COTTON
RESEARCH-EXTENSION REPORT – 2011

The University of Georgia
College of Agricultural and Environmental Sciences
Edited by G. Collins, C. Li, and D. Shurley

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2011 GEORGIA COTTON RESEARCH AND EXTENSION REPORT

Edited by Guy Collins, Associate editors: Changying Li and Don Shurley
Compiled by Guy Collins

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

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THE 2011 CROP YEAR IN REVIEW

Guy Collins and Jared Whitaker
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The 2011 production season was certainly unique and quite different from that of 2010. Georgia's planted cotton acreage increased approximately 20 % from 2010, with an estimated 1,520,000 acres harvested in Georgia during 2011, according to the National Agricultural Statistics Service. Most of the irrigated cotton crop this year was planted relatively on time, however the hot dry spring weather conditions resulted in poor stands in some dryland fields, necessitating replanting for many of these dryland fields. As a result, some dryland fields were planted and subsequently developed somewhat later than normal.

The 2011 planting season may have been one of the hottest and driest on record, causing significant stand establishment problems, even in a few irrigated fields with larger pivots that were slow to turn around. Rains returned across most of the state near the end of June, leading into July when earlier planted fields began blooming. The month of July was relatively wet, allowing much of the earlier planted (primarily irrigated) crop to develop a very large boll load with excellent yield potential. Rains began to subside across the state during August, possibly reducing the incidence of boll rot or hard lock issues for the early planted irrigated crop, which are often observed when rains are frequent in August. However, many of the later planted dryland fields began blooming around or near the first of August and the dry August weather may have penalized yield potential in some of these situations. There were also several reports of growers encountering difficulty defoliating which may have also resulted from the August weather conditioning the crop for poor defoliation. The remainder of the fall brought about sporadic rains and some periods of cool temperatures, allowing for more effective defoliation and somewhat decent harvest conditions. Although yields were highly variable depending upon rainfall, the average state yield was estimated at 805 lbs/acre per the January 12th, 2012 USDA NASS Crop Production Report, which isn't bad considering the spring weather. Average statewide yields continue to remain above 800 lbs/acre, despite the loss of DP 555 BR, which is a true testament to Georgia's growers, their commitment to cotton, and the release of superior varieties.

The 2011 season was the first season in several years that DP 555 BR was not planted, finalizing the transition to 2-gene Bt technologies. Now that other factors tend to drive variety selection in particular situations, -and- since a single replacement for DP 555 BG/RR was unlikely, growers began to plant a wider array of varieties in 2011. The 2011 cotton acreage in Georgia was predominately comprised of Deltapine varieties (59.2%), FiberMax varieties (11.7%), and Phytogen varieties (25.2%) (http://www.ams.usda.gov/AMSv1.0/). Herbicide resistant Palmer amaranth (pigweed) continued to be a serious production challenge across much of the state, and was the driving force behind variety selection in many areas.

Quality of the 2011 crop was noticeably better than previous years for some parameters. Of bales classed as of February 9, 2012, 3.7 percent were short staple (<34) and 9.7 percent were high mic (>4.9). Staple and micronaire were similar to that of 2010, and continue to be better than in years preceding 2010, likely due to the fiber characteristics of newer varieties. Fiber length uniformity continues to improve compared to previous years, which is a likely result of the changes in varieties.

Fiber Quality of Bales Classed at the Macon USDA Classing Office, 2008-2011

	Color Grade 31/41 or better (% of crop)	Bark/ Grass/ Prep (% of crop)	Staple (32nds)	Strength (g/tex)	Mic	Uniformity
2008	25 / 93	all < 1.0	34.4	28.7	46	80.2
2009	26 / 96	all < 1.0	35	28.8	45	80.3
2010	50 / 90	all < 1.0	35	29.9	48	81
2011	42 / 88	3 / <1 / 1	35.9	29.5	46	81.7

Bales classed short staple (< 34) and high mic (>4.9)
2008: 20% and 21%   2009: 22% and 20%   2010: 4% and 9%   2011: 3.7% and 9.7%
Fiber quality data as of February 9, 2012. Source: http://www.ams.usda.gov/AMSv1.0/

The UGA Cotton Team would like to sincerely thank the Georgia Cotton Commission for their generous support of the Cotton Team’s research and extension programs, allowing us to better serve Georgia Cotton Growers.

REDEFINING MANAGEMENT STRATEGIES FOR NEW COTTON VARIETIES IN THE POST DP 555 BR ERA

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Introduction

Prior to 2010, approximately 85 percent of the Georgia cotton acreage was planted to DP 555 BR. Due to the expiration of the EPA registration for the Bollgard™ technology, only an approximate 25 percent of the Georgia cotton acreage was planted to DP 555 BR in 2010, with the remaining 75 percent planted to relatively new varieties. In 2011, 100 percent of the Georgia cotton acreage was planted to varieties other than DP 555 BR. The 2011 acreage, and beyond, will likely be comprised of a diverse group of varieties, as a single predominate replacement for DP 555 BR is unlikely in the near future. Some of the most popular new varieties often exhibit vastly different fruiting characteristics than that of DP 555 BR. Most of these varieties tend to set more fruit on lower nodes and less fruit on upper nodes compared to DP 555 BR, and many do not appear to exhibit the excessive vegetative growth characteristics that DP 555 BR did. Therefore, many of the newer varieties may require less aggressive plant growth regulator (PGR) management in order to maximize boll set and lint yields.

Materials and Methods

A series of experiments was conducted during 2010 and 2011 in Tifton, GA and in Midville, GA to investigate the response of several of the newer cotton varieties to various PGR management strategies. These trials were conducted using a randomized complete block design containing four replications. All PGR treatments were applied using a CO_2-pressurized backpack sprayer calibrated to deliver 15 GPA using regular flat-fan nozzles. The objective of Experiment #1 was to quantify the response of several new varieties to an aggressive PGR treatment consisting of Mepiquat Chloride (MC) applied at a rate of 12 oz/A to 9-10 leaf(lf) cotton, followed by (fb) 16 oz/A MC at early bloom (EB), fb 16 oz/A MC at EB+2weeks (wk), and lastly 16 oz/A MC at EB+4wk only if needed to prevent plants from exceeding an optimal plant height. This PGR treatment was representative of a commonly used approach to adequately suppress plant height for DP 555 BR, especially in well-watered environments. The varieties included in Experiment #1 included DP 555 BR, DP 1050 B2RF, DP 1048 B2RF, DP 0949 B2RF, PHY 565 WRF, PHY 375 WRF, PHY 485 WRF, ST 4288 B2F, ST 5458 B2F, and FM 1740 B2F in 2010, and DP 0949 B2RF, DP 1137 B2RF, DP 1050 B2RF, DP 1048 B2RF, DP 0912 B2RF, FM 1740 B2F, FM 1845 LLB2, FM 1773 LLB2, ST 4145 LLB2, ST 4288 B2F, ST 5458 B2RF, PHY 565 WRF, PHY 375 WRF, and PHY 499 WRF in 2011 evaluated in both irrigated and dryland conditions in 2010 and irrigated conditions in 2011. The objective of Experiment #2 was to determine if a pre-bloom MC application was necessary to adequately suppress plant height for some of the new varieties, which included DP 555 BR (2010 only), DP 0949 B2RF, DP 0912 B2RF, and FM 1740 B2F. PGR treatments used in Experiment #2 included a non-treated control; an aggressive treatment consisting of 12 oz/A MC applied to 9-10 lf cotton fb 12 oz/A MC at EB fb 16 oz/a MC at EB+2wk; a mild treatment consisting of 12 oz/A MC at EB fb 16 oz/a MC at EB+2wk; and a non-aggressive treatment consisting of a single application of 16 oz/a MC at EB+2wk. The objective of Experiment #3 was to determine if Stance™ (ST) (usually resulting in milder, or more forgiving, plant height suppression) is a more appropriately used for pre-bloom applications, if justified, for an earlier maturing variety. Varieties included in Experiment #3 included DP 1050 B2RF and FM 1740 B2F and PGR treatments included a non-treated control; 2 oz/A ST applied to 9-10 lf cotton fb 3 oz/A ST at EB; 2 oz/A ST applied to 9-10 lf cotton fb 16 oz/A MC at EB; 3 oz/A ST applied to 9-10 lf cotton fb 16 oz/A MC at EB; 8 oz/A MC applied to 9-10 lf cotton fb 16 oz/A MC at EB; and 12 oz/A MC applied to 9-10 lf cotton fb 16 oz/A MC at EB.

Results

Results from Experiment #1 in 2010 indicated that newer varieties differ in their responses to an aggressive PGR treatment, which was previously required to manage growth of DP 555 BR. The greatest responses in the irrigated trial occurred with DP 555 BR, DP 0949 B2RF, ST 5458 B2RF, ST 4288 B2F, and PHY 565 WRF, however the first two varieties resulted in optimal plant height when treated with this aggressive PGR strategy – the latter three varieties tended to dramatically cease vegetative growth once treated. The greatest responses in the dryland trial occurred with DP 0949 B2RF and PHY 565 WRF, however a large number of the varieties tested were within the optimal plant height range without being PGR-treated. Some other key findings include the following: DP 0949 B2RF exhibited very similar growth potential to that of DP 555 BR in 2010 - all other varieties resulted in less aggressive growth and tended to respond more to PGR treatments; early maturing varieties such as ST 4288 B2RF, FM 1740 B2F, and most of the FM Liberty Link™ varieties (2011 only) tended to result in modest growth potential, suggesting that aggressive PGR management may not be necessary to achieve optimal plant height. In 2011, similar results occurred from this experiment, however the evaluation of newer varieties, including the LLB2 varieties, were interesting (Figures 1-3). Varieties like DP 0949 B2RF, DP 1050 B2RF, DP 1048 B2RF and the new PHY 499 WRF appear to have the most aggressive growth potential. ST4145 LLB2 ranked relatively high based on non-treated plant height but fell two positions in relative ranking when PGR-treated plant height was accounted for. This indicates that ST 4145 LLB2 may respond more so the PGRs than other varieties, but still exhibits growth potential on the medium range. A similar effect was observed for FM 1773 LLB2 and DP 0912 B2RF which also ranked higher than PHY 375 WRF and DP 1133 B2RF in the absence of PGRs, however their relative ranking fell below the latter two varieties once PGR-treated plant height was accounted for. FM 1845 LLB2 and FM

1740 B2F held a lower rank than other varieties regardless of PGR treatment, however some data suggests that FM 1845 LLB2 may be slightly more aggressive than FM 1740 B2F. Results from Experiment #2 indicated that a pre-bloom PGR application was necessary to achieve optimal plant height (38 to 45 inches) for DP 555 BR (2010 only) and DP 0949 B2RF, however the pre-bloom application resulted in less-than-optimal final plant height for the two early maturing varieties; DP 0912 B2RF and FM 1740 B2F. Especially in the case of FM 1740 B2F, optimal plant height was achieved when PGRs were applied at EB or thereafter, suggesting that similar earlier maturing varieties would require very little PGR management if any at all. Results from Experiment #3 suggest that 2 oz/A ST applied to 9-10 lf cotton fb 3 oz/A ST at EB resulted in taller plants compared to 12 oz/A MC applied to 9-10 lf fb 16 oz/A MC at EB for DP 1050 B2RF, however plant height was similar between these two PGR treatments when applied to FM 1740 B2F, suggesting that Stance™ may adequately suppress plant height for FM 1740 B2F whereas MC may be more appropriate for DP 1050 B2RF. Results from Experiment #4 (conducted only during 2010) indicated that 12 oz/A MC applied thrice resulted in significantly different plant height between DP 555 BR and FM 1740 B2F, however these two varieties responded similarly to all other PGR treatments. These results also indicated that 8 oz/A MC applied thrice to DP 555 BR resulted in similar plant height to that of 2 oz/A ST applied thrice to FM 1740 B2F. These data suggests that ST may be a more appropriate PGR option to suppress height for early maturing varieties, whereas standard MC products may be more appropriate for growth management of more vigorous later maturing varieties.

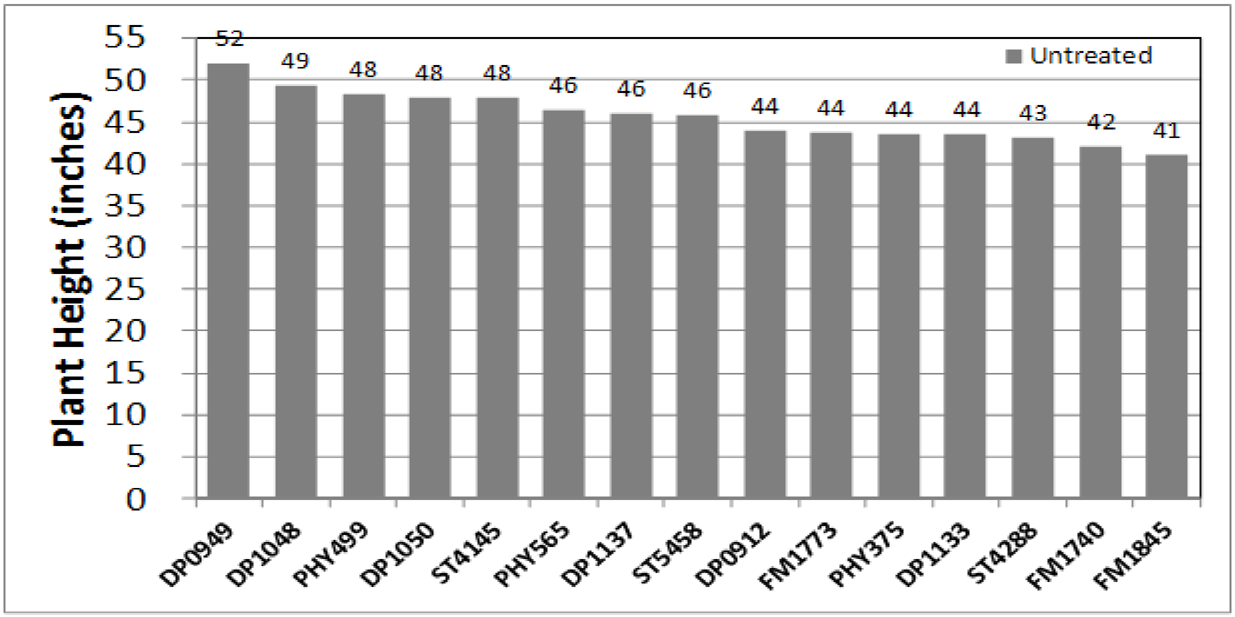

Figure 1. Plant height of non PGR-treated cotton varieties ranked in descending order. Data are combined over 2011 Tifton and Midville trials.

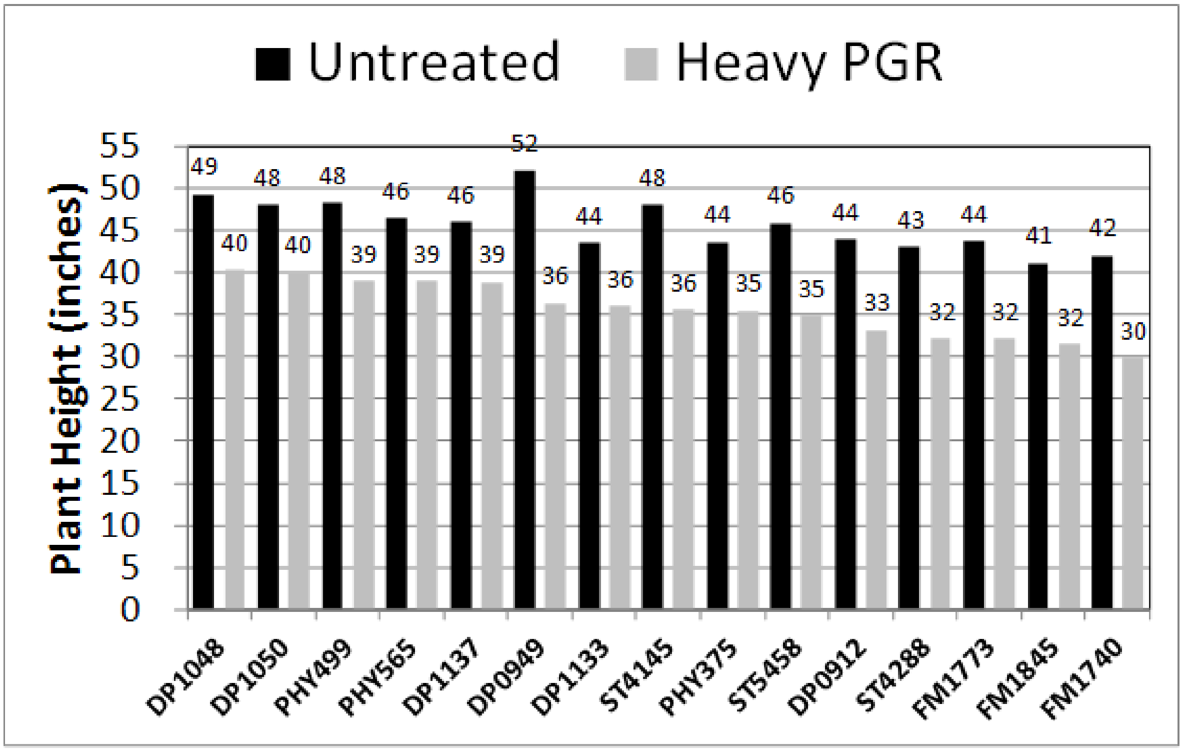

Figure 2. Plant height of PGR-treated cotton varieties ranked in descending order. Data are combined over 2011 Tifton and Midville trials.

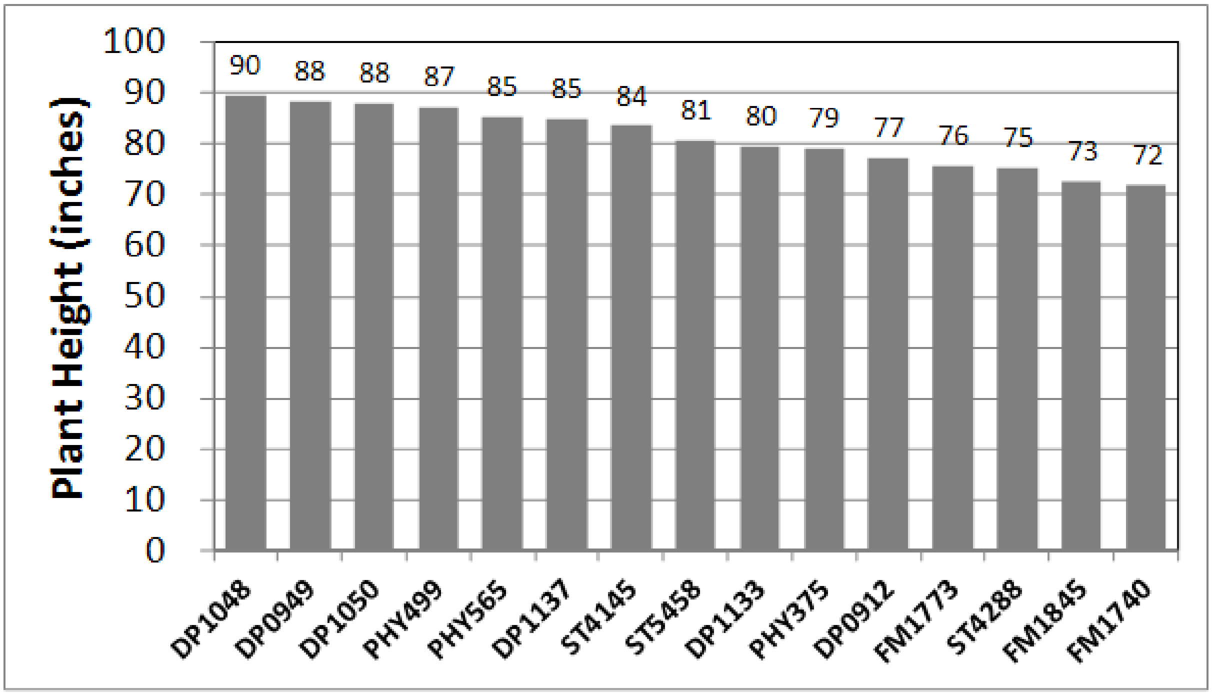

Figure 3. Plant height of the sum of Non-treated plus PGR-treated cotton. Data are combined over 2011 Tifton and Midville trials.

