HERBICIDE SUSCEPTIBILITY IN ULTRA-LOW GOSSYPOL COTTON

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Abstract

Glandless cotton emerged as a means to make the seed of a cotton plant more valuable. Normally it contains the toxin Gossypol, and can only be used as a food source (for humans or livestock) in restricted quantities. The protein profile of the seeds makes them an ideal source of protein, but gossypol limits what it can be used for. Glandless cotton lack the glands that produce gossypol in the entire plant, while Ultra-low Gossypol lines lack gossypol in the seeds. The original Acala glandless varieties of cotton were susceptible to damage by the pre-emergent herbicide Caparol. We tested the susceptibility of new Ultra-low Gossypol lines to pre-emergent herbicides Caparol, Cotoran, Staple and Dual Magnum. Seeds from two new lines, a non-transformed line, the original Acala line, and a commercial variety were planted in 6" pots and sprayed with one of the pre-emergent herbicides or water. Caparol and Cotoran caused chlorosis in the Acala glandless variety. There were some signs of damage in all varieties at various stages of growth, but not all were significant. The Ultra-low Gossypol lines had equal susceptibility to damage from the tested pre-emergent herbicides as the commercial variety. Further research could include field testing of pre-emergent herbicide applications, and check for possible susceptibility to damage by insect pests.

Introduction

Cotton (Gossypium hirsutum) is primarily used for its qualities as a fiber crop with the seed as a less valuable co-product. Cottonseed protein profile makes it a desirable livestock feed source, especially for dairies. However, the use of cottonseed as a livestock feed and a human protein source is restricted due to a natural toxin called gossypol, which is found in the seed and throughout the plant. Gossypol free cottonseed varieties were developed in the 1950's with the intention of increasing the use of cottonseed for human consumption and additional livestock industries. Gossypol free cottonseed would be much more valuable and would increase the profitability of cotton production. However, to obtain gossypol free cottonseed, the entire plant was devoid of gossypol. The lack of gossypol in the vegetative portion of the plant increased its susceptibility to pests. An additional detrimental effect of gossypol free cottonseed was its increased sensitivity to the active ingredients in some commonly used pre-emergent herbicides, such as prometryn in the herbicide Caparol.

Recently, Dr. Rathore and colleagues at Texas A&M University have developed cotton plants that contain ultra-low gossypol (ULG) levels in the seed, but contain normal gossypol glands in the rest of the plant. With normal levels of gossypol present in the vegetative tissues, the ULG cotton should not have increased sensitivity to prometryn or other pre-emergent herbicides. However, the herbicide tolerance needs to be confirmed before the ULG technology can be integrated into commercial cotton varieties. To test the sensitivity of the plants to pre-emergent herbicides, a greenhouse study was conducted with ULG, the non-transgenic parent line, the glandless Acala cotton variety, and DP1133B2RF variety and four pre-emergent herbicides.

Materials and Methods

Two ultra-low gossypol cotton lines (Coker 312-49b and Coker 312- 81) were tested alongside the non-transgenic parent line (Coker 312), an Acala gossypol free glandless variety, and a commercially available variety (Delta Pine 1133B2RF). Three seeds were planted by hand in each 6" pot at a depth of 1.5 inches. The soil type was a Weswood silty clay loam with a pH of 7.8. The pots were separated into groups to be sprayed with the appropriate herbicide. A CO2 hand sprayer at 15 gpa with 8002 XR nozzles was used to spray each of the herbicides. Each cotton cultivar received one of five treatments, including Caparol (prometryn), Cotoran (fluometuron), Staple (pyrithiobac-sodium), Dual Magnum (s-metachlor), or water.

After being sprayed with the herbicides at recommended rates the pots were transferred to the Borlaug Greenhouse on Texas A&M campus (Fig. 1). Pots were and set up in a completely randomized design and were hand watered. Pots were watered on an as-needed basis to ensure adequate plant emergence and seedling growth. All pots were kept weed free for the entire length of the study.

