Cotton
RESEARCH-EXTENSION REPORT – 2008

The University of Georgia
College of Agricultural and Environmental Sciences
Edited by M. Toews, G. Ritchie, and A. Smith

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2008 GEORGIA COTTON
RESEARCH AND EXTENSION REPORT

Edited by Michael Toews, Associate editors Glen Ritchie and Amanda Smith
Compiled by Michael Toews

Georgia Agricultural Experiment Stations
Georgia Cooperative Extension
University of Georgia College of Agricultural and Environmental Sciences

The Georgia Cotton Research and Extension Work Group would like to graciously thank the following for their support of cotton research and education in Georgia.

- The Georgia Agricultural Commodity Commission for Cotton
- Cotton Incorporated
- The Cotton Foundation

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THE 2008 CROP YEAR IN REVIEW

Phillip Roberts
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The 2008 production season was highly variable depending primarily on rainfall. In spite of droughty conditions in some areas and excessive rainfall in others, the 2008 season was another in which we made more cotton than we thought we would or should. Droughty conditions occurred in many areas during June, but scattered showers returned during July and early August and sustained the crop in many areas. Tropical storm Fay brought heavy rainfall in the southernmost and southwest counties, causing considerable damage in some fields. In excess of 15 inches of rain was reported in some southwest counties. In central and east Georgia, Tropical Storm Fay brought much needed rains which helped finish those crops. Unlike previous years, we had a relatively cool fall and an early frost which limited yield potential in later maturing fields. Harvest conditions were generally good. Although yields were highly variable, average yield was estimated at 840 lbs per harvested acre on 920,000 acres. This is the fourth consecutive year that the statewide yield has averaged over 800 lbs per harvested acre.

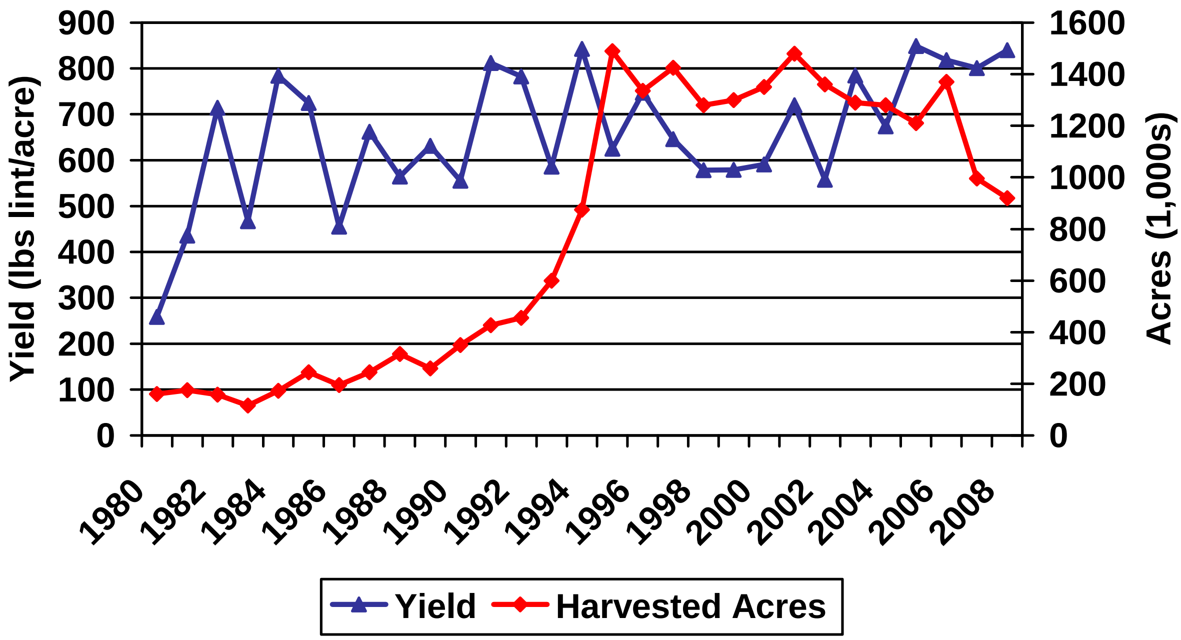

Figure 1. Average lint yield per harvested acre and acres harvested, Georgia 1980-2008. Source: http://www.nass.usda.gov/Publications/Reports_By_Date/index.asp

Quality of the 2008 crop was similar to slightly better compared with previous years. Short staple and high mic were observed in some dryland fields. Of bales classed, 17 percent were short staple (<34) and 10 percent were high mic (>4.9). Georgia still ranks near the bottom of the national averages in uniformity (Table 1).

Table 1. Fiber quality of bales classed at the Macon USDA Classing Office, 2006-2008.

	Color Grade 31/41 or better (% of crop)	Bark/ Grass/ Prep (% of crop)	Staple (32nds)	Strength (g/tex)	Mic	Uniformity
2006	49 / 97	all < 1.0	34.4	28.4	47	80.4
2007	39 / 97	all < 1.0	34.3	28.6	47	80.0
2008	22 / 89	2/<1/<1	34.5	28.6	45	80.2
Bales classed short staple (< 34) and high mic (>4.9) 2006: 20% and 21% 2007: 22% and 20% 2008: 18% and 11% Source: http://www.ams.usda.gov/AMSv1.0/						

DP 555 BG/RR again dominated the state's acreage, with almost 86 percent of crop planted to that variety (http://www.ams.usda.gov/AMSv1.0/). The USDA Survey estimated that about 90 percent of the Georgia crop was planted in single-gene Bt transgenic varieties (Bollgard) and 4.4 percent planted in 2-gene Bt transgenic varieties (Bollgard II and WideStrike). Producers are encouraged to gain experience with non-Bollgard varieties to prepare for the impending loss of the Bollgard registration and transition to new varieties. Herbicide resistant Palmer amaranth (pigweed) loomed large as a production challenge across much of the state.

COMPARISON OF COSTS FOR CONVENTIONAL TILLAGE AND CONSERVATION TILLAGE PRODUCTION METHODS IN BR COTTON

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Introduction

According to a survey conducted by the University of Georgia (UGA) Cooperative Extension during spring 2005, approximately 53 percent of cotton acreage in Georgia was under some form of conservation tillage (43 percent under strip-till, 3 percent under no-till and 7 percent under reduced-till). Cotton producers often inquire about the cost and benefit trade-off between conventional tillage and conservation tillage. Some benefits are intangible or difficult to place a value upon such as reduced erosion and improved soil quality. Others are more tangible. These tangible costs were analyzed through the use of enterprise budgets.

Materials and Methods

The UGA Cotton Enterprise Budgets are updated annually and modified as needed to accommodate changes in typical production practices, input prices and field operations. In 2008, Extension economists collaborated with Extension specialists on the UGA Cotton Team (an agronomist, entomologist, physiologist, plant pathologist and fertility specialist) to come up with likely production practices for a cotton farm in Georgia for the upcoming 2009 crop year. Furthermore, County Extension Agents, local input suppliers and industry professionals were surveyed to collect local input prices on all inputs associated with producing cotton.

The typical production practices and corresponding input prices were then incorporated into four cotton enterprise budgets for the Bollgard/Roundup Ready (BR) variety of cotton. The budgets were based on the BR variety because it accounted for over 86% of Georgia cotton acres in 2008. Conventional-till and strip-till budgets for both dryland and irrigated cotton were developed.

Although each individual farm operation varies, the budgets were designed to be used as a tool for cotton producers to begin calculating their own costs. The budgets included variable costs such as seed, fertilizer, chemicals, fuel, repairs/maintenance, labor and interest on operating capital. Fixed costs on machinery and equipment were also included in the budgets. These costs included depreciation, taxes, insurance and other overhead costs.

Results and Discussion

Based on the budgets, conventional-tillage and conservation-tillage cotton will likely have comparable costs for fertilizer, insect and disease control, plant growth regulation and defoliant in 2009; however, there are likely to be differences in herbicide, labor, fuel, repairs/maintenance and irrigation costs. Table 1 has a breakdown of these different inputs and costs between conventional-tillage and strip-tillage cotton for the 2009 crop year.

Table 1. Select variable inputs between conventional-till and strip-till BR cotton, dryland and irrigated, 2009.

Item	Dryland Conv.-Till BR Cotton	Dryland Strip-Till BR Cotton	Irrigated Conv.-Till BR Cotton	Irrigated Strip-Till BR Cotton
Seed ($/A)	$ 65.19	$ 71.71	$ 65.19	$ 71.71
Herbicide ($/A)	$ 32.15	$ 38.00	$ 32.15	$ 38.00
Labor (hrs./A)	2.24	1.95	2.34	2.00
Fuel (gal./A)	13.21	11.53	13.80	11.84
Repairs/Maintenance ($/A)	$ 20.92	$ 18.89	$ 21.07	$ 19.04
Irrigation ($/A)	NA	NA	$ 66.00	$ 57.75

According to the typical production methods outlined in the budgets, strip-till cotton producers are more likely to plant their cotton at a higher seeding rate (2.75 seed/ft compared to 2.5 seed/ft for conventional) resulting in an increased cost of $6.52 per acre. Furthermore, strip-till producers are more likely to spend more on herbicides ($5.85 per acre). This is mostly due to the additional spray required to burndown the cover crop, or winter growth in a fallow field, prior to planting.

Conventional-till cotton producers are likely to make more trips over the field with tillage equipment resulting in higher labor, fuel and repair/maintenance costs. The budgets show that strip-till cotton producers are likely to use approximately 1/3 of an hour, or 20 minutes, less labor per acre than conventional-till producers. In addition, strip-till cotton producers are likely to use 1.68 fewer gallons of fuel per acre of dryland cotton and 1.96 fewer gallons of fuel per acre of irrigated cotton. Repairs and maintenance costs are expected to be approximately $2.03 less per acre for strip-till cotton in 2009.

Also according to the budgets, strip-till cotton producers are more likely to use one less irrigation per acre resulting in a savings of $8.25 per acre. The irrigation savings were based on the assumption that soils in conservation tillage systems have an increased water holding capacity resulting in one less irrigation application than in conventionally-tilled systems.

The total, variable and fixed costs per acre and breakeven cost per pound for conventional-till and strip-till BR cotton are summarized in Table 2.

Table 2. Yield, variable, fixed and total costs per acre, and breakeven costs per pound between conventional- and strip-till BR cotton, dryland and irrigated, 2009.

Item	Dryland Conv.-Till BR Cotton	Dryland Strip-Till BR Cotton	Irrigated Conv.-Till BR Cotton	Irrigated Strip-Till BR Cotton
Yield (lbs./A)	700	700	1,100	1,100
Variable Cost ($/A)	$ 363.73	$ 366.27	$ 465.64	$ 458.20
Breakeven Variable Cost ($/lb.)	$ 0.52	$ 0.52	$ 0.42	$ 0.41
Fixed Cost ($/A)	$ 138.07	$ 131.76	$ 249.36	$ 240.80
Total Cost ($/A)	$ 501.80	$ 498.02	$ 715.00	$ 699.00
Breakeven Total Cost ($/lb.)	$ 0.72	$ 0.71	$ 0.65	$ 0.64

The budgets assumed cotton producers were established in their production practices and that yields between the two different tillage methods were similar. In 2009, conventional-till dryland cotton producers are likely to have slightly lower variable costs at $2.54 per acre as a result of fewer chemicals sprayed and a lower seeding rate. The difference in variable costs between conventional-till and strip-till irrigated cotton is greater at $7.44 per acre, with the advantage going toward strip-till. This was largely because of the expected savings on fuel, labor, machinery and irrigation as seen in Table 1. Even so, when yield is taken into consideration breakeven variable costs per pound were within a penny for both dryland and irrigated cotton.

Fixed costs are likely to be $6.31 per acre higher for dryland conventional-till cotton and $8.56 per acre higher for irrigated conventional-till cotton compared to strip-till. This results in a likely total cost savings of $3.78 per acre to dryland strip-till cotton producers and $16.00 per acre for irrigated strip-till cotton producers. Assuming comparable yields, the budgets showed a total breakeven cost difference of $0.01 per pound between conventional-till and strip-till cotton.

Acknowledgements

The authors greatly appreciate the collaboration with members of The UGA Cotton Team and the efforts of Georgia County Cooperative Extension Agents in updating the 2009 UGA Cotton Enterprise Budgets. The authors would also like to thank the Georgia Cotton Commission and Cotton Incorporated for partial funding and support.

Literature Cited

The 2009 UGA Cotton Enterprise Budgets are available online at http://agecon.uga.edu through the Extension links. The publication, *Conservation Tillage in Georgia Cotton Production: An Analysis of a 2005 Survey*, can be found online at http://www.ces.uga.edu/agriculture/agecon/pubs/comm/agecon-06-112.pdf.

AN ECONOMIC COMPARISON OF FM1735LLB2 TO DP555BR IN COLQUITT COUNTY, GEORGIA 2008

Scott Brown[1] and Don Shurley[2]
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Introduction

In 2008, over 90% of Georgia's cotton acreage was planted to BR (Bollgard® plus Roundup-Ready®) technology (USDA-AMS, September 2008). Approximately 86% of the state was planted to a single variety, Deltapine 555 BR.

Single-gene Bollgard technology and related variety types (B and BR) will expire September 30, 2009. Because this technology dominates the Georgia cotton landscape and because one variety, DP555BR, accounts for the vast majority of these acres, Georgia producers are concerned about the loss of single-gene technology and more specifically, DP555BR. DP555BR and other single-gene varieties will not be available for purchase after September 30, 2009 (availability in 2010 will be limited to very few remaining stocks booked prior to September 30).

Effective with the 2010 crop, alternatives available to cotton producers will be non-Bt cottons or two-gene cottons, Bollgard II® (B2) or Widestrike® (W). To-date, Georgia producers have not embraced available two-gene technologies; likely due to the yield advantage afforded by DP555BR.

Georgia producers also face increasing/spreading glyphosate resistance in Palmer Amaranth. To combat this resistance, producers can continue to use Roundup-Ready® and Roundup-Ready Flex® (RF) varieties and use residual chemistries in addition to glyphosate for weed control or use Liberty-Link® (LL) Ignite® glufosinate herbicide-resistance varieties.

Objective

With the loss of single-gene Bollgard technology, Georgia producers must find a two-gene or non-Bt (R, RF, or LL) replacement for DP555BR. At this time, the utility of non-Bt varieties is questionable due to the high level of pyrethroid resistance in tobacco budworm (Heliothis virescens) in Georgia.

To manage for both glyphosate resistance and pyrethroid resistance, producers could consider the use of B2R, B2RF, W, WR, or WRF varieties in combination with residual chemistries or use LLB2 varieties. The objective of this study was to compare Bayer CropScience FM1735LLB2 to DeltaPine DP555BR. The objectives of this study were to compare these varieties for lint yield, gin turn-out and cottonseed yield, fiber quality, cost of production, and net return.

Materials and Methods

Comparisons were made under both irrigated and non-irrigated production. The irrigated test was conducted at Windy Pond Farm/Tony Lassiter and Kelly Walker, Doerun, GA in Colquitt County. The non-irrigated test was conducted at Perryman Farms/Craig Perryman, Hartsfield, GA in Colquitt County.

Both tests consisted of large strips (plots) of the field. Each plot was approximately the same length within a given location. DP555BR and FM1735LLB2 were planted in alternating strips with a buffer variety (PHY480WR) planted between them (Figure 1). Each strip served as a replication for that variety. The buffer was used to intercept any Ignite or glyphosate drift which might result in injury and impact the results on the test.

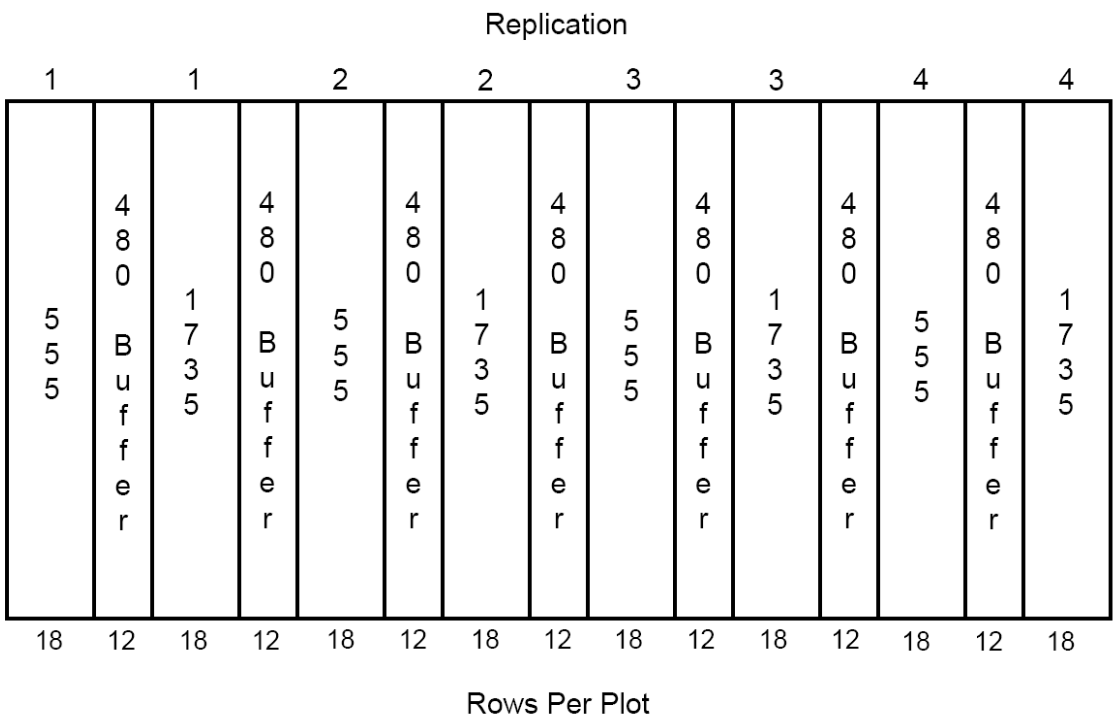

Figure 1. Example of windy pond field strips plot design, 4 of 5 reps shown.

The irrigated test consisted of 5 strips or replications of each variety. Each replication of 555 and 1735 was 18 rows wide. The buffer was 12 rows wide. All 90 rows of each variety (18 rows per plot x 5 reps) was picked, moduled, and ginned commercially. The ginned cotton was HVI classed at the USDA-AMS Classing Office in Macon. Yield per acre was determined by dividing the total ginned lint weight from all plots by the total area (acres) in all 5 plots. Cottonseed yield per acre was also similarly determined.

The non-irrigated test consisted of 3 strips or replications of each variety. Each replication was 12 rows wide. The buffer was 8 rows wide. Only eight rows of each plot (rows 1-4 and 9-12) were picked. The middle 4 rows of each plot were not picked to avoid any possible injury and yield impacts of tractor and sprayer tires and keep all rows picked uniform. The 8 rows of each rep for each variety were harvested and the seed cotton weighed. The total 24 rows of seed cotton for each variety (8 rows per plot x 3 reps) were then combined in trailers and ginned commercially in total. Lint yield and cotton seed yield for each seed cotton rep was determined based on the gin turn-out and total seed weight for the total 24 rows. The ginned cotton was HVI classed at the USDA-AMS Classing Office in Macon.

Cotton was valued at the November-December 2008 Southeast average spot (cash) price for Color 41/Leaf 4-Staple 34 cotton adjusted for fiber quality premiums and discounts (USDA-AMS). Value also included the November-December average LDP (Loan Deficiency Payment) calculated from weekly rates (USDA-FSA). The November-December average spot price plus LDP was 56.2 cents per pound. This price was then adjusted up or down for fiber quality of the variety.

Cottonseed was valued at the November-December 2008 average price received by Georgia farmers (GASS). The average price was $191 per ton.

For both irrigated and non-irrigated test, cost and net return was calculated for each variety. When comparing varieties for economic analysis, only costs that are associated with, or due to, variety and technology need to be considered. All other production practices and costs would be the same and thus irrelevant for comparison. Production practices and inputs applied by variety are shown in Tables 1 and 2.

Table 1. Production practices and inputs by variety, irrigated test, Windy Pond Farm.

	DP555BR	FM1735LLB2
Seed	2.5 seed per foot, 36-inch rows, with Dynasty seed treatment	2.5 seed per foot, 36-inch rows, with Trilex seed treatment
Herbicides	Pre-plant: Treflan 1.75 pt/ac impregnated on fertilizer	Pre-plant: Treflan 1.75 pt/ac impregnated on fertilizer
	At Planting: Cotoran 16 oz/ac + Staple .8 oz/ac in 18” band	At Planting: Cotoran 16 oz/ac + Staple .8 oz/ac in 18” band
	Post-OTT: Roundup 22 oz/ac	Post-OTT: Ignite 26 oz/ac
	Post-Directed: Roundup 22 oz/ac + Staple 2 oz/ac	Post-Directed: Ignite 26 oz/ac
	Layby: Diuron 1 qt/ac + MSMA 1 qt/ac + Aim 1.2 oz/ac	Layby: Ignite 26 oz/ac + Diuron 1 qt/ac
Insecticides and PGR	At Planting: Temik 5 lbs/ac	At Planting: Temik 5 lbs/ac
		Post-OTT: Orthene 3.2 oz/ac applied with first Ignite application
	Post-OTT: Stance 3 oz/ac	Post-OTT: Stance 3 oz/ac
	Post-OTT: Bidrin 4 oz/ac + bifenthrin 4 oz/ac + Stance 3 oz/ac	Post-OTT: Bidrin 6 oz/ac
	Post-OTT: Bidrin 4 oz/ac + bifenthrin 5 oz/ac	Post-OTT: Stance 3 oz/ac
	Post-OTT: Stance 3 oz/ac	Post-OTT: Bidrin 6 oz/ac
	Post-OTT: Bidrin 4 oz/ac + bifenthrin 5 oz/ac	Post-OTT: Bidrin 6 oz/ac

In the irrigated test (Table 1), all plots received the same fertilizer prior to planting and through the season including Treflan impregnated on the broadcast fertilizer prior to planting. Both varieties included a seed applied fungicide and were planted in 36-inch rows at 2.5 seed per foot. All plots of both varieties received Temik in-furrow and a banded application of Cotoran and Staple behind the press wheel at planting.

In post-emergence herbicides, DP555BR required the use of more residual chemistry compared to FM1735LLB2. In insecticides, FM1735LLB2 required the use of Orthene for thrips. Compared to FM1735LLB2, a two-gene Bt variety, DP555BR required the use of bifenthrin in addition to Bidrin. DP555BR required 3 applications (9 oz) of plant growth regulator (PGR) Stance compared to 2 applications (6 oz) for FM1735LLB2.

The reason for the thrips control failure in FM1735LLB2 has not been fully determined or explained. All varieties were treated with identical rates of Temik with no difference in application and placement and no equipment malfunction.

In the non-irrigated test (Table 2), all plots received the same fertilizer prior to planting and through the season including Prowl impregnated on the broadcast fertilizer prior to planting. Both varieties included a seed-applied fungicide and were planted in 38-inch rows at 2.1 seed per foot. All plots of both varieties received Temik in-furrow and a banded application of Cotoran and Prowl behind the press wheel at planting.

Post-emergence weed management was similar. Each variety received an over-the-top (OTT) application and directed application at layby. FM1735LLB2 received a second Ignite application plus Diuron and DP555BR received Diuron plus MSMA.

In insecticides, DP555BR required 2 applications of Upcide not needed with the B2 technology. Both varieties received 4 oz (2 applications) of plant growth regulator (PGR) Stance.

Table 2. Production practices and inputs by variety, non-irrigated test, Perryman Farms.

	DP555BR	FM1735LLB2
Seed	2.1 seed per foot, 38-inch rows, with Prevail seed treatment	2.1 seed per foot, 38-inch rows, with Prevail seed treatment
Herbicides	Pre-plant: Prowl 1 qt/ac impregnated on fertilizer	Pre-plant: Prowl 1 qt/ac impregnated on fertilizer
	At Planting: Cotoran 21 oz/ac + Prowl 6 oz/ac in 18” band	At Planting: Cotoran 21 oz/ac + Prowl 6 oz/ac in 18” band
	Post-OTT: Roundup 22 oz/ac	Post-OTT: Ignite 26 oz/ac
	Layby: Diuron 1 qt/ac + MSMA 1 qt/ac	Layby: Ignite 28 oz/ac + Diuron 1 qt/ac
Insecticides and PGR	At Planting: Temik 5 lbs/ac	At Planting: Temik 5 lbs/ac
	Post-OTT: dimethoate 4 oz/ac applied with Roundup application	Post-OTT: dimethoate 4 oz/ac applied with Ignite application
	Post-OTT: Bidrin 4 oz/ac + Upcide 5.33 oz/ac + Stance 2 oz/ac	Post-OTT: Bidrin 6 oz/ac + Stance 2 oz/ac
	Post-OTT: Bidrin 4 oz/ac + Upcide 5.33 oz/ac + Stance 2 oz/ac	Post-OTT: Bidrin 6 oz/ac + Stance 2 oz/ac

For comparison of net returns for DP555BR and FM1735LLB2, costs considered were seed, seed treatment, technology fees, herbicides, insecticides, and PGR as detailed in Tables 1 and 2. The cost of application (variable costs only), fuel and lube, repairs, and labor, was also included. This cost was based on UGA Cooperative Extension cotton estimated costs of production (Shurley and Ziehl). An application cost was not charged when herbicide or insecticide was applied with another operation that had to be done anyway, such as planting or spreading fertilizer. All other inputs and production practices were the same for both varieties thus, for the purpose of comparing the difference in net returns, are irrelevant.

Ginning, warehouse, storage, and marketing, classing, and promotions (state and national check-off fees) were also considered since they are yield-related. These costs were 8.5 cents per lb for ginning plus $15.30 per bale (bale weight was assumed to be 500 lbs). This cost was deducted from the value of cottonseed and the difference, if positive, was added to lint income or deducted from lint income, if negative.

Results and Discussion

Yield and Fiber Quality
In the irrigated test, FM1735LLB2 yielded equivalent to DP555BR (Table 3). Cottonseed production was almost 150 lbs per acre higher for FM1735LLB2. Fiber quality was better for FM1735LLB2 as it graded better on fiber length (Staple) and fiber length Uniformity. Color and Leaf grades were similar. FM1735LLB2 averaged higher in fiber Strength. The November-December 2008 "base quality" price plus LDP was 56.2 cents per pound. FM1735LLB2 had a high percentage of bales receive a premium for quality but some bales received a discount. On average, there was no premium or discount for FM1735LLB2 but it still graded 1.1 cents per pound higher than DP555BR.

Table 3. Yield and quality comparisons of DP555BR and FM1735LLB2.

	Irrigated		**Non-Irrigated**	
	DP555BR	**FM1735LLB2**	**DP555BR**	**FM1735LLB2**
Lint Yield Per Acre	1,329	1,339	741	621
Cottonseed Yield Per Acre	1,581	1,727	897	866
Seed:Lint	1.19	1.29	1.21	1.39
Average Color Grade (C1)	4.00	4.00	3.00	3.15
Average Color Grade (C2)	1.00	1.00	1.00	1.00
Average Leaf Grade	3.65	3.80	2.93	3.00
Average Staple	33.75	34.39	32.84	33.30
Average Micronaire	4.56	4.47	5.12	5.00
Average Strength	27.49	28.61	27.96	28.07
Average Uniformity	79.34	80.89	79.86	80.29
Average Cash Value Per Lb	$0.5510	$0.5620	$0.5250	$0.5341

In the non-irrigated test, DP555BR out-yielded FM1735LLB2 by 120 lbs per acre. Cottonseed yield for FM1735LLB2 was less than DP555BR due to the lower lint yield although FM1735LLB2 had higher seed per lb of lint.

Both varieties graded poorly due to drought. Color and Leaf grades were good but Staple was short and Micronaire was high. Uniformity was also a problem. DP555BR averaged 3.7 cents per lb discount for quality. FM1735LLB2 averaged 2.79 cents per lb discount. FM1735LLB2 graded 0.91 cents per lb higher than DP555BR.

Costs and Net Returns

In the irrigated test, Lint Value per acre was about $30 per acre higher for FM1735LLB2. Yield was essentially the same but lint value was higher due mostly to higher fiber quality (Table 4). Higher cottonseed yield for FM1735LLB2 more than offset the cost of ginning, warehousing, storage, etc. (GWSM) and gave a net return to income of $10.14 per acre based on $191 per ton for seed. The net cost of GWSM for DP555BR was $2.64 per acre or 0.2 cents per lb.

In the irrigated test, the cost of seed and tech fees, insecticides, herbicides, PGR and application totaled $186.33 per acre for DP555BR compared to $166.69 for FM1735LLB2. Net return was $52.66 per acre higher for FM1735LLB2. This can be attributed primarily to higher cottonseed weight (yield) and less expensive weed and insect control.

Table 4. Seed and technology related costs and net returns by variety.

	Irrigated		Non-Irrigated	
	DP555BR	**FM1735LLB2**	**DP555BR**	**FM1735LLB2**
Lint Yield	1,329	1,339	741	621
Price Per Pound	$0.5510	$0.5620	$0.5250	$0.5341
Lint Value Per Acre	**$732.28**	**$752.52**	**$389.03**	**$331.68**
Cottonseed Yield	1,581	1,727	897	866
Price Per Ton	$191.00	$191.00	$191.00	$191.00
Seed Value Per Acre	$150.99	$164.93	$85.66	$82.70
GWSM	$153.63	$154.79	$85.66	$71.79
Net Cost(-) or Gain(+)	**-$2.64**	**$10.14**	**$0.00**	**$10.91**
Seed and Tech Fees	$65.48	$62.04	$48.23	$45.67
Insecticides	$36.50	$28.61	$25.96	$23.90
Herbicides	$51.09	$45.69	$28.74	$37.35
PGR	$8.73	$5.82	$3.88	$3.88
Application	$24.53	$24.53	$12.05	$12.05
Total Related Costs	**$186.33**	**$166.69**	**$118.86**	**$122.85**
Net Return	**$543.31**	**$595.97**	**$270.17**	**$219.74**

In the non-irrigated test, Lint Value was $57.35 per acre less for FM1735LLB2. Although fiber quality was higher, the difference in yield resulted in higher Value for DP555BR. Due to higher cottonseed yield per pound of lint, FM1735LLB2 resulted in a net gain above the cost of ginning, etc. (GWSM). Accounting for this, the difference in combined lint and seed income was $46.44 per acre higher for DP555BR.

In the non-irrigated test, costs were similar. FM1735LLB2 was less costly for seed and technology fees and insecticides but more costly for herbicides. DP555BR, in total, was approximately $4.00 per acre less in production cost than FM1735LLB2. Net return was approximately $50 per acre higher for DP555BR compared to FM1735LLB2. Although costs were similar and FM1735LLB2 yielded more seed per pound of lint, the difference in yield resulted in higher net return for DP555BR.

Summary

Single-gene Bollgard® technology and related variety types (B and BR) expire September 30, 2009. Georgia producers also face increasing/spreading glyphosate resistance in Palmer Amaranth. Georgia producers must find a two-gene or non-Bt replacement for DP555BR. To do this and also manage for glyphosate resistance, producers could consider the use of B2R, B2RF, W, WR, or WRF varieties in conjunction with the use of residual chemistries or use LLB2 varieties. The objective of this study was to compare Bayer CropScience FM1735LLB2 to DeltaPine DP555BR. The comparison was made under both irrigated and non-irrigated production. The irrigated test was conducted at Windy Pond Farm/Tony Lassiter and Kelly Walker, Doerun, GA in Colquitt County. The non-irrigated test was conducted at Perryman Farms/Craig Perryman, Hartsfield, GA in Colquitt County.

In the irrigated test, FM1735LLB2 yielded equivalent to DP555BR. Fiber quality was better for FM1735LLB2. The cost of seed and tech fees, insecticides, herbicides, PGR and application costs totaled $186.33 per acre for DP555BR compared to $166.69 for FM1735LLB2. Net return was $52.66 per acre higher for FM1735LLB2. This can be attributed primarily to higher cottonseed weight (yield) and less expensive weed and insect control.

In the non-irrigated test, DP555BR out-yielded FM1735LLB2 by 120 lbs per acre. Both varieties graded poorly due to drought. Lint Value was $57.35 per acre less for FM1735LLB2. Although fiber quality was higher for FM1735LLB2, the difference in yield resulted in higher Value for DP555BR. Costs were similar. FM1735LLB2 was less costly for seed and technology fees and insecticides but more costly for herbicides. Net return was approximately $50 per acre higher for DP555BR compared to FM1735LLB2. Although costs were similar and FM1735LLB2 yielded more seed per pound of lint, the difference in yield resulted in higher net return for DP555BR.

This test used FM1735LLB2. This variety will be replaced by FM1845LLB2. FM1735LLB2 will be phased out beginning in 2010 but may be available beyond 2010.

Acknowledgements

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EXPIRATION OF SINGLE-GENE BOLLGARD® TECHNOLOGY: ANALYSIS OF ALTERNATIVES AVAILABLE TO GEORGIA COTTON PRODUCERS

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Introduction

Over 90% of Georgia's cotton acreage is planted to BR (Bollgard® plus Roundup-Ready®) technology (USDA-AMS, 2008). Less than 1% of the state is non-transgenic (conventional) cotton. The state used to plant a greater amount of straight Roundup Ready (RR) cotton but yields were not good. Adoption of BR technology was aided by much improved yields in BR varieties.

To date, the state has not widely adopted Bollgard II® (B2), RF (Roundup-Ready Flex®), Widestrike® (W), and Liberty-Link® (LL) technologies (Table 1). Previous research at The University of Georgia has concluded that these technologies are of value and have utility for the producer, but yield potential remains the major determinant of profitability (Jost, et al., Shurley, et al.)

Not only is over 90% of Georgia cotton acreage planted to BR varieties, but of greater significance is the fact that approximately 86% of the state is planted to a single variety: Deltapine 555 BR. Prior to the 2008 growing season, cotton specialists with The University of Georgia Cooperative Extension recommended that Georgia farmers begin to plant relatively small acreage of other technologies and varieties due to the pending expiration of single-gene Bollgard technology. There were slight increases in two-gene technologies B2R, B2RF, WR, and WRF in 2008 compared to 2007 (USDA-AMS, 2008). Even so, varieties planted to these technologies still comprised less than 5% of the state in 2008.

Situation

Single-gene Bollgard technology and related variety types (B and BR) expires September 30, 2009. Because this technology dominates the Georgia cotton landscape and because one variety, DP555BR, accounts for the vast majority of these acres, Georgia producers are concerned about the loss of single-gene technology and more specifically, DP555BR. DP555BR and other single-gene varieties will not be available after the 2009 crop year (availability in 2010 will be limited to very few remaining stocks).

In Georgia, DP555BR has offered a strong and consistent yield advantage compared to other varieties. To-date, Georgia producers have not embraced available two-gene technologies Bollgard II (B2) and Widestrike (W). Georgia producers also face increasing/spreading glyphosate resistance in Palmer Amaranth. Many two-gene varieties are "packaged" with RF but both R and RF have reduced value in Georgia due to the need to use residual chemistries to combat glyphosate resistance.

Table 1. Percent of Georgia cotton acres planted by technology and variety brand, 2008.[1]

	Variety Brand [2]					
Technology	**BCS-FM**	**BCS-ST**	**DP**	**PHY**	**Others**	**Total**
Conventional	.06		.56			.62
RR	.48		1.86			2.34
RF		.16				.16
B						
BR	.45	.28	89.60			90.33
B2R	.33		.05			.38
B2RF		.26				.26
LL						
B2LL	.12					.12
W						
WR				2.55		2.55
WRF				.40		.40
Not Specified		.04	1.20	.05	1.55	2.84
Total	**1.44**	**.74**	**93.27**	**3.00**	**1.55**	**100.00**

[1]/ Source: USDA-AMS, September 2008.
[2]/ BCS (Bayer CropScience), FM (Fibermax), ST (Stoneville), DP (Deltapine), PHY (Dow Phytogen)

The economic impact of the expiration and future unavailability of single-gene technology is uncertain. Questions remain concerning (1) the availability of variety and technology choices, (2) differences, if any, in lint yield and fiber quality, and (3) any differences in production practices and costs.

Objectives

The objective of this study was to investigate the impacts on Georgia cotton producers and farmer income due to the expiration of single-gene Bollgard (B) technology and the resulting need to change to other technologies and varieties. Specifically, objectives were (1) to compare and determine possible differences in lint yield, (2) to compare fiber quality characteristics, (3) to compare technology-related production practices and input costs for single-gene technology (DP555BR, specifically) to two-gene B2 and W technology, and (4) to analyze alternatives available to Georgia producers.

Materials and Methods

Effective with the 2010 crop, the alternatives available to cotton producers are non-Bt cottons (R/RR, F/RF, and LL) and/or two-gene cottons (B2, B2R, B2RF, B2LL, W, WR, and WRF). Table 2 illustrates the technology types and variety brands available based on 2008 acres (technology available by variety brand for those brands with acreage in Georgia) (USDA-AMS, 2008).

For this study, analysis was conducted comparing DP555BR to two-gene varieties included in The University of Georgia Later Maturity Official Variety Trials (OVT's). Data was analyzed for the 3-year period 2006-2007 (Day, et al., 2007, 2008, and 2009). Conventional (non-transgenic) and other non-Bt cotton's were not considered.

In 2008, DP555BR was the only BR variety in the tests (Table 3). There were 11 two-gene (B2 and W) varieties. In 2006 and 2007, there were 8 and 11 two-gene varieties respectively. OVT's included the same varieties in both irrigated and non-irrigated tests. Irrigated tests were conducted at 4 locations. Non-irrigated tests were also conducted at 4 locations but for this analysis, Athens was omitted from non-irrigated data because DP555BR is not adapted for that location.

Table 2. Alternatives available to single-gene Bollgard® technology by variety brand.

Technology		**Variety Brand**				
Non-Bt	Conventional	DP	ST		FM	Others
	RR or R	DP		PHY	FM	Others
	RF or F	DP	ST	PHY	FM	Others
	LL				FM	
Two-Gene	B2				FM	
	B2R	DP			FM	Others
	B2RF	DP	ST		FM	Others
	B2LL				FM	
	W			PHY		
	WR			PHY		
	WRF			PHY		

[1]/ FM (Fibermax), ST (Stoneville), DP (Deltapine), PHY (Dow Phytogen).

Table 3. Number of varieties in University of Georgia official variety trials[1], by technology type.

	Technology Type										
Year	**Conv**	**R**	**RF**	**BR**	**B2R**	**B2RF**	**B2LL**	**W**	**WR**	**WRF**	**Total[1]**
2006	1	1	3	9	1	4	2			1	22
2007	1		5	6		10				1	23
2008			2	1		6	1	1	1	2	14

[1]/ Includes company experimental not yet released. Excludes University of Georgia experimentals.
[2]/ Four locations, irrigated- Bainbridge, Tifton, Plains, and Midville. Three locations, non-irrigated- Tifton, Plains, and Midville.

University of Georgia OVT data for 2006-2008 was used to compare yield and fiber quality. The single highest yielding, top 3 yielding, top 5 yielding and average of all two-gene varieties were compared to DP555BR each year and averaged over 3-years; averaged across locations. Average yield across locations and time was used to allow technology and variety performance comparisons over a combination of environments.

Weed and insect management practices can vary by technology. Seed costs and technology fees also vary. Seed and technology-related costs were estimated for two-gene varieties and compared to DP555BR. These costs included insecticides, herbicides, cost of application (Shurley and Smith, 2008), seed and technology fees. Insecticide and herbicide programs were examples based on University of Georgia Cooperative Extension recommendations (University of Georgia, 2009) and were for illustration purposes only. Seed price and technology fees were for 2009 based on suggested prices from the manufacturer. All other inputs and practices were assumed the same regardless of technology and therefore irrelevant and need not be considered.

Results and Discussion

Yield

Over 3 years at 4 irrigated locations, the highest yielding two-gene variety each year averaged approximately 9% less than DP555BR (Table 4). The top 3 varieties averaged 12.5% less and the top 5 varieties averaged 14.5% less. The average yield of all two-gene cottons was approximately 18% less than DP555BR. Yield difference between the highest yielding two-gene variety and DP555BR has declined over time. Whether this is a function of better varieties and/or weather and/or location has not been determined.

Table 4. Yield comparison of two-gene varieties to DP555BR, later maturity, irrigated.

	Yield Per Acre				Comparison to DP555BR	
	2006	**2007**	**2008**	**Average**	**Pounds**	**Percent**
DP555BR	2,106	1,825	1,813	1,915		
Highest Two-Gene Variety	1,678	1,775	1,787	1,747	-168	-8.8
Top 3 Two-Gene Varieties	1,619	1,642	1,764	1,675	-240	-12.5
Top 5 Two-Gene Varieties	1,585	1,586	1,739	1,636	-278	-14.5
All Two-Gene Average [1]	1,528	1,509	1,682	1,573	-341	-17.8

[1]/ Eight varieties in 2006, highest 10 yielding varieties in 2007 and 2008.

Over 3 years at 3 non-irrigated locations, the highest yielding two-gene variety each year averaged 7% less yield than DP555BR (Table 5). The top 3 varieties averaged about 11% less and the top 5 varieties averaged about 13% less. The average yield of all two-gene cottons was approximately 17% less than DP555BR. Again, the yield difference between the highest yielding two-gene variety and DP555BR has declined over time. In 2007, the highest yielding two-gene variety yielded higher than DP555BR.

Table 5. Yield comparison of two-gene varieties to DP555BR, later maturity, non-irrigated.

	Yield Per Acre				Comparison to DP555BR	
	2006	**2007**	**2008**	**Average**	**Pounds**	**Percent**
DP555BR	1,329	911	1,275	1,172		
Highest Two-Gene Variety	1,106	1,020	1,156	1,094	-78	-6.7
Top 3 Two-Gene Varieties	1,082	942	1,120	1,048	-124	-10.6
Top 5 Two-Gene Varieties	1,061	904	1,100	1,022	-150	-12.8
All Two-Gene Average [1]	1,035	836	1,050	974	-198	-16.9

[1]/ Eight varieties in 2006, highest 10 yielding varieties in 2007 and 2008.

Typical of small plot OVT's, yields appear high relative to on-farm. Despite this, relative differences are worthy of analysis. Over the 3 years at multiple locations, the highest and best yielding two-gene varieties averaged about 10% less than DP555BR.

Fiber Quality

In addition to yield, University of Georgia OVT data was also analyzed for differences in gin turn-out and fiber quality. Fiber quality for the same two-gene varieties based on yield from Tables 4 and 5 was compared to DP555BR.

It has generally been believed that DP555BR is not the very best quality fiber. This study does not attempt to confirm or deny that belief, but it is nonetheless worth considering how a shift to two-gene varieties may impact Georgia fiber quality.

Seedcotton samples for each variety at each location were ginned and HVI classed. Seedcotton was ginned using a table-top hand operated "gin" that separates the seed and trash material from the lint. Fiber quality parameters reported in the OVT's, therefore, were not subject to a commercial ginning process. For this reason, Staple and Uniformity in particular may appear high. Nevertheless, relative differences in fiber quality can be observed.

In both irrigated (Table 6) and non-irrigated tests (Table 7), two-gene varieties on average have been higher in Staple and fiber length Uniformity than DP555BR. Georgia producers may experience some improvement in Uniformity and Staple but the differences appear slight based on the OVT's when averaged across location and time.

