Cotton
RESEARCH-EXTENSION REPORT – 2007

The University of Georgia
College of Agricultural and Environmental Sciences
Edited by T. Grey, M. Toews, and C. Perry

UGA/CPES Research-Extension Publication No. 6 May 2008

Issued in furtherance of Georgia Agricultural Experiment Stations research work, Cooperative Extension work, Acts of May 8 and June 30, 1914, The University of Georgia College of Agricultural and Environmental Sciences and the U.S. Department of Agriculture cooperating.

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

Printed at the University of Georgia, Athens, GA

2007 GEORGIA COTTON
RESEARCH AND EXTENSION REPORT

Edited by Timothy Grey, Associate editors Michael Toews, and Calvin Perry
Compiled by Timothy Grey

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 Georgia Cotton Research and Extension Work Group would also like to thank the following for their continued support of cotton research and education in Georgia:

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THE 2007 CROP YEAR IN REVIEW

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The 2007 production season was another in which we made more cotton than we thought we would or should. Persisting drought, which had limited planting of corn, cotton, and peanuts, was interrupted the first week of June, allowing a rush of activity just beyond the normal planting window. Parts of the state never recovered from the drought. Broad, general rains occurred only around Labor Day. The Boll Weevil Eradication Program certified 1,024,615 planted acres as of August 30, 2007. Still, despite the drought, some growers and counties made their "best crop ever." Variability marked the end results – good and bad yields were adjacent in many areas. The final tally will be about 1.65 million bales, with production averaging close to 785 lb/A.

Quality of the 2007 crop was better than anticipated and nearly the same as the 2006 crop. Given the extreme heat and drought of the season, high percentages of short staple, high mic cotton were expected. Final numbers on both will be slightly greater than 20 percent. Georgia still ranks at the bottom of the national average in uniformity.

Table 1. Average Cotton Acreage and Production Since 1980.

Time period	Planted acreage, x 1,000		Yield, lb/A		Total bales, x 1,000	
	Average	Range	Average	Range	Average	Range
1980-84	162	120-180	516	243-771	175	86-281
1985-89	269	225-350	573	395-696	321	185-370
1990-94	549	355-885	707	548–834	828	405-1,537
1995-99	1,426	1,350-1,500	610	512-739	1,810	1,542-2,079
2000-04	1,399	1,284-1,495	667	557-785	1,874	1,663-2,220
2005	1,214	—	849	---	2,140	---
2006	1,380	—	765	---	2,120	---
2007	1,025	—	784	—	1,650	---

*Yield based on planted acreage and total bale production estimate as of January 2008.

Table 2. Fiber Quality of Bales Classed at the Macon USDA Classing Office, 2006 and 2007.

	Color Grade 31/41 or better (% of crop)	Bark/ Grass/ Prep (% of crop)	Staple (32nds)	Leaf Grade	Strength (g/tex)	Mic	Uniformity
2006	49 / 97	0.7/0.4 /0.1	34.4	3.3	28.4	47	80.4
2007	39 / 97	all < 1.0	34.3	3.4	28.6	47	80.0

Bales classed short staple (< 34) and high mic (>4.9)
2006: 20 % and 21 %   2007: 22 % and 20 %

DP 555 BG/RR again dominated the state's acreage, with almost 84 percent of crop planted to that variety (USDA AMS Survey). The USDA Survey estimated that about 98 percent of the Georgia crop was planted in transgenic varieties, primarily in Bollgard/Roundup Ready varieties. Other technologies, including Bollgard II, Widestrike, Liberty Link, and Roundup Ready Flex, have been planted on limited acreage but will likely gain in future seasons. In addition to problems associated with prevalent drought, herbicide resistant Palmer amaranth (pigweed) loomed large as a production challenge across much of the state.

Table 3. Technology Distribution of Cotton Planted in Georgia in 2007.

Bollgard/Roundup Ready	Roundup Ready	Conventional	Other
92.3	2.4	0.1	2.8

USDA Agricultural Marketing Service Survey, September 2007.

ECONOMIC ANALYSIS OF REMOTE SENSING TECHNOLOGY USED TO DETERMINE MEPIQUAT CHLORIDE APPLICATION ON COTTON UNDER VARIABLE RATE IRRIGATION

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Introduction

Water is the most common environmental factor that limits crop productivity. Water is the primary component of actively growing crop plants, ranging from 70-90% of the fresh crop plant mass. Water is essential to nutrient transport, chemical reactions, cell enlargement, transpiration, and most other plant processes. All plants are affected by soil moisture deficit. Moisture deficit inhibits cellular growth, which affects plant growth and development {Gardner, 1984 #46}.

Water depletion affects cotton grown throughout the United States, particularly non-irrigated cotton. The costs of water application and the competitive demands for water further enhance the attractiveness of water-efficient cotton in production settings. For instance, much of the Southeast is currently experiencing moderate to severe drought, and agricultural use accounts for a significant portion of water consumption in the United States, even in normally relatively wet regions of the country such as Alabama, Georgia, and South Carolina. Bednarz *et al.* {, 2002 #32} stated that cotton grown in South Georgia requires about 18.1 inches of water for maximum yields. Although South Georgia receives about 23.6 inches of water during the average growing season {Anonymous, 2006 #89}, periodic dry periods often cause crop water stress, which can be resolved by irrigation. In Georgia, an estimated 617,750 acres of cotton are irrigated {Harrison, 2005 #70}. This means that about 16.8 million gallons of water are required to apply one inch of irrigation water to all of the irrigated cotton in Georgia alone. Other states are even more dependent on irrigation than Georgia. Technology that decreases crop water use can have a major impact on available water resources.

Cotton is an indeterminate crop with a fruiting habit that allows vegetative growth to continue above the fruiting branches after reproductive growth has been initiated. Left unchecked, cotton can exhibit rank growth {Cathey, 1980 #299}. This excess vegetative growth can cause fruit shed, difficulty in picking the cotton, boll rot, increased insect and disease pressure, decreased lint quality, and potentially impact yield {Nichols, 2003 #298}.

Mepiquat chloride has been recognized as a useful cotton growth regulator since the late 1970s {Kerby, 1985 #293}, due to its control of cotton height. Although some plants have a low response to mepiquat chloride, cotton is highly responsive to its action {Rademacher, 2000 #300}. Mepiquat chloride has been shown to decrease the number of nodes and reproductive branches, decrease internode length, increase maturity rate, and decrease boll rot {Nichols, 2003 #298}. The effects on maturity and the number of reproductive branches have also been linked to the enhanced retention of early buds and bolls {Cook, 2000 #296; Kerby, 1986 #294}. These effects may improve lint quality and impact yield as they inhibit excessive vegetative growth.

Because both irrigation and mepiquat chloride application have associated application costs, the benefits of these amendments might be increased by imagery-based application through remote sensing technology.

Data and Methods

This study was a split plot experiment conducted on a variable rate center pivot at the Stripling Irrigation Research Park in Camilla, Georgia. The pivot is designed to allow variable application of water in a randomized complete block design. DP 555 cotton was planted at a rate of three plants per foot with 36 inch row spacing on May 10, 2007. All pesticide and herbicide applications were based on University of Georgia extension guidelines. The costs of these chemical applications were consistent across all plots; therefore, they were not included in the economic analysis.

The irrigation component of this study formed the main plot. One irrigation was applied prior to planting, at a rate of 0.3 inches to all plots. An additional 1.1 inches of irrigation were applied to all plots within the first week after planting to facilitate emergence. Application costs for these two irrigations were consistent across all plots and were not included in the economic analysis.

Irrigation treatments were started on May 25, 2007, and continued until July 24, 2007, to a total of seven irrigation dates. The irrigation treatments consisted of a 100% irrigation treatment, a 75% irrigation treatment, a 50% irrigation treatment, and a non-irrigated control. Irrigation scheduling and rates were based on the 100% irrigation treatment. In the 100% irrigation treatment, watermark sensors were placed at depths of 8, 16, and 24 inches. Irrigation was commenced when watermark sensors measured -40 centibar soil tension. Because all plots were under a variable rate pivot, the costs of the irrigated plots were the same. The irrigation application costs for the irrigated plots were calculated at $7 per application for a total of $49/acre. There were no irrigation application costs associated with the non-irrigated plots.

The split plot consisted of four mepiquat chloride treatments: a non-applied control (No Pix), a mepiquat chloride regime based on a single aerial image prior to the first mepiquat chloride application (Single RS Pix), a mepiquat chloride regime based on aerial images collected prior to each mepiquat chloride application (Multiple RS Pix), and a standard mepiquat chloride application based on standard practice (Standard Pix). Mepiquat chloride was applied on June 22 and July 6, 2007. Each treatment was replicated four times for a total of 64 plots.

Mepiquat chloride application costs included the cost of the chemical at $0.26/oz and its physical application (fuel, labor and machinery operation costs) for either one or two trips across the field as determined by the aerial imagery. Total mepiquat chloride application costs ranged from $0.00/acre to $10.35/acre.

Other costs based on yield included ginning, storage, and warehouse costs minus a credit for cottonseed. The November 2007 southeast cottonseed price of $140 per ton was used.

Price was based on several quality factors: leaf, staple, strength and uniformity. We assumed that all of the plots were color 41. The southeast base price of $0.6158/lb was used for the base. Prices ranged from a low of $0.5983/lb to a high of $0.6413/lb.

Results and Discussion

The treatment programs had various impacts on yield (Table 1). As expected, the 100% irrigated plots yielded significantly higher than the variable rate-irrigated and non-irrigated plots. Furthermore, the Standard Pix plots yielded significantly less than the No Pix control plots.

Table 1. Average Yield by Treatment (lb/ac)

PGR Rate	Irrigation Rate			
	0% [y]	50% [y]	75% [y,z]	100% [z]
No Pix [a]	1,249 ± 60	1,313 ± 142	1,409 ± 117	1,381 ± 58
Single RS Pix [a,b]	1,248 ± 130	1,314 ± 57	1,238 ± 85	1,335 ± 93
Multiple RS Pix [a,b]	1,217± 73	1,396 ± 270	1,253 ± 12	1,270 ± 148
Standard Pix [b]	1,201 ± 80	1,230 ± 95	1,224 ± 93	1,301 ± 81

[a,b,y,z] Means with the same letter are not significantly different at a = 0.05

Taking yield into consideration, average total costs by treatment (Table 2) ranged from a low of $0.026/lb for the non-irrigated, No Pix plots to a high of $0.072/lb for the 50 and 75%-irrigated, Standard Pix plots. All non-irrigated plots had significantly lower total costs than the irrigated plots. The Single RS Pix and Multiple RS Pix had average total costs that were significantly higher than the No Pix plots, but significantly lower than the Standard Pix plots.

Table 2. Average Total Cost by Treatment ($/lb)

PGR Rate	Irrigation Rate			
	0% [y]	50% [z]	75% [z]	100% [z]
No Pix [a]	$0.026 ± 0.0034	$0.065 ± 0.0041	$0.062 ± 0.0042	$0.063 ± 0.0036
Single RS Pix [b]	$0.027 ± 0.0045	$0.065 ± 0.0052	$0.070 ± 0.0041	$0.071 ± 0.0037
Multiple RS Pix [b]	$0.028 ± 0.0028	$0.068 ± 0.0031	$0.071 ± 0.0048	$0.069 ± 0.0032
Standard Pix [c]	$0.033 ± 0.0006	$0.072 ± 0.0026	$0.072 ± 0.0044	$0.070 ± 0.0011

[a,b,y,z] Means with the same letter are not significantly different at a = 0.05

Average prices, based on quality and uniformity, are located in Table 3. Average prices ranged from $0.617/lb for the 100% irrigated, No Pix plots to $0.633/lb for the 75% irrigated, Single RS Pix plots. However, there were no significant differences between the average prices for all plots.

Table 3. Average Price Based on Premium/Discount for Quality by Treatment ($/lb)

PGR Rate	Irrigation Rate			
	0% [y]	50% [y]	75% [y]	100% [y]
No Pix [a]	$0.629 ± 0.009	$0.629 ± 0.005	$0.627 ± 0.006	$0.617 ± 0.015
Single RS Pix [a]	$0.620 ± 0.011	$0.631 ± 0.004	$0.633 ± 0.006	$0.627 ± 0.007
Multiple RS Pix [a]	$0.627 ± 0.012	$0.627 ± 0.011	$0.627 ± 0.004	$0.631 ± 0.010
Standard Pix [a]	$0.627 ± 0.008	$0.627 ± 0.005	$0.625 ± 0.008	$0.624 ± 0.007

[a,b,y,z] Means with the same letter are not significantly different at a = 0.05

The average net returns per pound of lint yield are located in Table 4. The non-irrigated plots had significantly higher net returns per pound of lint yield than the irrigated plots by $0.039/lb on average. The No Pix plots also had significantly higher net returns per pound of lint yield than the Standard Pix plots by $0.007/lb on average. The Single RS Pix and Multiple RS Pix had net returns that fell between the Standard Pix and No Pix. Even though these values were not statistically significant, there may be a slight savings through the use of remote sensing-based mepiquat chloride application compared to the standard application.

Table 4. Average Net Returns to Irrigation and Mepiquat Chloride Application by Treatment ($/lb)

PGR Rate	Irrigation Rate			
	0% [y]	50% [z]	75% [z]	100% [z]
No Pix [a]	$0.603 ± 0.0059	$0.564 ± 0.0084	$0.563 ± 0.0044	$0.554 ± 0.0153
Single RS Pix [a,b]	$0.593 ± 0.0145	$0.555 ± 0.0071	$0.559 ± 0.0110	$0.562 ± 0.0098
Multiple RS Pix [a,b]	$0.599 ± 0.0138	$0.563 ± 0.0036	$0.566 ± 0.0084	$0.555 ± 0.0053
Standard Pix [b]	$0.594 ± 0.0078	$0.553 ± 0.0079	$0.555 ± 0.0069	$0.554 ± 0.0063

[a,b,y,z] Means with the same letter are not significantly different at a = 0.05

The following risk-return plot (Figure 1) shows where each treatment regime was located dependent upon the variance, or risk, of the treatment program and the estimated net returns per pound of lint yield. The No Pix (triangles) at 100% irrigation created the most risk and the lowest net return. The Single RS Pix (diamonds) and Multiple RS Pix (circles) at zero irrigation were also risky; however they generated higher net returns than the No Pix at 100% irrigation. The Standard Pix (squares) appeared to have the least risk, but also had the lowest net returns on average. The non-irrigated, or 0% Irr, plots appeared to have the highest net returns, however there was more variability, or risk, associated with these plots than those that received irrigation. The plots that received 75% irrigation had the least variability, or risk, but also had lower net returns.

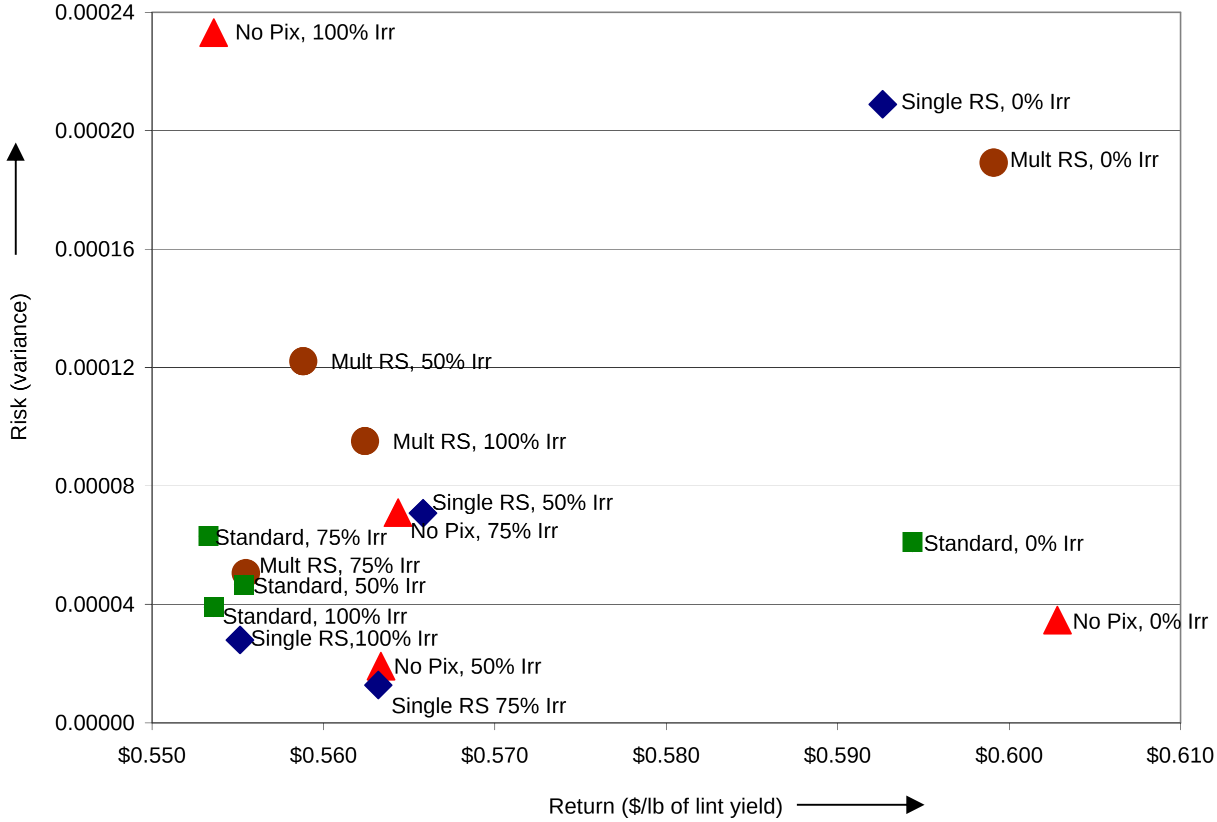

Figure 1. Risk-Return by Treatment

Acknowledgements

The authors would like to thank the cotton physiology support staff and the Stripling Irrigation Research farm staff for their assistance on this project. The authors would also like to express appreciation to the Georgia Cotton Commission and Cotton, Inc. for funding support of this project.

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ECONOMIC ANALYSIS OF THE EXPIRATION OF SINGLE-GENE BOLLGARD® TECHNOLOGY ON GEORGIA COTTON FARMS AND GINS

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Cotton is Georgia's number one row crop in acreage and farm income. Georgia ranks second in the US in cotton acres planted and typically 3rd in total cotton production. In 2007, Georgia accounted for 9.5% of US acres harvested and 8.7% of US production. In 2007, Georgia and US cotton acres decreased due to high prices and relatively high net returns from corn and soybeans but cotton still remains the state's largest crop in acreage and value by a significant margin.

Georgia farmers planted 1.03 million acres of cotton in 2007. Cotton acres reached a high of 1.5 million acres in 1995 and again in 2000. The 2007 Georgia crop is valued at approximately $500 million (lint and cottonseed).

Situation

Almost 100% of Georgia's cotton acreage is planted to transgenic varieties (seed that produces plants that are insect and/or herbicide resistant). Over 92% of Georgia acres are planted to single-gene Bollgard® varieties. Newer two-gene Bt varieties (Bollgard II® and Widestrike®) have not yet gained widespread acceptance.

Of the over 92% of Georgia acres planted to single-gene Bollgard (referred to in this analysis as "B1") varieties, this acreage is almost exclusively Delta and Pine Land (DPL) varieties (Table 1). Over 83% of the state's cotton acreage is planted to one variety-- DPL555BR. DPL555BR has proven to be a consistent high-yielding variety in University of Georgia Official Variety Trials (OVT's) and in practice on the farm.

Given the wide array of available cotton technologies (as illustrated in Table 1), University of Georgia research has shown that the most significant factors in profitability are yield and choice of variety within a technology. Research has shown that while there are differences in inputs and production costs among technologies, such differences in costs are relatively small and thus may be easily offset by difference in yield per acre. Georgia cotton farmers find both profitability and convenience in using transgenic technologies.

The registration on single-gene Bollgard technology (B1) will expire September 30, 2009. Available seed stocks will be phased out but use of carryover seed will be allowed in 2010. Monsanto will not pursue re-registration of the B1 technology and will transition to Bollgard II (B2) technologies for insect resistant management purposes.

Without B1 technology, cotton producers will plant non-B1 varieties. Non-B1 technologies would include B2, Widestrike (W), conventional or non-transgenic, or other varieties with herbicide resistance but without insect resistance traits such as Roundup Ready®, Roundup Ready Flex®, and Liberty Link®. The economic implications of such a change will depend on differences in lint yield per acre, differences in gin turn-out (T/O) as this impacts cottonseed yield, differences in seed and technology fees, and differences in production practices and other production costs if applicable.

Economic Factors

<u>Yield Considerations</u>

In University of Georgia Official Variety Trials (OVT's) at 4 irrigated locations from 2004 to 2007, the top-yielding non-B1 varieties averaged 13.1% less than DPL555BR and 7% less than other B1 varieties (Table 2). The top yielding B2 varieties averaged 15.3% less than DPL555BR and 9% less than other B1 varieties.

In non-irrigated OVT's at 3 locations (Table 3), the top-yielding non-B1 varieties averaged 5.2% less than DPL555BR and 4.3% less than other B1 varieties. The top yielding B2 varieties averaged 7.4% less than DPL555BR and 6.6% less than other B1 varieties.

DPL555BR is a full-season, late maturity variety. Because DPL555BR comprises the majority of acres in the state, the OVT results used for this analysis were for full-season, later maturing varieties only. Some Widestrike® varieties were included in these OVT's but others were in separate early-mid season tests and thus not considered in this analysis.

Georgia cotton yields have improved due to higher yielding varieties like DPL555BR, improved management of newer varieties, improved control of pests such as stink bugs, and favorable harvest conditions. For the 5 years 2003 to 2007, the "Olympic average yield" per acre harvested was 800 lbs per acre (dropping the high and low years and averaging the remaining 3 years) and the Olympic average yield per acre planted was 783 lbs per acre.

It is estimated that approximately 40% of Georgia's cotton production is irrigated (based on an average of UGA and Farm Service Agency estimates). Assuming irrigated yield has averaged 1,000 lbs per acre (which would be considered low on some farms), to achieve the state average yield of 800 pounds per acre, the average non-irrigated yield would be estimated at 667 lbs per acre.

Assuming 1,000 lbs per acre irrigated weighted average yield for B1 varieties, the estimated average yield for DPL555BR (83.6% of state acres and 90.5% of B1 acres) would be 1,007 lbs per acre and other B1 varieties (8.8% of state acres and 9.6% of B1 acres) would be 937 lbs per acre—7% less than DPL555BR yield.

Likewise, assuming 667 lbs per acre non-irrigated weighted average yield for B1 varieties, the estimated average yield for DPL555BR would be 668 lbs per acre and other B1 varieties would be 662 lbs per acre—1% less than DPL555BR yield.

Cottonseed and Gin Turn-Out

Gin turn-out (T/O) is the ratio of lbs of lint after ginning to lbs of seed cotton (picked cotton in the module or trailer) prior to ginning expressed as a percentage. Seed cotton includes not only lint but also seed, trash, and moisture. A T/O of 40%, for example, would mean that for every 1000 lbs of seed cotton there were 400 lbs of lint after ginning and 600 lbs of seed, trash, and moisture removed at ginning.

The lower the T/O, the higher the seed weight per lb of lint assuming no difference in trash and moisture content. Conversely, the higher the T/O the lower the seed weight per pound of lint. DPL555BR is known to have a high gin turn-out compared to other varieties due in-part to its relatively small seed size.

In the irrigated OVT's, the T/O for DPL555BR averaged 43.53% and T/O of other B1 varieties averaged 42.8%. This compares to 41.65% for non-B1 varieties and 40.4% for B2 varieties (Table 4). In the non-irrigated OVT's, the T/O for DPL555BR averaged 43.55% and T/O of other B1 varieties averaged 42.8%. This compares to 42.13% for non-B1 varieties and 41.5% for B2 varieties (Table 5).

Cotton producers depend on income from cottonseed to help offset the cost of ginning, warehousing, classing, and promotion fees. Total income from cotton production includes both lint and seed—the value of seed being used to offset these charges. For this analysis, the impact of change in seed technology includes change in cottonseed production in addition to lint yield.

The total effect of a change in yield on the farmer's income must also consider any change in cottonseed production due to a change in lint yield and/or T/O. An income loss associated with less lint yield, for example, could be offset slightly by any difference (increase) in seed weight and value due to a lower T/O. If the difference in lint yield is high (if the yield of another variety/technology is significantly lower, for example) a lower T/O (higher seed weight per pound of lint) may still also result in a loss of cottonseed weight and value.

Seed Cost and Technology Fees

For 2008, the suggested retail price for Deltapine (DPL) seed is $125.95 or $121.95 per 250,000-seed bag depending on the variety. DPL555BR is $125.95 per bag. Deltapine varieties comprise over 93% of cotton acres in Georgia. Therefore, for the purpose of this analysis, the cost of seed from other manufacturers was not considered.

Technology fees are in addition to the cost of seed. For BR (Bollgard with Roundup Ready) varieties with 250,000 seed per bag, the technology fee for 2008 is $291.70 per bag. The total cost for DPL555BR would be $417.65 per bag.

For Bollgard II technology (B2), the fee is $333.30 per bag if B2R and $381.00 per bag if B2RF. At present, very little B2 cotton is grown in Georgia (only .25%, see Table 1) but the acreage that is planted is packaged with Roundup-Ready Flex (RF) or Liberty Link (LL) technology.

Therefore, for the purpose of this analysis, it is assumed that all B1 acres upon loss of B1 seed availability would be planted to B2RF technology.

Other Costs and Considerations

For the purpose of this analysis, it is assumed there are no changes in production practices and other inputs such as insecticide sprays, herbicide sprays, plant growth regulator (PGR), defoliation, fertilizer, etc.

It is also assumed that harvesting costs do not change with a change in yield. Theoretically, if change in seed technology resulted in lower yield this could result in a slight savings in machinery and labor costs. But harvesting would be done at essentially the same rate or at the very least, any savings would not be directly proportional to yield. Therefore, for the purpose of this study no change in harvesting cost is assumed.

Results

Economic Loss On Cotton Farms

This analysis assumes 1.0 million acres of Georgia cotton of which 92.4% is B1 technology (83.6% DPL555BR and 8.8% other B1). Thus, 924,000 acres are used for the analysis and it is assumed that 40% is irrigated (369,600 acres) and 60% non-irrigated (554,400 acres).

The weighted average yield for all B1 irrigated cotton is assumed to be 1,000 lbs per acre. Using the percentage yield differences from UGA OVT's, the yield for DPL555BR is assumed to be 1,007 lbs per acre and the yield for all other B1 varieties 937 lbs per acre (7% less). The yield for B2 varieties is assumed to be 856 lbs per acre (15% less).

The weighted average yield for all B1 non-irrigated cotton is assumed to be 667 lbs per acre. Using the percentage yield differences from UGA OVT's, the yield for DPL555BR is assumed to be 668 lbs per acre and the yield for all other B1 varieties 661 lbs per acre (1% less). The yield for B2 varieties is assumed to be 618 lbs per acre (7.5% less).

The loss in the farmer's net income due to elimination of B1 technology is estimated at $59.44 million. This is considered to be a conservative estimate due to the assumptions used for this analysis.

Cotton was valued at 70 cents per pound and cottonseed at $150 per ton. At this price for cotton, there would be no Loan Deficiency Payment to consider. DCP (Direct and Countercyclical Payment) program payments are made on base acres and thus do not need to be considered. Ginning and warehouse charges are assumed to be 10.5 cents per pound which includes 8.5 cents for ginning and 2.0 cents (approximately $10 per bale) for warehousing and storage. Classing and state and national boards/promotions are assumed to be 1.0 cents per pound or approximately $5 per bale.

For this analysis, the net change in farm income due to the elimination of single-gene Bollgard technology (B1) was calculated as:

Change in the value of lint production + Change in the cost of ginning, warehousing, classing, and marketing + Change in the value of cottonseed production + Change in the cost of seed and technology fees. Cottonseed production was calculated using the gin T/O from UGA OVT's and assuming 10% of the seedcotton weight removed during ginning as trash, motes, moisture, etc.

Net Loss in farm income on 369,600 irrigated acres is estimated at $36.55 million or approximately $98.89 per acre (Table 6). Cotton production would decline by 111,136 bales for a loss in value of $37.34 million at 70 cents per pound. Lower yield would reduce ginning and warehouse charges resulting in a savings of $6.13 million but lower cottonseed production would result in a net savings on ginning of only $5.58 million. Seed and technology cost would increase by $4.79 million or $12.95 per acre ($89.30 per bag and 6.9 acres per bag). Lower lint income, minus the net savings on ginning charges, plus increased seed and technology costs result in a net farm income loss of $36.55 million on irrigated acres.

Net Loss in farm income on 554,400 non-irrigated acres is estimated at $22.89 million or approximately $41.29 per acre (Table 7). Cotton production would decline by 56,980 bales for a value of $19.15 million at 70 cents per pound. Lower yield would reduce ginning and warehouse charges resulting in a savings of $3.15 million. Although yield would decline, cottonseed weight would actually increase resulting in a total net savings on ginning of $3.44 million. Seed and technology cost would increase by $7.18 million or $12.95 per acre ($89.30 per bag and 6.9 acres per bag. Lower lint income, minus the net savings on ginning charges, plus increased seed and technology costs result in a net farm income loss of $22.89 million on non-irrigated acres.

Economic Loss to Gins

Savings to the cotton producer in ginning, warehouse, and storage charges due to less lint production represents an income loss to the cotton gin. Cotton production is estimated to decline 168,116 480-lb bales or 80.696 million pounds. At the 10.5 cents per pound assumed for ginning and warehouse/storage charges, this would be an income loss of approximately $8.47 million to Georgia cotton gins—approximately $134,000 annually on average per gin. This is a very conservative estimate since this assumes only 1 month of storage per bale.

If less cottonseed is produced, the gin also loses income on the "margin" when cottonseed from the farmer is later sold to an oil mill, for livestock feed, etc. On balance between irrigated and non-irrigated production and yield differences, cottonseed production is estimated to decline by 1,749 tons. Assuming $20 per ton average margin between the farmer price and mill/feed price, cottonseed margin would decline by a relatively small amount-- $34,980.

Losses in ginning, warehouse, storage, and cottonseed income is estimated to total $8.51 million.

Producers also pay classing fees and state and national boards/promotions. These fees total an estimated $5 per bale or an additional 1 cent per pound. This loss is not shown in the analysis but would total approximately $807,000.

Other Factors

Acreage Considerations

This analysis does not consider the income impacts of changes in acreage—acreage that could potentially shift out of cotton and into other crops due to the loss of B1 technology and change in income. US and Georgia cotton acreage has already declined due to competition with high-priced corn and soybeans. Loss in income due to yield differences when losing B1 technology could further reduce cotton's competitiveness.

When acres shift among crops, there is a multiplier effect on local economies and the state economy. Income impacts at the farm level and changes in production and inputs used have impact on input suppliers and infrastructure supporting production, processing, and marketing. Should the loss of B1 technology result in additional shift of acres out of cotton and into other crops, there would be a multiplier effect associated with that change in addition to the multiplier effect of the income loss estimated in this analysis.

While cotton producers have the flexibility of responding to economic signals and planting other crops if profitable, the cotton gin is only in the business of ginning cotton. The economic impacts of acreage and yield change are severely felt by gins.

Development of Higher Yielding Varieties

Currently there are no consistently high-yielding substitutes for DPL555BR on Georgia cotton farms. Non-B1 technologies including Bollgard II and Widestrike are currently available but not yet widely accepted and planted in Georgia. Widestrike varieties were planted on 2.3% of Georgia acres in 2007 and Bollgard II varieties on .25% of acres. This analysis assumed B1 acres would be planted to B2RF varieties.

The impact of the loss of B1 technology depends largely on differences in yield and production costs—specifically the seed cost and technology fee associated with non-B1 varieties. This analysis is based on comparative yields of currently available varieties and technologies. The eventual impacts of the elimination of B1 technology can be minimized by improved yield in available non-B1 varieties. Impact may also be minimized by reduced difference in seed and technology cost or savings in other production costs.

Summary

Assuming 1 million acres of Georgia cotton, 40% irrigated and 60% non-irrigated, and approximately 92.4% of acres in B1 varieties (83.6% in DPL555BR)—farm income loss is estimated to be $59.44 million. This further assumes that acres in B1 varieties would be planted in B2RF upon expiration of the B1 registration.

Income losses at the gin level due to lower cotton lint yield would include less income from ginning and warehouse/storage fees and less income on the resale margin for cottonseed. Gin losses are estimated at $8.51 million.

Total loss is estimated at $67.95 million (Table 8). This excludes multiplier effects and other losses not considered.

The cotton industry must move to two-gene technology in an effort to manage pest resistance. Technologies such as Bollgard II and Widestrike offer alternatives to single-gene technology. Varieties with these technologies, however, have not to-date consistently yielded as high as DPL555BR and other B1 varieties. DPL555BR comprised 83.6% of Georgia cotton acres planted in 2007.

UGA research has shown that yield and choice of variety within a technology are more important to profit than the technology itself. As the industry and state adjusts to the elimination of B1 technology, the eventual impact on farmer income and gins will depend on the yield potential of varieties available in 2010 and beyond and the seed and technology costs and production practices associated with those varieties.

The impact of the loss of B1 technology on Georgia farms could be minimized by a longer period of transition while newer/higher yielding varieties are developed to replace DPL555BR and/or lower seed cost and technology fees on two-gene varieties.

Table 1. Percent of Georgia Acreage Planted in 2007, By Variety and Technology Type

	Variety					
Technology	**Fibermax**	**DPL**	**Phytogen**	**Stoneville**	**Others**	**Total**
Conventional	0.10	0.52				0.62
RR	0.86	1.50				2.36
RF		0.11		0.10		0.21
B		0.07				0.07
BR [1]	1.01	90.85		0.43		92.29
B2R						0.00
B2RF		0.15				0.15
LL	0.07					0.07
B2LL	0.10					0.10
WR			2.30			2.30
Not Specified	0.05	0.02	0.06	0.01	1.69	1.83
TOTAL	**2.19**	**93.22**	**2.36**	**0.54**	1.69	**100.00**

SOURCE: USDA-AMS
[1]83.58% DPL555BR

Table 2. Yield Per Acre, UGA OVT, Irrigated, 4 Locations [1]

	2004	**2005**	**2006**	**2007**	**Average**
DPL555BR	1,687	1,613	2,105	1,825	1,808
Other B1 Varieties [2]	1,611	1,652	1,786	1,689	1,685
Non-B1 Varieties [3]	1,569	1,474	1,685	1,556	1,571
Top B2 Varieties [4]	1,538	1,458	1,619	1,512	1,532
Yield vs. 555					
Other B1	-76	+39	-319	-136	-123
Non-B1	-118	-139	-420	-269	-237
Top B2	-149	-155	-486	-313	-276
Difference vs. 555					
Other B1					-6.8%
Non-B1					-13.1%
Top B2					-15.3%
Difference vs. Other B1					
Non-B1					-6.8%
Top B2					-9.1%

1/ Tifton, Midville, Plains, and Bainbridge.
2/ Top 5 yielding other single-gene varieties. Excludes experimental cultivars.
3/ Top 5 yielding B2, non-Bt (conventional, RR, RF) and Widestrike. Excludes experimental cultivars.
4/ Average of all B2's if in "Non-B1" or the single top B2 if not in top-5 Non-B1. Excludes experimental cultivars.

Table 3. Yield Per Acre, UGA OVT, Non-Irrigated, 3 Locations [1]

	2004	2005	2006	2007	Average
DPL555BR	1,120	1,438	1,329	906	1,198
Other B1 Varieties [2]	1,030	1,541	1,217	961	1,187
Non-B1 Varieties [3]	1,011	1,443	1,150	938	1,136
Top B2 Varieties [4]	936	1,428	1,107	965	1,109
Yield vs. 555					
Other B1	-90	+103	-112	+55	-11
Non-B1	-109	+5	-179	+32	-63
Top B2	-184	-10	-222	+59	-89
Difference vs. 555					
Other B1					-0.9%
Non-B1					-5.2%
Top B2					-7.4%
Difference vs. Other B1					
Non-B1					-4.3%
Top B2					-6.6%

1/ Tifton, Midville, and Plains. Excludes Athens--DPL555BR not adapted for that location.
2/ Top 5 yielding other single-gene varieties. Excludes experimental cultivars.
3/ Top 5 yielding B2, non-B1 (conventional, RR, RF) and Widestrike. Excludes experimental cultivars.
4/ Average of all B2's in "Non-B1" or the single top B2 if not in top-5 Non-B1. Excludes experimental cultivars.