Discussion

In summary, results from these trials suggest that responses to PGR treatments vary among the varieties tested, and that an aggressive PGR strategy may result in suboptimal plant height for some varieties. Therefore PGR decisions should be made on a case by case basis with the variety's growth potential and fruiting characteristics (and especially the environment) taken into consideration. For some of the earlier maturing varieties, a pre-bloom PGR application may not be necessary to adequately suppress plant height. Through this research, varieties can also be grouped based on similarities in growth potential, and PGR recommendations can be made according to variety growth potential, as opposed to a one-size-fits-all management strategy that was used on DP 555 BR. Additionally, the use of Stance™ may be more appropriate than standard mepiquat products for earlier maturing varieties in some environments. This information provides new tools that enable growers to manage growth of new varieties for maximum yield potential. The tools developed through two years of this research may prevent growers from making unnecessary, and potentially yield-inhibitory PGR applications while also preventing excessive vegetative growth of new varieties. In addition, these tools serve as a guide for the appropriate use of certain PGR products in specific varieties and environments. The UGA Extension Cotton Agronomists, Dr. Guy Collins and Dr. Jared Whitaker, sincerely appreciate this opportunity to serve the cotton growers of Georgia through the gracious support of the Georgia Cotton Commission.

MANAGEMENT OF COTTON USING SUBSURFACE DRIP IRRIGATION

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Introduction

Subsurface drip irrigation (SSDI) can be used to achieve excellent yields in cotton in cases where water is a limiting factor. The technology is already used in vegetable production in Georgia, and a few producers are testing the efficacy of using SSDI as an alternative to center pivots in oddly shaped fields that would be not suitable for center pivot irrigation. Irrigation water is commonly applied using overhead sprinkler irrigation systems, which are currently used on approximately half of Georgia cotton acreage. However, negative impacts on fruit retention and changes in fruit distribution have been observed due to overhead irrigation. Jared Whitaker showed in his Master's degree research at the Stripling Irrigation Research Park that the more compact fruiting due to subsurface drip irrigation (SSDI) management can produce high yield and high quality cotton. However, his research focused on one cultivar, DP488BR, which is no longer on the market. The study was also limited to one irrigation rate for overhead irrigation.
In 2010, the University of Georgia began a partnership with the USDA National Peanut Laboratory in Dawson, Georgia, to expand the testing of subsurface drip irrigation in cotton. The bulk of the startup money for this project came through earmark money, most of which was used to pay for installation of the drip irrigation systems that were installed in Camilla, Georgia and in Midville, Georgia.

The initial measurements in 2010, while based on late planted cotton that received irrigation late in the season, suggested both a variety interaction and an increased yield for the drip irrigation methods. The project was quite large, with almost 200 plots established in Camilla. In 2011 the project was expanded, with plots in Midville operational and the plots in Camilla ongoing. The 2011 project narrowed the focus to two varieties subjected to multiple irrigation strategies. The results of the 2011 project revealed useful information for irrigation management in both SSDI and Overhead systems.

Calvin Meeks, a current graduate student under the direction of Dr. Collins, is using this project as his primary thesis research, and has presented the 2011 results at the 2012 Beltwide Cotton Conferences.

Materials and Methods

Research conducted in 2011 utilized SSDI at two depths (2 inch and 12 inch), two rates (65% and 100% of the UGA weekly chart recommendations), two irrigation trigger points (-40 cb and -70cb) for both OVHD and SSDI systems, and with two cultivars (the full-season DP1050 B2RF, and shorter-season FM1740 B2F). This research has two objectives:

1. Identify the growth, yield, and fiber characteristics of cotton subjected multiple subsurface drip and overhead irrigation strategies.
2. Comparing growth, maturity characteristics, yield distribution, and quality under subsurface drip irrigation in multiple environments.
3.

Plant heights and nodes above white bloom data were collected every other week as a measure of plant growth and maturity. Mapping of boll distribution was collected prior to harvest. Lint yield and HVI fiber quality were collected after ginning was conducted at the UGA Microgin.

Results

All irrigation systems and treatments improved yields when compared to dryland (Figure 1). Higher yielding treatments, ranging from the Shallow SSDI irrigated according to 100% of the UGA checkbook down to Shallow SSDI irrigated according to 65% of the UGA checkbook, yielded statistically similar, when pooled across varieties. In general, the -70cb trigger allowed for significant stress resulting in yield loss, when pooled across the two varieties (Figure 1). Yields were generally similar in overhead and SSDI systems. When pooled over the Camilla and Midville locations, data suggests that FM 1740 B2F may have a yield advantage over DP 1050 B2RF when irrigated with most SSDI treatments (Figure 2). Data also suggest that similar yields between the two varieties were only achieved when DP 1050 B2RF was irrigated when triggered at -40cb and FM 1740 B2F was irrigated when triggered at -70cb (Figure 2). In general, the -40cb trigger point minimized water stress for both varieties compared to the -70cb trigger which allowed for more stress to be encountered between irrigations (Figure 2). At both locations, data suggests that DP 1050 B2RF may be more tolerant to water stress, as indicated by similar yields for this variety between the 65 % and 100 % UGA checkbook methods, whereas there was a positive yield response for FM 1740 B2F associated with increased irrigation amounts (Figure 2). In some situations, FM 1740 B2F, obviously less tolerant to water stress, may respond better to shallow versus deep SSDI (Figure 3). This research shows that SSDI is a viable irrigation system for Georgia and that SSDI could increase yields if installed in fields where OVHD is impractical such as oddly shaped small fields, despite significant rainfall. Additionally, this research demonstrated that the current UGA weekly irrigation recommendations resulted in the highest yields in the Camilla trial (Figure 1). Data suggests that deficit irrigation may be feasible for some varieties, however this will need to be confirmed through subsequent research when significant water stress is encountered during the bloom period.

The authors would like to sincerely thank the Georgia Cotton Commission for their generous support of this project and other ongoing research.

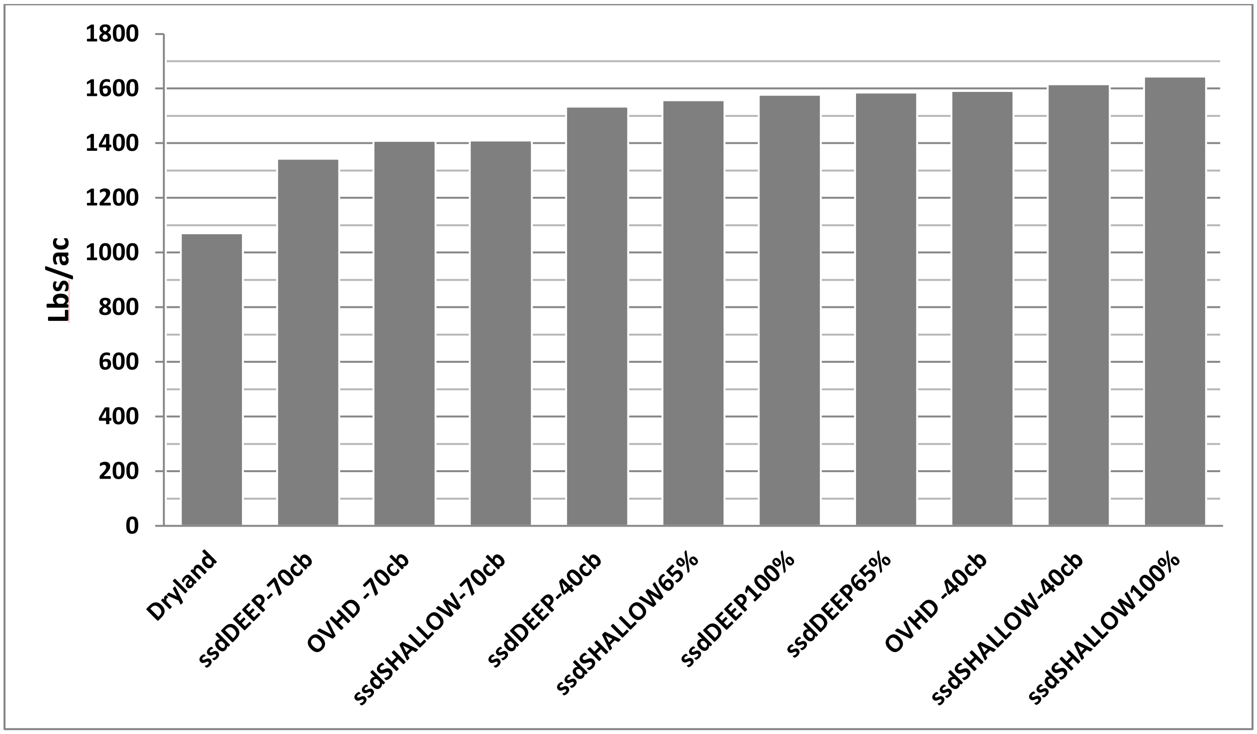

Figure 1. Lint Yield Response to SSDI and OVHD irrigation treatments in Camilla 2011.

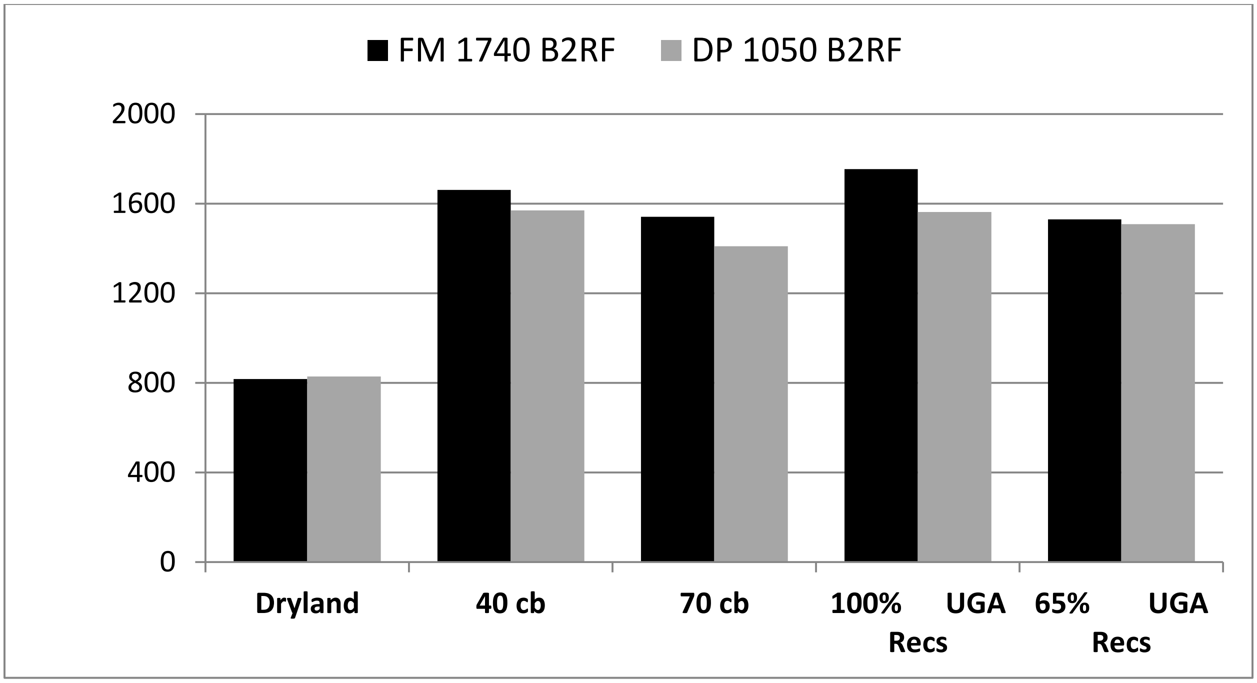

Figure 2. Lint Yield response of SSDI trigger points and irrigation checkbook in 2011 (data pooled over Camilla and Midville)

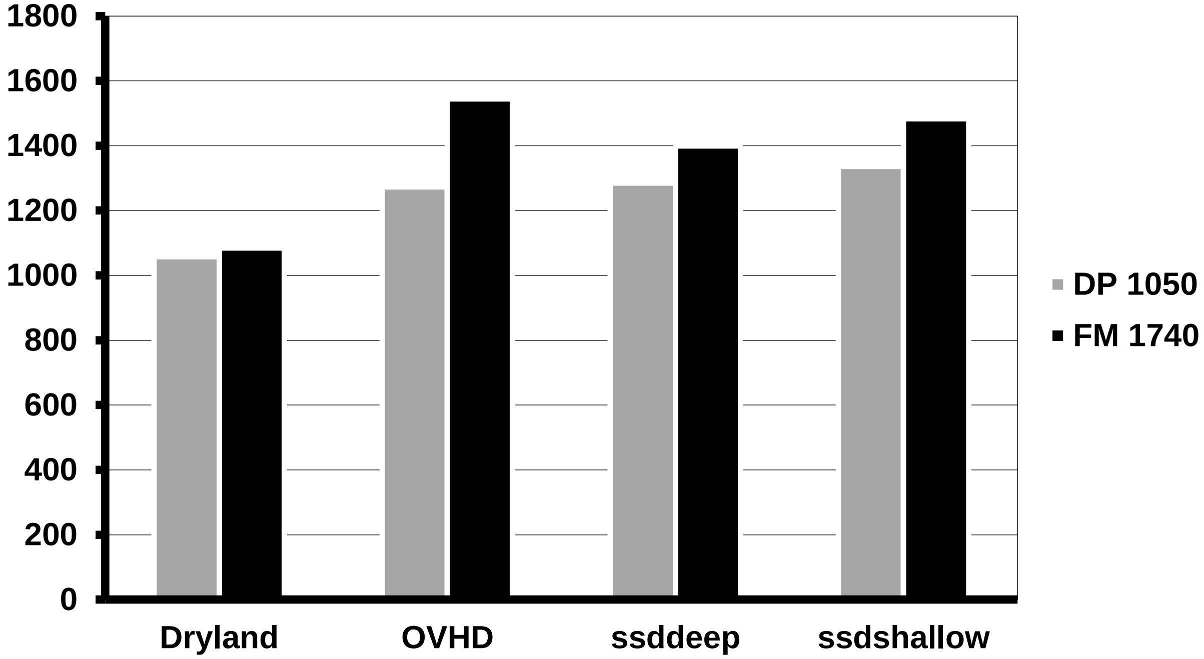

Figure 3. Variety lint yield response to depth of SSDI in 2011 (Camilla).

2011 COTTON OVT VARIETY TRIALS

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Introduction

The University of Georgia 2011 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 Annual Publication 104-3, January 2012.

Materials and Methods

The University of Georgia conducts Official Cotton Variety(OVT) and Strain(OST) trials across Georgia to provide Growers, Private Industry, Extension Specialist, and County Agents with performance data to help in selecting varieties. Data from the OVT assists 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 Director, 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 early and late maturing trial at Tifton, but the remaining portion of the seed cotton from the early and 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. Trials were picked with a state-of-the-art harvest system composed of an International IH 1822 picker fitted with weigh baskets and suspended from load cells. 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

The spring of 2011 began with abnormally dry soil, completely different than March 2010 wet and cold soil conditions. However, during early spring most areas did have enough moisture for seeding. Planting progressed ahead of 5-year averages. Plant stands and early season growth were good in most areas. Due to a dry April, in early May less than half of the state had adequate moisture, as the lack of rainfall and high temperatures continued into the end of May, 2/3 of the state was under a severe drought. Producers quickly fell behind in crop progress to late planting their crops or not planting at all. Most of the non-irrigated crops were severely damaged beyond salvage from the high heat and lack of moisture. Irrigation, which began at planting, struggled to keep up over much of the state throughout the summer and fall. Insects were a concern in most areas.

Crop maturity progressed ahead of the 5-year average and harvest conditions during 2011 were excellent. In 2011 cotton farmers seeded 1.60 million acres, 20% more than last year. Cotton per acre yield in 2011 of 837 pounds was two percent higher than last year and the highest per acre yield in six years. This yield level totaled over harvested acres of cotton produced a new record for cotton production in Georgia (2.7 million bales).

Among varieties in the Dryland Earlier Maturity Trials, PHY 499WRF, AM1511 B2RF, DP 0912 B2RF, and DP 1028 B2RF stand out as varieties with high yield and relative yield stability in the dryland trials averaged over four locations (Table 1). There were also 12 other varieties above average in yield (Table 1). When summarized over two years and four locations PHY 499 WRF was the top performer, while four other varieties were above average (Table 2).

Among the best performing earlier maturing varieties produced under irrigation, DP 0912 B2RF, PHY 499WRF, AM1511 B2RF, DP 1028B2RF, CG 3787 B2RF, ST 4145LLB2, DP 1133 B2RF, and AllTex ATX3039 B2RF were the top eight highest in yield when averaged over locations (Table 3). Thirteen other varieties performed well and were above average in yield (Table 3). PHY 499 WRF and DP 0920B2RF were the top yielding group when averaged over two years and locations in the Irrigated Early Maturity Trials conducted at Bainbridge, Midville, Plains, and Tifton. Five other varieties were above average in yield (Table 4).

The top yielding later maturity variety in the trial conducted without irrigation and averaged over four locations revealed the consistent performance of PHY 499WRF, AM1511 B2RF, DP 1137 B2RF, and BX 1262B2F (Table 5). An additional eight varieties were above average in yield (Table 5). Averaged over locations and years, PHY 499 WRF was the front runner along with four other varieties that yielded above average lint (Table 6).

Under irrigation, in the top significant group of the standard later maturing trials averaged over locations PHY 499 WRF, AM1511 B2RF, DP1252 B2RF, DP 1050 B2RF and MON 10R051 B2RF were the top five yielding varieties(Table 7). Five other varieties were above average in lint yield (Table7). Averaged over locations and two years, PHY 499 WRF, DP 1252 B2RF and DP 1050 B2RF were the three front runners, while three other varieties were above average in yield (Table 8).

The Earlier Maturity and Later Maturity Strains Trials(OST) portend improved varieties for crop seasons 2012 and beyond (Tables 9). Varieties from All-Tex, Americot, Dyna-Gro, Georgia, and Monsanto DP were high yielding performer among standard earlier and later maturing entries in the strains trial.

