SUMMARY OF CoRoN™ STUDIES IN ARKANSAS

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Abstract

Evidence has shown that soil fertilization cannot always meet cotton's high demand for nitrogen and supplementation with foliar fertilizer has become a widespread practice. However, yield responses to foliar-applied nitrogen have not always been consistent. CoRoN™, a slow release nitrogen fertilizer, has been proposed as a potentially superior alternative method of foliar feeding with nitrogen. The value of CoRoN™ for enhancing growth and yield of cotton was evaluated in a seven-year field study in Arkansas. Foliar application of CoRoN™ to field-grown cotton resulted in significant (P=0.05) yield increases in 2 out of 7 years, with an overall average increase of 44 kg lint ha^{-1} compared to the control. Compared to foliar-applied urea, CoRoN™ increased yields an average of 14 kg lint/ha but this was not statistically significant. Furthermore, CoRoN™ caused a significant increase in boll weight in 1 out of 5 years with no significant effect on boll number. The effect of CoRoN™ on petiole nitrate concentrations was inconsistent. Foliar application of CoRoN™ caused no significant phytotoxicity up to 22.4 kg N ha^{-1} (20 lb. N $acre^{-1}$), in contrast to foliar-applied urea which caused significant leaf burn at 11.2 kg N ha^{-1} (10 lb. N $acre^{-1}$). From this work it can be concluded that the effect of foliar-applied CoRoN™ on yield was not significantly different from urea. CoRoN™ had an advantage of not causing any significant foliar burn. These studies indicate that as a foliar nitrogen fertilizer CoRoN™ does not consistently improve cotton yield.

Introduction

Nitrogen (N) is used in large quantities throughout the life cycle of the cotton plant (Bassett *et al.,* 1970), but difficulties arise in maintaining an adequate balanced supply during critical periods for optimum yield. Traditionally, N has been supplied as a preplant and sidedress application, and most recently foliar applications have been introduced. While soil applications are the preferred method, conditions arise that call for the use of foliar fertilizers. Conditions favoring foliar feeding include: root growth problems, nematodes, poor soil conditions, etc. Advantages of foliar application methods include: rapid and efficient response to plant needs, less product needed and independence of soil conditions. While foliar feeding in cotton has gained wide acceptance across the Cotton Belt, recent research has identified some shortcomings. The response to foliar N fertilization has been shown to decrease three weeks after first flower (FF) (Keisling *et al.,* 1995). This lack of response is partly due to increased canopy leaf age and wax content of the cotton leaf (Bondada *et al.,* 1997). A possible solution to this dilemma is to use a controlled release nitrogen (CRN) source that is released slowly to the plant for successful absorption into the leaf.

CoRoN™ is a controlled release N (CRN) liquid fertilizer that contains 40% CRN and 60% foliar urea (White *et al.,* 1995), in a unique combination of polymethylene urea coupled with fast release low biuret urea. This combination provides a foliar fertilizer that can be used as a nitrogen source for increased leaf absorption and improved yield. CoRoN™ can be applied at higher rates than conventional foliar N fertilizers without concern for leaf burn. This product should alleviate problems of volatilization and lack of response to late season foliar N applications.

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The overall objective of these studies was to evaluate the benefits of CoRoN™ as a potential foliar fertilizer to enhance cotton yields. Specific objectives were:

- To investigate the effect of foliar-applied CoRoN™ on yield and components of yield.
- To determine the effect of foliar-applied CoRoN™ on petiole nitrate concentration.
- To compare the phytotoxicity of foliar-applied CoRoN™ with foliar-applied urea.

Materials and Methods

Replicated field plot research was conducted from 1993 to 2000 in Arkansas. Experiments were arranged in a randomized complete block design. Management of fertilizer, irrigation, weed control, and insect control inputs were according to state extension recommendations. Standardized foliar applications of CoRoN™ and urea were applied at two and four weeks after FF, except in 1998 where applications were at four and seven weeks after FF and in 2000 at two, four and six weeks after FF. CoRoN™ and urea were applied at a rate of 11.2 kg N ha^{-1} (10 lb. N $acre^{-1}$) per application, except in 1998, where both foliar fertilizers were applied at 11.2 (10 lb. N $acre^{-1}$), 16.8 (15 lb. N $acre^{-1}$), 22.4 (20 lb. N $acre^{-1}$) and 28.1 kg N ha^{-1} (25 lb. N $acre^{-1}$) to evaluate the phytotoxicity. In 1999, CoRoN™ and urea were applied at 5.6 and 5.2 kg N ha^{-1} (5.0 and 4.6 lb. N $acre^{-1}$) respectively. In 2000, CoRoN™ and urea were applied at 2.8 and 2.6 kg N ha^{-1} (2.5 and 2.3 lb. N $acre^{-1}$) respectively. Specific details of experimental procedures are presented in Table 1.