Table 4. Gin Turnout (Lint Lbs as a Percent of Seed Cotton), 4 Locations, Irrigated [1]

	2004	2005	2006	2007	Average
DPL555BR	43.60	42.50	43.5	44.50	43.53
Other B1 Varieties [2]	42.52	40.80	43.3	44.50	42.78
Non-B1 Varieties [3]	42.70	39.60	41.5	42.78	41.65
Top B2 Varieties [4]	40.90	39.13	39.63	41.90	40.39
Gin T/O vs. 555					
Other B1	-1.08	-1.70	-0.20	0.00	-0.75
Non-B1	-0.90	-2.90	-2.00	-1.72	-1.88
Top B2	-2.70	-3.37	-3.87	-2.60	-3.13

1/ Tifton, Midville, Plains, and Bainbridge.
2/ Top 5 yielding other single-gene varieties. Excludes experimental cultivars.
3/ Top 5 yielding B2, non-B1 (conventional, RR, RF) and Widestrike. Excludes experimental cultivars.
4/ Average of all B2's in "Non-B1" or the single top B2 if not in top-5 Non-B1. Excludes experimental cultivars.

Table 5. Gin Turnout (Lint Lbs as a Percent of Seed Cotton), 3 Locations, Non-Irrigated [1]

	2004	2005	2006	2007	Average
DPL555BR	43.50	42.00	44.40	44.30	43.55
Other B1 Varieties [2]	41.95	41.24	43.72	44.30	42.80
Non-B1 Varieties [3]	41.78	40.60	41.98	44.14	42.13
Top B2 Varieties [4]	40.90	39.70	41.00	44.40	41.50
Gin T/O vs. 555					
Other B1	-1.55	-0.76	-0.68	0.00	-0.75
Non-B1	-1.72	-1.40	-2.42	-0.16	-1.43
Top B2	-2.60	-2.30	-3.40	0.10	-2.05

1/ Tifton, Midville, and Plains. Excludes Athens-- DPL555BR not adapted for that location.
2/ Top 5 yielding other single-gene varieties. Excludes experimental cultivars.
3/ Top 5 yielding B2, non-B1 (conventional, RR, RF) and Widestrike. Excludes experimental cultivars.
4/ Average of all B2's in "Non-B1" or the single top B2 if not in top-5 Non-B1. Excludes experimental cultivars.

Table 6. Irrigated Acres, Estimated Change in Farm Income Due to Loss of Single-Gene Technology [1]

	Acres Currently Planted To		If Acres Planted To	Difference
	DPL555BR	**Other B1**	**B2**	
Irrigated Acres (40% of State)	334,400 (83.6%)	35,200 (8.8%)	369,600	
Assumed Yield	1,007	937 (7% Less)	856 (15% Less)	
Production (480-lb bales)	701,543	68,713	659,120	-111,136
Loss In Lint Income				$37.34 million
Ginning/Warehouse Fees Saved On Yield Difference				$6.13 million
Cottonseed Production	180,156 tons	18,140 tons	194,572 tons	-3,724 tons
Loss In Cottonseed Value				$558,600
Net Change (Savings) in Ginning [2]				$5.58 million
Increase In Seed and Tech Fees	$60.56/acre	$60.56/acre	$73.51/acre	$4.79 million
Net Income Change (Loss) [3]				**$36.55 million**
Loss Per Acre				**$98.89**

1/ One million acres planted, 40% irrigated, 92.4% to single-gene Bollgard (B1). B2 acres assumed yield of 15% less than DPL555BR.
2/ Savings on ginning and warehouse charges minus loss in cottonseed income.
3/ Loss in lint income minus net savings in ginning and warehousing charges plus increase in seed cost and technology fees

Table 7. Non-Irrigated Acres, Estimated Change in Farm Income Due to Loss of Single-Gene Technology [1]

	Acres Currently Planted To		If Acres Planted To	Difference
	DPL555BR	Other B1	B2	
Non-Irrigated Acres (60% of State)	501,600 (83.6%)	52,800 (8.8%)	554,400	
Assumed Yield	668	661 (1% Less)	618 (7.5% Less)	
Production (480-lb bales)	698,060	72,710	713,790	-56,980
Loss In Lint Income				$19.15 million
Ginning/Warehouse Fees Saved On Yield Difference				$3.15 million
Cottonseed Production	179,262 tons	19,195 tons	200,432 tons	+1,975 tons
Increase In Cottonseed Value				$296,250
Net Change (Savings) in Ginning [2]				$3.44 million
Increase In Seed and Tech Fees	$60.56/acre	$60.56/acre	$73.51/acre	$7.18 million
Net Income Change (Loss) [3]				**$22.89 million**
Loss Per Acre				**$41.29**

1/ One million acres planted, 60% non-irrigated, 92.4% to single-gene Bollgard (B1). B2 acres assumed yield of 7.5% less than DPL555BR.
2/ Savings on ginning and warehouse charges plus increase in cottonseed income.
3/ Loss in lint income minus net savings in ginning and warehousing charges plus increase in seed cost and technology fees

Table 8. Summary of Farm and Gin Income Losses

	Dollars Loss
Farm Income Loss- Irrigated Acres	$36.55 million
Farm Income Loss- Non-Irrigated Acres	$22.89 million
Loss In Ginning, Warehouse, Storage, Cottonseed	$8.51 million
Total	**$67.95 million**

APPLICATION OF WEATHER DATA TO HELP IMPROVE COTTON PRODUCTION

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Introduction

The year 2007 was one of the driest years on record, especially for North and Central Georgia. 2007 was also a very dry year when compared to 2005 and especially 2003 and 2004. Most of the weather stations of the Georgia Automated Environmental Monitoring Network (www.Georgiaweather.net) showed a negative water balance, demonstrating the need for supplemental irrigation. These continuing droughts are one of the main reasons that the availability of water for irrigation has become limited for Georgia farmers. The future does not look very bright, especially for farmers located in the Flint River basin. In 2000, the Georgia legislature approved the Flint River Drought Protection act. This act was implemented during the springs of both 2001 and 2002, when 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, 2007 turned out to be one of the driest years on record and has resulted in serious water use restrictions. 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. It is still unclear how the Georgia Comprehensive State-wide Water Management Plan, ratified by Georgia's General Assembly on January 18, 2008, will affect agriculture and access to water for irrigation.

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 system 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 applications of pesticides and herbicides. 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 74 stations in operation in Albany, Arlington, Calhoun, Camilla, Cordele, Dublin, Newton, Statesboro, Vidalia, and many other locations (Figure 1). Several of these weather stations have been installed in farmers' fields, such as at Georgetown and Cordele. In 2007, three new weather stations were installed at the Madison County Emergency Services in Danielsville, at the Miles Berry Farm in Baxley, Appling County, and on Ossabaw Island in Chatham County. 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 calculated.

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. A computer located at the Griffin Campus of the University of Georgia calls each station at hourly or more frequent intervals and downloads the data. After processing, error checking, and other procedures, all data are published 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 at Moultrie in Figure 2 and Figure 3, and local temperature predictions up to 12 hours ahead.

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 2007 were compared with the previous growing seasons for 2002 through 2006. Please note that the automated weather station network is continuously being expanded and that we, therefore, do not have complete weather records for all sites. Recent installations include Albany, Tiger, and Clarks Hill, South Carolina in 2004; Moultrie, Unadilla, Vienna, and Woodbine in 2005; Ty Ty, Tennille, and Blue Ridge in 2006, and Baxley, and Danielsville in 2007. 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 2002 through 2007 growing seasons are shown in Table 1. The maximum number of degree-days for 2007 was found in Valdosta at 3464, Albany at 3431, and Cairo at 3345. The minimum number of degrees in 2006 was found in Rome at 2685, Eatonton at 2686, and Griffin at 2712. For all sites, the cumulative total number of degree-days was significantly higher for 2007 than for 2006. For the six-year period from 2002 through 2007, 2003 had the lowest number of degree days, except for a few 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. Dearing and Watkinsville were the driest locations, with 10.8 and 12.2 inches respectively. Savannah, Vidalia, and Moultrie had the highest amount of precipitation, with 32.9, 29.2, and 28.9 inches of rain respectively. When comparing the period 2002 through 2007, the growing season of 2007 was dry and for some sites the driest for the past six years.

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. In 2007, all sites except Savannah had a negative water balance that ranged from -4.1 inches for Moultrie to -21.7 for Dearing. During the period from 2002 through 2007, five sites had a negative water balance for all six years. These include Attapulgus, Cairo, Camilla, Dearing, and Fort Valley, while seven sites had a negative balance during five of the six years, e.g., Arlington, Cordele, Dublin, Eatonton, 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 either the rainfall distribution or 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 exhibit high variability among years and locations. 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. For example, schedulers for irrigation management will be needed if water for agricultural use becomes 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.

Acknowledgments

This work was sponsored in part by the Georgia Cotton Commission, a partnership with the United States Department of Agriculture - Risk Management Agency, AgAmerica Empowerment Agency, Inc., and Federal and State Funds allocated to the University of Georgia - College of Agricultural and Environmental Sciences.

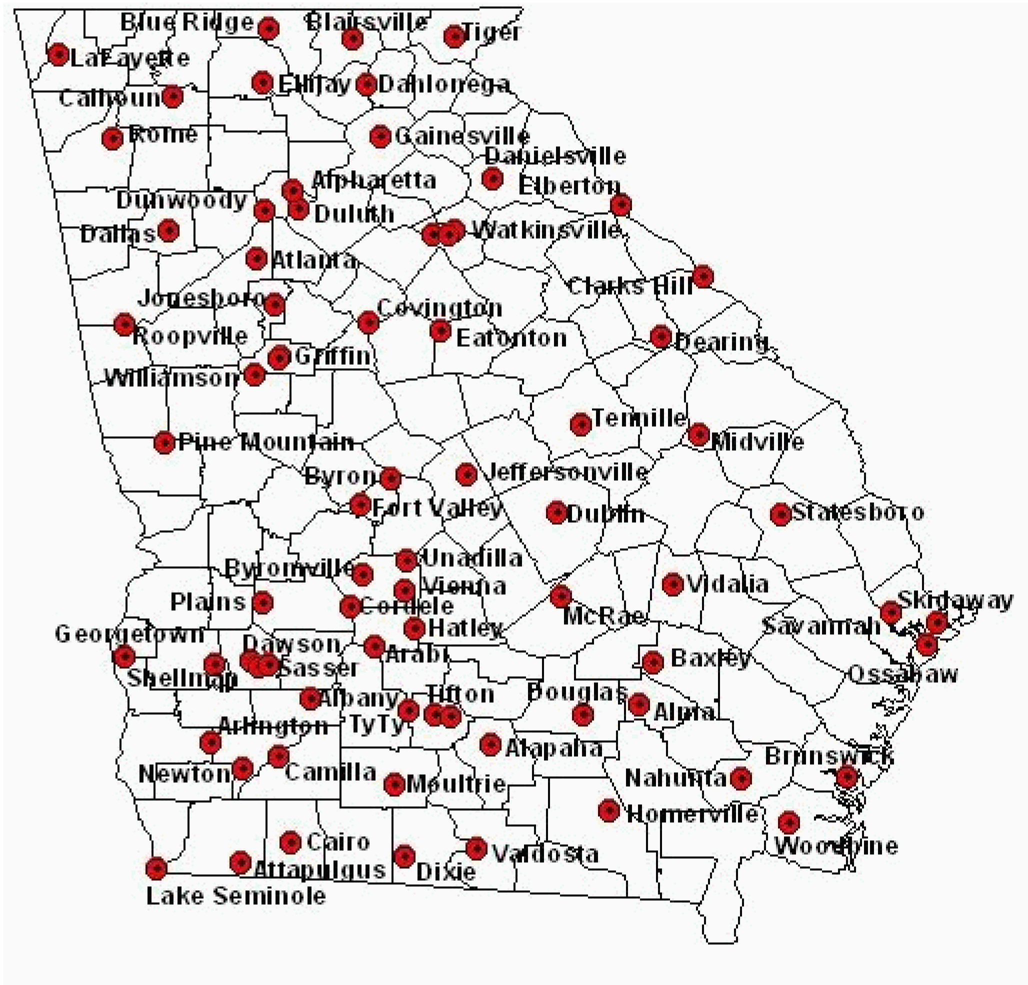

Figure 1. Location of the weather stations of the Georgia Automated Environmental Monitoring Network.

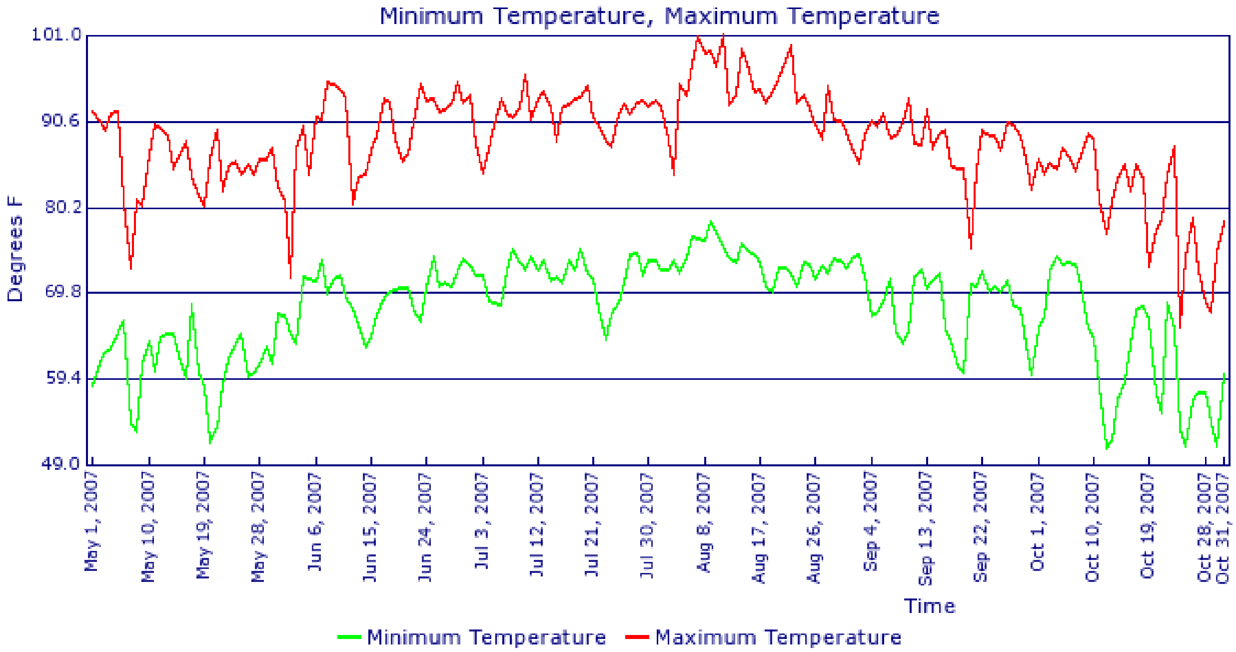

Figure 2. Daily maximum and minimum temperature for May 1 through October 31, 2007 at Moultrie, Georgia.

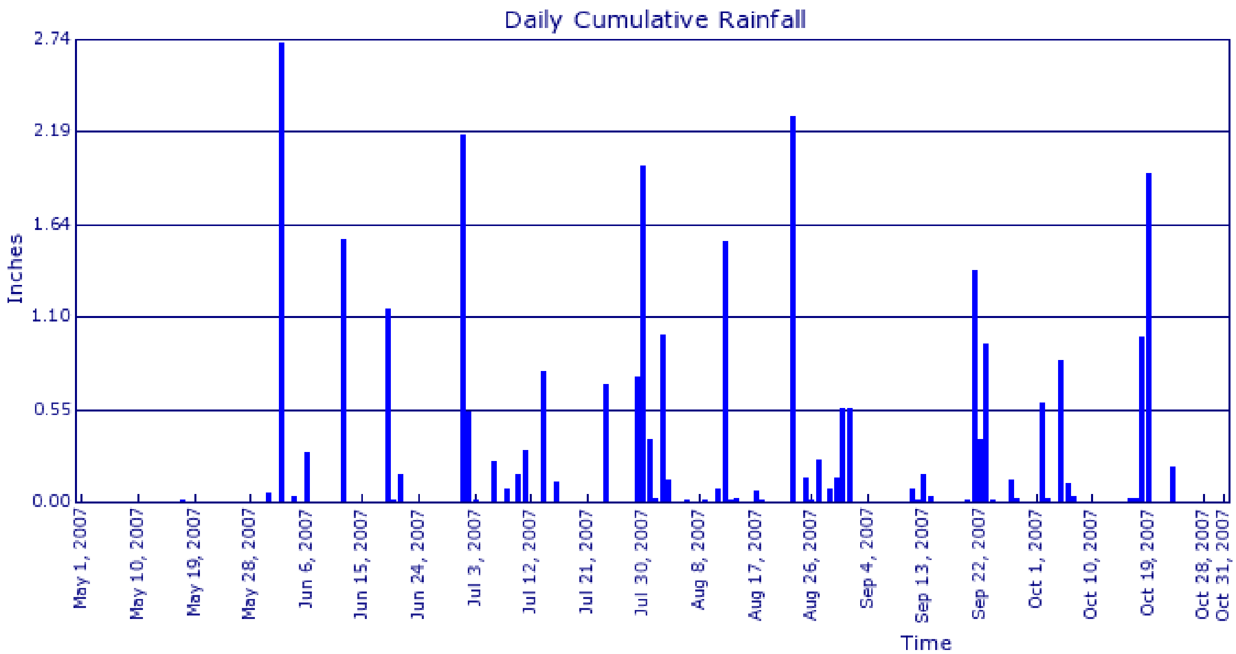

Figure 3. Daily total precipitation for May 1 through October 31, 2007 at Moultrie, Georgia.

Table 1. Degree-days from May 1 until October 31 with a base of 60 degrees Fahrenheit.

Site	2002	2003	2004	2005	2006	2007
Alapaha	N/A	2950	3065	3030	2605	3049
Albany	N/A	N/A	3293	3256	3259	3431
Alma	3297	3038	3196	3168	3064	3227
Arlington	3207	2932	3080	3092	2990	3197
Attapulgus	3297	3034	3109	2855	3053	3219
Cairo	3327	3053	3289	3192	3127	3345
Camilla	3354	3035	3238	3139	3101	3285
Cordele	3210	2954	3137	3108	3024	3151
Dearing	2983	2682	2995	2902	2842	3057
Dublin	3127	2825	3089	3054	2998	3056
Eatonton	2601	2282	2549	2509	2555	2686
Ft. Valley	2893	2619	2899	2901	2914	3038
Griffin	2571	2275	2526	2499	2542	2712
Jeffersonville	N/A	2605	2855	2785	2783	2888
McRae	N/A	N/A	2946	2922	2802	2936
Midville	3097	2764	3020	3025	2909	3090
Moultrie	N/A	N/A	N/A	3112	3144	3313
Pine Mountain	2615	2388	2545	2534	2494	2730
Plains	3016	2749	2949	2931	2951	3022
Rome	2610	2186	2441	2475	2446	2685
Savannah	3114	2944	2991	3257	3010	3155
Statesboro	3106	2825	3041	2728	2696	3049
Tifton	3252	2959	3210	3086	3031	3170
Valdosta	3438	3236	3482	3467	3393	3464
Vidalia	3147	2943	3143	3155	3090	3178
Watkinsville	2594	2300	2557	2498	2489	2764

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

Site	2002	2003	2004	2005	2006	2007
Alapaha	N/A	40.79	35.70	18.98	20.74	22.74
Albany	N/A	N/A	33.40	30.68	25.78	20.10
Alma	26.17	35.23	33.45	23.39	19.46	27.83
Arlington	28.36	23.49	32.61	28.56	28.62	18.16
Attapulgus	27.82	25.39	28.83	28.28	27.79	18.22
Cairo	19.99	27.29	28.11	27.85	19.76	25.13
Camilla	25.70	25.71	23.77	24.71	25.65	21.15
Cordele	19.40	27.71	34.72	19.81	17.16	18.91
Dearing	23.02	22.22	28.32	28.31	21.20	10.81
Dublin	22.95	32.42	31.73	17.93	17.06	20.53
Eatonton	17.48	25.11	32.95	23.33	15.96	17.71
Ft. Valley	24.40	17.04	20.56	23.94	12.20	21.09
Griffin	21.75	32.80	35.52	31.71	16.52	15.50
Jeffersonville	N/A	28.80	29.00	22.52	16.85	17.81
McRae	N/A	N/A	35.79	17.30	19.62	21.81
Midville	18.52	35.20	30.45	28.71	14.37	17.89
Moultrie	N/A	N/A	N/A	28.37	12.63	28.95
Pine Mountain	18.67	34.56	38.87	24.11	17.32	19.31
Plains	19.50	26.00	32.07	29.53	27.07	18.13
Rome	26.23	31.85	24.12	15.30	19.71	13.41
Savannah	38.28	24.52	37.85	31.00	18.48	32.86
Statesboro	25.67	36.34	24.37	28.86	19.28	25.55
Tifton	17.21	31.78	33.62	18.97	15.78	22.22
Valdosta	24.93	25.97	31.96	31.12	22.93	25.30
Vidalia	28.06	40.37	35.87	15.75	13.03	29.15
Watkinsville	19.48	34.27	30.36	29.02	17.70	12.21

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

Site	2002	2003	2004	2005	2006	2007
Alapaha	N/A	14.26	9.61	-6.60	-6.23	-9.49
Albany	N/A	N/A	1.35	-0.89	-7.84	-13.09
Alma	-3.38	5.72	2.40	-7.83	-14.22	-4.72
Arlington	-2.77	-5.32	2.52	-1.27	-3.89	-14.49
Attapulgus	-2.62	-3.03	-2.17	-1.80	-5.27	-13.87
Cairo	-9.79	-1.26	-2.26	-1.80	-12.95	-7.10
Camilla	-7.30	-4.13	-8.18	-7.20	-7.85	-10.79
Cordele	-14.36	-3.74	1.10	-14.21	-16.91	-14.77
Dearing	-6.85	-5.76	-2.18	-0.89	-10.53	-21.67
Dublin	-8.91	2.94	-0.60	-12.72	-14.59	-11.15
Eatonton	-12.05	-1.24	3.87	-3.42	-15.05	-13.33
Ft. Valley	-4.35	-7.00	-3.97	-0.18	-20.24	-12.07
Griffin	-7.37	5.18	7.10	3.51	-15.29	-16.13
Jeffersonville	N/A	2.12	-1.20	-8.10	-15.69	-14.16
McRae	N/A	N/A	5.35	-12.28	-11.92	-11.56
Midville	-11.90	7.17	3.52	1.22	-19.02	-15.58
Moultrie	N/A	N/A	N/A	-3.12	-21.51	-4.10
Pine Mountain	-8.64	9.17	13.37	-1.29	-8.99	-5.35
Plains	-9.77	-1.13	2.79	-1.27	-7.04	-15.86
Rome	-0.97	7.12	-1.47	-11.21	-9.03	-15.13
Savannah	6.98	-4.16	8.94	1.82	-13.43	2.09
Statesboro	-2.78	8.50	-5.40	0.35	-12.37	-6.37
Tifton	-15.52	0.80	2.61	-12.02	-17.71	-10.58
Valdosta	-5.48	-2.96	0.04	-0.75	-10.42	-6.81
Vidalia	-2.49	11.26	2.38	-15.40	-25.74	-8.05
Watkinsville	-9.78	7.39	1.17	1.02	-11.51	-18.76

A REAL-TIME SMART SENSOR ARRAY FOR SCHEDULING IRRIGATION: COMMERCIALIZATION

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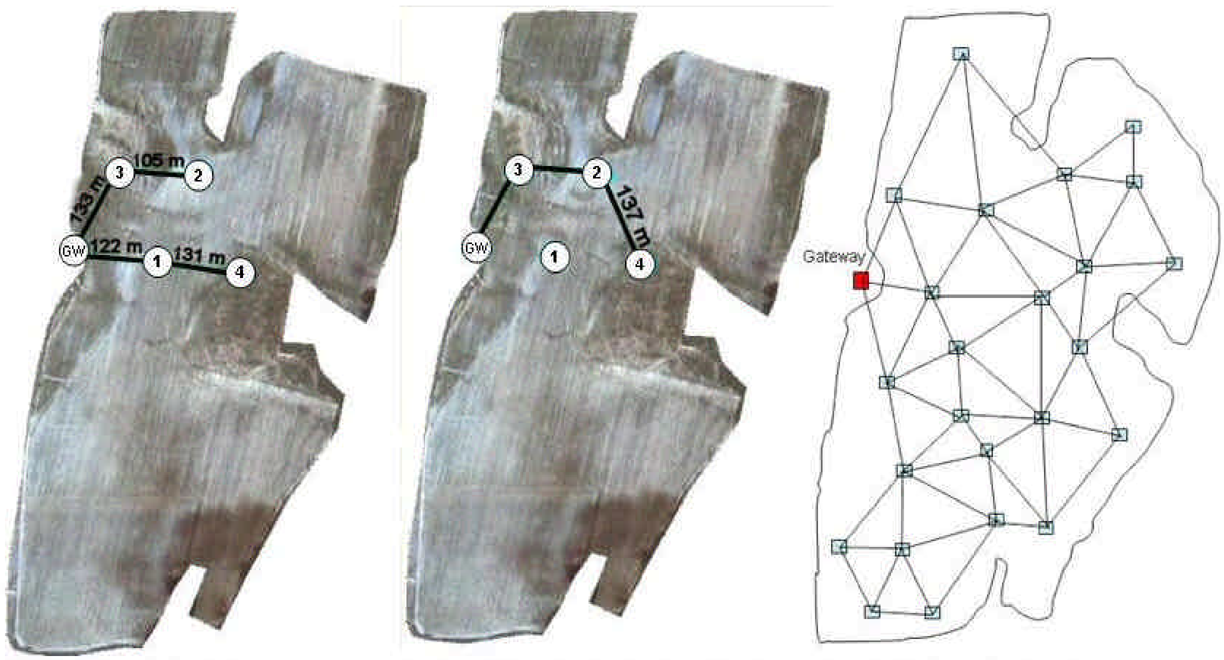
Introduction

In 2004 we first developed a real-time smart sensor array for measuring soil moisture and temperature. Further testing in 2005 and 2006 showed the system to be effective at providing real-time monitoring of soil moisture conditions. The sensor readings were used to schedule irrigation in several fields. Additionally, by observing sensor readings after irrigating, the sensor array provided a means of determining the effectiveness of an irrigation event in bringing soil moisture values to desired levels.

In our system, soil moisture values at each location, or node, in a field are transmitted wirelessly to a receiver and datalogger housed in an enclosure at the edge of a field. Each sensor node has the capability to read up to 3 Watermark® soil moisture sensors and up to 4 thermocouples. Radio Frequency Identification (RFID) tags were used as the transmitters for the sensor node. The RFID tags were chosen as the wireless component for their low-cost, reliability, and transmitting range. Although the RFID tags used have a transmitting range of up to 1/2 mile (line-of-sight), problems arise when the transmission path from a tag to the receiver is obstructed. Obstruction problems can be reduced by raising the tag(s) and/or installing the receiver on a tall mast. However, in undulating topography where hills, ridges, and depressions are located between a tag and the receiver, there may be no means of overcoming the obstructed transmission path. Other disadvantages of the RFID system are unidirectional transmitting and receiver costs. The RFID system is capable of only transmitting from the tag to the receiver. That is, the receiver does not have the capability to "talk to" the tags. Also, although the tags are relatively inexpensive the receiver is not. The Wherenet® RFID system we adapted for this project was designed for spatially tracking inventories. The receiver contains additional expensive circuitry not required in our application.

Because of these limitations with the Wherenet® RFID system, we have been evaluating alternative wireless systems for use with the sensor array. As the name implies, mesh networks create a wireless mesh network between the nodes. During 2006 we conducted a preliminary study using five Mica2 motes manufactured and sold by Crossbow® Technology Inc. The Mica2 motes are postage stamp-sized intelligent radio modules that are capable of acquiring, analyzing, and transmitting sensor data. Additionally, the motes act as repeaters to pass along data from other nodes to form a meshed network of motes. If any of the motes in a network stop transmitting or receiving or if signal pathways become blocked, the operating software will re-configure signal routes in order to maintain data acquisition from the mote network. To test this ability, we installed five motes in a cotton field as shown in Figure 1. The map on the left shows the original signal routing established by the mote system's software. The lines represent established signal paths that route data from the four motes installed in the field to the fifth mote acting as the gateway (GW). To mimic a failed mote, we turned off mote number 1. The middle map shows how the software automatically re-routed the signals between the remaining operational motes to maintain connectivity. Data from mote number 4 are now routed though motes 2 and 3 to reach the gateway. The schematic on the right in Figure 1 shows a hypothetical mesh network of motes based on sensor node locations installed at this site during 2006. Under our conditions, mote to mote transmission had an effective range of 350 to 450 ft. By using a series of motes, range can be extended indefinitely and topographical features become irrelevant. Because of this successful preliminary test, we proposed a more comprehensive evaluation during 2007. Clearly, mesh networks have a distinct advantage over the RFID technology because they overcome limitations of distance and topography that limit our current system. The objective of our 2007 study focused on integrating the mesh networks with the soil moisture and temperature measurement nodes we developed in our earlier work.



Initial routing of signals between motes. **Routing of signals after turning off mote number 1.** **Hypothetical Mesh network.**

Figure 1. Preliminary test of a mesh network conducted during 2006. The map on the left shows the original signal routing established by the mote system's software. The lines represent established signal paths that route data from the four motes installed in the field to the fifth mote acting as the gateway (GW). To mimic a failed mote, we turned off mote number 1. The middle map shows how the software automatically re-routed the signals between the remaining operational motes to maintain connectivity. Data from mote number 4 are now routed though motes 2 and 3 to reach the gateway. The schematic on the right shows a hypothetical mesh network of motes based on sensor node locations installed at this site during 2006.

Materials and Methods

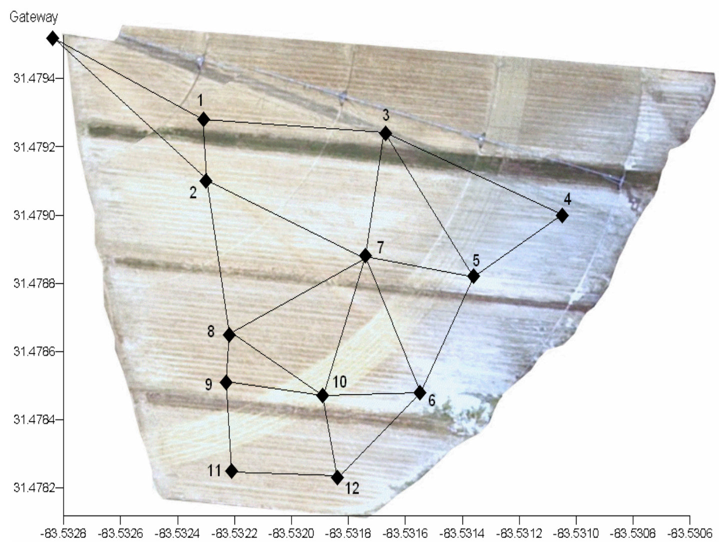


Figure 2. Mesh network established in the NESPAL field to evaluate the uses of motes for wireless transmission between sensor nodes.

For our 2007 study we used the same type of Mica2 motes used during the 2006 pilot study. These motes use transceivers operating at a radio frequency of 916 Megahertz (MHz) to provide the wireless component. The motes are manufactured and sold by Crossbow® Technology Inc. On board intelligent circuitry gives the motes the capability to acquire and analyze data in addition to transmitting the data wirelessly. Because the mote's radio circuitry includes a transceiver, the motes are capable of both transmitting and receiving wirelessly. This capability is used by the onboard operating system to allow the motes to act as repeaters – receiving and passing along transmissions from other motes. The transmission pathways, established mote-to-mote, create a mesh network. This is illustrated in Figure 1. If a pathway between motes becomes obstructed, the operating system will re-route the data through other motes. The wirelessly transmitted data from all motes in a network eventually reach a gateway where the data can then be uploaded to a data logger. The mote-to-mote communications and re-routing capabilities aid in overcoming obstructions and give the overall network great range.

During 2007, we substituted motes for the RFID tags in our smart senor nodes and installed the system in the NESPAL field for a season-long evaluation. The NESPAL field is 6 acres in size and located on the University of Georgia's Tifton Campus. Researchers performing a pest-related co-study in the field, planted the field in plots consisting of cotton, peanuts, and soybeans. Figure 2 shows the layout and mesh network established by the motes in the field. The photo in Figure 3 shows a node's circuit boards pulled part-way out of its enclosure. The green circuit board is the mote. The mote attaches to the sensor acquisition board through a 51-pin connector. The node circuitry is powered by two alkaline AA batteries mounted on the back side of the sensor acquisition board. Each node antenna was made from a 3.25 inch length of 14 gauge solid wire. The 3.25 inch length is specific to the mote’s 916 MHz transmit/receive frequency.

Results

Initially, the mesh network worked as expected, with each node reporting the soil moisture values. However, as the plant canopies grew taller, the motes’ transmission range decreased. This was most likely caused by a portion of the signal bouncing off

Figure 3. A sensor node's circuit board pulled part-way out of its PVC enclosure. The green circuit board is the mote. The node circuitry is powered by two alkaline AA batteries mounted to the back side of the sensor acquisition board.

the foliage and arriving at the receiving mote out-of-phase with the main component of the radio energy. This out-of-phase portion acts to attenuate the main rf beam. As the crop grew taller, the motes' transmitting and receiving ranges, which have a line-of-sight distance up to 400 feet over level, non-cropped ground, were reduced to a range of less than 120 feet.

One attempt to increase the motes' transmit range was to construct higher gain, collinear antennas. These are constructed by soldering together multiple 3.25 inch antenna sections. As the number of sections increases, gain, and ultimately range, increases. Initial tests of 4-section collinear antennas on non-cropped ground showed an increase of range of as much as 30%. However, when the collinear antennas were placed in the crop foliage, their range was no better than the original antennas.

To overcome this issue, the original antennas were inserted into the top of an 8 foot, 0.25 inch

Figure 4. To overcome the range issue, the original mote antennas were enclosed in an 8 foot, 0.25 inch diameter hollow, flexible, fiberglass rod. The rods were mounted to a PVC pipe used as a supporting stake with a spring used for conventional CB antennas. The pipe also supported the PVC enclosure housing the node circuitry including the Mica2 motes.

diameter hollow, flexible, fiberglass rod. The antenna was connected to the mote via an electrical cable that ran through the fiberglass rod. This placed the antenna above the plant canopy. The rods were mounted to the PVC enclosure protecting the electronics with a spring used for conventional CB antennas (Figure 4). The flexible rods and spring allowed field equipment, such as sprayers, to bend the rods and pass over the sensors without damaging them throughout the growing season. This solved the range issue but did make the node slightly more cumbersome to transport during installation. An unexpected benefit of this extended antenna was that it made the location of the sensor nodes easily visible and ensured that they would not be accidentally damaged during normal field operations.

A more serious problem may be that three of the 12 motes failed during the growing season. We were not able to determine the specific reason for the mote failures. After extensive discussions with the manufacturer, we concluded that the design of the motes may not have been robust enough to survive a full season in the field under the high heat, high humidity conditions experienced in southern Georgia.

We have recommended design modifications to the manufacturer which are now being implemented. A new design will be available for the 2008 growing season which should ensure that the motes will have a long, multi-season, life. The positive outcome of these failures was that we were able to document that the mesh network reestablished itself and the motes were able to re-route signals when the pathway between two motes failed.

Conclusions

Wireless mesh networks, formed by Mica2 motes, showed promise as an alternative to RFID tags for accessing soil moisture information from remote locations in an agricultural field. The motes were able to re-route signals when the pathway between two motes failed. Raising the antenna above the crop canopy allows the transmit/receive range of the motes to be maintained as the crop matures. We have held discussions with two different companies interested in commercializing the mesh network approach. The first is a small start-up agricultural electronics company based in Miller Co., Georgia. The second is a larger, well established agricultural electronics company based in Nebraska who has strong ties to national pivot manufacturers. There are no firm agreements at this time however we are optimistic that with the involvement of the Agricultural Innovation Center, progress will be made soon.