In order to compare ‘small gin’ seed/lint with samples processed through the Micro-gin (MG) on the Tifton Campus, data from the Tifton, Georgia, 2011, Early and Later Maturity cotton variety performance, irrigated, respectively, is presented in Table 10 and Table 11. The seed cotton from the 2011 Early and Later Maturity experiments were sub-sampled during picking, the seed separated using a small gin and for HVI analysis processed by Starlab in Knoxville, Tennessee. The remaining seed cotton was processed through the Micro-gin, Tifton Campus and also for HVI analysis sent to Starlab in Knoxville, TN.

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, 2011

	Lint Yield^{a}									
Variety	Athens	Midville	Plains	Tifton	4-Loc. Average	Lint	Unif. Index	Length	Strength	Mic.
	---------------------------- lb/acre				----------------------------	%	%	in	g/tex	units
PHY 499 WRF	**1725** ^{3}	**1238** ^{1}	**604** ^{10}	**2067** ^{2}	**1409** ^{1}	46.2	83.9	1.10	31.1	4.4
AM1511 B2RF	**1778** ^{1}	**1123** ^{2}	**648** ^{3}	**1946** ^{5}	**1374** ^{2}	45.5	83.8	1.09	30.3	4.5
DP 0912 B2RF	**1544** ^{7}	**1116** ^{3}	**687** ^{1}	**1964** ^{4}	**1328** ^{3}	43.5	83.8	1.12	29.9	4.7
DP 1028 B2RF	1395 ^{13}	1039 ^{5}	**672** ^{2}	**2130** ^{1}	**1309** ^{4}	47.2	84.1	1.13	27.9	4.5
AM 1550 B2RF	**1678** ^{4}	997 ^{9}	**606** ^{9}	1710 ^{12}	1248 ^{5}	43.6	83.7	1.10	26.8	4.4
BX 1262B2F	**1773** ^{2}	1002 ^{8}	**381** ^{30}	1808 ^{9}	1241 ^{6}	42.6	83.3	1.13	31.2	4.1
All-Tex 7A21	**1607** ^{6}	989 ^{11}	**475** ^{27}	**1843** ^{7}	1228 ^{7}	44.1	83.7	1.13	30.1	4.5
Dyna-Gro 2570B2RF	1450 ^{11}	961 ^{14}	**553** ^{17}	**1916** ^{6}	1220 ^{8}	42.6	83.7	1.11	29.6	4.4
ST 4288B2F	**1663** ^{5}	982 ^{13}	**500** ^{25}	1709 ^{13}	1214 ^{9}	40.8	83.5	1.13	28.0	4.3
CG 3787 B2RF	1463 ^{10}	994 ^{10}	**581** ^{12}	1805 ^{10}	1211 ^{10}	46.3	84.2	1.13	28.1	4.5
DP 0920 B2RF	1321 ^{22}	840 ^{24}	**607** ^{8}	**1986** ^{3}	1189 ^{11}	43.8	83.8	1.13	26.9	4.3
DP 0924 B2RF	1505 ^{9}	1011 ^{7}	**528** ^{21}	1628 ^{17}	1168 ^{12}	42.4	83.7	1.10	28.4	4.5
ST 4145LLB2	1371 ^{16}	1063 ^{4}	**518** ^{23}	1666 ^{16}	1155 ^{13}	43.6	83.0	1.11	29.8	4.2
PHY 375 WRF	1341 ^{21}	949 ^{16T}	**476** ^{26}	**1838** ^{8}	1151 ^{14}	44.1	83.4	1.09	28.3	4.1
BRS293	1512 ^{8}	986 ^{12}	**459** ^{28}	1625 ^{18}	1146 ^{15}	41.4	83.1	1.10	32.9	4.7
All-Tex ATX3039 B2RF	1433 ^{12}	939 ^{17}	**431** ^{29}	1708 ^{14}	1128 ^{16}	44.6	82.5	1.11	26.7	4.1
BRS286	1306 ^{25}	859 ^{23}	**614** ^{7}	1687 ^{15}	1116 ^{17}	41.0	82.9	1.09	30.3	4.3
DP 0949B2RF	1357 ^{17}	949 ^{16T}	**566** ^{15}	1566 ^{21}	1109 ^{18T}	44.5	83.3	1.12	30.0	4.7
BX 1252LLB2	1376 ^{15}	886 ^{20}	**627** ^{5}	1549 ^{23}	1109 ^{18T}	42.1	83.6	1.12	30.9	4.3
All-Tex LA122	1355 ^{19}	916 ^{18}	**578** ^{13}	1541 ^{24}	1098 ^{19}	44.4	83.4	1.11	27.8	4.3
DP 1133 B2RF	1240 ^{28}	793 ^{26}	**542** ^{18}	1774 ^{11}	1087 ^{20T}	45.3	84.2	1.13	30.7	4.6
GA2004143	1352 ^{20}	874 ^{21}	**555** ^{16}	1567 ^{20}	1087 ^{20T}	45.2	83.8	1.15	31.9	4.4
PHY 367 WRF	1318 ^{23}	958 ^{15}	**645** ^{4}	1425 ^{29}	1086 ^{21}	43.9	83.6	1.12	29.7	4.2
All-Tex ATX81144	1356 ^{18}	1036 ^{6}	**511** ^{24}	1426 ^{28}	1082 ^{22}	41.3	84.7	1.21	32.3	3.7
SSG HQ 210 CT	1313 ^{24}	862 ^{22}	**588** ^{11}	1552 ^{22}	1079 ^{23}	41.4	82.6	1.10	30.7	4.6
BCSX 1150B2RF	1383 ^{14}	888 ^{19}	**534** ^{19}	1430 ^{27}	1059 ^{24}	40.4	84.1	1.17	31.8	4.1
FM1740B2RF	1241 ^{27}	816 ^{25}	**567** ^{14}	1518 ^{25}	1035 ^{25}	43.2	83.2	1.12	28.5	4.2
GA2006106	1253 ^{26}	754 ^{28T}	**618** ^{6}	1401 ^{30}	1006 ^{26}	41.9	83.6	1.15	31.9	4.3
SSG CT310 HQ	1166 ^{29}	754 ^{28T}	**519** ^{22}	1569 ^{19}	1002 ^{27}	39.9	83.4	1.12	33.4	4.5
SSG CT Linwood	872 ^{31}	761 ^{27}	**531** ^{20}	1348 ^{31}	878 ^{28}	43.4	82.9	1.08	31.9	4.9
GA2008057	1004 ^{30}	621 ^{29}	**317** ^{31}	1493 ^{26}	859 ^{29}	41.0	84.3	1.16	32.8	4.3
Average	1402	934	550	1684	1142	43.3	83.6	1.12	30.0	4.4
LSD 0.10	254	128	N.S. ^{b}	305	144	1.2	0.7	0.02	1.3	0.2
CV %	15.4	11.7	31.1	15.4	17.2	1.9	0.9	2.19	4.7	5.1

[a] Superscripts indicate ranking at that location.

[b] The F-test indicated no statistical differences at the alpha = .10 probability level; therefore a LSD value was not calculated.1

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], 2010-2011

Variety	Lint Yield	Lint	Uniformity Index	Length	Strength	Micronaire
	lb/acre	%	%	inches	g/tex	units
PHY 499 WRF	**1303**	46.2	83.5	1.09	31.2	4.6
DP 1028 B2RF	1194	47.2	83.3	1.11	28.1	4.8
DP 0912 B2RF	1187	43.7	82.9	1.08	29.2	4.9
PHY 375 WRF	1072	44.5	82.9	1.08	27.9	4.3
Dyna-Gro 2570B2RF	1067	43.0	83.1	1.09	29.4	4.6
AM 1550 B2RF	1055	43.4	83.0	1.08	26.7	4.5
DP 0920 B2RF	1052	44.2	82.9	1.11	26.7	4.5
All-Tex 7A21	1042	44.3	83.3	1.13	29.9	4.7
All-Tex LA122	1033	44.3	83.2	1.11	27.9	4.5
DP 0924 B2RF	1026	43.1	82.7	1.07	28.1	4.7
ST 4288B2F	1023	40.8	82.4	1.10	27.4	4.5
PHY 367 WRF	1020	43.7	82.7	1.11	29.2	4.3
FM1740B2RF	977	43.3	82.6	1.09	28.5	4.5
GA2006106	966	41.9	82.8	1.15	31.6	4.5
SSG CT Linwood	864	43.1	82.3	1.07	31.4	5.0
Average	1059	43.8	82.9	1.10	28.9	4.6
LSD 0.10	73	0.4	0.4	0.02	0.7	0.1
CV %	16.8	2.0	0.9	2.54	4.5	5.3

[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, 2011, Irrigated

	Lint Yield[a]									
Variety	Bainbridge	Midville	Plains	Tifton	4-Loc. Average	Lint	Unif. Index	Length	Strength	Mic.
	---------- lb/acre				----------	%	%	in	g/tex	units
DP 0912 B2RF	**1847** ^{5}	**2924** ^{2}	**2022** ^{2}	1830 ^{8}	**2156** ^{1}	43.7	84.0	1.14	29.5	4.7
PHY 499 WRF	**1877** ^{4}	**2957** ^{1}	1778 ^{14}	**1946** ^{2}	**2139** ^{2}	46.5	84.9	1.15	32.4	4.6
AM1511 B2RF	**1886** ^{3}	2637 ^{5}	**1957** ^{3}	**1979** ^{1}	**2115** ^{3}	45.7	84.4	1.15	29.9	4.7
DP 1028 B2RF	**1942** ^{1}	**2777** ^{3}	1664 ^{20}	**1918** ^{3}	**2075** ^{4}	46.2	85.1	1.15	28.6	4.8
CG 3787 B2RF	**1781** ^{6}	2547 ^{12}	**1908** ^{8}	**1914** ^{4}	**2038** ^{5}	44.7	84.9	1.16	29.3	4.6
ST 4145LLB2	1566 ^{20}	2494 ^{18}	**2150** ^{1}	1806 ^{10}	**2004** ^{6}	42.7	84.7	1.18	32.6	4.2
DP 1133 B2RF	**1928** ^{2}	2335 ^{26}	**1947** ^{4}	1752 ^{16T}	**1991** ^{7}	45.9	85.3	1.17	31.9	4.6
All-Tex ATX3039 B2RF	1593 ^{18}	**2741** ^{4}	**1912** ^{7}	1713 ^{22}	**1990** ^{8}	44.1	84.1	1.16	28.5	4.3
PHY 375 WRF	1684 ^{10}	2528 ^{16}	1806 ^{12}	1783 ^{11}	1950 ^{9}	44.2	84.3	1.16	29.0	4.4
BX 1262B2F	1667 ^{12}	2534 ^{13T}	1821 ^{11}	1732 ^{20}	1938 ^{10}	43.3	84.7	1.18	30.8	4.6
BX 1252LLB2	1681 ^{11}	2567 ^{11}	1849 ^{9}	1605 ^{28}	1926 ^{11}	42.7	84.3	1.18	30.9	4.5
PHY 367 WRF	1640 ^{14}	2328 ^{27}	**1931** ^{5}	1778 ^{13}	1919 ^{12}	43.2	84.7	1.18	29.7	4.4
Dyna-Gro 2570B2RF	**1761** ^{7}	2426 ^{22}	1722 ^{17}	1765 ^{15}	1918 ^{13}	42.5	84.7	1.17	30.4	4.5
BCSX 1150B2RF	1626 ^{15}	2580 ^{10}	1677 ^{18}	1781 ^{12}	1916 ^{14}	40.1	85.2	1.22	33.7	4.7
DP 0920 B2RF	1507 ^{25}	2510 ^{17}	1798 ^{13}	**1845** ^{6}	1915 ^{15}	44.0	84.4	1.16	28.2	4.6
DP 0949B2RF	1655 ^{13}	2610 ^{6}	1624 ^{22}	1752 ^{16T}	1910 ^{16}	44.2	84.7	1.17	30.8	4.8
GA2004143	1617 ^{16}	2597 ^{8}	1577 ^{24}	1841 ^{7}	1908 ^{17}	44.2	85.3	1.23	33.8	4.4
ST 4288B2F	1606 ^{17}	2341 ^{25}	**1924** ^{6}	1737 ^{19}	1902 ^{18}	40.9	83.9	1.17	28.1	4.7
FM1740B2RF	1580 ^{19}	2532 ^{14}	1667 ^{19}	1813 ^{9}	1898 ^{19}	43.3	84.0	1.16	29.1	4.4
All-Tex 7A21	1503 ^{26}	2490 ^{19}	1848 ^{10}	1745 ^{18}	1897 ^{20}	44.2	84.8	1.19	31.1	4.6
DP 0924 B2RF	1468 ^{28}	2599 ^{7}	1661 ^{21}	**1857** ^{5}	1896 ^{21}	43.1	84.7	1.15	30.6	4.8
AM 1550 B2RF	1526 ^{22}	2439 ^{21}	1752 ^{16}	1718 ^{21}	1859 ^{22}	42.1	84.3	1.15	28.3	4.5
All-Tex ATX81144	1481 ^{27}	2530 ^{15}	1595 ^{23}	1751 ^{17}	1839 ^{23}	42.0	85.1	1.24	32.2	3.9
All-Tex LA122	1524 ^{23}	2387 ^{23}	1772 ^{15}	1622 ^{27}	1826 ^{24}	44.2	84.8	1.17	29.1	4.4
GA2006106	1691 ^{9}	2534 ^{13T}	1358 ^{28}	1677 ^{23}	1815 ^{25}	42.1	84.9	1.22	33.3	4.4
BRS293	1542 ^{21}	2582 ^{9}	1246 ^{30}	1769 ^{14}	1785 ^{26}	41.7	84.1	1.17	34.2	4.6
SSG HQ 210 CT	1399 ^{29}	2451 ^{20}	1541 ^{26}	1629 ^{26}	1755 ^{27}	40.6	83.4	1.15	31.6	4.6
BRS286	1707 ^{8}	2070 ^{29}	1567 ^{25}	1634 ^{25}	1745 ^{28}	41.5	83.4	1.13	31.7	4.5
SSG CT Linwood	1185 ^{31}	2347 ^{24}	1256 ^{29}	1664 ^{24}	1613 ^{29}	42.6	84.8	1.12	33.6	5.0
SSG CT310 HQ	1522 ^{24}	2197 ^{28}	1194 ^{31}	1526 ^{29}	1610 ^{30}	40.6	84.3	1.15	33.9	4.7
GA2008057	1302 ^{30}	1750 ^{30}	1452 ^{27}	1501 ^{30}	1501 ^{31}	41.1	85.1	1.21	33.6	4.2
Average	1622	2495	1709	1754	1895	43.2	84.6	1.17	31.0	4.5
LSD 0.10	190	244	270	137	170	0.9	0.6	0.02	1.1	0.2
CV %	10.0	8.4	13.4	6.6	9.7	2.1	0.8	1.95	4.7	5.0

[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], 2010-2011, Irrigated

Variety	Lint Yield	Lint	Uniformity Index	Length	Strength	Micronaire
	lb/acre	%	%	inches	g/tex	units
PHY 499 WRF	**1982**	46.1	84.9	1.15	32.5	4.7
DP 0912 B2RF	**1958**	43.1	83.8	1.12	30.0	4.8
DP 1028 B2RF	1885	46.1	84.7	1.16	29.4	4.8
DP 0924 B2RF	1785	43.1	83.9	1.13	30.5	4.9
FM1740B2RF	1776	43.3	83.8	1.15	29.7	4.6
Dyna-Gro 2570B2RF	1773	42.5	84.4	1.16	30.3	4.6
PHY 375 WRF	1771	44.1	84.1	1.16	29.7	4.4
DP 0920 B2RF	1762	43.8	84.2	1.15	28.4	4.6
PHY 367 WRF	1752	42.9	84.1	1.17	30.4	4.2
AM 1550 B2RF	1740	42.6	83.8	1.13	28.4	4.5
ST 4288B2F	1726	40.6	83.5	1.16	28.5	4.7
All-Tex 7A21	1712	44.0	84.7	1.19	31.5	4.5
All-Tex LA122	1675	44.0	84.7	1.18	29.4	4.4
GA2006106	1603	41.7	84.6	1.22	33.5	4.4
SSG CT Linwood	1553	42.8	84.3	1.12	33.4	5.0
Average	1764	43.4	84.2	1.16	30.4	4.6
LSD 0.10	78	0.4	0.4	0.01	0.7	0.1
CV %	10.6	2.0	0.7	1.85	4.2	5.1

[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, 2011

	Lint Yield^{a}									
Variety	Athens	Midville	Plains	Tifton	4-Loc. Average	Lint	Unif. Index	Length	Strength	Mic.
	---------------------------- lb/acre ----------------------------					%	%	in	g/tex	units
PHY 499 WRF	**1515** ^{1}	**1168** ^{1}	594 ^{9}	**2254** ^{1}	**1383** ^{1}	46.6	83.6	1.11	31.4	4.5
AM1511 B2RF	1226 ^{9}	**1150** ^{2}	**762** ^{1}	1906 ^{6T}	**1261** ^{2}	45.4	83.4	1.09	29.9	4.6
DP 1137 B2RF	**1407** ^{4}	**1056** ^{6}	**625** ^{8T}	1945 ^{4}	**1258** ^{3T}	45.2	83.9	1.11	28.5	4.6
BX 1262B2F	**1411** ^{3}	**1146** ^{3}	569 ^{13}	1906 ^{6T}	**1258** ^{3T}	44.3	83.0	1.12	30.3	4.5
DP 1050 B2RF	**1365** ^{5}	**1025** ^{11}	**680** ^{2}	1905 ^{7}	1244 ^{4}	45.6	83.3	1.12	27.1	4.4
DP 1048 B2RF	**1434** ^{2}	**1040** ^{8}	**632** ^{5}	1814 ^{11}	1230 ^{5}	45.4	83.5	1.11	27.9	4.4
DP 1034 B2RF	1284 ^{7}	**1032** ^{10}	591 ^{10}	1844 ^{10}	1188 ^{6}	45.0	83.4	1.12	27.3	4.4
DP 1252 B2RF	1169 ^{11}	840 ^{19T}	**646** ^{4}	**2022** ^{2}	1169 ^{7}	46.5	83.7	1.11	28.1	4.6
ST 5288B2F	1123 ^{13}	**1042** ^{7}	543 ^{14}	1957 ^{3}	1166 ^{8T}	42.9	83.1	1.10	27.1	4.4
MON 10R051 B2RF	1178 ^{10}	**1007** ^{13T}	**628** ^{6}	1850 ^{9}	1166 ^{8T}	46.1	83.3	1.11	27.9	4.5
BX 1254LLB2	1276 ^{8}	**1014** ^{12}	449 ^{19}	1895 ^{8}	1159 ^{9}	43.5	82.6	1.12	30.3	4.5
ST 5458B2RF	**1320** ^{6}	**1134** ^{4}	535 ^{15}	1626 ^{17}	1154 ^{10}	42.5	82.3	1.10	29.7	4.7
ST 4145LLB2	1158 ^{12}	995 ^{15}	576 ^{11}	1650 ^{19}	1094 ^{11}	42.9	82.9	1.11	30.2	4.2
DP 1133 B2RF	1062 ^{17}	840 ^{19T}	508 ^{16}	1940 ^{5}	1087 ^{12}	45.5	83.7	1.10	31.0	4.7
GA2004230	1046 ^{18}	1003 ^{14}	571 ^{12}	1657 ^{15}	1069 ^{13}	42.1	83.4	1.18	29.9	4.3
PHY 375 WRF	987 ^{19}	976 ^{16}	**627** ^{7}	1676 ^{13}	1067 ^{14}	44.2	82.9	1.10	27.8	4.1
PHY 565 WRF	1075 ^{16T}	**1039** ^{9}	480 ^{18}	1658 ^{14}	1063 ^{15}	41.5	83.3	1.11	30.1	4.1
GA2007095	1075 ^{16T}	952 ^{17}	**625** ^{8T}	1558 ^{19}	1052 ^{16}	41.7	83.3	1.14	29.7	4.3
PHY 440 W	1114 ^{15}	862 ^{18}	**650** ^{3}	1536 ^{20}	1041 ^{17}	42.1	83.7	1.10	31.0	4.1
BX 1252LLB2	1115 ^{14}	**1007** ^{13T}	386 ^{21}	1593 ^{18}	1025 ^{18}	42.6	83.5	1.14	31.3	4.3
BX 1261B2F	892 ^{21}	**1082** ^{5}	388 ^{20}	1690 ^{12}	1013 ^{19}	41.0	83.0	1.12	29.6	4.1
GA2008083	973 ^{20}	725 ^{20}	500 ^{17}	1442 ^{21}	910 ^{20}	45.6	82.5	1.09	31.7	4.5
Average	1191	1006	571	1787	1139	44.0	83.2	1.11	29.4	4.4
LSD 0.10	195	163	156	242	134	1.1	0.6	0.02	1.2	0.2
CV %	13.9	13.7	23.1	11.5	14.3	2.6	1.0	2.53	4.2	4.2

