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EFFECTS OF PLANT NUTRITION ON BLACK ROOT

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Abstract

Cotton in the poorly drained Atlantic Coastal Plain Flatwoods and in other poorly drained soils in Georgia is susceptible to black root (an abiotic disease, associated with soils containing high concentrations of Cl). Affected cotton has black roots, mottled leaves, and flowers with a protruding stigma that retains little pollen. When the disease is severe, little or no lint yield is obtained. Applications of broiler litter were effective in correction of the malady. Research at five field sites in 2001 indicated responses averaging 507 and 678 pounds of lint/acre for applications of 2 and 4 tons of litter/acre, respectively. Residual broiler litter from an application made to the previous crop also appeared to be effective. Neither high rates of N, P, K, nor applications of Cu, Zn, B, or Mo were effective.

Introduction

In areas of the flatwoods and other poorly drained soils planted to cotton, the disorder characterized by black roots has resulted in great economic losses as lint yield is always very low due to abscission of squares and hard-locked- and/or rotted- bolls. Since October 1998 we have collected data in cotton fields affected by black root that strongly suggests the disorder is associated with high levels of soil chlorides. Black roots also contain concentrations of chlorides that are 2 to 3 times greater than normal roots. Application of fertilizers with high chloride contents, principally muriate of potash, likely contribute to the problem. Our earlier studies of "Leaf Scorch" in soybean, occurring in the same flatwoods soils, implicated high soil chlorides as the causal factor. Fortunately, soybean chloride toxicity was found to be varietal dependent and the problem was alleviated by planting only varieties tolerant of high soil chlorides.

In 1999, we helped confirm our belief that high chlorides were involved in black root by developing the symptoms in cotton after applying high amounts of potassium and sodium chloride in the greenhouse. In two large field experiments in Appling and Berrien county flatwoods soils, we determined that none of the 48 varieties tested escaped black root symptoms, but there were large differences in lint yield, with some varieties producing only 60% of the top varieties. We also found that soil chloride concentrations varied greatly in the fields where we conducted our experiments. Those apparently natural variations had more effect on the lint yield than the muriate of potash (potassium chloride) rates that we applied. Analysis of the soil chloride data indicate that within the experiments lint yield was negatively related to the amounts of chlorides in the soil. In 1999, we also described leaf and flower symptoms associated with black root, roughly defined leaf and root critical levels, determined that the highest yielding varieties tested retained more of the chloride in their roots thereby preventing as much to be taken up to the above-ground portion of the plant. We also found black root problems in poorly drained soils outside of the flatwoods soil area.

In 2000, we made significant progress and identified a likely practical solution to the problem in our field research (Gascho et al., 2001) Two experiments were conducted at each of two flatwoods sites (Appling and Berrien counties) where black root had severe effects in 1996, 1997, 1998 and 1999. Severe symptoms were again found at the Berrien county site. Symptoms were less pronounced at the Appling site in both 1999 and 2000. One experiment at each site was to evaluate varieties that either did well or poorly in the 1999 experiment. The second experiment at each site included soil amendments that may alleviate chloride toxicity (the expected cause of black root from previous research). In the amendment study in Berrien County (where black root was severe) we found a significant response (600 lb lint/acre) and an alleviation of black root symptoms by application of 4 tons/acre of broiler litter/acre. A lesser response of about 165 lb lint/acre was attained by application of 2 tons broiler litter/acre. No variety completely escaped black root symptoms at the Berrien county site, but yield differences were recorded. Similar results were recorded at the Appling County site, but they were less striking, due to the lower incidence of black root and the poor growing conditions due to extreme drought in the summer at that location.

The objective of the research in 2001 was to more widely confirm the ability of broiler litter to alleviate black root, to determine if there is a residual effect from broiler litter applied in an earlier year, to determine if foliar Cu, Zn or B alleviate black root and to determine the reason for the response to broiler litter.

Procedures

Experiments were conducted in the greenhouse at Tifton and at five field locations in 2001.

Greenhouse

DeltaPine 33B was planted in pots containing 32 lb of soil from the black root check plots from Berrien county in 2000. The treatments included broiler litter rates of 0, 2, 4, and 6 ton/acre. Also included were treatments with applications of Cu and Zn, based on some low plant Cu and Zn analyses in the black root field plots in 2000. There were four replications (pots of 3 plants/pot) of each treatment. At maturity, bolls were counted, collected and weighed.