Acknowledgements

This work was supported by funds from the Georgia Cotton Commission, Cotton Inc., the Georgia Peanut Commission, the Peanut Foundation, the Georgia Research Alliance, and by Hatch and State funds allocated to the Georgia Agricultural Experiment Stations. Mention of commercially available products is for information only and does not imply endorsement.

CONTROLLING GLYPHOSATE-RESISTANT PALMER AMARANTH IN ROUNDUP READY AND LIBERTY LINK COTTON

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Introduction

Glyphosate-resistant Palmer amaranth is spreading rapidly throughout Georgia (Figure 1) and the Southeast. A grower's ability to manage this pest in Roundup Ready cotton is heavily dependent on residual herbicides. When timely rainfalls or irrigation do not activate these residual herbicides, cotton yield can be eliminated by this resistant pest. The objective of this trial was to determine if glyphosate-resistant Palmer amaranth could be controlled more effectively with Ignite-based programs in dryland cotton production in Georgia.

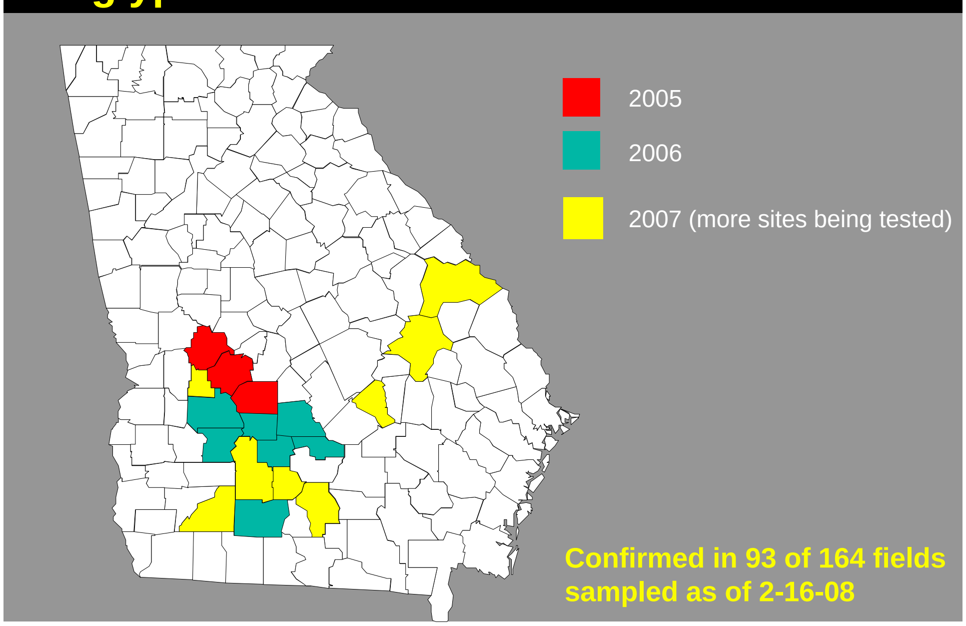

Figure 1. Georgia counties infested with glyphosate-resistant Palmer amaranth.

Materials and Methods

A research study was conducted in dryland cotton during 2007 to determine the most effective herbicide program available to control glyphosate-resistant Palmer amaranth in conventional tillage. The study was conducted in Macon County, GA on a loamy sand soil with 2.0% organic matter with a pH of 6.3 in an area that was disc-harrowed.

The randomized split-plot design experiment was conducted in a field with a heavy population of glyphosate-resistant Palmer amaranth. Treatments included two cultivars (Liberty Link FM 1735 LLB2 or DP 555 BRR) and six herbicide systems (Table 1) as whole plots. Whole plots were then split into subplots being cultivated (10 day after POST 1 and 10 day after POST 2) or not cultivated.

Preemergence (PRE) applications were made the day of planting. Rainfall did not occur until 17 days after planting. POST 1 applications were made to cotton in the 1- to 3-leaf stage infested with 2- to 3-inch Palmer amaranth and POST 2 applications were made to cotton in the 5- to 6-leaf stage. Palmer amaranth size at the POST 2 application ranged from 2 to 10 inches with 10 inch plants emerging at planting and escaping PRE and POST 1 treatments while 2 inch plants were present in plots where POST 1 treatments controlled early season emerged Palmer amaranth.

Table 1. Herbicide treatment options in Liberty Link and Roundup Ready cotton.*

PRE Application	POST 1 Application*	POST 2 Application	Layby
Prowl	Ignite or WeatherMax	Ignite or WeatherMax	Direx + MSMA
Prowl	Ignite or WeatherMax + Staple	Ignite or WeatherMax	Direx + MSMA
Prowl	Ignite or WeatherMax + Dual Mag.	Ignite or WeatherMax	Direx + MSMA
Prowl + Reflex	Ignite or WeatherMax	Ignite or WeatherMax	Direx + MSMA
Prowl + Reflex	Ignite or WeatherMax + Staple	Ignite or WeatherMax	Direx + MSMA
Prowl + Reflex	Ignite or WeatherMax + Dual Mag.	Ignite or WeatherMax	Direx + MSMA

*Ignite was applied in Liberty Link cotton and Roundup WeatherMax was applied in Roundup Ready cotton. Herbicide rates included Direx 2 pt/A; Dual Magnum 1 pt/A; Ignite 23 oz/A; MSMA 2.5 pt/A; Prowl 2.1 pt/A, Reflex 1 pt/A; Roundup WeatherMax 23 oz/A; and Staple LX 1.7 fl oz/A.

Results and Discussion

Although rainfall did not occur until 17 days after planting, cotton and Palmer amaranth emerged within 6 days of planting. Prowl and Prowl plus Reflex provided less than 35% control of the Palmer amaranth that emerged at planting (data not shown).

At harvest, Palmer amaranth was controlled less than 31% in all Roundup Ready programs not receiving cultivation primarily due to the residual herbicides not being activated with a timely rainfall (Table 2). Similar treatments in Liberty Link cotton using Ignite provided 70 to 88% control. In the Roundup Ready programs using Staple and cultivation, Palmer amaranth was controlled only 70%. Cultivation had minimal impact

on Palmer control of other Roundup Ready programs. Cultivation in all Ignite-based programs improved control to at least 93%.
Roundup Ready programs without cultivation could not be harvested (Table 2). Ignite-based programs without cultivation produced 1012 to 1133 lb/A of seed cotton. Cultivating did allow harvest of the Roundup Ready programs including Staple, with yields of 831 to 853 lb/A. Including cultivation in the Ignite-based programs increased yields 400 to 555 lb/A when compared to the same program without cultivation.

In dryland cotton production when residual herbicides can not be activated by rainfall or irrigation in a timely manner, Ignite-based programs were more effective than Roundup Ready programs in controlling glyphosate-resistant Palmer amaranth. Only Liberty Link programs with timely applications of Ignite in combination with cultivation provided adequate control of glyphosate-resistant Palmer amaranth.

Table 2. Palmer control at harvest in Liberty Link and Roundup Ready cotton.*

PRE application	POST 1 application*	POST 2 application	Percent late-season Palmer control		Seed cotton yield (lb/ac)	
			No cultivation	Cultivated	No Cultivation	Cultivated
Prowl	WMax	WMax	0 i	0 d	0 c	0 d
Prowl	WMax + Staple	WMax	30 f	70 b	0 c	831 b
Prowl	WMax + Dual Mag.	WMax	0 i	0 d	0 c	0 d
Prowl + Reflex	WMax	WMax	0 i	0 d	0 c	0 d
Prowl + Reflex	WMax + Staple	WMax	43 e	70 b	0 c	853 b
Prowl + Reflex	WMax + Dual Mag.	WMax	0 i	28 c	0 c	446 c
Prowl	Ignite	Ignite	70 d	96 a	1012 b	1568 a
Prowl	Ignite + Staple	Ignite	73 cd	93 a	1133 a	1476 a
Prowl	Ignite + Dual Mag.	Ignite	78 bc	95 a	1113 ab	1597 a
Prowl + Reflex	Ignite	Ignite	85 a	96 a	1218 a	1614 a
Prowl + Reflex	Ignite + Staple	Ignite	83 ab	93 a	1177 a	1676 a
Prowl + Reflex	Ignite + Dual Mag.	Ignite	88 a	94 a	1208 a	1573 a

*Data within a column is not different at P = 0.05. Ignite was applied in Liberty Link cotton and Roundup WeatherMax (WMax) was applied in Roundup Ready cotton. Herbicide rates included Direx 2 pt/A; Dual Magnum 1 pt/A; Ignite 23 oz/A; MSMA 2.5 pt/A; Prowl 2.1 pt/A, Reflex 1 pt/A; Roundup WeatherMax 23 oz/A; and Staple LX 1.7 fl oz/A. Direx + MSMA was directed over the trial area.

PALMER AMARANTH POLLEN SETTLING VELOCITY

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Introduction

Herbicide resistance can develop *de novo* in plant populations via spontaneous genetic mutation, meiotic recombination and transposable element activity. Herbicide resistance can also be acquired via gene-flow, which is achieved through the movement of fertilized ovules (seeds) and viable gametophytes (pollen). For species that are dioecious and/or produce seed that lack specialized dispersal structures pollen-flow is crucial for maintaining genetic variability. Although the importance of gene flow, relative to genetic mutation, as a source of resistance is still unknown, it is accepted that interpopulation gene-flow for outcrossing species occurs at rates that are evolutionarily significant. Because Palmer amaranth is wind-pollinated, it is likely that the herbicide-resistance trait can be transferred between spatially segregated intra- and inter-specific populations via atmospheric currents. The specific objective of this study was to describe the morphological and physical properties of Palmer amaranth pollen that influence pollen flight.

Materials and Methods

The ease with which pollen grains are liberated from the crop canopy and the length of time they remain airborne are determined, in part, by their gravitational settling velocity (*Vs*) in still air. The *Vs* for small (1 to ~100 µm), round particles, such as pollen, can either be determined, empirically, using a settling chamber, or else estimated using an application of Stoke's law

$$Vs = \frac{2}{9}\left(r^2\right)\left(g\right)\left(\frac{s_p - s_f}{m}\right)$$

where *r* is the radius of the particle (m), *g* is the acceleration due to gravity (981 m s^{-1}), s_p is the density of *A.* palmeri pollen and s_f is the density of air (1.184 kg m^{-3}), and µ is the dynamic viscosity of air (1.89 x 10^{-5} kg m^{-1} s^{-1}). Assuming that the density of Palmer amaranth pollen is a real number between 995 kg m^{-3} (the density of water) and 1500 kg m^{-3} (the density of pure starch, Palmer amaranth pollen grains are approximately 50% water and 7% starch), the *Vs* of Palmer amaranth pollen can be approximated after determining the mean diameter of the grains. Pollen density can be difficult to determine and there is some debate regarding methodology.

Fresh pollen was collected from multiple plants at the USDA/UGA Jones Farm in Tifton, GA for six days in July and August 2007. Pollen diameter measurements (N_{grains} = 1825) were made using digital images captured with a Diagnostic Instruments® SPOT™

Insight camera attached to an Olympus® BH-2 research microscope (400x magnification).

The distribution of settling velocities for Palmer amaranth pollen grains was determined, empirically, using a settling chamber. Our settling chamber is comprised of two nested, acrylic columns 1.8 m in height; the inner cylinder is 15 cm in diameter. Freshly harvested pollen grains (see previous) were released at the top of a 2 m tower and captured at the base using greased microscope slides attached to a rotating disk. The position of the slide on the disc and the speed at which the disc rotates determines the fall rate for grains trapped on each individual slide; grains on the first slides have faster *Vs* than grains on the last slides.

Results and Discussion

Our results indicate that the mean diameter for Palmer amaranth pollen was 31 µm (min= 21, max = 38), as opposed to 19.8 µm (as is reported in the literature) (Figure 1). All of the pollen grains examined were almost perfectly spherical when fully hydrated. Assuming a mean pollen diameter of 31 µm, the mean theoretical *Vs* for Palmer amaranth pollen grains should range from 2.7-4.1 cm s^{-1} if pollen density is between 995 kg m^{-3} (pure water; ~ 50% of an Palmer amaranth pollen grain is water) and 1500 kg m^{-3} (pure starch; starch is a major component of Palmer amaranth pollen (~7%)).

Results from the laboratory studies indicate that the bulk of single pollen grains settled at a rate of approximately 4.5 to 5.0 cm s^{-1} (Figure 2). The disparity between the empirical (4.5 to 5.0 cm s^{-1}) and the theoretical (2.7-4.1 cm s^{-1}) estimates of pollen *Vs* are likely the result of the assumptions associated with Stoke's law. The range of mean theoretical values for *Vs* was established using a model that assumes particles maintain a constant shape, size and density. As Palmer amaranth pollen becomes desiccated, the grains assume the shape of a deflated basketballs or bowls; this shape has a lower drag coefficient than does a sphere. Furthermore, the movement of a pollen grain may be affected by neighboring particles; an ensemble of pollen grains will settle faster than an individual. Stoke's law predicts the *Vs* of individual particles in the absence of particle-particle interactions.

Using the size and settling velocity data, we intend to develop a predictive model of pollen transport for Palmer amaranth. A better understanding of the processes governing the movement of herbicide resistance across the agricultural landscape will allow us to develop economical, ecological and effective detection and management strategies.

Figure 1. Distribution of Palmer amaranth pollen diameters.

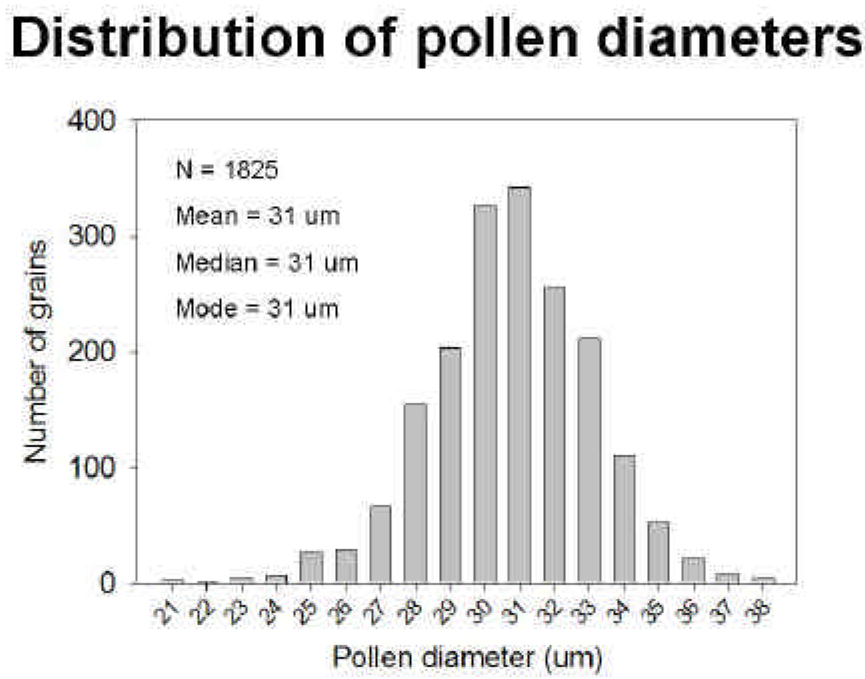
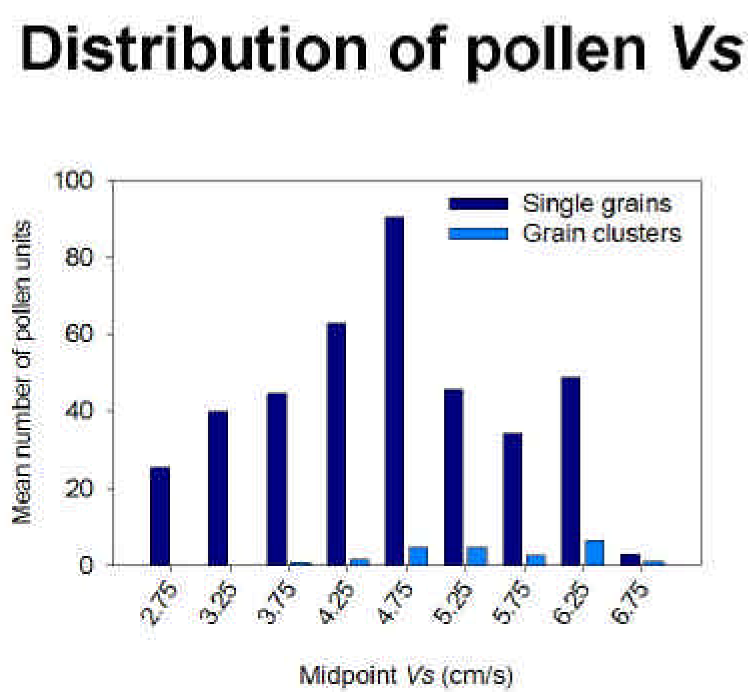


Figure 2. Distribution of Palmer amaranth settling velocities.



PALMER AMARANTH POLLEN VIABILITY

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Introduction

The probability of a successful germination event occurring at any given distance from a pollen source is dependant upon the performance of pollen grains post-anthesis. Although many authors have shown that the functional life of pollen decreases at higher temperatures, lower relative humidities (RH), and with increased exposure to ultra-violet (UV) radiation and atmospheric pollutants, there have been no comprehensive studies performed to describe how pollen of a weedy species, such as Palmer amaranth, is affected by a range of environmental conditions. Our objective was to describe how Palmer amaranth pollen viability changes over time.

Materials and Methods

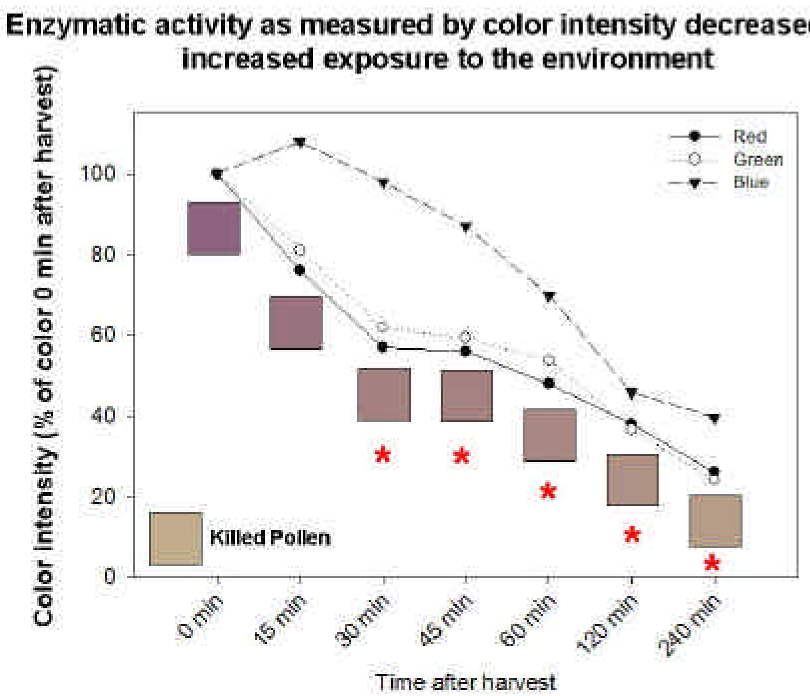
Because members of the family Amaranthaceae produce tri-nucleate pollen (tri-nucleate pollen produced by dicot species tend to have limited germinability *in vitro*), enzymatic assays, as opposed to an artificial germination media, were used to evaluate pollen longevity. In particular we employed 3-(4,5-dimethyl-2-thiazolyl)-2,5-diphenyl-2H-tetrazolium bromide (MTT). MTT is enzymatically converted (via dehydrogenase) from a yellow, soluble liquid to a reddish-purple, insoluble crystal in living cells.

Freshly harvest pollen grains were dusted onto microscope slides using a painter's brush and exposed to local atmospheric conditions for up to four hours for five days in July and August of 2007. Pollen grain sub-samples were brought into the lab at regular intervals and stained with MTT to monitor the change in dehydrogenase activity over time. Because the evaluation of color intensity is highly subjective (i.e. the concepts of dark, medium and light may differ among observers), we used a Diagnostic Instruments® SPOT™ Insight camera attached to an Olympus® BH-2 research microscope (400x magnification) to capture digital images of the pollen grains and then evaluated the degree of color development using RGB Color Analysis Software ©. The RGB software describes the color of any object, numerically, with respect to the amounts of red (R), green (G) and blue (B) present. Color values can range from 0 (very dark) to 255 (very light). Therefore, a combination of 255-R:255-G:255-B describes an object that is pure white, whereas 0-R:0-G:0-B describes an object that is pure black. Freshly harvested and enzymatically active pollen grains will stain darkly and have RGB values that are lower than more aged grains. No less than 300 pollen grains were scored for each time period each day.

Results and Discussion

Results show that the degree of color intensity, and therefore enzymatic activity, decreased with increased time post-harvest (Figure 1). When the RGB values were transformed to express color intensity as a percent of the freshly-harvested pollen (0 minutes) and statistically analyzed, it was determined that enzymatic activity was significantly reduced after 30 minutes. These results suggest that Palmer amaranth pollen viability may decrease rapidly, post-anthesis. Pollen grains that travel long-distances before contacting a receptive ovule may be less able to germinate and initialize a fertilization event than pollen grains with a shorter flight-time.

Figure 1. Change in color intensity of Palmer amaranth pollen grains over time.



EFFECTS OF VARYING IRRIGATION AND MEPIQUAT CHLORIDE APPLICATION ON COTTON HEIGHT, UNIFORMITY, YIELD, AND QUALITY

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Abstract

Irrigation and plant growth regulators (PGRs) affect cotton growth, height, and development. Irrigation increases crop height and slows maturity, while the addition of PGRs, such as mepiquat chloride, decreases crop height and increases maturity. Irrigation and PGR application both increase cotton management costs. We examined the effects of varied irrigation and mepiquat chloride application based on remote sensing to test the effects of precision mepiquat chloride application on input costs, crop uniformity, and crop yield and quality. Cotton was grown under a variable rate irrigation system at the Stripling Irrigation Research Park in Camilla, Georgia with four levels of irrigation and four replicates. Subplots within each irrigation plot had four levels of mepiquat chloride application. One was a full application, the second and third were based on varying levels of oversight based on aerial images during the season, and the fourth was a control treatment with no mepiquat chloride applied. Plant height and maturity were measured prior to each mepiquat chloride application, and crop yield and quality were measured at the end. The results suggest effects of varied application of both irrigation and mepiquat chloride application.

Introduction

Water is the most common environmental factor that limits crop productivity. Water is the primary component of actively growing crop plants, ranging from 70-90% of the crop plant fresh mass, and is essential to nutrient transport, chemical reactions, cell enlargement, transpiration, and most other plant processes. All plants are affected by soil moisture deficit. Moisture deficit inhibits cellular growth, changes enzyme concentrations, and eventually affects respiration, photosynthesis, and assimilate translocation, changing plant growth and development {Gardner, 1984 #46}.

Water depletion affects cotton grown throughout the United States, particularly non-irrigated cotton. The costs of water application and the competitive demands for water further enhance the attractiveness of water-efficient cotton in production settings. For instance, much of the Southeast is currently experiencing moderate to severe drought (Figure 1), and agricultural use accounts for a significant portion of water consumption in the United States, even in normally relatively wet regions of the country such as Alabama, Georgia, and South Carolina (Figure 2). Bednarz *et al.* {, 2002 #32} stated that cotton grown in South Georgia requires about 460 mm of water for maximum yields. Although South Georgia receives about 600 mm of water during the average growing season {Anonymous, 2006 #89}, periodic dry periods often cause crop water stress, which can be resolved by irrigation. In Georgia, an estimated 250,000 hectares of cotton are irrigated {Harrison, 2005 #70}. This means that about 1.8 billion liters of water are required to apply one cm of irrigation water to all of the irrigated cotton in Georgia alone. Other states are even more dependent on irrigation than Georgia. Technology that decreases crop water use can have a major impact on available water resources.

Cotton is an indeterminate crop with a fruiting habit that allows vegetative growth to continue above the fruiting branches after reproductive growth has been initiated. Left unchecked, cotton can exhibit rank growth {Cathey, 1980 #299}. This excess vegetative growth can cause fruit shed, difficulty in picking the cotton, boll rot, increased insect and disease pressure, decreased lint quality, and potentially impact yield {Nichols, 2003 #298}.

Mepiquat chloride (1,1-dimethylpiperidinium chloride) has been recognized as a useful cotton growth regulator since the late 1970s {Kerby, 1985 #293}, due to its control of cotton height. Mepiquat chloride is an ammonium-containing compound that blocks the early steps of gibberellic acid (GA) metabolism, decreasing production of GA and resulting in shorter cotton. Although some plants have a low response to mepiquat chloride, cotton is highly responsive to MC application {Rademacher, 2000 #300}. Mepiquat chloride has been shown to decrease the number of sympodial nodes and reproductive branches, decrease internode length, increase maturity rate, and decrease boll rot {Nichols, 2003 #298}. The effects on maturity and the number of reproductive branches have also been linked to the enhanced retention of early buds and bolls {Cook, 2000 #296; Kerby, 1986 #294}.

Because both irrigation and mepiquat chloride application have associated application costs, the benefits of these amendments might be increased by imagery-based application.

Materials and Methods

This study was a split plot experiment conducted on a variable rate center pivot at the Stripling Irrigation Research Park in Camilla, Georgia. The pivot is designed to allow variable application of water in a randomized complete block design. DP 555 cotton was planted at a rate of three plants per foot with 36 inch row spacing on May 10, 2007. All pesticide and herbicide applications were based on University of Georgia extension guidelines. The irrigation component of this study formed the main plot. One irrigation was applied prior to planting, at a rate of 0.3 inches to all plots. An additional 1.1 inches of irrigation were applied to all plots within the first week after planting to facilitate emergence. Irrigation treatments were begun on May 25, 2007, and continued until July 24, 2007. The irrigation treatments consisted of a 100% irrigation treatment, a 75% irrigation treatment, a 50% irrigation treatment, and a nonirrigated control. Irrigation scheduling and rates were based on the 100% irrigation treatment. In the 100%

irrigation treatment, watermark sensors were placed at depths of 8, 16, and 24 inches. Irrigation was commenced when watermark sensors measured -40 centibar soil tension.

The split plot consisted of four mepiquat treatments: a nonapplied control, a mepiquat regime based on a single aerial image prior to the first mepiquat application, a mepiquat regime based on aerial images collected prior to each mepiquat chloride application, and a standard mepiquat chloride application based on standard practice. Mepiquat chloride was applied on June 22 and July 6, 2007. Each treatment was replicated four times for a total of 64 plots.

Results and Discussion

Unsurprisingly, the control treatments with no mepiquat chloride added were consistently taller than the other treatments (Figure 1). The two remote sensing treatments were similar in height to each other and taller than the standard mepiquat treatment at the lower levels of irrigation, but were not different in the full irrigation treatment. The remote sensing mepiquat chloride rates were similar to the standard rate at both the 75% and 100% irrigation rate.

Plant height during the growing season was lowest for the nonirrigated treatment at 54 DAP, and trended lower than the same mepiquat chloride rates at different irrigation rates at day 82 (Table 1). However, by day 144 (harvest), the nonirrigated treatments were the tallest of any irrigation treatment (Figure 1). Similarly, mepiquat chloride treatments based on remote sensing data were similar in height to the standard mepiquat chloride treatment at 54 and 82 days after planting, but were higher at harvest at the 50% and 75% irrigation rate treatments.

Yield, staple, uniformity, and strength varied by irrigation and PGR (Table 2). In the no-Pix treatment, the irrigated treatments had significantly higher yield than the non-irrigated treatment. This trend was evident in most of the pix treatments, with the exception of the 75% irrigated treatment with pix based on multiple remote sensing measurements.

Figure 2 shows the relative yield distribution of the cotton plants with each irrigation and PGR treatment. The treatments with lower PGR rates showed the highest level of lint yield above node 16, as shown in Figure 2. The nonirrigated treatments also showed higher levels of yield above node 16, likely due to the late rainfall and the compensation of the crop to increase yield.

Acknowledgments

This research was funded through a grant by the Georgia Cotton Commission. Dudley Cook and the Stripling Irrigation Research Park technical staff provided field technical support for this project.

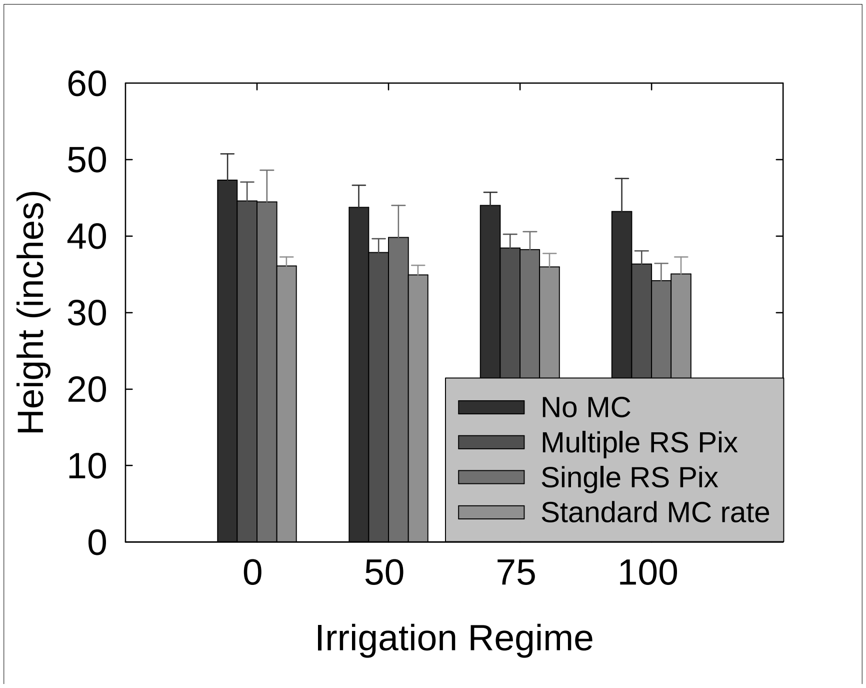

Figure 4. Final plant height of all treatments. Error bars represent standard error of the mean (n=4).

Table 1. Plant height during the growing season for all treatments.

		Irrigation			
DAP	PGR	Dry	50%	75%	100%
		Height (inches)			
54	No MC	17.85 ± 0.84	21.25 ± 0.92	21.8 ± 1.32	22.15 ± 0.78
	Multiple RS Pix	17.55 ± 0.58	18.95 ± 0.91	19.85 ± 1.2	20 ± 0.56
	Single RS Pix	18.3 ± 1.03	19.75 ± 1.06	19.95 ± 0.89	20.3 ± 1.01
	Standard	15.7 ± 0.68	17.95 ± 0.69	19 ± 1.09	19.45 ± 0.58
82	No MC	37.75 ± 0.95	40.4 ± 1.02	40 ± 1.38	38.7 ± 0.96
	Multiple RS Pix	37.3 ± 0.99	34.75 ± 1.09	34.45 ± 1.22	32.05 ± 1.18
	Single RS Pix	37.45 ± 2.12	34.45 ± 1.42	35.45 ± 1.02	31.9 ± 1.74
	Standard	31.3 ± 0.92	32.25 ± 1.95	30.75 ± 1.77	31.1 ± 0.88
144	No MC	47.3 ± 3.46	43.75 ± 2.9	44 ± 1.75	43.2 ± 4.34
	Multiple RS Pix	44.6 ± 2.48	37.85 ± 1.79	38.45 ± 1.79	36.35 ± 1.72
	Single RS Pix	44.5 ± 4.11	39.84 ± 4.16	38.25 ± 2.33	34.15 ± 2.31
	Standard	36.1 ± 1.18	34.95 ± 1.25	36 ± 1.73	35.05 ± 2.21

Table 2. Yield, staple, strength, and uniformity of all treatments. Errors represent standard error of the mean (n = 4).

		Irrigation			
PGR	Data	0	50	75	100
No Pix	Yield (kg/ha)	1402 ± 39	1474 ± 92	1582 ± 76	1550 ± 38
	Staple	34.5 ± 0.3	34.8 ± 0.6	34.5 ± 0.3	34.3 ± 0.6
	Strength	31.5 ± 1.9	29 ± 0.6	28.9 ± 0.8	30.1 ± 1.7
	Uniformity	0.805 ± 0.006	0.803 ± 0.0033	0.807 ± 0.0029	0.806 ± 0.0018
Multiple RS Pix	Yield (kg/ha)	1401 ± 84	1476 ± 37	1390 ± 55	1499 ± 60
	Staple	34.5 ± 0.7	34.5 ± 0.3	34.8 ± 0.6	35.5 ± 0.3
	Strength	32 ± 1.1	31.2 ± 2.2	28.5 ± 0.6	30.6 ± 0.9
	Uniformity	0.803 ± 0.0014	0.804 ± 0.0028	0.804 ± 0.001	0.808 ± 0.0016
Single RS Pix	Yield (kg/ha)	1366 ± 48	1567 ± 175	1406 ± 8	1426 ± 96
	Staple	34.5 ± 0.7	34.8 ± 0.3	36 ± 0.8	35 ± 0.5
	Strength	28.3 ± 1.1	31 ± 1.8	29.5 ± 1	31.5 ± 0.9
	Uniformity	0.81 ± 0.004	0.804 ± 0.0051	0.811 ± 0.0071	0.81 ± 0.0052
Standard Pix	Yield (kg/ha)	1349 ± 52	1381 ± 62	1374 ± 60	1460 ± 53
	Staple	34.8 ± 0.3	34.5 ± 0.3	35.3 ± 0.3	34.5 ± 0.3
	Strength	30.2 ± 1.4	29.3 ± 1.6	30.1 ± 1.4	30.7 ± 1.6
	Uniformity	0.803 ± 0.0021	0.808 ± 0.0038	0.809 ± 0.0026	0.807 ± 0.0019

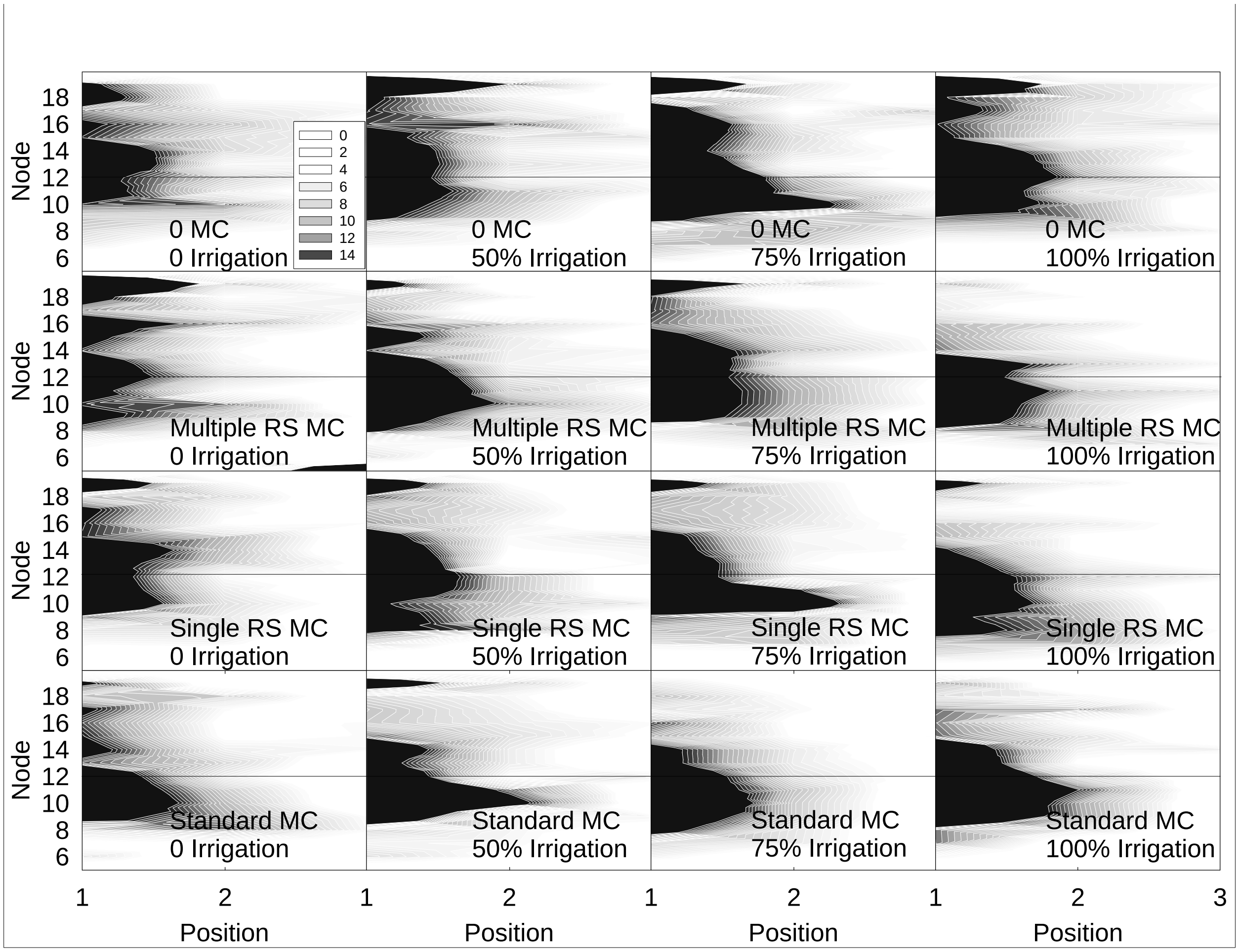

Figure 5. Yield distribution of all treatments. The darker regions of each graph represent regions of the plant with the highest yield.