[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 6. Two-Year Summary for Dryland Later Maturity Cotton Varieties at Four Locations[a], 2010-2011

Variety	Lint Yield	Lint	Uniformity Index	Length	Strength	Micronaire
	lb/acre	%	%	inches	g/tex	units
PHY 499 WRF	**1267**	46.5	83.4	1.09	31.3	4.6
DP 1050 B2RF	1144	46.2	83.3	1.11	27.4	4.6
DP 1137 B2RF	1143	45.6	83.4	1.10	27.9	4.7
DP 1048 B2RF	1115	45.8	83.1	1.10	27.7	4.6
DP 1034 B2RF	1081	45.4	83.1	1.11	27.6	4.6
DP 1252 B2RF	1063	46.9	83.3	1.10	28.4	4.8
ST 5458B2RF	1040	42.8	82.0	1.09	29.3	4.8
ST 5288B2F	1030	43.0	82.6	1.09	27.2	4.6
DP 1133 B2RF	1019	45.8	83.1	1.09	31.1	4.8
PHY 375 WRF	991	44.4	82.5	1.08	28.1	4.3
PHY 565 WRF	963	41.8	82.9	1.10	30.5	4.4
PHY 440 W	938	43.3	83.0	1.07	30.3	4.3
Average	1066	44.8	83.0	1.09	28.9	4.6
LSD 0.10	62	0.4	0.5	0.02	0.6	0.1
CV %	14.0	2.4	0.9	2.65	3.7	5.0

[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, 2011, Irrigated

	Lint Yield^{a}									
Variety	Bainbridge	Midville	Plains	Tifton	4-Loc. Average	Lint	Unif. Index	Length	Strength	Mic.
	--------------------------- lb/acre ---------------------------					%	%	in	g/tex	units
PHY 499 WRF	**1932** ^{1}	**3021** ^{1}	1689 ^{9}	**2072** ^{1}	**2179** ^{1}	44.7	85.0	1.15	32.4	4.4
AM1511 B2RF	1665 ^{9}	2786 ^{5}	**1995** ^{1}	**1976** ^{3}	**2105** ^{2}	44.9	84.7	1.15	30.2	4.7
DP 1252 B2RF	**1782** ^{2}	**2864** ^{2}	1778 ^{5}	**1958** ^{5}	**2095** ^{3}	46.2	85.1	1.17	29.2	4.5
DP 1050 B2RF	1693 ^{8}	2769 ^{6}	**1840** ^{3}	**2027** ^{2}	**2082** ^{4}	46.0	85.1	1.18	28.4	4.6
MON 10R051 B2RF	1749 ^{5}	**2794** ^{4}	**1838** ^{4}	1877 ^{10}	**2064** ^{5}	45.7	85.5	1.18	28.3	4.6
DP 1137 B2RF	1727 ^{6}	**2863** ^{3}	1682 ^{10}	1887 ^{9}	2040 ^{6}	45.0	85.0	1.16	28.5	4.5
DP 1048 B2RF	1584 ^{13}	2570 ^{15}	**1957** ^{2}	**1965** ^{4}	2019 ^{7}	44.3	85.0	1.18	28.6	4.4
ST 4145LLB2	1774 ^{3}	2456 ^{19}	1755 ^{8}	1897 ^{8}	1971 ^{8}	41.7	85.1	1.17	31.9	4.3
BX 1262B2F	1771 ^{4}	2638 ^{12}	1618 ^{12}	1853 ^{11}	1970 ^{9}	42.3	84.8	1.18	31.1	4.5
DP 1034 B2RF	1537 ^{14}	2624 ^{13}	1777 ^{6}	1933 ^{6}	1968 ^{10}	45.8	85.1	1.19	27.6	4.6
BX 1252LLB2	1708 ^{7T}	2754 ^{7}	1486 ^{18}	1732 ^{17}	1920 ^{11}	41.9	85.0	1.19	31.5	4.5
DP 1133 B2RF	1636 ^{11T}	2410 ^{21}	1768 ^{7}	1848 ^{12}	1916 ^{12}	45.1	85.6	1.18	31.7	4.6
PHY 375 WRF	1505 ^{16}	2674 ^{9}	1491 ^{17}	1901 ^{7}	1893 ^{13}	43.8	84.3	1.17	29.4	4.2
ST 5288B2F	1708 ^{7T}	2425 ^{20}	1637 ^{11}	1782 ^{13}	1888 ^{14}	42.1	84.1	1.16	28.8	4.5
ST 5458B2RF	1484 ^{17}	2710 ^{8}	1562 ^{15}	1772 ^{14}	1882 ^{15}	41.9	84.3	1.18	31.4	4.8
GA2007095	1663 ^{10}	2576 ^{14}	1545 ^{16}	1729 ^{18}	1878 ^{16}	42.0	84.5	1.18	31.3	4.6
GA2004230	1636 ^{11T}	2524 ^{16}	1571 ^{14}	1709 ^{19}	1860 ^{17}	41.9	84.7	1.24	31.4	4.4
GA2008083	1631 ^{12}	2646 ^{11}	1341 ^{22}	1641 ^{21}	1815 ^{18}	44.3	84.4	1.18	31.3	4.6
BX 1254LLB2	1394 ^{19}	2503 ^{18}	1584 ^{13}	1770 ^{15}	1813 ^{19}	43.3	84.4	1.19	31.6	4.9
PHY 565 WRF	1519 ^{15}	2509 ^{17}	1368 ^{20}	1767 ^{16}	1791 ^{20}	42.0	85.1	1.18	31.9	4.3
BX 1261B2F	1433 ^{18}	2652 ^{10}	1351 ^{21}	1677 ^{20}	1778 ^{21}	40.6	84.8	1.18	29.9	4.2
PHY 440 W	1193 ^{20}	2383 ^{22}	1480 ^{19}	1591 ^{22}	1662 ^{22}	41.1	84.8	1.16	30.7	4.4
Average	1624	2643	1642	1835	1936	43.5	84.8	1.18	30.3	4.5
LSD 0.10	157	227	213	138	135	1.1	0.6	0.02	1.1	0.2
CV %	8.2	7.3	11.0	6.4	8.2	2.2	0.7	1.86	3.7	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 8. Two-Year Summary for Later Maturity Cotton Varieties at Four Locations[a], 2010-2011, Irrigated

Variety	Lint Yield	Lint	Uniformity Index	Length	Strength	Micronaire
	lb/acre	%	%	inches	g/tex	units
PHY 499 WRF	**1893**	45.0	84.6	1.14	32.5	4.6
DP 1252 B2RF	**1841**	46.1	84.7	1.17	29.3	4.7
DP 1050 B2RF	**1840**	46.0	84.8	1.17	28.6	4.7
DP 1137 B2RF	1803	45.3	84.5	1.15	29.0	4.7
DP 1034 B2RF	1794	45.9	84.7	1.18	28.0	4.7
DP 1048 B2RF	1794	44.7	84.7	1.17	28.5	4.6
PHY 375 WRF	1744	43.8	84.1	1.16	29.4	4.3
DP 1133 B2RF	1731	45.1	85.3	1.18	32.0	4.7
ST 5458B2RF	1690	42.3	83.9	1.17	31.4	4.9
PHY 565 WRF	1687	42.7	84.5	1.18	32.2	4.2
ST 5288B2F	1684	42.7	83.4	1.15	28.9	4.6
PHY 440 W	1486	41.6	84.1	1.15	30.6	4.5
Average	1749	44.3	84.4	1.16	30.0	4.6
LSD 0.10	67	0.4	0.4	0.01	0.7	0.1
CV %	9.3	2.4	0.7	1.92	3.8	5.2

[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, 2011, Irrigated

	Lint Yield[a]								
Variety	Midville	Plains	Tifton	3-Loc. Average	Lint	Unif. Index	Length	Strength	Mic.
	---------------------- lb/acre ----------------------				%	%	inches	g/tex	units
DP 1050 B2RF	**2973** ^{1}	**1858** ^{1}	**2016** ^{4}	**2282** ^{1}	46.1	85.2	1.19	27.7	4.5
CT11622	2708 ^{4}	**1840** ^{2}	**2092** ^{1}	**2213** ^{2}	44.4	85.4	1.18	28.8	4.3
All-Tex 9C253 B2RF	**2750** ^{3}	**1697** ^{4}	**1946** ^{7}	**2131** ^{3}	44.2	84.9	1.17	31.7	4.9
DP 1044 B2RF	**2782** ^{2}	1515 ^{10}	**2049** ^{3}	2115 ^{4}	41.2	84.3	1.17	28.2	4.2
DP 1219 B2RF	2687 ^{5}	1558 ^{8}	**2082** ^{2}	2109 ^{5}	42.2	84.8	1.20	32.9	4.2
MON 10R020 B2RF	2524 ^{9}	**1815** ^{3}	**1939** ^{8}	2092 ^{6}	42.9	84.2	1.14	28.0	4.6
GA2009100	2677 ^{6}	1571 ^{7}	**1982** ^{5}	2077 ^{7}	44.3	85.2	1.20	33.9	4.0
MON 11R159 B2RF	2672 ^{7}	1423 ^{12}	**1966** ^{6}	2021 ^{8}	43.3	84.6	1.21	33.3	4.4
AMX003 B2RF	2422 ^{11}	**1658** ^{5}	1802 ^{12}	1961 ^{9}	45.1	84.8	1.19	28.5	4.7
CT11212	2417 ^{12}	1550 ^{9}	1909 ^{9}	1959 ^{10}	43.7	85.0	1.16	28.0	4.7
DP 1212 B2RF	2478 ^{10}	1477 ^{11}	1846 ^{10}	1934 ^{11}	42.2	85.1	1.22	30.4	4.8
PHY 440 W	2282 ^{16}	1611 ^{6}	1731 ^{13}	1875 ^{12}	41.6	84.8	1.17	30.5	4.4
GA2009148	2393 ^{13}	1359 ^{13}	1845 ^{11}	1866 ^{13}	42.9	84.4	1.17	32.2	4.7
GA2009037	2586 ^{8}	1231 ^{16}	1692 ^{15}	1836 ^{14}	42.3	83.9	1.19	30.3	4.5
All-Tex 9W2863 B2RF	2274 ^{17}	1348 ^{14}	1693 ^{14}	1772 ^{15}	41.2	85.5	1.22	31.8	4.5
GA2008016	2370 ^{14}	1274 ^{15}	1508 ^{17}	1717 ^{16}	41.6	84.8	1.18	33.7	4.6
GA2009180	2362 ^{15}	1090 ^{18}	1459 ^{18}	1637 ^{17}	40.2	84.9	1.22	34.5	4.2
GA2009147	2126 ^{18}	1136 ^{17}	1530 ^{16}	1597 ^{18}	40.7	83.6	1.20	32.3	4.0
Average	2527	1501	1838	1955	42.8	84.7	1.19	30.9	4.4
LSD 0.10	227	233	159	159	1.1	0.6	0.02	1.2	0.3
CV %	7.6	13.1	7.3	9.0	2.7	0.8	2.19	3.7	5.9

[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 10. Tifton, Georgia: Later Maturity Cotton Variety Performance including Micro-Gin Quality Data, 2011, Irrigated

Variety	Lint Yield	MG^1 Lint Yield	Lint	MG^1 Lint	Unif. Index^2	MG^1 Unif.	Length^2	MG^1 Length	Strength^2	MG^1 Strength*	Mic.^{2}	MG^1 Mic.
	lb/acre	lb/acre	%	%	%	%	inches	inches	g/tex	g/tex	units	units
AM1511 B2RF	**1976**	1768	45.8	40.7	84.8	83.2	1.15	1.15	29.7	31.4	4.6	4.9
BX 1252LLB2	1732	1633	41.7	38.2	85.2	83.3	1.20	1.18	31.6	32.4	4.0	4.7
BX 1254LLB2	1770	1670	42.6	39.1	84.8	83.1	1.19	1.18	33.2	32.5	4.6	5.0
BX 1261B2F	1677	1629	39.1	36.9	85.2	83.3	1.16	1.16	30.9	31.9	3.9	4.4
BX 1262B2F	1853	1766	42.2	39.0	84.5	83.3	1.18	1.17	31.1	31.8	4.2	4.7
DP 1034 B2RF	1933	1760	46.9	41.6	84.6	83.4	1.17	1.17	26.5	29.3	4.6	4.7
DP 1048 B2RF	**1965**	**1865**	45.6	41.8	85.0	83.4	1.18	1.17	28.9	28.7	4.4	4.7
DP 1050 B2RF	**2027**	**1923**	46.4	42.7	85.2	83.2	1.19	1.17	27.2	28.1	4.6	4.6
DP 1133 B2RF	1848	1717	45.7	41.3	85.4	84.1	1.17	1.16	32.3	32.6	4.4	4.8
DP 1137 B2RF	1887	1817	44.8	41.9	85.3	82.5	1.17	1.13	29.4	29.1	4.3	4.9
DP 1252 B2RF	**1958**	**1922**	45.5	43.4	85.2	83.0	1.18	1.14	28.6	29.6	4.2	4.8
GA2004230	1709	1576	43.1	38.6	83.5	83.9	1.22	1.24	30.9	31.8	4.3	4.4
GA2007095	1729	1611	42.4	38.2	84.2	83.3	1.17	1.18	30.9	31.8	4.3	4.4
GA2008083	1641	1526	43.9	39.6	84.9	83.0	1.19	1.18	31.7	32.4	4.3	4.7
MON 10R051 B2RF	1877	1762	46.1	42.1	85.8	83.3	1.17	1.15	29.7	29.0	4.5	4.7
PHY 375 WRF	1901	1769	43.7	39.4	84.6	82.7	1.17	1.15	28.8	29.3	4.1	4.6
PHY 440 W	1591	1501	40.7	37.2	84.6	83.3	1.15	1.15	32.2	31.3	4.3	4.5
PHY 499 WRF	**2072**	**1966**	44.8	41.5	84.6	83.5	1.13	1.15	32.4	31.6	4.3	4.9
PHY 565 WRF	1767	1654	41.4	37.7	85.0	83.4	1.21	1.19	32.0	32.0	3.9	4.5
ST 4145LLB2	1897	1730	41.6	37.1	85.9	83.4	1.19	1.17	32.8	31.8	3.8	4.4
ST 5288B2F	1782	1642	42.9	38.3	84.1	82.6	1.14	1.16	29.8	28.6	4.3	4.8
ST 5458B2RF	1772	1682	41.6	38.2	83.6	83.2	1.17	1.18	32.5	32.1	4.6	5.1
Average	1835	1722	43.6	39.8	84.8	83.2	1.17	1.17	30.6	30.9	4.3	4.7
LSD 0.10	138	117	1.2	0.5	1.1	0.5	0.04	0.02	2.3	1.1	N.S.^{1}	0.2
CV %	6.4	5.8	2.3	1.1	0.8	0.5	2.11	1.43	4.4	2.9	6.8	3.6

1. Micro-Gin quality samples are from total seed cotton harvested from each plot.
2. A random quality sample was taken on the picker during cotton harvest.
3. 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).

Planted:	April 27, 2011.
Harvested:	September 12, 2011.
Soil Type:	Tifton loamy sand.
Fertilization:	78 lb N, 54 lb P_2O_5, and 108 lb K_2O/acre.
Management:	Temik applied 5 lb/acre.

	April	May	June	July	Aug.	Sept.
Irrigation (in):	0.50	2.30	3.00	1.00	1.00	0
Rainfall (in):	1.48	0	1.94	4.06	1.26	4.53

Trials conducted by Larry Thompson.

