PROGRESS IN ELIMINATING BLACK ROOT IN FLATWOODS SOILS

Gary J. Gascho and Benjamin H. Baldree
Dept. of Crop and Soil Sciences, University of Georgia, Tifton, GA

Introduction

Our previous reports (Gascho et al., 2001 and Gascho and Baldree, 2002 and 2003) indicate that applications of broiler litter are effective in increasing lint yield greatly in Black root affected soils, but inorganic fertilizer applications are not effective. Field research indicated that an application of 2 to 4 tons of broiler litter/acre is effective in maintaining yield for 2 years (crops). Field research also indicated that an application of well decomposed gin trash increased lint yield, but the increase was less than where broiler litter was applied. Increasing irrigation water salt and chloride concentrations decreased cotton growth and boll weight in the greenhouse. Broiler litter and leachate from broiler litter greatly increased growth, boll weight and boll count, while gin trash, broiler feed, and cow manure had some positive effects. Inorganic ammonium-N and nitrate-N did not diminish black root or affect growth or yield of cotton. The active ingredient in broiler litter was shown to be in the manure not in the pine shaving bedding material. It is in a water-soluble fraction of the litter and appears to have its origin in broiler feed.

The objectives of studies reported here were to elucidate the effective ingredient in litter, determine the length of time an application of broiler litter is effective, and to determine if a high rate of gin trash application is effective.

Materials and Methods

Experiments were conducted in fields affected by black root and in a greenhouse employing soil from a Taylor Farm field in Cook County that was greatly affected by black root from 2000 to 2002 (Gascho and Baldree, 2003). Data from all experiments were submitted to analysis of variance and means were separated by Fishers Protected LSD (p =0.05).

<u>Greenhouse experiments</u>

Greenhouse studies were conducted from October 2002 to September 2003. For all experiments we filled 2 gal. pots with 32 lb of soil from the control (no amendment) plots from the Taylor Farm (Table 1). We planted six DPL 555BR seeds in each plot and thinned the stand to three upon establishment. Twelve hours of light and at least 80^o F were maintained in all greenhouse experiments. All pots were fertilized on a biweekly schedule and the total fertilization, accomplished in 8 weeks, amounted to double the rate of the fertilizer recommended by soil test.

The objective of the first study was to determine if the effects of added broiler litter or broiler litter leachate were due to microbiological or chemical effects. We added autoclaved broiler litter and broiler litter leachate as well as litter and leachate that was not autoclaved.

The leachate added was from leaching a mass of broiler litter equivalent to 4 ton/acre. It was applied in 4 split applications in order to not over-water the pots. Bolls were counted, dried and weighed at harvest (Table 1).

In a meeting with several members of the SE Watershed Research Unit at Tifton, we decided that roxarsone, a water-soluble arsenical, commonly added to broiler feed to enhance broiler growth, may have some positive effects in alleviation of black root. In an initial experiment, with application rates judged to be similar to the concentrations obtained from a 4 ton/acre application of broiler litter, we found little effect in 2002. However, we again investigated for any benefits of roxarsone in 2003, using higher rates. The low rate in the experiment was equivalent to the amount present in 6 ton/acre broiler litter and the high rate equivalent to the amount in an application of 12 ton broiler litter/acre (Table 2). The roxarsone was dissolved in distilled water and applied just prior to planting. At harvest we counted the bolls in each pot (3 plants/pot) cut the plants at the soil level, dried them and obtained dry weight and N concentration.

In a third greenhouse experiment we included broiler litter at a 6 ton/acre equivalent rate two weeks prior to planting (Table 3). Roxarsone and "low uric" acid rate were at the 6 ton/acre equivalent broiler litter rate. The "high uric" treatment was uric acid applied at the 12 ton/acre broiler litter equivalent rate. Both the roxarsone and uric acid were dissolved in distilled water and split-applied in equal applications at 2, 4, 6, and 8 weeks following seeding. Plant weight, green boll counts and dry weights and open boll counts and dry weight were recorded at harvest in September 2003.

Field experiments

Small plot experiments were conducted at two locations in the flatwoods in 2003. Each had four replications and were fertilized with commercial inorganic fertilizers according to University of Georgia recommendations from soil tests. No broiler litter was applied to plots that received broiler litter in 2001 and 2002. Plots that had receives 6 ton of gin trash in 2002 received 10 ton in 2003. The control (no amendment) plots that never received broiler litter were maintained.

These low-lying areas received much rainfall in early months of 2003 in contrast to the previous years of black root studies. Planting was delayed into the month of June and growing conditions remained poor due to excess soil moisture throughout the growing season and into the harvest season. Harvest was made with a single-row picker in late December.

Results and Discussion

Greenhouse experiments

Black root greatly affected both growth and development of cotton in the first greenhouse experiment in 2003 (Table 1). No bolls developed when neither broiler litter nor its water-extracted leachate were applied. Application of leachate resulted in more bolls than application of the litter and an equal boll dry weight. This result emphasizes that the ingredient in broiler litter responsible for the alleviation of black root is water soluble. Autoclaving the litter or its leachate did not negate or decrease their effectiveness in promotion of boll count or weight (alleviating black root). Therefore we deduce that organisms in broiler litter are not responsible for the litter's ability to alleviate black root.