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AN INTIMATE LOOK AT THE GROWTH DYNAMICS OF TWO COTTON VARIETIES

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Abstract

In Georgia, the dominant cotton variety is Delta & Pineland 555 BR, while in West Texas, FiberMax 960 B2R is a commonly grown, high-yielding variety 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. 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 BG/RR (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. 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.

Questions surrounding 555 fiber qualities are 1) whether this decrease in quality is due to a longer fruiting period, 2) the production of late maturing bolts that appear at the top of the plant, 3) the size of the bolls that are produced in the plant, differences in carbon partitioning, or 4) 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

Delta & Pineland 555 BG/RR and FiberMax 960 BGII/RRFlex 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 eerie deviation as the main plot, and a 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 a four replicates of each treatment, but at the Lang farm, the sensors were only placed into replicates of each treatment. Growth analysis measurements were made throughout the season, a two week intervals, including radiation capture measurements, soil moisture, plant height, notes above first square / white flower, and in-season fruit distribution.

Results and Discussion

Due to the large amounts of data associated with this study, all figures will be shown from the Newton study. Plant height was not significantly different between treatments until 44 DAP, when the nonirrigated treatments began to lag in growth (Figure 6). 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.

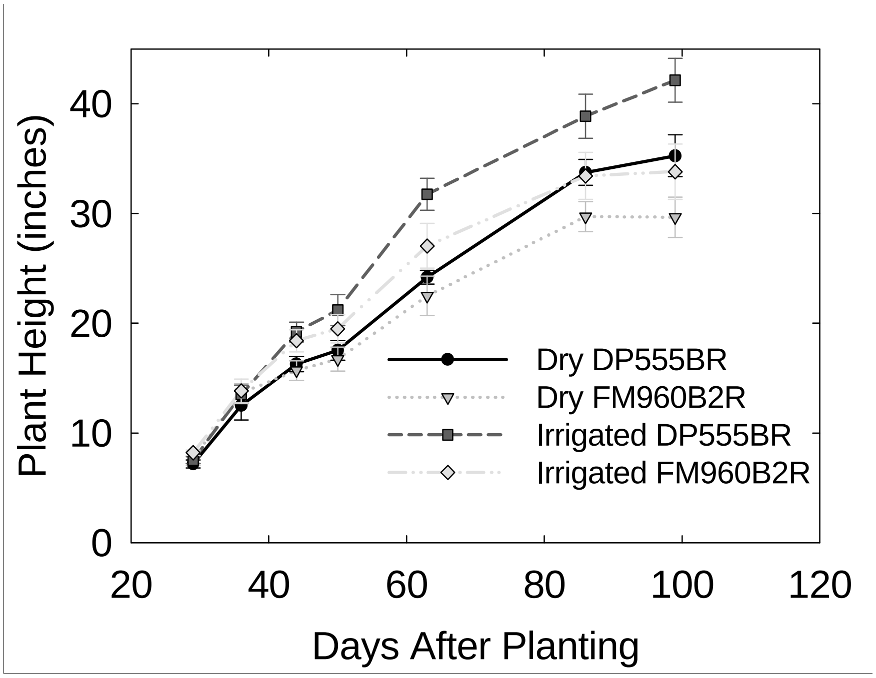

Figure 6. Height of irrigated and nonirrigated DP555 and FM960 at the Newton location during 2007. Error bars represent standard error of the mean (n = 8).

Radiation capture, defined by the equation 1, showed similar trends to those of plant height (Figure 7). Significant differences between irrigated treatments were seen by day 44, and these differences were evident until day 90. Prior to day 50, FM960 showed higher fractional PPF absorbed, but on day 69, DP555 showed a higher fractional PPF absorbed.

$$PPF_{abs} = \frac{PPF_{incident} - PPF_{reflected} - PPF_{transmitted} + R_{soil} \times PPF_{transmitted}}{PPF_{incident}} \quad \text{Equation 1}$$

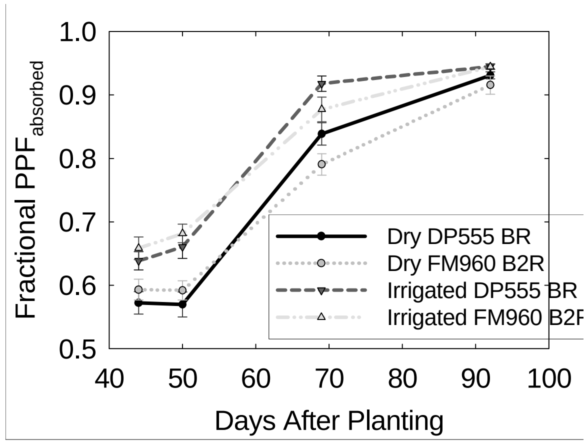

Figure 7. Radiation capture, expressed as fractional $PPF_{absorbed}$ for irrigated and nonirrigated DP555 and FM960 varieties in 2007. Error bars represent standard error of the mean (n = 8).

Because DP555 was consistently taller, but did not consistently have higher PPF absorbed than FM960, plant height and fractional PPF absorbed were compared for the two varieties. FM960 exhibited higher fractional PPF absorbed at height below 30 inches than DP555. Above 30 inches, the radiation capture curves were not different.

The DP555 FM960 showed significant differences in fruiting distribution both during the season and at the end of the season at the end of the season, as shown in Figure 8 and Figure 9. Some of these changes were evident at 50 days after planting (Figure **8**), where the irrigated DP555 cotton showed a distribution that trended toward the higher vertical nodes than the other treatments. This difference was more pronounced at 63 days after planting, when the irrigated DP555 cotton showed a significant increase in boll number at the higher vertical nodes (nodes 14 and above) than the irrigated FM960, and the nonirrigated DP555 showed a distribution almost identical with the irrigated FM960 and distributed higher vertically than the nonirrigated FM960. By day 78, both the irrigated and nonirrigated DP555 treatments showed a dramatic shift toward the higher vertical nodes on the plant. These differences were reflected in the final yield distribution at harvest (Figure 9), where the DP555 variety showed significantly more fruit at the higher vertical nodes than FM960.

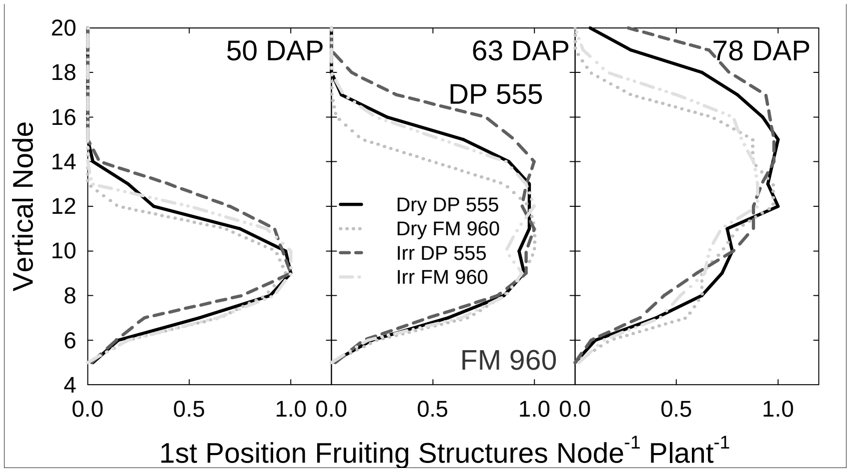

Figure 8. First position fruit per node per plant at 50, 63, and 78 days after planting. Values are means of 8 replicates.

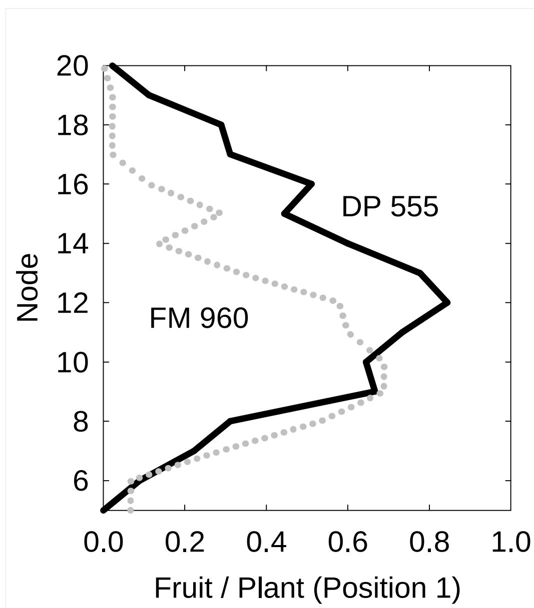

Figure 9. First position fruit per plant by node at harvest.

FiberMax 960 had significantly higher fruit weight below node ten at the first position, whereas Delta and Pine land 555 had higher fruit mass from nodes 12 through node 19 first position (Figure 10). DP555 also had higher fruiting distribution above node 10 in the second sympodial position. This difference was attributed to the increased boll numbers in these regions (Figures 4 and 5).

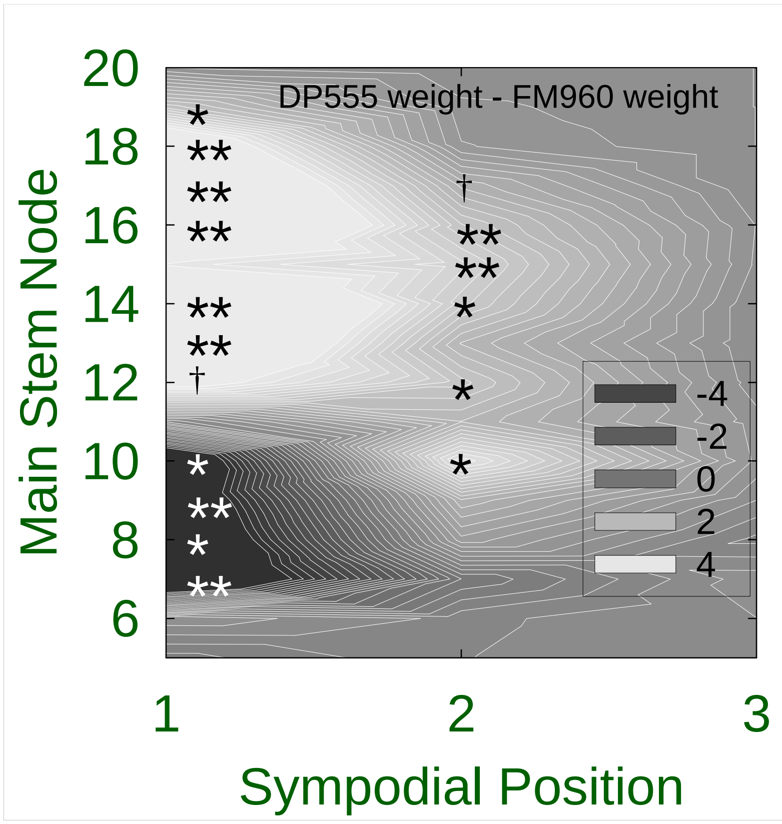

Figure 10. Difference in boll mass by main stem node and sympodial fruiting position between DP555 and FM960. Light regions of the graph indicate areas of the plant where DP555 has higher fruit mass than FM960, while dark regions indicate areas of the plant where FM960 has higher fruit mass than DP555. 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 11), suggesting more carbohydrate partitioning to the production of each boll in FM960 then in DP555. As shown in Figure 5, DP555 had significantly higher fruit numbers at the higher nodes. Much of the late production of fruit was identified in season (Figure 4).

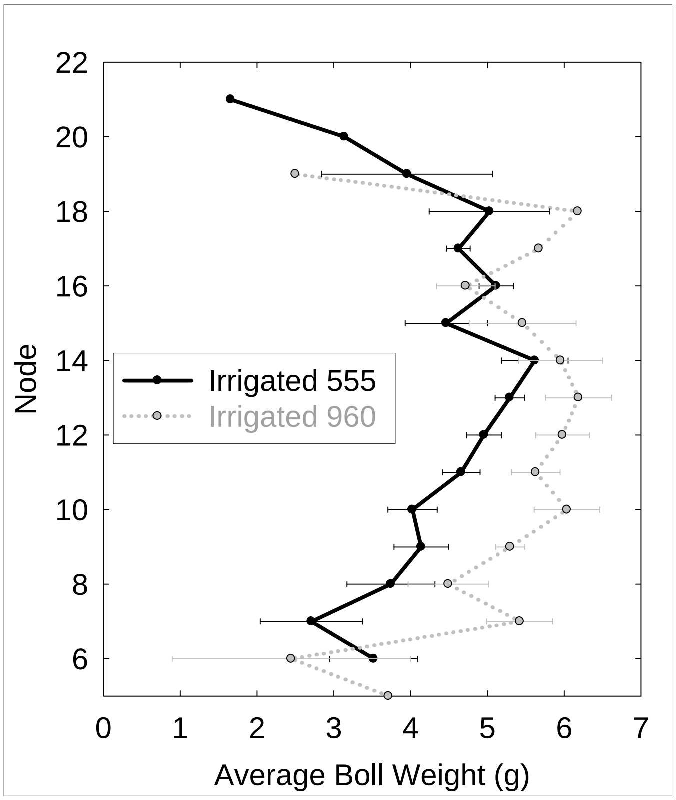

Figure 11. Average boll mass by node of irrigated DP555 and FM960. Error bars represent standard error of the mean (n = 8).

FiberMax 960 had significantly higher fiber length, fiber uniformity, and fiber strength. However, the micronaire content was higher in FiberMax 960 than in DP555. 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.

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. The 555 also exhibited more vigorous growth throughout the growing season.

Table 3. 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 4. 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*

Table 5. Newton 2007 yield and fiber quality: interaction of variety and irrigation.

	Dry DP555	Dry FM960	Irrigated DP555	Irrigated FM960	P-Value Irr*Var
Seed Weight	4359	3429	4521	4057	0.0683†
Lint Weight	1655	1195	1726	1413	0.1222
Turnout	0.3797	0.3484	0.3816	0.348	0.5449
Staple	35	36.875	35.25	36.75	0.1923
Micronaire	4.76	4.69	4.61	4.64	0.3417
Strength	30.4	31.8	30.0	31.4	0.979
Length	1.0925	1.145	1.0975	1.145	0.6216
Uniformity	0.811	0.812	0.8076	0.816	0.047*

Table 6. Lang, 2007 yield and fiber quality by irrigation.

	Dry	Irrigated	P-Value
Seed Weight	2282	4335	<0.0001**
Lint Weight	869	1646	<0.0001**
Turnout	0.379	0.378	0.9337
Staple	34.56	36.88	0.0001**
Micronaire	5.34	4.61	<0.0001**
Strength	30.781	32.038	<0.0001
Length	1.079	1.150	<0.0001**
Uniformity	0.819	0.822	0.1081

Table 7. Lang, 2007 yield and fiber quality by variety.

	DP555BR	FM960B2R	P-Value
Seed Weight	3489	3128	0.0333*
Lint Weight	1386	1129	0.0006**
Turnout	0.396	0.361	0.0001**
Staple	35.13	36.31	0.0003**
Micronaire	4.97	4.99	0.7929
Strength	31.200	31.619	0.5739
Length	1.094	1.135	0.0001**
Uniformity	0.816	0.825	0.0001**

Table 8. Lang, 2007 yield and fiber quality – interaction of variety and irrigation.

	Dry DP555	Dry FM960	Irrigated DP555	Irrigated FM960	P-Value Irr*Var
Seed Weight	2437	2126	4540	4130	0.757
Lint Weight	963	775	1808	1483	0.304
Turnout	0.394	0.363	0.398	0.359	0.251
Staple	33.75	35.38	36.50	37.25	0.128
Micronaire	5.34	5.35	4.60	4.63	0.930
Strength	30.063	31.500	32.338	31.738	0.178
Length	1.056	1.103	1.133	1.168	0.429
Uniformity	0.815	0.824	0.818	0.827	0.861

Acknowledgments

This research was funded through a grant by the Georgia Cotton Commission. Dudley Cook and the Stripling Irrigation Research Park technical staff provided field technical support for this project.

THE EFFECT OF PLANT SPACING ON YIELD ON LATE PLANTED COTTON IN COOK COUNTY, GEORGIA

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University of Georgia

Introduction

DPL 555 BG/RR was the most commonly grown cotton variety in Georgia during 2007. With the current price and profit potential for wheat, there are an increasing number of growers who are planting wheat. Many of those growers are considering late planted cotton behind wheat and other small grains. Since there is limited data relating to plant spacing effect on yields of late-planted full season varieties of cotton, the objective of this experiment was to determine any yield differences due to plant spacing.

Methods and Materials

In 2007 a field trial was conducted at the Lindsey Parrish Farm in Cook County. The experimental design was a randomized complete block design with 3 replications per treatment. The field was dryland cotton planted on May 24, 2007. However, seedlings did not emerge until June 6, 2007 due to extreme drought conditions at planting and lack of sufficient rainfall for germination until June 2, 2007. The cotton was planted at a seeding rate of 4 to 5 seed per foot and hand thinned on June 9, 2007 to achieve a final plant stand of 2.5 plants per foot, one plant per foot, one plant per 16 inches of row, and 2 plants per 14 inches of row to simulate the hill drop method. Each plot was 1 row wide and 20 feet in length. The row spacing was 38 inches. The cotton was handpicked on November 20, 2007 and weighed. Final lint cotton weights were determined using a 40% gin turnout for all treatments.

Results and Discussion

Average lint yields per treatment are provided in Table 1. Lint yield was significantly greater in the 2.5 plants per foot treatment compared with other treatments. No significant difference in yields was observed between the hill drop method and the final plant stand of one plant per foot. Yields from the final plant stand of one plant per 16 inches were significantly lower compared with the other treatments.

Results from this study suggest that low plant populations (1 per row foot or less) should be avoided on late planted full season varieties of cotton. However, it is worthy of mentioning that it was extremely dry in this particular area for several weeks after the cotton emerged. Adequate rainfall received during this study and differing environmental factors could impact the results.

Table 1. Average lint yields per treatment.

Treatment #	Treatment Name	Lint Yields
1	2.5 / ft.	1215.00 a
2	Hill Drop	1008.00 b
3	1 plant / ft.	973.67 b
4	1 plant / 16 in.	802.33 c

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

2007 COTTON VARIETY TRIALS

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Introduction

The 2007 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 714, January 2008.

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

2007 row crop season in Georgia can best be described as dry and hot for the second consecutive year. Beginning in April extreme to exceptional drought(a 100 year event) developed over two-thirds of the state. This area included all of Georgia north of the fall line and the western half of the Coastal Plain region. The only exception was the southeastern one-third of the state which received some beneficial rainfall from tropical storm Berry in early June.

During 2007, Cotton producers planted 1.04 million acres of cotton. This number of acres planted was a decrease of 26% less than 2006. The number of acres of harvested cotton was the lowest in 14 years and coupled with a four percent yield decrease, 1,650,000 bales were produced, a 30% reduction in yield from 2006.

Among varieties in the Dryland Earlier Maturity Trials, four varieties DP444BG/RR, DP455BG/RR, DP445BG/RR, and DynaGro CT07550, stand out as varieties with high yield and relative yield stability in the dryland trials (Table 1). There were 19 other varieties that performed above average(Table 1). When summarized over two years, DP 454 BG/RR, DP 445BG/RR, DP455BG/RR and PHY370WR, were the top performers (Table 2).

Among the best performing earlier maturing varieties produced under irrigation, DP454 BG/RR, ST4554B2RF, DP455BG/RR, ST4664RF, STX4678B2RF, PHY375WRF, PHY370WR, STX4596B2RF, DynaGro CT07550, and ST5327B2RF were the highest averaged over locations (Table 3). Twelve other varieties performed above average(Table 3). DP 454 BG/RR was the highest in yield when averaged over two years and locations in the Irrigated Early Maturity Trials conducted at Bainbridge, Midville, Plains, and Tifton; however, 10 other varieties yielded above average(Table 4).

Later maturity trials produced without irrigation also revealed the consistent performance of AM1550B2RF, DP445BG/RR, GA2004371, ST5599BR, GA2004392, DP455BG/RR, DP515BG/RR, ST5283RF, ST5327B2RF, DP555BG/RR, DP167RF, and STX06351B2RF (Table 5). Three other varieties performed above average(Table5). Averaged over locations and years, DP555BG/RR, DP454BG/RR, DP445BG/RR, DP515BG/RR, and ST5599BR were the front runners. But also yielding above average were three other varieties (Table 6).

Under irrigation, DP555 BG/RR, STX5458B2RF, DP515BG/RR, ST 5599BR, DP445BG/RR, and GA2004371 led the standard later maturing trials averaged over locations (Table 7), while 5 other varieties were above average in lint yield. Averaged over years and locations, DP555BG/RR was the best performer (Table 8) with another five varieties yielding above average, Stoneville's 5599BR (Table 8), a variety released in 2003, continues to show promise to help growers with root knot nematodes as it possesses some resistance to root knot.

The Earlier Maturity and Later Maturity Strains Trials portend improved varieties for crop seasons 2008 and beyond (Tables 9). Varieties from Bayer Cropscience FiberMax, and Georgia were high yielding performer among standard earlier maturing entries in the strains trial. In the Later Maturity group two lines from Georgia performed well.

Presented in Table 10 is the Tifton, Georgia, 2007 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 portend potentially higher yields and improved fiber packages available to Georgia growers.

Table 1. Yield Summary for Dryland Earlier Maturity Cotton Varieties, 2007

Entry	Athens	Midville	Plains	Tifton	4-Loc. Average	Lint	Unif. Index	Length	Strength	Mic.
	Lint Yield[a]									
	---------- lb/acre ----------					%	%	in	g/tex	units
DP 444 BG/RR	624 [7T]	**841** [2]	**862** [4]	**1675** [2]	**1001** [1]	45.3	81.6	1.08	28.4	3.9
DP 455 BG/RR	677 [2]	683 [8]	721 [15]	**1699** [1]	**945** [2T]	45.2	80.6	1.07	29.5	4.1
DP 445 BG/RR	624 [7T]	**719** [5]	792 [11]	**1644** [3]	**945** [2T]	44.5	82.2	1.09	29.8	4.2
DynaGro CT07550	570 [9]	654 [11]	**866** [3]	**1570** [5]	**915** [3]	44.2	82.1	1.07	29.2	4.3
DP 434 RR	547 [11]	599 [22T]	702 [17]	**1643** [4]	873 [4]	43.7	81.4	1.11	28.0	4.2
DP 454 BG/RR	658 [4]	**844** [1]	797 [9]	1187 [40]	872 [5]	45.8	81.8	1.06	27.6	4.0
FM1600LL	381 [43]	**815** [3]	830 [6]	1439 [17]	866 [6]	41.8	82.1	1.12	31.3	4.1
ST5283RF	674 [3]	**754** [4]	589 [38]	1434 [18T]	863 [7]	44.8	81.7	1.09	30.0	4.2
CG3035RF	651 [5]	648 [15]	779 [13]	1365 [26T]	861 [8]	44.3	81.9	1.07	28.9	4.2
ST5327B2RF	564 [10]	556 [31]	**908** [2]	1403 [21]	858 [9]	44.8	81.9	1.07	29.4	4.2
STX4678B2RF	498 [17]	694 [7]	794 [10]	1445 [16]	857 [10]	42.1	82.9	1.13	29.4	4.4
ST4427B2RF	480 [21]	495 [41]	**1058** [1]	1387 [23]	855 [11]	42.8	81.2	1.09	29.2	4.0
DP 121 RF	442 [31]	675 [9]	818 [8]	1416 [19]	838 [12]	44.6	81.9	1.09	29.4	4.5
CG3520B2RF	625 [6]	500 [40]	674 [25]	**1522** [8]	830 [13]	42.7	82.3	1.11	26.5	4.0
DynaGro 2520B2RF	**824** [1]	483 [42]	464 [45]	**1502** [10]	819 [14]	41.9	81.5	1.12	27.1	3.8
PHY375WRF	463 [26]	597 [23]	643 [30]	**1551** [6]	813 [15]	44.9	81.3	1.09	28.4	4.1
PHY370WR	520 [15]	584 [28]	775 [14]	1365 [26T]	811 [16]	43.9	81.7	1.06	29.2	4.3
ST 5242BR	470 [24]	614 [21]	700 [19]	1450 [15]	808 [17T]	43.9	81.8	1.05	27.6	4.1
STX4596B2RF	573 [8]	583 [29]	701 [18]	1376 [25]	808 [17T]	41.8	82.5	1.14	29.2	4.5
AM1532B2RF	542 [13]	471 [45]	700 [20]	**1515** [9]	807 [18T]	42.5	81.7	1.12	27.0	3.9
GA2004303	462 [27]	618 [20]	785 [12]	1361 [27]	807 [18T]	43.6	81.1	1.07	28.9	4.4
CG 3220B2RF	546 [12]	586 [27]	604 [35]	1458 [13]	798 [19]	41.9	82.1	1.11	28.6	4.2
PHY485WRF	486 [18]	666 [10]	680 [22]	1350 [30]	796 [20]	43.7	82.9	1.10	29.9	4.4
STX4498B2RF	539 [14]	621 [19]	687 [21T]	1334 [32]	795 [21]	43.4	81.9	1.08	30.7	4.1
FM1735LLB2	434 [32]	**718** [6]	580 [40]	1434 [18T]	791 [22T]	41.3	81.8	1.12	31.4	4.1
DP 393	501 [16]	650 [13]	602 [36]	1411 [20]	791 [22T]	43.3	82.2	1.11	29.5	4.3
PHY315RF	405 [39]	596 [24]	**860** [5]	1259 [38T]	780 [23]	45.0	80.9	1.08	28.0	4.1
FM9063B2F	402 [40]	599 [22T]	648 [29]	1454 [14]	776 [24]	42.0	81.4	1.13	30.4	3.9
ST 4554B2RF	423 [36]	641 [16]	653 [28]	1380 [24]	774 [25]	42.9	81.7	1.09	29.4	4.2
ST 4664RF	386 [41]	653 [12]	819 [7]	1236 [39]	773 [26]	43.1	81.6	1.07	29.7	4.2
PHY310R	461 [28]	591 [28]	668 [27]	1357 [28]	769 [27]	44.9	81.1	1.05	29.3	4.5
AM1504B2RF	354 [44]	507 [38]	716 [16]	1482 [11]	765 [28]	40.6	81.9	1.07	27.2	3.5
PHY425RF	473 [23T]	628 [18]	687 [21T]	1265 [37]	763 [29]	43.3	82.3	1.08	29.4	4.5
DP 432 RR	426 [33]	587 [29]	620 [32]	1399 [22]	758 [30]	43.3	82.2	1.07	29.0	4.2
FM955LLB2	384 [42]	638 [17]	435 [46]	**1537** [7]	749 [31]	40.2	81.7	1.14	29.3	4.4
ST 4357B2RF	474 [22]	479 [44]	557 [41]	1468 [12]	745 [32]	41.8	81.3	1.12	27.4	4.0
DP174RF	421 [37]	533 [33]	676 [24]	1276 [36]	727 [33]	46.2	81.5	1.10	28.1	4.6
DynaGro 2490B2RF	456 [29]	448 [46]	639 [31]	1356 [29]	725 [34]	40.0	81.3	1.06	27.3	3.3
PHY480WR	425 [34]	522 [35]	606 [34]	1327 [33]	720 [35]	42.7	82.5	1.10	29.5	4.4
CG3020B2RF	473 [23T]	480 [43]	542 [43]	1348 [31]	711 [36]	40.8	81.6	1.06	26.8	3.6

Table 1. (Continued) Yield Summary for Dryland Earlier Maturity Cotton Varieties, 2007

	Lint Yield[a]									
Entry	Athens	Midville	Plains	Tifton	4-Loc. Average	Lint	Unif. Index	Length	Strength	Mic.
	---------- lb/acre				----------	%	%	in	g/tex	units
DP161B2RF	481 [20]	510 [37]	553 [42]	1297 [34]	710 [37]	41.0	81.8	1.15	29.7	4.3
DP141B2RF	409 [38]	502 [39]	610 [33]	1291 [35]	703 [38]	42.3	80.6	1.12	29.7	4.2
DP 147 RF	465 [25]	649 [14]	595 [37]	1079 [43]	697 [39]	42.8	81.8	1.14	28.9	3.9
CG4020B2RF	424 [35]	517 [36]	584 [39]	1259 [38T]	696 [40]	42.0	80.9	1.10	26.5	3.9
DP 117 B2RF	444 [30]	545 [32]	679 [23]	1059 [44]	682 [41]	43.0	81.7	1.10	31.1	4.3
GA2004232	341 [45]	562 [30]	672 [26]	1104 [41]	670 [42]	45.2	81.7	1.13	30.7	4.3
DP 143 B2RF	484 [19]	527 [34]	532 [44]	1091 [42]	659 [43]	41.0	81.2	1.15	28.4	3.9
Average	497	604	691	1389	795	43.1	81.7	1.10	28.9	4.1
LSD 0.10	125	143	202	200	122	1.2	0.8	0.02	1.0	0.3
CV %	21.5	20.2	25.0	12.3	18.4	2.2	0.9	2.40	3.9	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 2. Two-Year Summary for Dryland Earlier Maturity Cotton Varieties at Four Locations[a], 2006-2007

Variety	Lint Yield	Lint	Uniformity Index	Length	Strength	Micronaire
	lb/acre	%	%	inches	g/tex	units
DP 454 BG/RR	**1095**	45.9	82.2	1.05	28.4	4.2
DP 445 BG/RR	**1062**	43.6	82.7	1.10	29.5	4.3
DP 455 BG/RR	**1062**	44.2	81.3	1.07	30.1	4.2
PHY370WR	**1041**	43.8	82.4	1.06	29.7	4.5
DP 444 BG/RR	1021	44.1	82.1	1.07	28.6	4.0
PHY485WRF	983	43.4	83.0	1.10	30.3	4.6
ST 5242BR	981	43.6	82.4	1.06	27.9	4.3
PHY310R	979	44.3	81.8	1.05	29.7	4.6
PHY480WR	977	42.1	83.1	1.11	30.1	4.6
PHY425RF	968	43.1	82.7	1.09	29.9	4.7
ST4427B2RF	961	42.3	81.9	1.09	29.7	4.3
DP 121 RF	948	43.9	82.4	1.09	29.8	4.7
DP 434 RR	942	42.9	81.9	1.11	28.1	4.5
FM9063B2F	937	41.8	82.3	1.15	31.0	4.1
DP 432 RR	932	42.3	82.6	1.07	29.0	4.4
DynaGro 2520B2	932	41.4	82.0	1.11	27.4	4.1
CG3520B2RF	928	42.1	82.4	1.10	26.4	4.2
DP 393	925	42.6	82.6	1.09	29.9	4.5
DP 117 B2RF	924	42.7	82.2	1.11	31.4	4.5
DP 143 B2RF	919	40.9	81.6	1.16	28.7	4.1
ST 4554B2RF	913	42.4	82.0	1.09	29.8	4.4
ST 4664RF	897	42.4	82.2	1.08	29.5	4.4
ST 4357B2RF	891	41.4	82.1	1.12	27.6	4.2
DP 147 RF	877	42.4	82.3	1.15	29.5	4.2
CG4020B2RF	855	41.5	81.6	1.10	27.0	4.2
CG3020B2RF	787	40.0	81.9	1.07	27.2	3.9
Average	951	42.7	82.2	1.09	29.1	4.3
LSD 0.10	68	0.4	0.4	0.02	0.8	0.2
CV %	17.3	2.3	0.9	2.40	4.4	5.9

[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, 2007, 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 454 BG/RR	**2399** [1]	1298 [31T]	**1840** [2]	**1947** [10]	**1871** [1]	45.5	82.4	1.11	29.6	4.2
ST 4554B2RF	2054 [15]	**1496** [3]	**1700** [3]	**2058** [3]	**1827** [2]	43.5	83.2	1.16	29.2	4.6
DP 455 BG/RR	2062 [14]	**1405** [17]	**1658** [5]	**2169** [1]	**1824** [3]	45.2	82.3	1.14	30.5	4.2
ST 4664RF	1845 [31]	**1430** [11]	**1845** [1]	**1991** [6]	**1778** [4]	44.1	82.6	1.13	29.9	4.5
STX4678B2RF	2095 [12]	**1421** [14T]	**1607** [7]	1926 [13]	**1762** [5]	41.5	83.7	1.18	29.8	4.6
PHY375WRF	2096 [11]	**1426** [12]	1325 [35]	**2168** [2]	**1754** [6]	45.2	83.3	1.17	30.0	4.3
PHY370WR	**2270** [2]	**1491** [4]	1385 [28]	1841 [22]	**1747** [7]	44.5	83.1	1.13	30.4	4.6
STX4596B2RF	2034 [17]	**1533** [1]	**1660** [4]	1656 [43]	**1721** [8]	41.6	83.6	1.21	30.2	4.6
DynaGro CT07550	**2228** [3]	**1391** [19]	1364 [30]	1895 [16]	**1720** [9]	44.0	83.5	1.16	28.9	4.7
ST5327B2RF	1884 [27]	**1436** [9]	**1600** [8]	1904 [15]	**1706** [10]	44.1	83.4	1.16	30.0	4.4
GA2004303	1968 [20]	1368 [24]	1523 [12]	1928 [11]	1697 [11]	44.0	82.9	1.14	31.2	4.7
DP161B2RF	2011 [18]	**1421** [14T]	1504 [15]	1840 [23]	1694 [12]	41.7	84.2	1.23	31.3	4.3
STX4498B2RF	1935 [22T]	**1481** [7]	1552 [11]	1792 [32]	1690 [13]	42.3	83.4	1.15	30.6	4.3
PHY315RF	1976 [19]	1358 [25]	1561 [10]	1862 [20]	1689 [14]	44.6	83.0	1.15	28.8	4.3
ST4427B2RF	1804 [35]	1371 [23]	**1609** [6]	**1959** [8]	1686 [15]	42.4	82.9	1.15	30.4	4.0
PHY425RF	**2225** [4]	**1390** [20]	1389 [26]	1714 [39]	1679 [16]	42.1	84.1	1.18	30.8	4.8
DP 434 RR	2094 [13]	1251 [36]	1454 [17]	1911 [14]	1677 [17]	43.1	83.2	1.19	28.3	4.4
DP174RF	2135 [7]	**1501** [2]	1509 [14]	1541 [46]	1672 [18]	46.3	83.6	1.18	28.7	4.6
FM1735LLB2	1841 [32]	**1453** [8]	1363 [31T]	**2010** [5]	1667 [19]	41.2	83.1	1.15	31.8	4.5
DP 445 BG/RR	1735 [42]	**1423** [13]	1386 [27]	**2042** [4]	1647 [20]	43.6	83.6	1.15	30.4	4.5
PHY485WRF	2127 [9]	1294 [32]	1398 [25]	1759 [37]	1645 [21]	42.5	83.9	1.17	30.6	4.7
PHY310R	1963 [21]	**1488** [6]	1231 [39]	1881 [17]	1641 [22]	45.7	83.3	1.12	30.0	4.6
DP 117 B2RF	2102 [10]	**1408** [16]	1402 [23T]	1617 [44]	1632 [23]	42.9	83.1	1.18	31.7	4.3
GA2004232	1847 [30]	**1385** [21]	1583 [9]	1676 [41]	1623 [24]	47.0	83.5	1.20	31.1	4.5
DP 444 BG/RR	1935 [22T]	1336 [28]	1402 [23T]	1809 [29]	1621 [25T]	44.2	83.4	1.15	29.4	4.3
PHY480WR	**2215** [5]	1181 [42]	1431 [19]	1658 [42]	1621 [25T]	41.5	84.1	1.17	30.4	4.6
DP 143 B2RF	2132 [8]	1304 [30]	1263 [38]	1776 [35]	1619 [26]	41.8	82.7	1.23	29.7	4.2
DP 121 RF	2048 [16]	1266 [34]	1357 [32]	1795 [31]	1616 [27]	44.0	83.6	1.16	30.1	4.7
DP141B2RF	2145 [6]	**1489** [5]	1065 [43]	1724 [38]	1606 [28]	41.6	82.9	1.23	30.2	4.3
ST5283RF	1740 [41]	**1417** [15]	1402 [23T]	1823 [27]	1596 [29]	44.1	83.3	1.16	31.0	4.4
FM1600LL	1848 [29]	**1432** [10]	1110 [42]	**1950** [9]	1585 [30]	41.9	83.5	1.17	32.5	4.5
DynaGro 2520B2RF	1920 [23]	1136 [45]	1427 [20]	1854 [21]	1584 [31]	41.9	83.3	1.19	27.7	4.3
AM1532B2RF	1905 [25]	1247 [37]	1363 [31T]	1816 [28]	1583 [32]	41.9	83.3	1.18	28.0	4.3
ST 5242BR	1910 [24]	**1392** [18]	1194 [40]	1825 [26]	1580 [33]	42.9	83.1	1.11	28.3	4.7
CG3520B2RF	1814 [33]	1184 [41]	1462 [16T]	1837 [24]	1574 [34]	42.4	83.3	1.18	27.2	4.2
AM1504B2RF	1680 [43]	1287 [33]	1445 [18]	1872 [18]	1571 [35]	41.4	83.4	1.13	28.4	4.1
CG3035RF	1806 [34]	1199 [40]	1347 [33]	1927 [12]	1570 [36]	43.2	83.4	1.15	29.5	4.4
ST 4357B2RF	1767 [39]	1255 [35]	1416 [22]	1834 [25]	1568 [37]	42.6	83.2	1.19	28.3	4.1
DP 432 RR	1890 [26]	1238 [38]	1344 [34]	1787 [33]	1565 [38]	42.6	83.8	1.15	29.8	4.5
DP 147 RF	1775 [37]	1309 [29]	1375 [29]	1782 [34]	1560 [39]	42.9	83.2	1.23	30.5	4.2

Table 3. (Continued) Yield Summary for Earlier Maturity Cotton Varieties, 2007, Irrigated.