Table 6. Fiber quality comparison of two-gene varieties to DP555BR, later maturity, irrigated. [1]

	Gin T/O	Uniformity	Staple	Strength	Micronaire
DP555BR	44.2	82.6	37.1	30.5	4.5
Highest Two-Gene Variety	42.6	82.8	38.1	30.0	4.5
Top 3 Two-Gene Varieties	41.8	83.0	37.6	30.2	4.4
Top 5 Two-Gene Varieties	41.6	83.2	37.6	30.6	4.4
All Two-Gene Average [2]	41.4	83.2	37.9	30.7	4.4

[1]/ Average of 4 locations over 3 years, 2006-08.

[2]/ Eight varieties in 2006, highest 10 yielding varieties in 2007 and 2008.

Table 7. Fiber quality comparison of two-gene varieties to DP555BR, later maturity, non-irrigated[1].

	Gin T/O	Uniformity	Staple	Strength	Micronaire
DP555BR	43.7	82.4	36.1	30.6	4.5
Highest Two-Gene Variety	42.3	82.2	36.6	28.5	4.3
Top 3 Two-Gene Varieties	42.0	82.5	36.6	29.8	4.4
Top 5 Two-Gene Varieties	41.8	82.6	36.7	30.4	4.4
All Two-Gene Average [2]	41.1	82.6	36.9	30.7	4.4

[1]/ Average of 4 locations over 3 years, 2006-08.
[2]/ Eight varieties in 2006, highest 10 yielding varieties in 2007 and 2008.

Costs

Upon expiration of single-gene Bollgard technology and producers then having to switch to other technology(ies), in addition to any yield and fiber quality effects, cost of production could also change. Such cost changes could include seed and associated technology fees, insect control, and weed control.

Estimated seed and technology cost per acre is shown in Table 8. This is based on 36-inch rows and planting 2 to 3 seed per foot (or 36,300 seed per acre) which is typical or thought to be an average for Georgia.

For 2009, the combined seed and technology cost per acre for DP555BR is $65.40 per acre. B2R and B2RF varieties are approximately $79.50 per acre (about $14.00 per acre higher). The least expensive two-gene varieties without weed management traits (W and B2) are $30.00 per acre and $15.00 per acre cheaper than DP555BR, respectively. B2LL and WR are approximately the same cost as DP555BR. WRF is about $10.00 per acre more than DP555BR.

Table 8. Seed and Technology Cost Per Acre [1], By Technology and Variety Brand [2], 2009.

	DP555BR	B2	B2R	B2RF	B2LL	W	WR	WRF
DP	$65.40		$79.68	$78.37				
FM		$50.08	$80.77	$79.46	$66.58			
ST				$79.46				
PHY						$34.88	$65.57	$75.07

[1]/ Based on 36-inch row spacing, 2 to 3 seed per foot of row.
[2]/ DP (Deltapine), FM (Fibermax), ST (Stoneville), PHY (Phytogen)

Table 9 represents an example comparison of insect control programs and costs for single-gene technology (B) compared to two-gene technology (B2 and W). The programs and materials shown are for illustration purposes only and do not constitute a recommendation. Situations and materials used vary widely.

Based on Georgia experience, compared to single-gene Bollgard (B), B2 is expected to provide improved control of corn ear worm. Sprays are expected to be needed for stink bugs only. Widestrike (W) technology is expected to also provide better control and less spray applications than B but generally not as good of control as B2.

Compared to single-gene technology, both B2 and W technologies offer the possibility of fewer applications and less cost. With either B2 or W, insecticide spray costs are expected to be lower than B, but the difference between B2 and W is expected to be moderate to minor on average.

Upon expiration of single-gene Bollgard technology, producers switching to two-gene varieties containing B2 and W will find this technology “packaged” with R/RR (Roundup Ready), RF/F (Roundup Ready Flex), or LL (Liberty Link). Therefore, compared to DP555BR, a switch to B2 or W will likely also mean a change in weed control technology and management.

Table 9. Estimated Insecticide Cost Per Acre By Technology[1], 2009.

Technology	Product	Rate Per Acre	Time of Application	Cost Per Acre	Application	Total
B	bifenthrin	4 oz	early to mid Jul	$4.38	$2.90	$7.28
	bifenthrin + dicrotophos	4 oz + 4 oz	mid to late Jul	$7.29	$2.90	$10.19
	dicrotophos	6 oz	late Jul to mid Aug	$4.36	$2.90	$7.26
Total						**$24.73**
B2	dicrotophos	6 oz	mid to late Jul	$4.36	$2.90	$7.26
	dicrotophos	6 oz	late Jul to mid Aug	$4.36	$2.90	$7.26
Total						**$14.52**
W	bifenthrin + dicrotophos	4 oz + 4 oz	mid to late Jul	$7.29	$2.90	$10.19
	dicrotophos	6 oz	late Jul to mid Aug	$4.36	$2.90	$7.26
Total						**$17.45**

[1]/ Does not constitute a recommendation. For illustration purposes only. Programs and costs vary.

Weed control (materials used and cost) varies widely and depends on weather, location, typical/common problems, management, and choice of materials. Table 10 represents one of many possible such programs. The programs and materials shown are for illustration purposes only and do not constitute a recommendation. The weed control program illustrated assumes the producer does not currently have glyphosate resistance but is managing to control resistance by using residual chemistry as needed.

Based on the example program, weed control spray and application cost is expected to be similar for RR, RF, and LL cottons. In the example, the same weed control program is assumed for RF and RR. While Roundup Ready Flex does offer utility and flexibility for the producer (specifically, the ability to spray beyond the 4-leaf stage if needed) the technology has limited value when managing for resistance.

While weed control problems and costs can, and do, vary widely, it is possible based on the example of Table 10 that there could be little difference in materials and application costs between R/RR, RF, and LL systems.

Upon expiration of single-gene Bollgard technology and as Georgia cotton producers shift acres from DP555BR to other (non-transgenic or two-gene) varieties, the costs that could be impacted include seed, technology fees, insecticides, and herbicides. In Table 11, B2RF, WRF, and B2LL varieties are compared to DP555BR.

The combined cost of seed and technology fee is estimated to range from about the same cost as DP555BR (for B2LL) to $10.00 to $14.00 per acre higher (for WRF and B2RF, respectively). Herbicide cost, due to the need to manage for glyphosate resistance, is similar regardless of technology. Insecticide cost is about $10.00 per acre cheaper for B2 and about $7.00 per acre cheaper for W.

For B2RF, the $10.00 per acre savings in spray materials and application is offset by the $14.00 increase in seed and technology cost. B2RF and WRF costs are approximately the same. B2LL is lower. Seed and technology-related costs vary but differences are relatively minor. Seed and technology-related cost was estimated to be $144.32 per acre for DP555BR compared to $147.82 for B2RF, $146.71 for WRF, and $134.37 per acre for B2LL.

Table 10. Estimated Herbicide Cost Per Acre By Technology[1], 2009.

Technology	Product	Rate Per Acre	Time of Application	Cost Per Acre	Application	Total
R or RF [2]	pendimethalin	2 pt	PPI or at planting	$6.00	$6.26	$12.26
	glyphosate + S-metolachlor	22 oz + 1.33 pt	POST OTT	$17.44	$2.90	$20.34
	glyophosate + flumioxazin	22 oz + 1.5 oz	POST Directed	$15.69	$5.91	$21.60
Total						**$54.20**
LL	pendimethalin	2 pt	PPI or at planting	$6.00	$6.26	$12.26
	glufosinate-ammonium + S-metolachlor	29 oz + 1.33 pt	POST OTT	$21.57	$2.90	$24.47
	diuron + MSMA	2 pt + 2.5 pt	POST Directed	$10.63	$5.91	**$16.54**
Total						**$53.27**

[1]/ Does not constitute a recommendation. For illustration purposes only. Programs and costs vary.
[2]/ Cost includes Monsanto rebates on use of residual chemistries if applicable.

Table 11. Comparison of Estimated Seed and Technology-Related Costs Per Acre.

	DP555BR	B2RF [1]	WRF	B2LL [2]
Seed	$20.03	$20.76	$19.89	$37.62
Technology Fees	$45.37	$58.34	$55.18	$28.96
Herbicides [3]	$54.20	$54.20	$54.20	$53.27
Insecticides [3]	$24.72	$14.52	$17.44	$14.52
Total Per Acre	**$144.32**	**$147.82**	**$146.71**	**$134.37**

[1]/ Seed cost is average of DP (Deltapine), ST (Stoneville), and FM (Fibermax)
[2]/ Seed cost includes LL fee.
[3]/ Includes cost of application.

Summary and Conclusions

Based on University of Georgia Official Variety Trials (OVT's), yield per acre for two-gene (B2 and W) varieties has been less than DP555BR. Over 3 years and multiple locations for both irrigated and non-irrigated production, the best two-gene varieties have averaged about 10% less lint yield than DP555BR. These differences in yield may have narrowed and new varieties continue to be developed. At present, however, there is no equal substitute for DP555BR. This variety accounted for 86% of Georgia acreage planted in 2008 and will no longer be available after the 2009 crop year.

Fiber quality could improve with the shift from DP555BR. Improvements in fiber length Uniformity and Staple are possible. The OVT data on this, however, is not strong/consistent.

Production practices, inputs, and cost of production vary widely. Cost estimates conducted for this study conclude that total seed and technology-related production costs for two-gene varieties could be similar to DP555BR. Depending on choice of variety and technology, costs could be lower than DP555BR or slightly higher.

Yield will likely continue to be the major factor in choosing a variety after expiration of single-gene Bollgard technology. There are cost differences. Two-gene technology packaged with Roundup-Ready Flex offers added protection and management flexibility for the producer and thus has utility and value. In terms of cost, however, differences in cost per acre are relatively minor in contrast to differences in yield. A $10.00 per acre savings, for example, is equivalent to less than 20 pounds of lint yield per acre at a 55-cent per pound net price to the producer. Therefore, yield will likely be at least as important as any other factor, as Georgia cotton producers decide how to adjust to the loss of single-gene Bollgard technology.

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YIELD, FIBER QUALITY, AND VALUE: 2008 VARIETY TRIALS IN BEN HILL AND IRWIN COUNTIES

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Introduction

Choice of variety is an important decision for cotton producers. Seed, and the associated technology fee, is the single most expensive production input in cotton production. When selecting seed, the producer is selecting a "package" that includes yield potential, fiber quality potential, and weed and insect management regimes.

In addition to research OVT's (official variety trials), it is often beneficial for producers to know how varieties and technologies compare under local on-farm situations. A large-plot on-farm variety trial was conducted in Ben Hill and Irwin Counties in 2008. This was the fourth year of such a study and, as a result, a large body of information has been accumulated on many of the varieties tested.

Materials and Methods

A total of 3 trials were conducted. Fifteen varieties were tested at 3 locations - the Phillips Farm in Ben Hill County and the Ross Farm and CASE farm in Irwin County. Each location was non-irrigated. For purposes of the study, each trial was considered a separate replication. The average of all 3 locations represents the average over different locations and management practices.

The Phillips Farm trial was strip-tilled and planted on May 30, 2008. Each variety plot was 8 rows wide with 36-inch rows. All 8 rows of each variety were harvested on October 28, 2008.

The Ross Farm trial was planted after wheat on June 6, 2008. Each variety plot was 12 rows in width and planted in 38-inch rows. Six rows of each plot were harvested on November 28, 2008.

The CASE Farm trial was planted in conventional tillage on May 21, 2008. Each variety plot was 8 rows wide with 36-inch rows. All 8 rows of each variety were harvested on December 20, 2008.

Stand counts were taken after emergence. Stand counts were consistent across each plot at each location. Harvest was done in a timely manner at each location with the exception of the CASE farm. Harvest of the CASE trial was delayed by weather and the availability of a picker.

At harvest, the seedcotton of each plot at each location was weighed. A large random sample of the seedcotton for each plot was then taken. The samples were ginned at the UGA Microgin in Tifton, GA. The seedcotton sample and ginned lint were both weighed to determine gin turn-out (lint weight as a percent of seedcotton weight). The gin turn-out was applied to the total seedcotton weight of the plot and lint yield per acre was determined based on the size of the plot.

Cotton seed from ginning was not weighed. The difference between seedcotton weight and lint weight consists of seed, trash, and moisture. Based on previous research, trash and moisture was estimated as a function of gin turnout. For each plot, cotton seed was then estimated as seedcotton weight minus lint weight minus estimated trash and moisture weight.

In addition to lint yield and cotton seed yield, fiber quality was also determined for each variety at each location. Ginned cotton from the Microgin was HVI classed at the USDA Cotton Classing Office in Macon. Fiber quality, Staple and Uniformity especially, of cotton ginned at the UGA Microgin may be higher than that of a commercial gin but still useful for relative comparisons.

Value Per Acre was calculated for each variety. Value Per Acre was calculated for the average lint yield, cottonseed yield, and fiber quality of all 3 trials. Lint was valued at the 2008 Loan Rate based on the fiber quality of each plot. Cotton seed was valued at the November-December 2008 Georgia average price received. The “base” Loan Rate is 52 cents per pound. If the Loan Rate for a variety is above this, the difference represents a net premium for quality. If the Loan Rate for a variety is below this, the difference represents a net discount for quality. The November-December 2008 average price for cotton seed was $191 per ton.

Value Per Acre was calculated as:

Lint Value + (Seed Value – GWSM)

GWSM is the cost of ginning, warehousing, storage, and marketing (classing and state and national check-off). Because this cost varies due to yield, it should be considered when comparing varieties. This cost per acre was estimated at 8.5 cents per pound for ginning plus $15.30 per bale ($8.00 for warehouse receiving and load-out, $2.00 for one month of storage, $1.85 for classing, and $3.45 for state and national boards). Cost per acre assumed a 500-lb bale.

In this analysis, production practices and cost of production were not considered. Varieties are compared for lint and cottonseed yield, fiber quality, and net Value Per Acre as defined.

Results and Discussion

Phillips Farm

Yield per acre varied from a high of 1,275 lbs per acre for DP174RF to 920 lbs per acre for DP167RF (Table 1). The top 1/3 (highest 5) yielding varieties were DP174RF, DP515BR, PHY370WR, DP141B2RF, and PHY485WRF.

Color Grades were mostly 31 and 41 with Leaf Grades mostly 4. Staple averaged 37.2, ranging from 35 to 40. Fiber Strength averaged 30.2 and fiber length Uniformity averaged 82.7 ranging from a low of 80.3 to a high of 85.2.

Ross Farm

Yield per acre varied from a high of 1,275 lbs per acre for DP555BR to 899 lbs per acre for DP167RF (Table 2). The top 1/3 (highest 5) yielding varieties were DP555BR, DP174RF, DP515BR, DP141B2RF, PHY485WRF, and PHY480WR.

Color Grade was mostly 31 with Leaf Grades 3 and 4. Staple averaged 36.9, ranging from 35 to 39. Fiber Strength averaged 29.6 and fiber length Uniformity averaged 82.0, ranging from a low of 80.2 to a high of 83.5.

The Ross Farm trial was June-planted behind wheat and harvested a month later than the Phillip Farm trial. Yield in this trial was similar to the Phillips Farm trial. Fiber quality was better.

CASE Farm

Yield per acre varied from a high of 1,361 lbs per acre for DP555BR to 785 lbs per acre for ST4554B2RF (Table 3). The top 1/3 (highest 5) yielding varieties were DP555BR, DP174RF, DP164B2RF, DP515BR, DP141B2RF, and PHY370WR.

Color Grades were 41 and 51 with Leaf Grade mostly 3. Staple averaged 36.2, ranging from 35 to 38. Fiber Strength averaged 29.4 and fiber length Uniformity averaged 81.8, ranging from a low of 80.4 to a high of 83.5.

The CASE Farm trial was planted in May but not harvested until late December. Staple, Strength, and Uniformity were lower compared to the other 2 trials and micronaire was higher. Color Grade was lower—mostly 51 compared to 31 and 41 for the other 2 locations. Color and Leaf are generally a function of weather, harvest timing, and other management factors, not variety genetics.

Average of All Three Tests

The highest yielding variety over all three test locations (reps) was DP555BR, which averaged 1,264 pounds per acre (Table 4). DP555BR was the highest yielding variety at 2 of the 3 locations. The yields of the top five varieties- DP555BR, DP174RF, DP515BR, PHY370WR, and DP141B2RF, were not statistically different. With the registration on single-gene Bollgard® technology expiring after the 2009 crop season, it is worth noting that two-gene varieties PHY370WR and DP141B2RF and non-Bt Variety DP174RF were not statistically different than DP555BR.

In addition to yield, Table 4 also shows the average fiber quality of the 15 varieties. Color grade is shown as the average of each of its 2 digits. A color grade of 31, for example, would be designated as a C1 of 3 and C2 of 1. DP555BR was highest in yield but among the lowest in fiber length Staple and Uniformity and lowest in Strength.

Staple ranged from 38.7 to 35.3. Strength ranged from 31.97 to 28.13. Uniformity ranged from 83.77 to 80.63. Color grade (C1) was mostly 3 and 4 and still averaged 4 or less for most varieties; although the late-harvested CASE location had C1 of 5 for most varieties.

<u>Comparison of Value Per Acre</u>
The highest Value Per Acre was DP555BR with a value of $699.33 per acre (Table 5). DP555BR was followed closely by DP174RF at $694.90 per acre. There was no statistical difference in Value Per Acre among the top eight varieties.

As measured by the Loan Rate, DP174RF had the highest fiber quality - receiving a loan premium of 3.5 cents per pound. This was followed by DP161B2RF with a loan premium of 3.41 cents per pound.

The top five yielding varieties were also, in that same order, the top five in Value.

Summary and Conclusions

Choice of variety is an important decision for cotton producers. Seed, and the associated technology fee, is the single most expensive production input in cotton production. A large plot on-farm variety trial was conducted in Ben Hill and Irwin Counties in 2008; the fourth year of such a study. Fifteen varieties were tested at 3 locations, the Phillips Farm in Ben Hill County and the Ross Farm and CASE farm in Irwin County.

The highest yielding variety over all three test locations was DP555BR which averaged 1,264 pounds per acre. The top five varieties, DP555BR, DP174RF, DP515BR, PHY370WR, and DP141B2RF were not statistically different in yield. Two-gene varieties PHY370WR and DP141B2RF and non-Bt Variety DP174RF were not statistically different in yield than DP555BR.

DP555BR was highest in yield but among the lowest in fiber length Staple and Uniformity and lowest in Strength. DP555BR was still the highest in Value Per Acre followed closely by DP174RF. There was no statistical difference in Value Per Acre among the top eight varieties.

As measured by the Loan Rate, DP174RF had the highest fiber quality—receiving a loan premium of 3.5 cents per pound. This was followed by DP161B2RF with a loan premium of 3.41 cents per pound. The top five yielding varieties were also the top five in Value, in that same order.

Acknowledgements

The authors would like to acknowledge the representatives who donated cotton seed for this trial: Chris Hopkins with Bayer Crop Science, Harold Roberts with Delta and Pine Land, and Steve Brown with Phytogen. We would especially like to thank the farmer cooperators: Wesley Paulk, Kyle Phillips, Kent Phillips, Darrell Ross and Jeffery Ross

Table 1. 2008 Variety trial, Phillips Farm location, non-irrigated, planted May 30, 2008, harvested Oct. 28, 2008, 36-inch rows.

Variety	Seedcotton Lbs/Acre	Lint Yield Lbs/Acre	% Gin Turn-out	Color Grade	Leaf Grade	Staple	Strength	Micronaire	Uniformity
DP174RF	3,321	1,275	38.39	31	4	38	29.4	4.2	84.6
DP515BR	3,150	1,209	38.38	41	4	35	29.0	4.1	82.1
PHY370WR	3,190	1,183	37.08	31	3	36	29.3	4.4	83.1
DP141B2RF	3,264	1,178	36.09	41	5	39	32.6	4.2	82.5
PHY485WRF	3,208	1,164	36.28	41	5	37	30.9	4.5	85.2
DP555BR	2,949	1,156	39.20	31	4	35	29.3	4.2	80.9
PHY480WR	3,158	1,127	35.69	41	4	37	30.3	4.5	84.7
PHY375WRF	3,021	1,114	36.88	41	3	36	31.2	3.9	82.1
DP147RF	3,050	1,110	36.39	41	4	38	29.9	3.9	82.8
ST5327B2RF	2,883	1,056	36.63	41	4	37	29.9	3.8	82.8
DP143B2RF	2,907	1,024	35.23	31	4	40	31.2	3.6	80.3
ST4554B2RF	2,826	1,009	35.70	31	4	36	27.3	4.0	81.6
DP161B2RF	2,788	971	34.83	31	4	39	32.5	4.0	83.6
DP164B2RF	2,658	931	35.03	41	3	38	29.2	3.8	81.4
DP167RF	2,614	920	35.20	41	3	37	30.4	4.0	82.8

Table 2. 2008 Variety trial, Ross Farm location, non-irrigated, planted Jun. 6, 2008, harvested Nov. 28, 2008, 38-inch rows.

Variety	Seedcotton Lbs/Acre	Lint Yield Lbs/Acre	% Gin Turn-out	Color Grade	Leaf Grade	Staple	Strength	Micronaire	Uniformity
DP555BR	3,230	1,275	39.47	31	3	36	27.3	3.7	80.9
DP174RF	3,065	1,243	40.51	31	3	37	28.6	4.1	83.3
DP515BR	3,228	1,197	37.08	31	3	36	29.9	3.9	82.3
DP141B2RF	3,226	1,188	36.83	31	4	38	30.6	4.1	81.2
PHY485WRF	3,170	1,179	37.19	41	4	36	30.8	4.1	83.5
PHY480WR	3,293	1,177	35.74	31	5	37	30.6	4.1	83.1
PHY370WR	3,067	1,150	37.50	31	4	35	29.0	3.9	82.6
DP143B2RF	2,944	1,056	35.87	31	4	37	28.6	3.5	80.4
DP164B2RF	2,879	1,005	34.91	31	3	37	29.6	3.5	80.2
PHY375WRF	2,620	1,004	38.32	31	3	37	27.5	3.8	81.9
DP161B2RF	2,822	999	35.40	31	4	39	32.5	4.1	83.6
ST5327B2RF	2,550	945	37.06	31	4	36	30.4	3.5	81.9
ST4554B2RF	2,610	933	35.75	31	4	37	29.9	4.1	82.2
DP147RF	2,618	927	35.41	31	3	38	30.2	3.8	81.7
DP167RF	2,523	899	35.28	31	3	37	29.0	3.7	80.9

Table 3. 2008 Variety trial, CASE Farm location, non-irrigated, planted May 21, 2008, harvested Dec. 20, 2008, 36-inch rows.

Variety	Seedcotton Lbs/Acre	Lint Yield Lbs/Acre	% Gin Turn-out	Color Grade	Leaf Grade	Staple	Strength	Micronaire	Uniformity
DP555BR	3,442	1,361	39.54	41	3	35	27.8	4.4	80.4
DP174RF	2,996	1,209	40.35	41	3	36	27.8	4.7	82.7
DP164B2RF	3,318	1,204	36.29	51	3	38	30.7	4.5	81.4
DP515BR	3,098	1,190	38.41	41	3	35	27.7	4.9	81.6
PHY370WR	3,093	1,185	38.31	51	3	35	28.2	4.7	81.6
DP161B2RF	3,253	1,175	36.12	41	3	38	30.9	4.4	82.5
DP143B2RF	3,184	1,168	36.68	41	4	37	27.2	4.3	81.2
DP141B2RF	3,142	1,141	36.31	51	4	37	29.8	4.5	81.9
DP167RF	3,072	1,124	36.59	41	3	37	30.6	4.5	82.9
PHY375WRF	2,833	1,086	38.33	51	3	36	29.5	4.3	82.6
DP147RF	2,866	1,054	36.78	51	3	37	31.2	4.2	81.1
PHY480WR	2,785	994	35.69	51	3	36	29.6	4.9	83.5
PHY485WRF	2,723	984	36.14	51	3	35	29.4	4.8	81.0
ST5327B2RF	2,730	980	35.90	51	3	36	30.1	4.4	81.7
ST4554B2RF	2,108	785	37.24	51	3	35	29.8	4.5	81.1

Table 4. 2008 Variety trial, yield and fiber quality, average of three locations.

Variety	Lint Yield Lbs/Acre [1]	% Gin Turn-out	Color (C1)	Color (C2)	Leaf Grade	Staple	Strength	Micronaire	Uniformity
DP555BR	1,264	39.39	3.33	1.00	3.33	35.3	28.13	4.10	80.73
DP174RF	1,242	39.75	3.33	1.00	3.33	37.0	28.60	4.33	83.53
DP515BR	1,199	37.96	3.67	1.00	3.33	35.3	28.87	4.30	82.00
PHY370WR	1,173	37.63	3.67	1.00	3.33	35.3	28.83	4.33	82.43
DP141B2RF	1,169	36.41	4.00	1.00	4.33	38.0	31.00	4.27	81.87
PHY485WRF	1,109	36.54	4.33	1.00	4.00	36.0	30.37	4.47	83.23
PHY480WR	1,100	35.71	4.00	1.00	4.00	36.7	30.17	4.50	83.77
DP143B2RF	1,083	35.93	3.33	1.00	4.00	38.0	29.00	3.80	80.63
PHY375WRF	1,068	37.85	4.00	1.00	3.00	36.3	29.40	4.00	82.20
DP161B2RF	1,048	35.45	3.33	1.00	3.67	38.7	31.97	4.17	83.23
DP164B2RF	1,046	35.39	4.00	1.00	3.00	37.7	29.83	3.93	81.00
DP147RF	1,031	36.16	4.00	1.00	3.33	37.7	30.43	3.97	81.87
ST5327B2RF	994	36.53	4.00	1.00	3.67	36.3	30.13	3.90	82.13
DP167RF	981	35.81	3.67	1.00	3.00	37.0	30.00	4.07	82.20
ST4554B2RF	909	36.22	3.67	1.00	3.67	36.0	29.00	4.20	81.63

[1]/ Yield per acre of the top five varieties was not statistically different, 95% confidence level, LSD=142 lbs per acre.

Table 5. 2008 Variety trial, value per acre, average of three locations.

Variety	Lint Yield Lbs/Acre	Loan Price Cents/Lb	Cotton Value/Ac	Seed Est. Lbs/Ac	Seed Value/Ac	GWSM	TOTAL Value/Ac [1]
DP555BR	1,264	54.73	$691.79	1,609	$153.66	$146.12	*$699.33*
DP174RF	1,242	55.50	$689.31	1,562	$149.17	$143.58	*$694.90*
DP515BR	1,199	54.43	$652.62	1,612	$153.95	$138.60	*$667.97*
PHY370WR	1,173	53.69	$629.78	1,597	$152.51	$135.60	*$646.69*
DP141B2RF	1,169	52.78	$617.00	1,670	$159.49	$135.14	*$641.35*
DP143B2RF	1,083	54.62	$591.53	1,576	$150.51	$125.19	*$616.85*
PHY480WR	1,100	53.23	$585.53	1,615	$154.23	$127.16	*$612.60*
DP161B2RF	1,048	55.41	$580.70	1,555	$148.50	$121.15	*$608.05*
PHY485WRF	1,109	52.36	$580.67	1,576	$150.51	$128.20	$602.98
PHY375WRF	1,068	53.85	$575.12	1,442	$137.71	$123.46	$589.37
DP164B2RF	1,046	53.59	$560.55	1,556	$148.60	$120.92	$588.23
DP147RF	1,031	53.86	$555.30	1,487	$142.01	$119.18	$578.13
DP167RF	981	55.18	$541.32	1,435	$137.04	$113.40	$564.96
ST5327B2RF	994	53.25	$529.31	1,413	$134.94	$114.91	$549.34
ST4554B2RF	909	53.80	$489.04	1,308	$124.91	$105.08	$508.87

[1]/ Value per acre is lint value plus cottonseed value minus GWSM (ginning, warehousing, storage, and marketing and promotions).

Value per acre of the top eight varieties is not statistically different at the 95% confidence level, LSD=$95.90 per acre.

APPLICATION OF WEATHER DATA TO HELP IMPROVE COTTON PRODUCTION

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Introduction

The year 2008 was again a very dry year, especially for North and Central Georgia, while Southwest Georgia was very wet and Southeast Georgia was very dry. When one analyzes the annual precipitation map that compares the 2008 rainfall with normal rainfall for the period 1971-2000, the spatial variability across Georgia is striking (Figure 1). The region around Attapulgus showed 15 inches above normal, while North Georgia showed between 10 and 17 inches below normal.

Most of the weather stations of the Georgia Automated Environmental Monitoring Network (www.Georgiaweather.net) showed a negative water balance for the cotton growing season, except for Attapulgus and Cairo, demonstrating the need for supplemental irrigation. The same observations were also made for previous years. These droughts are one of the main reasons that the availability of water for irrigation has become limited for Georgia producers. The future does not look very bright, especially for producers located in the Flint River basin. In 2000, the Georgia legislature approved the Flint River Drought Protection act. This act was implemented during both the 2001 and 2002 spring seasons. Farmers were asked to bid for acreage that they were willing to remove from irrigation. Fortunately, the drought mitigation act has not been implemented since 2003, as the weather outlook provided for a wetter growing season compared to the previous years. However, both 2007 and 2008 turned out to be one of the driest years on record. As a result, there serious water use restrictions across the state of Georgia. In addition, the discussions among the states of Georgia, Alabama, and Florida also intensified, especially due to the very limited availability of water for the greater Atlanta area.

The availability of near real-time weather data is critical for cotton production. This weather information can be used in various computer programs to help producers with their daily management decisions. There is a need to develop and implement computer-based information technologies for decision-making, using local weather data from Georgia and other input conditions such as soil and crop management. Although weather and decision support systems have not been listed as one of the research needs for the Georgia cotton industry, it directly or indirectly affects many issues and decisions that are made on a daily basis by producers. These decisions relate to planting date selection, deficit irrigation management, when to start and stop irrigation, replanting in case of establishment failure, irrigation timing and crop water use, and pesticide and herbicide applications. The strategic plan of the Georgia Cooperative Extension Service has identified Information Technology as one of the critical issues for the near future for dissemination of knowledge and information to farmers, producers, growers, consultants, and other stakeholders.

Materials and Methods

The College of Agricultural and Environmental Sciences of the University of Georgia has established an extensive network of automated weather stations that are located across the state of Georgia. There are currently 77 stations in operation in Albany, Arlington, Calhoun, Camilla, Cordele, Dublin, Newton, Statesboro, Vidalia, and many other locations (Figure 2). Several of these weather stations have been installed in farmers' fields, such as in Georgetown and Cordele. In 2008, two new weather stations were installed on the John A. Flowers Blueberry Farm in Odum, Wayne County, and on the Whitewater Creek Ranch in Howard, Taylor County. We expect the network to slowly expand in the coming years, with most of the new stations to be installed in areas where there is currently no or a poor coverage.

The weather variables that are collected include rainfall, air temperature, soil temperature, relative humidity, wind speed and direction, solar radiation, soil moisture, and barometric pressure. The data logger is the central core for the operation of the weather station and storage of the data and it automatically records the weather data. Each weather sensor is scanned at a one-second frequency and every 15 minutes summaries are calculated for the previous period. At midnight, daily extremes, daily totals, and other summaries are determined.

Each weather station is a stand-alone unit, powered by a battery, which is recharged by a solar panel. Communications are handled through a dedicated telephone line or cell phone, which is connected to the modem of each weather station. Recently, some new communication technologies have been added, including WiFi and a combination of local radio telemetry and the internet. A computer located at the Griffin Campus of the University of Georgia calls each station at 30-minute intervals or more frequently and downloads the data. After processing, error checking, and other procedures, all data are pushed to a web server. Users can retrieve various types of weather and climate data from www.Georgiaweather.net, including yesterday's conditions, weather conditions for the last 31 days, as well as historical data for temperature and rainfall. Weather data are also distributed to local news media, including television stations and newspapers, and to farmers and agribusinesses via electronic mail. Current weather conditions are now updated at least every 30 minutes for all sites and more frequently for some of the sites.

A key component for decision making by growers and producers is the suite of application programs that have been implemented on the web site (www.Georgiaweather.net). Users can calculate degree-days for any period of time until present. As part of the degree-day calculator, users can define the base temperature as well as a maximum temperature, above which no degree-days are calculated. During the winter months, users can also calculate chilling hour. A third calculator is the water balance calculator, which provides total precipitation received for any period of time, as well as potential evapotranspiration. Potential evapotranspiration is the potential amount of water that can be lost by a crop that is grown under well-watered conditions. The difference between total precipitation and total potential evapotranspiration reflects the need for irrigation to avoid water stress. Recent additions include simple calculators to provide the first and last frost dates. The newest tool has the capability to graph daily weather data, as shown for maximum and minimum temperature and daily total rainfall for Moultrie in Figure 3 and Figure 4, and local temperature predictions up to 12 hours ahead. Other new additions included a first and last frost date for each location where a weather station has been installed.

Results

For this study, we compared the cumulative number of degrees days, using a base temperature of 60 degrees Fahrenheit. We did not use a maximum temperature cutoff in our calculators. The results for 2008 were compared with the previous growing seasons from 2003 through 2007. Please note that the automated weather station network is continuously being expanded. As a result, we do not have complete weather records for all sites. Recent installations include Moultrie, Unadilla, Vienna, and Woodbine in 2005; Ty Ty, Tennille, and Blue Ridge in 2006, Baxley and Danielsville in 2007, and Howard and Odum in 2008. We defined the start of the growing season as May 1 and the end of the growing season as October 31. In reality, this can vary from location to location. Cumulative degrees days for the 2003 through 2008 growing seasons are shown in Table 1. The maximum number of degree-days for 2008 was found in Albany at 3267, Valdosta at 3243, Savannah at 3072, Cairo at 3060, and Vidalia at 3059. The minimum number of degrees in 2008 was found in Rome at 2357, Watkinsville at 2469 and Griffin at 2474. For all sites, the cumulative total number of degree-days was significantly lower for 2008 than for 2007. For the six-year period from 2003 through 2008, 2003 had the lowest number of degree days for about 70% of the sites, while 2008 had the lowest number of degree days for the remaining sites. 2004, 2005, and 2006 were very similar, while 2007 had the highest number of degree days.

Cumulative precipitation for May 1 until October 31 is shown in Table 2. Similar to the previous years, rainfall varied significantly across the state and among weather stations for this period. Cordele and Watkinsville were the driest locations, with respectively 15.5 and 16.8 inches. Attapulgus, Cairo, and Camilla had the highest amount of precipitation, with respectively 40.3 and 37.7, and 31.1 inches of rain. When comparing the period 2003 through 2008, the growing season of 2008 was wet for some sites, with the highest amount of rainfall received during the last six years. However, note that, for instance for Attapulgus, 16 inches of rain was recorded from August 20 through August 25. This shows that total amount of rain during the growing season is not always a good indicator for dry or wet conditions.

The water balance for the same period is presented in Table 3. The water balance represents the difference between incoming water through rainfall and outgoing water lost through potential evapotranspiration for a well-watered crop. All sites except for Attapulgus, Cairo, and Camilla had a negative water balance that ranged from -1.6 inches for Dixie to -17.7 for Cordele. During the period from 2003 through 2008, two sites had a negative water balance for all six years. These include Dearing, and Fort Valley, while eleven sites had a negative balance during five of the six years, e.g., Arlington, Attapulgus, Cairo, Camilla, Cordele, Dublin, Elberton, Jeffersonville, Plains, Rome, and Valdosta. This is somewhat of concern and could mean that for these sites an investment in supplemental irrigation should be recommended. Unfortunately, the water balance does not provide much information with respect to both the rainfall distribution and intensity, and only provides a seasonal summary. For instance, recent reports show that late rains really help boost cotton yields compared to the early estimates based on drought and heat stress.

Summary and Conclusions

Temperature and rainfall display a very strong annual variability, as well as among sites. Although this is not a new observation, it shows that the availability of local weather information is critical for day-to-day decision making by farmers. This weather information can be integrated in management and decision support tools, such as models, to provide alternate management options and solutions for farmers. Especially schedulers for irrigation management are needed if water for agricultural use will become restricted.

The automated weather station network will continue to collect local weather data as long as financial support will be provided by industry, government, and others interested in weather data to support their operation and management decisions. Weather information can be retrieved at no-cost via the world wide web at www.Georgiaweather.net and specific web pages have been developed for cotton producers to be able to quickly retrieve degree days (www.griffin.uga.edu/aemn/degreedays.htm) and cumulative rainfall (www.griffin.uga.edu/aemn/rainNOV.htm) for the main cotton producing areas in Georgia. The degree-day and water balance calculators can also be run interactively on the web, using local weather data as input. We feel that the combination of near real-time weather data and decision support systems is critical to maintain an economically sustainable farming operation.

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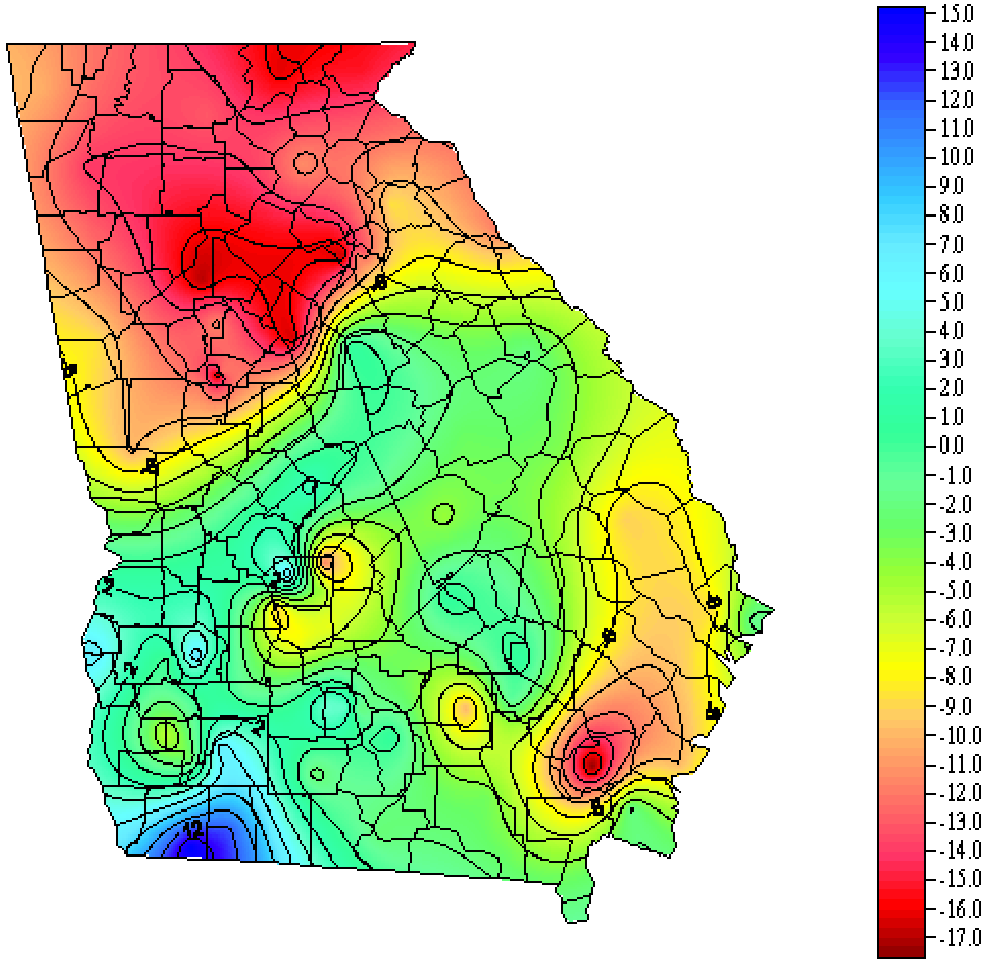

Figure 1. Deviation from normal (1971-2000) precipitation (inches) for January 1 - December 31, 2008

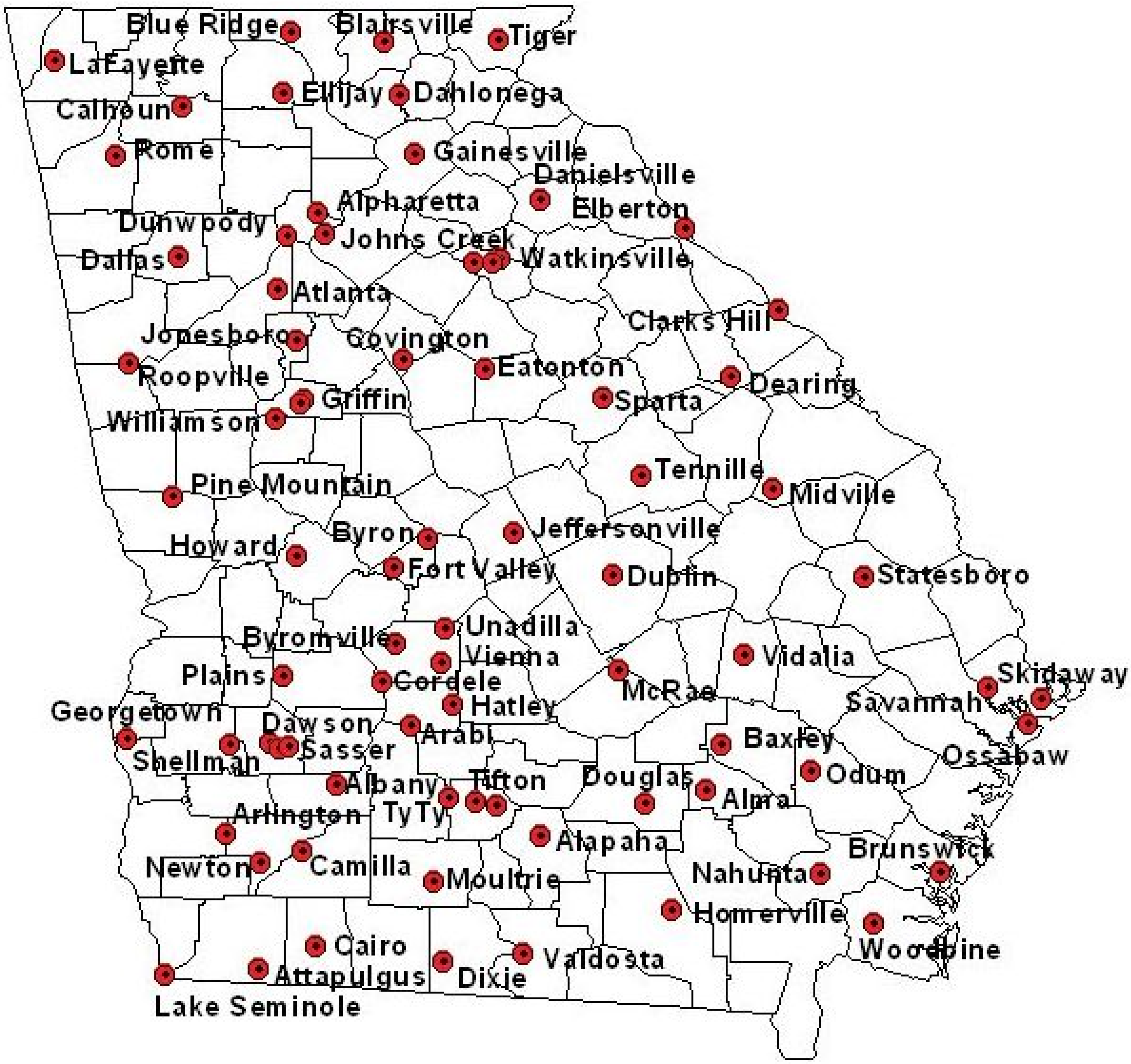

Figure 2. Location of the weather stations of the Georgia Automated Environmental Monitoring Network.