Table 1. Effect of broiler litter, its leachate, autoclaved broiler litter, and autoclaved leachate on cotton boll count and weight in the greenhouse using a flatwoods soil that supports black root.

Treatment	Boll count	Boll weight
	bolls/3 plants	dry boll weight/3 plants
None	0 c	0 c
Broiler litter	6 b	48 ab
Leachate	13 a	54 a
Autoclaved broiler litter	14 a	40 b
Autoclaved leachate	17 a	54 a

In a second greenhouse experiment the effect of roxarsone was inconclusive (Table 2). All plants had symptoms of black root, but a very limited number of bolls were produced for the low roxarsone treatment. That treatment also promoted reproductive development slightly as indicated by the lower concentration of N where it had been applied.

Table 2. Effects of Roxarsone on cotton plant dry weight, its N concentration and the number of squares produced in the greenhouse using a flatwoods soil that supports black root.

Treatment	Plant dry weight	Squares	Plant N concentration
	g/3 plants	no./3 plants	%
None	7.9 a	0 b	4.7 a
low Roxarsone	10.2 a	1.8 a	4.0 b
high Roxarsone	8.4 a	0 b	4.3 ab

A third greenhouse experiment was conducted in the summer of 2003 (Table 3). Quite mysteriously, little black root developed in the untreated pots. The only experimental difference from previous experiments was that we could not control the high temperature during the experiment. As in fields in 2003 black root was not a serious problem. Where no treatment was applied open boll counts and their weight were as great as for pots receiving broiler litter, roxarsone or uric acid. The high N nutrition provided by the "high uric" treatment resulted in dark green vegetative plants with unopened bolls. We could not deduce any value for either roxarsone or uric acid applications in this experiment.

Table 3. Effects of broiler litter, roxarsone, and uric acid on cotton plant and boll development in the greenhouse using a flatwoods soil that supports black root.

Treatment	Plant dry weight	Open boll		Green boll		Total bolls	
	g	No.	g dry wt.	No.	g dry wt.	No.	g dry wt.
None	21.7 c	7.0 a	27.2 a	0.6 d	0.4 b	7.6 a	27.6 ab
Roxarsone	34.4 c	6.7 a	25.2 a	1.6 c	4.5 b	8.3 a	29.7 ab
Broiler lit.	79.8 a	6.3 a	33.4 a	1.4 c	6.0 b	7.7 a	39.4 a
low uric	40.6 bc	6.0 a	23.8 a	3.0 b	7.2 b	9.0 a	31.0 ab
high uric	57.5 b	2.0 b	7.3 b	5.7 a	18.5 a	7.7 a	25.8 b

Field experiments

There was little evidence of black root in our experiments in 2003, even though black root losses were very high in previous years. Lint yields were low due to late planting and water logged conditions throughout most of the growing season and into the harvest season. At the Appling county site, lint yield was not affected by previous broiler litter applications or by the application of 10 ton/acre of gin trash in 2003. At the Jeff Davis county site, lint yield was increased slightly by only one previous application of broiler litter treatment. This was consistent with the fact that we did not receive a single report of black root problems from Extension or farmers during the year. Following 5 years of drought in the flatwoods, rainfall was excessive for cotton in 2003. The lack of black root in 2003 is consistent with our theory that black root results from an excess of chlorides in the rooting zone of cotton seedlings. During the wet spring of 2003 the chloride concentration of the soil water was decreased due to dilution and then later leached deeper into the soil profile.

Table 4. Lint yields in two field experiments as affected by residual broiler litter and by gin trash applications in 2003.

Application	Appling Co.	Jeff Davis Co.
	---------------------------- lb lint/acre	-----------------------------
None	435 a	228 b
2 ton broiler litter in 2001	379 a	478 a
4 ton broiler litter in 2001	369 a	372 ab
4 ton broiler litter in 2002	363 a	237 ab
10 ton gin trash in 2003	399 a	379 ab

References

Gascho, Gary, Lloyd May, Robert Bennett, Benjie Baldree, James Clark, and Forrest Connelly. 2001. Determining the cause and developing practices to manage black root. p. 120-129 in 2000 Georgia Cotton Research-Extension Reports. A. S. Culpepper and C. W. Bednarz (eds). University of Georgia College of Ag. and Environ. Sci., Athens, GA.

Gascho, Gary and Benjamin Baldree. 2002. Broiler litter, an agronomic fix for black root. p. 74-78 in 2001 Georgia Cotton Research-Extension Reports. C. W. Bednarz, A. Stanley Culpepper, and O. Lloyd May (eds). University of Georgia College of Ag. and Environ. Sci., Athens, GA.

Gascho, Gary J. and Benjamin H. Baldree. 2003. Progress in the control of black root. p. 99-106 in 2002 Georgia Cotton Research-Extension Reports. A. S. Culpepper, O. Lloyd May, and Phillip Jost (eds). University of Georgia College of Ag. and Environ. Sci., Athens, GA. Athens, GA.

Acknowledgments

The authors thank Cotton Incorporated for providing funding for providing financial support for this project through the Georgia Cotton Commission. We also thank James Rentz and Harold and Binky Williams for the use of their lands and for their cooperation in the field experiments, as well as, their respective County Extension Directors, James Clark and Timothy Varnadore. We also acknowledge the excellent analytical support provided by Cindy Roesel in our Soil and Plant Analyses Laboratory.