	Lint Yield[a]									
Entry	Bainbridge	Midville	Plains	Tifton	4-Loc.	Lint	Unif.	Length	Strength	Mic.
	---------------------------- lb/acre				----------------------------	%	%	in	g/tex	units
DynaGro 2490B2RF	1775 [38]	1168 [43]	1400 [24]	1808 [30]	1538 [40]	40.8	82.9	1.13	28.3	3.7
CG4020B2RF	1802 [36]	1160 [44]	1462 [16T]	1709 [40]	1533 [41]	42.2	83.1	1.19	27.7	4.1
DP 393	1750 [40]	1223 [39]	1285 [36]	1866 [19]	1531 [42]	42.7	84.3	1.19	30.5	4.7
CG 3220B2RF	1867 [28]	1298 [31T]	1423 [21]	1498 [47]	1522 [43]	41.9	83.7	1.18	29.1	4.6
FM9063B2F	1654 [44]	1354 [26]	1274 [37]	1768 [36]	1513 [44]	41.3	83.2	1.21	31.1	4.2
FM955LLB2	1418 [46]	**1379** [22]	1176 [41]	**1974** [7]	1487 [45]	39.7	83.5	1.21	30.7	4.6
CG3020B2RF	1440 [45]	1347 [27]	1511 [13]	1572 [45]	1467 [46]	40.4	83.4	1.14	27.9	4.0
Average	1935	1351	1434	1837	1639	42.9	83.3	1.17	29.8	4.4
LSD 0.10	228	157	255	230	173	1.1	0.6	0.02	0.7	0.2
CV %	10.1	9.9	15.2	10.7	11.5	2.2	0.8	1.59	2.8	4.9

[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], 2006-2007, Irrigated

Variety	Lint Yield	Lint	Uniformity Index	Length	Strength	Micronaire
	lb/acre	%	%	inches	g/tex	units
DP 454 BG/RR	**1840**	45.3	83.0	1.12	29.5	4.2
PHY370WR	1696	43.7	83.4	1.12	30.4	4.7
DP 455 BG/RR	1695	44.4	82.3	1.13	30.8	4.3
ST4427B2RF	1671	42.0	83.1	1.14	30.2	4.3
PHY425RF	1635	42.0	84.4	1.17	31.1	4.8
ST 4554B2RF	1635	42.3	83.3	1.14	29.2	4.7
PHY485WRF	1616	42.4	84.1	1.16	30.5	4.8
PHY480WR	1607	41.7	84.3	1.17	30.4	4.7
ST 4664RF	1596	43.1	82.8	1.12	29.5	4.7
PHY310R	1576	44.7	83.4	1.11	30.2	4.7
DP 117 B2RF	1567	42.5	83.6	1.17	32.2	4.4
DP 143 B2RF	1558	41.4	82.8	1.22	28.9	4.2
DP 434 RR	1538	42.4	83.6	1.17	27.7	4.4
DP 444 BG/RR	1535	43.4	83.4	1.13	29.3	4.3
DP 393	1521	42.1	84.2	1.17	30.4	4.7
DynaGro 2520B2RF	1521	41.2	83.4	1.17	27.9	4.4
ST 5242BR	1503	43.1	83.3	1.11	28.0	4.5
DP 147 RF	1501	42.0	83.4	1.22	31.0	4.2
DP 445 BG/RR	1501	43.0	83.7	1.14	29.9	4.6
DP 121 RF	1485	43.6	84.0	1.15	30.0	4.7
CG4020B2RF	1484	41.6	83.5	1.18	27.6	4.3
ST 4357B2RF	1480	41.6	83.5	1.17	28.0	4.3
CG3520B2RF	1475	41.4	83.5	1.16	26.7	4.4
FM9063B2F	1470	40.8	83.7	1.22	31.3	4.2
DP 432 RR	1465	42.7	83.8	1.14	29.7	4.7
CG3020B2RF	1382	39.5	83.4	1.12	27.6	4.2
Average	1560	42.5	83.5	1.16	29.5	4.5
LSD 0.10	79	0.4	0.4	0.01	0.5	0.2
CV %	12.3	2.2	0.8	1.64	3.0	5.3

[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, 2007

	Lint Yield[a]									
Entry	Athens	Midville	Plains	Tifton	4-Loc. Average	Lint	Unif. Index	Length	Strength	Mic.
	lb/acre					%	%	in	g/tex	units
AM1550B2RF	**559** [1]	**559** [8]	**659** [12T]	**1841** [1]	**904** [1]	43.9	81.1	1.06	26.4	4.2
DP 445 BG/RR	**494** [12]	**612** [4T]	**695** [9]	**1807** [2]	**902** [2]	44.5	82.3	1.11	29.6	4.1
GA2004371	**531** [3]	**601** [5]	**718** [6]	**1739** [3]	**897** [3]	46.0	82.3	1.08	29.3	4.8
ST 5599BR	**549** [2]	**623** [2]	**696** [8]	1676 [4]	**886** [4]	43.2	80.9	1.06	29.0	4.3
GA2004392	**500** [7]	**640** [1]	**854** [1]	1434 [16]	**857** [5]	43.1	82.0	1.07	30.9	4.9
DP 455 BG/RR	**496** [11T]	**577** [7]	**637** [15]	1668 [5]	**844** [6]	45.1	80.5	1.07	28.8	3.9
DP 515 BG/RR	**496** [11T]	469 [21]	**815** [2]	1518 [10]	**824** [7]	44.1	81.0	1.06	28.7	4.4
ST5283RF	**499** [8]	471 [20]	**795** [3]	1473 [14]	**810** [8]	45.2	81.9	1.07	29.7	4.1
ST5327B2RF	**506** [6]	517 [14]	**673** [11]	1541 [8]	**809** [9]	44.9	82.2	1.08	29.7	4.2
DP 555 BG/RR	**497** [10]	518 [13]	**698** [7]	1503 [11]	**804** [10]	44.3	80.4	1.07	28.5	4.4
DP 167 RF	434 [14]	**537** [11]	**658** [13]	1579 [7]	**802** [11]	41.8	81.0	1.11	29.1	4.2
STX06351B2RF	**515** [4]	**621** [3]	545 [19]	1524 [9]	**801** [12]	40.5	81.5	1.11	27.9	4.0
DP 493	366 [21]	519 [12]	**652** [14]	1597 [6]	783 [13]	44.9	81.2	1.08	30.7	4.7
DP 454 BG/RR	**498** [9]	**612** [4T]	**693** [10]	1320 [22]	781 [14]	44.6	81.4	1.06	28.1	3.7
STX5458B2RF	**496** [11T]	504 [17]	**659** [12T]	1442 [15]	775 [15]	43.1	81.0	1.08	29.0	4.4
GA2004356	418 [16]	**594** [6]	**626** [16]	1425 [17]	766 [16]	44.5	82.3	1.11	30.4	4.4
DP 147 RF	412 [18]	**540** [10]	**720** [5]	1304 [25]	744 [17]	42.5	80.9	1.13	29.4	3.9
DP 164 B2RF	**507** [5]	512 [15]	440 [23]	1502 [12]	740 [18]	41.6	81.2	1.12	28.5	4.3
DP161B2RF	446 [13]	**543** [9]	452 [21]	1484 [13]	731 [19]	41.8	81.5	1.14	29.9	4.3
DP174RF	358 [23]	511 [16]	570 [18]	1419 [18]	715 [20]	45.9	81.3	1.11	27.8	4.3
DP 143 B2RF	417 [17]	493 [18]	**600** [17]	1331 [20]	710 [21]	41.3	81.3	1.15	28.3	3.9
PHY745WRF	432 [15]	388 [24]	**775** [4]	1142 [26]	684 [22]	43.0	81.5	1.08	30.1	3.8
ST 6622RF	406 [19]	479 [19]	527 [20]	1318 [23]	683 [23]	41.1	81.9	1.11	30.7	4.2
ST 6611B2RF	345 [24]	401 [23]	438 [24]	1364 [19]	637 [24]	40.1	81.5	1.08	29.7	4.1
FM1880B2F	363 [22]	373 [25]	448 [22]	1314 [24]	625 [25]	41.0	80.8	1.10	30.3	3.8
DP141B2RF	388 [20]	451 [22]	305 [25]	1328 [21]	618 [26]	42.0	81.0	1.12	29.1	4.2
Average	459	526	629	1484	774	43.2	81.4	1.09	29.2	4.2
LSD 0.10	70	112	275	141	112	1.1	0.7	0.02	1.0	0.2
CV %	12.9	18.1	18.2	8.1	15.9	2.0	1.1	1.98	3.6	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 6. Two-Year Summary for Dryland Later Maturity Cotton Varieties at Four Locations[a], 2006-2007

Variety	Lint Yield	Lint	Uniformity Index	Length	Strength	Micronaire
	lb/acre	%	%	inches	g/tex	units
DP 555 BG/RR	**1029**	44.3	81.5	1.09	29.0	4.6
DP 454 BG/RR	**1026**	45.0	82.0	1.06	28.7	3.9
DP 445 BG/RR	**1007**	43.8	82.8	1.10	29.4	4.3
DP 515 BG/RR	**1004**	43.3	81.8	1.09	29.5	4.5
ST 5599BR	**978**	43.4	81.7	1.08	30.3	4.6
DP 493	971	44.4	81.9	1.10	30.6	4.7
DP 455 BG/RR	959	44.7	81.2	1.07	29.3	4.1
DP 167 RF	940	40.8	82.1	1.12	29.2	4.3
DP 147 RF	902	42.5	81.8	1.14	29.5	4.1
DP 143 B2RF	886	41.2	81.8	1.16	28.4	4.1
DP 164 B2RF	872	41.0	81.9	1.12	29.1	4.4
ST 6622RF	853	40.6	82.1	1.10	31.0	4.3
PHY745WRF	838	42.6	82.5	1.10	30.8	4.1
ST 6611B2RF	799	39.0	81.9	1.08	30.0	4.3
Average	933	42.6	81.9	1.10	29.6	4.3
LSD 0.10	57	0.4	0.5	0.02	0.7	0.2
CV %	14.8	2.0	1.0	2.24	4.1	5.9

[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, 2007, 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	**2250** [1]	**1400** [5]	**1625** [2]	**2026** [4]	**1825** [1]	44.5	82.7	1.16	29.8	4.6
STX5458B2RF	**2080** [3]	**1532** [1]	**1531** [5]	**1955** [5]	**1775** [2]	43.3	83.1	1.18	31.2	4.7
DP 515 BG/RR	**2074** [4]	1277 [14]	**1710** [1]	**1920** [6]	**1745** [3]	43.6	83.0	1.15	30.1	4.6
ST 5599BR	**2098** [2]	**1529** [2]	1414 [8]	1821 [10]	**1715** [4]	42.9	82.3	1.13	30.9	4.8
DP 445 BG/RR	1765 [16]	1342 [10]	**1622** [3]	**2063** [3]	**1698** [5]	43.7	84.0	1.17	30.3	4.5
GA2004371	2044 [5]	**1480** [3]	1371 [10]	1825 [9]	**1680** [6]	45.6	83.6	1.15	30.6	4.8
DP 454 BG/RR	2038 [6]	1165 [24]	1386 [9]	**2093** [1]	1670 [7]	46.9	82.8	1.13	29.8	4.0
GA2004392	1914 [9]	**1391** [6]	**1543** [4]	1752 [15]	1650 [8]	41.5	84.6	1.18	31.5	5.0
DP 455 BG/RR	1839 [12]	1308 [13]	1278 [13]	**2083** [2]	1627 [9]	45.4	82.2	1.15	31.5	4.1
DP174RF	1903 [10]	**1377** [7]	**1446** [7]	1778 [13]	1626 [10]	46.3	83.5	1.19	28.5	4.6
DP161B2RF	1951 [7]	1268 [16]	1351 [11]	**1910** [7]	1620 [11]	41.3	84.2	1.23	31.1	4.4
GA2004356	1880 [11]	1347 [9]	1180 [17]	1764 [14]	1543 [12]	44.2	84.0	1.18	31.8	4.8
ST 6611B2RF	1920 [8]	1273 [15]	1048 [23]	**1881** [8]	1530 [13]	40.1	82.7	1.14	31.4	4.5
AM1550B2RF	1620 [21]	1111 [25]	**1514** [6]	1806 [12]	1513 [14]	42.4	82.7	1.15	28.0	4.3
ST5327B2RF	1745 [18]	1211 [20]	1327 [12]	1687 [18]	1492 [15]	43.8	83.1	1.14	30.6	4.4
DP 143 B2RF	1796 [14]	1251 [17]	1232 [14]	1679 [19]	1490 [16]	41.1	82.4	1.23	28.7	4.0
DP 164 B2RF	1790 [15]	1223 [19]	1053 [22]	1814 [11]	1470 [17]	40.8	82.8	1.20	30.0	4.3
DP 147 RF	1688 [19]	1355 [8]	1218 [15]	1568 [25]	1457 [18]	42.3	83.4	1.23	30.5	4.2
DP 493	1761 [17]	1322 [11]	1022 [24]	1650 [21]	1439 [19]	45.0	82.8	1.16	31.2	4.8
DP 167 RF	1553 [24]	**1407** [4]	1195 [16]	1581 [24]	1434 [20]	41.3	83.2	1.20	29.9	4.4
DP141B2RF	1834 [13]	1176 [23]	962 [25]	1720 [16]	1423 [21T]	40.9	83.6	1.24	30.4	4.1
STX06351B2RF	1663 [20]	1318 [12]	1082 [21]	1628 [22]	1423 [21T]	40.7	83.2	1.19	29.7	4.4
ST5283RF	1612 [22]	1240 [18]	1116 [20]	1709 [17]	1419 [22]	43.3	83.5	1.16	30.4	4.4
ST 6622RF	1600 [23]	1198 [21]	1163 [18]	1601 [23]	1391 [23]	42.1	83.5	1.17	31.6	4.5
FM1880B2F	1459 [25]	1188 [22]	1138 [19]	1651 [20]	1359 [24]	41.0	82.9	1.19	30.3	3.9
PHY745WRF	1096 [26]	1010 [26]	951 [26]	1352 [26]	1102 [25]	42.7	83.8	1.19	31.0	4.1
Average	1807	1296	1288	1781	1543	42.9	83.2	1.18	30.4	4.4
LSD 0.10	192	168	275	213	154	1.3	0.7	0.02	0.7	0.2
CV %	9.0	11.0	18.2	10.1	11.9	2.7	0.9	2.01	2.8	5.2

[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], 2006-2007, Irrigated

Variety	Lint Yield	Lint	Uniformity Index	Length	Strength	Micronaire
	lb/acre	%	%	inches	g/tex	units
DP 555 BG/RR	**1965**	44.0	82.9	1.16	29.8	4.6
DP 515 BG/RR	1831	43.1	83.0	1.15	30.1	4.6
DP 454 BG/RR	1776	45.7	83.1	1.12	29.3	4.1
ST 5599BR	1683	43.0	82.7	1.14	30.8	4.8
DP 493	1674	45.4	83.2	1.16	30.6	4.7
DP 455 BG/RR	1638	44.6	82.3	1.14	30.8	4.2
DP 143 B2RF	1584	40.8	82.6	1.23	28.4	4.1
ST 6611B2RF	1557	39.2	82.8	1.14	31.2	4.6
DP 445 BG/RR	1538	42.6	83.7	1.15	29.4	4.6
DP 164 B2RF	1533	40.4	83.2	1.19	29.5	4.5
DP 147 RF	1493	42.2	83.4	1.22	30.0	4.2
DP 167 RF	1452	40.4	83.6	1.18	30.0	4.4
ST 6622RF	1422	41.2	83.7	1.15	30.9	4.5
PHY745WRF	1247	42.2	83.8	1.18	30.9	4.2
Average	1600	42.5	83.1	1.16	30.1	4.4
LSD 0.10	80	0.5	0.4	0.01	0.5	0.2
CV %	12.2	2.7	0.9	2.02	3.1	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 9. Yield Summary for Cotton Strains, 2007, Irrigated

	Lint Yield[a]								
Variety	Midville	Plains	Tifton	3-Loc. Average	Lint	Unif. Index	Length	Strength	Mic.
	---------- lb/acre ----------				%	%	inches	g/tex	units
Earlier Maturity									
FMX4366B2F	**1498** [4]	**1165** [4]	**1977** [3]	**1547** [3]	44.5	84.0	1.18	31.3	4.2
GA2004143	**1571** [2]	**1210** [3]	1857 [6]	**1546** [4]	48.8	83.8	1.19	31.4	4.7
GA2004230	**1459** [9]	**1216** [2]	1896 [5]	**1523** [5]	43.9	84.4	1.25	31.1	4.7
FMX4327B2F	**1388** [8]	978 [8]	1914 [4]	1427 [6]	44.3	82.7	1.18	32.3	4.4
GA2004089	**1436** [7]	951 [9]	1755 [7]	1380 [7]	46.3	84.7	1.23	30.7	4.6
FMX4330B2F	**1543** [3]	984 [7]	1477 [9]	1335 [8]	46.1	83.7	1.17	33.4	4.3
Average	*1482*	*1084*	*1813*	*1460*	*45.5*	*83.9*	*1.20*	*31.7*	*4.5*
Later Maturity									
GA2004137	**1637** [1]	**1245** [1]	**2007** [2]	**1630** [1]	46.8	83.5	1.18	31.1	4.8
GA2004358	**1470** [5]	**1117** [5]	**2188** [1]	**1592** [2]	46.0	83.0	1.16	30.5	4.8
GA2004236	**1191** [9]	**1077** [6]	1504 [8]	1258 [9]	46.0	83.0	1.17	29.0	4.7
Average	*1433*	*1146*	*1900*	*1493*	*46.3*	*83.2*	*1.17*	*30.2*	*4.8*
Overall summary averages and statistics:									
Average	1466	1105	1842	1471	45.8	83.6	1.19	31.2	4.6
LSD 0.10	N.S.[b]	177	224	187	1.4	0.8	0.02	1.1	0.2
CV %	13.7	13.2	10.0	12.1	1.6	1.1	1.93	2.3	4.0

[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 10. Later Maturity Cotton Variety Performance including Micro-Gin[a] Quality Data, 2007, Irrigated, Tifton, Georgia

		MG[a]		MG[a]	Unif.	MG[a]		MG[a]		MG[a]		MG[a]
Variety	Lint Yield	Lint Yield	Lint	Lint	Index[b]	Unif.	Length[b]	Length	Strength[b]	Strength	Mic.[b]	Mic.
	lb/acre	lb/acre	%	%	%	%	inches	inches	g/tex	g/tex	units	units
AM1550B2RF	1806	1609	46.3	41.9	81.2	80.7	1.10	1.07	26.6	22.7	4.5	4.7
DP 143 B2RF	1679	1429	44.0	38.2	81.7	79.5	1.21	1.16	27.6	25.2	4.0	4.1
DP 147 RF	1568	1336	45.8	40.0	83.0	80.0	1.20	1.15	28.7	25.9	4.0	4.1
DP 164 B2RF	1814	1627	42.9	39.2	82.4	81.0	1.19	1.15	28.7	27.3	4.2	4.7
DP 167 RF	1581	1410	43.3	39.4	82.5	81.1	1.16	1.15	29.8	27.2	4.2	4.5
DP 445 BG/RR	**2063**	**1748**	46.3	40.3	84.6	81.4	1.17	1.12	29.3	26.0	4.2	4.5
DP 454 BG/RR	**2093**	1522	55.2	41.0	82.6	80.6	1.12	1.05	29.4	26.4	3.9	4.0
DP 455 BG/RR	**2083**	**1721**	49.5	42.1	81.7	80.1	1.13	1.10	29.3	28.7	4.0	4.1
DP 493	1650	1453	47.7	42.3	82.1	80.4	1.13	1.05	30.6	28.3	4.7	4.8
DP 515 BG/RR	**1920**	**1664**	46.1	40.6	82.8	80.5	1.13	1.10	29.1	26.7	4.3	4.5
								1.10				
DP 555 BG/RR	**2026**	**1806**	46.8	42.1	82.1	80.2	1.14	1.15	28.5	27.3	4.5	4.5
DP141B2RF	1720	1450	44.5	38.1	82.8	79.9	1.19	1.18	28.9	27.3	4.2	4.3
DP161B2RF	**1910**	1442	42.9	38.5	84.6	81.7	1.22	1.12	30.1	29.0	4.1	4.5
DP174RF	1778	1550	48.3	42.7	83.5	80.5	1.17	1.14	26.8	23.4	4.4	4.5
FM1880B2F	1651	1438	43.5	38.4	82.2	80.0	1.19	1.10	29.0	28.4	3.7	3.9
								1.13				
GA2004356	1764	1572	46.6	42.0	83.5	81.2	1.16	1.08	31.3	29.0	4.5	4.6
GA2004371	1825	1634	48.1	43.6	83.2	81.0	1.11	1.10	29.7	26.6	5.0	5.0
GA2004392	1752	1531	43.6	38.8	83.8	82.0	1.18	1.11	31.6	28.6	4.6	5.0
PHY745WRF	1352	1136	45.2	38.2	83.1	81.3	1.14	1.08	29.5	29.5	3.9	4.2
ST 5599BR	1821	**1654**	44.3	41.0	81.8	80.1	1.12	1.10	29.4	27.5	4.6	4.7
ST 6611B2RF	**1881**	1574	44.0	37.8	81.8	80.7	1.12	1.12	30.3	28.0	4.5	4.6
ST 6622RF	1601	1361	44.8	39.4	83.1	81.3	1.15	1.12	29.9	29.6	4.4	4.5
ST5283RF	1709	1449	46.3	40.4	83.8	81.1	1.16	1.10	29.1	27.9	4.1	4.4
ST5327B2RF	1687	1427	46.6	40.5	84.1	81.5	1.14	1.09	29.6	28.4	4.3	4.6
STX06351B2RF	1628	1411	42.4	37.8	83.7	80.8	1.19	1.12	28.2	26.6	3.9	4.3
STX5458B2RF	**1955**	**1735**	44.7	40.2	82.7	80.2	1.16	1.09	30.7	27.7	4.4	5.0
Average	1781	1526	45.8	40.2	82.8	80.7	1.15	1.11	29.3	27.3	4.3	4.5
LSD 0.10	213	168	2.2	0.9	1.3	0.5	0.04	0.02	2.0	1.3	0.3	0.2
CV %	10.1	9.3	4.1	2.0	0.9	0.5	1.91	1.44	4.1	3.9	4.7	3.3

a. Micro-Gin quality samples are from total seed cotton harvested from each plot.
b. A random quality sample was taken on the picker during cotton harvest.
Bolding indicates entries not significantly different from highest yielding entry based on Fisher's protected LSD (P = 0.10).

Planted: April 23, 2007.
Harvested: September 19, 2006.
Soil Type: Tifton sandy loam.
Fertilization: 78 lb N, 54 lb P_2O_5, and 168 lb K_2O/acre.
Management: Temik 15G applied 5 lb/acre and Telone II applied 3 gal/acre.

	May	June	July	Aug.	Sept.
Irrigation (in):	2.25	1.80	2.10	2.00	0.0

Trials conducted by Larry Thompson.

2007 BEN HILL, IRWIN, and PULASKI COUNTY COTTON VARIETY TRIAL

Steve Brown UGA Extension Cotton Specialist
Ronnie Barrentine County Agent Pulaski County
Scott Carlson County Agent Ben Hill County
Phillip Edwards County Agent Irwin County
Ken Lewis, Southwest District Coordinator

Introduction

A multi-county large plot variety trial was initiated in 2007 in Ben Hill, Irwin and Pulaski County. Seed was requested from area seed representatives, farmer cooperators were located and plans finalized. Due to the drought conditions the plot was not conducted in the dry land plot in Irwin County. The two other trials in Ben Hill and Pulaski featured 12 stacked cotton varieties. The varieties included: CG 3020 B2RF, CG 3520 B2RF, CG 4020 B2RF, DP 117 B2RF, DP143 B2RF, DP 515 BG/RR, DP 555 BG/RR, FM 064330 B2F, FM 1880 B2F, PHY 370 WR, PHY 480 WR, and PHY 485 WRF. The Pulaski County Trial was planting on May 20, 2007 and harvested on November 15, 2007. The Ben Hill County Trial was planted on June 15, 2008 and harvested on November 21, 2007 (replications 1 and 2) and November 28, 2007 (replication 3). Many of these varieties were duplicated from the previous variety trials conducted across the state in 2005, and 2006. A large body of information has been gathered on these varieties and this trial adds to that base of information.

Materials and Methods

Both trials were identical in planting design and replicated three times. Both trials were established under strip till conditions. Each trial was maintained in similar fashion across all replications. At harvest of each replication the seed cotton was weighed and samples taken. Those samples were ginned at the UGA Micro Gin facility in Tifton.

Results and Discussion

A combined analysis of yield and quality are listed in Table 1. Data from the Ben Hill and Pulaski trial are shown in Tables 2 and 3 respectfully.

Conclusions

The trials were a good success in 2007. The trials allow agents and growers a closer look at these 12 varieties and their comparison to DP 555 BG/RR, which has become a the cotton cultivar for Georgia.

Table 1. Ben Hill and Pulaski County combined variety data 2007; Strip-tillage large cotton variety trial.

Variety	Lint lb/A
DP 555 BG/RR	1439.62 a
DP 515 BG/RR	1455.92 a
DP 117 B2RF	1284.05 b
PHY 485 WRF	1284.03 b
PHY 370 WR	1280.15 b
FM 064330 B2F	1247.90 bc
PHY 480 WR	1241.47 bc
FM 1880 B2F	1150.05 bcd
DP 143 B2RF	1114.18 cd
CG 4020 B2RF	1085.77 d
CG 3020 B2RF	1032.62 d
CG 3520 B2RF	1010.90 d

Table 2 Ben Hill county 2007 – Dryland strip-tillage large plot cotton variety trial.							
Variety	**Lint lb/A**	**Turnout %**	**Seed Cotton lb/A**	**Micronaire**	**Length**	**Uniformity**	**Strength**
DP 555 BG/RR	1195.7 a	0.3802 a	3141.3	3.5	1.16 de	81.23 d	30.13 cd
DP 515 BG/RR	1187.7 a	0.3582 cd	3323.2	3.6	1.17 d	82.70 c	31.80 bc
PHY 485 WRF	1177.2 ab	0.3549 d	3301.0	4.0	1.20 bc	83.73 ab	31.57 bc
PHY 480 WR	1173.3 ab	0.3599 cd	3253.4	3.9	1.19 cd	83.63 abc	31.83 abc
PHY 370 WR	1139.1 ab	0.3666 bc	3097.2	3.9	1.12 f	83.03 bc	29.03 de
DP 117 B2RF	1107.3 ab	0.3624 cd	3058.4	3.7	1.18 cd	82.70 c	33.80 a
FM 064330 B2F	1057.2 abc	0.3754 ab	2835.3	3.3	1.22 ab	84.13 a	32.67 ab
CG 4020 B2RF	1028.37 bc	0.3431 e	2992.7	3.9	1.18 cd	83.73 ab	29.57 de
FM 1880 B2F	947.23 c	0.3376 e	2775.5	3.1	1.18 cd	81.13 d	30.13 cd
CG 3520 B2RF	915.7 c	0.3252 fg	2818.1	3.6	1.17 d	82.70 c	27.73 e
DP 143 B2RF	910.1 c	0.3330 ef	2730.7	3.3	1.23 a	80.77 d	30.20 cd
CG 3020 B2RF	908.8 c	0.3172 g	2847.3	3.4	1.14 ef	82.80 bc	28.43 de

Agent Scott Carlson and Phillip Edwards

Grower Kyle and Kent Phillips

Planted 15-Jun-07

Harvested 21-Nov-07 and 28-Nov-07

Table 3 Pulaski County 2007 irrigated strip-tillage large plot cotton variety trial.							
			Seed				
Variety	**Lint/A**	**Turnout %**	**Cotton/A**	**Micronaire**	**Length**	**Uniformity**	**Strength**
DP 515 BG/RR	1715.5 a	0.3703	4632.6	4.6	1.12	80.5	28.4
DP 555 BG/RR	1684.1 ab	0.3823	4405.2	4.4	1.14	83.5	29.1
DP 117 B2RF	1460.9 bc	0.3605	4052.5	4.1	1.14	81.8	32.2
FM 064330 B2F	1439.5 c	0.3677	3914.9	3.8	1.18	83.5	33.7
PHY 370 WR	1420.0 c	0.3660	3879.9	4.2	1.12	81.8	30.4
PHY 485 WRF	1390.8 c	0.3504	3969.3	4.6	1.15	82.9	29.8
FM 1880 B2F	1334.7 cd	0.3355	3978.3	3.8	1.16	81.4	31.2
DP 143 B2RF	1317.6 cde	0.3464	3803.7	4.0	1.19	80.9	30.2
PHY 480 WR	1288.8 cde	0.3464	3720.5	4.2	1.15	83.7	31.7
CG 3020 B2RF	1156.2 de	0.3233	3576.1	3.6	1.11	82.4	26.8
CG 4020 B2RF	1140.8 de	0.3316	3440.3	3.9	1.18	82.5	29.1
CG 3520 B2RF	1105.8 e	0.3344	3306.8	3.9	1.12	82.9	27.4

Agent Ronnie Barentine

Grower Alfred & Mike Carr

Planted 5-20-07

Harvested 11-15-07

BREEDING CULTIVARS AND GERMPLASM WITH ENHANCED YIELD AND QUALITY, 2007

Edward L. Lubbers, Stephen Walker, and Peng W. Chee
Dept. of Crop & Soil Science, University of Georgia, Tifton, GA

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 2007 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. Forty-five F_2-bulk populations from F_1 crosses made in 2006 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 2006, 10 were advanced in 2007 to F_3 for single plant selection. F_3 plants with lint fractions less than 39% were discarded and then further selected on the basis of HVI fiber properties. Five hundred and five F_3 plants selected in 2006 were advanced to F_4 progeny rows in Plains, GA, in 2007 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 severely damaged by hail at about the 5th true leaf stage in June; no plant escaped having the terminal meristem broken off of the plant. However, almost no plants were killed and the decision was made to disregard any potential, immeasurable interaction effect with the hail damage. 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 2008. The 2007 PTs were conducted at the William Gibbs Research Farm, UGA–Tifton campus, Tifton, GA in fields 04210, 04211, 04212, and 04213. Each PT had 18 F_5 breeding lines and 2 commercial conventional checks (FiberMax FM 966 and Deltapine DP 147RF) in a three replicate, randomized complete block designs for a total of 108 experimental entries. The F_6 Advanced Trials were conducted at the University of

Georgia – Tifton campus, Tifton, GA (AT1 at the William Gibbs Research Farm, fields 04211 and 04213) and Southwest Georgia Research and Education Center, Plains, GA (AT 1 and AT 2 in field 62). The ATs each consisted of 27 experimental entries and three checks (FiberMax FM 966, Deltapine DP 491, and Deltapine DP 147RF) planted in a three replicate, randomized complete block design for a total of 54 F_6 breeding lines tested. Prior to machine harvest of all trials except the F2 and F4 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 Cotton Program Macon Classing Office in Macon, GA for HVI analysis. The elite (material $> F_7$) germplasm lines with high potential were tested in the 2007 University of Georgia Strains (UGA) Tests and Official Variety Trials (Day and Thompson, 2008)

Results and Discussion

Of the six elite lines that were advanced to the UGA Strains Trials for the 2007 season (Day and Thompson, 2008), the 4 top lines over locations were selected based on lint yield and acceptability of fiber traits to be advanced to the 2008 UGA Official Variety Trials (OVTs) for further testing. They are GA 2004137, GA 2004143, GA 2004230, and GA 2004358. These lines will be joining GA 2004303, GA 2004371, and GA 2004392 which tested well enough to continue to compete in the GA OVTs.

The ATs revealed a number of promising lines with acceptable fiber quality packages that had lint yields that exceeded those of the checks (Table 1 & 2). The coefficients of variance for the ATs were between 9.98% and 8.89% thus indicating that the tests were managed well. The good coefficients of variance in the AT tests in Plains also supported the decision to not discard these tests which were damaged by hail at the same time as the F_4 test but not as severely. This year the research material was divided into the two AT tests by putting the lines that were improved yielders with adequate fiber quality into AT1 and the lines that had enhanced fiber quality with adequate yield into AT2. A perusal of Tables 1 and 2 indicate that the lines generally performed as expected in this regard but obviously there were specific lines that did not continue to follow the criteria that were used to place them. The ATs continue to show a lot of variability between Plains and Tifton that were noticed in previous years and this indicates the necessity of using both locations. Only two lines, GA 2006168 and GA 2006127, were not significantly different from the best yielding line in Plains and of those two only GA 2006127 was not significantly different from the best yielder in Tifton. The micronaire in both locations, but particularly the Plains location, was generally higher than normal as seen from the performance of the checks. In the AT2, GA 2006128 was the best yielder with a micronaire that compared adequately to these checks. Of the 8 lines that were not significantly different from the best yielder in their respective tests, only 6 (GA 2006093, GA 2006109, GA 2006106, GA 2006053, GA 2006127, and GA 2006168) were either considered to have from excellent to adequate fiber quality with high yield or acceptably high yield that was worth further testing. Five of these six lines (GA 2006109, GA 2006106, GA 2006053, GA 2006127, and GA 2006168) along with GA 2006128 were advanced to the 2008 UGA Strains Trials. GA 2004093 was not advanced because a harvesting error led to an inadequate seed supply.

Information from the 2006 PTs was used to select lines for further testing in 2007 (Tables 3, 4, and 5). Forty lines were selected for testing in the 2007 ATs based primarily on lint yield with acceptable fiber quality secondary for the AT1 or based primarily on excellent fiber quality with acceptable yield performance secondary for the AT2. The lines will be separated as needed to fit the lines into each test due to the constraints of field sizes. This separation of selection criteria will continued to be used to bring additional material forward with excellent fiber quality.