Table 11. Tifton, Georgia: Earlier Maturity Cotton Variety Performance including Micro-Gin Quality Data, 2011, Irrigated

Variety	Lint Yield	MG[1] Lint Yield	Lint	MG[1] Lint	Unif. Index[2]	MG[1] Unif.	Length[2]	MG[1] Length	Strength[2]	MG[1] Strength*	Mic.[2]	MG[1] Mic.
	lb/acre	lb/acre	%	%	%	%	inches	inches	g/tex	g/tex	units	units
All-Tex 7A21	1745	1588	45.0	40.0	84.8	83.4	1.16	1.17	31.8	31.7	4.9	5.0
All-Tex ATX3039 B2RF	1713	1549	44.5	39.6	83.8	82.5	1.16	1.15	27.7	28.2	4.5	4.5
All-Tex ATX81144	1751	1576	42.1	37.7	85.3	84.3	1.22	1.23	32.8	33.4	4.0	4.1
All-Tex LA122	1622	1522	43.9	40.5	84.1	83.0	1.15	1.16	28.8	27.9	4.4	4.5
AM 1550 B2RF	1718	**1646**	42.1	39.9	84.6	82.0	1.14	1.13	29.1	28.5	4.1	4.8
AM1511 B2RF	**1979**	**1630**	45.7	41.1	83.8	82.7	1.14	1.13	29.5	30.1	4.8	5.1
BCSX 1150B2RF	1781	1582	40.7	36.2	85.5	84.4	1.20	1.21	34.9	33.3	4.6	4.7
BRS286	1634	1524	40.7	38.0	82.8	82.0	1.10	1.12	31.9	30.7	4.5	4.7
BRS293	1769	**1618**	41.5	37.6	83.8	82.9	1.15	1.16	34.5	33.7	4.6	4.8
BX 1252LLB2	1605	1433	44.1	38.9	84.3	82.9	1.18	1.15	31.1	32.6	4.5	5.0
BX 1262B2F	1732	1451	43.3	39.2	84.5	83.2	1.19	1.16	31.4	30.6	4.3	4.8
CG 3787 B2RF	**1914**	**1625**	45.7	42.3	85.1	83.4	1.15	1.16	30.2	29.5	4.7	4.9
DP 0912 B2RF	1830	**1683**	43.1	39.4	84.4	82.4	1.13	1.11	30.5	29.3	4.6	5.3
DP 0920 B2RF	**1845**	**1703**	44.9	41.1	84.9	82.5	1.16	1.16	28.8	28.3	4.5	5.1
DP 0924 B2RF	**1857**	**1647**	44.4	38.8	84.8	82.8	1.13	1.12	31.4	30.3	5.0	5.2
DP 0949B2RF	1752	**1616**	45.1	40.9	84.6	82.7	1.17	1.14	32.5	30.5	4.9	5.2
DP 1028 B2RF	**1918**	**1771**	47.5	43.3	85.0	83.5	1.14	1.13	28.8	29.1	4.6	5.0
DP 1133 B2RF	1752	**1609**	46.0	41.8	85.4	84.3	1.16	1.16	33.3	31.9	4.4	5.0
Dyna-Gro 2570B2RF	1765	**1700**	42.3	39.9	84.4	83.0	1.15	1.15	30.9	29.9	4.3	4.8
FM1740B2RF	1813	1534	44.1	39.7	84.6	83.1	1.14	1.14	29.6	29.7	4.2	4.8
GA2004143	1841	**1712**	44.3	40.9	85.6	83.3	1.25	1.21	34.6	32.0	4.1	4.6
GA2006106	1677	1528	42.7	38.0	84.4	83.2	1.18	1.19	32.4	32.6	4.4	4.8
GA2008057	1501	1358	41.5	36.8	85.0	83.6	1.22	1.19	33.8	33.3	4.1	4.5
PHY 367 WRF	1778	**1632**	43.3	39.5	84.8	83.0	1.16	1.16	30.5	29.5	4.2	4.5
PHY 375 WRF	1783	**1615**	44.6	40.3	84.3	82.5	1.14	1.14	30.2	28.5	4.3	4.6
PHY 499 WRF	**1946**	**1783**	46.1	41.9	85.3	83.3	1.14	1.13	34.5	32.9	4.4	4.8
SSG CT Linwood	1664	1517	43.4	39.1	85.2	83.1	1.10	1.12	33.7	32.9	4.9	5.2
SSG CT310 HQ	1526	1429	40.6	36.3	84.3	83.1	1.13	1.15	34.2	34.8	4.5	4.7
SSG HQ 210 CT	1629	1567	39.9	37.8	83.9	81.8	1.16	1.13	32.7	31.5	4.7	5.0
ST 4145LLB2	1806	1596	43.1	37.7	84.8	83.4	1.16	1.17	34.3	31.1	3.9	4.6
ST 4288B2F	1737	1532	42.0	36.9	83.7	82.3	1.14	1.16	27.3	28.7	4.9	4.9
Average	1754	1590	43.5	39.4	84.6	83.0	1.16	1.15	31.5	30.9	4.5	4.8
LSD 0.10	137	175	0.9	0.7	1.1	0.6	0.04	0.02	2.3	1.2	0.4	0.2
CV %	6.6	9.3	1.7	1.5	0.8	0.6	1.97	1.71	4.3	3.3	5.4	2.9

1. Micro-Gin quality samples are from total seed cotton harvested from each plot.
2. A random quality sample was taken on the picker during cotton harvest.
3. 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).

Planted: April 27, 2011.
Harvested: September 12, 2011.
Soil Type: Tifton loamy sand.
Fertilization: 78 lb N, 54 lb P_2O_5, and 108 lb K_2O/acre.
Management: Temik applied 5 lb/acre.

	April	May	June	July	Aug.	Sept.
Irrigation (in):	0.50	2.30	3.00	1.00	1.00	0
Rainfall (in):	1.48	0	1.94	4.06	1.26	4.53

Trials conducted by Larry Thompson.

BREEDING CULTIVARS AND GERMPLASM WITH ENHANCED YIELD AND QUALITY, 2011

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Introduction

The classical breeding component of the University of Georgia cotton improvement program works to develop germplasm with traits that can be used to meet the requirements of both producers and consumers. Higher and more stable yields combined with the fiber properties requested by the yarn and textile manufacturers are the goals for profitable production and processing to support the Georgia Cotton Industry. The objective of this report is to update progress made toward meeting these goals during the 2011 production season.

Materials and Methods

Our crosses mate elite University of Georgia breeding lines with promising germplasm and non-transgenic commercial cultivars to produce 10 sets of 5 half-sib families. These F_2-bulk populations from crosses made in the previous year and advanced at the counter-seasonal nursery in Tecoman, MX are 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, GA 230, constituting a test. Of the F_2-bulk populations evaluated, the highest yielding populations are advanced in to F_3 for single plant selection. The first level of selection of the F_3 plants are decided by visual determination with more individuals selected from the best populations, fewer individuals from the better populations, and perhaps none from the poorer populations. If a segregation of a desirable and non-desirable class is evident in the poorer populations, individual desirable plants are selected from each of these populations. Of the approximately 1,000 selected F_3 plants, the plants with lint fractions less than 39% are discarded and then further selected on the basis of HVI fiber properties. One thousand two hundred ninety-five plants were selected from the field in 2011. The plants have yet to be selected based on lint % and fiber quality. Six hundred eighty selections were advanced to F_4 progeny rows in Plains, GA, in 2011 (fields 29/30) for evaluation in an un-replicated grid design, with the middle row of each 9 row set of the trial assigned to the University of Georgia cultivar GA 230. The F_4 test is machine harvested and the seed-cotton yield of each F_4 progeny row is compared with the seed-cotton yield of the nearest row of GA 230 which is, in turn, modified depending on the distribution of the yield values across the test field. Further selections of the F_4 are based essentially on the fiber quality measures of length, strength, and fineness and on lint percentage to promote for testing in the F_5 preliminary yield trials (PTs). 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. Additional increases are planted at the

University of Arizona's Maricopa Agriculture Center in Maricopa, AZ to provide excellent quality seed for the field tests in the subsequent years. The seven 2011 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 (GA 230 and Deltapine DP 493) in a three replicate, randomized complete block designs for a total of 126 experimental entries. The F_6 Advanced Trials (ATs) were conducted at the University of Georgia – Tifton campus, Tifton, GA (AT1 at the William Gibbs Research Farm, fields 04243 and 04244) and Southwest Georgia Research and Education Center, Plains, GA (AT 1 in fields 27/28). The AT1 consisted of 28 experimental entries with three checks (GA 230, GA 2004303, GA 2004143, and Monsanto DP 493) that were planted in a three replicate, randomized complete block design. Prior to machine harvest of all trials except the F_2 and F_4 generations, 25 unweathered, open bolls from the middle of the fruiting zone were harvested from each plot, and subsequently ginned on a 10-saw laboratory model gin to determine lint percentage. Fiber samples of the PTs and ATs were submitted to Cotton Incorporated in Cary, NC for HVI fiber analysis. The elite (material > F_7) germplasm lines with high potential were tested in the 2011 Georgia Official Strains Trial (OST) and Official Variety Trials (OVTs) (Day and Thompson, 2012).

Results and Discussion

Six of our lines (GA 230, GA 2007095, and GA 2008083 with the later maturing varieties and GA 2004143, GA 2006106, and GA 2008057 with the earlier maturing varieties) were tested in the 2011 GA OVTs (Day and Thompson, 2012). The following is a general synopsis of these lines with further details found in the Georgia 2011 Peanut, Cotton, and Tobacco Performance Tests (Day et al., 2012). All of our lines were affected to some degree with emergence issues that came from undetermined causes. Furthermore, the growing season was different from the last 2 years in that a late crop was not favored by the environment.

In the irrigated Earlier Maturity Trial, GA 2004143 was ranked 17th over all of the locations for lint yield out of 31 entries with an excellent fiber quality package. It was the most uniform and 2nd best length and strength; subjectively #1 overall as a complete fiber package. It yielded better in Midville (8th) and Tifton (7th) than it did in Bainbridge (16th) and Plains (24th). It did not yield relatively as well in the dryland trial with a small drop, ranking 20th overall (16th to 21st), but it maintained an overall very good ranking in fiber quality. In lint yield in 2010 and 2011, both the irrigated and dryland yields of GA 2006106 compared poorly to the best yielding variety and it will not be retested even though its fiber quality is very good. GA 2008057 also compared poorly to the best yielding variety this year, but since its fiber quality package was excellent and the field population density was suspect, it will be tested again. Another point of interest, all the conventional cotton cultivars ranked toward the bottom of the test; it could be that this is a proper comparison of the genetics unconfounded by transgenes or it could be that the Bt cultivars are showing their inherent strength.

In the Later Maturity Trial, the three GA entries (GA 230, GA 2007095, and GA 2008083) ranked in the bottom third of the trial. All persist in showing solid fiber packages in the irrigated trial while there was some separation in the dryland trial. GA 230 continues to show excellent length under all conditions with very good uniformity, strength, and micronaire. GA 2007095 also had solid fiber quality across the board, but GA 2008083 did not fare as well under dryland conditions in length and uniformity.

Five lines were promoted last year to the 2011 Georgia OSTs from the 2010 ATs: GA 2009037, GA 2009100, GA 2009147, GA 2009148, and GA 2009180 with a sixth retested line GA 2008016 (Day et al., 2012). We had some emergence issues here in this irrigated trial as we did in the OVTs. The entire group had solid to excellent fiber packages, as good as or better than the competition. GA 2009100 was the best yielder of our material; ranked 7th across the three locations (Midville, Plains, and Tifton). Some of these may be retested in 2012 given their excellence in length or strength. They would have good possibilities to be released as germplasm.

The 2011 AT1 trial had the most severe emergence issues of all our field experiments. AT1 in Tifton gave us unreliable data and will be replanted in 2012. The AT1 in Plains did not have as much emergence difficulty as we had in Tifton. Using lint yield and fiber quality measures, only one line GA 2010098 was promoted to the 2012 GA OSTs (Table 1). One line GA 2010064 had excellent fiber length, uniformity, strength, and micronaire, but low lint %; it will be used as parental material and also reviewed for possible germplasm release after further study (Table 1).

From the 2011 PTs (Tables 2, 3, 4, and 5), twenty-six lines were selected for testing in the 2012 ATs based primarily on lint yield and fiber qualities as compared to checks. Higher lint % and uniformity index as well as of course increased lint yield are the primary components of the selection within these populations looking to develop a cultivar better than our GA 230.

Based on lint yield comparisons, one hundred forty-seven F_4 progenies were selected for placement in the 2012 PTs with further selections to be made utilizing fiber quality measures. One thousand two hundred ninety-five single plants were selected in the F_3 populations to be placed in the F_4 plant-to-row yield test, again, with further selections based on fiber quality.

Fifty F_1 crosses, 43 were made in the summer of 2011 and 7 from previous crosses that we wanted to revisit, were sent to the USDA-ARS Cotton Winter Nursery in Tecoman, Mexico for selfing to the F_2 generation. These will be placed in replicated 2012 F_2 yield tests to determine the suitability of the germplasm populations to be further tested. The 2011 F2 yield test will be redone because it was mowed down inadvertently.

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Table 1. Results of 2011 Advanced (F_6) Trial 1 from Plains.

ENTRY	**Lint Yield,** lbs./acre	**Lint** %	**UHM** in.	**UI** %	**mic**	**Str** g/tex
DP 493	**1,749**	39.88	1.14	83.50	5.34	30.45
GA 2010098	**1,697**	36.38	1.21	84.60	5.02	32.70
GA 2010085	**1,594**	**42.83**	1.21	84.10	5.13	30.85
GA 2010106	**1,560**	40.28	1.21	83.70	5.10	31.60
GA 2010002	**1,547**	39.01	1.23	85.00	4.67	32.50
GA 2010102	**1,536**	37.28	1.22	85.10	5.07	34.15
GA 2004303	**1,534**	39.75	1.18	83.10	5.03	32.40
GA 2010024	1,499	40.14	1.21	85.60	4.88	32.75
GA 2010070	1,496	**42.93**	1.17	82.90	4.80	31.30
GA 2010064	1,465	36.55	**1.31**	**87.10**	4.27	34.50
GA 230	1,463	38.39	**1.28**	**86.40**	4.91	32.00
GA 2010032	1,454	39.65	1.25	84.15	4.64	30.40
GA 2010019	1,443	37.96	1.26	84.85	4.54	32.90
GA 2010038	1,421	41.32	1.22	85.30	4.51	32.85
GA 2010079	1,395	36.88	1.21	84.10	5.08	32.05
GA 2010050	1,368	37.26	1.17	83.55	5.11	31.75
GA 2010052	1,355	37.88	1.17	83.90	4.96	32.00
GA 2010015	1,346	38.17	1.25	84.45	4.46	32.25
GA 2010016	1,304	34.84	1.24	84.40	4.28	32.80
GA 2010069	1,293	38.40	1.22	85.25	4.82	33.30
GA 2010063	1,292	37.89	1.22	86.00	4.60	33.05
GA 2010047	1,292	37.73	1.17	85.35	5.08	32.40
GA 2010068	1,271	39.08	1.26	85.00	4.45	34.80
GA 2010074	1,266	40.66	1.20	84.60	5.26	32.25
GA 2010067	1,246	35.84	1.25	85.15	4.78	32.50
GA 2004143	1,198	**42.02**	1.20	83.30	5.15	33.45
GA 2010058	1,187	37.99	1.23	84.45	4.37	31.85
GA 2010076	1,140	34.63	1.26	83.40	4.74	35.15
GA 2010049	1,118	38.02	1.24	84.90	5.14	35.05
GA 2010021	1,075	34.77	1.26	84.45	4.32	31.75
GA 2010030	1,061	35.33	1.24	85.05	4.52	31.85
GA 2010086	854	38.36	1.21	84.95	5.02	33.05
$LSD_{0.10}$	**236**	**1.30**	**0.04**	**0.97**	**0.35**	**ns**

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

‘ns’ signifies no significant differences within the list.

Exception: acceptable micronaire (mic) is a range; so the significant differences above 5.0 that are considered unacceptable are highlighted (i.e. > 5.35 is significant).

DP 493, GA 230, and GA 2004303 are check varieties for comparison purposes.

Table 2. Results of 2011 Preliminary (F_5) Trials 1 and 2.

2011 PT1							**2011 PT2**						
ENTRY	**Lint Yield**	**Lint %**	**UHM in.**	**UI %**	**Str g/tex**	**mic**	**ENTRY**	**Lint Yield**	**Lint %**	**UHM in.**	**UI %**	**Str g/tex**	**mic**
GA 2011002	**1391**	41.80	1.15	84.05	**32.70**	4.96	GA 2011019	1521	**45.01**	1.07	81.85	29.25	4.46
GA 2011005	**1389**	43.54	1.14	83.60	29.60	4.54	GA 2011030	1467	42.01	1.17	**84.25**	29.45	4.47
GA 2011015	**1365**	44.24	1.13	82.60	30.15	4.71	GA 230	1435	40.94	**1.23**	**83.80**	**32.15**	4.44
GA 2011004	**1321**	42.96	**1.18**	83.35	**31.85**	4.77	GA 2011032	1407	43.84	1.13	82.45	27.75	4.35
GA 2011013	**1309**	44.08	1.11	83.30	28.95	4.88	GA 2011020	1377	**45.39**	1.10	82.40	30.45	4.77
GA 2011010	**1308**	**47.76**	1.10	84.20	29.35	4.78	GA 2011023	1364	43.32	1.16	82.85	27.55	4.68
GA 2011014	**1290**	44.32	1.10	83.25	30.20	4.95	GA 2011021	1348	43.10	1.11	**83.75**	29.25	4.77
GA 2011008	**1259**	45.77	1.14	83.35	29.00	5.12	GA 2011017	1329	43.44	1.08	82.10	28.15	4.83
GA 2011011	**1239**	45.90	1.09	83.65	30.55	4.98	GA 2011022	1318	42.55	1.17	**84.00**	30.20	4.66
GA 2011009	**1238**	43.61	1.12	81.90	30.00	4.63	GA 2011024	1308	42.10	1.13	82.55	28.85	4.57
GA 2011007	**1221**	45.81	1.08	82.20	28.85	4.99	GA 2011034	1293	42.70	1.16	82.35	28.30	4.85
DP 493	**1195**	42.97	1.09	82.25	29.50	4.96	GA 2011018	1232	**44.06**	1.13	**83.25**	29.40	4.62
GA 2011006	**1184**	44.53	1.15	83.20	31.15	4.80	GA 2011026	1220	43.26	1.11	81.30	27.30	4.92
GA 2011012	**1145**	43.16	1.12	83.00	31.05	4.62	GA 2011028	1217	42.97	1.13	82.70	27.95	4.60
GA 2011003	1049	43.83	1.14	82.75	31.00	4.92	GA 2011031	1213	**44.20**	1.13	81.75	28.20	4.62
GA 2011001	1004	46.12	1.11	81.85	29.65	4.54	GA 2011033	1184	41.40	1.12	82.60	28.60	4.75
GA 2011016	890	44.42	**1.16**	84.50	30.00	4.82	DP 493	1169	43.33	1.08	81.75	28.45	4.91
GA 230	882	40.46	**1.19**	82.10	**31.50**	4.38	GA 2011029	n/a	41.63	1.14	82.40	29.60	4.79
LSD$_{0.10}$	**248**	**1.63**	**0.03**	**ns**	**1.26**	**0.15**	**LSD$_{0.10}$**	**ns**	**1.07**	**0.03**	**1.05**	**1.04**	**0.12**

The bold type indicates the lint yields that are not significantly different from the top.
‘ns’ signifies no significant differences from top to bottom of the list.
mic in bold type indicates values outside of the acceptable range.
GA 230 and DP 493 are check varieties for comparison purposes.

Table 3. Results of 2011 Preliminary (F_5) Trials 3 and 4.