Foliar applications were made with a CO_2 backpack sprayer calibrated to deliver 93.5 L solution ha^{-1}. Measurements were taken to record petiole nitrogen content, phytotoxicity, boll weight, boll number, yield and quality. The two-middle rows of each plot were machine harvested when more than 60% of bolls were open. Furrow irrigation was applied as needed, except in 1999 where the field trial was grown under dryland conditions.

Results and Discussion

Foliar Burn

In general, no visual symptoms of leaf burn were observed in the CoRoN™ treated plots. The urea treated plants showed mild signs of leaf burn with a highest rating of 2 by the fourth day after the first application (data not shown). None of the plants in any of the treatments showed any sign of foliar burn after the second foliar application (data not shown). In 1998, cotton plants treated with a single CoRoN™ application showed no significant visual symptoms of foliar burn (i.e. <5%) when up to as much as 22.4 kg N ha^{-1} (20 lb. N $acre^{-1}$) was applied as a foliar spray (Fig. 1). In contrast, the urea treated plants showed significant leaf burn at 11.2 kg N ha^{-1} (10 lb. N $acre^{-1}$) (i.e. about 28%) and the phytotoxicity increased with increasing N rates with over 65% leaf burn at 28.1 kg N ha^{-1} (25 lb. N $acre^{-1}$) (Fig. 1). In 2000, leaf burn after the first two applications was very low, with no significant differences between treatment (P=0.05). After the third application, there was increased (7%) leaf burn on plots treated with urea (Fig. 2). Leaf burn reduces photosynthetic rates and membrane integrity of the leaf tissue, thereby reducing yields.

Petiole Analysis
CoRoN™ caused a non-significant and inconsistent increase in petiole nitrate concentration. In all the studies carried out from 1993 to 1996, nitrogen content in the petioles was not significantly different (P=0.05) between CoRoN™ and urea treatment, each used alone (data not shown).

Average Boll Weight and Boll Number
In 1994, the plants treated with CoRoN™ had a significant larger boll size (5.6 g), compared to urea-treated plants (4.9 g) and untreated control plants (4.7 g) (Table 2). In 1995, 1996, and 1999 there were no significant differences among treatments in boll weight (Table 2). The number of bolls per square meter was unaffected by foliar-applied CoRoN™ or urea (Table 3). In 2000, the untreated control had fewer bolls per square meter, but these bolls were larger (Tables 2,3).

Lint Yield
In 1993, the lint yield for CoRoN™ treated plants was 31 and 139 kg ha^{-1} higher than the urea treated and the control respectively (Table 4). In 1994, the lint yield for CoRoN™ treated plants was 58 and 116 kg ha^{-1} higher than the urea treated and the control respectively (Table 4). However, during the subsequent five years of the study, no significant differences among treatments were evident (Table 4). Averaged over the seven years of the study, CoRoN™ increased yields over the untreated control by 44 kg lint ha^{-1} and by about 14 kg lint ha^{-1} over the foliar urea treatment (Table 4).

Fiber Quality
No significant differences in fiber quality were observed among treatments for the two years, 1994 and 1995, that the data were recorded (data not shown).

Conclusions

- CoRoN™ increased lint yield significantly in 2 out of the 7 years of the study by an average of 44 kg/ha compared to the untreated control and 14 kg/ha compared to foliar-applied urea. CoRoN™ did not increase yields significantly compared to urea alone.
- CoRoN™ caused a slight increase in boll weight in 1 out of 5 years, but had no effect on boll number per plant.
- CoRoN™ had no significant affect on fiber quality.
- CoRoN™ had no consistent affect on petiole nitrate concentration.
- CoRoN™ resulted in significantly less foliar burn compared to urea when high rates (>11.2 kg N ha^{-1}) were used.

Literature Cited

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Table 1. Experiment details of seven years (1993-2000) of field research with CoRoN™ on cotton in Arkansas.