Based chiefly on lint yield comparisons, 143 F_4 progenies were sent for fiber testing to Cotton Incorporated for further selection for the 2008 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 were made in the summer of 2007 and the seed was 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.

Acknowledgments

The authors thank the Georgia Commodity Commission for Cotton for funding this research (Project Number 00-860GA CY 2003), Cotton Incorporated for providing HVI fiber analysis and seed production in Arizona under Core Funded Project 03-404, Don Day, Larry Thompson, and staff for conducting the University of Georgia Official Variety Trials, Stan Jones and Ronnie Pines at Southwest Georgia Branch Experiment Station, Plains, GA, and Gordon Sephus Willis at the William Gibbs Research Farm, Tifton, GA for providing technical support in the conduct of trials at their respective locations.

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Table 1. Results of 2007 Advanced (F6) Trial 1.

2007 AT 1 Tifton							**2007 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 2006093	**2010**	44.0	1.16	83.9	4.9	32.6	GA 2006168	**1612**	42.5	1.14	83.6	5.2	33.6
GA 2006109	**2001**	40.9	1.27	85.2	4.6	35.6	GA 2006127	**1544**	43.6	1.11	83.9	5.1	29.1
GA 2006106	**1959**	42.9	1.23	85.0	5.2	32.1	GA 2006139	1491	43.8	1.07	83.1	5.6	31.9
GA 2006053	**1934**	42.2	1.18	82.6	5.3	28.0	GA 2006112	1487	41.4	1.17	83.5	5.3	34.3
GA 2006127	**1927**	43.7	1.16	83.7	5.0	35.2	GA 2006064	1487	44.2	1.21	84.0	5.0	32.5
GA 2006159	**1887**	43.4	1.15	84.0	5.3	33.1	GA 2006158	1439	41.2	1.15	84.7	5.8	32.8
GA 2006112	**1880**	41.6	1.20	83.2	5.3	36.5	GA 2006053	1439	40.3	1.20	84.6	5.5	31.4
GA 2006126	1855	44.1	1.11	83.5	5.3	30.0	GA 2006159	1353	42.8	1.12	84.4	5.6	30.5
GA 2006030	1853	40.7	1.15	83.2	5.1	33.4	GA 2006126	1350	43.2	1.10	83.9	5.2	30.4
GA 2006045	1834	42.3	1.20	84.1	5.1	32.9	GA 2006073	1342	39.4	1.19	84.2	5.1	33.0
GA 2006170	1805	43.9	1.17	83.5	5.2	36.2	GA 2006170	1338	42.9	1.16	84.2	5.1	31.5
GA 2006168	1797	42.8	1.16	84.5	5.0	34.5	GA 2006045	1284	41.7	1.15	84.0	5.1	32.1
GA 2006073	1793	39.8	1.18	84.7	5.0	29.5	GA 2006030	1277	41.9	1.16	84.0	5.2	32.2
GA 2006064	1768	44.5	1.18	83.8	5.2	29.2	GA 2006152	1275	41.6	1.13	83.9	4.9	33.6
GA 2006167	1742	40.8	1.18	85.0	5.4	34.3	GA 2006009	1271	44.7	1.20	85.8	5.5	35.4
GA 2006124	1741	40.7	1.15	82.8	5.1	31.2	GA 2006164	1266	41.3	1.14	84.7	5.1	34.3
GA 2006164	1690	42.2	1.19	85.4	5.0	36.0	GA 2006106	1261	41.4	1.16	84.5	5.3	36.2
GA 2006006	1651	43.2	1.18	84.4	5.1	31.7	GA 2006167	1245	40.9	1.10	84.4	5.2	32.9
GA 2006089	1641	41.0	1.20	83.6	5.0	34.3	DP 147RF	1233	41.1	1.19	83.4	5.7	31.6
FM 966	1632	39.1	1.20	85.2	4.6	38.1	GA 2006124	1181	41.7	1.09	83.6	5.4	31.8
GA 2006139	1627	44.5	1.16	83.9	5.5	34.3	GA 2006006	1166	42.9	1.24	86.2	5.4	33.7
GA 2006009	1621	44.6	1.20	83.3	4.7	31.6	GA 2006093	1141	41.7	1.16	84.1	4.8	35.2
DP 147RF	1613	41.1	1.24	83.7	4.7	32.3	GA 2006066	1098	40.9	1.14	84.4	5.5	32.5
GA 2006031	1591	40.8	1.17	83.2	5.4	34.1	GA 2006155	1088	41.7	1.21	84.9	5.4	33.5
DP 491	1536	43.2	1.20	84.5	5.2	33.9	GA 2006031	1062	41.3	1.19	84.5	5.4	33.7
GA 2006158	1486	41.0	1.25	84.0	5.0	34.1	GA 2006109	1060	42.1	1.14	83.8	5.1	33.2
GA 2006152	1478	42.5	1.16	84.9	5.2	32.4	DP 491	1048	43.1	1.15	84.7	5.1	33.7
GA 2006066	1282	42.1	1.20	84.2	5.3	33.9	GA 2006113	1042	40.2	1.16	84.3	5.5	30.9
GA 2006113	1068	39.0	1.21	84.0	5.1	33.1	GA 2006089	942	39.7	1.20	84.1	5.1	34.3
GA 2006155	621	42.6	1.17	83.9	5.0	33.9	FM 966	853	40.8	1.15	84.0	5.0	36.6
$LSD_{0.10}$	148	0.8	0.05	0.7	0.3	1.2	**$LSD_{0.10}$**	118	0.5	0.05	1.0	0.3	1.6

The bold type indicates the lint yields that are not significantly different from the top yielder.
DP 491, DP147RF, and FiberMax FM 966 are check varieties for comparison purposes.

Table 2. Results of 2007 Advanced (F6) Trial 2, Plains, GA.

ENTRY	Lint Yield	Lint %	UHM in.	UI %	mic	Str g/tex
GA 2006036	**1472**	42.6	1.10	83.0	5.5	31.1
GA 2006063	1329	40.7	1.12	83.4	5.6	32.9
GA 2006128	1305	41.6	1.19	84.0	5.3	32.1
GA 2006042	1301	43.1	1.11	83.4	5.3	31.9
GA 2006041	1282	43.0	1.15	84.1	5.1	30.9
GA 2006020	1263	43.7	1.17	83.6	5.4	32.7
GA 2006078	1255	42.0	1.13	83.9	5.1	31.2
GA 2006149	1249	42.4	1.18	83.2	5.6	31.8
GA 2006034	1241	41.7	1.19	84.2	5.4	32.2
GA 2006047	1200	42.2	1.19	84.7	5.2	35.2
GA 2006088	1174	42.9	1.18	83.4	5.0	32.9
DP 147RF	1169	42.1	1.17	83.6	4.9	34.0
GA 2006086	1150	41.3	1.11	83.9	5.3	34.0
GA 2006028	1148	41.0	1.14	84.3	5.4	31.5
GA 2006015	1143	44.0	1.11	83.1	5.4	33.3
GA 2006065	1138	40.0	1.14	84.4	5.1	32.2
GA 2006103	1128	43.0	1.12	84.2	5.3	33.2
GA 2006035	1091	40.7	1.15	84.4	5.2	32.1
GA 2006120	1089	41.6	1.09	83.7	5.0	34.2
GA 2006016	1085	44.1	1.19	83.8	5.3	33.0
GA 2006171	1078	42.1	1.18	83.6	5.3	37.2
GA 2006032	1077	42.3	1.12	83.4	5.3	32.1
GA 2006123	1055	41.7	1.12	83.5	5.3	33.9
GA 2006162	1045	42.1	1.14	83.7	5.2	33.5
FM 966	1025	42.3	1.10	83.8	5.1	36.8
DP 491	1023	43.5	1.18	84.1	5.0	34.8
GA 2006008	1013	41.8	1.14	83.3	5.5	32.9
GA 2006069	1011	41.1	1.15	82.9	5.4	33.3
GA 2006173	978	43.4	1.15	84.3	5.3	36.3
GA 2006122	910	41.5	1.13	83.6	5.4	35.6
$LSD_{0.10}$	114	0.8	0.035	0.8	0.2	1.0

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 3. Results of 2007 Preliminary (F5) Trials 1 and 2.

2007 PT1							**2007 PT2**						
ENTRY	**Lint Yield**	**Lint %**	**UHM in.**	**UI %**	**mic**	**Str g/tex**	**ENTRY**	**Lint Yield**	**Lint %**	**UHM in.**	**UI %**	**mic**	**Str g/tex**
GA 2007015	**1768**	44.1	1.19	85.0	5.2	31.8	GA 2007032	**1671**	39.39	1.3	85.7	4.9	34.6
GA 2007004	**1685**	44.8	1.17	85.2	5.3	33.2	GA 2007031	**1657**	43.97	1.21	84.4	4.9	34.6
GA 2007010	**1670**	42.5	1.22	85.4	5.1	32.7	GA 2007036	1427	43.03	1.2	85.2	5.0	34.1
GA 2007003	1585	44.0	1.23	84.8	5.2	35.3	FM 966	1400	39.89	1.2	85.0	4.8	37.6
GA 2007001	1530	44.0	1.25	85.2	4.8	33.4	GA 2007025	1387	43.85	1.23	84.2	5.0	33.5
GA 2007007	1482	43.3	1.21	83.5	5.0	33.3	GA 2007021	1367	43.21	1.26	84.7	4.7	33.9
GA 2007017	1455	41.7	1.24	85.3	5.2	34.1	GA 2007020	1366	43.60	1.22	85.0	5.0	33.0
FM 966	1426	39.1	1.22	84.9	4.9	37.2	GA 2007035	1342	42.57	1.23	83.8	4.9	35.6
GA 2007009	1414	41.2	1.21	84.9	5.0	35.6	GA 2007033	1333	43.64	1.2	83.9	5.0	34.0
GA 2007006	1393	42.0	1.18	84.5	5.1	34.0	GA 2007023	1324	42.74	1.2	84.3	5.1	33.3
GA 2007013	1387	43.2	1.2	83.9	5.0	33.8	DP 147RF	1277	40.97	1.26	84.4	4.5	33.2
GA 2007014	1371	43.9	1.15	84.7	5.0	33.8	GA 2007029	1266	39.77	1.25	85.6	4.6	33.7
DP 147RF	1351	40.1	1.26	83.4	4.5	32.4	GA 2007026	1240	41.82	1.18	84.1	5.4	33.2
GA 2007018	1302	45.4	1.24	84.3	5.2	32.9	GA 2007027	1155	43.39	1.19	84.6	4.8	34.0
GA 2007005	1261	44.4	1.16	84.6	4.8	35.7	GA 2007024	1146	40.29	1.23	85.5	5.4	33.5
GA 2007002	1254	41.7	1.19	84.7	5.2	34.0	GA 2007019	1124	42.05	1.23	84.5	5.1	33.6
GA 2007008	1254	40.5	1.21	85.1	4.7	38.4	GA 2007022	1121	39.50	1.23	84.7	4.8	33.8
GA 2007016	1165	41.2	1.22	85.2	4.8	34.7	GA 2007028	992	41.51	1.21	84.9	4.8	34.6
GA 2007012	1155	39.9	1.15	84.5	4.7	35.2	**$LSD_{0.10}$**	226	0.9	0.03	0.9	0.3	2.3
$LSD_{0.10}$	158	0.7	0.03	0.7	0.3	1.1							

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 4. Results of 2007 Preliminary (F5) Trials 3 and 4.

2007 PT3

ENTRY	Lint Yield	Lint %	UHM in.	UI %	mic	Str g/tex
FM 966	**1583**	40.1	1.18	84.5	4.7	36.5
GA 2007041	**1516**	43.1	1.21	85.1	5.0	32.1
GA 2007040	1416	41.7	1.18	83.9	5.1	34.5
GA 2007045	1397	40.0	1.28	84.9	4.9	35.2
GA 2007051	1369	42.0	1.15	83.6	5.1	32.8
GA 2007053	1365	44.1	1.15	84.6	5.0	33.5
GA 2007044	1348	42.0	1.17	84.8	5.0	34.1
GA 2007049	1255	41.0	1.19	84.4	5.1	32.6
GA 2007048	1252	41.1	1.16	85.1	4.8	31.2
GA 2007037	1233	41.2	1.22	85.4	5.0	32.3
GA 2007054	1178	41.2	1.2	84.6	4.5	31.2
GA 2007047	1167	43.2	1.15	83.7	5.5	32.2
GA 2007052	1140	41.5	1.16	85.1	5.4	34.0
DP 147RF	1094	41.5	1.21	84.6	4.7	33.1
GA 2007038	1047	44.3	1.18	84.3	5.0	32.6
GA 2007039	1043	40.7	1.21	85.0	4.8	34.6
$LSD_{0.10}$	136	1.2	0.04	0.7	0.3	2.1

2007 PT4

ENTRY	Lint Yield	Lint %	UHM in.	UI %	mic	Str g/tex
GA 2007067	**1647**	30.0	1.17	84.2	5.5	32.3
GA 2007068	**1524**	29.3	1.11	83.9	5.5	32.1
GA 2007069	**1488**	29.7	1.08	83.6	5.4	31.3
GA 2007070	**1481**	28.6	1.13	84.8	5.9	34.4
GA 2007072	1446	28.4	1.12	84.2	5.4	31.6
GA 2007066	1409	28.6	1.16	83.4	5.5	32.9
GA 2007058	1369	27.4	1.15	84.3	5.5	33.6
FM 966	1361	26.7	1.13	84.3	5.4	36.3
GA 2007064	1314	28.2	1.17	84.2	5.5	33.6
GA 2007059	1291	28.7	1.11	83.2	5.6	30.0
GA 2007055	1230	27.2	1.12	83.3	5.4	33.2
GA 2007065	1209	28.3	1.19	83.7	5.5	34.4
GA 2007063	1175	27.7	1.14	84.5	5.5	33.1
GA 2007071	1152	28.1	1.19	84.8	5.2	35.0
GA 2007061	1133	27.9	1.18	84.7	5.2	34.3
DP 147RF	1119	28.2	1.15	84.4	5.2	31.7
GA 2007062	1068	26.2	1.14	84.0	4.9	35.7
GA 2007060	1051	27.1	1.12	84.2	5.3	31.2
GA 2007057	976	28.1	1.15	83.8	5.1	34.1
GA 2007056	801	27.0	1.15	83.7	4.9	32.3
$LSD_{0.10}$	165	1.2	0.04	0.7	0.3	1.5

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 2007 Preliminary (F5) Trials 5 and 6.

2007 PT5

ENTRY	Lint Yield	Lint %	UHM in.	UI %	mic	Str g/tex
FM 966	**1400**	40.0	1.17	84.6	5.1	35.2
GA 2007076	**1395**	41.9	1.15	83.2	5.4	33.9
GA 2007075	**1374**	43.2	1.17	84.7	5.3	34.9
GA 2007077	**1357**	43.0	1.12	82.9	5.4	32.7
GA 2007087	**1307**	41.2	1.13	83.4	5.2	33.5
GA 2007083	**1290**	40.1	1.15	85.0	5.2	34.1
GA 2007090	**1282**	42.7	1.12	82.2	5.3	31.8
GA 2007079	**1267**	41.2	1.14	83.1	5.1	31.8
GA 2007074	**1239**	41.6	1.11	82.8	5.4	34.5
GA 2007088	**1239**	43.2	1.16	84.2	5.2	34.3
GA 2007089	1102	40.7	1.20	83.3	4.8	32.3
DP 147RF	1064	42.5	1.14	83.0	4.9	30.0
GA 2007081	1014	41.3	1.14	84.4	5.0	33.0
$LSD_{0.10}$	243	1.3	0.04	1.1	0.3	2.1

2007 PT6

ENTRY	Lint Yield	Lint %	UHM in.	UI %	mic	Str g/tex
GA 2007094	**1580**	29.3	1.11	83.7	5.4	31.7
GA 2007093	**1501**	28.9	1.14	83.6	5.8	33.4
GA 2007108	**1486**	29.2	1.11	82.5	5.5	31.9
GA 2007091	**1472**	29.9	1.13	81.8	5.7	32.8
FM 966	**1467**	27.4	1.13	84.9	5.2	36.7
GA 2007095	1430	29.2	1.15	83.0	5.3	32.6
GA 2007100	1404	27.3	1.08	83.1	5.2	33.0
GA 2007104	1356	27.0	1.13	83.8	5.1	33.0
GA 2007103	1328	27.0	1.08	83.2	5.5	31.8
GA 2007098	1320	26.2	1.15	83.5	5.3	35.7
GA 2007107	1299	26.7	1.09	83.8	5.4	32.7
GA 2007101	1267	26.3	1.11	83.5	5.5	30.8
GA 2007097	1244	28.7	1.14	84.5	5.1	33.2
GA 2007099	1241	28.2	1.14	82.7	5.2	33.2
DP 147RF	1238	28.2	1.13	83.8	5.5	31.3
GA 2007102	1227	27.7	1.13	84.0	5.1	33.3
GA 2007096	1070	27.9	1.11	83.3	5.3	33.1
$LSD_{0.10}$	144	1.2	1.12	1.3	0.4	2.4

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.

ADDING ROOT-KNOT NEMATODE RESISTANCE TO GEORGIA-ADAPTED COTTON GERMPLASM, 2007

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Introduction

State surveys of the densities of nematodes reveal that the major cotton-producing counties in Georgia have damaging levels of nematodes (state loss of 137,423 bales ... valued at $53,594,970 in 1998) and is increasing from previous years (National Cotton Council, 1998). From 1991 to 1998, almost 98 thousand bales per year valued at a total of $300 million were lost (National Cotton Council, 1998). It is estimated that Georgia producers specifically lose about 77,000 bales of cotton annually from root-knot nematodes (*Meloidogyne incognita,* RKN) damage (Blasingame and Petal, 2001). Crop rotation, while a recommended cultural practice to lessen soil populations of RKN, is not an option for most Georgia growers because of the lack of suitable non-host crops with which to rotate their cotton acreages. Therefore, inherent genetic resistance provides an attractive alternative to pesticides and crop rotation.

Poor profit potential of cotton production from yield stagnation and high pest management costs impels creation of cultivars with inherent genetic resistance to enhance economic returns for cotton producers. Insect, nematode, and weed pest management costs are among the highest expenditures growers face in cotton production (National Cotton Council, 2001), thus their reduction would enhance profitability of cotton production. Since Georgia is the second ranked cotton producing state with 1.4 million acres (NASS, 2006), cotton cultivars adapted for the unique aspects of the environment of Georgia, such as rainfall patterns, soils types and depth, and presence of root-knot nematodes must be developed to give the best available genetics to the GA producer.

Despite the widespread occurrence of RKN in Georgia and most cotton production areas in the Southeast and that genetic resistance to RKN has existed since 1974 (Shepherd, 1974), private cultivar developers have previously exhibited little interest in fulfilling this need. Commonly cited reasons for the slow progress in developing RKN resistant cultivars is that the current screening process is costly, tedious, time consuming and destructive for identifying resistance genotypes. Further, most breeding stations have neither the facilities nor personnel with expertise in nematology to carry out the screening process to identify resistant material. Of those RKN-resistant (CPCSD Acala NemX) or tolerant cultivars (ST LA887 or PM H1560) that have been distributed by commercial cotton seed companies, none are adapted to the Southeast.

Our objective, to develop Georgia-adapted, value-added cotton germplasm with RKN resistance, will benefit the state's producers by providing increased yield and decreased production costs whereas the increased availability of RKN-resistant germplasm will benefit the cotton industry across the belt.

Materials and Methods

In a previous project, Drs. Chee, May, and Davis developed advanced RKN parents from a backcross breeding population using M120RNR and M155RNR root-knot nematode resistant donor parent with the elite breeding line PD94042 (May, 1999). The best resistant BC3F3 lines will be crossed with Georgia adapted, value added lines from our UGA Cotton Breeding program. A ten plant sample of this material was challenged twice with a very high rate of RKN in a pot-based greenhouse test following Shen et al. (2006). Further samples were then grown at the Gibbs Farm, University of Georgia-Tifton campus in an RKN infested field following the procedure of Davis and May (2005). The resistant lines were verified in an additional pot-based greenhouse test. Resistant lines 103-7, 201-A, 506-5, and 506-11 were selected as parents to introgress the RKN resistance into the Georgia-adapted germplasm GA 98028 and GA 2001078. Selection of the resistant offspring will use DNA marker-assisted selection (MAS) with the markers being developed in a companion project (Shen et al., 2006). The chromosomal region bearing the RKN resistance that is indicated by these molecular markers has been already verified independently (Ynturi et al., 2006), although the work in our lab appears to have markers that are, at present, closer to the RKN resistance gene. We have found the markers to be polymorphic between the parental Georgia lines and both parents of the RKN resistance donors. The most current molecular markers will be used in a three-cycle backcrossing program in the greenhouse to insert the RKN resistance gene during 2007 but our crossing schedule was disrupted by inviable seed from the second backcross. We have sent F_1 seed to the winter nursery in Mexico to obtain seed for the 2008 growing season to use our standard breeding approach (Lubbers et al., 2006) as well as testing samples of the F_2 population with the molecular markers for RKN resistance. We are also continuing to follow our backcrossing plan as a two-pronged approach to enhance the likelihood of selecting the RKN resistance in a better genetic background for Georgia-adapted production. After the F_2 yield test and the F_3 selections with fiber quality testing within the standard approach and the single plant selections with fiber quality testing in the BC_2F_1 population of the backcrossing approach, we will plant an unreplicated modified augmented design yield test (with every 5th row in the trial assigned to a conventional check cultivar) in either Tifton or Plains to select for yield and to test/verify the homozygosity of the RKN resistance marker(s). This trial will be machine harvested and the seed-cotton yield of each F4 progeny row compared with seed-cotton yield of the nearest check row. We will then harvest boll samples for lint %, fiber quality, and for seed in a parallel increase field for the rows that significantly out-yield the nearest check plot. The preliminary trial (PT), which is the next step, will be conducted near Tifton or Plains, GA, depending upon land availability. Advanced generation germplasm lines promoted from the PT shall be tested in an advanced yield trial (AT) in Plains and Tifton. Elite germplasm lines from a successful performance in the ATs will be tested in locations throughout the state in both dryland and irrigated fields in the University of Georgia Official Variety Trials.

Interim Results and Discussion

The backcross approach was delayed by failed crosses and/or inviable seeds at BC_1 stage. We are theorizing that this was caused by the high temperatures found in greenhouses in the summer, but we didn't note any excessive afternoon wilting and the plants grew vigorously without any obvious stress or stunting. The backcrossing is continuing; but to increase the likelihood of success, the F_1 seed has been sent to the winter nursery in Mexico to furnish F_2 seed to use in our standard conventional breeding approach as a hedge against any further difficulties in the backcross approach.
Further field research with the PD 94042-derived, parental RKN resistance donors (and related lines) for this project was conducted in 2007 to further verify the field-level effectiveness of the genes that came from M120RNR and M155RNR. This test used fumigated and non-fumigated soil to compare the efficacy of the introgressed RKN resistance genes. The lint yield and fiber quality analyses are expected to be completed in late January 2008 and will be placed in an updated version of this technical report published in the 2007 Georgia Cotton Research and Extension Reports. Seed increase plots were also produced for multi-location agronomic testing upcoming in 2008.
This approach should quickly provide a solid performing release of RKN resistant germplasm/cultivars. But, even though MAS is generally considered a reliable procedure, it is a relatively recent innovation and has not been extensively utilized, and there may be technical problems associated with it.

Acknowledgements

We thank the Georgia Cotton Commission (Project No. 06-908GA) for financial support for this project.

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COTTON RESPONSE TO PENDIMETHALIN FORMULATION, METHOD AND TIME OF APPLICATION

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Introduction

Over 50% of the cotton in Georgia is currently produced using either no-tillage or strip-tillage techniques. With the elimination of cultivation as a control tactic in conservation tillage systems, herbicides are now the primary and often only method used for weed control. When glyphosate-resistant varieties were first introduced, glyphosate was applied two to four times on most fields and may have been the only herbicide used. In Georgia, 93% of the cotton acres received at least one glyphosate application in 2005. Glyphosate is a highly effective herbicide that controls a broad spectrum of annual and perennial grass and broadleaf weeds. However, the incidence of glyphosate-tolerant or resistant weeds emerging in the southeast has increased the need for multiple herbicide modes of action in weed management systems.

Pendimethalin, a dinitroanaline herbicide which inhibits cell growth, is applied preemergence or preplant incorporated to approximately 30% of Georgia cotton for control of grasses and small-seeded broadleaf weed species. Pendimethalin is often used in combination with glyphosate-resistant cotton. There are two different formulations of pendimethalin registered for cotton. Both are liquids: Prowl 3.3 EC contains 3.3 lb active ingredient (ai)/gallon as an emulsifiable concentrate (EC); and Prowl H_2O contains 3.8 lb ai/gallon pendimethalin formulated as a microencapsulated (ASC) aqueous capsule suspension. One potential method of obtaining extended weed control may be to apply pendimethalin as an in season application, i.e. postemergence to the cotton crop. However, injury to cotton from Prowl 3.3 EC has prevented over-the-top postemergence application labels. Cotton response to Prowl H_2O ASC is unknown and may be less injurious to cotton because of its formulation. Additionally, an alternative method of application may be to impregnate pendimethalin onto fertilizer for in season application to save a trip across the field. Comparisons for pendimethalin EC to ASC for in crop application have not been evaluated. Therefore, studies were conducted in cotton to evaluate cotton response to Prowl 3.3 EC and Prowl H_2O ASC when spray applied or impregnated on cotton.

Materials and Methods

Field trials were conducted in 2005, 2006, and 2007 at the University of Georgia Ponder Research Station near Ty Ty, Georgia. Delta and Pineland 555 BG/RR was planted in 2005 and Delta and Pineland Flex 445 BG/RR in 2006 and 2007 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 treatments replicated four times. Plots were two rows by 25 feet.

Four different methods of pendimethalin application were made at 4 different times during the growing season. All herbicide treatments consisted of 1.0 lb ai/acre of pendimethalin. Only the method or time of application varied. Treatments were Prowl EC or Prowl H_2O with method of application as either 1) spray applied in water at 15 gallons/acre or 2)impregnated on fertilizer (10-10-10) that was spread at a rate of 250 lb/ha applied with a Gandy fertilizer applicator. All plots were fertilized equally.

The 4 different herbicide application timings were 1) preemergence (PRE), 2) at cotton emergence (AC) from the soil, 3) at 3-leaf (3LF) cotton, and 4) 6-leaf or greater (POST) cotton. A non-treated control was included for comparison for a total of 17 treatments. All plots were maintained weed free by hand pulling weed escapes and treatments with glyphosate.

Cotton injury ratings were evaluated after applications using a scale of 0 (no injury) to 100 % (complete death). Cotton height measures were made 3 times in 2005 and 5 times in 2006 and 2007. Yield was determined by mechanical harvesting each plot.

Results and Discussion

There were no differences for cotton injury for PRE spray and fertilizer applications of Prowl 3.3 EC or Prowl H_2O ASC (Table 1) and were less than 4%. However, AC and 3-LF Prowl 3.3 EC spray applications caused 37 to 48% injury. Prowl H_2O PRE and 3-LF spray applications were less injurious with 22 and 12%, respectively. When impregnated on fertilizers at the AC timing, Prowl 3.3 EC injured cotton 30% compared to Prowl H_2O with 15%. Therefore, if farmers wanted to impregnate pendimethalin and apply it with fertilizer for the AC timing, they should use Prowl H_2O. When impregnated on fertilizers for the 3-LF application, injury was less than 4% for Prowl 3.3 EC and Prowl H_2O. For the POST applications, there were no injury differences.

Cotton height was reflected in the injury for the formulation, method and timing of application (Figure 1). There were no differences between any treatment for the PRE applications (Figure 1 A). But when Prowl 3.3 and H_2O were spray applied AC (Figure 1 B) or 3-LF (Figure 1 C) timings, cotton height was reduced at 45, 60, and 75 DAP by as much as 10 to 15 cm. Conversely, height was not different than the nontreated check for these same DAP measures when either pendimethalin formulation was impregnated on fertilizer. No differences were noted in height for the POST treatment timings (Figure 1 D).

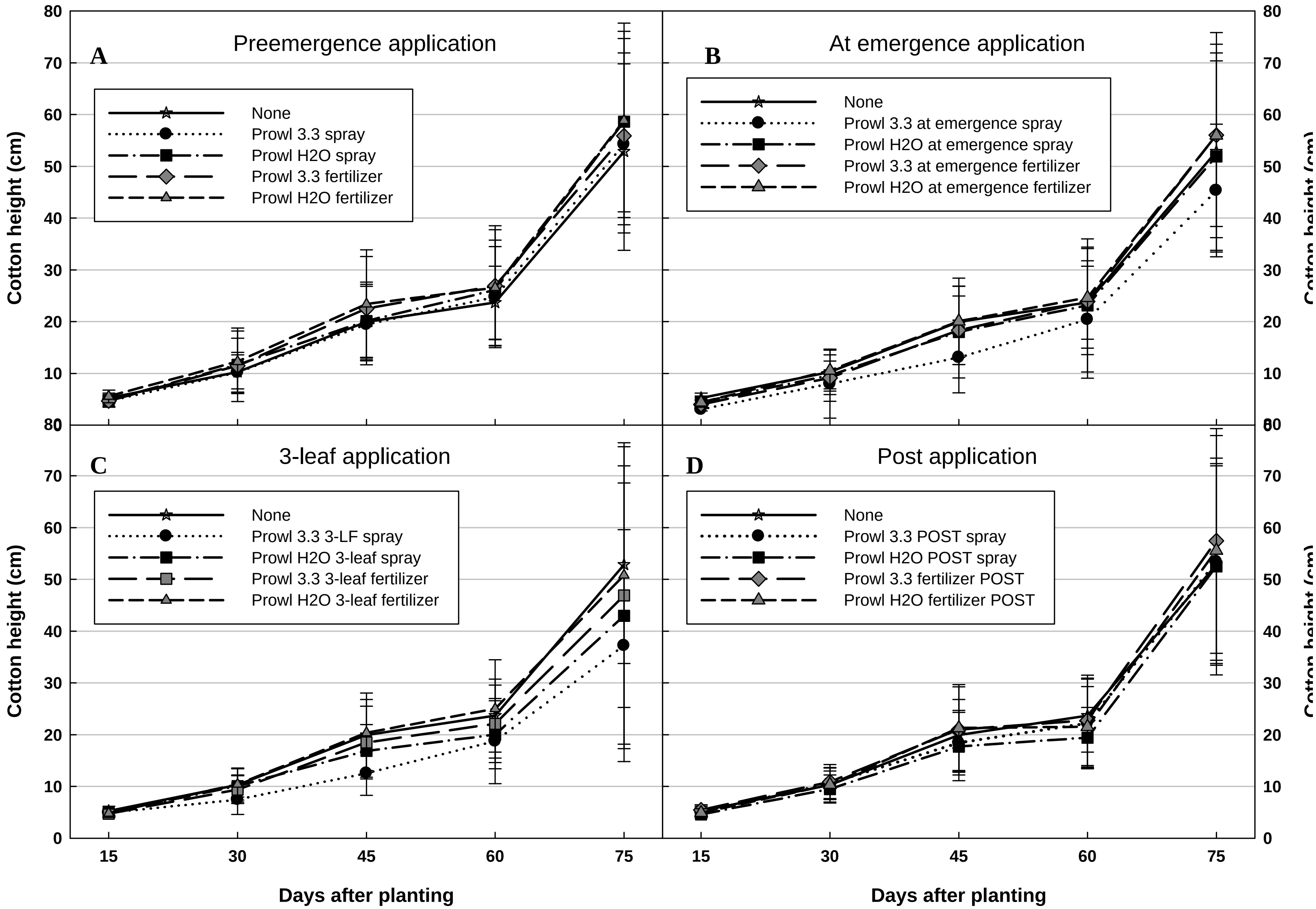
Data indicated significant seed cotton yield reductions for the spray applications of Prowl 3.3 EC as an AC and 3-LF treatment with 2490 and 2360 lb/acre, respectively (Table 1). All other pendimethalin treatment combinations for Prowl 3.3 EC, Prowl H2O either spray or fertilizer impregnated, did not significantly reduce yield. Thus, while injury and height may have been reduced by Prowl H_2O spray applications, this did not translate into yield reduction.

Table 1. Cotton injury and yield as influenced by pendimethalin formulation, method and timing of application.

Herbicide	Application method	Timing[a]	Injury		Cotton yield	
			%		lb/acre	
Prowl 3.3	Spray	PRE	4	a	3350	a
Prowl H_2O	Spray	PRE	4	a	3360	a
Prowl 3.3	Fertilizer[b]	PRE	3	a	3320	a
Prowl H_2O	Fertilizer	PRE	2	a	3630	a
Prowl 3.3	Spray	AC	48	e	2490	b
Prowl H_2O	Spray	AC	22	bc	3080	a
Prowl 3.3	Fertilizer	AC	30	c	3170	a
Prowl H_2O	Fertilizer	AC	15	b	3280	a
Prowl 3.3	Spray	3-leaf	37	de	2360	b
Prowl H_2O	Spray	3-leaf	12	ab	3050	a
Prowl 3.3	Fertilizer	3-leaf	4	a	3200	a
Prowl H_2O	Fertilizer	3-leaf	2	a	3430	a
Prowl 3.3	Spray	POST	4	a	3160	a
Prowl H_2O	Spray	POST	1	a	3500	a
Prowl 3.3	Fertilizer	POST	0	a	3410	a
Prowl H_2O	Fertilizer	POST	0	a	3380	a
Nontreated			0	a	3290	a

[a]Abbreviations: PRE, preemergence; AC, at cotton emergence; 3-LF, 3-leaf cotton; POST, postemergence to 6 leaf cotton.
[b]Fertilizer was 10-10-10 and all plots were supplemented to have equal amounts applied. Prowl 3.3 and H_2O were impregnated onto the fertilizer by continuous rotation with drip application during rotation.

Figure 1. Affect of pendimethalin formulation, method and time of application on cotton height.



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 2007, continuing a program initiated more than 20 years ago.

Bollworm cultures were established from larvae collected in corn, cotton, millet and tobacco in Burke, Coffee, Screven, Sumter, Tift, and Union Counties. Tobacco budworm cultures were established from larvae collected in tobacco in Tift County. Third-instar F_1 or F_2 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 addition, adult bollworm moths were collected in pheromone traps in Sumter County (1 mile east of Plains)

In the larval bioassays, susceptibility of all the various populations of bollworms and tobacco budworms for both ?-?-cyhalothrin and cypermethrin was elevated in comparison with historical levels, although the overall levels did not change relative to the 2006 results. Similarly, susceptibility of adults males in the adult vial tests did not change significantly from 2006 to 2007, although there were a few higher responses in early July. These results indicate that tolerance to pyrethroids in the bollworm and tobacco budworm may be increasingly widespread in Georgia, and that there is a great need for growers to utilize insecticide resistance management practices to steward these products. However, there appears to have been no significant change in susceptibility of the bollworm to pyrethroids since 2006, which is a promising development. Our results also suggest that the developing resistance may not be

stable, as we observed again in 2007 a tendency for reduced tolerance after only a single generation in the laboratory in the Sumter County population.

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 1979, we have performed bioassays on major lepidopteran cotton pests to monitor development of insecticide resistance. In 2004, we began to see elevated levels of tolerance to pyrethroids. Our monitoring has continued with larvae and adults of the bollworm, *Helicoverpa zea*, and the tobacco budworm, *Heliothis virescens*, bioassayed for resistance to certain pyrethroid. Throughout most of the past 28 years, Georgia did not experience any widespread resistance problems, while other states did. Clearly, the potential exists and our findings indicate pyrethroid resistance is now our problem as well as that of other states.

Materials and Methods

Bollworm cultures were established from larvae collected in corn, cotton, or millet in Burke, Screven, Sumter, Tift, and Union Counties. Eggs and larvae collected on tobacco in Coffee Co., though expected to be tobacco budworms, were found to be almost entirely bollworms. These were included in our bollworm bioassays. 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 Tift Co. tobacco. 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. 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 2007.

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. In many instances, larvae treated with pyrethroids linger on several days beyond 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.

