 12% to 30% in furrow-irrigated systems (Bronson, 2008; Constable and Rochester, 1988). Failure of a crop to recover and utilize the majority of the applied nitrogen (N) has far reaching financial and environmental implications. Fertilizer input costs have steadily risen with time; annual average fertilizer costs nearly tripled in the period from 2002 to 2012 alone (USDA-ERS, 2012). Environmental repercussions from over-application of N range from accumulation of nitrates in the subsoil to groundwater pollution (Boquet and Brietenbeck, 2000). Although less than optimal N rates reduce the amount of nitrates in the subsoil (McConnell et al., 1993), insufficient N can drastically reduce yields (Bondada and Oosterhuis, 2001; Wadleigh, 1944) and therefore result in poor stewardship through inefficient utilization of other applied inputs.

One of the most common fertilizers used on cotton in the Mississippi Delta is 32% UAN, which is a mixture of urea and ammonium nitrate. The N in this fertilizer is susceptible to volatilization, leaching, and denitrification. As a result, N fertilizer is recommended by the University of Arkansas Cooperative Extension Service to be applied in a split application to reduce N loss and increase NCE (Barber and McClelland, 2012). Another method which has been shown to increase NCE, and therefore increase yields at lower applied N rates, is the utilization of fertilizers which contain calcium (Ca; Ron and Loewy, 2007; Gately, 1994). Research has indicated that the addition of soluble Ca can increase ammonium uptake (Taylor et al., 1985) and reduce ammonia losses (Fenn et al., 1981; Witter and Kirchmann, 1989). Some studies have also shown synergistic effects when Ca and urea were used in combination (Horst et al., 1985). As a result of these studies and others, YaraLiva (Yara North America Inc, Tampa, Fla.) has developed a new liquid N fertilizer containing Ca. This product, UCAN-23, contains a total N concentration of 23% N, with 8% in the form of nitrate, 5% in the form of ammonium, and 10% in the form of urea. The fertilizer also contains 4% Ca. The main objective of this research was to examine the response of cotton to UCAN 23 in contrast to the commonly used UAN 32.

**PROCEDURES**

A randomized complete block trial consisting of five replications was designed and conducted at two locations in the 2012 growing season. The trial at the Lon Mann Cotton Research Center in Marianna, Ark., consisted of 4-row plots 50 ft in length. The trial at the Arkansas Agricultural Research and Extension Center in Fayetteville, Ark., consisted of 4-row plots 20 ft in length on 36-in. wide rows. Soil samples were taken in early February for the Marianna and the Fayetteville sites and sent to the Soil Testing and Research Laboratory at Marianna for analysis.

Stoneville 4288 B2RF cotton was planted at a seeding rate of 3.5 seeds/ft on 18 May and 14 May for the Fayetteville and Marianna sites, respectively. Treatments consisted of a 0 lb applied N/acre (control) and rates of 50, 75, and 100 lb N/acre from the N sources UCAN 23 and UAN 32. Fertilizer N applications were surface dribbled within 6 in. of the row and applied in split applications, with 12 lb N/acre applied after emergence and the remaining (38, 63, or 88 lb N/acre) split treatment applied during the second week of squaring. All other inputs were managed to assure that N was the only yield-limiting factor. After defoliation, 39.5 in. of row were hand-picked from the Marianna plots to determine boll number and ginned through a micro-gin to determine lint percentage. After hand-picking, a mechanical picker with a weigh cell harvested the center two rows of each four-row plot to determine seedcotton yield. At the Fayetteville site, 79 in. of row were hand harvested to determine boll number and after ginning with a micro-gin, lint weight and lint percentage were determined.

Statistical analysis tested fertilizer N rate (0, 50, 75, and 100 lb N/acre), N source (UCAN 23 and UAN 32), and the interaction between fertilizer N rate and source on the response variables of lint yield, boll number, and boll weight. Linear and quadratic yield and boll number responses for fertilizer N rate were tested and evaluated at a significance level of $P \leq 0.10$.

**RESULTS AND DISCUSSION**

Soil test reports from both sites indicated sufficient soil Ca concentrations (Table 1) and recommended an N rate for cotton of 90 lb N/acre. Visible differences between the check
and treated plots were evident soon after the application of the second split application in Fayetteville. Unfortunately, the Fayetteville trial received severe hail damage within 2 weeks of the second application, from which the crop never fully recovered. Still, the response of lint yield and boll number to fertilizer N rate was significant at the $P \leq 0.10$ and $P \leq 0.05$ levels, respectively. Both significant response variables increased positively and linearly as fertilizer N rate increased (Fig. 1). Source of N did not significantly affect yield. The hail damage at the Fayetteville location prevented the establishment of strong N stress, as yield potential was destroyed.

Visible differences between the control and N-treated plots were also evident at the Marianna site soon after the second N (split) application was made, however a significant rainfall event did not occur to move the fertilizer down the profile from the top of the bed. As a result, the stained fertilizer band was visible on the bed late into the boll-fill stage. Still, the quadratic response of lint yield to fertilizer N rate was significant ($P \leq 0.10$) suggesting the optimal N rate was reached and exceeded by the 100 lb N/acre rate. The agronomically optimal fertilizer N rate appeared to be near 75 lb N/acre. As in the Fayetteville trial, boll number was also significantly increased by increased fertilizer N rate ($P \leq 0.05$), but average boll weight was not significantly affected (not shown). This is most likely due to the ability of the cotton plant to shed bolls which it cannot adequately fill. Failure of increased N fertilizer rate to significantly increase average boll weight has also been noted in prior studies (Bondada and Oosterhuis, 2001). Also, the source of fertilizer N did not have a significant impact on seedcotton yield at the Marianna site. Failure of N source to affect yield parameters may in part be due to high concentrations of Ca already present in the soil. According to the University of Arkansas Cooperative Extension Service, Ca deficiencies are not commonly observed in soils above 400 ppm or in soils where the pH is maintained in the recommended range (Espinoza et al., 2012).

**PRACTICAL APPLICATIONS**

Lint yield response to fertilizer N at the Marianna site supports results of previous research which suggest excessive N applications can negatively impact yield. Although significant differences were not noted between cotton receiving UAN 32 and UCAN 23 at either tested site, Ca concentrations and soil pH at both sites were within the sufficient range for optimal cotton production. More research must be conducted to determine if UCAN 23 has a positive effect on cotton yield in fields that possess insufficient soil Ca concentrations or low soil pH.

**LITERATURE CITED**


Table 1. Soil-test results from samples taken from two trials in early February 2012. The results for the Marianna site represent the value of one composite soil sample. The results for the Fayetteville site represent the range from four composite samples.

<table>
<thead>
<tr>
<th>Location</th>
<th>Calcium content of soil</th>
<th>Estimated base saturation</th>
<th>pH (1:2 soil-water)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marianna, Ark.</td>
<td>967</td>
<td>52.1</td>
<td>7.1</td>
</tr>
<tr>
<td>Fayetteville, Ark.</td>
<td>1010-1121</td>
<td>59.6-62.1</td>
<td>6.7-6.9</td>
</tr>
</tbody>
</table>

Fig. 1. Response of boll number and lint yield to fertilizer N rate during the 2012 growing season.