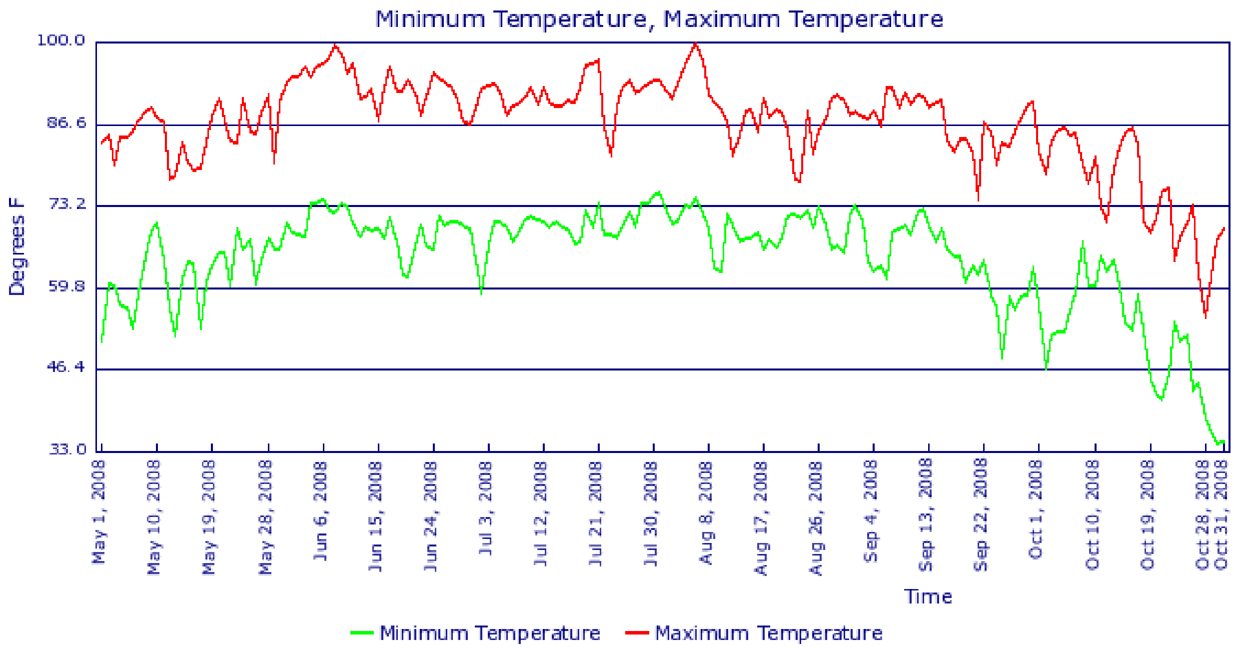

Figure 3. Daily maximum and minimum temperature for May 1 through October 31, 2008 for Cordele, Georgia.

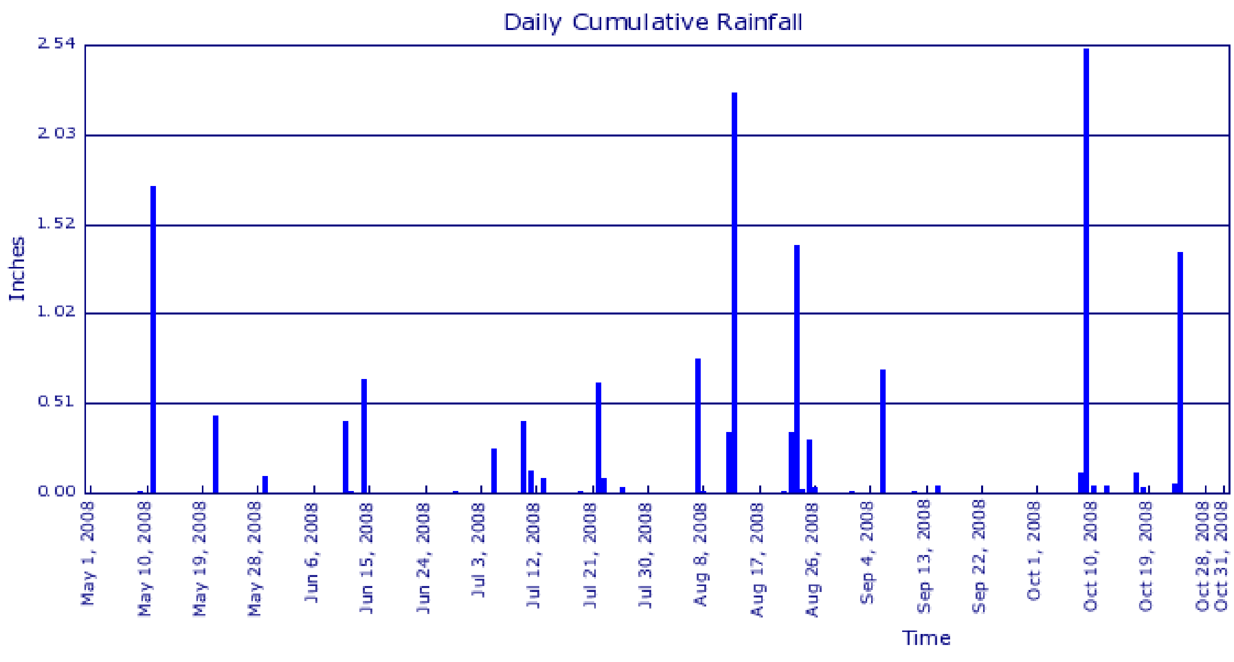

Figure 4. Daily total precipitation for May 1 through October 31, 2008 for Cordele, Georgia.

Table 1. Degree-days from May 1 until October 31 with a base of 60 ^{o}F.

Site	2008	2007	2006	2005	2004	2003
Alapaha	2850	3038	2600	3025	3052	2941
Albany	3267	3421	3253	3250	3279	N/A
Alma	3035	3216	3056	3162	3182	3030
Arlington	2941	3189	2985	3086	3067	2923
Attapulgus	2945	3209	3046	2850	3096	3023
Cairo	3060	3335	3120	3185	3275	3043
Camilla	2882	3275	3096	3133	3225	3026
Cordele	2920	3144	3020	3102	3124	2946
Dearing	2861	3050	2837	2898	2984	2676
Dixie	2814	3263	3009	3208	3242	3067
Dublin	2980	3047	2993	3048	3077	2818
Elberton	2700	2950	2612	2720	2749	N/A
Ft. Valley	2805	3031	2910	2895	2889	2610
Georgetown	2888	3100	2926	2892	2936	2822
Griffin	2474	2709	2540	2495	2515	2269
Homerville	2920	3115	2983	3137	3125	2966
Jeffersonville	2738	2882	2779	2780	2845	2597
McRae	2875	2929	2798	2916	2934	N/A
Midville	2955	3081	2904	3019	3010	2758
Moultrie	3041	3302	3136	3105	N/A	N/A
Plains	2712	3015	2947	2924	2938	2741
Rome	2357	2684	2444	2475	2430	2182
Savannah	3072	3142	3001	3251	2983	2936
Statesboro	2821	3040	2689	2724	3029	2818
Tifton	2935	3161	3025	3080	3196	2950
Valdosta	3243	3452	3384	3456	3467	3224
Vidalia	3059	3169	3082	3147	3219	2935
Watkinsville	2469	2761	2487	2497	2548	2294

Table 2. Total precipitation (inches) from May 1 until October 31.

Site	2008	2007	2006	2005	2004	2003
Alapaha	21.76	22.74	20.74	18.93	35.70	40.79
Albany	29.50	20.10	25.78	30.15	33.34	N/A
Alma	27.69	27.83	19.46	23.39	33.45	35.23
Arlington	23.68	18.16	28.62	28.11	32.61	23.49
Attapulgus	40.29	18.22	27.79	28.13	28.83	25.39
Cairo	37.74	25.13	19.76	27.51	28.10	27.29
Camilla	31.13	21.15	25.65	24.24	23.77	25.71
Cordele	15.49	18.91	17.16	19.77	34.72	27.71
Dearing	20.38	10.18	21.20	28.31	28.32	22.22
Dixie	30.20	28.93	20.27	32.97	35.63	27.84
Dublin	19.29	20.53	17.06	17.93	31.73	32.42
Elberton	18.88	9.56	19.39	25.60	23.40	N/A
Ft. Valley	23.16	21.09	12.20	23.94	20.56	17.04
Georgetown	27.50	19.13	17.90	25.63	25.52	33.29
Griffin	20.10	15.50	16.52	31.71	35.52	32.80
Homerville	25.58	25.28	16.72	28.89	40.88	32.63
Jeffersonville	18.18	17.81	16.85	22.52	29.00	28.80
McRae	23.54	21.81	19.62	17.30	35.79	N/A
Midville	17.65	17.89	14.37	28.71	30.45	35.20
Moultrie	21.60	28.95	12.63	28.20	N/A	N/A
Plains	24.78	18.13	27.07	29.11	32.07	26.00
Rome	18.27	13.41	19.61	15.30	24.12	31.85
Savannah	27.81	32.86	18.48	31.00	37.85	24.52
Statesboro	17.98	25.55	19.28	28.86	24.37	36.34
Tifton	26.31	22.22	15.78	18.84	33.62	31.78
Valdosta	27.72	25.30	22.93	31.12	31.96	25.97
Vidalia	27.51	29.15	13.03	15.75	35.86	40.37
Watkinsville	16.76	12.21	17.70	29.02	30.36	34.27

Table 3. Water balance (inches) from May 1 until October 31. (The calculation of the water balance is based on [total seasonal rainfall - total seasonal evapotranspiration]).

Site	2008	2007	2006	2005	2004	2003
Alapaha	-9.00	-9.39	-6.13	-6.60	9.69	14.35
Albany	-4.64	-12.98	-7.74	-0.91	1.38	N/A
Alma	-4.57	-4.63	-14.13	-7.83	2.50	5.82
Arlington	-9.09	-14.40	-3.80	-1.27	2.62	-5.22
Attapulgus	10.89	-13.77	-5.18	-2.48	-2.08	-2.92
Cairo	5.80	-7.00	-12.85	-1.80	-2.17	-1.16
Camilla	1.13	-10.69	-7.76	-7.20	-8.08	-4.04
Cordele	-17.73	-14.68	-16.82	-14.21	1.21	-3.64
Dearing	-11.84	-21.58	-10.45	-0.89	-2.10	-5.67
Dixie	-1.57	-4.15	-11.60	3.15	4.49	-1.96
Dublin	-11.45	-11.06	-14.51	-12.72	-0.51	3.04
Elberton	-15.83	-25.27	-10.41	-4.27	-5.05	N/A
Ft. Valley	-8.20	-11.99	-20.15	-0.18	-3.90	-6.92
Georgetown	-2.11	-11.78	-13.28	0.88	-0.77	6.92
Griffin	-10.23	-16.06	-15.21	3.51	7.18	5.27
Homerville	-4.57	-5.08	-14.56	0.97	12.15	5.07
Jeffersonville	-13.75	-14.07	-15.61	-8.10	-1.11	2.21
McRae	-7.31	-11.46	-11.84	-12.28	5.44	N/A
Midville	-15.30	-15.48	-18.93	1.22	3.59	7.25
Moultrie	-10.83	-3.99	-21.43	-3.12	N/A	N/A
Plains	-4.83	-15.77	-6.96	-1.27	2.87	-1.04
Rome	-9.27	-15.05	-9.07	-11.21	-1.41	7.19
Savannah	-2.46	2.18	-13.34	1.82	9.02	-4.06
Statesboro	-15.12	-6.27	-12.29	0.35	-5.31	8.59
Tifton	-6.67	-10.47	-17.61	-12.02	2.70	0.90
Valdosta	-4.81	-6.71	-10.32	-0.75	0.06	-2.85
Vidalia	-4.35	-7.95	-25.64	-15.40	2.47	11.35
Watkinsville	-13.69	-18.68	-11.44	1.02	1.24	7.47

COMPARISON OF THE UGA MICRO GIN, A LABORATORY GIN, AND A COMMERCIAL GIN IN GEORGIA

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Abstract

The University of Georgia Micro Gin located on the Tifton Campus provides an opportunity for researchers to gin research size cotton samples. Since its completion in 2004, UGA researchers at the Tifton campus as well as other researchers across the cotton belt have used the UGA Micro Gin as a tool for various research projects. However, some questions regarding the performance and the proper ginning protocol of the UGA Micro Gin still remain. The overall goal of this study is to compare the UGA Micro Gin with a commercial gin located in southwest Georgia based on fiber quality and turn out rate. The laboratory gin was used as a standard to compare them. In total, five different cotton varieties grown in southwest Georgia with five replicates were tested.

Introduction

Cotton researchers generally use small research plot trials to evaluate the fiber quality from certain varieties, various treatments, as well as other growing methods (Brown et al., 2004). These small research plots cannot generate enough cotton for a commercial gin to separate the lint from seeds, which is a necessary step for fiber lint quality evaluation (Boykin et al., 2008). Researchers have been using the laboratory gin to gin the small amount of cotton samples for many years. However, the hand gin also has several drawbacks for fiber quality evaluation: first, it usually has a totally different design from the commercial gin: it does not have seed cotton cleaning and lint cleaning steps, which are standard procedures in any commercial gin. This different design typically contributes to the overestimation of the cotton fiber quality such as staple, strength, and uniformity; second, the lab gin can only gin a small amount of cotton from the plot, not the complete research plot. This leads to the large variation due to different methods used to draw cotton samples from the research plot. For instance, fiber quality of cotton samples drawn from the end of a row might be quite different from that of cotton samples drawn from the middle of the row.

The Micro Gin at The University of Georgia Tifton Campus provides an opportunity for researchers to gin research size cotton samples and enable the ginning of cotton samples from a whole research plot. By using the Micro Gin, researchers can gin small size (e.g. 30 lbs) cotton samples and evaluate new cotton varieties or treatments in a quick manner. Since its completion in 2004, UGA researchers at the Tifton campus as well as other institutions across the cotton belt have used it to do numerous research projects. However, several questions still remain unanswered, such as how well the UGA Micro Gin performs compared to a commercial gin? Can the UGA Micro Gin be used as a substitute of a commercial gin to accurately predict the cotton fiber quality and lint yield? Although one previous study was made to fill this knowledge gap (Brown et al., 2004), due to lack of replicates, this study could not compare different ginning methods statistically. This study is a continuation of the previous study in order to answer the fundamental question raised above.

Objectives

The overall goal of this study was to compare the UGA Micro Gin and a commercial gin based on the fiber quality and turnout rate over several cotton varieties. The laboratory gin was used as a standard to compare them. Specific objectives were:

- To compare the UGA Micro Gin, commercial gin, and laboratory gin regarding their ginning turnout rate;
- To compare the UGA Micro Gin, commercial gin and laboratory gin in terms of the cotton fiber quality based on the HVI data.

Materials and Methods

Cotton was grown in Colquitt County in Georgia and harvested in October, 2008. Five cotton varieties, ST 4554, PHY 375, PHY 480, ST 5327, and DPL 555, were used for the ginning turnout portion of the study. Three cotton varieties, PHY 480, DPL 555, and FM 1735, were used for fiber quality comparison. Five replicates were used for each cotton variety. In order to compare the performance of the three gins, cotton samples were collected in the field from the picker as the cotton was unloaded into the module builder and the same cotton samples from the same field were ginned across all three gins.

Three gins were compared in this study: the UGA Micro Gin (Lummus Inc., Savannah, GA and Cherokee Inc., Salem, Alabama), a commercial gin (due to the mutual agreement, the name of the commercial gin was not released), and a laboratory gin (Continental Eagle 10 saw laboratory gin). The UGA Micro Gin uses the same equipment used in commercial gin but in one foot wide versions. The equipment is arranged in the standard configuration for spindle picked cotton. Unlike the laboratory gin, the UGA Micro Gin provides full drying as well as seed cotton and lint cleaning. Seed cotton cleaning is accomplished in two stages. Stage one includes a six cylinder incline cleaner dropping into a stick machine. Cleaning in stage two is accomplished with the use of another six cylinder incline cleaner feeding into a Trashmaster cleaner. If the research calls for it, either of the seed cotton cleaning stages may be bypassed. Once the seed cotton leaves the first two stages of cleaning it enters the extractor feeder and gin stand. The gin stand is a 24 saw version of a Lummus gin stand. Once the lint is removed from the seed in the gin stand the lint cleaning portion of the process begins. The first stage of lint cleaning is done with an air jet type cleaner. The second stage consists of two saw type lint cleaners manufactured by Cherokee Fabrication. Just like the seed cotton cleaning process, there is an option to use one, two, or even no lint cleaners depending on how the researcher wants the cotton processed.

All samples ginned at the UGA Micro Gin are processed using a set standard operating procedure. This standard operating procedure consists of conditioning, weighing, ginning, and fiber sample collection. The conditioning portion of the process begins by lining the bags up inside the gin and allowing them to sit for at least a 24 hour period. This gives time for each bag to come to equilibrium as far as moisture is concerned. Once the bags have conditioned, the incoming weights are taken just before ginning begins. The ginning procedure is set forth by the researcher. The final step of the process is to collect fiber samples. Once the lint has been cleaned it is collected in bags, this allows the lint to be weighted to determine lint turn out. As the lint is entering the bag three fiber samples are taken at the beginning, middle, and end of the run. These three sub samples are then combined to make one fiber sample for each replication of the study being ginned. The fiber samples are then sent to the USDA Classing Office for testing.

For both the ginning turnout and fiber quality comparison study, cotton samples were roughly 30 lbs for the UGA Micro Gin, and 1 lb for the laboratory gin. Cotton samples were put into mesh bags (for Micro Gin) and paper bags (for laboratory gin), and laid out in the UGA Micro Gin facility for at least 24 hours to condition them before ginning.

The turnout rate for the UGA Micro Gin and the laboratory gin was calculated by dividing the lint weight by the total seed cotton weight from each cotton sample. As a result, five turnout rates were obtained from five replications of each variety. However, for the commercial gin, the turnout rate was calculated by dividing the lint weight of a module (the smallest ginning unit) by the total weight of the seed cotton in that module. Therefore, only one turnout rate was obtained from each variety for the commercial gin. No statistics were calculated for the commercial gin turnout rate for a certain variety.

Fiber quality was evaluated by HVI (Uster Technologies, Knoxville, TN) at the USDA Cotton Classing Office in Macon, GA. Five fiber quality parameters were selected for the purpose of comparison: staple length, micronaire, strength, leaf grade, and uniformity.

The t-test statistical analysis was performed using Data Analysis Module of Excel 2007 (Microsoft Inc., Redmond, WA). For gin turnout comparison, since there was only one module for each variety from the commercial gin, no statistical analysis was made for the turnout rate of the commercial gin. For fiber quality comparison, t-test was performed to test the “equal means” of cotton fiber quality parameters between the UGA Micro Gin vs. commercial gin, and the UGA Micro Gin vs. laboratory gin, respectively.

The null hypothesis was that the mean values of a certain fiber quality parameter from two treatments were equal. All tests were conducted under the significant level of 95%.

Results and Discussion

As shown in Figure 1, ginning turnout rate of the laboratory gin was consistently higher than that of the other two gins across 5 varieties. This is reasonable because the lab gin does not have seed cotton cleaning and lint cleaning procedures, so more trash ends up going into the final lint product, which contributes to the higher turnout rate. The error bars in the figure show the standard deviation of each measurement. It was observed that variances of the turnout rate were relatively small for most of the varieties except for PHY 375 and PHY 480 for lab gin treatment. The turnout rate of the UGA Micro Gin was slightly higher than that of the commercial gin for 3 varieties (ST 4554, PHY 375, PHY 480), but lower than that of the commercial gin for the other 2 varieties (ST 5327, DPL 555). The performance of the UGA Micro Gin is much closer to the commercial gin regarding the turnout rate. For three out of the five varieties, the UGA Micro Gin had slightly higher turnout rates, while the commercial gin had slightly higher turnout rates than the UGA Micro Gin for the remaining two varieties. The UGA Micro Gin had higher variation for two varieties: ST 4554 and PHY 375, while the variation for the other three varieties were relatively small.

As indicated in Figure 2 and Table 1, no significant differences were observed between the UGA Micro Gin and laboratory gin regarding four quality parameters: staple, micronaire, strength, and uniformity across all three tested cotton varieties. However, leaf grade from the lab gin was much worse than that of the UGA Micro Gin, because no seed cotton cleaning or lint cleaning was performed during ginning of lab gin. This indicates that the UGA Micro Gin performs very closely to the lab gin in terms of the damage to the cotton fiber.

The significant differences were observed between the UGA Micro Gin and the commercial gin regarding staple, strength, and uniformity. Lint fiber quality (staple, strength, and uniformity) from UGA Micro Gin was consistently better than that from the commercial gin (this suggests that the UGA Micro Gin is less aggressive than commercial gin with regard to fiber damage). However, for micronaire, no significant difference was observed among the three gins, which suggests that micronaire is not a quality parameter that can be affected by the ginning process. For leaf grade, the UGA Micro Gin and the commercial gin are significantly different (3 vs. 4) in two varieties (DPL 555 and FM 1735), but not significantly different (4 vs. 4) for variety PHY 480.

Conclusion

The UGA Micro Gin was compared with a commercial gin and a laboratory gin in terms of ginning turnout rate and the fiber quality of the ginned lint. Based on results obtained above, the turnout rate of the UGA Micro Gin is much closer to the commercial gin than

the lab gin. In five tested varieties, the turnout rate of the UGA Micro Gin was higher than that of the commercial gin in three varieties, but lower in two varieties. As for the damage to the cotton fiber, the UGA Micro Gin is less aggressive than the commercial gin with regard to staple, strength, and uniformity. No significant difference was observed for micronaire in all three tested varieties. The UGA Micro Gin gave a better leaf grade (lower leaf grade value) than the commercial gin did for two varieties, but the difference was not significant in one variety.
Although this study showed differences between a commercial gin and the UGA Micro Gin, the differences between these two gins were narrower than those between a lab gin and commercial gin. This study only chose one commercial gin as a comparison, which did not provide a good representation. More than one commercial gins should be selected for comparison and better control of sampling methods will be taken in the future study.

Acknowledgements

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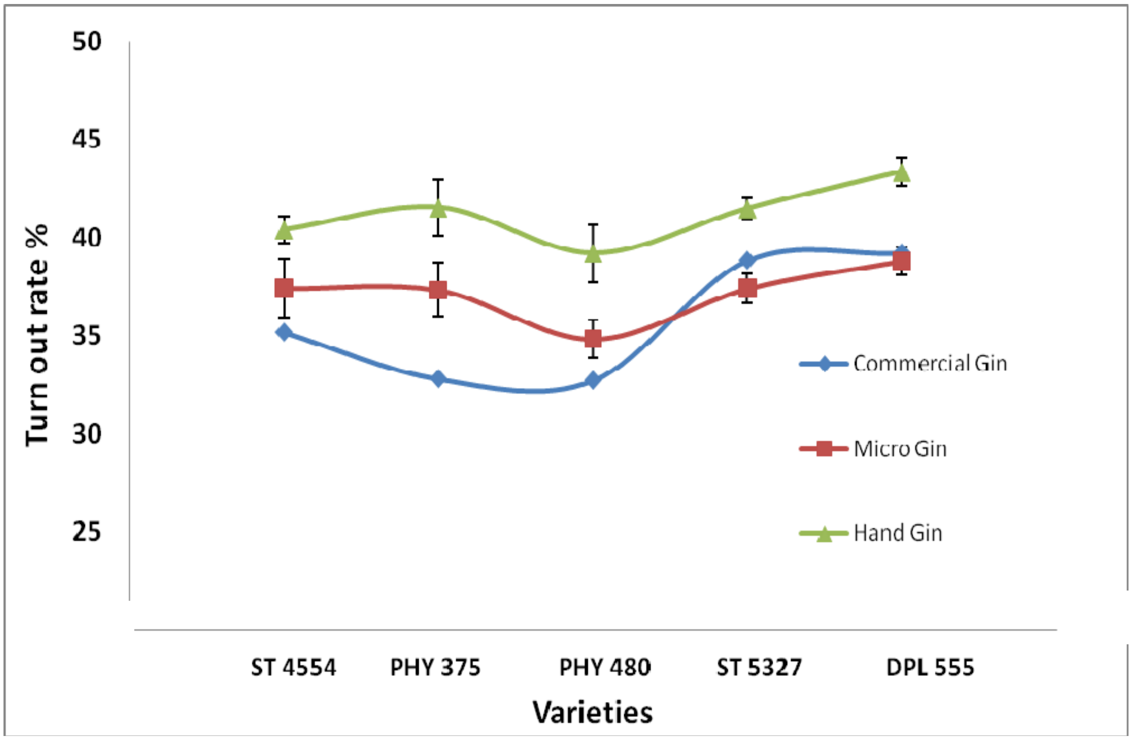

Figure 1. Turn out rate comparison of three gins.

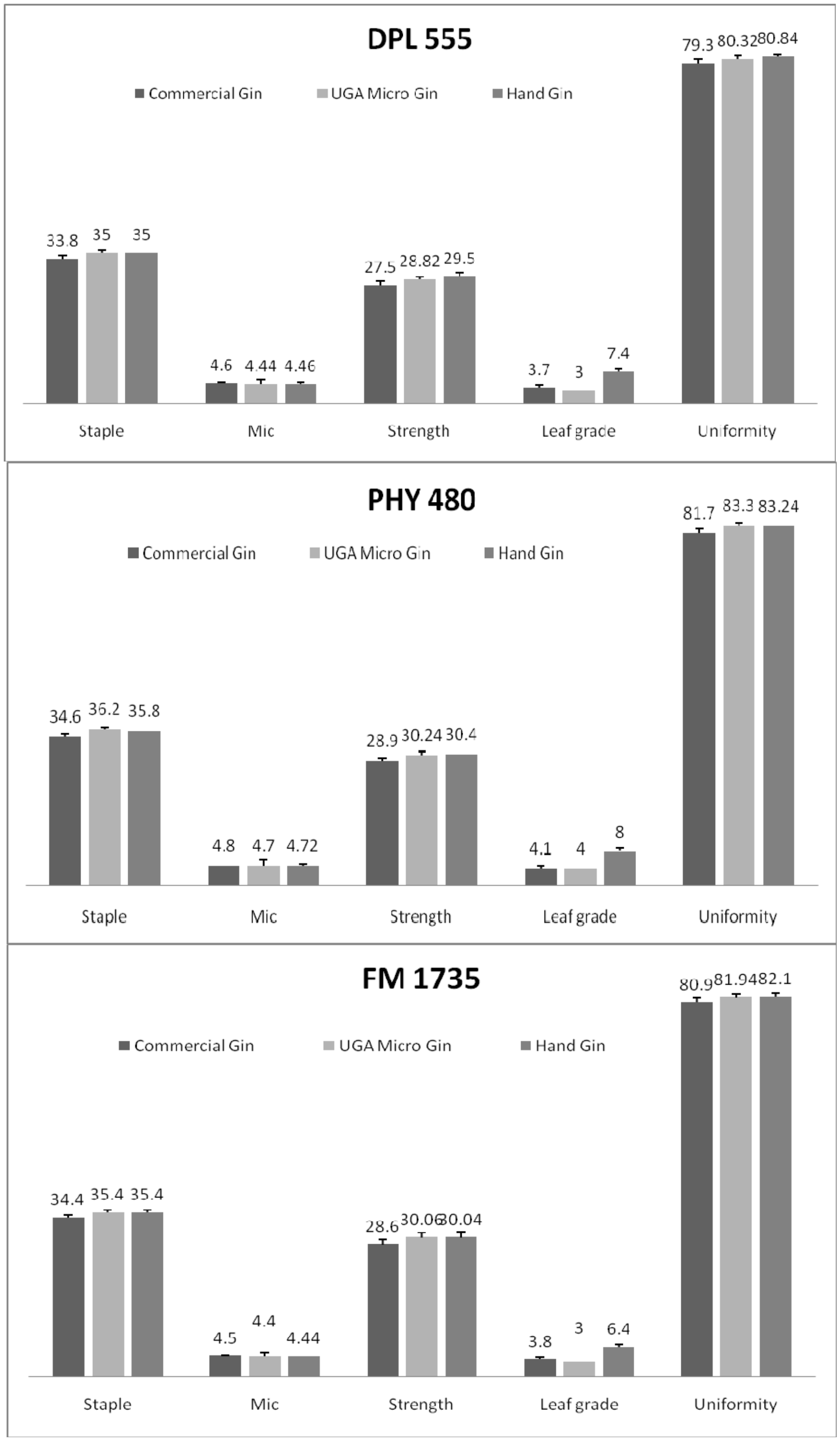

Figure 2. Comparison of three gins on five cotton fiber quality parameters across 3 cotton varieties.

Table 1. Performance comparison of three gins on the cotton fiber quality using the t-test (significant level 95%).

		Staple	Micronaire	Strength	Leaf grade	Uniformity
DPL 555	M vs. C	P=0.006	n.s.	P=0.003	P=0.0001	P=0.0135
	M vs. H	n.s.	n.s.	n.s.	P<0.0001	n.s.
PHY 480	M vs. C	P<0.0001	n.s.	P=0.01	n.s.	P=0.0016
	M vs. H	n.s.	n.s.	n.s.	P<0.0001	n.s.
FM 1735	M vs. C	P=0.005	n.s.	P=0.0129	P<0.0001	P=0.0038
	M vs. H	n.s.	n.s.	n.s.	P<0.0001	n.s.

M: UGA Micro Gin; C: Commercial Gin; H: laboratory gin;
n.s.: no significant difference

2008 COTTON VARIETY TRIALS

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Introduction

The 2008 University of Georgia Cotton Variety Trials (OVT) were conducted at five locations across Georgia, spanning the cotton belt from southwest to northeast Georgia. Irrigated trials were conducted on-farm in Decatur County and at University research stations and/or education centers in Midville, Plains, and Tifton. Dryland trials were conducted on University research stations and/or education centers in Athens, Midville, Plains, and Tifton. Performance data in these tables, combined with data from previous years should assist growers in variety selection, one of the most important if not most important decisions in an economically viable cotton production plan. Data collected from the University of Georgia Variety Testing Cotton Program can be found at the Statewide Variety Testing Website: www.swvt.uga.edu. Also, the data is published in the UGA Agricultural Experiment Station Research Report Number 719, January 2009.

Materials and Methods

The University of Georgia conducts Official Cotton Variety and Strain trials across Georgia to provide growers and county agents with performance data to help in selecting varieties. Data from the OVT also helps the private seed companies assess the fit of their products in Georgia. The University of Georgia cotton OVT is conducted by J. LaDon Day, Program Coordinator Cotton OVT, Griffin, GA. along with Mr. Larry Thompson, Research Professional I, Tifton, GA. The OVT is split into variety and strain trials with placement of varieties or strains into the particular trial chosen by its owner. Trials are separated by maturity. Irrigated OVT trials are conducted at Bainbridge, Midville, Plains, and Tifton, while dryland OVTs are conducted at Athens, Midville, Plains, and Tifton, thus varieties placed into the OVT are included in eight trials per year, giving a fair size data set with which to evaluate variety performance. The strains trials are irrigated and conducted at Midville, Plains, and Tifton. Trials consist of 4-replicate, randomized complete block designs. An accepted, common, management system is employed at each location for agronomic and pest management, but transgenic cultivars are not produced according to their intended pest management system(s). A random quality sample was taken on the picker during harvest and ginned to measure lint fraction on all plots including the irrigated late maturing trial at Tifton, but a portion of the seed cotton from the later maturity plots was bagged and sent to the Micro Gin at Tifton for processing. All fiber samples were submitted to Starlab, Knoxville, TN for HVI analyses. All trials were harvested with a state-of-the-art harvest system composed of a International IH 1822 picker fitted with weigh baskets and suspended from load sells. This system allows one person to harvest yield trials where the established bag-and-weigh approach required eight people or more. The electronic weigh system allowed for timely harvest of yield trials. Data from all trials and combined analyses over locations and years are reported as soon as fiber data are available from the test lab in Adobe pdf and Excel formats on the UGA Cotton Team Website maintained at www.ugacotton.com. Also, the data is available at the Statewide Variety Testing Website: www.swvt.uga.edu.

Results and Discussion

2008 row crop season in Georgia can best be described as dry and hot for the third consecutive year. Beginning in April extreme to exceptional drought (a 100 year event) developed over two-thirds of the state. Above normal summer temperatures, especially during the very hot first two weeks of June, and drought conditions took their toll on the dryland crops. However, areas across the southern part of the Coastal Plain received some beneficial tropical storm rainfall. Greater amounts of irrigation were needed to produce what turned out to be a good crop year.

During 2008, cotton producers planted 950,000 acres of cotton. This number of acres planted was a decrease of 8% less than 2007; further, it was the first year since 1994 that Georgia cotton farmers last planted less than a million acres of cotton. The number of acres of harvested cotton was the lowest in 14 years but a surprising 843 pounds per acre lint yield produced 1.65 million bales, only a 1% reduction from 2007.

Among varieties in the Dryland Earlier Maturity Trials, three varieties GA2004230, GA2004303, and DP0935B2RF stand out as varieties with high yield and relative yield stability in the dryland trials (Table 1). There were five other varieties that performed above average (Table 1). When summarized over two years and four locations GA2004303 and ST5327B2RF were the top performers (Table 2).

Among the best performing earlier maturing varieties produced under irrigation, PHY370WR, DP164B2RF, DP0924B2RF, FM1740B2RF, and PHY375WRF were the top five highest averaged over locations (Table 3). Eight other varieties performed well within the top group (Table 3). PHY370WR, ST 4554B2RF, and PHY375WRF when averaged over two years and locations in the Irrigated Early Maturity Trials conducted at Bainbridge, Midville, Plains, and Tifton, were the top yielding group. However, nine other varieties yielded above average (Table 4).

Later maturity trials produced without irrigation and averaged over four locations revealed the consistent performance of DP555BG/RR, GA2004137, DP0935B2RF, DP174RF, GA2004371, GA2004358, DP164B2RF, BCSX0614B2RF, and PHY375RF as significant high yielding (Table 5). Averaged over locations and years, GA2004371 and DP555BG/RR were the front runners (Table 6).

Under irrigation, DP555 BG/RR, BCSX0727B2RF, DP0935B2RF, DP174RF, and PHY375WRF led the standard later maturing trials averaged over locations (Table 7), while 8 other varieties were within the top group in lint yield. Averaged over years and locations, DP555BG/RR was the best performer (Table 8) with two other varieties yielding above average.

The Earlier Maturity and Later Maturity Strains Trials contain improved varieties for crop seasons 2009 and beyond (Tables 9). Varieties from Bayer CropScience, Georgia, and Monsanto DP were high yielding performers among standard earlier and later maturing entries in the strains trial.

Presented in Table 10 is the Tifton, Georgia, 2008, Later Maturity cotton variety performance, irrigated, data comparing 'small gin' seed/lint with samples processed through the Micro-gin (MG) on the Tifton Campus. The seed cotton from the Later Maturity experiment was sub-sampled, ginned and sent to Star Lab in Knoxville, TN for HVI analysis. The remaining seed cotton was sent to the Micro-gin, Tifton Campus for processing and also sent to Star Lab for HVI analysis.

In summary, several new varieties described herein signify higher yield potential and improved fiber quality available to Georgia growers.

Table 1. Yield summary for dryland earlier maturity cotton varieties, 2008.

	Lint Yield[a]														
Entry	Athens		Midville		Plains		Tifton		4-Loc. Average		Lint	Unif. Index	Length	Strength	Mic.
	---------------------------- lb/acre ----------------------------										%	%	in	g/tex	units
GA2004230	953	20	**1475**	2	**1100**	3	**979**	1	**1127**	1	43.6	84.5	1.25	33.2	4.7
GA2004303	981	16	**1559**	1	**1002**	5	**963**	2	**1126**	2	45.1	82.5	1.14	33.6	5.0
DP 0935 B2RF	**1024**	9	**1425**	4	951	9	**933**	4	**1083**	3	43.7	82.6	1.14	30.7	4.7
DP 555 BG/RR	985	15	**1440**	3	**1120**	2	**753**	14	**1074**	4	43.8	81.5	1.14	32.5	4.7
DP141B2RF	932	22T	1331	10	**983**	6	**904**	5	**1037**	5T	43.4	82.9	1.22	33.0	4.7
GA2004143	**1039**	5	1321	11	**1146**	1	642	23	**1037**	5T	46.7	83.0	1.20	35.0	4.9
DP 143 B2RF	**1022**	10	1368	7	961	8	**749**	15	**1025**	6	42.4	82.6	1.23	31.7	4.6
DP161B2RF	**1041**	4	1220	20	842	15	**953**	3	**1014**	7	40.6	83.3	1.20	33.5	4.8
FM1740B2RF	**1123**	2	1248	17	772	22T	**888**	6	**1008**	8	44.4	83.3	1.15	31.5	4.9
NG3331B2RF	954	19	1363	8	932	11	696	20	986	9	43.3	83.9	1.13	34.2	5.4
PHY370WR	883	26	1399	5	817	17	**787**	10	972	10	44.5	82.6	1.10	31.0	4.9
PHY315RF	925	24	1356	9	**970**	7	611	29	965	11	44.2	82.4	1.14	30.3	4.7
NG4370B2RF	932	22T	1313	12	937	10	647	22	958	12	42.2	82.9	1.14	31.4	4.9
ST5327B2RF	**1034**	7	1245	18	917	12	628	26	956	13	43.6	82.7	1.14	32.3	4.7
ST 4554B2RF	955	18	1179	24	772	22T	**864**	7	943	14	43.2	82.0	1.13	31.7	5.0
PHY440W	**1145**	1	1072	34	887	13	616	28	930	15	43.2	83.6	1.16	32.3	5.0
DP 0924 B2RF	822	31	1377	6	738	24	**740**	16	919	16T	43.7	82.5	1.14	31.3	5.1
NG4377B2RF	880	27	1203	21	733	25	**860**	8	919	16T	43.1	82.4	1.12	30.2	5.0
ST4427B2RF	974	17	1065	35	**1081**	4	543	34	916	17	42.7	82.7	1.14	31.3	4.6
BCSX0187LLB2	991	12	1283	15	796	19	571	32	910	18T	42.7	82.2	1.15	33.2	4.8
PHY375WRF	866	28	1286	14	681	29	**805**	9	910	18T	46.1	82.3	1.14	30.3	4.8
FM1735LLB2	986	14	1180	23	698	28	**772**	13	909	19	40.6	82.8	1.14	35.5	4.8
STX4498B2RF	**1038**	6	1235	19	773	21	551	33	899	20	41.9	82.5	1.14	33.2	4.8

DP 164 B2RF	933	21	1158	27	709	27	**779**	11	895	21	40.6	82.9	1.19	33.2	4.9
BCSX0888LLB2	**1056**	3	1277	16	775	20	467	36	894	22	42.7	83.3	1.17	34.2	5.3
CG4020B2RF	**1020**	11	1094	32	770	23	677	21	890	23T	43.1	82.5	1.17	28.9	4.5
PHY485WRF	846	30	1167	26	772	22T	**775**	12	890	23T	41.8	83.0	1.16	33.3	5.0
AM1550B2RF	782	34	1134	30	880	14	737	17	883	24	43.8	81.9	1.14	29.2	5.0
CG 3220B2RF	927	23	1183	22	772	22T	593	31	869	25T	43.1	82.2	1.15	29.9	5.0
CG3035RF	**1028**	8	1142	29	668	31	639	24	869	25T	43.9	82.9	1.15	30.2	4.8
AM1532B2RF	909	25	1104	31	832	16	594	30	860	26	41.8	82.7	1.17	28.6	4.6
PHY425RF	805	33	1300	13	671	30	632	25	852	27	42.5	83.3	1.15	31.6	5.1
CG3520B2RF	989	13	1143	28	713	26	504	35	837	28	42.0	83.5	1.17	28.5	4.5
PHY480WR	740	35	1090	33	811	18	702	19	836	29	41.8	83.0	1.16	32.4	5.1
DP 121 RF	862	29	1173	25	654	33	617	27	827	30	44.3	83.2	1.14	32.3	5.0
CG3020B2RF	818	32	994	36	660	32	706	18	794	31	40.6	82.4	1.13	28.2	4.2
Average	950		1247		842		719		939		43.1	82.8	1.16	31.8	4.8
LSD 0.10	146		148		182		239		127		1.2	0.8	0.02	1.3	0.2
CV %	13.1		10.1		18.5		28.3		16.6		2.8	1.0	2.11	4.2	5.4

[a] Superscripts indicate ranking at that location.
Bolding indicates entries not significantly different from highest yielding entry based on Fisher's protected LSD (P = 0.10).

Table 2. Two-year summary for dryland earlier maturity cotton varieties at four locations[a], 2007-2008.

Variety	Lint Yield	Lint	Uniformity Index	Length	Strength	Micronaire
	lb/acre	%	%	inches	g/tex	units
GA2004303	**966**	44.3	81.8	1.10	31.2	4.7
ST5327B2RF	**907**	44.2	82.3	1.11	30.8	4.5
PHY370WR	891	44.2	82.2	1.08	30.1	4.6
ST4427B2RF	885	42.7	81.9	1.11	30.3	4.3
PHY315RF	873	44.6	81.7	1.11	29.1	4.4
DP141B2RF	870	42.8	81.7	1.17	31.3	4.4
CG3035RF	865	44.1	82.4	1.11	29.6	4.5
DP161B2RF	862	40.8	82.5	1.17	31.6	4.5
PHY375WRF	861	45.5	81.8	1.12	29.4	4.5
ST 4554B2RF	858	43.1	81.8	1.11	30.5	4.6
FM1735LLB2	850	40.9	82.3	1.13	33.5	4.4
STX4498B2RF	847	42.6	82.2	1.11	32.0	4.5
PHY485WRF	843	42.8	83.0	1.13	31.6	4.7
DP 143 B2RF	842	41.7	81.9	1.19	30.0	4.2
CG3520B2RF	834	42.4	82.9	1.14	27.5	4.3
AM1532B2RF	833	42.1	82.2	1.15	27.8	4.2
CG 3220B2RF	833	42.5	82.1	1.13	29.3	4.6
DP 121 RF	832	44.4	82.6	1.12	30.9	4.8
PHY425RF	808	42.9	82.8	1.12	30.5	4.8
CG4020B2RF	793	42.6	81.7	1.14	27.7	4.2
PHY480WR	778	42.2	82.7	1.13	30.9	4.8
CG3020B2RF	753	40.7	82.0	1.10	27.5	3.9
Average	849	42.9	82.2	1.13	30.1	4.5
LSD 0.10	61	0.5	0.5	0.02	0.7	0.1
CV %	17.4	2.7	0.9	2.28	4.0	5.6

[a] Athens, Midville, Plains, and Tifton.

Bolding indicates entries not significantly different from highest yielding entry based on Fisher's protected LSD (P = 0.10).

Table 3. Yield summary for earlier maturity cotton varieties, 2008 irrigated.