Adult vial tests were conducted on adult males collected in pheromone traps in Crisp, Macon, Mitchell, Sumter, and Tift Counties during the summer of 2007. Traps were monitored periodically and when adequate CEW captures were attained, moths (captured the previous night) were assayed using the Adult Vial Test (AVT) procedure. AVTs were performed using 20 ml scintillation vials coated with an acetone solution of technical grade cypermethrin with dosages of 5 or 10 µg/vial and an acetone treated check. Vials were obtained from two sources, Russ Ottens at the University of Georgia and Greg Payne at West Georgia College. Individual moths were placed in treated and untreated vials and survival was checked after 24 hours. Only moths that were able to fly in a normal manner were considered alive. Percent mortality in the treated vials was corrected for mortality in the untreated. If survivorship in the untreated vials was below 80 percent, the test was discarded.

Results and Discussion

The ED_{50}, ED_{90}, LD_{50}, and LD_{90} values for the 2007 Tift Co. bollworm larval bioassays are presented in tables 1, 2, 3, and 4, respectively. With the exception of Screven Co., all ED_{50} values for ?-?-cyhalothrin increased in comparison with those of Tift Co. in 2006 and all were higher than the Tift Co. long-term average since testing began in 1985 (Table 1).   Though all ED_{50} values for cypermethrin, with the exception of Coffee Co. bollworms, decreased in comparison with those of 2006, all were higher than the Tift Co. long-term average since testing began in 1983 (Table 1).

Comparing the 2007 bollworm results with those from which collections in the same counties were evaluated in 2006 (Tift and Union counties) indicates that the levels of pyrethroid tolerance changed little, and may have even declined slightly. In 2006, the F_1 studies revealed an ED_{50} of 1.25 for the Tift County population, compared with ED_{50}s of 0.65 and 0.47 in 2007 for the June and September populations, respectively (Table 1).

Similarly, the ED_{50} of the Union County population declined from 1.68 in 2006 to 0.45 in 2007. It is unclear why these changes occurred; however, if they are real, then it is possible that the development of resistance in bollworm populations may be slowing. We would need to compare more geographic populations year to year to be able to determine more clearly if this trend is real. It is possible that there are significant fitness costs associated with maintaining pyrethroid resistance in bollworms. In the laboratory we have found that ED_{50}s consistently decline as bollworms are reared for successive generations in the laboratory, suggesting that the resistance declines in the absence of section pressure.

The ED_{50}, ED_{90}, LD_{50}, and LD_{90} values for the 2007 tobacco budworm larval bioassays are presented in tables 5, 6, 7, and 8, respectively. All values for ?-cyhalothrin and cypermethrin were higher than the Tift Co. value for 2005 (tobacco budworm bioassays were not performed in 2006), and 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).

Adult vial tests indicated that in early July a number of sampled populations exhibited elevated pyrethroid tolerance relative to that observed in 2006 (Fig. 1). However, the remainder of the season, tolerance levels returned to rates similar to those observed in 2006. This indicates that although overall pyrethroid tolerance levels in the corn earworm have not intensified since 2006, they also have not improved, and there was at least one period when tolerance was higher. These results suggest that the problem persists, and may have the potential to worsen.

The trend toward increased pyrethroid tolerance in bollworms and tobacco budworms appears to have continued in 2007, although there appears to be evidence for slowing in bollworms relative to the upward trend since 2003. It will be critical that current insecticide resistance management schemes continue to be emphasized and utilized by growers

Acknowledgments

We appreciate funding from the Georgia Cotton Commission and Cotton Incorporated in support of this work. We also appreciate the assistance of Alton Hudgins, Melissa Thompson, and Javier Sanchez in rearing the colonies.

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Table 1. ED_{50}'s for various insecticides against larval *Helicoverpa zea* (CEW) at 72 hr post-treatment. 2007.

Chemical	Gen.	No. Reps	ED_{50} (µg/g larval wt.)	95% C.I.	Change (+/-) from Tift Co. 2006	Change (+/-) from Tift Co. avg	Slope ± SE
?-cyhalothrin							
Coffee Co.	F_1	4	0.48	0.33 – 0.65	+0.22	+0.35	1.61 ± 0.27
Screven Co.	F_1	4	0.21	0.11 – 0.31	-0.05	+0.08	1.22 ± 0.22
Tift Co.	F_1	5	0.57	0.38 – 0.75	+0.31	+0.44	2.07 ± 0.36
Union Co.	F_1	4	0.29	0.22 - 0.40	+0.03	+0.16	1.56 ± 0.24
Cypermethrin							
Burke Co.	F_1	4	0.42	0.33 - 0.51	-0.37	+0.04	2.53 ± 0.34
Coffee Co.	F_1	5	0.80	0.59 – 1.02	+0.01	+0.42	2.22 ± 0.28
Screven Co.	F_1	5	0.56	0.41 – 0.70	-0.23	+0.18	2.02 ± 0.27
Sumter Co.	F_2	4	0.44	0.35 – 0.53	-0.35	+0.06	3.15 ± 0.44
Tift Co. (Jun)	F_1	4	0.65	0.34 - 0.96	-0.14	+0.27	1.71 ± 0.30
Tift Co. (Sep)	F_1	3	0.47	0.31 – 0.62	-0.32	+0.09	2.92 ± 0.58
Union Co.	F_1	4	0.45	0.30 - 0.60	-0.34	+0.07	1.83 ± 0.28

Table 2. ED_{90}'s for various insecticides against larval *Helicoverpa zea* (CEW) at 72 hr post-treatment. 2007.

Chemical	Gen.	No. Reps	ED_{90} (µg/g larval wt.)	95% C.I.	Change (+/-) from Tift Co. 2006	Change (+/-) from Tift Co. avg	Slope ± SE
?-cyhalothrin							
Coffee Co.	F_1	4	3.01	1.86 – 7.21	+1.39	+2.45	1.61 ± 0.27
Screven Co.	F_1	4	2.30	1.34 – 6.30	+0.68	+1.74	1.22 ± 0.22
Tift Co.	F_1	5	2.36	1.67 – 4.34	+0.74	+1.80	2.07 ± 0.36
Union Co.	F_1	4	1.94	1.16 - 4.83	+0.68	+1.38	1.56 ± 0.24
Cypermethrin							
Burke Co.	F_1	4	1.34	1.01 - 2.05	-3.07	-0.26	2.53 ± 0.34
Coffee Co.	F_1	5	3.03	2.33 – 4.39	-1.38	+1.43	2.22 ± 0.28
Screven Co.	F_1	5	2.40	1.80 – 3.69	-2.01	+0.80	2.02 ± 0.27
Sumter Co.	F_2	4	1.12	0.90 – 1.58	-3.29	-048	3.15 ± 0.44
Tift Co. (Jun)	F_1	4	3.68	2.58 - 6.50	-0.73	+2.08	1.71 ± 0.30
Tift Co. (Sep)	F_1	3	1.30	0.98 – 2.09	-3.11	-0.30	2.92 ± 0.58
Union Co.	F_1	4	2.26	1.60 - 3.92	-2.15	+0.66	1.83 ± 0.28

Table 3. LD_{50}'s for various insecticides against larval *Helicoverpa zea* (CEW) at 72 hr post-treatment. 2007.

Chemical	Gen.	No. Reps	LD_{50} (µg/g larval wt.)	95% C.I.	Change (+/-) from Tift Co. 2006	Change (+/-) from Tift Co. avg	Slope ± SE
?-cyhalothrin							
Coffee Co.	F_1	4	0.68	0.48 – 0.96	-0.04	+0.41	1.54 ± 0.28
Screven Co.	F_1	4	0.26	0.14 – 0.39	-0.46	-0.01	1.17 ± 0.21
Tift Co.	F_1	5	0.80	0.50 – 1.15	+0.08	+0.53	1.42 ± 0.29
Union Co.	F_1	4	0.51	0.39 - 0.71	-0.21	+0.24	1.78 ± 0.27
Cypermethrin							
Burke Co.	F_1	4	0.58	0.46 - 0.73	-1.19	-0.43	2.35 ± 0.33
Coffee Co.	F_1	5	1.18	0.89 – 1.50	-0.59	+0.17	1.86 ± 0.21
Screven Co.	F_1	5	0.81	0.55 – 1.10	-0.96	-0.20	1.33 ± 0.22
Sumter Co.	F_2	4	0.65	0.28 – 1.15	-1.12	-0.36	1.97 ± 0.45
Tift Co. (Jun)	F_1	4	1.20	0.0004 - 3.38	-0.57	+0.19	0.91 ± 0.31
Tift Co. (Sep)	F_1	3	0.74	0.53 – 0.94	-1.03	-0.27	2.92 ± 0.52
Union Co.	F_1	4	0.66	0.45 - 0.89	-1.11	-0.35	1.61 ± 0.25

Table 4. LD_{90}'s for various insecticides against larval *Helicoverpa zea* (CEW) at 72 hr post-treatment. 2007.

Chemical	Gen.	No. Reps	LD_{90} (µg/g larval wt.)	95% C.I.	Change (+/-) from Tift Co. 2006	Change (+/-) from Tift Co. avg	Slope ± SE
?-cyhalothrin							
Coffee Co.	F_1	4	4.64	2.65 – 13.82	-4.57	+2.39	1.54 ± 0.28
Screven Co.	F_1	4	3.25	1.79 – 10.21	-5.96	+1.00	1.17 ± 0.21
Tift Co.	F_1	5	6.41	3.52 – 23.11	-2.80	+4.16	1.42 ± 0.29
Union Co.	F_1	4	2.68	1.59 - 6.71	-6.53	+0.43	1.78 ± 0.27
Cypermethrin							
Burke Co.	F_1	4	2.04	1.48 - 3.41	-9.10	-5.65	2.35 ± 0.33
Coffee Co.	F_1	5	5.75	4.29 – 8.64	-5.39	-1.94	1.86 ± 0.21
Screven Co.	F_1	5	7.43	4.44 – 18.88	-3.71	-0.26	1.33 ± 0.22
Sumter Co.	F_2	4	2.90	1.52 – 20.69	-8.24	-4.79	1.97 ± 0.45
Tift Co. (Jun)	F_1	4	31.13	7.96 – inf.	+19.99	+23.44	0.91 ± 0.31
Tift Co. (Sep)	F_1	3	2.02	1.53 – 3.22	-9.12	-5.67	2.92 ± 0.52
Union Co.	F_1	4	4.10	2.68 - 8.34	-7.04	-3.59	1.61 ± 0.25

Table 5. ED_{50}'s for ?-cyhalothrin and cypermethrin against larval *Heliothis virescens* (TBW) at 72 hr post-treatment. 2007.

	Gen.	No. Reps	ED_{50} (µg/g larval wt.)	95% C.I.	Change (+/-) from Tift Co. 2005	Change (+/-) from Tift Co. avg	Slope ± SE
?-cyhalothrin							
Tift Co.	F_1	5	3.32	2.22 – 5.63	+2.76	+3.01	1.11 ± 0.18
Cypermethrin							
Tift Co.	F_1	5	3.38	2.65 – 4.21	+0.94	+2.37	1.99 ± 0.26

Table 6. ED_{90}'s for ?-cyhalothrin and cypermethrin against larval *Heliothis virescens* (TBW) at 72 hr post-treatment. 2007.

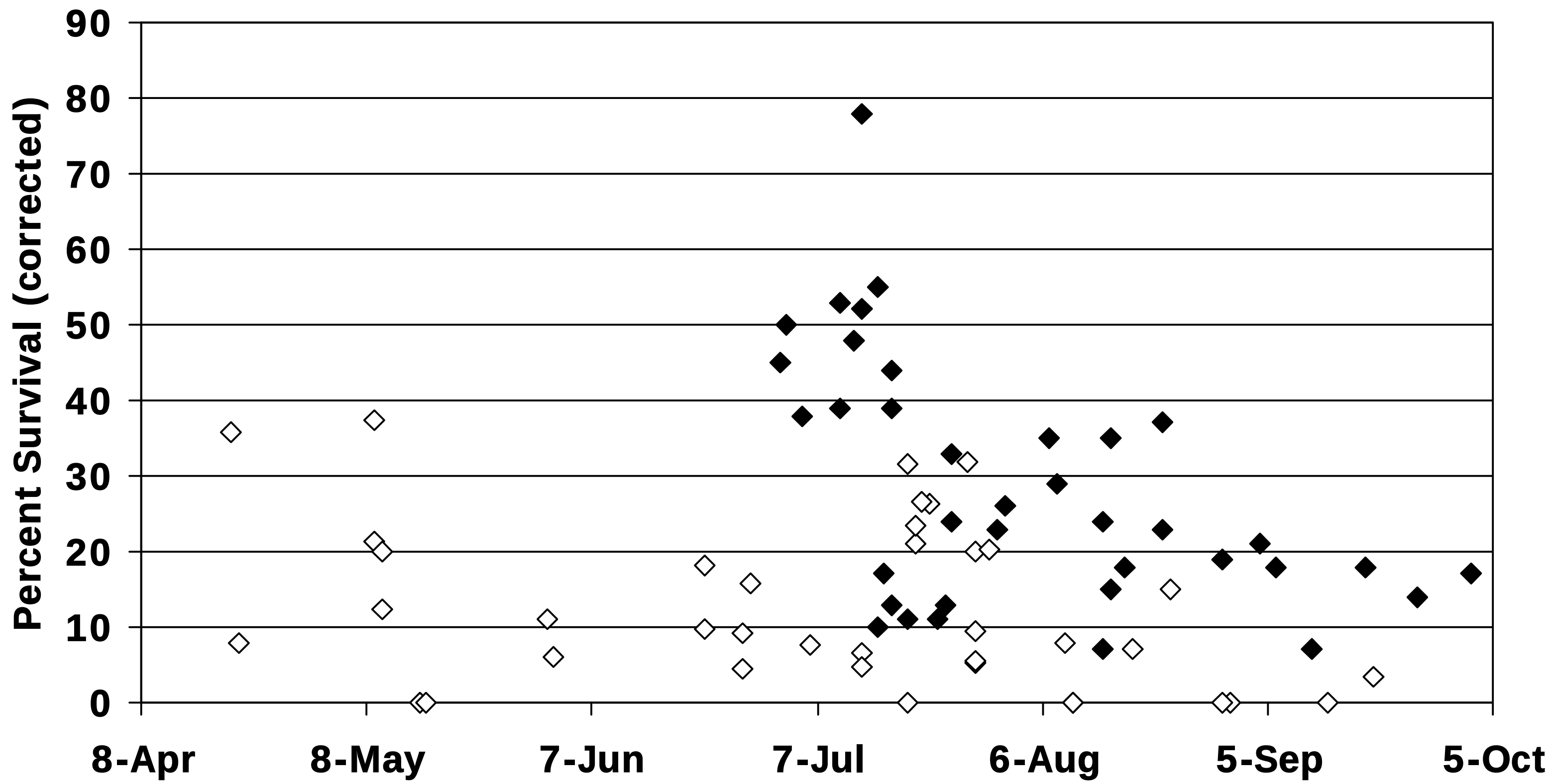
Chemical	Gen.	No. Reps	ED_{90} (µg/g larval wt.)	95% C.I.	Change (+/-) from Tift Co. 2005	Change (+/-) from Tift Co. avg	Slope ± SE
?-cyhalothrin							
Tift Co.	F_1	5	46.89	20.23 – 215.59	+44.13	+43.36	1.11 ± 0.18
Cypermethrin							
Tift Co.	F_1	5	14.87	10.63 – 24.95	+0.21	+9.28	1.99 ± 0.26

Table 7. LD_{50}'s for ?-cyhalothrin and cypermethrin against larval *Heliothis virescens* (TBW) at 72 hr post-treatment. 2007.

Chemical	Gen.	No. Reps	LD_{50} (µg/g larval wt.)	95% C.I.	Change (+/-) from Tift Co. 2005	Change (+/-) from Tift Co. avg	Slope ± SE
?-cyhalothrin							
Tift Co.	F_1	5	11.89	5.82 – 50.56	+10.70	+10.78	0.78 ± 0.17
Cypermethrin							
Tift Co.	F_1	5	5.70	4.32 – 7.72	+1.38	+0.99	1.51 ± 0.22

Table 8. LD_{90}'s for ?-cyhalothrin and cypermethrin against larval *Heliothis virescens* (TBW) at 72 hr post-treatment. 2007.

Chemical	Gen.	No. Reps	LD_{90} (µg/g larval wt.)	95% C.I.	Change (+/-) from Tift Co. 2005	Change (+/-) from Tift Co. avg	Slope ± SE
?-cyhalothrin							
Tift Co.	F_1	5	510.86	94.18 – 29,513	+500.08	+468.00	0.78 ± 0.17
Cypermethrin							
Tift Co.	F_1	5	40.35	23.93 – 97.78	+17.36	-50.68	1.51 ± 0.22



2006 (n=742 moths tested)
2007 (n=1,057 as of Oct 3)

Fig. 1. Percent survival of adult male *Helicoverpa zea* in treated vials at 5 g cypermethrin per vial. Open diamonds are data from 2006 and closed diamonds are from 2007.

IMPORTANCE OF NATURAL ENEMIES FOR STINK BUG CONTROL IN GEORGIA: 2007

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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*. 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. The purpose of this project is to characterize the suite of stink bug natural enemies present in Georgia and to determine their efficacy.

Methods

Parasitoid and Pathogen Survey. Cotton (Bollgard II, DPL434), Group 5 soybeans, and Group 7 soybeans were planted in Sumter County, Tift County, and Decatur County, Georgia. These crops were sampled regularly 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 in the photoperiod of 14 hours. 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 three criteria: (1) parasitoid egg(s) present on the bug cuticle, (2) parasitoid emerged from the bug, and/or (3) parasitoid immatures present in bug at the time of host death.

Predation of Stink Bug Egg Masses. In addition to assessing parasitism of nymphs and adults, egg masses were occasionally placed in the field to evaluate parasitism of eggs. Available egg masses were placed in eight cotton plots, four of which were treated with hydramethylnon ant bait (Amdro®) to exclude the red imported fire ant, *Solenopsis invicta* (Hymenoptera: Formicidae). Each plot was 0.5 acres. Egg masses were placed on the center row of each plot, with 1.5 m between placement sites, radiating out from the center of the plot. The number of egg masses placed and the duration of their tenures in the field varied among trials. All plots were planted with Bt cotton (DPL 555BR) on 4 June 2007. 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 *S. invicta* inclusion plot and one *S. invicta* exclusion plot. Plots were approximately square, and a 10x10m area in the center of each plot was designated for sampling. *Solenopsis invicta* exclusion plots were treated with Amdro at a rate of 1.1 kg of formulated bait per ha on 28 June, 16 July, 4 August, and 22 August 2007 to eliminate *S. invicta*. To assess the exclusion treatment, ant detection tests were conducted on 6 August and 2 September. This test consisted of placing three 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 tallied.

Predation trials were conducted using egg masses of two species of stink bug: *P. guildinii*, and *N. viridula*. Eggs of *N. viridula* were obtained from a lab colony, whereas eggs of *P. guildinii* were obtained from field-collected adults. Three separate predation trials were conducted during the 2007 field season (11-14 July, 24-27 July, and 21-25 September); however, the number of eggs obtained for each trial varied due to inconsistent egg availability, causing the amount of replication used during the trials to fluctuate. During the 11 July trial a total of 8 egg masses of *N. viridula* were placed in cotton foliage of two treatment plots (four masses per plot) – one excluding ants and one including them. Thirty-two egg masses of *P. guildinii* were also placed in cotton foliage of the same two treatment plots (16 masses per plot). One egg mass was stapled to the lower surface of the uppermost, expanded leaf per cotton plant (total of 40 plants utilized). Five egg masses were placed on plants in each of 4 rows of cotton, which were separated from one another by three rows. One egg mass of *N. viridula* and four egg masses of *P. guildinii* were placed in each row. All egg masses were collected on 14 July and egg counts were not conducted between egg deployment and collection (3-day period). During the 24 July trial 20 egg masses of *N. viridula* were divided evenly among four plots (two ant exclusion plots and two inclusion plots). These eggs were similarly attached to the underside of the uppermost, fully expanded leaf. After deployment, these eggs similarly remained in the field for a 3-day period during which no egg counts were conducted until the final collection day (27 July). During the September predation trial, 34 egg masses were placed evenly among all eight treatment-plots (four or five per plot). Egg counts were then made at 1, 72 and 96 hours after all eggs had been deployed. The activity of predators on egg masses was observed during each egg mass count period. Predators were identified to species in the field 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. Due to the varying availability of stink bug egg masses data were analyzed using a one-way analysis of variance for each sampling period. Data from the 11 July sampling period were analyzed using one-way ANOVA (Proc GLM) with *S. invicta* status (presence or absence) as the treatment factor using SAS for Windows version 8. Data from the 24 July and 21 September sampling periods were similarly analyzed using one-way ANOVA (proc GLM); however, due to a high degree of variability across treatment plots, comparisons were made between plots from individual treatment blocks in order to search for significant differences that would not have been apparent across the entire field site.

Results and Discussion

Parasitoid and Pathogen Survey. A total of 1559 stink bugs of all life stages were collected in the survey, with the predominant species being *N. viridula* (Table 2), which accounted for 1165 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 nymphal and adult bugs was low, and the majority of the parasitism (82.3%) was concentrated on the adult stage. Only 31 individuals were parasitized in the nymphal stages, and only in the 4th and 5th instars.

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 which fly larvae bore into the host to become internal parasites. One adult specimen of *E. servus*, which had three fly eggs on its membranous wing, yielded an adult of the tachinid fly *Euthera tentatrix.* A possible third fly species was also obtained from a few bug specimens, based on differences in the puparial structure, but no adults emerged from these puparia. Two bugs were parasitized by an unidentified braconid wasp that produced a white cocoon. One of the bugs was collected on soybeans in Plains on 18 September as a fifth instar (*N. viridula*), from which the parasitoid emerged while the bug was still a nymph. The other wasp emerged from the adult stage of a *E. servus* collected as a fifth-instar nymph on soybeans in Tifton on 12 September.

Tachinid eggs on the bodies of the stink bugs were most commonly found on the ventral surface of the body, and most typically on the thorax (Fig. 1), with the total number per bug ranging from 1 to 7 eggs. As others have noted (e.g., McPherson et al. 1982), however, the presence of eggs may not be a particularly good indicator of parasitism, as many of the eggs fail to translate into larvae developing in the host (Fig. 2). In our study, of the 165 bugs encountered with external eggs only 52.7% produced parasitoids (including those that were dissected from hosts that died). However, 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. 2). Further, an additional 28 bugs produced fly parasitoids without having external eggs on them -- about 1/3 as many as emerged from bugs with eggs on the integument. 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 poor predictors of actual parasitism and mortality rates.

Male *N. viridula* were more heavily attacked by tachinids than were females, with 30.2% of males being parasitized compared to 22.7 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 soybeans. The first was an adult female *E. servus* collected in Tifton on 24 September. The second was an adult male *E. servus* collected in Plains on 10 October. 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. This represents 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.

Predation of Stink Bug Egg Masses. Surprisingly, egg masses of *P. guildinii*, in cotton foliage suffered no attrition by predators, including *S. invicta*. Laboratory observations confirmed that although *S. invicta* workers investigated and manipulated egg masses of *P. guildinii* with their mandibles, they do not eat the eggs. Unlike the eggs of *P. guildinii*, eggs of *N. viridula* were observed in the field to be readily fed upon by *S. invicta* and the big eyed bug *Geocoris punctipes* (Hemiptera: Geocoridae). Actual egg removal rates, however, varied greatly among dates as well as treatment blocks. During the 11 July stink bug egg trial stink bug loss rates did not differ between ant exclusion plot one and ant inclusion plot one after three days ($F_{1,6}$=2.95, P=0.13). During the 24 July trial there were similarly no differences between exclusion and inclusion plots for either block one or block two ($F_{1,8}$=1.95, P=0.2; $F_{1,8}$=3.6, P=0.09). Predation rates did, however, differ significantly during the September stink bug egg mass trial (Table 3). Although there were no significant differences in predation rates between inclusion and exclusion plots from blocks one, two or three, there were significantly more eggs absent from *S. invicta* inclusion plots 72 hours post-deployment ($F_{1,8}$=6, P=0.04). At 96 hours post-egg deployment, significantly more eggs were found with their contents removed (shell left intact) in *S. invicta* exclusion plots than in inclusion plots ($F_{1,8}$=5.69, P=0.04); however, total predation (proportion of eggs removed, emptied and chewed) was significantly higher in inclusion plots than exclusion plots ($F_{1,8}$=11.52, P=0.009, Table 3).

This study is among the first to assess the impact of *S. invicta* predation on eggs of stink bugs (see also Krispyn and Todd 1982). Predation on stink bug eggs by *S. invicta* varied considerably among treatment blocks. Ehler (2002) observed that although predators readily fed upon nymphs of *N. viridula*, they rarely fed upon *N. viridula* eggs. In the current study we observed predation on eggs of *N. viridula* by both *S. invicta* and *G. punctipes*; however, eggs of *P. guildinii* were left untouched for the duration of egg predation trial (3 days). As noted above, the avoidance of *P. guildinii* eggs by predators has also been observed in laboratory feeding trials (Ruberson, unpubl. data) and suggests that within the Hemiptera there may be defensive chemicals secreted onto the surface of eggs, some of which deter predation. Bundy & McPherson (2000) observed a great deal of variation in the surface architecture of stink bug eggs which may also influence the ability of predators to feed on the eggs of particular species. These factors may have strong implications for pest management given that *P. guildinii*, originally from South and Central America, appears to be expanding its range in the southern US, and is becoming a significant pest of US soybeans (Panizzi & Slansky 1985, J. Temple, Louisiana State Univ., personal comm.).

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Table 1. Stink bug sample dates and protocols for the respective locations, 2007.

Location	Dates sampled	Crops sampled	Sampling procedure
Attapulgus, Decatur Co., Georgia	25 July	Soybeans (Group V)	240 sweeps
	15 August	*Peanuts*	200 sweeps
		Cotton	200 sweeps
		Soybeans (Group V)	300 sweeps
	30 August	Cotton	300 sweeps
		Soybeans (Group V)	300 sweeps
	7 September	Cotton	300 sweeps
	20 September	Soybeans (Group VII)	280 sweeps
	9 October	Soybeans (Group VII)	500 sweeps
		Cotton	300 sweeps
		Peanuts	300 sweeps
Plains, Sumter Co., Georgia	27 July	Soybeans (Group V)	240 sweeps
		Cotton	480 sweeps
	1 August	Soybeans (Group V)	270 sweeps
		Soybeans (Group VII)	270 sweeps
		Cotton	400 sweeps + 10 m shakes
	7 August	Soybeans (Group V)	280 sweeps
		Soybeans (Group VII)	280 sweeps
		Cotton	300 sweeps + 10 m shakes
	14 August	Soybeans (Group V)	280 sweeps
		Soybeans (Group VII)	280 sweeps
		Cotton	300 sweeps + 10 m shakes
	21 August	Soybeans (Group V)	280 sweeps + 10 m shakes
		Soybeans (Group VII)	280 sweeps + 10 m shakes
		Cotton	500 sweeps + 10 m shakes
	28 August	Soybeans (Group V)	280 sweeps + 10 m shakes
		Soybeans (Group VII)	280 sweeps + 10 m shakes
	4 September	Cotton	442 sweeps
		Soybeans (Group V)	280 sweeps + 10 m shakes
		Soybeans (Group VII)	280 sweeps + 10 m shakes

	11 September	Soybeans (Group V)	280 sweeps + 10 m shakes
		Soybeans (Group VII)	280 sweeps + 10 m shakes
	18 September	Soybeans (Group V)	280 sweeps + 10 m shakes
		Soybeans (Group VII)	280 sweeps + 10 m shakes
	4 October	Soybeans (Group V)	500 sweeps
		Soybeans (Group VII)	300 sweeps
Tifton, Tift Co., Georgia	22 August	Soybeans (Group V)	250 sweeps
	29 August	Cotton	250 sweeps
	12 September	Soybeans (Group V)	250 sweeps
		Soybeans (Group VII)	250 sweeps
	19 September	Soybeans (Group V)	280 sweeps
		Soybeans (Group VII)	280 sweeps
	2 October	Millet	2 hours of searching heads
		Soybeans (Group V)	280 sweeps
		Soybeans (Group VII)	280 sweeps
	11 October	Soybeans (Group V)	280 sweeps
		Soybeans (Group VII)	280 sweeps
	23 October	Millet	2 hours of searching heads
	30 October	Millet	2 hours of searching heads

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	1st instar	0	8	0	8 (0)
	2nd instar	1	48	1	50 (0)
	3rd instar	0	86	8	94 (0)
	4th instar	20	74 (3)	64 (4)	158 (7)
	5th instar	6	207 (18)	143 (5)	356 (23)
	Adult male	15 (1)	147 (49)	85 (32)	247 (82)
	Adult female	3	168 (36)	81 (21)	252 (57)
Euschistus servus	2nd instar	0	7	0	7 (0)
	3rd instar	1	21	6	28 (0)
	4th instar	4	24	7	35 (0)
	5th instar	2	66	24 (1)	92 (1)
	Adult male	3	29	5	37 (0)
	Adult female	8	52 (1)	7	67 (1)
Acrosternum hilare	4th instar	0	18	5	23 (0)
	5th instar	0	5	2	7 (0)
	Adult male	0	20 (2)	0	20 (2)
	Adult female	0	19 (2)	0	19 (2)
Piezodorus guildinii	5th instar	2	0	3	5 (0)
	Adult male	7	0	3	10 (0)
	Adult female	2	0	9	11 (0)
Euschistus tristigmus	Adult male	3	0	4	7 (0)
	Adult female	7	2	3	12 (0)
Euschistus quadrator	Adult male	1	1	2	4 (0)
	Adult female	10	0	0	10 (0)

Table 3. Proportion (±SE) of *Nezara viridula* eggs preyed upon in fire ant inclusion and exclusion plots of each cotton block at 72 and 96 hours after eggs were initially deployed (on 24 July 2007). Predation type refers to the method by which eggs were fed upon. In cases where egg contents were removed the eggshell remained in place. Asterisks denote significant differences between inclusion and exclusion plots at the indicated time interval, based on one-way analysis of variance (ANOVA, *P<0.05).

Trial location	Proportion of eggs preyed upon at specified observation time:			
	Time since deployment (hrs)	Predation type	*Ant inclusion*	Ant exclusion
Block 1	72	Eggs removed	0.005 ± 0.005	0.019 ± 0.010
	96	Eggs removed	0.015 ± 0.010	0.013 ± 0.008
Block 2	72	Eggs removed	0.270 ± 0.240	0
	96	Eggs removed	0.039 ± 0.020	0
Block 3	72	Eggs removed	0.065 ± 0.060	0.035 ± 0.030
	96	Eggs removed	0.065 ± 0.060	0.047 ± 0.040
Block 4	72*	Eggs removed	0.600 ± 0.240	0.072 ± 0.070
	96*	Eggs removed	0.800 ± 0.200	0.081 ± 0.070
	96*	Only egg contents removed	0	0.013 ± 0.005

Fig. 1. Relative abundance and distribution of tachinid eggs on the bodies of parasitized stink bugs. Solid portions of the bars indicate the ventral surface, and stippled portions indicate the dorsal surface of the bug's integument.

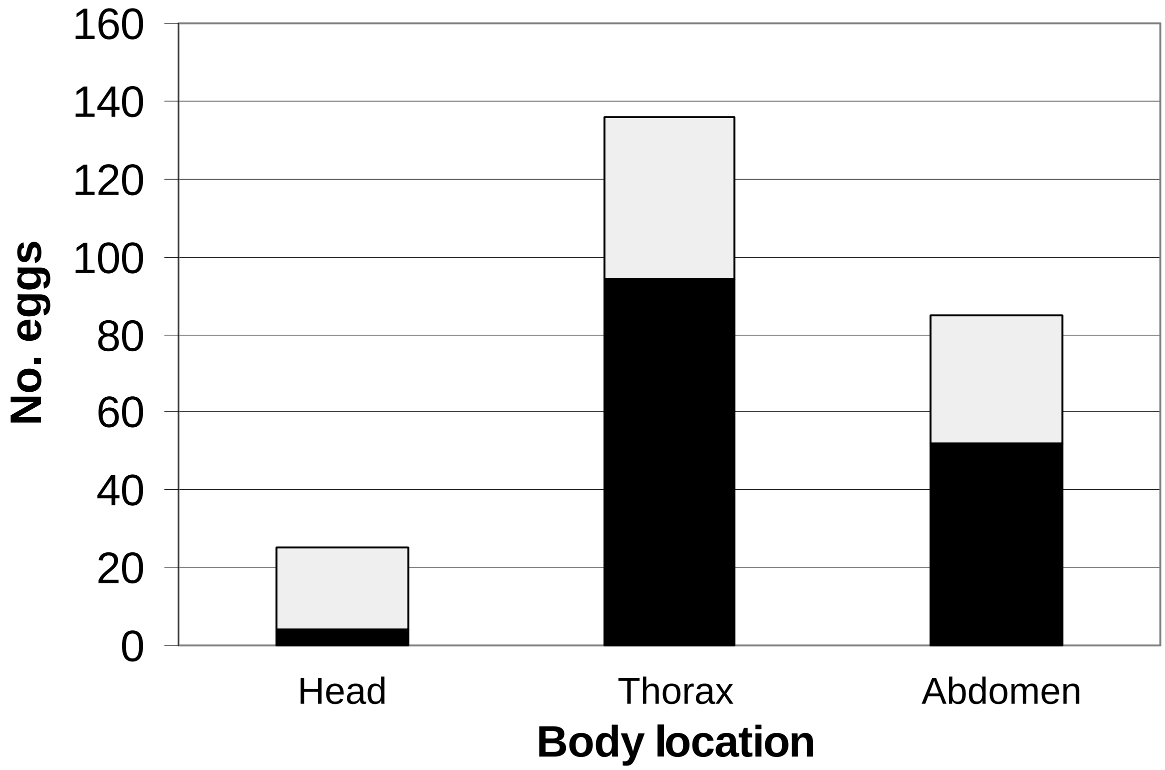
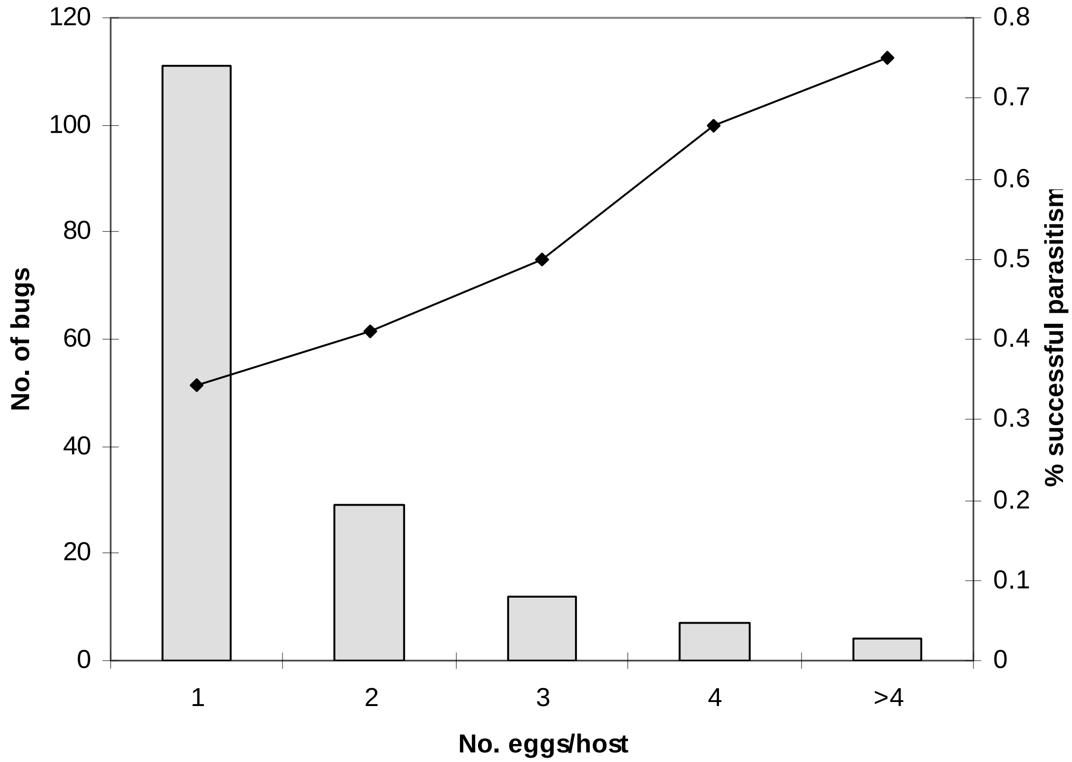


Fig. 2. Numbers of tachinid eggs per stink bug body (solid bars) in relation to successful stink bug parasitism (line). Parasitism is successful if a parasitoid was able to develop within the host to at least the second larval instar.