2011 PT3							2011 PT4						
ENTRY	**Lint Yield**	**Lint %**	**UHM in.**	**UI %**	**Str g/tex**	**mic**	**ENTRY**	**Lint Yield**	**Lint %**	**UHM in.**	**UI %**	**Str g/tex**	**mic**
GA 2011038	**1556**	41.70	1.16	84.05	27.95	4.45	GA 2011082	**1683**	44.03	1.13	80.95	27.25	4.52
GA 2011042	**1465**	**43.91**	1.15	83.15	29.80	4.25	GA 2011090	**1587**	39.03	1.12	83.30	29.55	4.83
GA 2011044	**1447**	42.73	1.10	84.45	29.55	**5.35**	GA 2011093	**1577**	43.44	1.14	**84.65**	31.15	4.77
GA 2011036	**1423**	41.41	**1.18**	82.60	28.80	4.53	GA 2011057	**1499**	43.68	1.13	**83.55**	30.05	4.79
GA 2011040	**1411**	41.94	1.15	83.75	28.40	4.29	GA 2011061	**1469**	43.72	1.12	**83.70**	**31.65**	5.01
GA 2011039	**1399**	42.15	1.16	84.05	29.15	4.37	GA 2011089	**1455**	43.05	1.13	**83.60**	29.80	5.02
GA 2011035	**1388**	43.15	1.14	82.95	27.95	4.52	DP 493	1428	41.83	1.08	82.55	30.80	4.83
DP 493	**1372**	42.67	1.09	82.25	30.00	4.89	GA 2011078	1398	42.58	1.16	81.90	28.55	4.80
GA 2011051	1363	38.87	1.13	83.25	29.80	4.70	GA 2011088	1386	40.13	1.16	**83.80**	**31.95**	4.91
GA 2011053	1341	**44.96**	1.13	83.20	30.00	4.58	GA 2011056	1386	41.60	1.12	83.25	30.55	4.39
GA 2011041	1333	41.05	1.15	83.40	30.10	4.60	GA 2011085	1350	40.40	1.17	82.00	29.80	4.39
GA 2011043	1263	**44.20**	1.12	84.10	29.90	4.35	GA 2011068	1041	39.93	1.11	**83.65**	29.65	4.51
GA 2011037	1149	40.82	1.11	83.50	27.90	4.33	GA 230	983	38.73	**1.22**	**83.55**	**32.00**	4.46
GA 2011055	1148	42.40	1.14	85.05	**34.15**	4.36	GA 2011060	810	**47.16**	1.07	83.25	28.45	5.13
GA 2011054	1118	43.29	1.10	83.75	29.30	4.93	GA 2011087	757	36.71	1.14	**84.10**	**32.80**	4.73
GA 2011048	1031	39.69	1.09	84.42	31.06	4.79	GA 2011065	n/a	n/a	n/a	n/a	n/a	n/a
GA 2011050	987	38.69	1.14	83.85	30.75	4.30	GA 2011069	n/a	43.35	1.14	**83.75**	31.15	4.51
GA 230	n/a	39.71	**1.21**	84.30	29.65	4.19	GA 2011083	n/a	43.99	1.14	83.25	29.15	4.92
LSD$_{0.10}$	**185**	**1.55**	**0.04**	**ns**	**2.13**	**0.28**	**LSD$_{0.10}$**	**239**	**1.35**	**0.03**	**1.16**	**1.38**	**0.22**

The bold type indicates the lint yields that are not significantly different from the top.
‘ns’ signifies no significant differences from top to bottom of the list.
mic in bold type indicates values outside of the acceptable range.
GA 230 and DP 493 are check varieties for comparison purposes.

Table 4. Results of 2011 Preliminary (F_5) Trials 5 and 6.

2011 PT5							**2011 PT6**						
ENTRY	**Lint Yield**	**Lint %**	**UHM in.**	**UI %**	**Str g/tex**	**mic**	**ENTRY**	**Lint Yield**	**Lint %**	**UHM in.**	**UI %**	**Str g/tex**	**mic**
GA 2011095	**1652**	**42.97**	1.12	82.40	27.40	4.75	GA 2011151	**1825**	**45.31**	1.11	**84.05**	**30.75**	**5.37**
GA 2011124	**1638**	**43.82**	1.12	83.30	30.20	5.05	GA 2011157	**1784**	42.96	1.11	83.10	30.05	**5.29**
GA 2011108	**1500**	37.79	**1.16**	82.45	29.40	4.51	GA 2011156	**1696**	**44.20**	1.15	**84.15**	**31.50**	4.76
GA 2011127	1411	**43.55**	1.07	82.05	28.05	**5.24**	DP 493	**1674**	42.32	1.13	83.15	30.30	5.11
GA 2011096	1346	39.81	1.11	82.95	29.95	5.01	GA 2011136	**1630**	43.41	1.10	82.10	28.60	4.70
GA 2011121	1339	**42.79**	**1.19**	82.55	**32.40**	4.48	GA 2011144	**1630**	43.37	1.10	82.90	29.05	5.16
DP 493	1321	42.13	1.09	82.15	29.85	5.03	GA 2011158	1563	42.77	1.14	**83.95**	29.95	4.82
GA 2011113	1316	**43.28**	1.14	82.60	29.60	4.89	GA 2011131	1525	**43.95**	1.14	**83.65**	**30.80**	**5.28**
GA 2011106	1310	39.74	1.12	82.05	27.90	4.74	GA 2011146	1475	42.54	1.12	**84.35**	28.95	**5.34**
GA 2011119	1261	42.07	1.12	82.85	28.70	4.81	GA 2011140	1471	43.18	1.08	82.50	30.40	**5.43**
GA 2011103	1213	42.46	1.11	83.25	29.50	4.82	GA 2011154	1460	43.13	1.14	**84.10**	30.10	**5.36**
GA 2011125	1205	42.20	**1.19**	82.70	**31.80**	4.75	GA 2011134	1325	43.55	1.13	82.85	29.20	5.01
GA 2011118	1143	41.47	1.11	83.35	**32.10**	5.09	GA 2011155	1271	43.65	1.12	82.85	28.15	5.18
GA 2011114	1114	41.96	1.12	83.05	**32.05**	4.78	GA 2011149	1261	43.82	1.11	82.70	29.70	5.00
GA 2011117	1053	40.91	1.15	83.95	**32.05**	5.01	GA 2011141	1242	42.44	1.12	**83.80**	29.70	**5.23**
GA 230	883	38.65	**1.20**	83.20	**31.35**	4.62	GA 2011133	1237	43.53	1.08	82.15	29.00	**5.54**
GA 2011126	830	**43.19**	1.10	82.30	30.45	5.18	GA 230	1226	39.81	**1.23**	**84.35**	**31.90**	4.18
GA 2011097	n/a	39.11	1.13	82.70	29.90	**5.25**	GA 2011159	1185	**44.30**	1.12	83.25	29.85	5.05
LSD$_{0.10}$	**241**	**1.60**	**0.04**	**ns**	**1.42**	**0.22**	**LSD$_{0.10}$**	**208**	**1.42**	**0.02**	**0.77**	**1.33**	**0.22**

The bold type indicates the lint yields that are not significantly different from the top.
‘ns’ signifies no significant differences from top to bottom of the list.
mic in bold type indicates values outside of the acceptable range.
GA 230 and DP 493 are check varieties for comparison purposes.

Table 5 Results of 2011 Preliminary (F_5) Trial 7.

2011 PT7						
ENTRY	**Lint Yield**	**Lint %**	**UHM in.**	**UI %**	**Str g/tex**	**mic**
GA 2011167	**1686**	41.21	1.11	**84.24**	30.77	4.93
GA 2011164	**1651**	**43.57**	1.10	82.60	29.85	4.83
GA 2011182	**1626**	39.80	1.11	81.95	29.95	**5.30**
GA 2011161	**1620**	**42.56**	1.10	82.55	29.35	4.85
GA 2011174	**1490**	40.17	1.12	**83.35**	**31.75**	5.00
GA 2011181	**1460**	41.45	1.12	**83.20**	**31.80**	4.77
GA 2011191	**1447**	**42.86**	1.12	82.65	29.75	4.95
GA 2011179	**1438**	40.80	1.09	81.35	29.90	5.17
GA 2011163	**1438**	**42.60**	1.12	**83.25**	29.85	4.93
GA 2011177	**1433**	39.68	1.12	**83.20**	30.90	5.08
GA 2011165	1410	42.22	1.08	81.85	31.15	5.01
GA 2011180	1353	**42.32**	1.11	81.70	28.90	4.80
DP 493	1258	**42.84**	1.05	81.40	29.15	5.19
GA 2004303	1256	**42.75**	1.11	81.70	30.05	5.03
GA 2011178	1249	37.98	1.13	81.25	**32.00**	5.10
GA 230	1066	37.49	**1.22**	**83.70**	**32.40**	4.41
GA 2011186	312	36.31	1.11	82.16	**32.73**	4.76
GA 2011169	n/a	**43.59**	1.09	82.14	29.17	**5.30**
LSD$_{0.10}$	**259**	**1.27**	**0.03**	**1.11**	**1.54**	**0.23**

The bold type indicates the lint yields that are not significantly different from the top.
‘ns’ signifies no significant differences from top to bottom of the list.
mic in bold type indicates values outside of the acceptable range.
GA 230, GA 2004303, and DP 493 are check varieties for comparison purposes.

ROOT-KNOT NEMATODE RESISTANCE IN COMMERCIAL AND PUBLIC COTTON CULTIVARS

Peng Chee and Edward Lubbers, Univ. of Georgia and Richard Davis, USDA-ARS
Project Number: 11-931

2011 Technical Report

Introduction

Host plant resistance is overall the most economical, practical, and environmentally sound method to provide crop protection against root-knot nematodes (RKN). Despite the widespread occurrence of RKN in most cotton production areas in the Southeast and that genetic resistance to RKN has existed since 1974 (Shepherd, 1974), private cultivar developers have exhibited minor interest in fulfilling this need.

However, now that it was announced in August, 2010 that the registered use of Temik is scheduled to be phased out by 2018 (High Plains Journal, 2010), RKN control in cotton has lost an important tool. Temik has been the most widely used nematicide in US cotton production and works well in controlling RKN, but it is already becoming difficult to find. Previously, RKN resistance in commercial cotton cultivars has been garnered only through direct utilization by the commercial cotton breeding companies of cultivars developed by public cotton breeders. These include the RKN-resistant CPCSD Acala NemX and the tolerant ST LA887 and PM H1560 that have been distributed by commercial cotton seed companies; none of which were particularly developed for cotton production in the Southeast. There are now four other cultivars that are directly touted in the websites of the three major commercial cotton breeders in the United States. Unbiased testing regarding the strength of the resistance offered to the cotton grower and the improvement of yield from this trait is needed to determine the value of RKN resistant cultivars in the Southeast. Additional testing of several newly released public cultivars is also needed to determine if any RKN resistance is available from these new public genetic resources. Altogether this will benefit United States producers by providing an evaluation of these cultivars for yield and decreased production costs.

Materials and Methods

Parallel yield tests of the four RKN tolerant commercial cultivars (PhytoGen PHY 367 WRF, Bayer CropScience ST 4288B2F and ST 5458B2RF, and Monsanto DP 174 RF) and four newly released public conventional cultivars (University of Georgia's GA 230, University of Arkansas' UA 48, and Louisiana State University's LA 17 and LA 35rs were planted with three checks (University of Georgia's GA 120R1B3, a resistant check; Acala NemX, a resistant check; and Monsanto's DP 0935 B2RF, a susceptible check) in soils with and without high populations of root-knot nematodes over a two year span at the Gibbs Farm of the University of Georgia-Tifton Campus. The tests use standard cotton agronomic practices utilized by the farm personnel and promulgated by the UGA Extension Cotton Team. The test in the infested field had 8 replications to cover an expected biological variability of the RKN infestation of the cotton roots. The test without high nematode populations had 4 replications and used granular, gypsum-based Temik insecticide banded in at planting at 5 pounds/acre which is generally considered a nematicidal rate. The seed was treated with Baytan, Thiram, and Allegiance for fungal control as labeled. We have found no nematicidal effects reported by others using this seed treatment. Besides harvesting for yield, we will also checking the lint percentage and fiber quality for any unexpected changes.

Results and Discussion

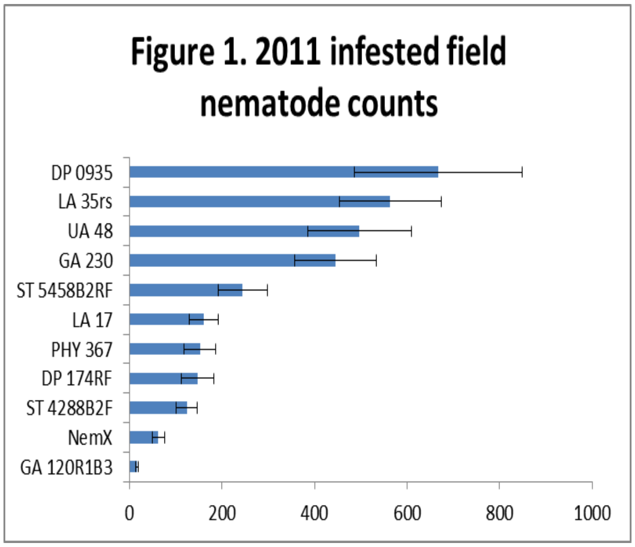


Figure 1. 2011 infested field nematode counts

The first year data of the nematode counts indicate that the four touted commercial cultivars are definitely not extremely susceptible to RKN, but nothing is as resistant as the two resistant checks, GA 120R1B3 and NemX (Fig. 1). In comparing the resistant checks, GA 120R1B3 is significantly better than NemX or any other cultivar. One conventional cultivar LA 17 appears to have a level of RKN resistance that is essentially equivalent with the commercial cultivars. All of the commercial cultivars along with LA 17 seem to cluster between the resistant checks and the susceptible check. The other conventional cultivars cluster with the susceptible check as would be expected if they are indeed susceptible.

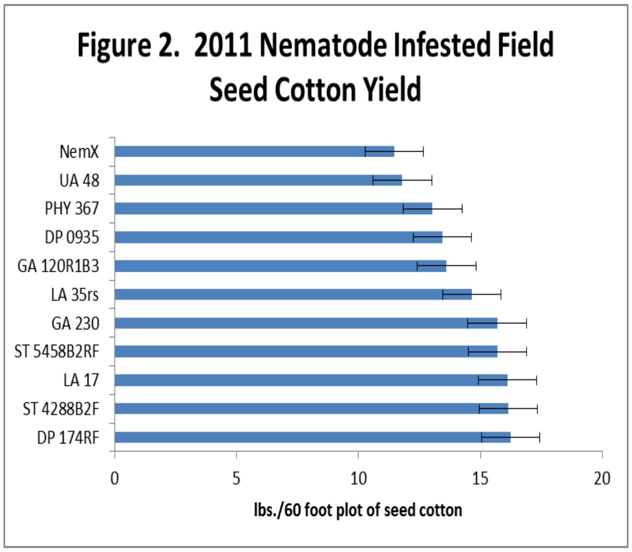
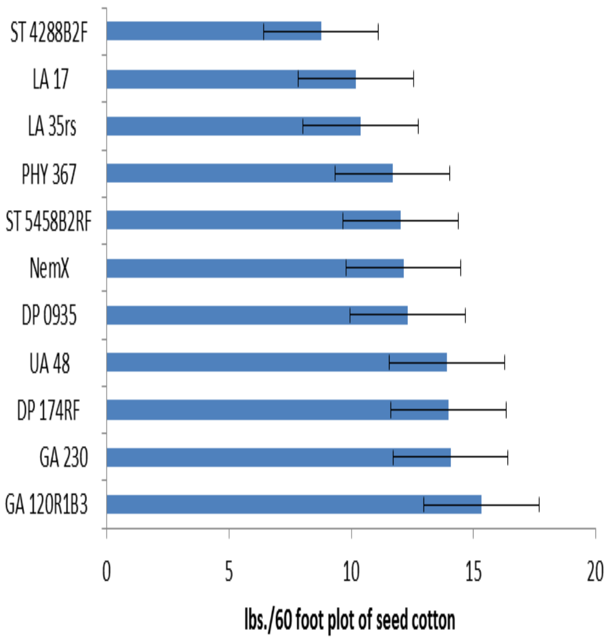


Figure 2. 2011 Nematode Infested Field Seed Cotton Yield

The best seed cotton yielder in the RKN infested field was DP 174RF followed by two commercial cultivars and two public cultivars that were not significantly different (Fig. 2). The lowest ranking cultivar was the resistant cultivar NemX. The rankings of the cultivars for seed cotton yield do not match the ranking of the cultivars for the nematode counts. This was not unexpected since the background genetics for the agronomic performance of the cultivars is unlikely to be correlated with the RKN resistance trait. For example, NemX is an Acala cotton that is not adapted to the Southeast. The high RKN resistance of NemX cannot completely compensate for the fact that NemX is not adapted to the Southeast. The resistant check GA 120R1B3 yielded better than the NemX because it was developed in and for the Southeast and has two major genes of an elite RKN resistance.

Figure 3. 2011 Nematode Clear Field Seed Cotton Yield



The top yielders in the nematode clear field, GA 120R1B3 and GA 230, were the two cultivars developed in and for the Southeast (Fig. 3). Another putative susceptible cultivar UA 48 with the susceptible check DP 0935 B2RF also did better in the clear field vs. the infested field. Neither of these occurrences is unexpected. However, the interactions between the yields of the infested field and the clear field are not completely evident. DP 174RF ranked high in both fields, but ST 4288B2F was on opposite ends. One also would expect that the RKN resistant cultivar that was developed for Georgia conditions GA 120R1B3 would rank high in both fields. Further research is needed to determine the nature of the interaction between the RKN resistance and the traits required for adapted cultivars. We will be looking at these issues particularly for the Southeast in the second year of this research project, 2012.

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IRRIGATION OF COTTON MAKES “CENTS”

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Abstract

Irrigation of cotton makes sense to growers interested in improving crop production, but investment and operation of irrigation equipment is costly. This paper examines budgeted irrigation costs in several of the Southeastern cotton producing states, conducts an analysis of investment and operating costs, and a sensitivity analysis of profitability.

Introduction

Irrigation makes sense to a lot of growers interested in improving crop production, reducing yield variability and potentially increasing profits. However, irrigation can be costly. Investment and operating costs on irrigation equipment are significant and financing may be difficult to obtain. Water availability may be restricted and energy sources can be limited; adding to the cost to irrigate. Furthermore, the benefits to irrigation over non-irrigated production methods may be reduced due to rainfall during the growing season. The objective of this paper is to examine irrigation costs in several of the Southeastern cotton producing states and conduct a sensitivity analysis of profitability.

Analysis and Results

An analysis of cotton enterprise budgets from Arkansas, Georgia and Texas was conducted to summarize budgeted, or expected, differences in yield and cost of production. Budget data were summarized by production method and irrigation method (i.e. dryland versus furrow-irrigated versus pivot-irrigated). Table 1 shows budgeted yields, variable, fixed, and total costs. Arkansas budgets reflect an expected increase in yield due to irrigation of 400 pounds per acre, whereas irrigation is budgeted to increase yield by 500 pounds over dryland yields in Georgia and by 690 to 850 pounds per acre in Texas depending upon the type of irrigation method. Additional costs associated with irrigated cotton production are not only a result of the irrigation application. Irrigated acres tend to have more field operations due to increased weed, disease and insect pressure. There may also be additional cost associated with land preparation in the case of furrow irrigated acreage. Irrigated acres are budgeted to cost an additional $124 to $190 per acre over dryland production costs in Arkansas, an additional $254 per acre over dryland production costs in Georgia, and $279 to $390 per acre over dryland production costs in Texas.

Table 1. Cotton Enterprise Budgets, Selected Southeastern States, Cost per Acre and per Pound, 2012

	Arkansas			Georgia		Texas		
Production Method	Dryland	Furrow	Pivot	Dryland	Pivot	Dryland	Furrow	Pivot
Yield, pounds	800	1,200	1,200	700	1,200	430	1,120	1,280
Variable Cost, per acre	$415	$520	$553	$433	$571	$318	$562	$667
Fixed Cost, per acre	$102	$121	$153	$131	$247	$36	$71	$77
Total Cost, per acre	$517	$641	$706	$564	$818	$354	$634	$744
Total Cost, per pound	$0.65	$0.53	$0.59	$0.81	$0.68	$0.82	$0.57	$0.58

Sources: University of Arkansas, 2012 Cotton Enterprise Budgets, The University of Georgia 2012 Cotton Enterprise Budgets, Texas AgriLife Extension Service 2012 Cotton Enterprise Budgets.