Entry	Lint Yield[a] Bainbridge	Midville	Plains	Tifton	4-Loc. Average	Lint	Unif. Index	Length	Strength	Mic.
	lb/acre	lb/acre	lb/acre	lb/acre	lb/acre	%	%	in	g/tex	units
PHY370WR	**1684** [2]	**2380** [1]	**1502** [6T]	1472 [15]	**1759** [1]	44.3	82.7	1.12	30.9	4.5
DP 555 BG/RR	1400 [30]	2177 [7]	**1605** [2]	**1807** [1]	**1747** [2]	44.3	82.3	1.16	31.8	4.3
DP 164 B2RF	**1634** [3]	2063 [24]	1368 [16]	**1779** [2]	**1711** [3]	43.4	83.6	1.21	33.2	4.3
DP 0924 B2RF	**1613** [5]	2197 [6]	1351 [20]	**1648** [5]	**1702** [4]	43.7	82.8	1.15	30.7	4.6
FM1740B2RF	1362 [36]	**2253** [4]	**1615** [1]	1534 [9]	**1691** [5]	43.7	83.3	1.16	31.5	4.3
PHY375WRF	1510 [15]	**2349** [2]	1362 [17]	1452 [16]	**1668** [6]	44.2	82.8	1.15	29.8	4.1
DP141B2RF	1433 [25]	**2286** [3]	1346 [21]	1596 [6]	**1665** [7]	42.2	83.1	1.22	31.7	4.0
DP 143 B2RF	**1576** [8]	2163 [9]	**1519** [3]	1397 [19]	**1664** [8]	42.4	83.1	1.25	32.3	3.9
ST5327B2RF	1534 [12]	2095 [19]	**1433** [10]	1542 [8]	**1651** [9]	43.2	83.2	1.16	32.1	4.3
ST4427B2RF	**1616** [4]	2081 [21]	**1416** [11]	1479 [14]	**1648** [10]	43.6	82.7	1.16	31.5	4.3
PHY480WR	1520 [13]	2113 [15]	**1415** [12]	1508 [11]	**1639** [11]	42.3	83.8	1.18	32.7	4.5
GA2004143	1381 [33]	2143 [11]	**1515** [4]	1506 [12]	**1636** [12]	45.4	83.5	1.22	34.1	4.5
DP 0935 B2RF	1474 [22]	2164 [8]	1098 [35]	**1750** [3]	**1622** [13]	43.8	82.7	1.15	30.0	4.4
STX4498B2RF	1493 [17]	2111 [16]	1360 [18]	1492 [13]	**1614** [14]	43.1	83.4	1.15	32.1	4.3
DP161B2RF	1430 [26]	2127 [13]	1200 [31]	**1680** [4]	1609 [15]	42.3	84.0	1.24	33.7	4.3
NG3331B2RF	1541 [11]	2156 [10]	1320 [23]	1417 [17]	1608 [16]	43.2	83.6	1.14	32.2	4.7
CG 3220B2RF	**1686** [1]	1991 [27]	1381 [15]	1351 [25]	1602 [17]	43.4	82.8	1.17	30.2	4.4
GA2004230	1453 [24]	1887 [33]	**1462** [7]	1593 [7]	1599 [18]	43.2	84.0	1.27	32.6	4.2
ST 4554B2RF	1464 [23]	2107 [17]	1312 [24]	1510 [10]	1598 [19]	43.0	82.5	1.15	31.6	4.5
GA2004303	1404 [29]	**2221** [5]	1308 [25]	1393 [21]	1581 [20]	43.8	82.5	1.15	32.9	4.6
AM1550B2RF	**1608** [6]	2078 [22]	**1459** [8]	1174 [34]	1579 [21]	43.2	82.9	1.14	28.6	4.2

BCSX0187LLB2	1548	10	1946	30	1409	13	1407	18	1577	22	42.3	82.7	1.14	33.7	4.5
CG4020B2RF	1406	28	2036	25	**1508**	5	1293	27	1561	23	42.4	82.6	1.20	29.1	4.2
PHY440W	1373	35	2125	14	**1502**	6T	1239	29	1560	24	42.8	83.5	1.17	30.9	4.3
NG4370B2RF	1507	16	1989	28	1333	22	1390	22	1555	25	43.1	83.2	1.17	31.7	4.5
PHY315RF	**1568**	9	2072	23	1180	32	1358	23	1545	26	45.1	82.9	1.17	30.3	4.1
CG3520B2RF	**1595**	7	1920	31	**1452**	9	1163	35	1532	27	42.7	83.4	1.19	27.5	4.1
PHY485WRF	1419	27	2129	12	1165	34	1324	26	1509	28	42.2	83.5	1.17	31.7	4.6
NG4377B2RF	1491	18	1861	35	1273	28	1394	20	1505	29	42.9	84.0	1.17	31.7	4.4
DP 121 RF	1385	32	2091	20	1174	33	1353	24	1501	30T	43.9	83.0	1.15	31.5	4.7
CG3035RF	1483	21	2012	26	1277	27	1232	31	1501	30T	43.6	83.0	1.16	30.8	4.5
FM1735LLB2	1484	20	2103	18	1209	30	1181	33	1494	31	40.6	83.1	1.16	34.1	4.2
BCSX0888LLB2	1376	34	1954	29	1356	19	1271	28	1489	32	41.4	82.9	1.17	32.7	4.7
CG3020B2RF	1513	14	1853	36	1383	14	1162	36	1478	33	42.1	83.2	1.16	27.7	4.0
AM1532B2RF	1486	19	1903	32	1298	26	1206	32	1473	34	41.4	82.8	1.21	28.7	3.9
PHY425RF	1390	31	1880	34	1218	29	1237	30	1431	35	42.2	84.0	1.17	31.5	4.8
Average	1495		2084		1363		1425		1592		43.1	83.1	1.17	31.4	4.3
LSD 0.10	134		173		203		179		145		1.7	0.6	0.02	1.3	0.2
CV %	7.6		7.1		12.7		10.7		9.3		2.5	1.0	1.59	5.1	5.7

[a] Superscripts indicate ranking at that location.
Bolding indicates entries not significantly different from highest yielding entry based on Fisher's protected LSD (P = 0.10).

Table 4. Two-year summary for earlier maturity cotton varieties at four locations[a], 2007-2008, irrigated.

Variety	Lint Yield	Lint	Uniformity Index	Length	Strength	Micronaire
	lb/acre	%	%	inches	g/tex	units
PHY370WR	**1753**	44.4	82.9	1.1	30.6	4.5
ST 4554B2RF	**1713**	43.3	82.8	1.2	30.4	4.5
PHY375WRF	**1711**	44.7	83.0	1.2	29.9	4.2
ST5327B2RF	1678	43.6	83.3	1.2	31.0	4.4
ST4427B2RF	1667	43.0	82.8	1.2	31.0	4.1
DP161B2RF	1652	42.0	84.1	1.2	32.5	4.3
STX4498B2RF	1652	42.7	83.4	1.2	31.4	4.3
DP 143 B2RF	1641	42.1	82.9	1.2	31.0	4.0
GA2004303	1639	43.9	82.7	1.1	32.0	4.6
DP141B2RF	1636	41.9	83.0	1.2	31.0	4.2
PHY480WR	1630	41.9	84.0	1.2	31.5	4.5
PHY315RF	1617	44.8	83.0	1.2	29.5	4.2
FM1735LLB2	1580	40.9	83.1	1.2	32.9	4.4
PHY485WRF	1577	42.3	83.7	1.2	31.1	4.7
CG 3220B2RF	1562	42.7	83.2	1.2	29.6	4.5
DP 121 RF	1559	44.0	83.3	1.2	30.8	4.7
PHY425RF	1555	42.1	84.0	1.2	31.2	4.8
CG3520B2RF	1553	42.6	83.3	1.2	27.3	4.1
CG4020B2RF	1547	42.3	82.8	1.2	28.4	4.1
CG3035RF	1535	43.4	83.2	1.2	30.1	4.5
AM1532B2RF	1528	41.7	83.1	1.2	28.4	4.1
CG3020B2RF	1473	41.2	83.3	1.2	27.8	4.0
Average	1612	42.8	83.2	1.2	30.4	4.4
LSD 0.10	72	0.4	0.5	0.01	0.7	0.1
CV %	10.8	2.4	1.0	1.56	4.0	5.6

[a] Bainbridge, Midville, Plains, and Tifton.

Bolding indicates entries not significantly different from highest yielding entry based on Fisher's protected LSD (P = 0.10).

Table 5. Yield summary for dryland later maturity cotton varieties, 2008.

	Lint Yield[a]														
Entry	Athens		Midville		Plains		Tifton		4-Loc. Average		Lint	Unif. Index	Length	Strength	Mic.
	---------------------------- lb/acre ----------------------------										%	%	in	g/tex	units
DP 555 BG/RR	**944**	15	**1427**	8	**1109**	1	**1289**	1	**1192**	1	43.6	82.9	1.15	33.1	4.6
GA2004137	**1121**	3	**1429**	7	908	4	**1286**	2	**1186**	2	44.1	83.5	1.18	34.2	5.0
DP 0935 B2RF	**1173**	2	**1533**	3	912	3	1022	8	**1160**	3	43.9	82.3	1.14	29.8	5.0
DP174RF	**991**	12	**1534**	2	845	9	**1242**	4	**1153**	4	46.9	82.6	1.18	30.0	4.9
GA2004371	**965**	14	**1404**	11	880	5	**1241**	5	**1122**	5	44.7	83.8	1.17	33.1	5.2
GA2004358	**1008**	8	1212	18	**963**	2	**1261**	3	**1111**	6	44.0	83.2	1.18	32.8	5.0
DP 164 B2RF	**1002**	9	**1471**	6	730	13	**1158**	6	**1090**	7	40.8	83.3	1.19	33.0	4.7
BCSX0614B2RF	**1191**	1	1334	14	836	10	982	9	**1086**	8	40.4	83.6	1.20	33.4	4.8
PHY375WRF	**1077**	5	**1489**	5	850	7	912	14	**1082**	9	45.5	82.0	1.13	29.6	4.9
BCSX0727B2RF	**996**	10	**1610**	1	851	6	781	16	**1059**	10	44.2	82.4	1.15	29.8	5.1
BCSX0102LLB2	**1011**	7	**1418**	10	849	8	909	15	1047	11	42.5	83.8	1.22	34.3	5.0
DP161B2RF	**1103**	4	1351	13	717	14	981	10	1038	12	41.0	83.2	1.20	33.8	5.1
PHY425RF	**869**	18	**1510**	4	682	17	**1059**	7	1030	13	42.6	83.3	1.15	31.9	5.2
GA2004392	**1013**	6	1332	15	707	16	919	12	993	14T	42.0	83.9	1.16	33.4	5.2
PHY480WR	**993**	11	**1424**	9	645	18	913	13T	993	14T	42.2	82.9	1.17	31.5	5.0
PHY485WRF	**918**	17	1231	17	805	11	913	13T	967	15	42.3	83.1	1.15	32.1	5.2
PHY440W	**989**	13	1369	12	741	12	736	17	959	16	43.5	82.3	1.14	32.2	5.1
BCSX0721B2RF	**920**	16	1244	16	713	15	930	11	952	17	44.4	82.6	1.17	30.2	5.0
Average	1016		1407		819		1030		1068		43.3	83.0	1.17	32.1	5
LSD 0.10	N.S.[b]		222		160		266		137		1.2	0.8	0.02	1.4	0.3
CV %	16.2		13.3		16.5		21.6		16.9		2.8	1.0	1.96	4.7	5.1

[a] Superscripts indicate ranking at that location.

[b] The F-test indicated no statistical differences at the alpha = .10 probability level; therefore a LSD value was not calculated.

Bolding indicates entries not significantly different from highest yielding entry based on Fisher's protected LSD (P = 0.10).

Table 6. Two-year summary for dryland later maturity cotton varieties at four locations[a], 2007-2008, irrigated.

Variety	Lint Yield	Lint	Uniformity Index	Length	Strength	Micronaire
	lb/acre	%	%	inches	g/tex	units
GA2004371	**1010**	45.4	83.0	1.12	31.2	5.0
DP 555 BG/RR	**998**	43.9	81.7	1.11	30.8	4.5
DP174RF	934	46.4	82.0	1.14	28.9	4.6
GA2004392	925	42.5	82.9	1.12	32.1	5.0
DP 164 B2RF	915	41.2	82.3	1.16	30.8	4.5
DP161B2RF	885	41.4	82.3	1.17	31.9	4.7
Average	944	43.5	82.4	1.14	31.0	4.7
LSD 0.10	67	0.5	0.5	0.01	0.9	0.2
CV %	17.0	2.7	1.0	1.99	4.9	6.1

[a] Athens, Midville, Plains, and Tifton.

Bolding indicates entries not significantly different from highest yielding entry based on Fisher's protected LSD (P = 0.10).

Table 7. Yield summary for later maturity cotton varieties, 2008, irrigated.

	Lint Yield[a]									
Entry	Bainbridge	Midville	Plains	Tifton	4-Loc. Average	Lint	Unif. Index	Length	Strength	Mic.
	lb/acre					%	%	in	g/tex	units
DP 555 BG/RR	1521 [8]	**2255** [2]	1551 [7]	**1926** [3]	**1813** [1]	44.6	82.0	1.16	31.8	4.2
BCSX0727B2RF	**1727** [2]	**2136** [6]	**1677** [2]	1608 [11]	**1787** [2T]	43.9	82.4	1.16	30.4	4.5
DP 0935 B2RF	**1655** [3]	**2228** [3]	1327 [17]	**1937** [1]	**1787** [2T]	44.1	82.5	1.14	29.7	4.3
DP174RF	1589 [4]	**2120** [7]	1580 [4]	1626 [10]	**1729** [3]	46.8	83.6	1.20	29.9	4.3
PHY375WRF	**1762** [1]	2010 [8]	1532 [8]	1568 [14]	**1718** [4]	44.1	82.7	1.16	30.1	3.9
DP161B2RF	1508 [10]	**2187** [4]	1401 [14]	1730 [8]	**1707** [5]	42.3	84.1	1.23	34.7	4.1
PHY480WR	1492 [11]	**2291** [1]	1442 [13]	1555 [15]	**1695** [6]	42.1	84.1	1.18	31.9	4.5
GA2004358	1523 [7]	1934 [11]	1526 [9]	1734 [7]	**1679** [7]	43.7	83.0	1.19	33.5	4.4
BCSX0102LLB2	1536 [6]	2006 [9]	1552 [6]	1577 [13]	**1668** [8]	41.7	84.2	1.24	33.8	4.2
PHY485WRF	1560 [5]	1987 [10]	1584 [3]	1529 [16]	**1665** [9]	43.0	83.4	1.17	31.9	4.5
BCSX0721B2RF	1472 [12]	1621 [17]	**1773** [1]	1785 [6]	**1663** [10]	45.4	83.6	1.20	29.7	4.3
GA2004137	1428 [15]	1740 [15]	1559 [5]	**1906** [4]	**1659** [11]	44.9	83.5	1.19	33.8	4.6
GA2004392	1407 [16]	1897 [12]	1509 [10]	1693 [9]	**1626** [12]	42.1	83.7	1.17	33.1	4.8
GA2004371	1511 [9]	1570 [18]	1372 [15]	**1932** [2]	1596 [13]	45.4	84.1	1.18	31.4	4.7
PHY440W	1451 [13]	**2161** [5]	1482 [11]	1288 [18]	1595 [14]	42.3	82.9	1.17	31.6	4.2
BCSX0614B2RF	1306 [17]	1872 [13]	1370 [16]	1605 [12]	1538 [15]	40.2	83.2	1.20	30.9	4.1
DP 164 B2RF	1264 [18]	1706 [16]	1304 [18]	**1823** [5]	1524 [16]	43.2	82.8	1.20	32.9	4.1
PHY425RF	1444 [14]	1794 [14]	1449 [12]	1401 [17]	1522 [17]	41.5	84.1	1.18	31.8	4.6
Average	1509	1973	1499	1679	1665	43.4	83.3	1.18	31.8	4.4
LSD 0.10	166	230	164	151	198	1.2	0.7	0.02	1.4	0.3
CV %	9.3	9.8	9.2	7.6	9.1	1.9	1.0	1.63	4.4	5.8

[a] Superscripts indicate ranking at that location.

Bolding indicates entries not significantly different from highest yielding entry based on Fisher's protected LSD (P = 0.10).

Table. 8. Two-year summary for later maturity cotton varieties at four locations[a], 2007-2008, irrigated.

Variety	Lint Yield	Lint	Uniformity Index	Length	Strength	Micronaire
	lb/acre	%	%	inches	g/tex	units
DP 555 BG/RR	**1819**	44.5	82.4	1.2	30.8	4.4
DP174RF	1677	46.5	83.5	1.2	29.2	4.4
DP161B2RF	1663	41.8	84.2	1.2	32.9	4.2
GA2004371	1638	45.5	83.8	1.2	31.0	4.8
GA2004392	1638	41.8	84.1	1.2	32.3	4.9
DP 164 B2RF	1497	42.0	82.8	1.2	31.5	4.2
Average	1656	43.7	83.5	1.2	31.3	4.5
LSD 0.10	79	0.3	0.5	0.01	0.7	0.2
CV %	11.6	1.6	1.1	2.02	4.0	5.9

[a] Bainbridge, Midville, Plains, and Tifton.

Bolding indicates entries not significantly different from highest yielding entry based on Fisher's protected LSD (P = 0.10).

Table 9. Yield summary for cotton strains, 2008, irrigated.

	Lint Yield[a]								
Variety	Midville	Plains	Tifton	3-Loc. Average	Lint	Unif. Index	Length	Strength	Mic.
	---------------------- lb/acre			----------------------	%	%	inches	g/tex	units
07W505DF	**2279** [3]	**1841** [1]	**1504** [6]	**1875** [1]	44.5	82.8	1.14	30.5	4.8
DP 555 BG/RR	**2153** [6]	**1663** [2]	**1459** [8]	**1758** [2]	44.6	82.4	1.16	32.1	4.2
GA2006053	2079 [7]	1536 [5]	**1644** [2]	**1753** [3]	42.6	84.0	1.20	30.6	4.5
DP 0935 B2RF	**2196** [4]	1349 [10]	**1699** [1]	**1748** [4]	44.7	83.1	1.16	29.7	4.5
BCSX0217	1990 [8]	1644 [3]	**1495** [7]	**1710** [5]	42.1	82.5	1.17	32.6	4.2
BCSX0805LL	1972 [9]	1575 [4]	**1565** [4]	**1704** [6]	41.9	81.8	1.14	29.9	4.1
DP 0924 B2RF	1963 [10]	1515 [7]	**1591** [3]	**1690** [7]	43.0	83.1	1.15	31.0	4.6
GA2006127	**2173** [5]	1374 [9]	**1451** [9]	**1666** [8]	44.9	83.3	1.19	30.8	4.4
07X440DF	**2330** [1]	1157 [13]	**1429** [10]	**1639** [9]	48.6	83.0	1.14	26.2	4.3
GA2006168	**2285** [2]	1239 [12]	**1378** [11]	**1634** [10]	44.1	83.1	1.17	33.6	4.8
GA2006128	1938 [11]	1529 [6]	**1308** [13]	**1591** [11]	43.4	84.2	1.22	32.5	4.6
GA2006106	1800 [13]	1290 [11]	**1518** [5]	**1536** [12]	44.1	83.7	1.20	35.2	4.5
GA2006109	1862 [12]	1396 [8]	**1314** [12]	**1524** [13]	44.1	83.6	1.23	33.7	4.2
Average	2078	1470	1489	1679	44.0	83.1	1.17	31.4	4.4
LSD 0.10	233	188	N.S.[b]	N.S.	0.8	0.8	0.03	1.8	0.3
CV %	9.4	10.7	12.7	10.8	2.2	1.1	1.84	5.6	5.8

[a] Superscripts indicate ranking at that location.

[b] The F-test indicated no statistical differences at the alpha = .10 probability level; therefore a LSD value was not calculated.

Bolding indicates entries not significantly different from highest yielding entry based on Fisher's protected LSD (P = 0.10).

BREEDING CULTIVARS AND GERMPLASM WITH ENHANCED YIELD AND QUALITY, 2008

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Introduction

The classical breeding component of the University of Georgia cotton improvement program works to develop germplasm with traits that can be used to meet the requirements of both producers and consumers. Higher and more stable yields combined with the fiber properties requested by the yarn and textile manufacturers are the goals for profitable production and processing to support the Georgia Cotton Industry. The objective of this report is to update progress made toward meeting these goals during the 2008 production season.

Materials and Methods

Our crosses mate elite University of Georgia breeding lines with promising germplasm and non-transgenic commercial cultivars to produce 10 sets of half-sib families. Fifty F_2-bulk populations from crosses made in 2007 and advanced at the counter-seasonal nursery in Tecoman, MX were evaluated for lint yield in 2-replicate, randomized complete block designs, with each set of half-sib F_2 families, the GA breeding line parent, and the check cultivar Deltapine DP 491 constituting a trial. Of the F_2-bulk populations evaluated in 2007, 16 were advanced in 2008 to F_3 for single plant selection. The first level of selection of the F_3 plants were decided by visual determination with more individuals selected from the better populations and none from the worst population. In other years, individual plants were selected from even the worst populations as a segregation of a desirable and non-desirable class was evident. Original F_3 plants with lint fractions less than 39% were discarded and then further selected on the basis of HVI fiber properties. Seven hundred and sixty-six F_3 plants selected in 2007 were advanced to F_4 progeny rows in Plains, GA, in 2008 for evaluation in an un-replicated grid design, with the middle row of each 9 row set of the trial assigned to Deltapine DP 147RF. The trial was machine harvested and the seed-cotton yield of each F_4 progeny row was compared with the seed-cotton yield of the nearest row of DP 147RF. Separate, late-planted seed increase plots that are grown in isolation near Tifton, GA allow additional visual selection and hand harvest of seed-cotton to maintain genetic purity of the F_4, F_5, F_6, and elite generation experimental lines. A small number of additional increases are planted at the University of Arizona's Maricopa Agriculture Center, Maricopa, AZ to provide excellent quality seed for the later generation field tests. Further selections of the F_4 are based mainly on the fiber quality measures of length, strength, and fineness and on lint percentage for promotion for testing in the F_5 preliminary yield trials (PTs) in 2009. The 2008 PTs were conducted at the William Gibbs Research Farm, UGA - Tifton campus, Tifton, GA in fields 04230, 04231, 04232, 04233, and 04234. Each PT had 18 F_5 breeding lines and 2 commercial conventional checks (FiberMax FM 966 and Deltapine DP 147RF) in three replicate, randomized complete block designs for a total of 108 experimental entries. The F_6 Advanced Trials (ATs) were conducted at the University of Georgia - Tifton campus, Tifton, GA (AT1 at the William Gibbs Research Farm, fields 04250 and 04251) and Southwest Georgia Research and Education Center, Plains, GA (AT 1 and AT 2 in fields 39/40). The ATs each consisted of 22 experimental entries and two checks (Bayer CropScience FiberMax FM 966 and Monsanto Deltapine DP 147RF) planted in a three replicate, randomized complete block design for a total of 44 F_6 breeding lines tested. Prior to machine harvest of all trials except the F_2 and F_4 generations, 25 unweathered, open bolls from the middle of the fruiting zone were harvested from each plot, and subsequently ginned on a 10-saw laboratory model gin to determine lint percentage. Fiber samples of the PTs and ATs were submitted to the Starlab in Knoxville, TN for HVI fiber analysis. The elite (material > F_7) germplasm lines with high potential were tested in the 2008 University of Georgia Strains (UGA) Tests and Official Variety Trials (Day and Thompson, 2009)

Results and Discussion

Of the six elite lines, GA 2006053, GA 2006127, GA 2006168, GA 2006128, GA 2006106, and GA 2006109, that were advanced to the UGA Strains Trials for the 2008 season (Day and Thompson, 2009), none were statistically significant from each other for yield and all had acceptable fiber quality measures. The top three yielding lines, GA 2006053, GA 2006127, and GA 2006168, will be advanced to the 2009 GA Official Variety Trials (OVTs). GA 2004303, GA 2004143, and GA 2004230 tested well enough in 2008 to continue to compete in the OVTs and are expected to be released soon as cultivars or germplasm lines.

The ATs revealed a promising line, GA2007095, with a very good fiber quality package that yielded better than the checks averaged over the Tifton and Plains locations (Tables 1, 2, & 3). It will be advanced to the 2009 UGA Strains Trials. Of the fiber quality measures, micronaire (mic) was high this year in our plots. Mic, which is interrelated to both maturity and fineness, is correlated to yield; a high mic fiber is coarser, thereby heavier, so it generally yields more. To conform to the market discounts, mic is selected to be within a range from >3.5 to <5.0 and this often forces breeders to select against a high yielding line that would have steep discounts due to high mic. Our program had a large number of excellent yielding lines that will not be selected to be advanced because they also had very high mic. We will be using some of them as parents in our crossing block to develop new lines that will maintain the excellent yield potential along with a more acceptable mic. The ATs continue to show a lot of variability between Plains and Tifton that has been noticed previously. Both the lint yield and lint percentage showed significant interaction across the locations whereas none of the fiber quality measures showed any location by entry interaction (Table 2). Therefore, the lint yield and lint percentage should not be combined for analysis whereas the fiber quality measures can be combined. For the past 2 years the research material was divided into the two AT tests by putting the lines that were elite yielders with acceptable fiber quality into AT1 and the lines that had enhanced fiber quality with adequate yield into AT2. This year the lines did not perform as expected in this regard and we are reevaluating the desirability of this particular protocol.

The plot work in both locations has had within-test variability that we could not pinpoint as to the cause. The coefficient of variance (CV) for yield for the AT1 trial in Plains was high without an obvious reason. The Tifton PTs also had very high CVs but in this case one obvious problem was that the defoliation/boll opening was not uniform; probably due to operator error. This type of abnormal variability makes selecting the lines to be advanced to the next stage of testing much more difficult. Thirty three lines were selected from the 2008 PTs (Tables 4, 5, and 6) for testing in the 2009 ATs based primarily on lint yield as compared to checks and also potential outstanding lint % or fiber qualities. Eleven additional lines will be added from the 2006 and 2007 PTs from lines that were only considered marginal because of the many excellent lines available from the populations in those tests.

Based chiefly on lint yield comparisons, 123 F_4 progenies will be further selected for placement in the 2009 PTs. About 500 single plants were selected in the F_3 populations to be placed in the F_4 plant-to-row yield test.

Fifty F_1 crosses that were made in the summer of 2008 were sent to the USDA-ARS Cotton Winter Nursery in Mexico for selfing to the F_2 generation. These will be placed in replicated yield tests to determine the suitability of the germplasms to be further tested.

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Table 1. Results of 2008 advanced (F6) trial 1.

2008 AT 1 Tifton							2008 AT 1 Plains						
ENTRY	**Lint Yield**	**Lint %**	**UHM in.**	**UI %**	**mic**	**Str g/tex**	**ENTRY**	**Lint Yield**	**Lint %**	**UHM in.**	**UI %**	**mic**	**Str g/tex**
GA 2007095	**1418**	45.5	1.22	85.1	4.8	33.9	GA 2007094	1427	45.7	1.14	82.7	6.1	34.3
GA 2007094	**1357**	48.1	1.18	85.1	5.7	36.5	GA 2007068	1278	44.4	1.14	85.4	5.6	35.3
GA 2007072	**1347**	47.2	1.13	85.2	5.7	34.5	GA 2007007	1111	45.9	1.19	84.9	5.5	35.8
GA 2007108	**1284**	43.6	1.19	85.8	5.0	36.8	120-R1-B1	1099	45.2	1.18	85.6	5.0	31.7
GA 2007004	**1282**	47.6	1.10	83.2	5.6	34.0	GA 2007010	1094	44.3	1.18	86.4	5.3	35.0
GA 2007066	**1277**	47.3	1.16	84.3	5.3	31.6	GA 2007066	1092	43.5	1.19	84.6	5.5	34.3
GA 2007076	**1239**	42.9	1.16	85.3	5.2	36.0	GA 2007031	1081	44.3	1.17	84.6	5.5	34.6
GA 2007083	1236	44.5	1.15	85.2	5.3	34.8	FM 966	1079	41.3	1.13	84.5	5.1	36.3
GA 2007067	1224	47.1	1.18	84.4	5.0	32.4	GA 2007041	1029	44.4	1.18	85.5	5.5	35.8
GA 2007068	1188	45.4	1.16	85.4	5.4	34.9	GA 2007072	1026	44.2	1.16	86.1	5.7	33.3
GA 2007090	1164	44.6	1.17	84.7	5.2	35.0	GA 2007076	992	41.6	1.17	84.4	5.6	34.1
GA 2007041	1129	46.2	1.17	84.6	5.1	33.8	155-R1-B1	929	40.4	1.13	83.0	5.7	33.4
120-R1-B3	1123	47.4	1.18	85.2	5.1	31.7	GA 2007095	925	41.9	1.22	85.7	5.2	33.9
GA 2007079	1104	43.5	1.16	84.5	5.3	33.8	GA 2007079	900	41.6	1.16	84.9	5.3	33.1
GA 2007007	1078	47.4	1.13	83.7	5.0	37.2	GA 2007087	892	43.0	1.16	83.9	5.4	34.7
GA 2007087	1052	44.5	1.18	83.2	5.0	31.9	GA 2007004	875	45.3	1.17	85.6	5.7	34.6
120-R1-B1	1038	50.9	1.14	84.1	5.0	31.4	GA 2007104	872	40.2	1.17	85.5	5.2	35.4
GA 2007031	1015	46.9	1.13	84.1	5.6	33.9	GA 2007108	853	41.8	1.18	85.0	5.4	36.9
GA 2007010	988	46.7	1.11	85.0	5.4	32.5	GA 2007032	826	41.1	1.21	85.8	5.4	36.4
DP 147RF	983	44.1	1.18	84.5	4.9	34.1	GA 2007067	802	46.2	1.18	84.8	5.2	34.4
GA 2007032	949	43.3	1.12	83.9	5.7	32.8	GA 2007090	781	41.2	1.21	85.7	5.0	34.1
GA 2007104	942	42.8	1.16	84.7	5.2	35.6	DP 147RF	746	41.8	1.20	85.4	5.0	32.9
155-R1-B1	922	43.8	1.13	84.5	5.4	35.1	GA 2007083	715	42.3	1.16	85.4	5.5	35.7
FM 966	868	42.0	1.15	84.5	5.0	40.2	120-R1-B3	591	43.6	1.18	85.4	4.9	32.4
$LSD_{0.10}$	**114**	**1.3**	**NS**	**NS**	**0.3**	**2.4**	**$LSD_{0.10}$**	**NS**	**0.8**	**0.03**	**NS**	**0.3**	**1.7**

The bold type indicates the lint yields that are not significantly different from the top yielder.
DP147RF and FiberMax FM 966 are check varieties for comparison purposes.

Table 2. Results of 2008 advanced (F6) trial 1 over Tifton and Plains, GA.

ENTRY	Lint Yield	Lint %	UHM in.	UI %	mic	Str g/tex
GA 2007004	1078	46.50	1.13	84.38	5.65	34.28
GA 2007007	1095	46.68	1.16	84.28	5.23	36.45
GA 2007010	1041	45.52	1.15	**85.65**	5.33	33.73
GA 2007031	1048	45.61	1.15	84.33	5.53	34.20
GA 2007032	887	42.23	1.17	**84.85**	5.53	34.60
GA 2007041	1079	45.32	1.17	**85.05**	5.28	34.78
GA 2007066	1184	45.42	1.17	84.43	5.38	32.93
FM 966	974	41.65	1.14	84.48	5.00	**38.23**
GA 2007067	1013	46.62	1.18	84.58	5.10	33.38
GA 2007068	1233	44.92	1.15	**85.35**	5.50	35.10
GA 2007072	1187	45.69	1.15	**85.65**	5.65	33.88
GA 2007076	1116	42.25	1.17	**84.83**	5.35	35.05
GA 2007079	1002	42.56	1.16	84.65	5.25	33.43
GA 2007083	975	43.44	1.15	**85.25**	5.38	35.23
GA 2007087	972	43.75	1.17	83.53	5.18	33.25
DP 147RF	864	42.93	1.19	**84.95**	4.90	33.45
GA 2007090	973	42.92	1.19	**85.15**	5.05	34.50
GA 2007094	1392	46.94	1.16	83.88	5.85	35.38
GA 2007095	1172	43.68	**1.22**	**85.35**	4.98	33.88
GA 2007104	907	41.54	1.16	**85.08**	5.18	35.50
GA 2007108	1069	42.73	1.18	**85.38**	5.20	**36.80**
120-R1-B1	1069	48.07	1.16	**84.80**	4.98	31.53
120-R1-B3	857	45.51	1.18	**85.25**	4.98	32.05
155-R1-B1	926	42.12	1.13	83.73	5.53	34.25
location by entry interaction	†	*	**NS**	**NS**	**NS**	**NS**
$LSD_{0.10}$	**-**	**-**	**0.03**	**0.95**	**0.20**	**1.45**

When location by entry interaction is significant, the locations should not be combined to compare for significant differences; † **- 10%, * - 5%, NS – not significant.**

The bold type indicates the measures that are not significantly different from the best.

Acceptable micronaire (mic) is a range, so significant differences are not highlighted.

DP147RF and FiberMax FM 966 are check varieties for comparison purposes.

Table 3. Results of 2008 advanced (F6) trial 2, Plains, GA.

ENTRY	Lint Yield	Lint %	UHM in.	UI %	mic	Str g/tex
GA 2007036	**1415**	44.7	1.16	84.4	5.5	35.4
GA 2007029	**1396**	44.7	1.19	85.5	5.5	31.9
FM 966	**1392**	40.8	1.10	84.1	5.3	36.2
GA 2007071	**1390**	44.0	1.17	84.8	5.2	34.1
GA 2007015	**1389**	45.5	1.14	85.4	5.7	33.5
GA 2007001	**1383**	46.7	1.18	85.0	5.6	35.8
GA 2007016	**1366**	44.7	1.16	85.7	5.5	35.9
GA 2007003	**1334**	46.0	1.17	85.1	5.8	36.9
GA 2007075	**1333**	42.4	1.13	83.6	5.5	37.1
GA 2007017	**1315**	44.0	1.16	84.9	5.7	35.2
GA 2007044	**1309**	42.2	1.20	85.3	5.2	35.5
GA 2007062	**1294**	41.5	1.13	83.7	5.7	35.9
GA 2007065	**1281**	43.2	1.20	85.7	5.4	33.6
GA 2007021	1228	45.3	1.21	84.4	5.6	33.6
DP 147RF	1218	42.8	1.18	84.8	4.9	32.5
GA 2007045	1194	41.9	1.24	85.8	5.6	36.3
GA 2007030	1193	42.3	1.18	84.3	5.4	37.1
GA 2007037	1135	42.7	1.24	86.6	5.5	36.5
GA 2007061	1126	44.7	1.20	85.2	5.6	35.4
GA 2007025	1105	44.9	1.18	84.7	5.5	33.4
GA 2007089	1090	41.8	1.18	84.1	5.2	33.5
GA 2007035	1084	40.4	1.23	85.1	5.6	38.2
GA 2007098	1076	38.5	1.15	84.1	5.0	35.7
GA 2007088	951	44.4	1.17	83.6	5.4	34.4
LSD0.10	**177**	**0.9**	**0.04**	**NS**	**NS**	**1.3**

The bold type indicates the lint yields that are not significantly different from the top.
DP147RF, DP491, and FiberMax FM 966 are check varieties for comparison purposes.

Table 4. Results of 2008 preliminary (F5) trials 1 and 2.

2008 PT1							2008 PT2						
ENTRY	Lint Yield	Lint %	UHM in.	UI %	mic	Str g/tex	ENTRY	Lint Yield	Lint %	UHM in.	UI %	mic	Str g/tex
GA2008001	**1198**	42.04	1.18	85.90	35.85	5.15	GA2008027	**2211**	45.57	1.17	85.40	32.35	5.25
GA2008014	**1143**	45.01	1.20	85.75	34.45	5.35	GA2008021	**1852**	45.15	1.22	86.65	33.35	5.20
GA2008010	**1137**	43.50	1.15	84.75	32.45	4.90	GA2008029	**1769**	44.65	1.19	86.50	35.95	5.50
GA2008011	**1054**	40.61	1.20	85.95	34.25	5.10	GA2008035	1683	43.05	1.20	85.65	34.85	5.15
GA2008007	**1044**	42.84	1.17	86.00	36.70	5.10	GA2008025	1600	45.04	1.23	86.55	33.70	5.15
GA2008018	**1042**	42.02	1.21	86.65	40.00	5.30	GA2008030	1556	44.05	1.21	86.15	34.80	5.00
GA2008005	**1029**	42.20	1.20	85.80	33.00	4.90	GA2008026	1479	45.02	1.18	85.80	35.00	5.20
GA2008003	978	43.79	1.19	85.30	33.60	4.95	GA2008028	1468	42.86	1.21	86.35	35.35	5.30
GA2008004	955	41.59	1.16	84.20	35.60	5.35	GA2008023	1462	41.80	1.24	86.50	36.55	5.05
GA2008008	946	42.28	1.19	85.70	37.85	5.00	GA2008033	1443	44.33	1.19	85.90	33.55	5.15
DP 147RF	937	41.87	1.22	85.75	34.25	4.65	DP 147RF	1440	41.11	1.25	85.95	34.55	4.60
FM 966	921	40.16	1.15	85.10	38.20	4.50	GA2008020	1424	45.19	1.18	85.10	32.50	5.20
GA2008002	899	42.94	1.21	86.15	32.75	4.90	GA2008022	1374	43.76	1.19	85.85	32.70	5.30
GA2008013	878	43.34	1.21	86.10	36.50	5.10	GA2008019	1280	44.27	1.16	85.15	35.70	5.30
GA2008015	823	39.87	1.20	86.60	38.10	5.50	GA2008034	1247	45.61	1.17	85.85	33.00	4.85
GA2008006	780	44.06	1.17	86.20	34.75	5.20	GA2008024	1146	44.68	1.22	86.45	34.10	5.10
GA2008016	715	42.54	1.24	87.20	37.50	5.15	FM 966	1054	39.60	1.15	85.30	39.35	4.80
GA2008012	714	38.85	1.23	86.75	37.80	5.20	GA2008036	1007	45.46	1.16	85.30	35.45	5.55
GA2008017	669	38.21	1.23	86.40	38.05	5.00	GA2008032	795	43.81	1.20	84.95	34.15	5.20
GA2008009	655	40.11	1.17	85.85	37.00	5.35	GA2008031	789	44.06	1.20	85.65	33.60	4.80
$LSD_{0.10}$	**196**	**0.97**	**0.03**	**0.96**	**2.18**	**0.25**	**$LSD_{0.10}$**	**492**	**1.32**	**0.03**	**NS**	**NS**	**0.31**

The bold type indicates the lint yields that are not significantly different from the top.
DP 147RF and FiberMax FM 966 are check varieties for comparison purposes.

Table 5. Results of 2008 preliminary (F5) trials 3 and 4.

2008 PT3							2008 PT4						
ENTRY	**Lint Yield**	**Lint %**	**UHM in.**	**UI %**	**mic**	**Str g/tex**	**ENTRY**	**Lint Yield**	**Lint %**	**UHM in.**	**UI %**	**mic**	**Str g/tex**
GA2008045	1750	41.50	1.19	86.05	35.75	5.20	GA2008063	1743	44.54	1.17	85.90	32.60	5.10
GA2008040	1458	42.43	1.18	86.15	35.55	5.05	DP 147RF	1697	41.74	1.20	85.75	34.65	4.65
GA2008037	1430	46.43	1.18	84.90	33.65	5.10	GA2008057	1549	44.85	1.23	86.95	36.55	5.10
GA2008038	1402	44.47	1.23	87.00	34.85	5.05	FM 966	1298	39.16	1.17	85.35	37.50	4.40
GA2008039	1367	41.17	1.23	86.30	37.00	4.75	GA2008060	1243	44.48	1.22	87.75	33.95	5.35
GA2008048	1364	41.13	1.18	85.60	35.35	4.90	GA2008058	1136	42.76	1.20	87.55	36.15	4.90
FM 966	1302	40.16	1.17	84.85	39.65	4.70	GA2008059	1115	41.41	1.16	85.90	31.45	5.10
GA2008054	1240	41.40	1.23	86.90	35.80	4.70	GA2008066	1073	43.68	1.17	86.45	31.15	5.05
GA2008047	1224	39.30	1.15	84.65	35.80	4.85	GA2008072	1006	43.77	1.18	86.25	34.55	5.25
GA2008049	1216	39.87	1.17	85.90	38.45	4.55	GA2008064	960	43.47	1.16	84.95	32.85	4.95
GA2008041	1161	38.77	1.21	85.70	36.80	4.60	GA2008062	888	41.95	1.23	87.20	37.70	4.65
GA2008042	1138	39.10	1.17	85.90	40.80	5.00	GA2008065	878	41.24	1.21	87.15	35.40	5.00
GA2008043	1058	38.00	1.23	87.05	39.10	5.10	GA2008067	876	40.60	1.21	86.45	35.05	4.70
GA2008050	1015	35.16	1.21	85.85	35.05	4.75	GA2008056	869	44.47	1.19	85.20	34.60	5.05
GA2008046	994	38.85	1.13	85.30	36.60	5.00	GA2008071	863	41.97	1.22	85.83	34.74	4.51
GA2008044	949	40.76	1.22	86.10	36.95	4.75	GA2008068	840	41.70	1.19	85.70	34.85	4.95
DP 147RF	886	39.79	1.21	85.95	33.95	4.55	GA2008069	814	43.48	1.14	84.70	31.95	5.10
GA2008053	754	38.13	1.22	86.90	39.75	5.00	GA2008070	796	44.73	1.17	86.15	32.45	5.20
GA2008051	740	40.52	1.21	85.60	36.40	4.45	GA2008061	735	42.61	1.18	86.70	32.75	5.15
GA2008052	725	41.03	1.23	86.55	34.60	4.40	GA2008055	699	42.61	1.24	86.50	34.90	4.50
$LSD_{0.10}$	**NS**	**2.47**	**0.03**	**NS**	**2.27**	**0.26**	**$LSD_{0.10}$**	**NS**	**1.66**	**0.04**	**NS**	**NS**	**0.34**

The bold type indicates the lint yields that are not significantly different from the top.

DP 147RF and FiberMax FM 966 are check varieties for comparison purposes.

Table 6. Results of 2008 preliminary (F5) trials 5 and 6.