Field

Based on a history of black root and high chloride concentrations in the soil (Table 1), we, together with County Extension Directors, selected five sites for field experiments. All treatments (Table 2) were replicated four times. Individual plot size varied somewhat due to the size of the affected area at each location. The average plot size was 6 rows by 60 to 90 feet. Broiler litter and 10-10-10 treatments were applied 2 to 4 weeks prior to planting. Plant protection was provided as standard by the farmer. Foliar treatments were made at pinhead square. Plant height measurements and leaf and root analyses were made at full bloom (data not shown). A center row of each plot was harvested with a one-row picker in November.

Results and Discussion

Greenhouse

Broiler litter mixed with the Berrien county soil increased boll weight more than 2 fold (Table 3). The response was significant to the 4 ton/acre rate. Neither foliar Cu, Zn, B nor seed applied Mo had any effect on boll weight of cotton in the greenhouse.

Field

Lint yields at 5 locations followed similar trends to the data collected in the greenhouse (Table 4). Four tons of broiler litter significantly increased lint yield at all locations. The mean increase, above the zero litter rate was 678 lb/acre. Two tons of litter increased lint yield significantly at 4 of 5 locations. The mean increase to 2 tons of litter was 507 lb lint/acre. Regression of lint yields on boiler litter rate indicated that 95% of the yield attained at the 4 ton rate would be attained by application of 3 ton/acre. From an agronomic standpoint, broiler litter application is a good solution to the black root problem.

Data from the Kent location in Berrien county indicate that broiler litter applied in 2000 had a positive effect on the lint yield of cotton harvested in 2001 (Table 5). The 4 ton rate applied in 2000 significantly increase lint yield by 361 lb/acre. That increase was actually greater than the increase from application of 4 ton/acre in 2001 at the Kent location (Table 4). Additional data is needed to confirm the positive residual effect of litter for control of black root.

Data from the additional treatments at the Kent location also indicate that the black root problem is not solved by high applications of N, P, or K (Table 5). Applications of 700 or 1400 lb 10-10-10 failed to increase lint yield above that obtained by the control. Likewise, foliar B had no effect on lint yield.

Reference

Gascho, G. J., L. May, R. Bennett, B. Baldree, J. Clark, and F. Connelly. 2001. Determining the cause and developing practices to mange black root. p 120-125 *In* Culpepper, S. and C. Bednarz (ed). Cotton Research and Extension Report 2000. University of Georgia, Tifton, GA.

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Table 1. Chloride concentrations and total chlorides in soils to a depth of 36 inches.

		Chloride	
Farm	County	Mean ppm	Total lb/acre
Rentz	Appling	58	522
Altman	Appling	58	522
Williams	Jeff Davis	44	396
Taylor	Cook	72	648
Kent	Berrien	52	468

Table 2. Treatments in black root field experiments in 2001.

Locations	Treatments
All	Control (nothing)
	2 ton/acre broiler litter
	4 ton/acre broiler litter
	Foliar Cu
	Foliar Zn
Additional at Berrien	2 ton residual broiler litter, applied in 2000
	4 ton residual broiler litter, applied in 2000
	Foliar B
	700 lb/acre 10-10-10
	1400 lb/acre 10-10-10

Table 3. Boll weights as affected by broiler litter and foliar applications in greenhouse, 2001.

Treatment	Boll weight grams/pot
Control (nothing)	18 c
2 ton/acre broiler litter	32 b
4 ton/acre broiler litter	37 ab
6 ton/acre broiler litter	41 a
Foliar Cu	19 c
Foliar Zn	16 c
Foliar B	17 c
Mo	18 c

Table 4. Lint yields in field experiments as affected by broiler litter and foliar nutrients in 2001.

	Treatment				
Farm	Control	2 ton litter	4 ton litter	Cu	Zn
	----------lb lint/acre----------				
Rentz	481 b	1062 a	1236 a	537 b	438 b
Altman	722 cd	1257 b	1692 a	909 c	604 d
Williams	658 b	1096 a	1115 a	653 b	468 b
Taylor	0 b	838 a	972 a	247 b	165 b
Kent	595 b	738 ab	832 a	593 b	513 b
Mean	491	998	1169	588	438
Increase	---	507	678	97	---

Table 5. Lint yields as affected by residual broiler litter (applied in 2000), 10-10-10, and foliar B at the Berrien county location.

Treatment					
Control	**2 ton litter**	**4 ton litter**	**700 lb 10-10-10**	**1400lb 10-10-10**	**B**
	----------lb lint/acre----------				
595 b	701ab	956 a	531 bc	462 bc	363 c
Increase ---	106	361	---	---	---