BURNDOWN TIMING OF CRIMSON CLOVER OR WHEAT SURFACE RESIDUES IN CONSERVATION TILLAGE AND ASSOCIATION WITH THRIPS MANAGEMENT IN COTTON

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Introduction

Use of conservation tillage in cotton production has economic advantages for growers. Increased hazard for pest problems in reduced tillage cotton occurs during the seedling plant stages, with enhanced risk for problems with cutworms, beet armyworms, aphids, and plant bugs. On the other hand, tobacco thrips, *Frankliniella fusca* (Hinds), infestations are reduced in conservation tillage cotton systems. Use of legume (crimson clover) over grass cover crop prior to conservation tillage cotton may have agronomic advantages, but influence on seedling pests such as thrips, cutworms, and plant bugs is not well understood. Seedling pests can be controlled with insecticides, but efficacy of various products in conservation tillage is not well understood. Temik^{R} (15% granule) is a common planting time insecticide for thrips management in cotton at a rate of approximately 3.5 lbs product/acre, with the granules applied in a continuous stream in the seed furrow during planting. The insecticide also has some benefit for management of plant feeding nematodes using in-furrow placement of granules. Temik^{R} rates can be reduced by half or more using precision or spot placement of the insecticide with seed, and thrips control is as good or better than seed furrow application of the insecticide. The objective was to study the influence of legume (crimson clover) vs grass (wheat) cover crops on thrips infestation of seedling cotton. The influence of selected glyphosate burndown timing regimes on the two cover crops and precision placement of Temik^{R} with cotton seed on thrips management was evaluated in each cover crop system.

Materials and Methods

An experiment was established at the University of Georgia Plant Sciences Farm near Athens. A field was tilled 2/12/2007 and randomized into six sections, of which three were planted in crimson clover and three in wheat. Each of those sections was then split into four blocks to serve as the 1^{st}, 2^{nd}, and 3^{rd} burndown (conservation tillage), and a conventional tilled block. Three glyphosate applications @ 13 ounces/acre were made to wheat or clover in plots at 32, 15, and 5 days before planting cotton. Temik^{R} @ 0.64 lbs/acre was applied on top of each seed with a bazooka applicator device (precision placement) prior to closing the seed furrow, and untreated check plots (4 rows each) were established in each conservation tillage burndown or conventional tillage block. Cotton, DP164BIIRF, was planted 05/15/2007 with a John Deere vacuum planter. Burndown plots were 8 rows x 20 ft long x 38 in row width with 3.5 inch seed spacing.

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 at 21 and 28 days after planting and immersed in alcohol to remove thrips. Thrips samples were returned to the laboratory where immature and adult thrips were identified and counted using a dissecting microscope. It was not possible to irrigate the test field after midseason, so yield was not taken due to severe drought damage to the cotton. Data was analyzed using SAS GLM ($P<0.05$) procedures and t-tests LSD for separation of means.

Results and Discussion

The thrips data from the samples taken at 21 and 28 days in each plot were combined for analysis. The alcohol samples contained mostly tobacco thrips (less than 5% western flower thrips, *F. occidentalis* (Pergande), and flower thrips, *F. tritici* (Fitch)) adults (30%) and immatures (70%) and there was a trend for higher numbers of both life stages in wheat (1.5 thrips/plant) as compared to clover (1.1 thrips/plant) when comparing all the conservation tillage treatments. A similar trend occurred in noninsecticide treatments of conservation tillage wheat (3.3 thrips/plant) as compared to crimson clover (2.3 thrips/plant). Overall, precision placement of Temik^{R} @ 0.64 lbs/acre reduced thrips numbers on plants by 81.4% compared to check plants (difference significant @ $P < 0.05$).

Table 1 shows that thrips populations were significantly less on cotton planted in conservation tillage with either crimson clover or wheat cover when sprayed with glyphosate either 15 or 5 days before planting. Thrips numbers were similar in either crimson clover or wheat plots of conservation tillage. There was no significant difference in thrips on cotton in the conservation tillage plots with burndown applications as compared to conventional tillage at 32 days before planting.

Table 2 shows that the precision placement treatment of Temik^{R} @ 0.64 lbs product per acre did significantly reduce thrips populations in either tillage system. This rate is substantially lower than conventional rates (2.5 to 5.0 lbs/acre) of Temik^{R} used in in-furrow application of granules along the entire length of rows. There was no indication of an additive effect in reducing thrips populations in conservation tillage with Temik^{R}, as evidenced by the insect control that occurred at the different burndown application dates. This is because the thrips control by Temik^{R} in conservation tillage plots with the 32 day glyphosate burndown application (where there was no effect by conservation tillage in reducing thrips numbers) was similar to efficacy of the insecticide in the plots with either the 15 or 5 day glyphosate burndown applications.

We have observed the increase in thrips numbers on cotton planted in conservation tillage residues with longer burndown timing (30 or more days) before planting in other tests and it is difficult to explain. Some regrowth of weedy plants in the plots had started at the time the cotton was germinating and these plants may have attracted or sustained thrips populations. These data indicate that waiting longer than 15 days to plant cotton after glyphosate burndown of surface residues in conservation tillage increases hazard for thrips infestations.

Table 1. Timing of glyphosate burndown of clover or wheat on thrips infestations in conservation tillage cotton not treated with insecticide.

Tillage Regime	Burndown Timing (days before planting) $\bar{x}$ no. thrips/plant		
	32	15	5
Conservation Till Wheat	4.8 a	1.3 a	2.0 a
Conservation Till Clover	3.8 a	1.5 a	1.5 a
Conventional Till	4.2 a	4.2 b	4.2 b

Means within columns with the same letter are not significantly different in analysis of variance $P<0.05$.

Table 2. Thrips control with Temik at 0.64 lbs/acre applied by precision placement with cotton seed planted in either different glyphosate burndown regimes in conservation tillage with crimson clover or wheat cover or in conventional tillage plots.

Tillage Regime	Burndown Timing (days before planting) $\bar{x}$ no. thrips/plant		
	32	15	5
Conservation Till Wheat	4.8 a	1.3 a	2.0 a
Temik Precision Placement	1.2a	0.7 b	0.9 b
Conservation Till Clover	3.8 a	1.5 a	1.5 a
Temik Precision Placement	0.6 b	0.5b	0.7 b
Conventional Till	4.2 a	4.2 a	4.2 a
Temik Precision Placement	0.8 b	0.8 b	0.8 b

Means within columns with the same letter are not significantly different in analysis of variance $P<0.05$.

EVALUATION OF SELECTED INSECTICIDES FOR CONTROL OF BOLLWORM (BW) AND TOBACCO BUDWORM (TBW) ON NON BT COTTON AT THE SOUTHEASTERN BRANCH RESEARCH AND EDUCATION CENTER, MIDVILLE

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Introduction

We have conducted full season efficacy trials of new and recommended (University of Georgia, Cooperative Extension Service) insecticides on non-Bt cotton at the Southeastern Branch Research and Education Center (SEBRS), Midville, for over 30 years as a way to track chemical performance in eastern cotton growing areas of the state, which typically has high percent bollworm, Helicoverpa zea (Boddie), (BW) compared to tobacco budworm, Heliothis virescens (Fabricius), (TBW) populations in heliothine infestations. The SEBRS generally experiences moderate to high heliothine infestations in non-Bt cotton, so insecticide testing gives a fair indication of chemical performance in both Bt and non-Bt cotton situations requiring heliothine control. The recent report of Bt resistant populations of H. zea in more than a dozen crop fields in Mississippi and Arkansas between 2003 and 2006 (http://www.erekalert.org/pub/2008-02/uoa-fdc020508.php) gives credence to the concept of keeping abreast of insecticide performance on non-Bt cotton varieties, as these type cotton varieties may have greater use if Bt resistance becomes widespread.

Materials and Methods

The test had a RCB design with 4 replications and one untreated check per replication. The plots were 4 rows by 50 ft with an untreated row on each side of a plot. The rows were planted with DPL494RR cotton on beds spaced 38 inches apart using a 4-row Max Emerge II John Deere planter. Temik® 15G at 3.0 lbs/acre was placed in-furrow at planting for early season thrips control. Treatment applications began on 7/19 when square damage was approaching threshold. Treatments were applied with a CO_2 spraying system mounted on a high cycle sprayer traveling at 3 mph. Treatments were applied at a spray volume of 10 gpa, at 50 psi, with 3 nozzles per row. TX-3 hollow cone nozzles were used. Treatments were applied on 7/19, 7/26, 8/02, and 8/08. Efficacy surveys were done by randomly selecting 5 plants from the middle two rows of each plot and counting all squares on the upper half of each plant. All counted squares, flowering squares, and small bolls were checked for feeding damage and the presence of larvae. A Hardstack moth trap baited with either *H. zea* or *H. virescens* sex pheromone was placed adjacent to the test area. The efficacy surveys and trap counts were conducted on 7/03, 7/12, 7/19, 7/26, 8/02, and 8/08. On 11/6, yield was determined by mechanically harvesting the two middle rows of each plot. Means for percentage and yield were analyzed using ANOVA for RCB with means separation using Tukey's Studentized Range, with $P<0.05$.

Results and Discussion

The sex pheromone traps had a high ratio of *H. zea* compared to *H. virescens* from mid-July through mid-August, which was the period when larval infestations of cotton were highest (Tables 1 and 2). The untreated check plots had high larval infestations during mid-July through mid-August. All of the insecticide treatments reduced damage significantly more than the untreated checks on 7/26, 8/02, and 8/08. Rynaxypyr (DPX-E2Y45 SC 200g/L) at 0.088 lbs AI/acre had best overall efficacy throughout the test. Karate Z[R] (lambda-cyhalothrin) at 0.025 lbs AI/acre did not perform as well as expected. Karate Z[R] has been used for over a decade in tests at the SEBRS at various rates and has produced good control of heliothine infestations in the past. Diamond[R] 0.83 E (novaluron) used at a rate of 0.83 lbs AI/acre had improved efficacy with each application beginning on 7/19 and ending on 8/8. The combination treatments of Diamond[R] with Karate Z[R] had improved efficacy over either product alone. The two Cobalt[R] (chlorpyrifos 2.5 lbs + gamma-cyhalothrin 0.045 lbs/gal) treatments of 19 and 29 oz/acre produced significant control of larval damage compared to the untreated check, but did not perform as well as other insecticide the treatments. Tracer[R] (spinosad) produced good control of insect damage at a rate of 0.062 lbs AI/acre. Prolex[R] (gamma-cyhalothrin) treatments at a rate of 0.0125 lbs AI/acre had >10% infested squares on 7/26 and 8/02, but damage was reduced to 2.3 and 5.0% on 8/08 and 8/15. There were no significant differences in yield in the test, but yield was highest in Prolex[R], rynoxypyr, and Tracer[R] treatments, which were all 600 lbs or more greater in seed cotton than the untreated check cotton.

Table 1. 2007 Pheromone trap counts by date.

Species	7/03	7/12	7/19	7/26	8/02	8/08	8/15	8/22	8/30
H. zea	77	249	322	469	477	590	884	647	431
H. virescens	75	1	0	0	0	1	75	260	91

Table 2. The percent square damage and yield for each treatment on DPL494RR cotton.

Treatment/ formulation	Rate lb (AI) acre	% Damaged Squares				Seed Cotton Yield (lb/acre)
		7/26	8/02	8/08	8/15	
Diamond 0.83EC	0.058	14.8b	11.2bcd	4.8b	4.6b	2465a
Diamond 0.83EC+ KarateZ 2.09CS	0.058+ 0.0125	10.0b	11.3bcd	8.2b	9.4ab	2671a
Diamond 0.83EC+ KarateZ 2.09CS	0.039+ 0.0125	9.7b	5.5cd	4.1b	5.2ab	2692a
KarateZ 2.09CS	0.025	9.7b	10.0cd	11.3b	2.9b	2720a
Cobalt	29 oz/A	18.8b	26.0b	11.0b	6.5ab	2847a
Cobalt	19 oz/A	11.3b	20.7bc	15.4b	7.4ab	2895a
Tracer 4SC	0.062	9.4b	8.4cd	2.6b	4.8ab	3001a
Rynaxypyr	0.088	3.2b	1.9d	0.0b	0.0b	3108a
Prolex	0.0125	11.8b	10.8bcd	2.3b	5.0ab	3184a
Untreated		45.6a	51.6a	47.5a	20.0a	2365a

Means with the same letter within the same column are not significantly different ($P<0.05$).

MANAGEMENT OF THRIPS WITH SELECTED RATES OF TEMIK® IN CONSERVATION TILLAGE AND CONVENTIONAL TILLAGE COTTON

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Introduction

The fact that thrips populations are often reduced in conservation tillage cotton compared to conventional tillage systems was observed in the early 1990s (All et al. 1992). This phenomenon has been verified in subsequent years in many tests where different conservation tillage systems were compared to conventional tillage. However, reduction in thrips on seedling cotton in conservation tillage (which varies by an estimate of 20 to 50% as compared to conventional tillage) does not occur at the same level of suppression as standard rates of Temik® (aldicarb). Over the years, we have evaluated various rates of Temik® in conventional tillage cotton for thrips control (e.g., All 1994, 1995, Roberts and All 1998, Roberts et al. 1999) and have observed a clear reductive response of thrips numbers with increasing Temik® rates on seedling plants. The purpose of this experiment was to determine if the phenomenon of having reduced thrips populations on seedling cotton in conservation tillage could be used to reduce the rate of Temik® required for reducing thrips numbers needed for control of infestations.

Materials and Methods

A test was conducted at the University of Georgia Plant Sciences Farm near Athens in a field with a wheat cover. The field was separated into 8 blocks, 4 blocks were selected for conservation tillage and 4 blocks for conventional tillage. Conventional tillage blocks were mowed, then plowed three times over two weeks to establish a smooth seed bed for planting. Cotton, DP164BIIRF, was planted 6/15 with a John Deere four-row vacuum planter following a KMC striptill chisel implement that was used in both tillage systems. Granular insecticide hoppers were calibrated to apply Temik® at rates of 5.0, 3.5, 2.5, 1.75, and 0.88 lbs product/acre. Additionally, one treatment with Temik® was done using spot (precision) placement of granules using a bazooka metering device on each seed at a rate of 0.64 lbs product/acre prior to closing the seed furrow. One treatment used seed treated with Cruiser® 5FS (thiamethoxam) at a rate of 2.9 ml/lb of seed. Plots were 4 rows x 25 ft long x 38 in row width. Conservation tillage and conventional tillage blocks were paired and insecticide treatments were arranged in a randomized complete block design.

Thrips populations in the plots were sampled 13, 21, and 27 days after planting by dipping whole plants into 100 ml specimen cups that were half filled with 70% ethyl alcohol. Adult and immature thrips are both removed from leaves in this manner. Twenty plants were taken at random from each plot on each date. The thrips samples were returned to the laboratory where immature and adults were counted and identified using a dissecting microscope. Since the thrips populations were low, the samples from the three collection dates were combined for data analysis. Yield was taken on 11/28 by harvesting the two middle rows of each plot with John Deere cotton picker. The data was analyzed using SAS GLM ($P < 0.05$) and t tests LSD for separation of means.

Results and Discussion

The test was planted late in the season in order to harvest the wheat from the field and because of persistent hot dry weather in June. Low thrips numbers occurred on plants on the three sampling dates (during 21 days after planting) and there was no significant difference in populations in conservation tillage compared to conventional tillage. More than 98% of the adult thrips in the samples were identified as tobacco thrips, *Frankliniella fusca* Hinds. Table 1 shows that the rates of 5.0, 3.5, and 2.5 lbs Temik®/acre that were applied in-furrow significantly reduced thrips numbers on cotton in conservation tillage plots, but the 1.75 and 0.88 lbs Temik® rates did not significantly control the insects. Thrips numbers on conservation tillage with Cruiser® seed treatments or the Temik® precision placement treatments were similar to nontreated plots. In the conventional tillage plots, the Temik® rates of 3.5 and 5.0 lbs product/acre had significantly fewer thrips on plants during the 27 days after planting than the untreated check plots, and the Cruiser® and Temik® precision placement treatments had significantly fewer insects during the sampling period. These results were not expected, as there are usually lower thrips populations in conservation tillage systems and may reflect the fact that very low numbers of thrips occurred during the 27 days of sampling. The weather was hot and very dry during the period and may have influence insect numbers in the test. Overall yield was higher in the conservation tillage treatments than the conventional tillage cotton, but there was no significant difference among treatments. Yield was compromised by a substantial infestation of morning glory, *Ipomoea* sp., in a portion of the field.

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Table 1. Thrips populations on seedling cotton treated with selected rates of Temik® and a seed treatment with Cruiser®. In conservation tillage and conventional tillage cotton.

		Mean thrips/plot		Yield (lbs seed cotton/acre)	
Insecticide	Rate	Conservation Tillage	Conventional Tillage	Conservation Tillage	Conventional Tillage
Untreated		18.5a	18.0a	2013.0a	1850.2a
Temik IF	0.88 lbs/A	11.5ab	13.3ab	1967.8a	1994.9a
Temik IF	1.75 lbs/A	14.3ab	7.0bc	2216.6a	1768.8a
Temik IF	2.5 lbs/A	7.3b	9.3abc	1687.3a	2189.5a
Temik IF	3.5 lbs/A	7.5b	5.0bc	1832.1a	2004.0a
Temik IF	5.0 lbs/A	9.5ab	2.3c	2004.0a	1741.6a
Temik PP	0.64 lbs/A	18.5a	8.8bc	2284.5a	1497.3a
Cruiser	2.9 ml/lb of seed	17.0a	8.8bc	2587.5a	1918.0a

Means followed by the same letter are not significantly different (P<0.05,Tukey).

STINK BUG MOVEMENT INTO COTTON FROM ADJACENT CROPS

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Introduction

Cotton production in Georgia has undergone profound changes in the last two decades. Successful eradication of the cotton boll weevil and deployment of *Bt*-transgenic cotton have helped increase Georgia's cotton acreage from 125,000 acres in 1996 to more than 1 million acres recently. In addition, pest management advancements have helped reduce insecticide applications from more than 15 per year in 1996 to less than 3 in 2007. However, the insect pest complex has also changed and previously unimportant insect pests like stink bugs threaten productivity and fiber quality.

A complex of phytophagous stink bugs including the southern green stink bug, *Nezara viridula*, the green stink bug, *Acrosternum hilare*, and the brown stink bug, *Euschistus servus* have become serious pests of Georgia cotton production. These pests pose difficult management challenges because of limited information on basic ecology, distribution within fields and across the farmscape, and a lack of management tactics other than chemical control. The objective of this study was to determine if adjacent crops were likely to increase stink bug damage near the edges of cotton fields.

Materials and Methods

Four to 5.5 acre conventionally tilled fields were planted using the generic plot plan shown in Figure 1. Two fields (replicates) were planted in Tift County and a third field was planted in Decatur County. Corn (DKC 69-72 P26 RR) was planted the week of May 6, while cotton (DPL 143 B2RF), soybeans (DPL 7870 RR), and peanuts (Georganic) were planted during the week of May 20. All crops were irrigated and grown using conventional agronomic practices, but no insecticides that affected stink bugs were used. Corn, peanuts, and soybeans were harvested when they were ready, all prior to the cotton.

At the end of the year the cotton patch was defoliated, alleys were cut to create plots, the plots were harvested, resulting cotton samples were ginned, and a representative fiber sample was sent to the Macon USDA classing office. A single 2-row by 50-foot plot was cut at three distances associated with each adjacent crop: along the border with each adjacent crop, 30-feet from the border with each adjacent crop, and 60-feet from the border with each adjacent crop. The estimated lint value in each plot was calculated from seedcotton yield, gin turnout, and the 2007 upland cotton loan premium and discount values.

Treatments were arranged in a randomized complete block design and analyzed with ANOVA (adjacent crops) or trend analyses (distance from field edge). Linear contrasts were conducted to investigate the change in response variable as a function of distance from adjacent crops.

Results and Discussion

Statistical differences among adjacent crops or distance from field edges were observed with four response variables including seedcotton yield, gin turnout, fiber yellowness, and lint value. Analyses of seedcotton yield suggested an interaction between adjacent crop and distance from the field edge ($F = 2.59$; $df = 4, 11$; $P = 0.09$) (Figure 2A) and we expect this interaction will become more evident with increased replications. Seedcotton yield increased with distance from the field edge ($F = 4.66$; $df = 2, 11$; $P = 0.03$). Gin turnout also increased with distance from field edge ($F = 4.37$; $df = 2, 11$; $P = 0.04$) but was similar among adjacent crops ($P = 0.33$) (Figure 2B). Fiber yellowness, a symptom of stink bug feeding, decreased with distance from the field edge ($F = 4.94$; $df = 2, 10$; $P = 0.03$) (Figure 3A) but was not influenced by adjacent crop ($P = 0.94$). Overall lint value was also affected by distance from the field edge ($F = 5.28$; df = , 10; $P = 0.03$) but not adjacent crop ($P = 0.64$) (Figure 3B). Significant linear trends ($P < 0.05$) for distance from field edge were apparent for seedcotton yield, yellowness, and lint value.

These data strongly suggest that stink bug damage to cotton bolls was more severe near field edges. We suspect that the infestations generally started on the edge and moved toward the center of the field, but temporal analyses of boll damage are needed to confirm this hypothesis. If true, scouting for stink bugs and their associated damage should be targeted to field edges to improve efficiency. Although less clear from the statistical analyses, it appears from the plotted data that stink bug damage may be worse in cotton planted adjacent to soybeans and peanuts than corn. Further work is needed to better understand these temporal changes in host preference.

Acknowledgements

This work was supported by Cotton Incorporated and the USDA/CSREES Special Grants program. We appreciate excellent technical support from David Griffin, Jessica Corbett, Blake Crabtree, and Seth Hamer.

Figure 1. Generalized plot layout for planting cotton with adjacent corn, peanuts, and soybeans. Overall field size (including all four crops) ranged from 4 to 5.5 acres.

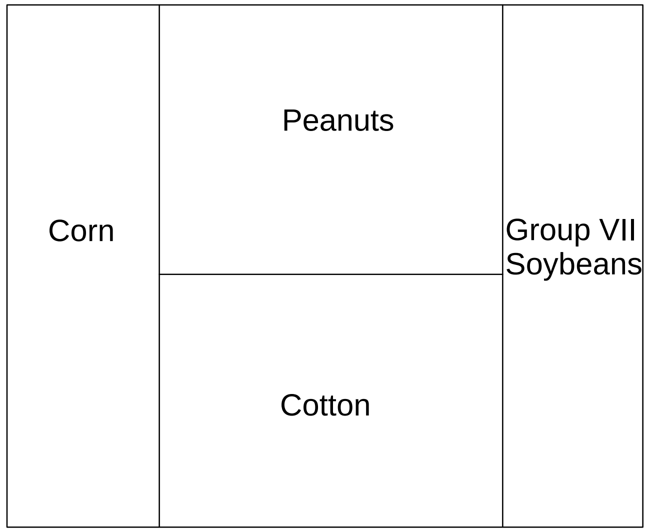


Figure 2. (A) Seedcotton yield and (B) gin turnout as a function of distance from field edge adjacent to corn, peanuts, and soybeans.

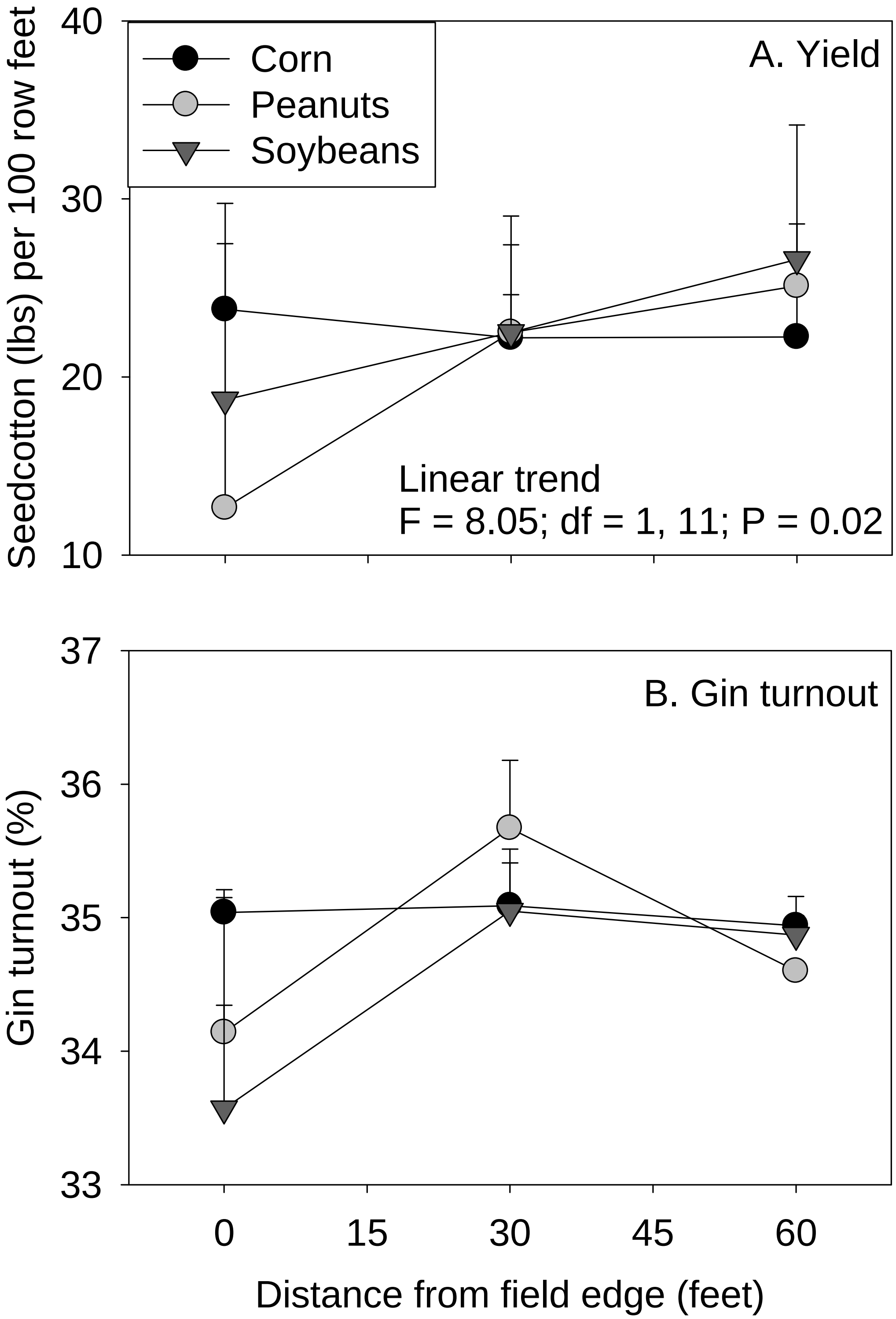
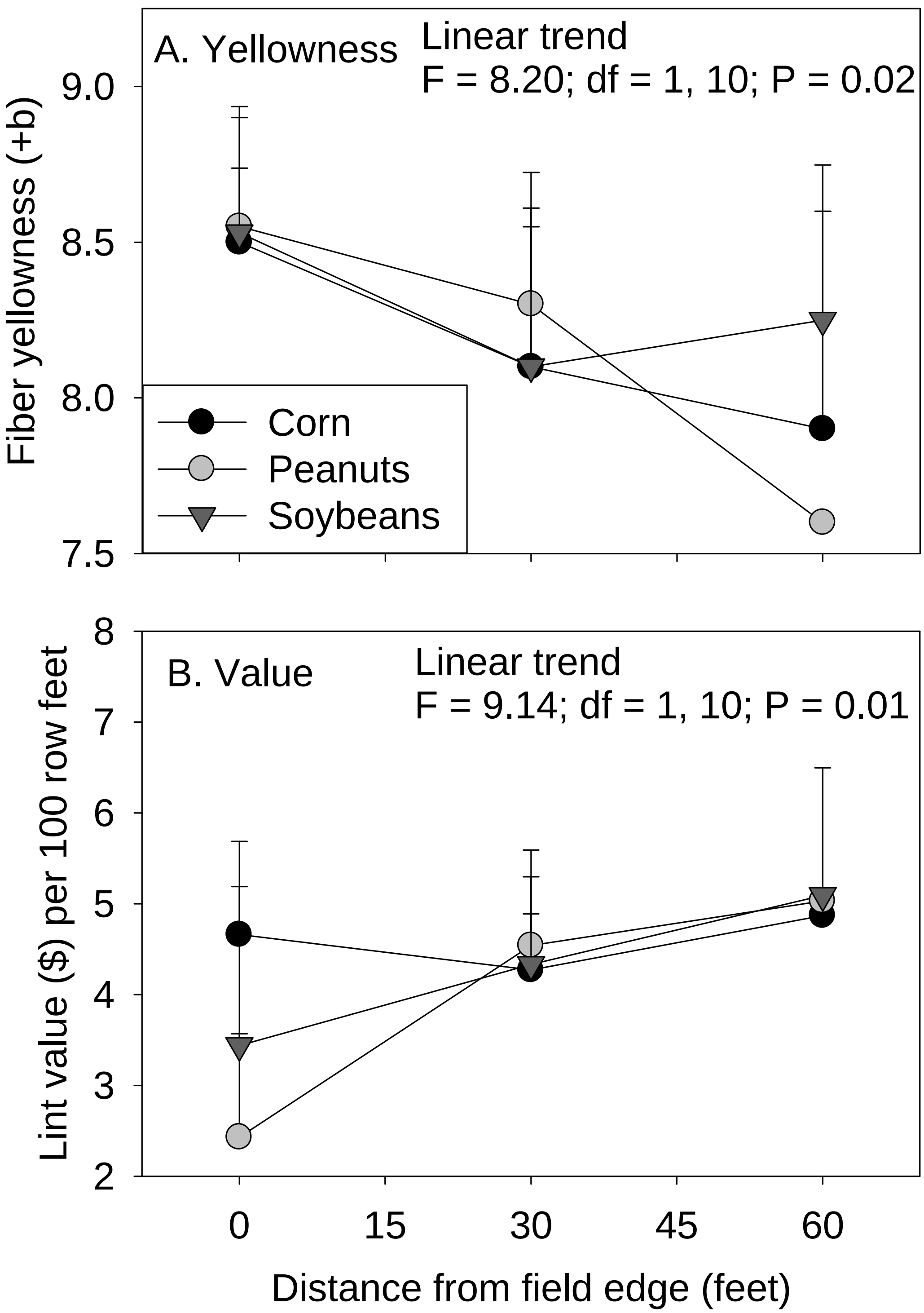


Figure 3. (A) Fiber yellowness and (B) lint value as a function of distance from field edge adjacent to corn, peanuts, and soybeans.



FUNGAL FERMENTATION PRODUCTS FOR CONTROL OF ROOT-KNOT NEMATODES

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Introduction

Plant-parasitic nematodes are serious pests in most Georgia cotton production areas. Results from a survey of cotton fields in Georgia showed that 69% of the sampled fields had root-knot nematodes (Kemerait, 2005). Other nematode species that attack cotton, such as reniform and Columbia lance nematodes, can be found in other fields in Georgia, so it is safe to say that most growers have to deal with nematode problems at some level. In 2006, according to Georgia Cooperative Extension Service estimates, plant-parasitic nematodes caused crop losses equal to 10% of the crop, for a total of $74.5 million in direct economic losses, and incurred 86% of the cost of pesticides used for disease control (Martinez et al., 2007). Plant-parasitic nematodes typically have a scattered, or patchy distribution across farms and production areas, so the actual losses experienced by growers may vary widely from the overall estimates.

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

Materials and Methods

Fermentation products from selected fungal cultures were tested for nematicidal compounds through a series of lab, greenhouse, and field trials. Initially, candidate fungi are isolated from various environments by dilution-plating and use of selective growth media. Using this procedure, thousands of isolates of fungi have been obtained. Fungal isolates are then selected from the collection and evaluated for production of nematicidal compounds. For evaluation, each fungus is placed in flasks containing nutrient agar and fermented with aeration on platform shakers for 10 days. As an in-vitro assay, liquid cultures are micro-filtered (0.22 μm) and pipetted into sterile microwell plates with freshly-hatched Southern root-knot nematode (*Meloidogyne incognita*) juveniles. Sterile water is used as a control treatment. Nematode survival rates are determined at 2, 4, 24, and 48 hours after suspension, with 6 replications per isolate. At the same time that the in-vitro assay is performed, liquid fungal-culture filtrates are also 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 are also applied. Southern root-knot nematode (*M. incognita*) eggs are added to the pots, and cotton (cv. DP555 RR) is planted in each pot to serve as a susceptible host. Each treatment is applied to 6 replications. Plants are grown on greenhouse benches for 45 days. Plant roots are then removed from the pots and washed, and the nematode eggs are collected and counted. Total numbers of nematode eggs are 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 are selected for further evaluation using additional research protocols. The methods used are similar to the greenhouse screening, but with different treatments applied. During the 2007 project, several fungal isolates were selected for evaluation as dehydrated-powdered products. After fermentation of the fungal isolates, filtrates were allowed to air-dry and the resulting material was applied to greenhouse pots as already described. Liquid media from the same fermentation batches were reserved and applied at the same time as the dehydrated products, for comparison.

During the 2007 growing season, advanced-stage fungal isolates were evaluated in field plots. 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 were fermented in quantities sufficient to treat soil in small field plots at rates equivalent to those used in greenhouse studies. Research plots were located at the Attapulgus Research and Education Center. Plots were planted with cotton DP555 RR on 30 April 2007. The fungal treatments, along with a water control, were applied to 16 replicate plots each. Root-knot nematodes (juveniles+eggs) were assayed during the growing season, and cotton was harvested at maturity.

Results and Discussion

In cotton field plots located at the Attapulgus Research and Education Center, soil application of culture filtrates from fungal isolate Ga534 significantly decreased the numbers of root-knot nematodes in soil assays over a time period that extended into late August (Table 1). In the first reading, taken on 2 July 2007, root-knot numbers were reduced by 85% in the plots treated with GA534, as compared to the controls. By 30 August 2007, plots treated with Ga534 still had 40% lower root-knot nematode counts than the controls. At the end of the growing season (10 October 2007) there were no treatment differences. Although root-knot nematode population densities were reduced by application of GA534, significant differences in cotton yields were not observed during the 2007 growing season. The extended control of root-knot nematodes late into the growing season was not expected, and such a long-lasting impact from an at-plant application is not typical of nematicides currently on the market. Usually, nematode counts drop soon after application of a nematicide, then resurge to numbers higher than the untreated controls by the end of the season. This longer-lasting impact could be a valuable tool for protecting the current crop, and could also provide carry-over benefits to subsequent crops. These studies need to be repeated, and eventually scaled up to larger treatment areas. Our program is currently limited in scale by the amount of product that can be fermented in our laboratory.

Table 1. Evaluation of fungal culture filtrates for control of root-knot nematodes (*Meloidogyne incognita*) on Cotton (DP 555 RR) in plots located at Attapulgus Research and Education Center .

Fungal isolate	Number of root-knot nematodes (juveniles+eggs)/ 100 cm^3 soil — Nematode assay date			
	2 Jul 07	30 Jul 07	30 Aug 07	4 Oct 07
Ga516	460 ab*	6,060 a	981 a	489 a
Ga534	115 b	3,154 b	645 b	523 a
Ga630	293 ab	5020 ab	977 a	437 a
Control	756 a	7,511 a	1,068 a	500 a

*Means of 16 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.

Greenhouse studies during 2007 were directed toward evaluation of dehydrated fungal fermentation products for control of root-knot nematodes. Complete factorial design experiments were done to compare liquid and dehydrated-powdered culture filtrates of selected fungal isolates. These studies showed that the culture filtrates from Ga534 and Ga630 performed equally well in control of root-knot nematodes on cotton whether in liquid or powder form. These results are an essential finding in our evaluation of the commercialization potential of the biologically-derived nematicidal products, since marketing and distribution of a product would probably require a dried product.

Acknowledgments

This work was supported in part by the Georgia Cotton Commission and Cotton Incorporated.

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