2008 PT5							**2008 PT6**						
ENTRY	**Lint Yield**	**Lint %**	**UHM in.**	**UI %**	**mic**	**Str g/tex**	**ENTRY**	**Lint Yield**	**Lint %**	**UHM in.**	**UI %**	**mic**	**Str g/tex**
GA2008089	**704**	44.59	1.16	85.05	39.18	5.32	GA2008095	**445**	43.28	1.17	85.75	35.55	5.30
GA2008075	**666**	46.44	1.16	85.55	33.20	5.35	GA2008107	**398**	41.93	1.20	85.65	35.15	5.15
GA2008077	**650**	43.35	1.14	85.20	35.95	5.05	FM 966	**389**	39.20	1.13	84.75	40.55	4.75
GA2008078	**574**	38.13	1.13	84.70	32.95	4.60	GA2008098	**384**	44.09	1.18	84.25	35.45	4.95
GA2008076	**554**	42.61	1.14	86.65	35.80	5.30	GA2008101	**356**	41.20	1.11	84.40	32.05	5.35
GA2008085	**543**	43.49	1.12	84.05	36.20	5.45	DP 147RF	**352**	40.63	1.20	83.90	33.55	4.60
DP 147RF	**517**	41.27	1.19	84.20	33.35	4.70	GA2008102	**334**	42.17	1.18	85.45	34.75	4.75
GA2008079	**513**	39.29	1.15	85.30	35.15	4.95	GA2008094	277	43.24	1.14	84.65	36.20	5.25
GA2008087	493	44.80	1.09	83.45	35.05	5.35	GA2008106	273	41.44	1.16	85.80	36.00	5.20
GA2008083	469	47.25	1.14	84.90	34.45	5.40	GA2008104	268	44.35	1.18	85.35	35.05	5.00
FM 966	462	39.19	1.15	85.00	37.85	4.55	GA2008105	259	40.04	1.15	86.25	35.30	5.25
GA2008086	458	42.50	1.18	84.70	34.95	5.00	GA2008103	241	44.67	1.14	84.10	33.30	5.15
GA2008090	429	45.16	1.14	85.40	32.15	4.85	GA2008100	237	43.04	1.18	85.50	35.80	5.20
GA2008084	408	42.10	1.20	85.85	35.15	5.10	GA2008108	227	41.26	1.17	86.25	34.50	5.20
GA2008080	407	38.04	1.11	84.85	35.45	5.40	GA2008097	212	44.28	1.14	85.25	34.35	4.85
GA2008073	363	43.48	1.21	86.60	31.65	4.90	GA2008092	208	42.35	1.21	85.30	34.00	5.15
GA2008088	335	43.24	1.19	85.95	35.15	4.80	GA2008096	159	42.39	1.21	86.75	34.80	5.20
GA2008082	274	41.58	1.14	84.20	32.55	5.00	GA2008091	46	42.45	1.18	85.45	35.05	5.15
GA2008074	202	41.77	1.20	86.20	33.90	4.95	GA2008093	-	43.01	1.19	85.45	33.55	4.85
GA2008081	161	41.53	1.17	86.00	34.85	4.25	GA2008099	-	41.89	1.19	84.95	33.45	4.65
$LSD_{0.10}$	**204**	**1.57**	**0.03**	**1.08**	**1.45**	**0.32**	**$LSD_{0.10}$**	**135**	**1.16**	**0.03**	**NS**	**1.29**	**0.26**

The bold type indicates the lint yields that are not significantly different from the top.
GA2008089 has missing data for the fiber quality measures, so evaluate it cautiously; the lint yield and lint % is not missing.
DP 147RF and FiberMax FM 966 are check varieties for comparison purposes.

CONTROLLING GLYPHOSATE-RESISTANT PALMER AMARANTH WITH DEEP TILLAGE

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Introduction

Cotton is the most vulnerable agronomic crop to competition from glyphosate-resistant Palmer amaranth infestations and managing glyphosate-resistant Palmer amaranth in glyphosate-resistant cotton has proven to be nearly impossible, especially when relying exclusively on herbicides. Glyphosate-resistant Palmer amaranth currently infests over 300,000 acres of land across 26 Georgia counties (Figure 1). Once Palmer amaranth resistant to glyphosate escapes the at-plant herbicides, it can only be controlled during early season cotton development with topical applications of pyrithiobac (Staple LX). Palmer amaranth resistant to pyrithiobac is common throughout the cotton belt and Palmer amaranth populations with resistance to glyphosate and pyrithiobac have been confirmed in Georgia. Palmer amaranth with resistance to both glyphosate and ALS-inhibiting herbicides can not be managed or even suppressed with any topical herbicide application in glyphosate-resistant or non-transgenic cotton.

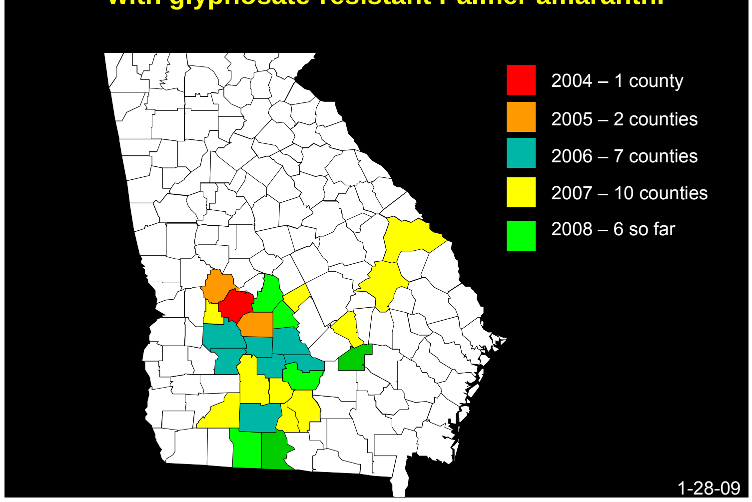

Figure 1. Georgia counties confirmed to be infested with glyphosate-resistant Palmer amaranth.

A grower's ability to manage glyphosate-resistant Palmer amaranth in Roundup Ready cotton is heavily dependent on residual herbicides. With greater than 50% of the cotton acreage in Georgia produced without irrigation, timely rainfalls often do not activate these residual herbicides in a timely manner. An experiment was conducted to determine the impact of deep turning or preplant incorporating (PPI) a yellow herbicide on the control of this resistant pest.

Materials and Methods

A research study was conducted in dryland cotton during 2008 in Macon County, GA on a loamy sand soil with 2% organic matter having a pH of 5.9. The randomized split-plot design experiment was conducted in a field with a heavy population of glyphosate-resistant Palmer amaranth. Treatments included two tillage options (deep turning land 10 inch deep or not turning land) and four herbicide systems (Table 1).

Soil Inversion	Herbicide Options*			
	At-Plant	Early POST (5-leaf cotton)	Mid POST (8-leaf cotton)	Layby (13 lf cotton)
Yes	--	--	--	--
No	--	--	--	--
Yes	--	glyphosate	glyphosate	glyphosate
No	--	glyphosate	glyphosate	glyphosate
Yes	Prowl + Reflex PRE^	glyphosate + Dual	--	Direx + MSMA
No	Prowl + Reflex PRE	glyphosate + Dual	--	Direx + MSMA
Yes	Treflan PPI + Reflex PRE	glyphosate + Dual	--	Direx + MSMA
No	Treflan PPI + Reflex PRE	glyphosate + Dual	--	Direx + MSMA

*Herbicide use rates: Direx at 2 pt/A; Glyphosate = Roundup WeatherMax at 22 oz/A; MSMA at 2 lb ai/A; Prowl H_20 at 2.1 pt/A; Reflex at 1 pt/A; Treflan at 1 pt/A; and Dual Magnum at 1 pt/A.
^Abbreviations: PRE = preemergence; PPI = preplant incorporated with tillage.

Plot size was 4 rows by 30 feet and cotton was harvested with a single row cotton harvester. The first rainfall occurred 5 d after planting DP 555 BR cotton and applying at-plant herbicides.

Results and Discussion

At 1 month after planting, Palmer amaranth plant emergence was reduced 60% by deep turning the land when residual herbicides were not applied. Although populations were reduced throughout the season by deep turning the land, no visual control was noted at harvest when residual herbicides were not applied because of the robust size of plants that did emerge. Applications of glyphosate did not impact Palmer amaranth control regardless of tillage option. Deep turning the land in the Prowl PRE system improved Palmer amaranth control 15% and cotton yield by 19% when compared to the same herbicide program without deep turning the land. Deep turning the land did not significantly impact control or yield with the Treflan PPI system. When comparing the

Prowl PRE and Treflan PPI systems without deep turning the land, Palmer amaranth control was 11% greater and yield was 26% greater with the Treflan PPI system when compared to the Prowl PRE system. No differences were noted between the Prowl PRE and Treflan PPI systems when the land was deep turned.

ENVOKE, STAPLE, AND DUAL MAGNUM FOR POST EMERGENCE FLEX COTTON WEED CONTROL

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Introduction

Glyphosate resistant (GR) cotton became the standard technology grown throughout the southern U.S. due to its ease of use for weed control and high-yield, productive cultivars (i.e DP 555). Traditional cotton herbicide programs included preplant incorporated, preemergence (PRE), and postemergence-directed herbicide applications, but these were largely replaced with weed management systems often consisting of only glyphosate postemergence (POST) applications. Although glyphosate effectively controls most common weeds, herbicide tolerant and herbicide resistant weeds became more troublesome. This was in part due to the elimination of other, more effective herbicides with POST and residual activity. These weeds include glyphosate tolerant Benghal dayflower (a.k.a. tropical spiderwort) and glyphosate resistant Palmer amaranth with both becoming two of the most common and troublesome weeds in Georgia cotton. These weeds have significantly altered weed control tactics, especially with respect to POST glyphosate applications. The need to reduce the number of glyphosate applications has led farmers to become more dependent on other herbicides. In addition, ALS resistant Palmer amaranth is also prevalent across Georgia.

Flex-cotton was developed for use with glyphosate POST, and the successor to Roundup Ready-cotton. Sales of DP 555 seed will end in 2009. Farmers have not adapted to other Roundup Ready cotton cultivars due to DP 555s positive agronomic attributes. Thus, after 2009 they will be seeking other quality cultivars. Some Flex cotton cultivars may become more prevalent as farmers shift away from Roundup Ready cotton. However, with the increase in Flex cotton production, changes in weed control will need to be made. This is because farmers are likely to become less reliant on glyphosate due to herbicide tolerant and resistant weeds and the need to manage the use of ALS herbicide applications given the high incidence of ALS-resistant Palmer amaranth in Georgia. Therefore, studies were conducted to evaluate POST herbicides in Flex cotton for weed control using Roundup Weathermax (glyphosate), Staple (pyrithiobac), Envoke (trifloxysulfuron), or Dual Magnum (*S*-metolachlor) at Plains and Ty Ty, GA.

Materials and Methods

Field trials were conducted in 2007 and 2008 at the University of Georgia Ponder Research Farm near Ty Ty, GA and the Southwest Georgia Research and Education Center near Plains, GA. Stoneville ST4554B2RF Flex cotton was planted for all experiments using a Monosem precision vacuum planter set to deliver 4.3 seed per foot of row. The experimental design was a randomized complete block with a factorial arrangement of treatments replicated four times. Plots were two rows by 25 feet long in Tifton, and two rows by 30 feet long in Plains. Standard agronomic practices were conducted including conventional tillage along with fertility, and pest control recommendations (other than weeds) by the University of Georgia Cooperative Extension.

All tests included a nontreated control for weed comparison. Applications of herbicides began at the 3 leaf stage of cotton with a POST treatment of Roundup Weathermax at 22 oz/ac applied to all plots, except the nontreated control. Other treatments included Envoke at 0.15 oz/ac, Envoke 0.15 oz/ac plus Dual Magnum at 16 oz/ac, Dual Magnum at 16 oz/ac plus Roundup Weathermax at 22 oz/ac, Envoke at 0.15 oz/ac plus Roundup Weathermax at 22 oz/ac, Staple at 3.8 oz/ac, Envoke at 0.15 oz/ac plus Staple at 3.8 oz/ac POST applied to either 5 leaf, or 8 leaf cotton, for a total of 13 treatments (Table 1). Herbicides were applied by tractor or backpack, pressurized by compressed air or CO_2, delivering 15 gal/ac.

Visual estimates of crop tolerance and weed control (on a scale of 0 to 100%, where 0% = no injury or weed control and 100% = cotton death or complete weed control) were estimated throughout the growing season. Weed species included sicklepod, wild poinsettia, and Palmer amaranth at Plains and smallflower and ivyleaf morningglory, Florida beggarweed, and Texas panicum at Ty TY. Yield was determined by mechanically harvesting each plot. Data was subjected to an analysis of variance appropriate for a randomized complete block design for a factorial arrangement of treatments. The nontreated control was not included in the analysis to provide homogeneity.

Results and Discussion

Different weeds appeared at each location so these were analyzed separately. Weed pressure also varied between years for each location so data is presented separately by year. There was an interaction between the 5 leaf and 8 leaf treatments for all variables for Plains so data is presented by treatment application timing for this location. There was not a significant interaction for the treatment timing for the Ty Ty location, therefore data was combined across application timing. Additionally, there were no differences for cotton injury for any treatment, with less than 8% observed for any treatment and this was transient across years and locations (Data not shown).

Wild poinsettia control was very poor, (50% or less) in 2007 for Plains for any 5 leaf herbicide application (Table 1). This was attributed to the continued emergence of wild poinsettia after the 3 leaf glyphosate and 5 leaf residual herbicide applications. Even though the initial treatments controlled wild poinsettia, only the 8 leaf applications that contained Roundup Weathermax provided acceptable control (95% and greater). By the time the 8 leaf applications of Envoke, Envoke plus Dual Magnum, Staple, or Envoke plus Staple were applied, the wild poinsettia had become established, greater than 4 inches tall, and were not controlled (36% and less). In contrast, in 2008 all 5 leaf treatments provided 88% or greater wild poinsettia control. Only Staple alone applied at the 8 leaf stage did not provide acceptable wild poinsettia control, 63% in 2008. These data indicate that wild poinsettia control with these herbicides can be highly variable from one year to the next, and farmers should continue to scout fields where this weed is present since it can continuously emerge throughout the growing season.

Sicklepod was effectively controlled by all 5 leaf herbicide treatments following the 3 leaf application of Roundup Weathermax (Table 1). Only Staple applied alone at the 8 leaf cotton stage of growth had reduced sicklepod control at 80% in 2007 and 84% in 2008. Envoke and Roundup Weathermax provided good to excellent sicklepod control, but Staple has poor activity for this weed. While early season control of sicklepod control was achieved with the 3 leaf application, Roundup Weathermax or Envoke was required to maintain adequate season-long control.

For Plains, this Palmer amaranth population was susceptible to Roundup Weathermax and the ALS herbicide Envoke and Staple with 82% or greater control for the 5 leaf applications (Table 1). However, Envoke plus Dual Magnum applied at 8 leaf cotton resulted in reduced Palmer amaranth control, 67%. Compared to Envoke alone at the 8 leaf stage of cotton growth, which was 88%, there could be some antagonism of Envoke activity by Dual Magnum for control of Palmer amaranth when these two herbicides were tank-mixed. Further research needs to be conducted to establish if there is potential antagonism occurring.

For the Ty Ty studies in 2007 and 2008, all herbicide treatments and timings effectively controlled Florida beggarweed, smallflower and ivyleaf morningglory, and Palmer amaranth (Table 2). Previous reports have indicated poor smallflower morningglory control with Envoke, but this was avoided with the use of Roundup Weathermax applied to 3 leaf cotton growth.

Seed cotton yield varied by location and year (Table 2 and 3). For Plains in 2007, data indicated significant seed cotton yield reductions for any application containing Envoke or Staple. This was attributed to the lack of wild poinsettia control at this location for these treatments. Yield was significantly greater for the treatments containing Roundup Weathermax in 2007 at the 5 leaf and 8 leaf growth stages. While farmers may try to reduce the overall use of glyphosate in their Roundup Ready or Flex cotton systems due to herbicide resistance, other weed spectrums may necessitate its use to prevent crop failure. Yield for Plains and Ty Ty in 2007 and 2008 were greater than the nontreated controls each year (Tables 2 and 3).

In conclusion, farmers need to continue to scout fields and properly identify weed spectrums in order to apply herbicides that will provide timely weed control. But they should also scout fields to ensure that their herbicides are working properly after application and throughout the growing season. Flex cotton can be adapted into these systems.

Table 1. Cotton weed control as influenced by herbicide and timing of post emergence application for Plains GA[1].

Herbicide	Rate	Wild poinsettia				Sicklepod				Palmer amaranth			
		2007		2008		2007		2008		2007		2008	
		Timing		Timing		Timing		Timing		Timing		Timing	
		5 leaf	8 leaf	5 leaf	8 leaf	5 leaf	8 leaf	5 leaf	8 leaf	5 leaf	8 leaf	5 leaf	8 leaf
	oz/ac	%				%				%			
Envoke	0.15	24 c[2]	35 bc	98 a	99 a	92	92	99 a	99 a	82 ab	88 ab	99 a	99 a
Envoke + Dual Magnum	0.15 + 16	24 c	24 c	91 a	99 a	92	92	99 a	99 a	88 ab	67 c	99a	99 a
Dual Magnum + RUWM	16 + 22	50 b	95 a	95 a	99 a	93	97	96 ab	99 a	93 ab	95 ab	98ab	99 a
Envoke + RUWM	0.15 + 22	24 c	97 a	93 a	99 a	94	96	96 ab	99 a	88 ab	97 a	96 ab	99 a
Staple LX	3.8	24 c	24 c	88 b	63 c	92	80	91 bc	84 c	90 ab	86 ab	93 bc	88 c
Envoke + Staple LX	0.15 + 3.8	24 c	36 bc	98 a	99 a	88	92	99 a	99 a	88 ab	89 a	99 a	99 a

[1]Ratings taken in mid August of each year, 8 to 12 weeks after herbicide applications. A nontreated control was included for all treatments (data not shown), but not included in the analysis. A 3 leaf application of Roundup Weathermax at 22 oz/ac was applied to all treatments, except the nontreated control each year.
[2]Means followed by same letter in columns for the same year do not differ significantly (P=0.05) using Fishers protected LSD test.

Table 2. Cotton weed control and yield as influenced by herbicide and timing of post emergence application for Ty Ty GA[1].

		Florida beggarweed		Morningglory species: Smallflower		Morningglory species: Ivyleaf		Texas panicum		Yield	
Herbicide	Rate			2007	2008	2007	2008	2007	2008	2007	2008
	oz/ac	%		%				%		lb/ac	
Envoke	0.15	98	98 a[2]	97	96 a	96	96 a	96	95	1140	1550
Envoke + Dual Magnum	0.15 + 16	99	91 b	99	92 b	99	93 b	98	92	1040	1440
Dual Magnum + RUWM	16 + 22	99	96 a	99	95 ab	99	95 ab	99	95	1210	1750
Envoke + RUWM	0.15 + 22	99	98 a	99	96 a	99	96 a	99	96	1070	1680
Staple LX	3.8	99	97 a	99	97 a	99	96 a	98	96	1070	1690
Envoke + Staple LX	0.15 + 3.8	98	96 a	99	96 a	99	96 a	98	96	1130	1440

[1]Ratings taken in mid August of each year, 8 to 12 weeks after herbicide applications. A nontreated control was included for all treatments (data not shown), but not included in the analysis. A 3 leaf application of Roundup Weathermax at 22 oz/ac was applied to all treatments, except the nontreated control each year. Yield of the nontreated was 530 and 60 lbs/ac for 2007 and 2008, respectively.
[2]Means followed by same letter in columns for the same year do not differ significantly (P=0.05) using Fishers protected LSD test. The two-way interaction of herbicide application timing of 5 leaf and 8 leaf was not significant, therefore data were combined across treatment timings.

Table 3. Cotton yield as influenced by herbicide and timing of post emergence application for Plains GA[1].

		2007		2007	
		Timing		Timing	
Herbicide	Rate	5 leaf	8 leaf	5 leaf	8 leaf
	oz/ac	lbs/ac			
Envoke	0.15	1190 e[2]	1340 e	1190	1150
Envoke + Dual Magnum	0.15 + 16	1660 de	1510 e	1060	1170
Dual Magnum + RUWM	16 + 22	2480 bcd	3530 a	1110	1110
Envoke + RUWM	0.15 + 22	2600 bc	3350 ab	1140	1160
Staple LX	3.8	1270 e	1210 e	1070	1200
Envoke + Staple LX	0.15 + 3.8	1700 cde	1920 cde	1170	1110

[1]A nontreated control was included for all treatments (data not shown), but not included in the analysis. A 3 leaf application of Roundup Weathermax at 22 oz/ac was applied to all treatments, except the nontreated control each year. Yield of the nontreated was 1240 and 150 lbs/ac for 2007 and 2008, respectively.
[2]Means followed by same letter in columns for the same year do not differ significantly (P=0.05) using Fishers protected LSD test.

Movement of Glyphosate-Resistant Palmer Amaranth Pollen Under Field Conditions.

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Summary

Palmer amaranth is one of the most troublesome weeds of cotton and other Southern row crops. In addition to being a strong competitor, Palmer amaranth has developed resistance to several important agricultural herbicides, including glyphosate. The objective of this study was to determine if the glyphosate resistance trait can be transferred via pollen movement from a glyphosate-resistant (GR) Palmer amaranth population to a glyphosate-susceptible (GS) population. In 2006, a GR Palmer amaranth pollen source population was planted in the center of a 30 Ha field. Nine GS plants were planted in plots located at distances of 1, 5, 10, 25, 50, 75, 100, 150, and 200 m from the edge of the source in each of eight directions (N, NE, E, SE, S, SW, W, and NW). In 2007, 15 GS plants were planted in plots at distances of 5, 50, 250, 200, 250, and 300 m from the GR source in the same eight directions. Except for the GR source population, the interior of the field and surrounding acreage (300 m from the field edge) were kept free of Palmer amaranth by chemical and physical means. Seed was harvested from 249 and 301 mature females in October 2006 and 2007, respectively. Offspring from each GS mother plant were treated with 0.5 kg ae/Ha glyphosate when the plants were 5-7 cm tall and evaluated 7 and 14 DAT. At 14 DT, the GR and GS standards were controlled by glyphosate 4% and 100%, respectively. Resistant offspring were observed at each distance from the GR source in each direction, although the percentage of resistant individuals decreased with increased distance from the pollen source. Approximately 50-60% of the offspring at the 1 m and 5 m distance were resistant to glyphosate; approximately 20-40% of the offspring were resistant at 250 m and 300 m. An integrated approach to herbicide resistance management should require that suspected resistant individuals are controlled prior to reaching reproductive maturity to prevent both seed and pollen from dispersing the resistance trait.

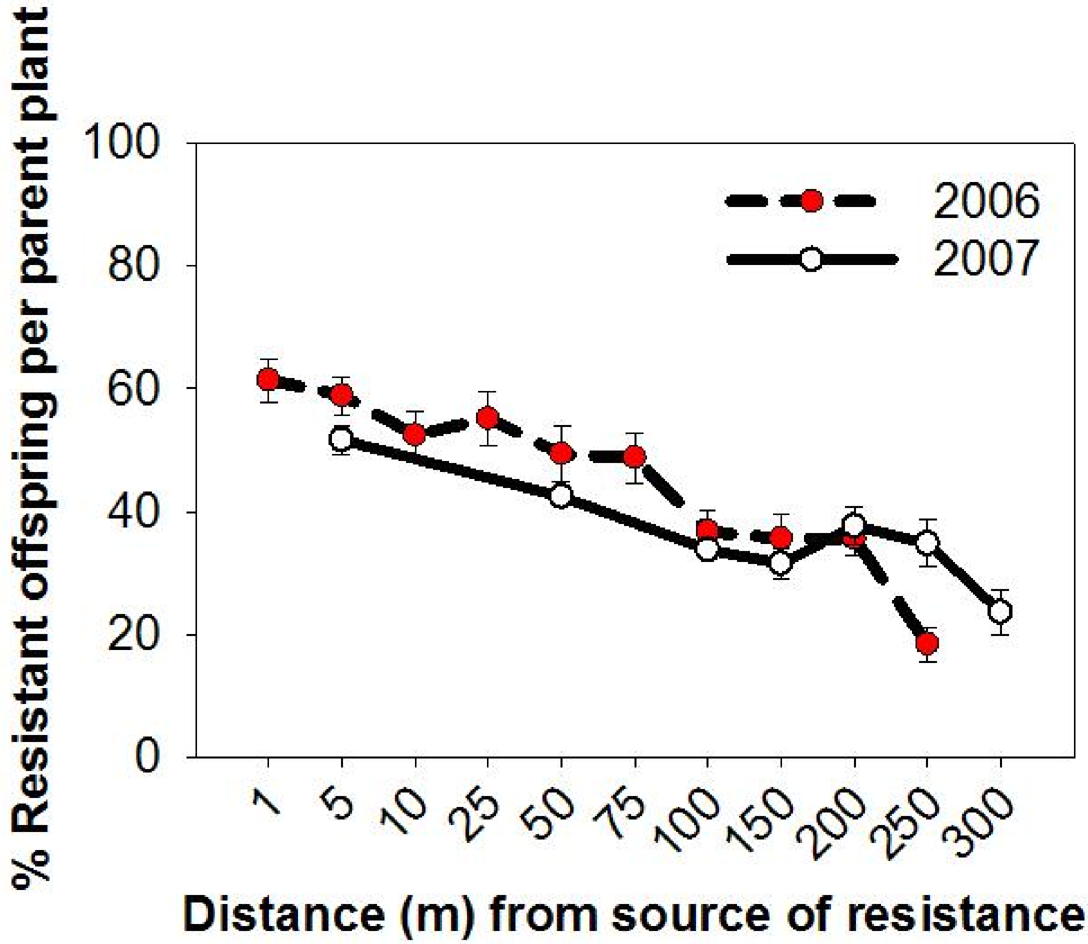

Figure 2. Relationship between distance from source of resistance and resistant offspring.

A NOVEL SCREENING METHOD OF WATER STRESS IN MULTIPLE COTTON VARIETIES

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Abstract

One of the challenges with genetic selection of cotton for yield and fiber quality is the assessment of phenological changes in the plant that impart improved yield and quality. The identification of these changes can help with the selection of varieties both in breeding programs and in grower selection for desirable attributes. We propose a method for screening large numbers of plots using multiple remote sensing technologies to identify crop growth habits that contribute to final yield and quality in irrigated and non-irrigated situations. The plot study consisted of fifteen varieties grown in randomized complete block planted in two row, 40-ft. plots. The study was replicated in a irrigated and non-irrigated scenarios. Instruments to detect the normalized difference vegetation index (NDVI), plant height, plant temperature, and plant light capture were used to track the growth and health of the varieties during the season. At the end of the growing season, crop yield and quality were measured for each variety, and these were compared with the in-season measurements. We found that all of the measurements had unique relationships with the final growth and yield of the cotton varieties, suggesting that with more familiarity, this can be used as a valid screening method in the future.

Introduction

Water is the most common environmental factor that limits crop productivity. Many of the exotic relatives of domestic cotton (genus Gossypium) are well-adapted to heat and drought stress, but domestication and selection for crop yield have narrowed the genetic variability for drought resistance in modern cultivars. In addition, new varieties have limited in-season growth comparisons with other competing varieties, due to the large amounts of time required to make growth measurements.

Drought tolerance is attractive both for dryland growing conditions and during times of water shortage. Identification of stress mechanisms can also help in the selection for attributes that will improve yield stability under water limiting conditions. This work will improve our knowledge of physiological parameters that may identify adaptations to water deficit and improved drought tolerance.

Several types of adaptations to water stress have been observed in cotton, including shifts in fruiting patterns (including leaf or fruit abscission), osmotic regulation, changes in leaf expansion, decreased transpiration rates, and changes in partitioning of carbohydrates (Dumka et al., 2004; Gerik, 1996; Guinn and Mauney, 1984; Ritchie, 2007). Identifying the specific adaptation(s) that are operational in particular genotypes, together with their influence (if any) on other aspects of plant productivity and quality, facilitates selection for those adaptations that are most likely to result in more water efficient but still commercially acceptable cotton. We seek to characterize the mechanism(s) used by cotton varieties in adaptation to or tolerance of drought stress and associated temperature stress.

Some specific outcomes that we expect to result from this research are:

(1) Identification of plant stress response mechanisms that can be used as screening tools to select cotton for improved drought tolerance.

(2) The addition of physiology to the cotton breeding equation.

(3) Cost analysis of the yield and quality parameters in each variety.

Materials and Methods

This study was conducted during the summer of 2008. A 3-foot wide aluminum adjustable height research cart with a platform on top was used as a platform for the sensing equipment. The cart was designed to allow it to move over the top of a single cotton row without touching the cotton. The cart was designed by the University of Georgia Machine Shop in Athens, Georgia. Equipment on the cart included a DataQ DI-710 datalogger (DataQ Instruments, Akron, OH), GreenSeeker spectrometer (NTech Industries, Inc., Ukiah, CA), a SI-111 IRT sensor, quantum sensor, line quantum sensor (Apogee Instruments, Logan, UT), and a distance sensor (Trossen Robotics, Inc., Westchester, IL).

The GreenSeeker measures NIR and red reflectance from the plant canopy. Vegetation indices, such as the normalized difference vegetation index (NDVI) are calculated from these reflectance values. In our study, we used the NDVI (NIR-Red)/(NIR+Red) to measure canopy growth. The IRT sensor measures thermal infrared emittance, which is used to calculate temperature to within 0.2 ^{o}F. The line quantum sensors measure incoming light, and light capture by the plant is measured as 1-$light_{transmitted}$/$light_{incoming}$, where $light_{incoming}$ is the measurement of light above the crop canopy and $light_{transmitted}$ is the measurement of light under the crop canopy. The distance sensor measures distance based on sonar, and we calibrated distance measurements in a controlled environment to the output signal. Variance in the controlled system was +/- 1 inch. The datalogger was connected by a USB cable to a Sony Vaio handheld computer mounted on the research cart. All of the sensors except for the GreenSeeker were connected to the datalogger, while the GreenSeeker was connected through a separate USB cable to the computer. Twenty measurements in each plot were collected while the cart moved through, and the measurements were averaged to give an integrated measurement of each sensor per plot.

Both irrigated and non-irrigated plots were harvested with JD 9930 research spindle cotton picker. The picker has been customized, the auger has been removed from the basket and a solid shoots implemented into the basket for individual plot bagging purposes. The picker enables for production equivalent harvesting.

The cotton was ginned at the University of Georgia's Microgin. There quality sub-samples were collected and sent for further lint assessment at the USDA Classing Office in Macon, GA.

From each plot three feet of plants were removed for boxpicking. Boxpicking is the hand removal of the seed cotton and is separated by node and position. Plant mapping consisted of removing each individual boll from a plant and placing the boll in a grid box compartment that corresponded to the main-stem node (the cotyledon node being 0) and fruiting position. A marker was placed in the compartment for each fruit as well, allowing measurements of total boll number by node and position. The removed fruit was weighed by node and position to measure boll mass by node and position. Fruiting positions greater than three were rare, and were combined with the third position bolls when observed. Bolls produced by vegetative branches were placed in a separate compartment to minimize the confounding influence. One drawback of plant mapping method is that some bolls and locules come off during the harvest, transport, and storage. Special care was taken to minimize these losses, and the lost cotton in each bundle was measured. The cotton will be hand ginned, and lint and seed weights will be taken for data.

Results

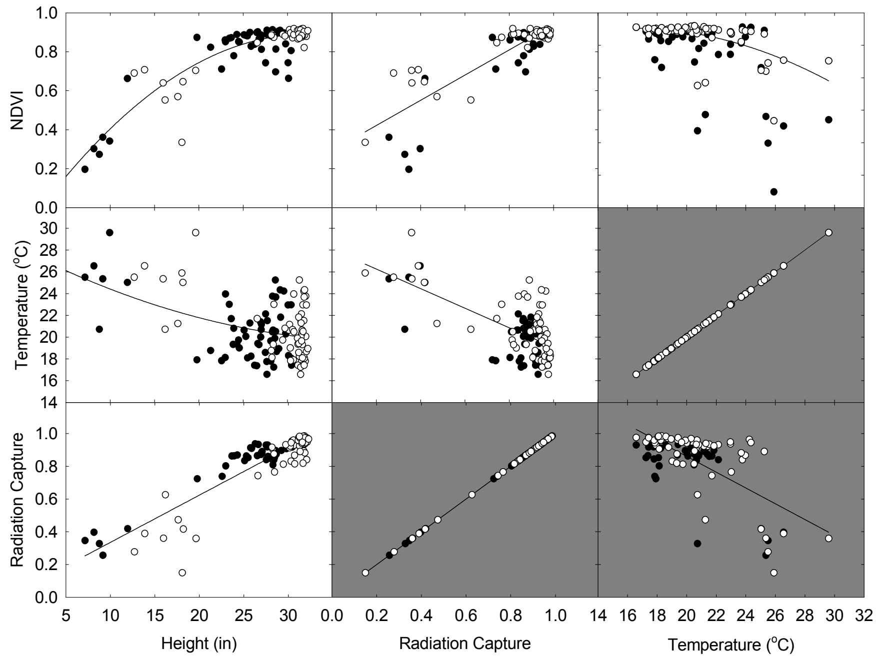

Figure 3. Relationship between NDVI, height, temperature, and radiation capture

The relationship between height and NDVI became nonlinear at about 22.5 inches. The NDVI measurements stayed constant after this point while the plant continued to grow taller. Radiation capture and NDVI were linearly correlated, and temperature was negatively correlated with NDVI.

Height and temperature were negatively correlated. As the height increased the temperature of the plants decreased. Radiation capture and temperature also had a negative slope. The height and radiation capture had a positive slope.

In 2008, the relationships between all parameters measured were examined in this study (Figure 2). Several interesting results were seen in-season. First, NDVI tended to plateau or reach a maximum at about 22 inches in height. NDVI has been criticized in the past for not being sensitive to higher levels of vegetative cover, but it is a widely used standard. Radiation capture appeared to be sensitive to a wider range of plant height, suggesting that this measurement may give a more accurate full-season view of crop growth. Crop temperature was of added interest, because it was less closely tied to either crop height or radiation capture, but followed the same general pattern. This suggests that temperature may allow the detection of stress even in tall or lush canopies, even in the humid climate of South Georgia.

Irrigated Plots July 9, 2008

Variety	Height (in)	NDVI	Temp (°C)	Radiation Capture	Lint Yield Lbs/acre	Micronaire
1	26.4 AB	0.886 A	19.8 CD	0.118 BC	1746 A	3.8 CDE
2	27.1 AB	0.821 A	20.2 CD	0.109 BC	1448 BC	3.83 CDE
3	8.2 C	0.258 B	24.3 AB	0.477 A	815 D	3.38 F
4	27.8 AB	0.875 A	20.5 BCD	0.06 C	1443 BC	4.13 ABC
5	28 AB	0.891 A	18.9 CD	0.116 BC	1378 BC	4.23 AB
6	26.6 AB	0.861 A	21.6 BCD	0.059 C	1402 BC	4.13 ABC
7	26.6 AB	0.8 A	19.8 CD	0.14 BC	1408 BC	3.55 EF
8	28.2 A	0.892 A	21.8 AB	0.05 C	1577 AB	3.85 BCDE
9	26.8 AB	0.818 A	17.6 D	0.082 C	1495 ABC	3.9 ABCDE
10	7.8 C	0.345 B	25.7 A	0.336 AB	964 D	3.63 DEF
11	25.2 B	0.871 A	17.9 CD	0.078 C	1291 C	3.78 CDE
12	27.4 AB	0.844 A	21.5 BCD	0.114 BC	1540 ABC	4.25 A
13	25.4 AB	0.863 A	19.9 CD	0.035 C	1408 BC	3.9 ABCDE
14	28.2 A	0.877 A	21.9 AB	0.068 C	1529 ABC	3.7 DEF
15	25.9 AB	0.848 A	19.1 CD	0.052 C	1428 BC	3.98 ABCD

All measurements from the research cart detected differences between varieties. Varieties 1 and 8 prove to be the highest yielding in our study. The varieties proving to have the lowest yields were 3 and 10. All parameters collected differed dramatically except for NDVI and micronaire compared to other varieties.

Discussion

This was the first year of a multi-year study testing this system of screening methods of water stress as a practical solution of in-season growth measurements over a wide area. Further analysis and improved techniques will improve and quantify measurement in the upcoming year. Future plans with this project include measuring the interaction of water stress with variety, mounting these instruments on a Spider research sprayer, and comparing these with more quality parameters.

Acknowledgments

The Georgia Cotton Commission and Cotton Incorporated provided funding for this project. Special thanks to the University of Georgia Cotton Team for assistance and advice on this project.

YIELD DYNAMICS OF TWO COTTON VARIETIES IN GEORGIA IN 2007-2008

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Abstract

In Georgia, the dominant cotton variety is Delta & Pineland 555 BR, while in West Texas, FiberMax 960 B2R and 9063 B2RF are commonly grown, high-yielding varieties with good fiber quality parameters. Several factors may play roles in the performance and popularity of these varieties, including season length characteristics of both varieties and phenotypic response to the very different environments between Georgia and West Texas. The objective was to determine growth characteristics of these two varieties in Texas and Georgia to determine growth and source-to-sink relationships in each environment based on temperature, sunlight, and precipitation/soil moisture. However, due to hail at the Texas location, the study was conducted at two locations in Georgia in 2007. In 2008, the study was conducted at one location in Georgia and one in Texas. The parameters were used to ascertain contributing factors to the yield and quality of the plants. There was a unique variety affect on fruiting response and growth response throughout the season, and these changes in fruiting and growth response can potentially affect yield and/or quality.

Introduction

The most commonly grown variety of cotton in Georgia is Delta&Pineland 555 Bollgard / Roundup Ready (DP555). Although this variety yields well in Georgia, its quality is average at best. In other locations of the Cotton Belt, DP555 is not grown as commonly as it is in Georgia. Some of this difference may be attributable to differences in growing season and climate. Georgia has mild falls, during which cotton will continue to grow after the point at which it would be considered completely mature in other regions of the cotton belt. Georgia also has cloudy days, limiting daily incoming solar radiation. In addition, because peanut harvest occurs at the same time as cotton harvest, producers typically leave the cotton crop out in the field longer than another regions of the cotton belt. This allows a full season variety like 555 to continue to increase its yield potential, provided water and nutrients are available for the plant to grow.

Cotton has been shown to have different fruit development and distribution patterns based on several factors, including variety, water application, plant density, and PGR application (Bednarz et al., 2000; Dumka, 2002; Dumka et al., 2004). Cotton has also been shown to have differential yield distribution based on the genetic technology (BG vs. BG2 and RR vs RRF) (Mills et al., 2008).

One of the questions surrounding 555 fiber quality is whether this decrease in quality is due to a longer fruiting period, the production of late maturing bolts that appear at the top of the plant, the size of the bolls that are produced in the plant, differences in carbon partitioning, or some other factor, such as within-boll fiber growth. To identify some of these potential issues, Delta&Pineland 555 BG/RR (DP555) and FiberMax 960 BGII/RRFlex (FM960) were grown together under dryland and irrigated conditions to identify growth habits, water uptake, and yield distribution.

Materials and Methods

In the 2007 study in Georgia, Delta & Pineland 555 BG/RR and FiberMax 960 BGII/RF were planted at the density of 3.5 plants/foot on May 9 in the Newton field of the Stripling Irrigation Research Park in Camilla, Georgia, and on May 17 (Newton) at the Lang Research Farm in Tifton, Georgia (Lang). The plot layout was a split plot design, with irrigation as the main plot and variety as the split plot. The irrigation treatments consisted of a dryland treatment and a fully irrigated treatment, which were laid out in a randomized complete block design. The varieties were planted side-by-side in four row plots in the center of each irrigation treatment. Watermark sensors were placed in the second row of each irrigation treatment to monitor soil moisture. At the Stripling irrigation Research Park, the watermark sensors were placed in four replicates of each treatment, but at the Lang farm, the sensors were only placed in two replicates of each treatment. Growth analysis measurements were made throughout the season, at two week intervals, including radiation capture measurements, soil moisture, plant height, notes above first square / white flower, and in-season fruit distribution.

In 2008, the experiment was repeated on adjacent plot space at the Newton field with the same main plots and split plots as in 2007. FiberMax discontinued FM 960 in most of the cotton belt after 2007, so FiberMax 9063 BGII/RF, a closely related variety with similar growth habits, was planted instead. In Georgia, the study was planted on May 17, 2008.

In-season yield distribution was measured nondestructively. Five plants in each plot were selected based on uniformity, lack of plant damage, and consistent row spacing (no plants with gaps of more than 6 inches on either side were selected). These plants were marked by tying a strip of flagging tape loosely around the base of the plant and staking the tape across the row. At first square and at selected intervals afterward (every two weeks in 2007, and every week in 2008), the location and maturity of each fruiting structure on each plant was tabulated. Plastic nursery tabs were attached to fruiting branches at nodes 5, 10, and 15 (when necessary) for ease of counting and to minimize node counting mistakes. Each fruiting structure counted was assigned a growth stage, with 4 growth stages between pinhead square and white flower and 5 boll sizes from early boll to completely filled boll. Fruiting structures from adjacent plots were removed, sorted by size and stage, dried, and weighed to provide a representative estimate of fruiting structure dry biomass. The average of at least 20 fruiting structures of each size was used to determine average dry fruit biomass. These dry mass numbers were then related to in-season growth stage measurements to estimate fruit mass by node and fruiting position over the growing season.

At the end of the season, each tagged plant was removed, and the fruit distribution was determined using box-mapping. Fruit from all plants in a plot was pooled, and the total bolls and total boll mass at each node and position, in addition to vegetative bolls and lost cotton were measured. Lost cotton was in all cases less than 1% of the total boll mass for each plot.

Due to the large amounts of data associated with this study, all figures will be shown from the Newton studies. Plant height was not significantly different between treatments until 44 DAP, when the nonirrigated treatments began to lag in growth (Figure 1). On day 50, the DP555 variety began to show significant differences in height with FM960. These differences continued throughout the growing season. The nonirrigated DP555 attained the same height as the irrigated FM960 by 86 DAP and trended higher at 99 DAP. Differences in total mass by node and fruiting position were observed, with FM960 having more boll mass near the bottom of the plant and DP555 having more boll mass at the top and outer positions of the plant (Figure 2).

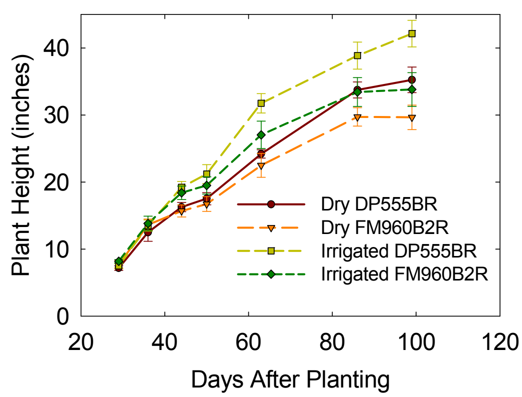

Figure 1. Height of irrigated and nonirrigated DP555 and FM960 at the Newton location during 2007. Error bars represent standard error of the mean (n = 8).

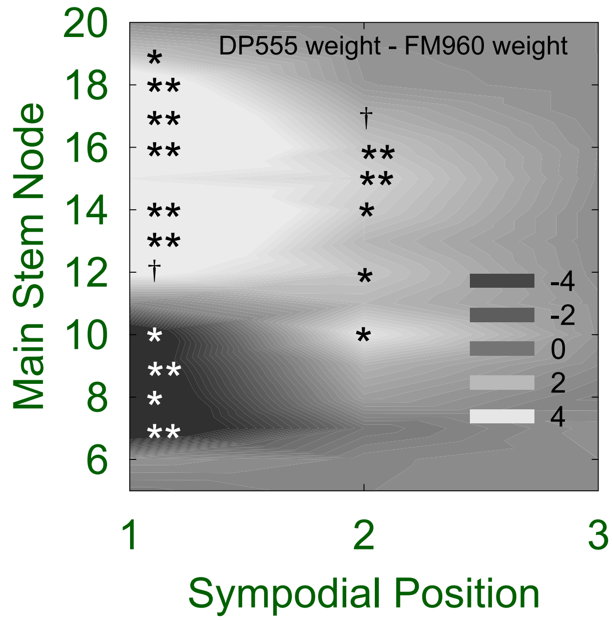

Figure 2. Difference in boll mass by main stem node and sympodial fruiting position between DP555 and FM960. Light regions of the graph indicate areas of the plant where DP555 has higher fruit mass than FM960, while dark regions indicate areas of the plant where FM960 has higher fruit mass than DP555. Symbols represent significance: † P<0.10; *P<0.05; **P<0.01

FiberMax 960 had significantly higher average boll weight then DP555 at almost every node (Figure 3), suggesting more carbohydrate partitioning to the production of each boll in FM960 then in DP555. As shown in Figure 4, DP555 had significantly higher fruit numbers at the higher nodes. Much of the late production of fruit was linked to the increased yield of DP555. This pattern of late fruiting is part of the reason that DP555 has shown good yield characteristics in a variety of conditions in Georgia. The late fruiting can be seen as a compensation mechanism by which the plant is able to add yield as long as growing conditions are favorable.