Percent emergence was rated at 7 and 14 days after planting. Visual vigor of the cotton seedlings on a 1 to 5 scale, with 5 being this best vigor, was rated 7 and 14 days after emergence. At 28 days past emergence, a final percent injury rating was given, and the stems were clipped at the soil surface, dried for 5 days at 125o F, and dry matter weights were recorded. ANOVA was performed and means separation using LSD with P=0.05. Statistics were run using ARM version 8.

Fig. 1: Taking vigor ratings on the seedlings in the Borlaug Center Greenhouse

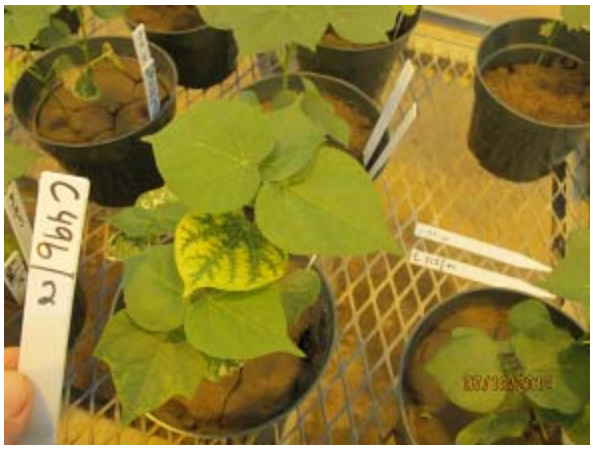

Fig. 2: Chlorosis on Coker 312 49b Plants Treated with Cotoran

Fig. 3: Healthy Dual Magnum treated Coker 312 and Coker 312 81 seedlings

Fig. 4: Herbicide damage on Coker 312 49b plants compared to the untreated

Table 1. Percent Seedling Stand of Multiple Cotton Lines Treated with Pre-emergent Herbicides

Seedling Stand										
	Acala Glandless		Coker 312 49b		Coker 312 81		Coker 312		DP 1133	
Herbicide	7DAE[1,2,3]	14DAE	7DAE	14DAE	7DAE	14DAE	7DAE	14DAE	7DAE	14DAE
Caparol 4.8 pt/a	93 a	93 a	87 a	93 a	86 a	80 a	93 a	80 a	53 a	53 a
Cotoran 3.2 pt/a	66 a	67 b	80 a	80 a	80 a	80 a	93 a	100 a	73 a	73 a
Staple 2.1 oz/a	80 a	87 a	83 a	83 a	87 a	93 a	83 a	83 a	50 a	50 a
Dual Magnum 1.33 pt/a	77 a	77 ab	80 a	80 a	80 a	80 a	87 a	67 a	73 a	73 a
UNTR	93 a	93 a	87 a	93 a	93 a	93 a	100 a	100 a	60 a	67 a

[1]Means followed by same letter do not significantly differ (P=.05, LSD)

[2]Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

[3]Days After Emergence

Table 2. Vigor Ratings of Multiple Cotton Lines at 7 and 14 Days After Emergence with Pre-emergent Herbicides

Vigor (1-5)[4]										
	Acala Glandless		Coker 312 49b		Coker 312 81		Coker 312		DP 1133	
Herbicide	7DAE[1,2,3]	14DAE	7DAE	14DAE	7DAE	14DAE	7DAE	14DAE	7DAE	14DAE
Caparol 4.8 pt/a	4.4 a	2.9 b	4.1 a	3.7 a	3.9 a	3.2 a	4.8 a	3.3 a	4.6 a	3.3 a
Cotoran 3.2 pt/a	4.7 a	3.8 a	4.9 a	4.3 a	4.9 a	3.9 a	4.6 a	4.2 a	4.3 a	2.9 a
Staple 2.1 oz/a	4.8 a	3.8 a	4.9 a	4.5 a	3.8 a	3.6 a	4.3 a	3.3 a	4.5 a	3.5 a
Dual Magnum 1.33 pt/a	4.4 a	3.8 ab	4.2 a	3.6 a	4.8 a	3.1 a	4.5 a	3.8 a	3.3 a	3.1 a
UNTR	4.9 a	4.5 a	4.4 a	3.9 a	5.0 a	4.5 a	4.6 a	4.1 a	4.1 a	3.8 a