Investment and operating costs can vary significantly among farms and by states. An analysis of investment and operating cost data on irrigation was conducted for Georgia and Texas. Investment and operating costs can be found in Tables 2-5. Investment costs are calculated depending upon the size of the irrigation system, type of irrigation system, size and type of the power unit and pump, and size and depth of the well.

Investment costs (Tables 2-3) in Georgia, assuming a 160 acre center pivot and a 300' well, range from $140,000 to $153,000 for electric and diesel operation, respectively. Operating costs for the diesel-operated pivot are $148.84 an acre, using a diesel fuel price of $3.55 per gallon. Operating costs for the electric-operated pivot in Georgia are $73.00 per acre; not including a potential surcharge for use of electricity during peak energy use hours.

Table 2. Initial Investment and Annual Ownership and Operating Costs, Center Pivot, Diesel Operation, 300’ Well, 160 acres in Georgia

	Investment ($)	Useful Life (years)	Depreciation ($)	Interest ($)	Taxes & Insurance ($)
Sprinkler System	65,000	20	3,250	2,275	813
Power Unit	15,500	12	1,292	543	194
Well	28,000	20	1,400	980	350
Pump & Gearhead	33,500	12	2,792	1,173	419
Installation	11,000	20	550	385	138
Total Investment	$153,000		$9,283	$5,355	$1,913
Annual Fixed Cost:			$16,551		
Annual Fixed Cost per Acre:			$103.44		
Total Operating Cost per Acre:			$148.84		
Diesel Fuel Cost per Acre:			$112.20		
Lube, Repairs & Maintenance Cost per Acre:			$25.46		
Labor Cost per Acre:			$11.17		

Table 3. Initial Investment and Annual Ownership and Operating Costs, Center Pivot, Electric Operation, 300’ Well, 160 acres in Georgia

	Investment ($)	Useful Life (years)	Depreciation ($)	Interest ($)	Taxes & Insurance ($)
Sprinkler System	65,000	20	3,250	2,275	813
Power Unit	15,500	12	1,292	543	194
Well	28,000	20	1,400	980	350
Pump	31,500	20	1,525	1,068	381
Total Investment	$140,000		$7,467	$4,865	$1,738
Annual Fixed Cost:			$14,069		
Annual Fixed Cost per Acre:			$87.93		
Total Operating Cost per Acre:			$73.00		
Electricity Cost per Acre:			$36.98*		
Lube, Repairs & Maintenance Cost per Acre:			$26.55		
Labor Cost per Acre:			$ 9.48		

*Does not include potential surcharge for operation during peak hours.

Investment costs (Tables 4-5) in Texas, assuming a 160 acre pivot or 160 acre furrow irrigation system and a 350’ well, range from $170,000 to $137,000, respectively. Operating costs for the natural gas-operated pivot are $111.97 an acre, using a natural gas price of $6.00 per thousand cubic feet. Operating costs for the natural-gas operated furrow irrigation system are $141.23 per acre. The furrow-irrigation system has the highest labor cost because of the additional labor involved in land preparation and moving pipe.

Table 4. Initial Investment and Annual Ownership and Operating Costs, Center Pivot, Natural Gas Operation, 350’ Well, 160 acres in Texas

	Investment ($)	Useful Life (years)	Depreciation ($)	Interest ($)	Taxes & Insurance ($)
Distribution System	65,000	25	2,780	2,433	869
Engine	9,000	25	360	315	113
Well	45,500	25	1,820	1,593	569
Pump	46,000	25	1,840	1,610	575
Total Investment	$170,000		$6,800	$5,950	$2,125
Annual Fixed Cost:			$14,875		
Annual Fixed Cost per Acre:			$ 92.97		
Total Operating Cost per Acre:			$111.97		
Natural Gas Cost per Acre:			$59.15		
Lube, Repairs & Maintenance Cost per Acre:			$38.47		
Labor Cost per Acre:			$14.36		

Source: Amosson et al., 2011. “Economics of Irrigation Systems.” Texas AgriLife Extension Service Bulletin B-6113.

Table 5. Initial Investment and Annual Ownership and Operating Costs, Furrow Irrigation, Natural Gas Operation, 350' Well, 160 acres in Texas

	Investment ($)	Useful Life (years)	Depreciation ($)	Interest ($)	Taxes & Insurance ($)
Distribution System	36,800	25	1,472	1,288	460
Engine	9,000	25	360	315	113
Well	45,500	25	1,820	1,593	569
Pump	46,000	25	1,840	1,610	575
Total Investment	$170,000		$5,492	$4,806	$1,716

Annual Fixed Cost:	$12,014
Annual Fixed Cost per Acre:	$ 75.09
Total Operating Cost per Acre:	$141.23
Natural Gas Cost per Acre:	$70.85
Lube, Repairs & Maintenance Cost per Acre:	$46.10
Labor Cost per Acre:	$24.28

Source: Amosson et al., 2011. "Economics of Irrigation Systems." Texas AgriLife Extension Service Bulletin B-6113.

Irrigation makes economic sense when revenue from increased yield exceeds the increased cost of production. Table 6 shows the yields needed to cover the added cost of irrigation at varied prices of lint cotton. In Arkansas, the added cost of irrigation is $124 per acre for furrow irrigation and $190 per acre for pivot irrigation. At a lint price of $0.80 per pound, a grower will need an additional 155 to 237 pounds of cotton to justify paying the higher costs of irrigation. In Georgia, the added cost of irrigation is $254 per acre. At a lint price of $0.80 per pound, growers need an additional 318 pounds of cotton to justify paying the higher costs of irrigation. In Texas, the added cost of irrigation is $279 per acre for furrow irrigation and $390 per acre for pivot irrigation. At a lint price of $0.80 per pound, growers need an added 350 to 488 pounds of cotton to justify paying the higher costs of irrigation.

Table 6. Lint Yield Needed to Cover Added Cost of Irrigation by Type of Irrigation System and Lint Price, Selected Southeastern States, 2012

	Arkansas		Georgia	Texas	
Lint Price $/lb	Furrow (lb)	Pivot (lb)	Pivot (lb)	Furrow (lb)	Pivot (lb)
$0.70	178	271	363	399	558
$0.80	155	237	318	350	488
$0.90	138	211	282	310	434

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CAN SUBSURFACE DRIP IRRIGATION BE A FEASIBLE AND PROFITABLE PRACTICE FOR GEORGIA COTTON PRODUCTION?

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Situation and Overview

It is estimated that approximately 45% of Georgia's cotton acreage is irrigated (Harrison). The vast majority of this acreage is irrigated with center pivot irrigation. Although non-irrigated production is risky, compared to other crops in Georgia, cotton is considered relatively more drought tolerant. University of Georgia crop enterprise budget estimates assume an expected yield of 700 pounds per acre for non-irrigated production compared to 1,200 pounds per acre for irrigated (Shurley and Smith).

In general, fields in row crop production even on large farms can be small and/or irregular sized. This means it is not uncommon for some fields to be able to accommodate only a relatively small to medium size pivot or for the pivot to not operate a full circle. This increases the investment and fixed costs per acre and thus the yield increase needed to make the system profitable.

There is increased producer and research interest in subsurface drip irrigation (SSDI)—perhaps as an alternative to pivot/overhead irrigation in small-field situations or to irrigate non-irrigated portions of a field that a pivot is unable to reach. There are many factors determining the economics of SSDI and questions from a producer standpoint that need to be addressed before making a decision. These questions include:

1. How do costs compare to center pivot systems?
2. Where and how would SSDI fit in my farming operation?
3. Is SSDI application reliable?
4. Will SSDI yield comparable with pivot irrigation?
5. Is SSDI compatible with different crop row spacing?
6. Is SSDI compatible with my desired crop rotations?
7. What are the implications for tillage practices?

Objectives and Methodology

Research began in 2010 at the University of Georgia Stripling Irrigation Research Park (SIRP) near Camilla, Georgia to investigate the effectiveness and economic viability of SSDI in typical row-crop rotations (Perry). The first full year of data and results was

2011. The purpose of this specific paper is to utilize data from the 2011 study to begin investigating the economic feasibility of SSDI in Georgia cotton production.

The 2011 SIRP study consisted of 22 treatments, 6 replications of each treatment. The 22 treatments are summarized as follows:

<u>SSDI</u>
2 varieties x 2 drip tape depths x 4 application amounts/triggers = 16 treatments

<u>Pivot</u>
2 varieties x 2 application amounts = 4 treatments

<u>Non-Irrigated</u>
2 varieties = 2 treatments

Cotton was planted on 36-inch row spacing. Two varieties were used in the study—DP 1050 B2RF and FM 1740 B2F. For the SSDI portion of the study, drip tape was set on every other row middle (every 72 inches). Drip tape was set at 2 inches (shallow) and 12 inches (deep). For each variety at each depth, irrigation was applied based on 4 triggers or amounts—full, deficit, 40cb, and 70cb. These are as follows:

Full = 100% of the UGA recommendation (Collins, page 113) if adequate rainfall was not received
Deficit = 65% of the UGA recommendation if adequate rainfall was not received
40cb = 100% UGA applied when soil moisture meter reading was 40cb
70cb = 100% UGA applied when soil moisture meter reading was 70cb

For pivot irrigation, only the 40cb and 70cb triggers were used. When triggered, 1 inch of water was applied regardless of the recommendation and growth stage of the cotton.

Yield Results

For the purpose of economic analysis, the main results to be gleaned from the 2011 SIRP study are yield, differences in yield depending on irrigation system type and water application/timing, and irrigated yield compared to non-irrigated.

The average yield for deep drip irrigation (DD) was 1,510 pounds per acre (Figure 1). FM 1740 yielded higher than DP 1050 but the average of both varieties was 1,510 lbs. Shallow drip irrigation (DS) yielded slightly higher at 1,556 pounds per acre average for both varieties. The average pivot irrigated (PVT) yield for both varieties was 1,500 pounds per acre. Statistically, there was no difference in yield between deep drip, shallow drip, and pivot irrigation. The average non-irrigated (NI) yield was 1,071 pounds per acre and was statistically different than irrigated yields.

Deep (12”) drip irrigation was evaluated for 2 varieties and 4 water application triggers/amounts (8 treatments) (Figure 2). While yield across all treatments averaged 1,510 per acre, the highest yield was for FM 1740 B2F irrigated using the full (100%) UGA recommendation amount as needed. Yields varied by 409 pounds per acre but there was no statistical difference in yield, however, among the top 7 treatments.

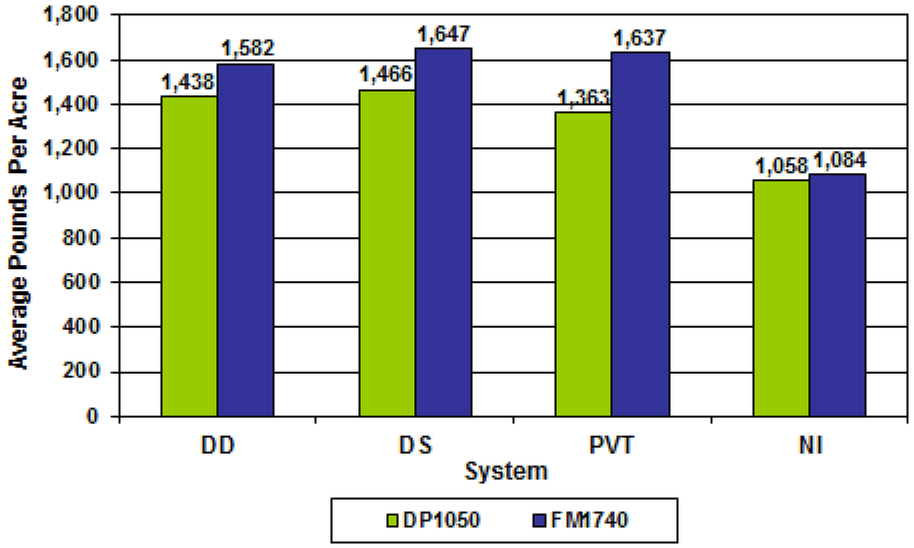

Figure 1. Average Yield of All Applications, By System and Variety

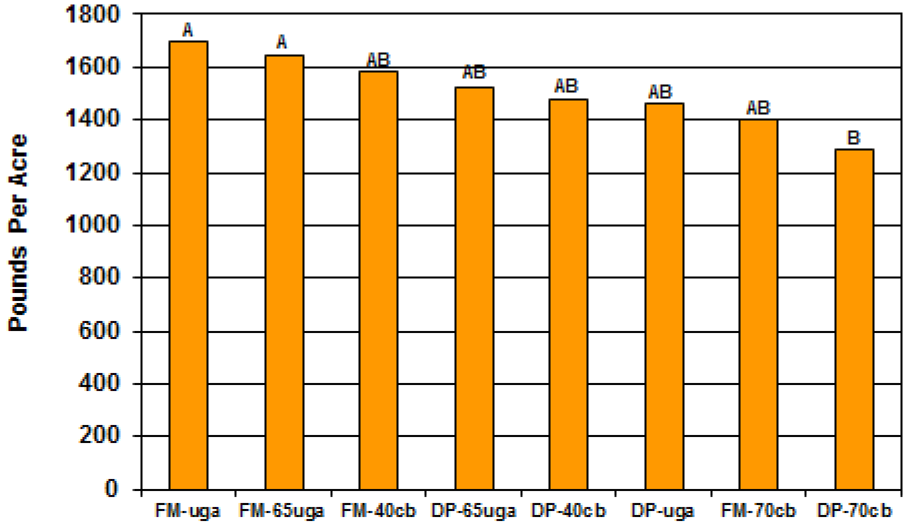

Figure 2. SSDI, 12”, By Variety and Application

* Yields with the same letter(s) are not statistically different.

Shallow (2”) drip irrigation was also evaluated for the same 8 treatments (Figure 3). The yield across all 8 treatments averaged 1,556 pounds per acre but ranged from 1,768 pounds per acre to 1,336 pounds per acre. The highest yield was again for FM 1740 B2F, irrigated at the full (100%) UGA recommendation but there was no statistical difference among the top 7 of the 8 treatments.

Shallow (2”) drip out-yielded deep (12”) in 6 of the 8 treatments (Figure 4). The only exceptions were both varieties with irrigation applied at the “deficit” amount (only 65% of the UGA recommendation). Statistically, there was no difference in yield among the top 12 of the 16 treatments. Also, statistically there was no difference in the worst yield and the 6th highest yield.

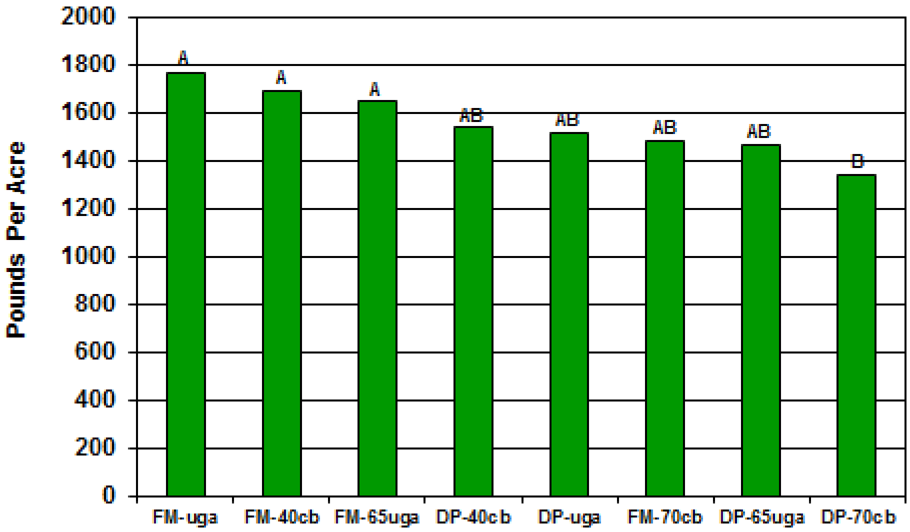

Figure 3. SSDI, 2”, By Variety and Application

* Yields with the same letter(s) are not statistically different.

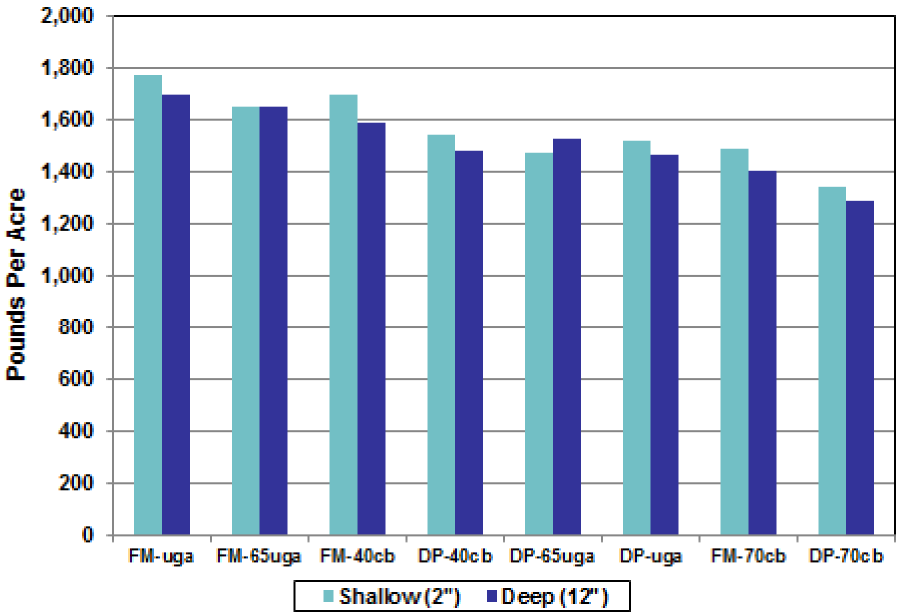

Figure 4. SSDI, By Depth and Variety and Application

Regardless of irrigation method, the lowest yields occurred when irrigation was not applied until the soil moisture sensor reading was 70cb (Figure 5). This resulted in the least number of applications and the least amount of water applied. The remaining yield observations were all within less than 150 pounds per acre of each other regardless of the irrigation type and amount of irrigation applied. The yields shown are the average of both varieties for each treatment.