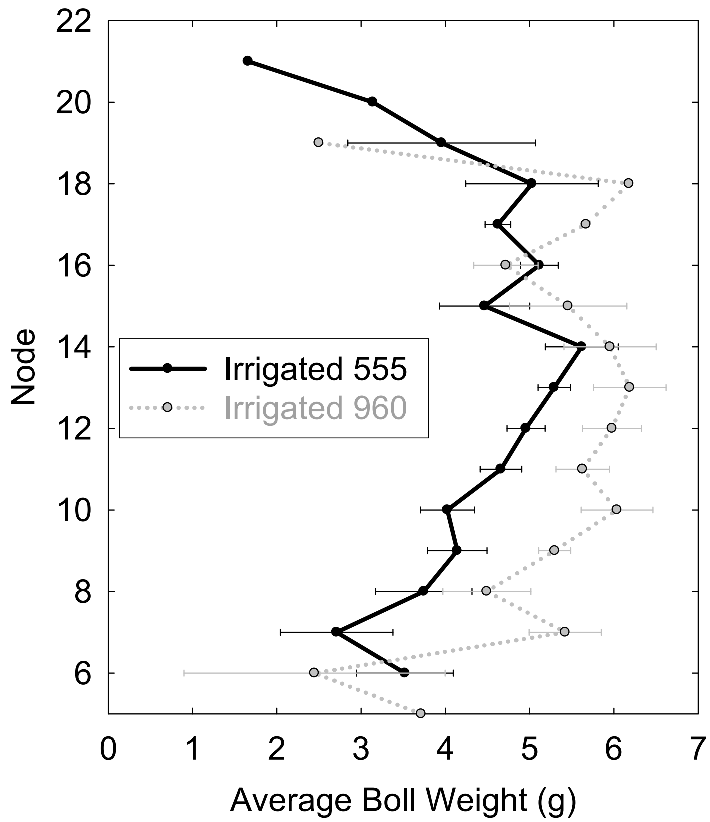

Figure 3. Average boll mass by node of irrigated DP555 and FM960. Error bars represent standard error of the mean (n = 8).

Irrigation did not have an effect on length, uniformity, and strength, but did have an effect on micronaire (P=0.0642), as shown in Table 1. This is consistent with previous studies at the University of Georgia, which have shown drought stress to increase micronaire. FiberMax 960 had significantly higher fiber length, fiber uniformity, and fiber strength. However, the micronaire content was higher in FiberMax 960 than in DP555 (Table 2).

Table1. Effect of irrigation on yield, turnout, and fiber quality.

	Dry	Irrigated	P-Value
Seed Weight	3894	4289	0.0036**
Lint Weight	1425	1569	0.0048**
Turnout	0.3641	0.3648	0.7003
Staple	35.94	36.00	0.6587
Micronaire	4.725	4.625	0.0642†
Strength	31.10	30.72	0.5937
Length	1.1188	1.1213	0.6216
Uniformity	0.8115	0.8118	0.8606

Table 2. Effect of variety on yield, turnout, and fiber quality.

	DP555BR	FM960B2R	P-Value
Seed Weight	4440	3743	<0.0001**
Lint Weight	1690	1304	<0.0001**
Turnout	0.381	0.348	<0.0001**
Staple	35.1	36.8	<0.0001**
Micronaire	4.6875	4.6625	0.632
Strength	30.21	31.61	0.0597†
Length	1.095	1.145	<0.0001**
Uniformity	0.8093	0.814	0.0136*

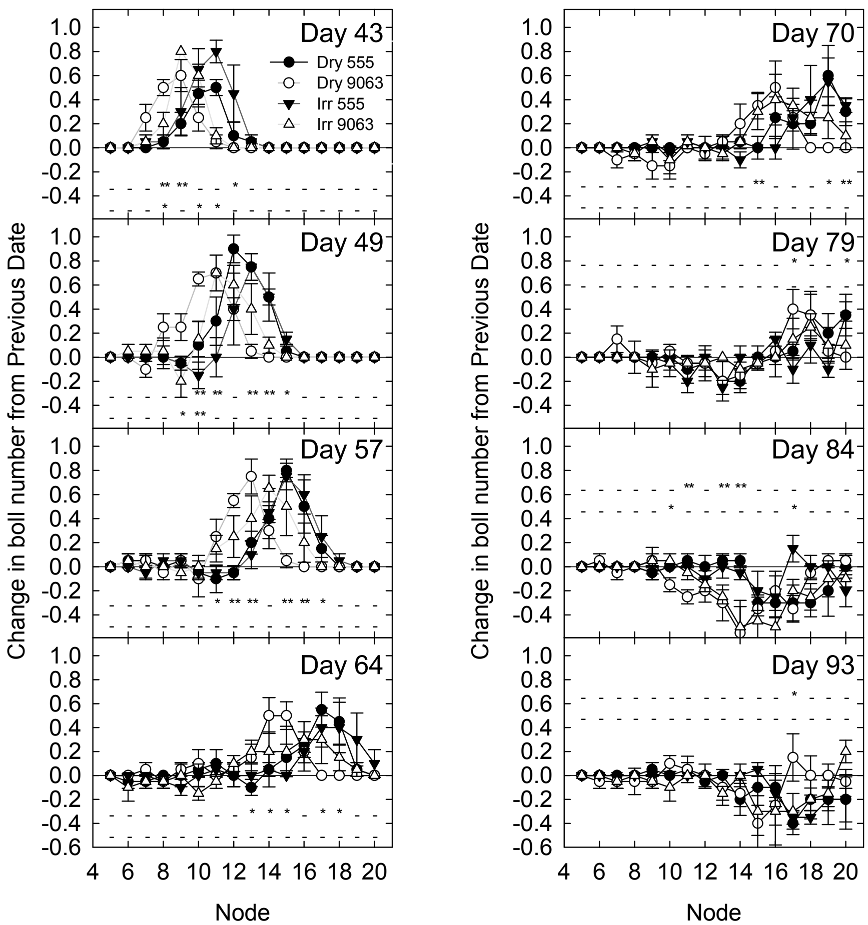

Figure 4. Change in first position boll number by node at each measurement date, showing the formation and loss of fruiting structures during the 2008 test. Error bars represent standard error of the mean for each treatment at each node.

* P < 0.05

** P < 0.01

- not significant.

Figure 4 shows the change in first position boll number by node at each measurement date in 2008. These graphs show the location of new fruiting structures throughout the growing season. The DP555 plots consistently produced more fruiting structures higher in the plant than the FiberMax varieties in both seasons, while the FiberMax plants produced more fruiting structures in the lower portion of the plant and shed more fruit above node 14. The highest levels of fruit shed for FM9063 in 2008 occurred between days 79 and 93, as shown in Figure 4.

Discussion

There are several possible reasons for the difference in fiber quality between the two varieties, due to growth differences within the plant. As it was observed in the study, 555 had an increase of boll production at higher nodes, an increase in second position bolls, a decrease in first position bolls at the lower mainstem nodes, and decreased boll weight throughout the plant.

Acknowledgments

This research was funded by the Georgia Cotton Commission. Special thanks to the Stripling Irrigation Research Park and the UGA Cotton Physiology Team.

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EVALUATION OF SELECTED THRIPS MANAGEMENT PROGRAMS AND THE EFFECT OF THRIPS DAMAGE ON EARLY SEASON ROOT GROWTH

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Introduction

Thrips are predictable pests of seedling cotton in Georgia and other areas of the southeast. The most common species infesting cotton seedlings in Georgia is the tobacco thrips, however other species such as western flower thrips and flower thrips may sometimes be observed. Thrips become active in the spring and winged adults disperse in search of suitable host plants. Adult females insert eggs into tender plant tissues which hatch in about four days. Immature thrips feed on the plant for about six days, pupate in the soil, and adults emerge approximately 4 days later.

Both adult and immature thrips damage cotton by rasping tender leaves, especially in the terminal bud. Damaged cotyledons often have a silvery appearance on the underside of leaves whereas damaged true leaves appear crinkled and distorted as they expand. Thrips injury can cause stunted plants, delays in maturity, loss of apical dominance, and even stand loss in severe cases. Thrips infestations are generally higher on April and early May plantings compared with late May and June planting dates. Slow seedling growth associated with cool temperatures or other plant stresses exacerbates thrips injury. At plant preventive systemic insecticides provide a consistent yield response and are used by most growers for thrips control. Foliar insecticide applications may be needed to supplement preventive insecticides in some situations. The threshold for seedling thrips is 2-3 per plant, especially if immature or wingless thrips are present at threshold levels. The presence of immature thrips suggests that the preventive insecticide used at planting is not effective. Seedlings are most susceptible to thrips during early stages of development. Treatment for thrips is rarely necessary after plants attain 5 true leaves and are growing vigorously.

Significant plant stunting of seedlings is observed when excessive thrips injury occurs. A gradient of plant heights is commonly observed in small plot field trials where treatments provide varying degrees of thrips control. Is below ground plant growth also stunted when excessive thrips injury occurs? Sadras and Wilson 1998 observed early season reductions in leaf area, shoot dry weight, and tap root dry weight when significant numbers of thrips infested seedling cotton in Australia. In a study evaluating the potential interaction of pendimethalin and systemic insecticides for thrips control in cotton; Grey et.al. 2006 observed greater root weights in treatments which provided thrips control compared with untreated plots. Brown et.al. 2008 also observed an inverse relationship between thrips damage and early season root growth. Potentially, poor early season root growth could influence the plants ability to tolerate drought and other plant stresses such as nematode infestations. The objective of this study was to evaluate selected thrips management programs and further quantify the effect of thrips damage on early season root growth.

Materials and Methods

A field trial was established in Tift County Georgia during 2008. Plots were two rows wide, 40 feet in length, and arranged in a randomized complete block design with four replications. Treatments included an untreated check, the seed treatments Cruiser and Avicta Complete Cotton, Temik, and Avicta Complete Cotton treated with two foliar applications of dimethoate at 14 and 21 days after planting (DAP), 1 and 2-3 leaf cotton respectively. Dimethoate was applied at 0.25 lb ai/acre in a 12 inch band using a CO2 backpack sprayer calibrated to deliver 15 gpa. Telone was applied to the trial area which was conventional tilled and irrigated. DP 555 BR was planted on April 29, 2009. Plots were maintained according to UGA Extension recommendations.

Thrips infestations were sampled at 14, 21, and 28 DAP by randomly selecting 5 plants per plot and immediately submersing and swirling plants in 4 oz specimen cups filled with a 70% ETOH solution to dislodge and preserve thrips. Samples were returned to the laboratory and immature and adult thrips were quantified. Adult thrips were identified to species. Thrips damage ratings were conducted at 21, 28, and 35 DAP using a 1-5 scale with 0.5 increments where 1=no damage, 2=slight damage, 3=moderate (acceptable) damage, 4=heavy damage, and 5=severe damage. Plant biomass was quantified by carefully extracting five plants per plot with a narrow spade at 30 and 42 DAP. Plants were severed at the soil surface line and above ground (shoots) and below ground (roots) dry weights were attained by drying plant material at 60 degrees C for 48 hrs in a forced air oven. Plant heights were quantified by measuring shoot lengths. Plots were machine picked on September 19 using a spindle picker and a lint fraction of 42 percent was assumed for all plots to determine lint yields.

Data were subjected to analysis of variance and treatment means were separated using LSD at P=0.05. Root dry weights were regressed against shoot dry weights and thrips damage ratings.

Results and Discussion

Thrips infestations were moderate to high, exceeding the recommended threshold of 2-3 thrips per plant on all sample dates in untreated plots. All insecticide treatments significantly reduced immature thrips at 14 and 21 DAP, no significant differences were observed among insecticide treatments (Table 1). Temik and the Avicta Complete Cotton (ACC) treated with foliar applications of dimethoate significantly reduced immature thrips at 28 DAP. All insecticide treatments significantly reduced adult thrips at 14 DAP compared with the untreated, no insecticide treatments significantly reduced adult thrips at 21 and 28 DAP. Tobacco thrips was the primary thrips species infesting the trial area. At 14, 21, and 28 DAP, tobacco thrips averaged 94, 66, and 80 percent of the adult thrips infesting the treatments. Western flower thrips were observed at 2, 27, and 9 percent and flower thrips at 2, 6, and 9 percent at 14, 21, and 28 DAP respectively. Species complex among treatments was variable, at 21 DAP the percent western flower thrips infesting individual treatments ranged from 7-42 percent.

Thrips damage ratings exceeded 3 on a scale of 1-5 which is considered an acceptable level of plant injury for all treatments at 21 DAP (Table 2). However, all insecticide treatments significantly reduced thrips damage ratings compared with the untreated check. Temik and the ACC treated with foliar applications of dimethoate (ACC+dimethoate) significantly reduced thrips damage compared with Cruiser and ACC treatments. At 28 DAP thrips damage ratings were significantly greater in the untreated > Cruiser > ACC and Temik > ACC+dimethoate. At 35 DAP ACC+dimethoate had significantly lower damage ratings compared with Temik < Cruiser and ACC < untreated. Plant heights were significantly greater in insecticide treatments compared with the untreated at 30 and 42 DAP. At 42 DAP plant height was significantly greater in ACC, Temik, and ACC+dimethoate treatments compared with Cruiser > untreated. All insecticide treatments significantly increased lint yield compared with the untreated, no significant differences were observed for yield among insecticide treatments but the ACC+dimethoate was the numerically highest yielding treatment.

All insecticide treatments significantly increased both below ground (roots) and above ground (shoots) plant dry weights compared with the untreated at 30 and 42 DAP. Root dry weights were significantly greatest the Temik and ACC+dimethoate treatments at 42 DAP > Cruiser and ACC > untreated. Shoot dry weights followed a similar trend at 42 DAP, Temik and ACC+dimethoate > ACC > Cruiser > untreated. Figure 1 illustrates the correlation of root dry weight to shoot dry weights at 30 and 42 DAP. R-squared values were 0.90 and 0.96 for 30 and 42 DAP, suggesting a very strong correlation of above ground to below ground plant growth. Figure 2 illustrates the correlation of root growth with thrips injury. R-squared values of 0.68 and 0.77 indicate that thrips injury is the primary factor influencing root growth, explaining about 70 percent of the variability observed in root growth among plots.

These data strongly suggests that excessive thrips feeding on seedling cotton impacts root growth and development. Plant stunting which is observed above ground strongly correlates with below ground plant growth. Early season root development is an important factor for successful production. Poor or delayed root development may impact the plants ability to endure plant stresses such as drought or nematode attack. These data do not suggest that we need to make wholesale foliar thrips treatments. Unneeded early season foliar insecticides may create additional problems such as flaring or increasing the risk of aphid and spider mite outbreaks. The primary point is that thrips impact root development and appropriate thrips management programs are an important part of the overall production system. Additional studies investigating various interactions with thrips management are needed.

Table 1. Immature and adult thrips populations in selected preventive thrips insecticide treatments, Tift Co. GA, 2008.

	Thrips per Five Plants					
	Immatures			Adults		
Treatments	14 DAP[b]	21 DAP	28 DAP	14 DAP	21 DAP	28 DAP
Untreated	13.00 a	68.25 a	109.25 a	18.50 a	21.50 bc	14.75 a
Cruiser	1.00 b	12.25 b	221.50 a	7.50 b	43.50 a	18.75 a
Avicta Complete Cotton	2.00 b	12.00 b	107.75 a	5.75 b	25.50 abc	13.75 a
Temik 15G (5 lb/acre)	0.50 b	5.50 b	54.75 b	7.00 b	9.50 c	15.75 a
Avicta Complete Cotton +dimethoate foliar[a]	0.75 b	9.75 b	58.50 b	6.75 b	29.75 ab	11.50 a

[a] Foliar sprays applied at 14 and 21 DAP.
[b] Means in a column followed by the same letter do not significantly differ (P=0.05, LSD), data were transformed (arcsine square root percent) prior to analysis.

Table 2. Thrips damage ratings, plant heights, and yield of selected preventive thrips insecticide treatments, Tift Co. GA, 2008.

	Thrips Damage Rating			Plant Height (cm)		Yield (lbs lint/acre)
Treatments	21 DAP[b]	28 DAP	35 DAP	30 DAP	42 DAP	
Untreated	4.50 a	4.50 a	4.50 a	6.75 b	7.50 c	904 b
Cruiser	3.50 b	4.00 b	3.75 b	11.45 a	24.85 b	1575 a
Avicta Complete Cotton	3.50 b	3.50 c	3.63 b	12.08 a	26.83 a	1617 a
Temik 15G (5 lb/acre)	3.25 c	3.50 c	3.13 c	12.35 a	29.88 a	1607 a
Avicta Complete Cotton +dimethoate foliar[a]	3.13 c	3.00 d	2.63 d	13.38 a	31.40 a	1811 a

[a] Foliar sprays applied at 14 and 21 DAP.
[b] Means in a column followed by the same letter do not significantly differ (P=0.05, LSD).

Table 3. Root and shoot dry weights in selected preventive thrips insecticide treatments, Tift Co. GA, 2008.

	Plant Dry Weight (g)			
	30 DAP		42 DAP	
Treatments	Roots [b]	Shoots	Roots	Shoots
Untreated	0.16 c	1.10 c	0.33 c	1.77 d
Cruiser	0.27 b	2.67 b	2.43 b	19.43 c
Avicta Complete Cotton	0.35 ab	3.01 b	3.16 b	24.68 b
Temik 15G (5 lb/acre)	0.33 b	3.16 b	4.47 a	31.44 a
Avicta Complete Cotton +dimethoate foliar [a]	0.42 a	4.37 a	4.70 a	35.54 a

[a] Foliar sprays applied at 14 and 21 DAP.
[b] Means in a column followed by the same letter do not significantly differ (P=0.05, LSD).

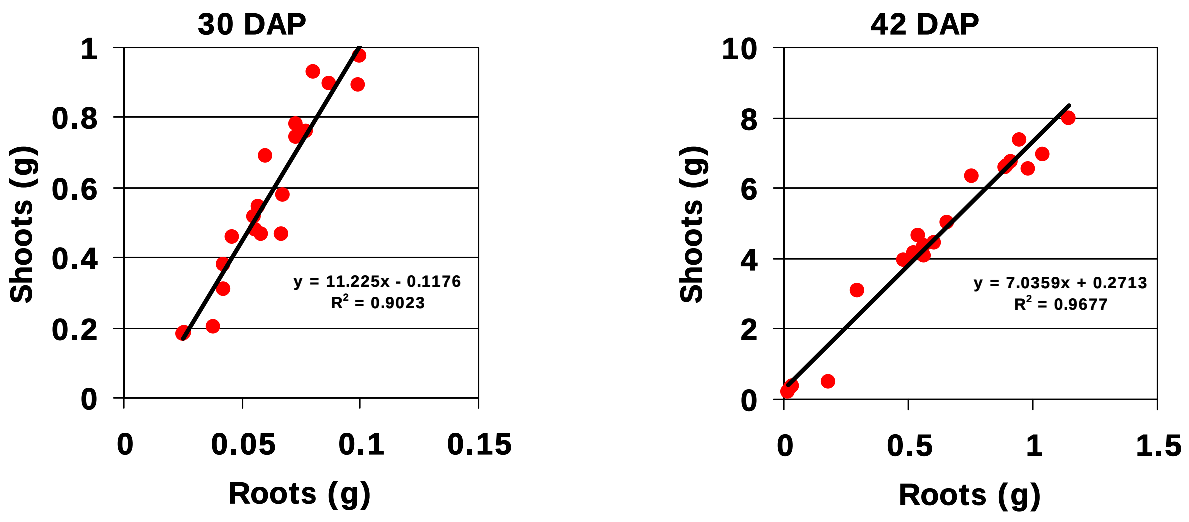

Figure 1. Correlation of root and shoot dry weights in selected preventive thrips insecticide treatments, Tift Co. GA, 2008.

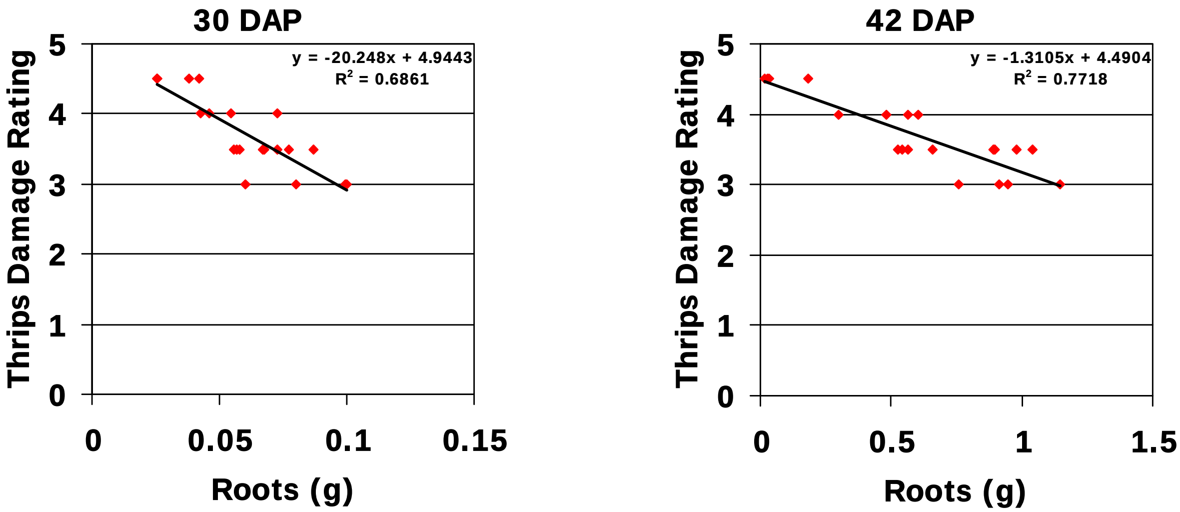

Figure 2. Correlation of thrips damage ratings with root dry weights in selected preventive thrips insecticide treatments, Tift Co. GA, 2008.

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IMPORTANCE OF NATURAL ENEMIES FOR STINK BUG CONTROL IN GEORGIA

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Introduction

A complex of stink bug species has become a very serious problem in Georgia cotton production. The problem is exacerbated by the widespread distribution of stink bugs across the landscape, the numerous host plants available to them for feeding and reproduction, and the difficulties associated with finding them in cotton and characterizing their damage. The dominant stink bug species in Georgia are the southern green stink bug, *Nezara viridula*, the green stink bug, *Acrosternum hilare*, and the brown stink bug, *Euschistus servus*, with the southern green stink bug generally dominating by a significant margin. In addition to these species, several other species have become increasingly abundant including the red banded stink bug, *Piezodorus guildinii*, and *Euschistus quadrator*, both of which seem to be more abundant in the southernmost portions of the state (pers. observ.).

Various natural enemies have been reported attacking stink bugs in various regions of the world (e.g., Yeargan 1979, Jones 1988, Ehler 2002), but the natural enemy complex in the southeastern United States has been poorly defined. This project was initiated in 2007 to characterize the suite of stink bug natural enemies present in Georgia and to determine their efficacy. In 2007, we found that the parasitoid complex attacking stink bugs was primarily active against adult stink bugs, and had little impact on immatures. However, we obtained a few specimens of an unrecognized wasp from nymphs of the southern green stink bug and an adult brown stink bug. These studies were continued in 2008 to obtain further information on the role and diversity of stink bug natural enemies.

Materials and Methods

Parasitoid and Pathogen Survey. Cotton (Bollgard II, DPL143RF), Group 5 soybeans (DP5915R), and Group 7 (Asgrow H1242R) soybeans were planted in Sumter County (2 June), Tift County (16 June), and Decatur County (12 June), Georgia. These crops were sampled for stink bug populations (see Table 1 for sampling dates at each location), and all stink bugs collected in the samples were returned to the laboratory and held for parasitoid emergence. Collected bugs were held in 50 ml sample cups and provided with pieces of green bean pods and sunflower kernels as food. Bugs were checked daily for survival and parasitoid emergence. Bugs were held in an environmentally controlled rearing room at 24°C with a photoperiod of 14:10 (L:D). Dead bugs were dissected to evaluate the presence of pathogens and parasitoids. Bugs were considered to be parasitized if they met one or more of the following four criteria: (1) parasitoid egg(s) present on the bug cuticle, (2) parasitoid emerged from the bug, (3) parasitoid immatures present in bug at the time of host death, and/or (4) the presence of a tracheal funnel in the stink bug, signifying that a parasitoid larva had completed development in the host and departed (see Fig. 1).

Predation of Stink Bug Egg Masses. In addition to assessing parasitism of nymphs and adults, egg masses of the southern green stink bug were placed in a set of eight 0.5-acre experimental cotton plots (DPL143B2/RF; planted 16 June) to evaluate egg predation and parasitism. Four of the plots were treated to exclude red imported fire ants, *Solenopsis invicta*. Egg masses were placed on plants in the center of the plot, with 2 m between placement sites, in a 2x3 or 2x4 layout (either 3 or 4 egg masses placed on each of the two rows). The number of egg masses placed in the field varied among trials (Table 3). Plots were separated from one another by open gaps of 3 m of bare soil tilled at regular intervals. The plots were arranged in 4 blocks, each containing one fire ant inclusion plot and one fire ant exclusion plot. Plots were approximately square, and a 10x10m area in the center of each plot was designated for sampling. Fire ant exclusion plots were treated with hydramethylnon ant bait (Amdro®) at a rate of 1.1 kg of formulated bait per ha on 18 June, 8 July, 22 July, 4 August, and 4 September 2008 to eliminate fire ants. To assess the exclusion treatment, ant detection tests were conducted on 8 July, 9 August, and 16 September. This test consisted of placing six 33-ml test tubes containing a small piece (5 gm) of hotdog in each plot. After 1 hour all tubes were recovered and sealed, and transported back to the lab where the tubes were emptied and the number of ants was recorded.

Predation trials were conducted using southern green stink bug egg masses. The egg masses were obtained from a lab colony maintained on green bean pods and shelled sunflower seeds. Eggs were placed in the field on multiple occasions (see Table 3 for dates). Each egg mass was stapled to the lower surface of the uppermost expanded leaf. Three to four egg masses were placed on plants in each of two rows of cotton, which were separated from one another by six rows. All egg masses were collected after 72 hours of exposure to enemies. Egg counts were then made at 1, 6, 18, 24, 48, and 72 hours after all eggs had been deployed by digitally photographing each egg mass. This minimized disturbance of the egg mass and allowed us to make more accurate counts on the computer. The activity of predators at each observation period also was recorded on the digital images of the egg masses. Predators were identified to species in the field or from the images and were recorded either preying upon or simply occupying egg masses.

Data Analyses. Survey results are reported without analysis at this point because we are still gathering data in the laboratory from more than 100 stink bugs that are still alive. We are also still processing the egg mortality data, so summary statistics are presented here for dates that have been processed.

Results and Discussion

Parasitoid and Pathogen Survey. A total of 1604 stink bugs of all life stages of four species were collected in the survey, with the predominant species being the southern green stink bug (Table 2), which accounted for 961 of all individuals collected. The majority of bugs were collected from soybeans at each location because they were much more abundant in this crop than in cotton or peanuts. Overall parasitism of nymphs and adult bugs was low, and the majority of the parasitism (76.2%) was concentrated on the adult stage, as we found in 2007. Only 41 individuals were parasitized in the nymphal stages out of 751 nymphs collected (0.5%), and only in the 4^{th} and 5^{th} instars. In contrast, 120 out of 822 adults collected were parasitized (14.6%). Most parasitism was found in the southern green stink bug (6.3% of nymphs and 27.0% of adults). Parasitism was much lower in the other species collected.

Parasitism of stink bug adults and nymphs was heavily dominated by a single species, the tachinid fly *Trichopoda pennipes.* This fly lays external eggs on the bugs (from 1 to 10 eggs per host in the present survey), from which fly larvae bore into the host to become internal parasites. Nine bugs were parasitized by a braconid wasp that produced a white cocoon (Fig. 2), which has since been identified as *Aridelus rufotestaceus*, a species native to the Sino-Russian region (Shaw et al. 2001), and recorded for the first time in the Americas in the present studies. Two of these wasps were reared from stink bugs in 2007. The wasps in 2008 were obtained from stink bugs in soybeans in Tifton (5^{th} instar southern green stink bug; 10 October) and the remainder were collected in Plains (two 4^{th} instar southern green stink bugs, five 5^{th} instar southern green stink bugs, and one 5^{th} instar brown stink bug; all from 17-25 September). It is encouraging to encounter a few more in 2008 than in 2007, and in two locations, although all cases were found late in the season.

The probability of successful parasitism increased with the number of eggs placed on a host, although the majority of bugs had only a single egg placed on them (Fig. 3). The data also suggest that antagonism may occur among competing parasitoids if the number of eggs placed on a host is too high (e.g., >4), leading to reductions in successful parasitism. Further, an additional 26 bugs produced fly parasitoids without having external eggs on them (16.0% of all parasitism). Some of these bugs may have been parasitized as nymphs, and could have lost the external egg during the molts preceding the adult stage. Regardless, external eggs are not particularly good predictors of actual parasitism and mortality rates.

Male southern green stink bugs were more heavily attacked by tachinids than were females, with 30.5% of males being parasitized compared to 23.8 of females. This corresponds with what other studies have found, and appears to be due to parasitoid attraction to the sex pheromone released by males as they signal for mates (Harris and Todd 1980).

Two adult bugs were infected with an entomopathogenic fungus. Both were collected in Plains. Both were adult male brown stink bugs, one collected in cotton on 2 October and the other collected in soybeans on 25 September. Both individuals died in the lab, and dissections revealed dense mycelial mats occupying the abdomens of the cadavers. Both specimens were sent to Dr. Donald Steinkraus at the University of Arkansas for determination. Unfortunately, because the cadavers were not sporulating, Dr. Steinkraus was unable to give a definitive identification, but indicated that both specimens represented species of the fungal order Entomophthorales, an important group of entomopathogenic fungi. These observations and the two specimens collected in 2007 comprise the first record of fungal infection of *Euschistus* in North America, and may provide opportunities to further examine the pathogen in the future for developing biological control programs. However, we must first identify the fungus and induce it to sporulate before we can conduct further studies.

Predation of Stink Bug Egg Masses. The Amdro treatments were effective in suppressing fire ant populations. Fire ants were found in 50 (76.3 ants per tube), 62.5 (95.9 ants per tube), and 70.8% (106.8 ants per tube) of the 24 tubes placed in the ant inclusion plots on 8 July, 9 August, and 16 September, respectively. In contrast, ants were obtained in only 1 out of 24 tubes on both 8 July and 9 August, and each tube contained a single ant. Predation of stink bug eggs by chewing predators after 72 hours ranged from 7.8 to 51.5% of all eggs in cotton plants with fire ants present (overall mean of 17.85%; Table 3). In contrast, predation by chewing predators in plots without ants ranged from 0 to 6.3% after 72 hours (overall mean of 0.20%). Sucking predators had limited impact on stink bug egg mortality, accounting for an overall mean of only 0.15% when fire ants were present, and 0.20% when they were absent (Table 3). Ant presence had no apparent effect on sucking predation. Several species of sucking predators were found feeding on egg masses, with the big-eyed bug *Geocoris punctipes,* dominating the complex. Other species that were observed feeding on stink bug eggs were the cotton fleahopper, *Pseudatomoscelis seriatus*; the plant bug *Spanagonicus* sp.; brown stink bug nymphs; and the big-eyed bug *Geocoris uliginosus*. Actual egg removal rates, however, varied greatly among dates as well as treatment blocks (Table 3), although the differences were more pronounced in the fire ant inclusion plots because of the much greater range of mortality in these plots.

This study is among the first to assess the impact of fire ant predation on eggs of stink bugs (see also Krispyn and Todd 1982). Predation on stink bug eggs by fire ants varied considerably among treatment blocks. Ehler (2002) observed that although predators readily fed upon southern green stink bug nymphs, they rarely fed upon the eggs. In the current study we observed predation on eggs of southern green stink bugs by fire ants, *G. punctipes*, larval green lacewings, *Chrysoperla rufilabris*, and several other species observed infrequently. Egg loss was quite variable, but it is obvious that fire ants are the most important predators of stink bug eggs, accounting for loss as high as 50% on one occasion.

The growth of conservation tillage in cotton may contribute to increased fire ant populations, and enhanced predation of stink bug eggs in cotton. Further, expanded distribution of *Aridelus rufotestaceus* may contribute to large-scale partial suppression, as this wasp is currently parasitizing about 20% of southern green stink bug nymphs in some areas of Italy (Shaw et al. 2001).

Acknowledgments

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Table 1. Stink bug sample dates and protocols for the respective locations, 2008.

Location	Dates sampled	Crops sampled	Sampling procedure
Live Oak, Florida	15 April	Potatoes, weeds	3 hours of searching plants
Attapulgus,	5 June	Peach trees (fruiting)	3 hours of searching plants
Decatur Co., Georgia	15 July	Soybeans (Group V)	300 sweeps
	24 July	Soybeans (Group V)	300 sweeps
	31 July	Cotton	300 sweeps
	20 August	Cotton	300 sweeps + 30 shakes
	16 September	Cotton	300 sweeps + 30 shakes
	26 September	Cotton	300 sweeps + 30 shakes
		Soybeans (Group VII)	300 sweeps
Plains,	23 July	Soybeans (Group V)	300 sweeps
Sumter Co., Georgia	30 July	Soybeans (Group V)	300 sweeps
	6 August	Soybeans (Group V)	480 sweeps
		Cotton (2nd week of flower)	320 sweeps + 16 shakes
	15 August	Soybeans (Group (V)	300 sweeps
		Cotton	320 sweeps + 16 shakes
	21 August	Soybeans (Group (V)	300 sweeps
		Cotton	320 sweeps + 16 shakes
	28 August	Soybeans (Group (V)	300 sweeps
		Cotton	320 sweeps + 16 shakes
	11 September	Soybeans (Group (V)	300 sweeps
		Cotton	320 sweeps + 16 shakes
	17 September	Soybeans (Group V/VII)	300 sweeps
		Cotton	320 sweeps + 16 shakes
	25 September	Soybeans (Group V/VII)	300 sweeps
		Cotton	320 sweeps + 16 shakes
	2 October	Soybeans (Group VII)	300 sweeps
		Cotton	320 sweeps + 16 shakes
	10 October	Soybeans (Group VII)	300 sweeps
		Cotton	320 sweeps + 16 shakes
	16 October	Soybeans (Group VII)	300 sweeps
		Cotton	320 sweeps + 16 shakes
Tifton,	29 April	Crimson clover	270 sweeps
Tift Co., Georgia		Wheat	450 sweeps
	2 May	Crimson clover	400 sweeps
	8 May	Crimson clover	400 sweeps
	27 May	Flowering wild mustard	300 sweeps
	29 May	Flowering wild mustard	400 sweeps
	31 July	Soybeans (Group V)	300 sweeps
	9 September	Soybeans (Group V)	300 sweeps
	17 September	Soybeans (Group V)	300 sweeps
	2 October	Soybeans (Group (V/VII)	300 sweeps each
	10 October	Soybeans (Group (V/VII)	300 sweeps each

Table 2. Numbers of stink bugs collected, and number parasitized (in parentheses beneath), by location. Numbers are pooled across sample dates and host plants (cotton, soybeans, and millet).

Species	Life stage	Location			Totals
		Attapulgus	Plains	Tifton	
Nezara viridula	2nd instar	16 (0)	8 (0)	9 (0)	33 (0)
	3rd instar	4 (0)	29 (0)	53 (0)	86 (0)
	4th instar	10 (0)	55 (1)	36 (1)	101 (2)
	5th instar	16 (0)	186 (31)	105 (1)	307 (32)
	Adult male	27 (13)	75 (31)	95 (16)	197 (60)
	Adult female	29 (10)	86 (32)	91 (7)	206 (49)
Euschistus servus	2nd instar	1 (0)	0	1 (0)	2 (0)
	3rd instar	0	4 (0)	2 (0)	6 (0)
	4th instar	1 (0)	6 (0)	3 (0)	10 (0)
	5th instar	7 (0)	38 (0)	24 (0)	69 (0)
	Adult male	24 (0)	17 (0)	18 (0)	59 (0)
	Adult female	22 (1)	25 (0)	25 (1)	72 (2)
Acrosternum hilare	3rd instar	3 (0)	5 (0)	3 (0)	11 (0)
	4th instar	0	5 (0)	15 (1)	20 (1)
	5th instar	5 (0)	23 (6)	44 (1)	72 (7)
	Adult male	9 (0)	17 (2)	40 (2)	66 (4)
	Adult female	3 (0)	21 (2)	28 (3)	52 (5)
Piezodorus guildinii	5th instar	0	0	34 (0)	34 (0)
	Adult male	24 (0)	0	55 (0)	79 (0)
	Adult female	42 (0)	0	49 (0)	91 (0)
					1573 (162)

Also collected stink bugs in Live Oak, Florida: 17 adult female *Nezara viridula* (1 parasitized), and 14 males (10 parasitized)

Table 3. Proportion (±SE) of *Nezara viridula* eggs preyed upon in fire ant inclusion and exclusion plots of cotton at 24, 48, and 72 hours after eggs were initially deployed. Predation type refers to the method by which eggs were fed upon. In cases where egg contents were sucked out, the eggshell remained in place. Chewed eggs were either removed, or fragments of eggshells were left attached to the substrate.

Trial start date/ No. egg masses	Proportion of eggs preyed upon (chewed/sucked out) at specified observation time:					
	Ants present			Ants absent		
	24 h	48 h	72 h	24 h	48 h	72 h
9 July N = 48	14.1/0	19.6/0	20.9/0	0/0	0/0	0/0.1
22 July N = 48	40.1/0	47.5/0	51.5/0	2.5/0	3.2/0	4.2/0.1
6 Aug N = 48	7.6/0	7.8/0	7.8/0	0/0	0/0	0/0
14 Aug N = 48	15.8/0	20.3/0	20.3/0	0.4/0	0.5/0	0.5/0
28 Aug N = 48	2.4/0.1	8.4/0.1	13.0/0.1	0.02/0	0.02/0	0.02/0
3 Sept N = 48	6.6/0	10.7/0	10.7/0	0.1/0/0	0.1/0	0.1/0.3
9 Sept N = 64	0/0.1	0.1/0.1	7.9/0.1	0.8/0,3	3.0/0.8	6.3/0.9
16 Sept N = 64	6.0/1.0	8.0/1.0	10.7/1.0	0.1/0.2	0.1/0.2	0.8/0.2
Mean % chewed	11.60	15.30	17.85	5.13	0.87	1.49
Mean % sucked out	0.15	0.15	0.15	0.06	0.13	0.20

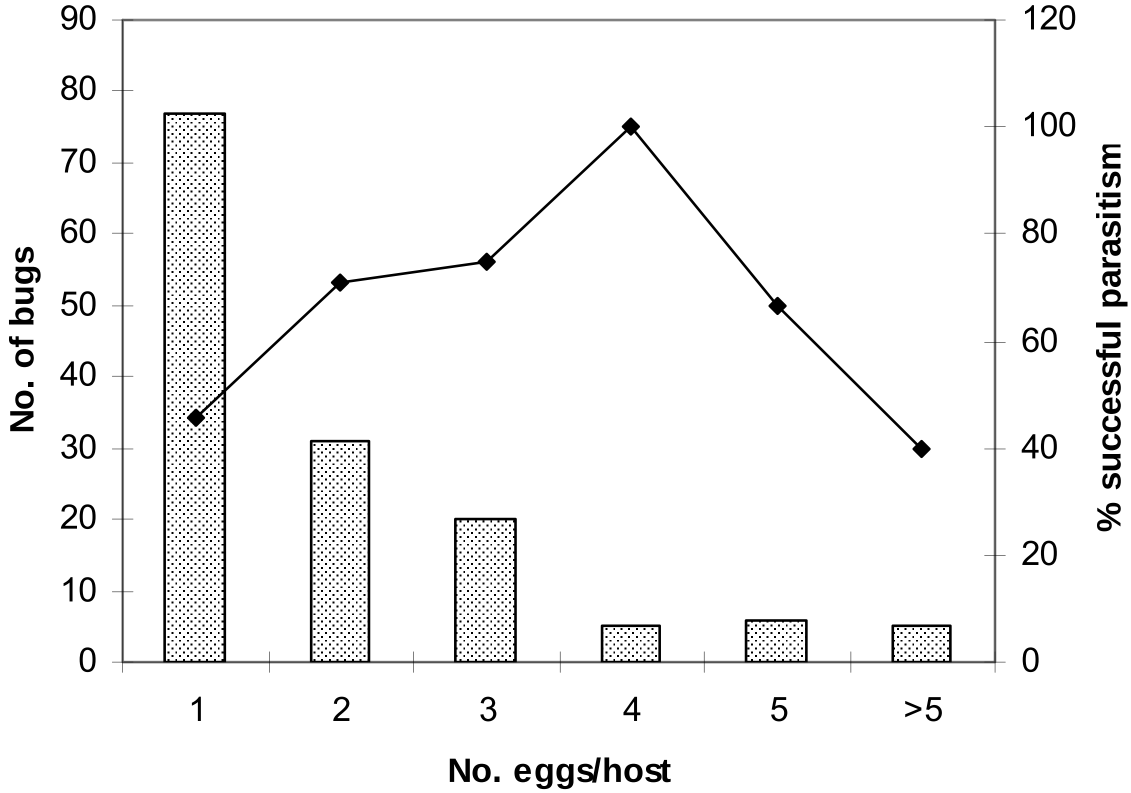

Fig. 3. Numbers of tachinid eggs per stink bug body (solid bars) in relation to successful stink bug parasitism (line). Parasitism is successful if a parasitoid was able to develop within the host to at least the second larval instar.

INFLUENCE OF ADJACENT CROPS ON COTTON FIBER QUALITY WITH RESPECT TO STINK BUG MOVEMENT

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Abstract

Stink bugs have become serious insect pests in southeastern US cotton production. Research shows that these pests actively move among crops in search of developing seeds. Therefore, understanding when and where stink bugs will move into cotton fields may help growers better manage infestations. To investigate how adjacent crops affect stink bug damage in cotton fields, a second year of data on replicated 4 to 5 acre trials were conducted with unsprayed corn, peanut, and soybean bordering an unsprayed cotton field. The cotton in rows 1, 5, 10, 20, and 50 from each adjacent crop was sampled weekly during weeks 3 through 6 of bloom. At the end of the year, representative plots from distances of 1, 10, 20, and 50 rows from the adjacent crop were harvested, ginned, and classed. Results show that boll damage, fiber color, and lint value were negatively affected when the cotton was immediately adjacent to peanuts and soybeans.