[1]Means followed by same letter do not significantly differ (P=.05, LSD)

[2]Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

[3]Days After Emergence

[4]On a 1 to 5 scale, 5 being the highest

Table 3. Percent Injury and Biomass of Multiple Cotton Line Seedlings 28 Days After Emergence with Pre-emergent Herbicides

Crop Injury (%) and Shoot Biomass (g)										
	Acala Glandless		Coker 312 49b		Coker 312 81		Coker 312		DP 1133	
Herbicide	Injury[1,2,5]	Biomass	Injury	Biomass	Injury	Biomass	Injury	Biomass	Injury	Biomass
Caparol 4.8 pt/a	0.0 b	71.9 a	0.5 b	133.0 a	0.0 a	47.9 a	0.0 a	61.6 a	0.0 a	70.6 a
Cotoran 3.2 pt/a	5.8 a	73.1 a	7.0 a	162.3 a	2.4 a	62.9 a	4.2 a	77.4 a	5.2 a	48.7 a
Staple 2.1 oz/a	0.0 b	98.1 a	0.5 b	169.8 a	0.4 a	71.1 a	0.3 a	41.5 a	0.0 a	86.6 a
Dual Magnum 1.33 pt/a	0.0 b	71.9 a	0.0 b	109.4 a	0.0 a	75.3 a	0.0 a	92.5 a	0.0 a	71.4 a
UNTR	0.0 b	100 a	0.0 b	100 a	1.3 a	100 a	0.0 a	100 a	0.0 a	100 a

[1]Means followed by same letter do not significantly differ (P=.05, LSD)

[2]Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Results and Discussion

The differences in stand counts for the ULG lines, and the commercial line were not statistically significant. The 14 DAE stand in the Acala glandless line in the Cotoran treatment did differ significantly from the untreated Acalas (Table 1).

The seedling vigor of the ULG lines and the commercial line was not affected by any of the herbicides (Fig. 3). The glandless variety at 14 DAE was significantly lower than the control (Table 2). Caparol caused chlorosis and discoloration in the glandless variety, lowering the vigor ratings at 14 DAE.

The significant differences in percent injury were between the glandless cotton, Cotoran had a higher percent injury, and the Coker 312 49b Caparol and Cotoran (Table 3, Fig. 2). These were the only percent injury ratings that differed significantly from the rest of the individual variety.

Differences in biomass were not significant in any of the cotton lines, despite the lower stand in the Cotoran treated Acala line. This could be due to the plants with less competition growing more and making up the difference of the mass of another plant.

Previous studies showed injury to glandless cotton caused by Caparol, and a lack of injury caused by Cotoran. The results in vigor ratings follow that current trend, but the final percent injury rating shows significantly higher injury in Acala as well as the Coker 312 49b lines treated with Cotoran than the untreated or Caparol pots (Fig. 4).

Summary

Our results showed that the new Ultra-low Gossypol lines are not susceptible to damage from the pre-emergent, Caparol. The Ultra-low Gossypol lines (Coker 312 49b and Coker 81) were equally susceptible to herbicide damage as the non-transformed (Coker 312) or the DP 1133 B2RF variety to the herbicides of Caparol, Cotoran, Staple, or Dual Magnum when applied at the labeled rates. Although not always consistent, the Acala lines demonstrated increased susceptibility to both Caparol and Cotoran . Some varieties demonstrated some signs of herbicide damage, continued screening for herbicide susceptibility at varied life stages.

Further research ideas should include field research with monitoring for pests as well as checking for other incongruences with conventional agriculture practices.

Acknowledgements

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References

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