Experiment details	Year 1993	1994	1995	1996	1998	1999	2000
Location	Marianna	Fayetteville	Rohwer	Rohwer	Clarkedale	Clarkedale	Clarkedale
Soil type	calloway silt loam	captina silt loam	hebert silt loam	hebert silt loam	dundee silt loam	dundee silt loam	dundee silt loam
Cumulative rainfall (cm)[1]	34.8	39.4	32.3	35.1	44.7	40.9	38.4
Avg. monthly max. temp (ºC)[1]	30.8	27.9	29.9	31.3	31.7	31.0	31.3
Avg. monthly min. temp (ºC)[1]	17.7	16.2	18.9	19.2	18.7	17.2	18.1
Cultivar	DP 50	DP 20	DP 20	SG 125	SG 125	SG 125	SG 747
Planting date	13-May	16-May	11-May	6-May	6-May	11-May	12-May
Number of foliar applications	2[2], 4	2, 4	2, 4	2, 4	4, 7	2, 4	2, 4, 6
CoRoN™	10[3]	10	10	10	10, 15, 20, 25	5.0	2.5
Urea	10	10	10	------[4]	10, 15, 20, 25	4.6	2.3

[1]From 1 May through 30 September, [2]Weeks after first white flower, [3]Rate in lb. N acre^{-1} for ease of understanding, [4]Treatment not included.

Table 2. Effect of foliar-applied CoRoN™ or Urea on boll weight.

Year	Avg. boll weight (g) Control	CoRoN™	Urea	Sign.[1]
1994	4.76 b[2]	5.61 a	4.91 b	
1995	4.21	4.22	4.19	NS[3]
1996	5.01	5.02	------[4]	NS
1999	4.23	4.40	4.16	NS
2000	4.53	4.48	4.46	NS

[1]Significance (P=0.05), [2]Numbers followed by the same letter within a row are not significantly different (P=0.05), [3]NS = non significant, [4]Treatment not included.

Table 3. Effect of foliar-applied CoRoN™ or Urea on final boll number.

Year	Number of open bolls m^{-2} Control	CoRoN™	Urea	Sign.[1]
1993	131	152	138	NS[2]
1994	101	86	93	NS
1996	75	79	------[3]	NS
2000	84	85	89	NS

[1]Significance (P=0.05), [2]NS = non-significant, [3]Data not recorded.

Table 4. Effect of CoRoN™ and Urea on lint yield during the seven years (1993-2000) of field research in Arkansas.

Treatment	Lint yield 1993[1]	1994[1]	1995[1]	1996[1]	1998[2]	1999[1]	2000[3]
	--	----------	kg ha^{-1}	----------	------------------------------------		
Control	967	1124	1587	1481	773	754	1195
CoRoN™	1106	1240	1549	1426	820	843	1204
Urea	1068	1182	1572	------[4]	806	791	1259
$LSD_{(0.05)}$	52	91	NS[5]	NS	NS	NS	57

[1]Two foliar applications during flowering and boll development, [2]Two foliar applications during late boll development, [3]Three foliar applications during flowering and boll development, [4]Treatment not included, [5]NS = non-significant (P=0.05).

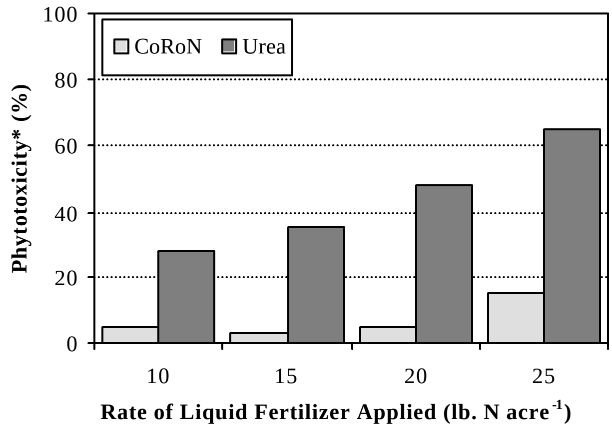

Figure 1. Phytotoxicity advantage of CoRoN™ versus Urea after a single foliar application. Clarkedale, Arkansas 1998. *Phytotoxicity expressed as the proportion of the leaf showing visual damage.

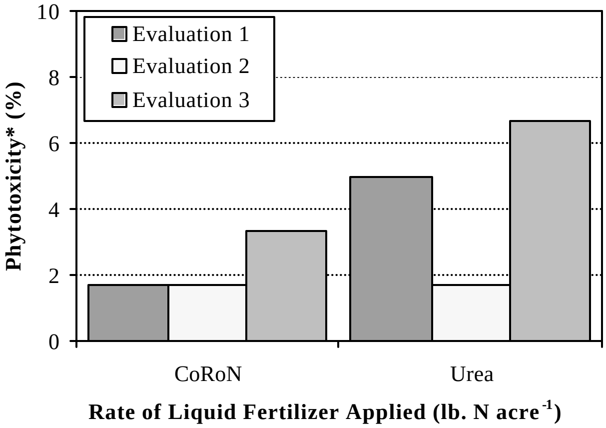

Figure 2. Phytotoxicity advantage of CoRoN™ versus Urea after each foliar application. Clarkedale, Arkansas 2000. *Phytotoxicity expressed as the proportion of the leaf showing visual damage.