Introduction

The within-farm configuration of resource patches utilized by a particular species is commonly referred to as the farmscape. This concept is different from a landscape in that the latter is a much larger geographic areas composed of a mosaic of local ecosystems. The farmscape, made up of the cultivated and naturally occurring plant hosts, is the appropriate scale for studying mobile insect populations at the local ecosystem level. Stink bugs are best studied in this context because they have a broad host range comprising over 200 known plant species where stink bug feeding and development were observed or implied. Some commonly rotated cultivated hosts of stink bugs in the southeastern US include: corn, grain sorghum, peanut, and soybean. Stink bugs overwinter in non-crop vegetation and then infest a sequence of fruiting non-cultivated hosts until large acreages of cultivated hosts are available. The spatial arrangement of these hosts favors the development of high pest densities and subsequent economic damage to late maturing crops like cotton. Objectives of this study were to 1) assess stink bug induced damage and fiber quality in cotton fields planted adjacent to corn, peanut, and soybean, and 2) determine how far observed damage extended into cotton fields.

Materials and Methods

Four to five acre fields were equally divided into four separate plots at each study site for planting common agronomic crops in Georgia farmscapes. Crops included corn, peanut, and soybean bordering a centrally located cotton field (Fig.1). Three locations each were monitored in 2007 and 2008. Stink bug pressure in 2008 was much greater than 2007. Location of the adjacent crops (cotton was always in one of the two center positions) was randomized to avert any directional bias. Cultivars and planting dates were patterned after typical commercial practices for Georgia producers. Crops were planted on a 36-inch row spacing under conventional tillage and all fields were irrigated. Each crop was grown using Georgia Cooperative Extension recommended agronomic practices, except no broad spectrum (pyrethroid or organophosphate) insecticide applications were made after planting.

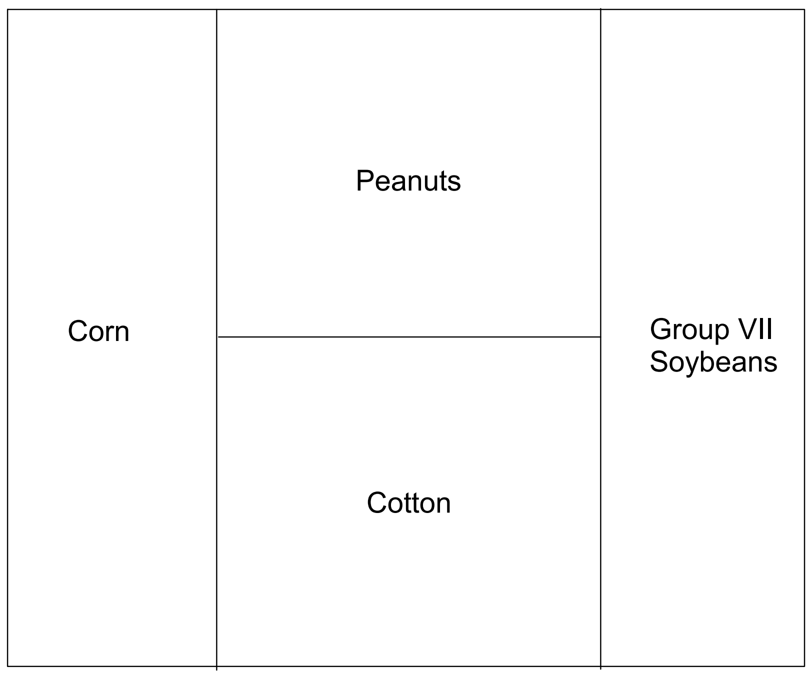

Fig. 1. Generic plot layout including position of corn, peanuts, and soybeans (randomized in each replicate of the experiment) positioned around a central cotton field.

A comprehensive sampling plan including boll damage, seed cotton yield, and fiber quality assessment was conducted in the cotton plots. Assessments of boll damage were completed weekly during weeks 3 through 6 of white flower. Quarter sized soft bolls from rows 1, 5, 10, 20, and 50 were pulled and internally examined for signs of stink bug damage including stained lint, carpal warts, and boll rot. Regardless of the distance from the edge of the field, sampling activities were always confined inside a centered 50 foot zone (parallel to the adjacent border of interest) to avoid bias as a result of sampling in the corners of the field were two adjacent crops came together. At the end of the growing year the cotton was picked, weighed, ginned, and classed. Following defoliation, alleyways were mowed into the plots to facilitate operation of a 2-row cotton picker (spindle picker) modified to collect seed cotton into bags. A total of 100 row feet of cotton were picked into separate bags at each distance from the adjacent crop. A single cotton sample was also picked from the center of each cotton plot (50 rows). Bags were weighed to determine seed cotton yield before being ginning at the UGA Microgin (Tifton, GA), a pilot scale facility that handles research quantities of seed cotton. Representative ginned fiber samples from each plot were then sent to the USDA Classing Office located at Macon, GA.

Lint value was calculated for each replication of each treatment. Value was based on the November 2008 average Georgia cash (spot) price received for base quality (Color 41-Leaf 4, Staple 34) cotton adjusted for fiber quality. Lint yield was multiplied by the price per pound adjusted for the fiber quality. The November average price included LDP (Loan Deficiency Payment) if applicable (USDA-FSA). The November 2008 base price including the average LDP for the month was 54.91 cents per pound.

Results and Discussion

Across years, cotton boll damage differed significantly as a function of adjacent crop and distance from the edge of the cotton plot. Cotton bolls in row 1 adjacent to peanut and soybean both exceeded 60% damage while similar positioned bolls experienced 20% damage adjacent to corn. These data suggest that more stink bugs are moving directly into cotton from peanuts and soybeans. The percent boll damage rapidly decreased with distance into the cotton field regardless of adjacent crop (Fig. 2). This observation suggests that stink bugs likely colonize the edges of cotton fields before moving into the field interior.

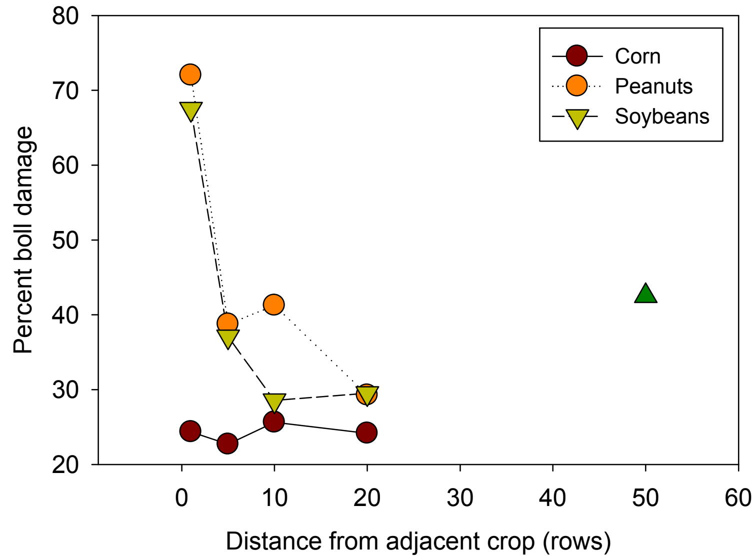

Fig. 2. Average percent boll damage as a function of distance from the field edge and adjacent crop.

The plot of seedcotton yield was a mirror image of boll damage. Edges of the cotton field that were heavily damaged by stink bugs yielded proportionally less seedcotton than regions of the field with less damage (Fig. 3). These data also support the hypothesis that stink bugs first colonize field edges and then move around and colonize the interior portions of the field.

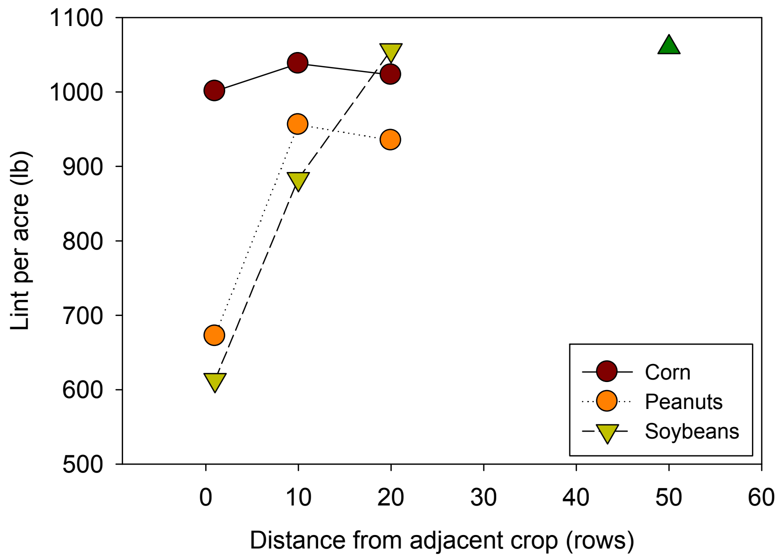

Fig. 3. Seedcotton yield as a function of distance from the field edge and adjacent crop.

Fiber quality of the cotton was impacted by the stink bug infestations near the field edges. Both color Rd (fiber brightness) and color +b (fiber yellowness) showed obvious signs of stink bug damage (Fig. 4). Generally speaking, cotton harvested from the rows immediately adjacent to peanut or soybean were classed one color grade worse than the average cotton in that plot (ex. color grade 52 next to peanut compared to color grade 41 across the rest of the plot).

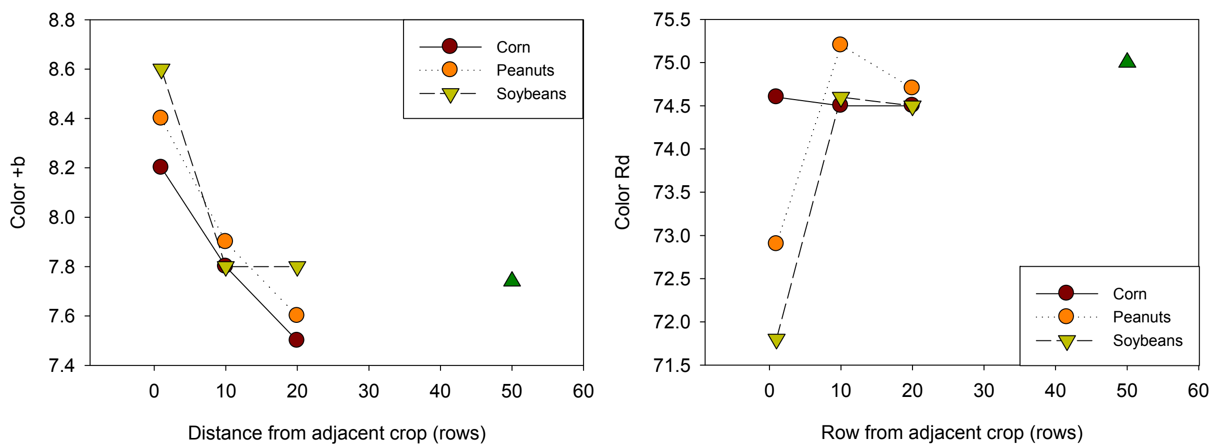

Fig. 4. Changes in color +b (left) and color Rd (right) as a function of distance from the field edge and adjacent crop.

Finally, lint values were calculated to reflect the monetary value of the seedcotton based on yield and fiber quality on a per acre basis. Areas of the field that were heavily damaged by stink bugs produced considerably less lint and lint of lower quality. Therefore, these areas produced lower valued product (Fig. 5). These data suggest that growers need to be much more proactive about managing stink bug populations near peanut and soybean fields.

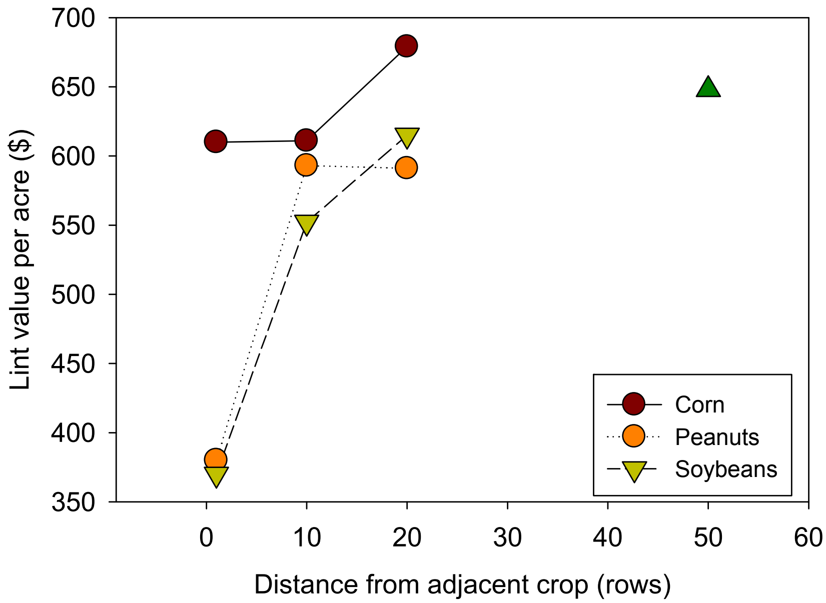

Fig. 5. Mean lint value as a function of distance from the field edge and adjacent crop.

Stink bugs are known to be particularly sensitive to host quality. They are constantly in search of plants that are in the process of setting fruit. This may help explain why corn is a good stink bug host early in the year, but cotton placed adjacent to corn field did not suffer stink bug damage to the same degree that would have been expected. Because the reproductive stages of the two plants are not closely synchronized, the stink bugs likely left the corn in search of new hosts before the cotton was attractive. Obviously, peanuts and soybeans are serving as a stink bug source when located adjacent to cotton fields. The exact distance that stink bugs will travel to find a cotton field is unknown, but it is likely that the population would be diluted in time and space thereby reducing damage.

Acknowledgments

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INSECTICIDE EFFICACY ON HELIOTHINE AND STINK BUG INFESTATIONS IN NON*BT* COTTON

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Introduction

We have conducted field tests evaluating insecticide performance in non*Bt* cotton at the Southeastern Branch Research and Education Center (SEBRC) near Midville for over 30 years. Sex pheromone trapping of male moths indicates that the SEBRC usually has higher proportion of bollworm, *Helicoverpa zea* (Boddie), to tobacco budworm, *Heliothis virescens* F., infestations in cotton during late July-August. Populations of various species of stink bugs tend to increase in cotton throughout the season at the SEBRC and significant injury to fruit may occur during July-September. This research was conducted to evaluate performance consistency of registered insecticides for control of heliothine and stink bug infestations for comparison to previous years and to assess efficacy of new chemical materials for the pests.

Materials and Methods

A field test was conducted at the UGA Southeastern Branch Research and Education Center (SEBRC) in Burke County. The cotton was DP494R and four row plots (with one buffer row separating each plot) were established that were 40 feet long with 38 inch row width, separated by 15 foot alleys arranged in a randomized complete block design replicated four times. Plots were sprayed with a high cycle sprayer equipped with a four row boom using three TX 4 spray nozzles/row. The sprayer traveled at 3 mph and applied 10 gallons per acre finished spray volume. Sprays were initiated when 8% squares showed damage in the field on July 10 and applications were continued on July 17, 24, 31, and August 8. Adult bollworm and budworm (heliothine) populations were monitored weekly using a Hardstack pheromone trap for each species placed adjacent to the test field. Heliothine infestations were surveyed by examining the fruiting structures in plots for damage by selecting five plants in the two middle rows of each plot and examining all fruiting structures in the upper half of the plant for injury and larvae. Stink bug populations were monitored with sweep nets by sweeping over the upper third of plants in 25 feet of row in random locations in non-sprayed cotton in the field area. Stink bug injury to cotton in each plot was assessed on August 27 by randomly selecting four plants in each plot, removing all the bolls, freezing the samples, and then microwaving frozen bolls for four minutes to aid in opening for examination of stylet injury, hyperplasia (warts), and lint staining. The two middle rows of each plot were harvested with a cotton picker on November 20. Infestation and harvest data were analyzed using SAS Anova ($P<0.05$) procedures and Tukey's Studentized Range (HSD) Test for means separation.

Results and Discussion

Higher numbers of tobacco budworm as compared to bollworm were captured in sex pheromone traps on 7/10/08 and 7/17/08, but this reversed on 7/22/08 with higher percent bollworm to budworm through the last collection on 8/12/08 (Table 1). The most severe heliothine infestations were sampled on 7/22/08 and 7/29/08 (Table 3). Belt™, Tracer™, Coragen™, and Baythroid™ provided best control of heliothine infestations during this period in comparison to treatments with Leverage™, Endigo™, Orthene™, and Baythroid™ (Table 3). On the other hand, the data on stink bug injury (Table 4) shows these latter four treatments had best control whereas the first three compounds Belt™, Tracer™, and Coragen™ had poor suppression of stink bug damage. Yield (Table 4) was highest in Baythroid™, Belt™, Coragen™, Leverage™, and Endigo™ treatments.

The authors thank the Georgia Commodity Commission for Cotton for financial support of this research.

Table 1. Adult male moths caught in Hardstack pheromone traps during 2008 at the SEBRC.

Pheromone Trap Counts		
Date	**# *zea***	**# *virescens***
7/10/08	313	919
7/17/08	367	646
7/22/08	889	219
7/29/08	448	149
8/05/08	427	48
8/12/08	410	75

Table 2. Insecticide treatments used in 2008 SEBRC field experiment.

Treatment	Rate
Belt (flubendiamide) 4SC+ NIS (nonionic surfactant)	0.094 lbs ai/A + 0.5 lbs ai/A
Belt SC+ MSO	0.094 lbs ai/A + 0.5 lbs ai/A
Leverage (low rate) (imidacloprid, 17% + cyfluthrin 12%) 2.7 SC + NIS	0.048 lbs ai /A imidacloprid+ 0.033 lbs ai/A cyfluthrin + 0.5 lbs ai/A NIS
Leverage (high rate) + NIS	0.063 lbs ai/A imidacloprid+ 0.043 lbs ai/A cyfluthrin + 0.5 lbs ai/A NIS
Endigo (L-cyhalothrin 9.48% + thiamethoxam 12.6%) ZC+ NIS	0.0344 ai/A L-cyhalothrin + 0.0461 ai/A thiamethoxam + 0.5 lbs ai/A NIS
Orthene (asephate) 97S	0.8 lbs ai/A
Baythroid (beta-cyfluthrin) 1XL + NIS	0.017 lbs ai/A + 0.5 lbs ai/A
Tracer (spinosad) (480g/l) XL	0.063 lbs ai/A
Intrepid (methoxyfenozide) 2F	0.094 lbs ai/A
Coragen (rynaxypyr) 1.67 SC	0.088 lbs ai/A

Table 3. SEBRC helothine infestations during 2008.

	Damage assessment and larval counts on cotton by percentages and dates									
	7/14/08		7/22/08		7/29/08		8/5/08		8/12/08	
Treatments	Square	Larvae	Square	Larvae	Square	Larvae	Square	Larvae	Square	Larvae
Check	6.1a	1.0a	15.5abc	0.25a	25.4ab	2.3b	5.3b	0.5a	2.1b	0.0b
Orthene	6.6a	1.0a	19.9ab	0a	44.7a	5.8a	45.6a	1.5a	8.1a	1.3a
Endigo+NIS	6.6a	1.3a	23.7a	0a	23.9ab	1.8b	9.1b	0.5a	0.5b	0.3ab
Intrepid	4.0a	0.3a	10.9bcd	0a	13.6bc	1.5b	12.5b	1.3a	3.2b	0.5ab
Leverage (L) +NIS	4.9a	0.8a	10.3cde	0a	9.6bc	1.5b	1.3b	0.0a	1.3b	0.0b
Leverage (H) +NIS	4.3a	0.3a	9.9cde	0a	15.2bc	1.3b	3.8b	0.0a	0.0b	0.0b
Baythroid +NIS	3.1a	0.0a	9.8cdef	0a	4.2bc	0.5b	2.5b	0.0a	0.0b	0.0b
Tracer	1.7a	0.0a	3.1def	0a	11.9bc	0.3b	1.2b	0.3a	1.3b	0.0b
Belt+NIS	3.9a	0.3a	0.4f	0a	1.9c	0.3b	0.6b	0.0a	0.0b	0.0b
Belt+MSO	3.1a	0.3a	1.2ef	0a	0.0c	0.0b	0.0b	0.0a	0.0b	0.0b
Rynaxypyr	1.1a	0.3a	1.3ef	0a	0.0c	0.0b	1.7b	0.0a	0.0b	0.0b

Table 4. Stink bug injury to cotton bolls on 8/27/08 and yield in SEBRC experiment.

	Percent damage assessment by stink bug on cotton bolls				
Treatments	% Warts	% Staining + Stylet Punctures	% Stylet Punctures Only	% Damaged Bolls Overall	Lint Yield (Lbs/A)
Check	39.5abcd	4.1a	2.1a	43.5abc	1133.3cd
Orthene	31.7bcde	3.8a	5.0a	37.0abc	825.8d
Endigo+NIS	16.0cde	2.0a	0.6a	18.2c	1585.9ab
Intrepid	60.8a	2.4a	3.4a	63.1a	1332.4bc
Leverage (L) +NIS	17.3cde	3.7a	1.9a	21.9bc	1632.0ab
Leverage (H) +NIS	10.9e	4.4a	1.3a	15.9c	1426.7abc
Baythroid+NIS	12.7de	6.4a	1.5a	19.3c	1805.2a
Tracer	41.4abc	4.5a	6.4a	47.7ab	1441.2abc
Belt+NIS	39.2abcd	4.3a	3.9a	44.1abc	1568.0ab
Belt+MSO	36.9abcde	5.0a	5.6a	43.5abc	1634.6ab
Rynaxypyr	55.7ab	3.4a	6.1a	60.0a	1637.3ab

INSECTICIDE RESISTANCE MONITORING IN LEPIDOPTERAN COTTON PESTS

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Abstract

Larvae of the bollworm, *Helicoverpa zea*, and the tobacco budworm, *Heliothis virescens*, were bioassayed for resistance to selected pyrethroid insecticides in 2008, continuing a program initiated more than 20 years ago.

Bollworm cultures were established from larvae collected in corn in Sumter and Tift Counties. Tobacco budworm cultures were established from larvae collected in tobacco in Coffee and Tift Counties. Third-instar F_1 or F_2 (and in once case, F_3) progeny were treated with 89.9% technical grade cyhalothrin and 92.4% technical grade cypermethrin. Stock solutions in acetone were prepared and serially diluted to obtain the desired concentrations. Larvae were observed 72 hr post-treatment for mortality.

In the larval bioassays, susceptibility of all the various populations of bollworms and tobacco budworms for both cyhalothrin and cypermethrin fluctuated in comparison with historical levels, although the overall levels did not appear to change significantly relative to results obtained in 2007. These results indicate that tolerance to pyrethroids in the bollworm and tobacco budworm has not changed in recent years, but has remained at serious high levels for the tobacco budworm, and at threatening levels for the corn earworm. Further, we obtained additional data supporting previous observations that pyrethroid tolerance in the corn earworm may be physiologically costly to maintain in the absence of insecticide pressure. If this is the case in the field, then reduced use of pyrethroids would contribute to some reduction in pyrethroid tolerance in this species. There continues to be a great need for growers to utilize insecticide resistance management practices to steward these products, and the growing availability of effective tools with alternative modes of action provides a valuable toolbox for resistance management.

Introduction

Insecticides remain the method of choice for control of lepidopteran pests in Georgia cotton, though great strides have been made during the past two decades in reducing chemical use. The successful eradication of the boll weevil combined with the planting of transgenic cotton, effective scouting, and careful crop management have all served to significantly lessen reliance on insecticides. Nevertheless, the older insecticides, particularly pyrethroids, continue to play a key role in management of pests in cotton due to their general effectiveness and low costs. Newer insecticides have become available, but their specificity tends to impose limits on their general utility, and they are more expensive to use. It is, therefore, important that we understand the susceptibility of target pests to insecticides so that we can make appropriate management decisions to prolong their effectiveness.

Since the introduction of pyrethroid insecticides, Georgia has historically had few pyrethroid resistance problems with major caterpillar pests, whereas other states did, most notably in the Midsouth. The prolonged susceptibility in Georgia was verified beginning in 1979, when bioassays of Georgia populations of major lepidopteran cotton pests were initiated to monitor insecticide resistance. However, in 2001, we detected increased levels of tolerance to pyrethroids in the tobacco budworm, and by 2004 this tolerance was widespread and had increased significantly (12-15-fold) over historical levels. In addition, in 2005 we detected elevated levels of pyrethroid tolerance in populations of the corn earworm in Georgia (3-5 times higher than historical levels of susceptibility), and have since documented this upward trend to be widespread in the state, although the levels of tolerance have increased very little since 2005. Because of concerns about the possible intensification of resistance, monitoring of larvae and adults of the bollworm, *Helicoverpa zea*, and the tobacco budworm, *Heliothis virescens*, has continued for resistance to certain pyrethroids. Clearly, the potential for serious problems exists and our findings indicate pyrethroid resistance in certain caterpillar pests is a Georgia problem, as well as in other states.

Materials and Methods

Bollworm cultures were established from larvae collected in corn in Sumter and Tift Counties. Two collections were made in Tift Co. corn, the first in June and the second in September. Tobacco budworm cultures were established from eggs and larvae collected in tobacco in Coffee and Tift Counties. Field-collected larvae were reared to adulthood and eggs were collected from the moths confined in 1 gal plastic containers with cheesecloth lids serving as oviposition sites. Upon hatching, neonate larvae were placed on pinto bean meal synthetic diet in 30 ml plastic cups. Both F_1 and F_2 larvae were used for the bioassays. In addition, F_3 larvae of Tift County corn earworms were tested to evaluate the persistence of tolerance across generations. All life stages of the insects were held in an incubator at 27 $\pm$ 2^{o}C, ca 60% RH and a 14:10 hr light: dark cycle. No adult bioassays were performed in 2008.

Evaluation of larval susceptibility of *H. zea* basically followed protocol outlined in the ESA Standard Test Method for detection of resistance in *Heliothis* spp. (Anon. 1970). Larvae were treated with 89.9% technical grade cyhalothrin or 92.4% technical grade cypermethrin. Stock solutions in acetone were prepared and serially diluted to obtain the desired concentrations. Microgram equivalents were calculated, adjusting for the percent active ingredient in the technical materials. One microliter of solution was applied to the dorsal thoracic region of each larva using a Microliter no. 705 (Hamilton Company, Reno, NV) hand-held applicator. Three to five replications were used in each bioassay with ten third instar, 30-40 mg larvae per dosage and an acetone check.

Observations were made 72 hr post-treatment and a larva was considered dead if it made no movement when prodded with a pencil point. Larvae were considered moribund if they moved when prodded, yet appeared black and as small or smaller than their size at treatment. These were considered alive when determining LD (lethal dosage) values, but considered dead when calculating ED (effective dosage) values (50 and 90 represent the dosage at which 50 and 90% of the individuals in the population would be impaired (ED) or killed (LD), respectively). In many instances, larvae treated with pyrethroids linger on several days beyond the observation time as moribund larvae that eventually die. For this reason we present ED values as well as LD values to present a more complete picture of dosage-response. Data were analyzed using Daum's (1970) probit analysis computer program.

Results and Discussion

The ED_{50}, ED_{90}, LD_{50}, and LD_{90} values for the 2008 Tift Co. bollworm larval bioassays are presented in tables 1, 2, 3, and 4, respectively. The cypermethrin ED_{50} for the Tift County population nearly doubled since 2007, but the ED_{50} for cyhalothrin declined by half, indicating that there is variability in response to types of pyrethroids (Table 1). The Sumter County populations exhibited a lower ED_{50} for cypermethrin than the Tift County population, but was comparable for cyhalothrin (Table 1). All ED_{50} and ED_{90} values for cypermethrin and cyhalothrin increased in comparison with the Tift County long-term average since testing began in 1983 (Tables 1 and 2). The LD_{50}, and LD_{90} values were more variable relative to the historical values (Table 3 and 4).

There was a decline in pyrethroid tolerance in Tift County corn earworms from the first (F_1) to the second generation (F_2) in the laboratory (Tables 1-4), where the insects were not exposed to insecticides except during the bioassays. This suggests that there are physiological costs associated with the elevated pyrethroid tolerance, which is degraded across at least one generation. These results confirm previous findings with Georgia corn earworms that pyrethroid tolerance declines significantly after one generation in the laboratory (in the absence of selection). However, the values for the third generation (F_3) were somewhat elevated relative to the second generation, although the values were still lower than those observed for the first generation. These results suggest that reduced pyrethroid use, reducing selection pressure on corn earworms, can effectively delay or prevent resistance from intensifying.

The ED_{50}, ED_{90}, LD_{50}, and LD_{90} values for the 2008 tobacco budworm larval bioassays are presented in tables 5, 6, 7, and 8, respectively. The values for cyhalothrin and cypermethrin tolerance varied relative to the Tift Co. value for 2007, with a very large drop in the cyhalothrin LD_{90} for the Tift County population. Nevertheless, nearly all values continue to be higher than the long-term average of bioassays performed on Tift Co. larvae since 1985 for cyhalothrin and since 1983 for cypermethrin (Tables 5-8), indicating that resistance continues to be a serious issue with the tobacco budworm.

The results of adult vial testing yielded results similar to those obtained with the larval testing (Fig. 1) – no significant change from recent years (Fig. 2). Overall levels of pyrethroid tolerance did not increase relative to those observed in 2006 and 2007, and may have even declined somewhat. This is encouraging, because resistance mechanisms can vary between adults and caterpillars. Concentration on only one life stage can lead to deceptive results.

Elevated pyrethroid tolerance in tobacco budworms and bollworms appears to have persisted in 2008, although it has not intensified in bollworms. It will be critical that current insecticide resistance management schemes continue to be emphasized and utilized by growers to preserve these important management tools.

Acknowledgments

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Table 1. ED_{50}'s for various insecticides against larval *Helicoverpa zea* (CEW) at 72 hr post-treatment (2008).

Chemical	Gen.	No. Reps	ED_{50} (□g/g larval wt.)	95% C.I.	Change (+/-) from Tift Co. 2007	Change (+/-) from Tift Co. avg	Slope ± SE
Cyhalothrin							
Tift Co.	F_1	4	0.24	0.16 - 0.32	-0.33	+0.10	1.76 ± 0.27
Sumter Co.	F_1	4	0.20	0.16 - 0.27	-0.37	+0.06	2.10 ± 0.36
Cypermethrin							
Tift Co.	F_1	4	1.16	0.92 - 1.52	+0.51	+0.72	2.01 ± 0.26
Tift Co.	F_2	4	0.48	0.36 - 0.61	-0.17	+0.04	2.06 ± 0.30
Tift Co.	F_3	4	0.80	0.65 - 0.98	+0.15	+0.36	2.51 ± 0.30
Sumter Co.	F_1	4	0.69	0.50 – 0.90	+0.04	+0.26	2.01 ± 0.31

Table 2. ED_{90}'s for various insecticides against larval *Helicoverpa zea* (CEW) at 72 hr post-treatment (2008).

Chemical	Gen.	No. Reps	ED_{90} (□g/g larval wt.)	95% C.I.	Change (+/-) from Tift Co. 2007	Change (+/-) from Tift Co. avg	Slope ± SE
Cyhalothrin							
Tift Co.	F_1	4	1.28	0.90 - 2.25	-1.08	+0.64	1.76 ± 0.27
Sumter Co.	F_1	4	0.82	0.52 - 1.95	-1.54	+0.18	2.10 ± 0.36
Cypermethrin							
Tift Co.	F_1	4	5.04	3.35 - 9.62	+1.36	+3.21	2.01 ± 0.26
Tift Co.	F_2	4	2.01	1.41 - 3.56	-1.67	+0.18	2.06 ± 0.30
Tift Co.	F_3	4	2.61	1.96 - 3.96	-1.07	+0.78	2.51 ± 0.30
Sumter Co.	F_1	4	3.01	2.12 – 5.33	-0.67	+1.18	2.01 ± 0.31

Table 3. LD_{50}'s for various insecticides against larval *Helicoverpa zea* (CEW) at 72 hr post-treatment (2008).

Chemical	Gen.	No. Reps	LD_{50} (□g/g larval wt.)	95% C.I.	Change (+/-) from Tift Co. 2007	Change (+/-) from Tift Co. avg	Slope ± SE
Cyhalothrin							
Tift Co.	F_1	4	0.52	0.38 - 0.70	-0.28	+0.25	1.54 ± 0.23
Sumter Co.	F_1	4	0.22	0.17 - 0.31	-0.58	-0.05	1.96 ± 0.35
Cypermethrin							
Tift Co.	F_1	4	1.92	1.52 - 2.62	+0.72	+0.85	2.22 ± 0.31
Tift Co.	F_2	4	0.66	0.51 - 0.84	-0.54	-0.41	2.08 ± 0.29
Tift Co.	F_3	4	1.19	0.98 - 1.46	-0.01	+0.12	2.60 ± 0.32
Sumter Co.	F_1	4	0.95	0.68 – 1.27	-0.25	-0.12	1.66 ± 0.27

Table 4. LD_{90}'s for various insecticides against larval *Helicoverpa zea* (CEW) at 72 hr post-treatment (2008).

Chemical	Gen.	No. Reps	LD_{90} (□g/g larval wt.)	95% C.I.	Change (+/-) from Tift Co. 2007	Change (+/-) from Tift Co. avg	Slope ± SE
Cyhalothrin							
Tift Co.	F_1	4	3.55	2.18 - 8.23	-2.86	+1.17	1.54 ± 0.23
Sumter Co.	F_1	4	1.00	0.59 - 2.79	-5.41	-1.38	1.96 ± 0.35
Cypermethrin							
Tift Co.	F_1	4	7.27	4.72 - 14.92	-23.86	-0.39	2.22 ± 0.31
Tift Co.	F_2	4	2.71	1.87 - 4.90	-28.42	-4.95	2.08 ± 0.29
Tift Co.	F_3	4	3.70	2.75 - 5.77	-27.43	-3.96	2.60 ± 0.32
Sumter Co.	F_1	4	5.58	3.54 – 12.45	-25.55	-2.08	1.66 ± 0.27

Table 5. ED$_{50}$'s for cyhalothrin and cypermethrin against larval *Heliothis virescens* (TBW) at 72 hr post-treatment (2008).

	Gen.	No. Reps	ED$_{50}$ (□g/g larval wt.)	95% C.I.	Change (+/-) from Tift Co. 2007	Change (+/-) from Tift Co. avg	Slope ± SE
Cyhalothrin							
Tift Co.	F_1	4	1.38	2.26 - 1.00	-1.94	+1.00	1.62 ± 0.34
Cypermethrin							
Coffee Co.	F_1	4	6.86	4.65 – 10.68	+3.48	+5.65	1.29 ± 0.25
Tift Co.	F_1	4	4.80	3.86 – 6.32	+1.42	+3.59	2.72 ± 0.47

Table 6. ED$_{90}$'s for cyhalothrin and cypermethrin against larval *Heliothis virescens* (TBW) at 72 hr post-treatment (2008).

Chemical	Gen.	No. Reps	ED$_{90}$ (□g/g larval wt.)	95% C.I.	Change (+/-) from Tift Co. 2007	Change (+/-) from Tift Co. avg	Slope ± SE
Cyhalothrin							
Tift Co.	F_1	4	8.54	4.21 - 43.84	-38.35	+4.69	1.62 ± 0.34
Cypermethrin							
Coffee Co.	F_1	4	67.77	31.94 – 333.44	+52.90	+61.73	1.29 ± 0.25
Tift Co.	F_1	4	14.22	9.73 – 29.09	-0.65	+8.18	2.72 ± 0.47

Table 7. LD_{50}'s for cyhalothrin and cypermethrin against larval *Heliothis virescens* (TBW) at 72 hr post-treatment (2008).

	Gen.	No. Reps	LD_{50} (□g/g larval wt.)	95% C.I.	Change (+/-) from Tift Co. 2007	Change (+/-) from Tift Co. avg	Slope ± SE
Cyhalothrin							
Tift Co.	F_1	4	2.50	1.67 - 6.02	-9.39	+1.30	1.64 ± 0.39
Cypermethrin							
Coffee Co.	F_1	4	16.89	10.56 – 40.25	+11.19	+12.02	1.13 ± 0.23
Tift Co.	F_1	4	7.49	5.60 – 11.99	+1.79	+2.62	2.16 ± 0.38

Table 8. LD_{90}'s for cyhalothrin and cypermethrin against larval *Heliothis virescens* (TBW) at 72 hr post-treatment (2008).

Chemical	Gen.	No. Reps	LD_{90} (□g/g larval wt.)	95% C.I.	Change (+/-) from Tift Co. 2007	Change (+/-) from Tift Co. avg	Slope ± SE
Cyhalothrin							
Tift Co.	F_1	4	15.12	6.20 - 160.73	-495.74	-25.76	1.64 ± 0.39
Cypermethrin							
Coffee Co.	F_1	4	231.86	76.69 – 2981.11	+191.51	+144.46	1.13 ± 0.23
Tift Co.	F_1	4	29.35	16.64 – 89.30	-11.00	-58.05	2.16 ± 0.38

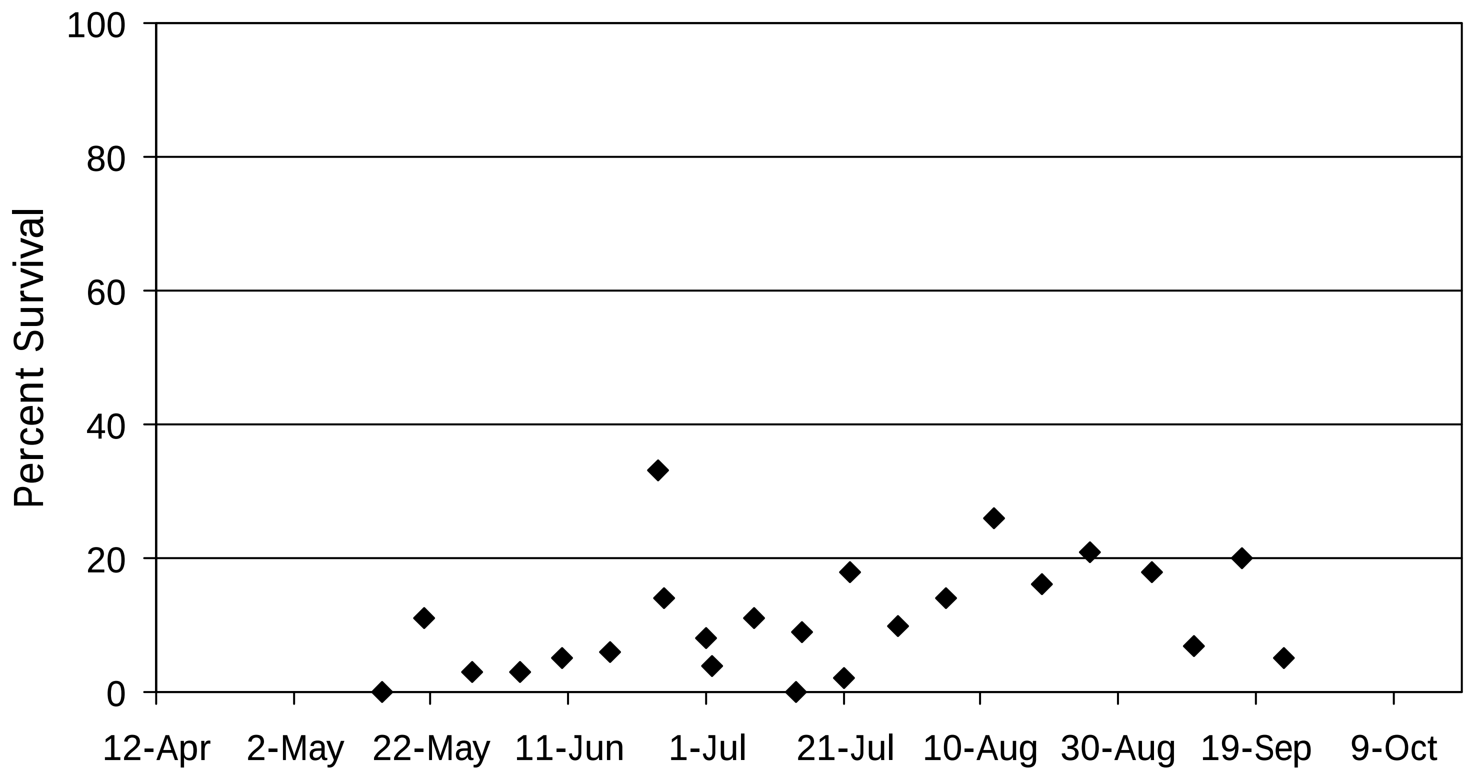

Fig. 1. Survival of adult corn earworm moths after 24 hours of exposure to 5 µg of cypermethrin in a glass vial, 2008.

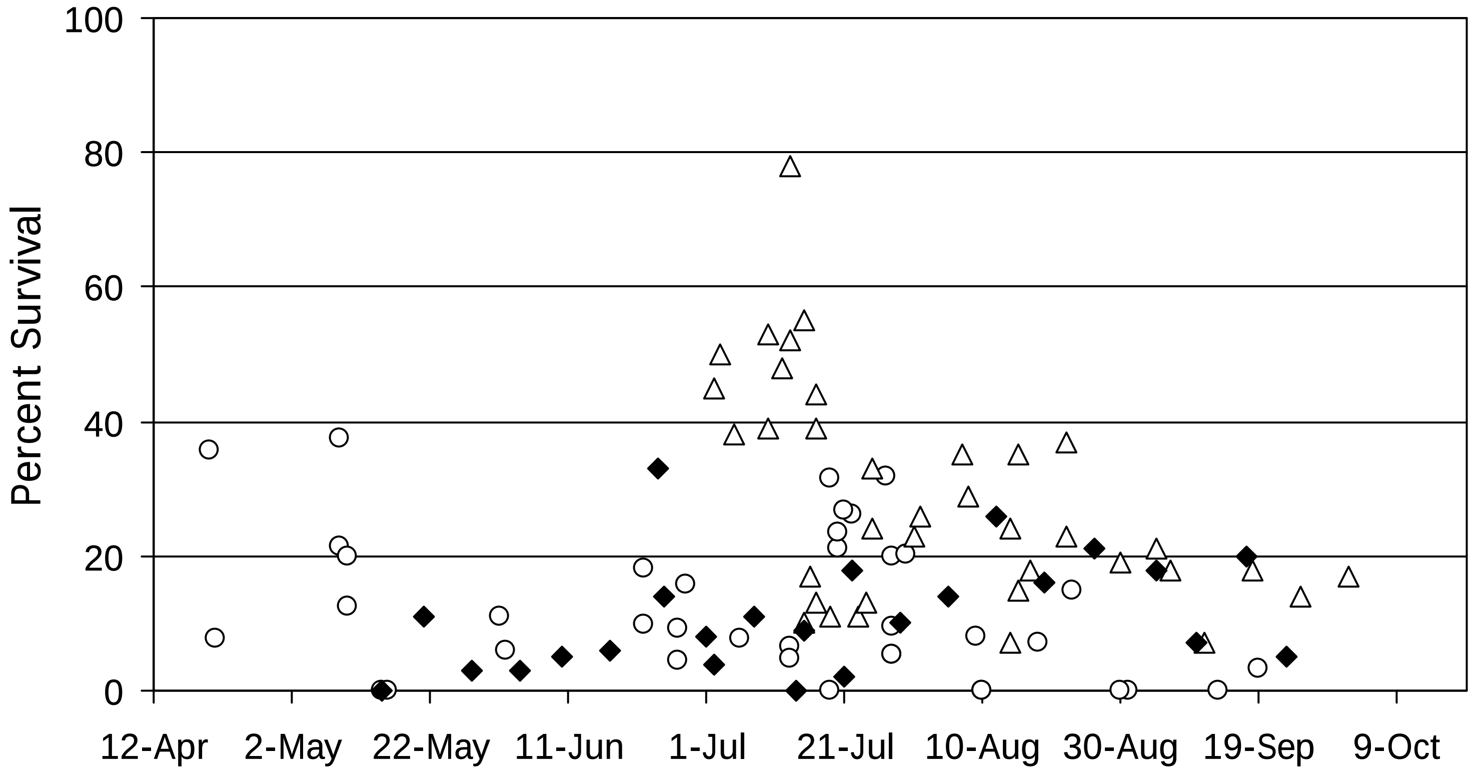

Fig. 2. Survival of adult corn earworm moths after 24 hours of exposure to 5 µg of cypermethrin in a glass vial, 2006 (open circles), 2007 (open triangles), and 2008 (closed diamonds).

PRELIMINARY STUDY OF USING A GC-FID FOR VOLATILE DETECTION ON STINK BUG INFESTATED COTTON BOLLS

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Abstract

Sucking insect pests, such as stink bugs, have become one of the most important pest complexes of southeastern cotton production. Stink bug feeding can cause young bolls to fall off the plant, lint staining, uniformity issues, reduced lint quality, and reduced yields. Currently, manual boll collection and internal evaluation is the most effective method to identify and quantify the boll damage; however, this procedure is labor intensive. The objective of this study was to explore the volatile profile differences between stink bug damaged and undamaged cotton bolls using a GC-FID. Results show that the volatile profiles emitted by undamaged and stink bug damaged cotton bolls were similar, but most volatiles were identified in decreased quantity in the stink bug damaged bolls. The result suggests that further separation among treatment levels may be possible, but will be challenging due to the minute differences in volatile profiles under current treatment.

Introduction

Piercing/sucking insect pests including stink bugs and plant bugs are quickly replacing the budworm/bollworm complex as the most important insect complex of Georgia cotton production. Stink bug feeding can cause young bolls to fall off the plant, lint staining, uniformity issues, reduced lint quality, and reduced yields. Toews et al. (2008) recently showed that quantifying internal boll damage is by far the most sensitive sampling technique for this pest. Unfortunately, manually dissecting individual bolls was also the most time consuming sampling method tested. Growers and scouts desire a quicker method to ascertain the level of internal damage.

A common plant defense to insect attack is the synthesis of volatile compounds that repel herbivores and attract the natural enemies. Lewis (1990) reported that plant volatiles induced by herbivore feeding are often used as olfactory signals by foraging herbivores and their natural enemies. Keen scientists view these intricate ecological relationships as an opportunity to exploit the system for pest management purposes. In pioneering work with cotton and southern green stink bugs, Williams et al. (2005) found that (1) female southern green stink bug feeding induced volatile production in plants, (2) feeding injury by female southern green stink bug increased volatile emissions in intact maize by approximately 2-fold compared to control plants, and (3) volatile production was affected by gender and life stage of the bug. Traditionally, chemical ecologists have used gas chromatography and mass spectrometry (GC-MS) for detecting individual components in an odor profile. A gas chromatograph (GC) equipped with a flame ionization detector (GC-FID) usually suffice when individual compounds do not need to be identified. This information may help develop an alternative sensing approach for stink bug infestation on cotton bolls.

Objective

Based on the rationale above, the objective of this study was to characterize differences in the volatile profile between intact and stink bug damaged cotton bolls using the GC-FID detector.

Materials and Methods

Prior to analyses, cotton bolls were systematically damaged by caging stink bugs on the developing bolls for fixed periods of time. Cotton plants (FM 9063 B2RR) were grown in 11.3 liter pots housed in a greenhouse at the Coastal Plain Experiment Station at Tifton. When the bolls reached 7-10 days past anthesis, lab-reared southern green stink bugs (5^{th} instars) were caged on the bolls for a duration of 72 h. Boll circumference was measured with a veneer calipers following the stink bug exposure to assure similar bolls. In total, 6 treatments were made. Negative control bolls were completely undamaged while the positive control was mechanically damaged using a number 00 insect pin. The pin was inserted five times in each boll to a depth of 3 mm. Stink bug damaged bolls were treated in four different ways: 2 bugs for 2 days, 2 bugs for 4 days, 4 bugs for 2 days, and 4 bugs for 4 days (Table 1).

Table 1. Cotton boll samples and treatment

Bag	Trt	Days on boll	Boll dia (inch)
5	Control	0	1.5
9	Control	0	2.1
1	Control	0	1.7
16	Pin	0	2
15	Pin	0	2.4
35	2 bugs	2	1.4
54	2 bugs	2	2.5
57	2 bugs	2	1.4
42	2 bugs	4	1.8
40	2 bugs	4	1.9
51	2 bugs	4	1.7
28	4-bugs	2	2.6
37	4-bugs	2	3.1
44	4-bugs	2	1
59	4-bugs	4	1.4
48	4-bugs	4	1.7
50	4-bugs	4	1.7

Following insect exposure, bolls were excised from the plant and individually analyzed using chromatography. A gas chromatograph (GC) coupled with a flame ionization detector (GC-FID) (Agilent 6890) was used in this study to characterize and quantify volatiles produced by the treated bolls. Procedures for GC analyses included setting the initial oven temperature at 40°C with a 4°C/min ramp until the temperature reached 180°C. The temperature of detector was set to a static 250°C. Helium was used as the carrier gas with a flow rate of 3 ml/min. Volatiles were separated on a 30 m x 250 um x 0.25 um capillary column. The solid phase micro extraction fiber (SPME) was used due to its ease of use.

The following parameters were taken when sampling using the SPME:
P=5 min (permeation time: amount of time bolls were encased in the collection bottle prior to VOC collection).
E=60 min (exposure time of SPME fiber to volatiles)
S=5 sec (storage time: amount of time volatiles were stored on the fiber prior to injection)
T=15 min (thermal desorption time of SPME fiber in the GC-FID injection port)

Results

As shown in Figure 1, chromatographs from intact (undamaged) and damaged bolls were very similar overall except for a few compounds that were observed in different quantities, such as those observed at RT 9.5 min and RT 2.1 min. Although the compound at RT 9.5 min showed up in chromatographs of both control and damaged bolls, its relative abundance in the stink bug damaged bolls was greater compared to the undamaged or mechanically damaged cotton bolls. The abundance of this compound was relatively small in both chromatographs of control bolls. A second compound, found at RT 2.1, was found in small amounts in the damaged bolls but was absent in the spectra of undamaged bolls. These two compounds need to be identified by their mass spectra.

We observed on the chromatographs that the overall concentration of volatile compounds from intact bolls was greater than observed from the damaged bolls. This was further proven by the integrated peak areas in Table 2. The external standard was established to quantify the mass of the volatile compound from the integrated peak area. For instance, the integrated peak area of volatile compound RT 11.735 min in undamaged bolls was 335.6 pA*s (corresponding to 24.5 ng), while the integrated area and concentration of the same compound (RT 9.46 min in chromatograph of damaged bolls) was only 42 pA*s (3.1 ng). It was observed that most volatile compounds emitted by both intact bolls and damaged bolls were in the ng range, which is obviously a very low concentration.

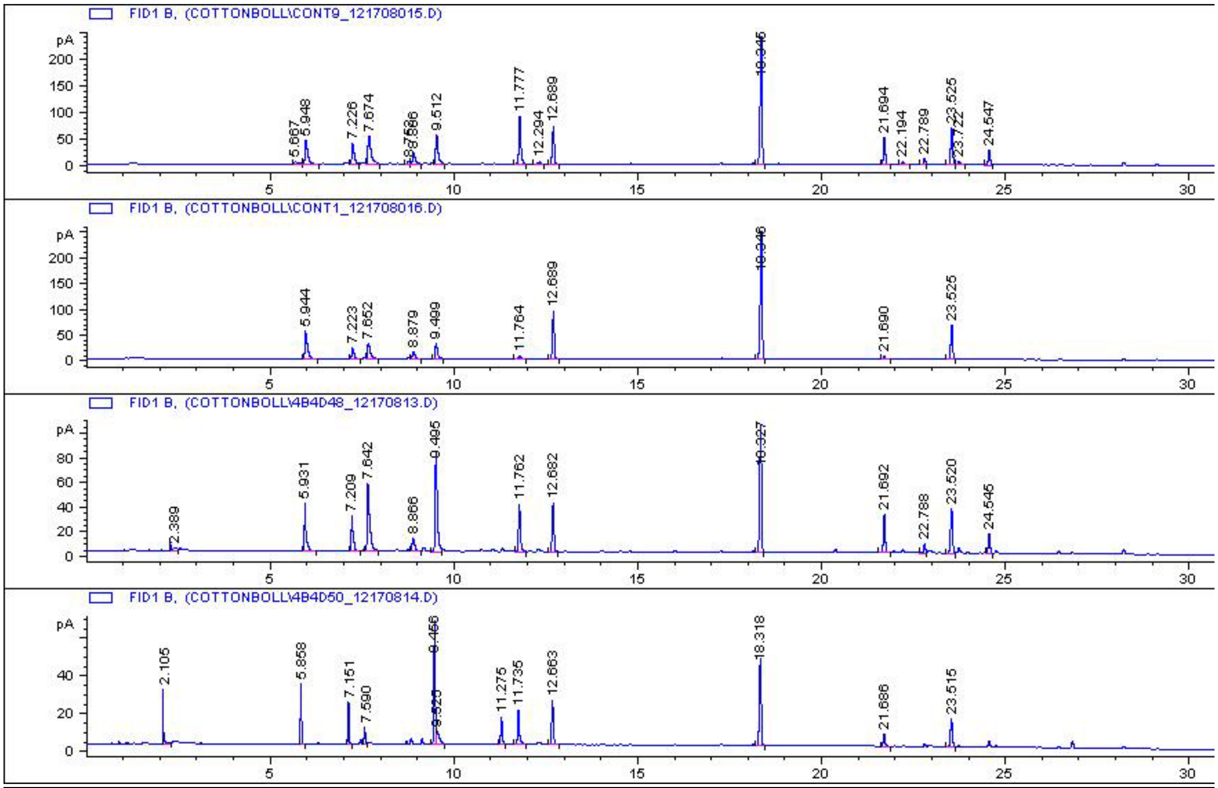

Figure 1. Gas chromatographs of control (top two graphs) and stink bug damaged (bottom two graphs) cotton bolls.

Table 2. Chromatograph area integration and quantification of major volatile compounds.

Intact bolls			**Damaged bolls**		
RT	Area (pA*s)	Conc. (ng)	RT	Area (pA*s)	Conc. (ng)
5.948	225	16.445	2.105	40	2.941
7.674	318	23.214	5.858	67	4.913
9.512	259	18.907	7.590	22	1.635
11.77	335.6	24.4988	9.456	174	12.702
21.694	175.5	12.8115	11.735	42	3.066
24.547	94.67	6.91091	21.685	22.3	1.6279

Summary

Based on chromatographs obtained from the GC-FID, it was observed that volatile profiles detected from intact and damaged bolls were similar except for the relative abundance of a few volatiles. The concentration of these volatile compounds was very low (6-24 ng for control group and 1-12.7 ng for damaged group). More samples and improved infestation strategies are needed to characterize the volatile profiles from stink bug damaged cotton bolls. This information may shed light on the possibility of developing an alternative sensing approach for stink bug infestation on cotton bolls using a gas sensor.

Acknowledgements

The authors wish to thank Tim Rutland, David Griffin, Jessica Corbett, and Blake Crabtree for excellent technical support. We also extend our appreciation to the Georgia Cotton Commission for funding support through 2009.

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REDUCING INSECTICIDE REQUIREMENTS FOR THRIPS MANAGEMENT IN CONSERVATION TILLAGE COTTON

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Introduction

Thrips (primarily tobacco thrips, *Frankliniella fusca* (Hinds)), infestations on seedling cotton are often reduced in conservation tillage systems (All et al. 1992). Reduction in thrips on seedling cotton in conservation tillage (which varies by an estimated 20 to 50% as compared to plow tillage systems) have generally not reduced infestations to the level of suppression that standard rates of Temik^{R} provide to young plants. In tests with various rates of Temik^{R} in plow tillage systems, there is a reductive response in thrips numbers with increasing Temik^{R} rates on seedling plants (All 1994, 1995; Roberts and All 1998; Roberts et al. 1999). These tests were conducted to determine if the reduction effect of conservation tillage on infestations would enable reduced rates of Temik to be used for thrips management on seedling cotton.

Materials and Methods

A field was planted at the Plant Science Farm (PSF) near Athens and the Southeastern Branch Research and Education Center (SEBRC) near Midville in wheat in the fall of 2007. Plow tillage blocks were plowed 3 weeks and 1-2 days before planting. Plots were 4 rows x 30 ft long x 38 in row width arranged in a random complete block split plot design with 4 replications. The fields were divided into eight 30-foot blocks (4 conservation tillage and 4 plow tillage) with 5 ft alleys. The conservation tillage blocks were treated with glyphosate 7 days before planting to “burn down” the wheat. Seven insecticide treatments were applied during planting: aldicarb (Temik 15G (clay granule)) in-furrow @ 5 lbs (product)/A, 3.5 lbs/A, 2.5 lbs/A, 1.75 lbs/A, and 0.88 lbs/A, precision placement (dropping granules adjacent to seed prior to closing the furrow) of Temik^{R} @ 1.28 lbs/acre, thiomethoxam Cruiser 5FS (2.9 ml/lb of seed (0.25 mg a.i./seed) treated with a Wintersteirger Hege II centrifugal seed treater), and an untreated check, on 05/15/2008. The entire field was chiseled 12 in deep with a KMC^{R} stripper. Seed was planted with a John Deere four-row vacuum planter and had 3.2-inch seed spacing in rows. Seed for the Cruiser plots was treated in the lab prior to planting using a Wintersteiger Hege II seed treater. The precision placement plots were treated with a hand-held applicator (bazooka) modified for precision placement of Temik^{R} over each seed. The furrow was left open at the time of planting these plots, which allowed visible seeds to be treated, and the furrow was closed after treating. The Midville field was irrigated as needed within the center pivot irrigation program for the experiment station. Irrigation was not possible at the Plant Science Farm field and the crop had severe drought damage after midseason; yield was not taken in the plots.

One-hundred milliliter specimen cups were filled half full of alcohol and labeled for use in collecting thrips from seedling cotton. Ten plants were taken at random from the two middle rows of each plot and immersed in the alcohol to remove thrips at 14 and 22 days after planting. Thrips samples were returned to the laboratory where immature and adult thrips were identified and counted using a dissecting microscope.

At Midville the cotton plant heights were taken 47 days after planting on 25 consecutive plants in the left middle row of each plot on 7/2/2008, and in 10 feet of the right row the numbers of plants were counted. At Midville the two outside rows of each plot were harvested and weighed on 10/28/2008 with an International 1822 two-row picker with single row weighing capabilities to determine yield. Data was analyzed using SAS ANOVA ($P<0.05$) procedures and T-tests. Tukey's HSD analysis was used for separation of means.

Results and Discussion

Microscopic observation of thrips in ethanol samples collected at 14 and 22 days after planting at both Midville and Athens indicated that >95% were tobacco thrips and others were either western flower thrips, *Frankliniella occidentalis* (Pergande), or flower thrips, *Frankliniella tritici* (Fitch). Thrips infestations on untreated plow tillage cotton were substantial at Midville during 22 days after planting and were significantly higher (87.8%) than in conservation tillage plots (Table 1). The difference and damage impact by thrips feeding on untreated plants in plow tillage plots was obvious for up to 47 days after planting, when height measurements were taken showing significantly reduced growth as compared to cotton in the untreated conservation tillage plots. Reduction in thrips numbers during 22 days was similar in untreated conservation tillage plots to the various in-furrow Temik[R] treatments in plow tillage. Thrips numbers on plants in the various Temik[R] in-furrow treatments in conservation tillage were reduced by half or greater as compared to their counterpart plots in plow tillage. At the PSF there was similar reduction in the number of thrips infesting untreated conservation tillage cotton (84%) compared to plow tillage plots, however, the various insecticide treatments had similar good levels of control in both tillage systems (Table 3).

Cruiser[R] (0.25 mg/seed) plots had significantly reduced numbers of thrips on plants compared to the untreated checks in plow tillage at both PSF and SEREC, but generally produced less control than any of the Temik[R] treatments (Tables 2 and 3). The precision placement treatment of Temik[R] (@ 1.28 lbs/ acre) is an idea that we have worked on for several years and again verified in these tests that a reduced per acre rate of the insecticide can be applied with the seed and produce similar control as higher in-furrow rates of the chemical (Lohmeyer et al 2003).

Overall, the results at the SEBRC suggest that in-furrow rates of Temik[R] can be reduced in conservation tillage and produce adequate thrips management. The data indicates that an additive effect may occur between conservation tillage and insecticide in reducing thrips populations on cotton during the seedling stage, contributing to reduced injury and optimum growth and yield.

Table 1. Tobacco thrips management with selected rates of Temik^R or Cruiser^R seed treatment in conservation tillage or plow tillage cotton, Midville, GA.

Insecticide Rate & Application Method	Mean number (Adult + Immature) Thrips/Plant 14 and 22 days after planting	
	Plow Tillage	Conservation Tillage
	Total	Total
Check	3.6a	0.8cde
Cruiser 0.25 mg/seed	2.2b	1.0cde
Temik 0.88 IF	1.4c	0.6cde
Temik 1.75 IF	1.2cd	0.6cde
Temik 2.5 IF	1.2cde	0.7cde
Temik 3.5 IF	1.4cde	0.5de
Temik 5.0 IF	1.2cde	0.4e
Temik 1.28 PP	0.9cde	0.5de

Table 2. Tobacco thrips management with selected rates of Temik^R or Cruiser^R seed treatment in conservation tillage or plow tillage cotton, Athens, GA.

Insecticide Rate & Application Method	Mean number (Adult + Immature) Thrips/Plant	
	Plow Tillage	Conservation Tillage
	Total	Total
Check	2.3a	0.6b
Cruiser 0.25 mg/seed	0.5bc	0.3bcd
Temik 0.88 IF	0.3cd	0.2cd
Temik 1.75 IF	0.2cd	0.1d
Temik 2.5 IF	0.1d	0.1d
Temik 3.5 IF	0.2cd	0.2cd
Temik 5.0 IF	0.1d	0.1d
Temik 1.28 PP	0.2cd	0.1d

Table 3. Plant height (48 days after planting) and yield in conservation tillage & plow tillage cotton treated with selected rates and application methods of Temik[R] & Cruiser[R] insecticides.

Insecticide Rate & Application Method	Plant Heights (cm)		Yield in Lint lbs/Acre	
	Plow Tillage	Conservation Tillage	Plow Tillage	Conservation Tillage
Check	32.2c	50.4ab	1145.6b	1694.8ab
Cruiser 0.25 mg/seed	47.6ab	55.5a	1346.9ab	1763.5a
Temik 0.88 IF	42.8bc	51.7ab	1255.5ab	1437.1ab
Temik 1.75 IF	51.0ab	52.6ab	1358.5ab	1405.7ab
Temik 2.5 IF	50.5ab	50.2ab	1408.6ab	1424.3ab
Temik 3.5 IF	50.8ab	54.8ab	1162.5b	1415.8ab
Temik 5.0 IF	49.4ab	56.5a	1419.6ab	1453.4ab
Temik 1.28 PP	51.5ab	50.1ab	1520.3ab	1501.1ab

Means followed by the same letter are not different at p = 0.05.

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SPATIAL MAPPING OF STINK BUGS IN COTTON FIELDS USING THREE SCOUTING TECHNIQUES

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Abstract

Researchers and Extension professionals have promoted the use of internal feeding symptoms as the most accurate method for stink bug scouting in cotton. However, this method requires considerable time and effort; therefore, scouts and growers may be unwilling to invest adequate resources to make pest management decisions using this method. To examine differences among common stink bug scouting techniques, we scouted commercial cotton fields weekly using three common techniques, dissection of 20 quarter sized soft bolls, 50-sweeps with a 15-inch sweep net, and shaking 12-linear feet of row over a white drop cloth. Results clearly show that the internal method was the most accurate and the most time consuming.

Introduction

We monitored seven commercial cotton fields (~15-25 acres each) at a density of one sampling site per acre across the entire field. Fields (located in Colquitt, Mitchell, and Tift counties) were first mapped using GIS software and then 8-foot tall flags were placed at sampling locations for reference during the rest of the summer. Sampling methods included 50 double row sweeps, 12-linear feet on a shake sheet, and 20-quarter sized soft bolls. To avoid biasing the samples, each sampling procedure was executed on a different side of the sampling flag. Fields were scouted starting approximately the second week of bloom until no more soft bolls were available. Results were then plotted by week as contour maps using SigmaPlot software.

Results and Discussion

A summary of research findings is shown in Table 1 below. While internal boll damage required eight minutes to complete, sweep net sampling and drop cloth sampling could be completed in only a fraction of the time. However, nearly 90% of the 20-boll samples had at least one boll with internal feeding damage. In comparison, about 15% of the sweep net samples and less than 10% of the drop cloth samples indicated the presence of stink bugs. All three methods suggested that the stink bug populations were highly aggregated in cotton fields. These data strongly suggest that assessments of internal boll damage should be considered the “gold standard” by which all new methods are compared. Results conclusively show that using boll damage is nearly 6-times more sensitive than using a sweep net and nearly 10-times more sensitive than using a drop cloth. However, internal boll damage required 4-times longer than using a sweep net and 8-times longer than using a drop cloth. New detection technologies are needed that have the speed of the sweep net but the sensitively of the internal boll damage.

Table 1. Comparison of sampling procedures for stink bugs in cotton. Asterisks (*) indicate a significant departure from zero (P<0.05, n = 1115 samples per method).

Sampling method	Time per sample	% samples with insect or damage	Variance to mean ratio	Statistical distribution
Boll damage	8 min	88	2.25	Aggregated
Sweep net	2 min	15	4.36	Aggregated
Drop cloth	1 min	9	2.91	Aggregated

Data were also spatially mapped to related captures in time and space. Although all three sampling methods showed similar trends, the heightened sensitivity of the internal method was highly evident on the spatial maps (Figs.1 through 3). When the maps of sweep net captures and drop cloth samples detected insect populations along the northern edge of this field, the boll damage showed similar patterns, plus an additional incursion of damage from the west and a smaller area in the center of the field. Similar to the summary data shown in Table 1, the maps also show that internal boll damage is a much more sensitive detection method. Furthermore, these results suggest that scouts relying on quicker methods like a sweep net or drop cloth are likely missing significant damage.

Temporal analyses show that infestations tended to start near the edge of the field before possibly moving to the field center. Interestingly, infestations did not always increase in time and a few decreased during subsequent weeks. We hypothesize that that there are significant biotic or abiotic factors governing stink bug population dynamics. Perhaps biological control may be more important than currently appreciated to help keep stink bug populations in check. Alternatively, the stink bugs may be moving out of the cotton and into better quality host plants.

Acknowledgments

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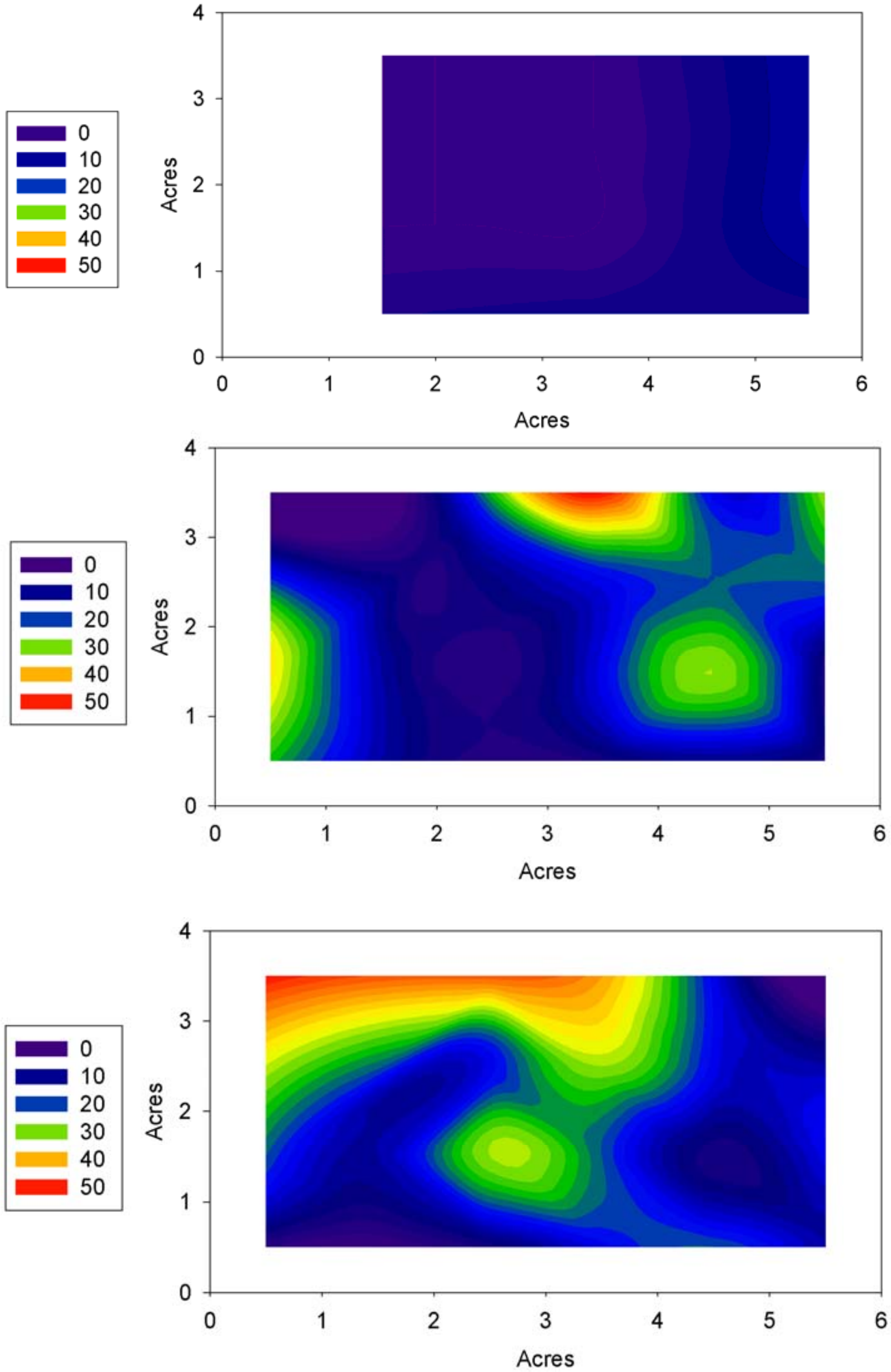

Fig. 1. Spatial mapping of internal boll damage in a single unsprayed field when sampled using internal boll damage. Data shown are percent damage (20 bolls dissected per sampling location). Sampling dates shown include August 3 (top), August 31 (middle), and September 9 (bottom).

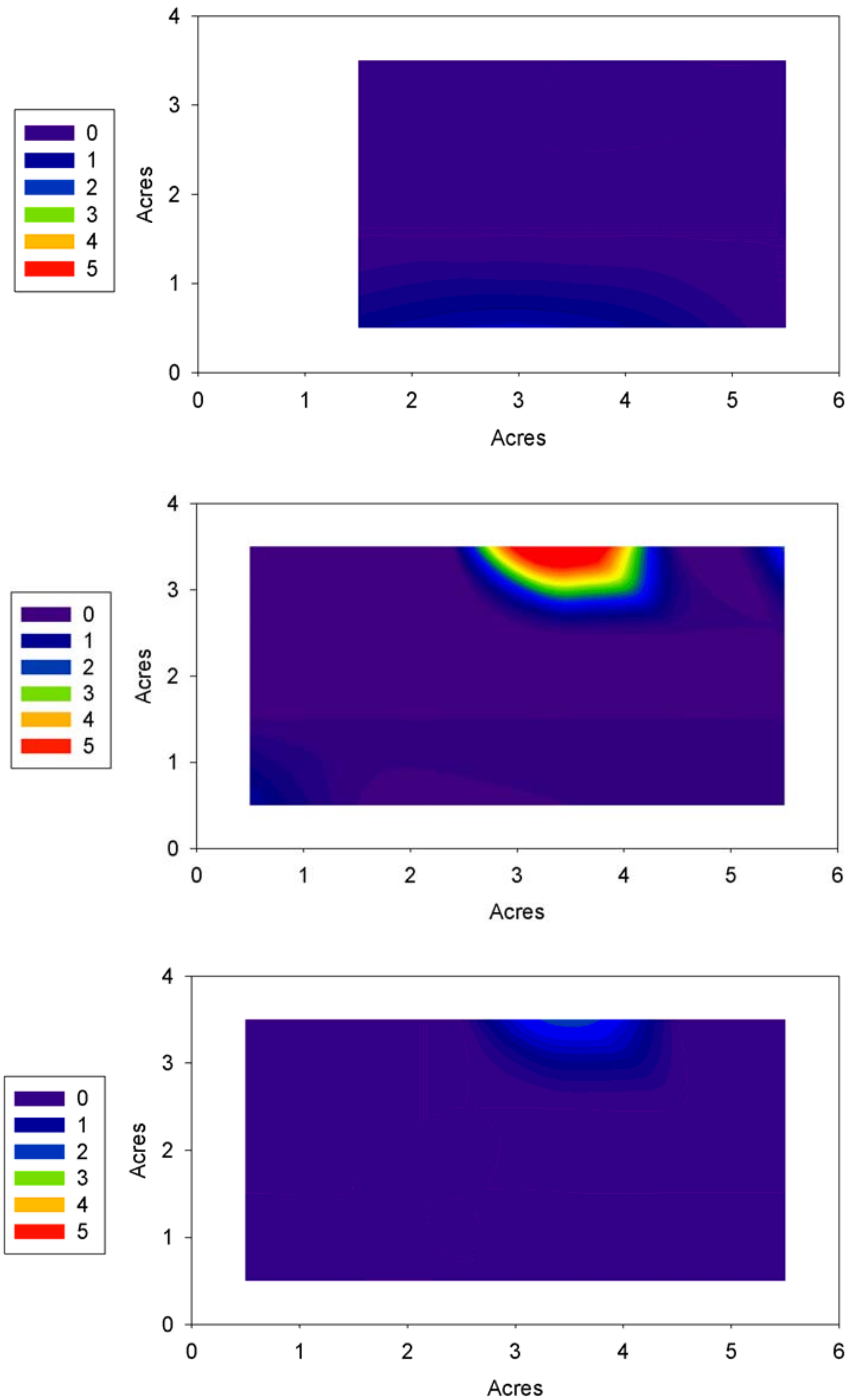

Fig. 2. Spatial mapping of stink bug individuals recovered in a single unsprayed field when sampled using 50 sweeps with a 15-inch sweep net at each sampling location. Sampling dates shown include August 3 (top), August 31 (middle), and September 9 (bottom).

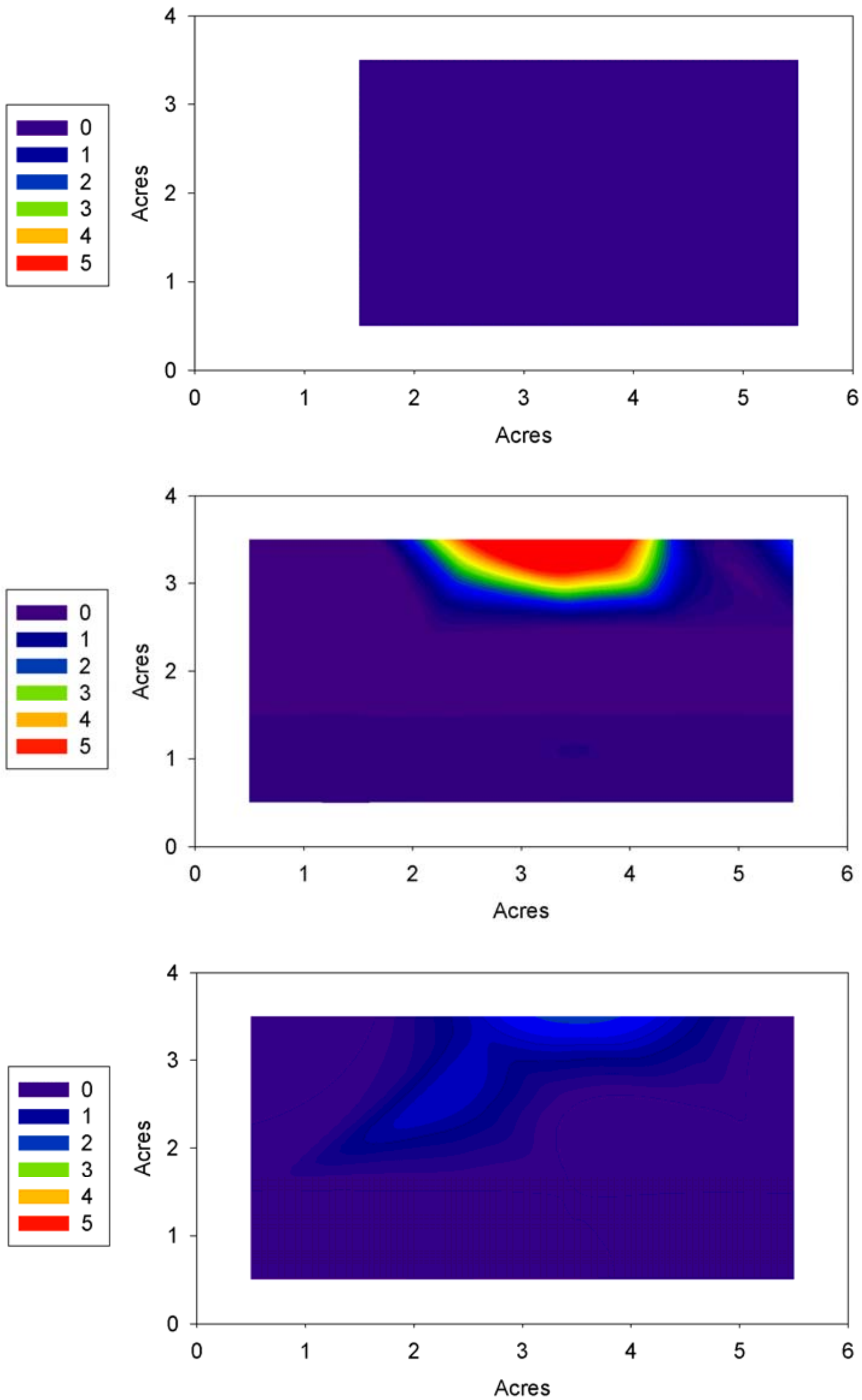

Fig. 3. Spatial mapping of stink bug individuals recovered in a single unsprayed field when sampled using 12-linear feet of row shaken over a drop cloth at each sampling location. Sampling dates shown include August 3 (top), August 31 (middle), and September 9 (bottom).

FUNGAL FERMENTATION PRODUCTS FOR CONTROL OF ROOT-KNOT NEMATODES

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Introduction

Nematodes are the number one disease problem in Georgia on cotton. In 2007, according to the University of Georgia Cooperative Extension estimates, plant-parasitic nematodes caused crop losses equal to 8% of the crop, for a total of $50.2 million in direct economic losses, and incurred 86% of the cost of pesticides used for disease control (Martinez, A., et. al., 2008). Approximately 69% of cotton fields in Georgia have root-knot nematodes (Kemerait, R., 2005) and there are several other species of parasitic nematodes that have been found in other fields. Plant-parasitic nematodes typically have a scattered or patchy distribution across farms and production areas, so actual losses experienced by growers are likely to vary widely from overall estimates.

The goal of this project is to identify and develop biologically-based nematicidal products. At this time, growers rely mainly on Temik (aldicarb) and Telone (1-3 dichloropropene) for pesticide control of nematodes in cotton. More options, that are both cost-effective and more environmentally acceptable, are needed for growers. Biologically-based nematicides are more targeted against nematodes and are less hazardous to the environment than traditional chemistries. We anticipate that the use of new biologically-based nematicides may also enhance consumer acceptance of the resulting cotton products for both fiber and feed.

Materials and Methods

As part of our ongoing effort to develop new nematicidal chemistries, fermentation products from selected fungal cultures have been tested for the presence of nematicidal compounds through a series of lab, greenhouse, and field trials. In this process, fungal cultures were isolated from various environments by dilution-plating and use of selective growth media. Using this procedure, thousands of isolates of fungi have been obtained from different fields and environments. The resulting fungi were evaluated for production of nematicidal compounds.

To obtain the products to be tested, each fungal isolate was placed in flasks containing nutrient agar and fermented with aeration on platform shakers for 21 days. To test for evidence of nematicidal activity, the liquid cultures were micro-filtered (0.22 μm) and pipetted into sterile microwell plates with freshly-hatched Southern root-knot nematode (*M. incognita*) juveniles. The micro-filtering removed all viable stages of the fungus and left only the products of the fermentation. Sterile water was used as a control treatment. Nematode survival rates were determined at 2, 4, 24, and 48 hours after suspension with 6 replications per isolate. At the same time that the in-vitro assay was performed, liquid fungal-culture filtrates were applied to a sterile soil mix in 6" greenhouse pots.

Control treatments of sterile water, and a filtrate of the nutrient agar used for fermentation were also applied. Southern root-knot nematode (*M. incognita*) eggs were added to the pots and cotton cv. DP555 was planted in each pot to serve as a susceptible host. Each treatment was applied to 6 replications. Plants were grown on greenhouse benches for 45 days. Plant roots were then removed from the pots and washed. The nematode eggs were collected and counted. Total numbers of nematode eggs were compared using ANOVA followed by mean separation (LSD) for each fungal-isolate treatment and the controls. After mass screening of the fungal collection, a few isolates were selected for further evaluation using additional research protocols. The methods used to prepare products for field trials were similar to the methods used for greenhouse screening, but with much larger quantities required.

During the 2008 project, we continued the field evaluations of several fungal isolates. Additionally, promising products were selected from the results of greenhouse trials done in 2007 for field evaluation as dehydrated-powdered products. After fermentation of the fungal isolates, filtrates were allowed to air-dry and the resulting material was applied to field plots. Two advanced-stage fungal isolates were evaluated for a second year in field plots during the 2008 growing season. The tests were identical for the two year span of this trial and data were combined for presentation in this report.

The objective of this study was to evaluate the practical effectiveness of fungal products that had shown activity in the greenhouse by studying them over an entire growing season in the field. Three fungal isolates (two nematicidal candidates, and a fungal control with no nematicidal activity) were fermented in quantities sufficient to treat soil in small field plots at rates equivalent to those used in greenhouse studies. The research plots were located at the Attapulgus Research and Education Center. At the beginning of the experiment, the plots were inoculated with root-knot nematodes and planted with cotton DP555. The fungal treatments, along with a water control, were applied to 12 replicate plots for each treatment in 2008, and 16 plots for each treatment in 2007. Root-knot nematodes (juveniles+eggs) were assayed during the growing season, and cotton was harvested at maturity. The same trial that was conducted at Attapulgus for two years was replicated at the Plant Science Farm in Oconee County for the first time in 2008 using the methods already described. This same protocol was also used to evaluate the dry-formulations of the fungal products with 10 replicate plots for each treatment at the Attapulgus Research and Education Center.

Results and Discussion

In combined data from the 2007 and 2008 growing seasons collected from field plots located at the Attapulgus Research and Education Center, soil application of culture filtrates from fungal isolate GA534 significantly ($p<0.05$) decreased the numbers of root-knot nematodes in soil assays over a time period that extended into late August (Table 1). Root-knot nematode numbers were reduced by 74% in the plots treated with GA534, as compared to the water controls, 60 days after planting. By 120 days after planting, plots treated with GA534 had 44% lower root-knot nematode counts than the controls. There were no treatment differences at harvest. This lack of treatment effect at harvest is often observed after defoliation of the cotton plants when the nematodes have ceased feeding. The isolates GA630 and GA516 did not provide a significant reduction in nematode counts at any of the assay dates when compared to the water control. Although root-knot nematode population densities were reduced by application of GA534, significant differences in cotton yields were not observed among the treatments during the 2007 or 2008 growing season. However, the extended control of root-knot nematodes late into the growing season was a bonus for this experimental product. Long-term reduction of nematode population densities from at-plant application is not typical of nematicides currently on the market. Oftentimes, nematode counts drop soon after application of a nematicide and then resurge to numbers similar to or higher than the untreated controls by the end of the season.

Also during the 2008 growing season, a similar test was conducted at the Plant Science Farm in Oconee County for the first time. The root-knot nematode numbers were very low in the newly-developed test site and a significant difference among treatments was observed only at 120 days after planting (Table 2). The very low nematode population densities at the beginning of the season provided little information, but as the season progressed and root-knot nematodes increased in number, GA534 again proved effective in lowering the nematode counts in cotton. No differences in cotton yields were observed among the treatments. Even so efficacy for GA534 in the different soil environment found in the Piedmont area was observed, but this trial will need to be repeated with higher population densities of root-knot nematodes.

A third experiment was conducted at the Attapulgus Research and Education Center during 2008 to evaluate dry-formulations of the same products that were used in the liquid-fermentation studies. There were no significant differences among the treatments at any of the nematode assay dates in this study (data not shown). Greenhouse studies had shown efficacy for GA534 and GA630 when applied after drying, but effective rate and application methods in the field studies for the dry formulations have not been developed. This is an essential component for the commercialization potential of biologically-derived nematicidal products since marketing and distribution of a product would probably require a dried product. We will continue to develop and test methods for dry formulations in future field tests.

Acknowledgments

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Table 1. Evaluation of fungal culture filtrates for control of root-knot nematodes (*M. incognita*) on Cotton DP 555 in plots located at Attapulgus Research and Education Center for 2007 and 2008 growing seasons combined.

Fungal isolate	Number of root-knot nematodes (juveniles+eggs)/100 cm^3 soil			
	Nematode assay date			
	60 DAP*	90 DAP	120 DAP	Harvest
Ga516	1150 ab**	5562 ab	742 ab	418 a
Ga534	417 b	4122 b	516 b	401 a
Ga630	697 ab	5292 ab	760 ab	348 a
Control	1593 a	7676 a	914 a	440 a

* Days after planting.

** Means of 28 replicate plots over 2 years. Rows with different letters are significantly different (P=0.05). Data were transformed log10(x+1) for analysis. Antilogs are presented for comparison.

Table 2. Evaluation of fungal culture filtrates for control of root-knot nematodes (*M. incognita*) on Cotton DP 555 in plots located at the Plant Science Research Farm, Oconee County, GA for the 2008 growing season.

Fungal isolate	Number of root-knot nematodes (juveniles+eggs)/ 100 cm^3 soil			
	Nematode assay date			
	60 DAP*	90 DAP	120 DAP	Harvest
Ga516	76 a**	31 a	35 a	146 a
Ga534	14 a	5 ab	3 b	10 a
Ga630	11 a	3 b	130 a	75 a
Control	9 a	8 ab	66 a	40 a

* Days after planting.
** Means of 10 replicate plots. Rows with different letters are significantly different (P=0.05). Data were transformed log10(x+1) for analysis. Antilogs are presented for comparison.

Literature Cited

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Martinez, A. , 2008. 2007 Georgia plant disease loss estimates. Cooperative Extension Service, Univ. of Georgia College of Ag. and Env. Sciences. Pub. SB41-10.

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