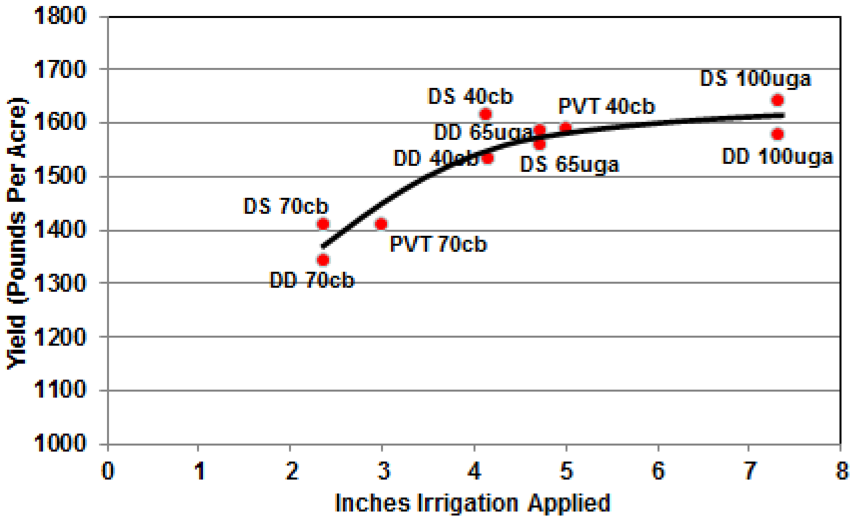

Figure 5. Yield By Treatment and Amount of Irrigation Applied

From these yield results, several conclusions could be made that are relevant to economic analysis:

- Subsurface drip irrigation (SSDI) can result in yield comparable to pivot irrigation.
- SSDI can possibly yield as well as pivot but with less water applied.
- Numerically, shallow drip tends to yield better than deep drip but the yield difference was not statistically significant in this study.
- Irrigated yield averaged 42% higher than non-irrigated yield. Non-irrigated treatment yields were very high, however-- averaging 1,071 pounds per acre.

Economic Comparisons

Where is subsurface drip irrigation (SSDI) likely to be a feasible and potentially profitable production practice? This research analyzes 3 scenarios considered typical of decisions in which using SSDI might need to be evaluated:

1. A well and center pivot (full circle) already exists. Add SSDI to adjacent non-irrigated acres not reachable by the pivot due to field size and/or shape.
2. Smaller, irregular field where a full circle is not possible. A partial pivot (less than a full circle) with remaining area left un-irrigated compared to SSDI for the entire field.
3. Small area not feasible for pivot. SSDI compared to non-irrigated.

In conducting economic analysis for each of these typical on-farm scenarios, several assumptions are made. These include:

- A 450 pound per acre yield difference is assumed between irrigated and non-irrigated production. This would be consistent with 750 pounds and 1,200 pounds per acre for non-irrigated and irrigated production respectively and also consistent with the average yield difference (451 pounds) between all irrigated treatments and the non-irrigated treatments in the SIRP study.
- SSDI is assumed to yield the same as pivot irrigation.
- Fiber quality is not considered. Quality is assumed the same for SSDI, pivot irrigation, and non-irrigated.
- Pivot irrigation is assumed to be 81% as efficient as SSDI (Amosson). For example, if 1” of water were applied by pivot, only .81” of water would need to be applied through SSDI to provide the same benefit to the crop due to less transpiration loss and runoff.
- An average or typical season total application by pivot is assumed to be 8”.

For each of the three irrigation scenarios, system costs were actual irrigation dealer bid estimates. These three SSDI scenarios were developed in consultation with producers and irrigation dealers and actual dealer estimates developed for each situation. Each system and each estimate is an actual farm/field situation.

Economic Results

Scenario #1

In this example, there is an existing well and 114-acre pivot (full circle). SSDI is added to 4 adjacent non-irrigated areas (totaling 62 acres) not reachable by the pivot. The SSDI system cost $102,700 or $1,656 per acre.

Annual fixed costs include depreciation, interest, insurance, and taxes. These costs total $137.69 per acre (Table 1). Variable (application) costs include diesel and/or electricity, maintenance and repairs, and labor. These costs are estimated at $11.00 per acre inch of water applied (Shurley and Smith, Amosson). Application is assumed to be 6½ inches per year-- 81% of what is assumed typically applied (8 inches) through center pivot.

In this scenario, SSDI is added to an existing well and pivot system and compared to what would otherwise be non-irrigated cotton not reached by the pivot. Assuming a 450-lb per acre yield increase and applying 6½ inches of water SSDI, net income is estimated to increase by $113.81 per acre (Table 1).

Table 1. SSDI Added to Existing Pivot, Compared to Non-Irrigated, 62 Acres.

Income Gained		**Additional Variable Costs**[2]	
Additional Yield Per Acre	450 lbs	Irrigation Application	$71.50
Net Price Per Lb[1]	$0.80	Other Inputs	$37.00
Additional Income Per Acre	**$360.00**		
		Additional Fixed Costs[3]	
		Depreciation	$62.12
		Interest	$67.29
		Tax and Insurance	$8.28
		Total Additional Cost Per Acre	**$246.19**
Per Acre Net Income Gain or Loss			**$113.81**

1/ Price should include the net gain or loss on cottonseed-- the value of cottonseed minus the cost of ginning, storage and warehousing, classing, and promotions. For this example, this value is assumed to be zero.

2/ Application is 6½ inches at $11 per inch. Other inputs include higher cost under irrigation for fertilizer, etc.

3/ Based on SSDI system cost of $102,700 ($1,656 per acre), average operational life of 20 years with salvage value of 25%, interest rate of 6.5%, and taxes and insurance totaling .8% of average value.

The analysis also assumes an additional cost of $37 per acre for other inputs such as increased fertilizer, defoliation, etc. in irrigated production compared to non-irrigated (Shurley and Smith). In practice, however, since the non-irrigated areas where SSDI is to be installed are adjacent to an area already irrigated, there may be no difference in inputs and production practices between irrigated and non-irrigated.

A net cotton price of 80 cents per pound is assumed but prices are highly variable from year to year. Assuming a 450-lb yield gain, the "breakeven price" needed to cover all additional costs would be 55 cents per pound ($246.19 / 450 lbs = $0.547).

Scenario #2

In this example, a 48-acre rectangular field can be partially irrigated by center pivot. The pivot can cover only a partial circle and irrigate 37 acres. The remaining 11 acres would be non-irrigated. This is compared to using SSDI to irrigate the entire 48 acres.

The 37-acre pivot would cost $52,100 or $1,408 per acre. Alternatively, SSDI on all 48 acres would cost $62,900 or $1,310 per acre.

The cost of the well, pump, and motor are not considered in this analysis because these costs would be incurred and are assumed the same with either pivot or SSDI. In practice, however, SSDI may require less horsepower and less GPM per acre and thus may be cheaper.

For SSDI on the 48 acres, Net Income (return above irrigation costs only) is estimated at $779.57 per acre (Table 2). Alternatively, if 37 acres were irrigated by pivot and 11 acres remained non-irrigated, Net Income is estimated at $727.39 per acre. Net Income is $52.18 per acre higher with SSDI.

Table 2. SSDI Compared to Partial Pivot and Non-Irrigated, 48 Acres.

SSDI (48 Acres)		Pivot (37 Acres)	
Yield Per Acre	1,200 lbs	Yield Per Acre	1,200 lbs
Net Price Per Lb[1]	$0.80	Net Price Per Lb[1]	$0.80
Income Per Acre	**$960.00**	**Income Per Acre**	**$960.00**
Irrigation Application[2]	$71.50	Irrigation Application[2]	$88.00
Fixed Costs[3]		Fixed Costs[4]	
Depreciation	$49.14	Depreciation	$45.06
Interest	$53.24	Interest	$54.92
Tax and Insurance	$6.55	Tax and Insurance	$6.76
Total Irrigation Cost Per Acre	**$180.43**	**Total Irrigation Cost Per Acre**	**$194.74**
Net Income Per Acre	**$779.57**	**Net Income Per Acre**	**$765.26**
		Non-Irrigated (11 Acres)	
		Yield Per Acre	750 lbs
		Net Price Per Lb[1]	$0.80
		Income Per Acre	**$600.00**
		Average Net Income Per Acre[5]	**$727.39**
Per Acre Net Income Gain or Loss			**$52.18**

1/ Price should include the net gain or loss on cottonseed-- the value of cottonseed minus the cost of ginning, storage and warehousing, classing, and promotions. For this example, this value is assumed to be zero.

2/ Pivot application assumed to be 8 inches and SSDI 6 ½ inches. Both systems are assumed to be $11 per inch.

3/ Based on SSDI system cost of $62,900 ($1,310 per acre), average operational life of 20 years with salvage value of 25%, interest rate of 6.5%, and taxes and insurance totaling .8% of average value.

4/ Based on center pivot system cost of $52,100 ($1,408 per acre), average operational life of 25 years with salvage value of 20%, interest rate of 6.5%, and taxes and insurance totaling .8% of average value.

5/ Weighted average of pivot and non-irrigated.

Annual Fixed Cost for the partial center pivot is estimated at $106.74 per acre. This compares to Fixed Cost of $108.93 for SSDI. Because the pivot is not operating a full circle, fixed cost per acre will be high but the difference was expected to be more than this example showed. Fixed Cost per acre for the partial pivot was actually slightly less than for SSDI. The Net Income gain for SSDI was due to yield difference on the non-irrigated portion of the field and lower amount and cost of application in SSDI.

Scenario #3

In this situation, there are adjacent fields unfeasible for pivot due to size and/or shape. SSDI is analyzed as an alternative to non-irrigated production totaling 38 acres.

SSDI for this 38 acres would cost $56,000 ($1,474 per acre). Well, pump, and motor would cost $25,000.

Compared to non-irrigated production, SSDI was estimated to increase net income by $79.13 per acre (Table 3). Additional Income is estimated at $360 per acre and Additional Variable and Fixed Costs are estimated at $281 per acre.

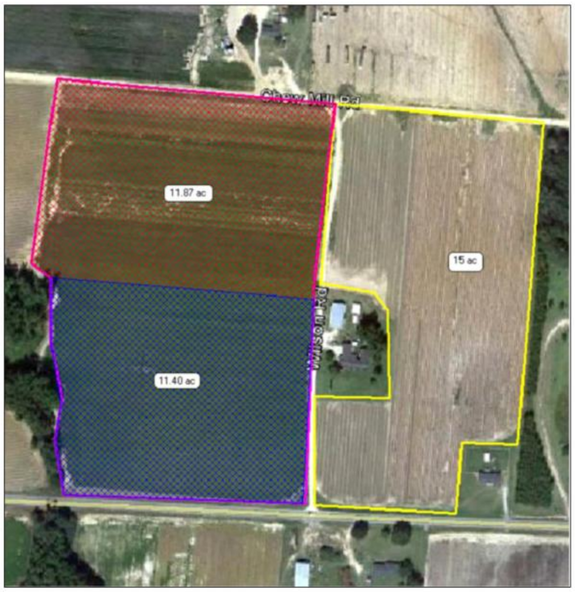

Table 3. SSDI Compared to Non-Irrigated, 38 Acres.

Income Gained		**Additional Variable Costs**[2]	
Additional Yield Per Acre	450 lbs	Irrigation Application	$71.50
Net Price Per Lb[1]	$0.80	Other Inputs	$37.00
Additional Income Per Acre	**$360.00**		
		Additional Fixed Costs	
		SSDI[3]	$122.50
		Well, pump, and motor[4]	$49.87
		Total Additional Cost Per Acre	**$280.87**
Per Acre Net Income Gain or Loss			**$79.13**

1/ Price should include the net gain or loss on cottonseed-- the value of cottonseed minus the cost of ginning, storage and warehousing, classing, and promotions. For this example, this value is assumed to be zero.

2/ Application is 6½ inches at $11 per inch. Other inputs include higher cost under irrigation for fertilizer, etc.

3/ Based on SSDI system cost of $56,000 ($1,474 per acre), average operational life of 20 years with salvage value of 25%, interest rate of 6.5%, and taxes and insurance totaling .8% of average value.

4/ Based on well/pump/motor cost of $25,000, average operational life of 25 years with salvage value of 20%, interest rate of 6.5%, and taxes and insurance totaling .8% of average value..

The analysis assumes a 450-lb yield increase due to irrigation and a net cotton price of 80 cents. Analysis also assumes 6½ inches of water applied and an additional $37 per acre in other variable inputs. The breakeven net price of cotton needed to cover Total Additional Cost of SSDI compared to non-irrigated production is approximately 63 cents per pound ($280.87 / 450 lbs = $0.624 per lb).

Summary and Conclusions

There is increased interest in subsurface drip irrigation (SSDI) as an alternative to pivot/overhead irrigation. There are many factors determining the economics of SSDI compared to pivot irrigation and/or non-irrigated production.

Based on 2011 research conducted at the Stripling Irrigation Research Park (SIRP) near Camilla, SSDI can yield equivalent to pivot irrigation and, further, may be able to do so with less water applied. Numerically, shallow drip irrigation yielded higher than deeper drip but results were not statistically different.

Three on-farm scenarios were identified that were believed to be representative of situations where SSDI might be considered and the types of decisions cotton producers would have to make. Economic analysis (budgeting) of each of these scenarios suggest that SSDI can be profitable to reach adjacent areas not reached by an already existing center pivot but profitability depends on the distance and cost of reaching the non-irrigated area and the amount of area to be irrigated.

Analysis also suggests that SSDI could be a profitable alternative in a situation where a pivot cannot operate a full circle due to field size or shape. In the situation budgeted in this study, the advantage for SSDI was much less than anticipated, however. Every farm situation will vary and economies of scale come into play.

SSDI was also compared to non-irrigated production where a pivot is not feasible. SSDI provided increased net income.

Depending on yield, price, costs, and economies of scale, SSDI can be profitable. Success with SSDI, however, may have as much to do with management as it does with economics. Questions still exist concerning proper depth of the drip tape—2 inches may too shallow and 12 inches may be too deep depending on soil type (texture, depth to B horizon, etc.), slope or erodibility of the field, and other crops in rotation with cotton. How is the feasibility and profitability of SSDI impacted by different row spacings, various crop rotations, and different tillage systems? SSDI may also require use of GPS and auto steer.

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IMPORTANCE OF NATURAL ENEMIES FOR STINK BUG CONTROL

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Summary

Studies were conducted to characterize which predators in cotton and soybeans attack Southern green and Brown stink bugs. It is relatively easy to demonstrate loss of stink bugs in cotton and other crops, but it is far more complex to determine who or what is responsible for the loss so that the appropriate natural enemies can be conserved. If we can determine particular natural enemy species that are especially active in consuming stink bugs, then we can target those natural enemies for conservation or enhancement. We applied molecular methods to address this issue. DNA primers were developed at the University of Kentucky to allow us to assay the gut contents of predators for the presence of stink bug DNA. This provides positive evidence for predation, and allows us to determine which predator species are feeding on stink bugs in the field. Two primers were developed – one for the Southern green stink bug, *Nezara viridula,* and the other for the Brown stink bug, *Euschistus servus*. We evaluated stink bugs and predators in three crops: 1) cotton (B2RF), 2) soybeans MG5 and 3) soybeans MG7. All three crops were planted at three locations: the Belflower Farm, Tifton, GA; the Attapulgus Research and Education Center, Attapulgus, GA; and the Southwest Research and Education Center, Plains, GA. All crops were sampled by sweep net and all arthropods taken in the samples were counted, and all predators and stink bugs were placed in 100% ethanol in preparation for DNA testing. Collected samples were sent to the University of Kentucky for processing. Due to the high number of specimens needing to be processed, we are still running DNA analyses and, therefore, we can only present preliminary conclusions here. All assays should be completed by early March, but thus far 629 out of the 1,873 collected predators have been assayed for the presence of stink bug DNA. So far, five predator species have tested positive for stink bug DNA – four species for Southern green stink bugs, and only one (an assassin bug, *Zelus* sp.) tested positive for Brown stink bug. The species positive for Southern green stink bug were the big-eyed bug *Geocoris punctipes*, the pirate bug *Orius insidiosus*, the maculate lady beetle *Coleomegilla maculata*, and the hooded beetle *Notoxus monodon*. Of these species, the big-eyed bugs had the highest populations in the field, of which 4.5% were positive for stink bug DNA. Hooded beetles were less common, but 6.8% of them tested positive. This is a new record for stink bug predation by this species, and provides direction for future work. Only 1.9% of pirate bugs were positive. Forty percent of the maculate lady beetles were positive, but only five individuals have been assayed so far, and this species was relatively uncommon in the field. Our preliminary data indicate that predation of stink bugs is occurring, but perhaps at low rates, and that the rates of predation may differ with stink bug species (Southern green higher than Brown).

Completion of the assays will provide us much more insight into the role of predation and which predator species are most important for stink bug suppression.

Introduction

A complex of stink bug species has become a serious and persistent problem in Georgia cotton production. The problem is exacerbated by the widespread distribution of stink bugs across the landscape and their mobility, the numerous host plants available to them for feeding and reproduction, the sporadic and unpredictable occurrence of their populations, 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, *Chinavia hilaris*, and the brown stink bug, *Euschistus servus*, with the Southern green stink bug historically dominating by a significant margin, followed by the Brown stink bug. 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.), and the former appears to have limited interest in cotton, feeding chiefly in soybeans.

Various natural enemies have been reported attacking stink bugs in different regions of the world (e.g., Yeargan 1979, Jones 1988, Ehler 2002, Eubanks 2001) and in some cases have been found to be very important (e.g., Kiritani 1964, Nishida 1966), but the natural enemy complex in the southeastern United States has been poorly defined. This overall project was initiated in 2007 with the support of the Georgia Cotton Commission and Cotton Incorporated to characterize the suite of stink bug natural enemies present in Georgia and to determine their efficacy. In previous studies we found that the parasitoid complex attacking stink bugs was primarily active against adult stink bugs, and had little impact on immatures. We also found previously that the eggs of stink bugs are susceptible to predation in cotton, but that predation was not particularly high (typically less than 25%). In the present study we are applying molecular techniques to field sampling to determine which predators in the field are consuming stink bugs in cotton. Once we have a better idea of which predators attack stink bugs in cotton, we can pursue in more detail the stink bug life stages they attack, and better determine how much of an impact they are having. This study represents a significant step in that direction. The project is still underway due to logistical bottlenecks that slowed progress. As a result, what is presented here will by necessity be a preliminary report of the progress and outcomes.

Materials and Methods

Primer Development: DNA primers were developed at the University of Kentucky to examine the gut contents of stink bug natural enemies for the presence of stink bug DNA indicating predation on stink bugs by the assayed predator. Specimens of the

Southern green stink bug (*Nezara viridula*) and the Brown stink bug (*Euschistus servus*) were collected from lab colonies and various field locations in Tifton, GA, in May 2011. In addition, we collected 127 non-target species from the field locations and transported them to the University of Kentucky for further processing. Each specimen was preserved in the field in 95% ethanol and stored in the freezer until extraction.

DNA was extracted from all specimens using Qiagen DNeasy Blood and Tissue Kits©. Following extraction, *N. viridula, E. servus* and non-target DNA was amplified using general 16S primers 16Sbr-H (5'- CCG GTC TGA ACT CAG ATC ACG T -3') and 16Sar-L (5'- CGC CTG TT ATC AAA AAC AT -3'). Following amplification, the bands were visualized on 2% agarose gels. The PCR product was then sent off for sequencing at AGTC (University of Kentucky, Lexington, KY). Sequences were editing using Geneious© (Biomatters Ltd) and aligned using MUSCLE (http://www.ebi.ac.uk/Tools/msa/muscle/). Primer design occurred using Primer3 (http://frodo.wi.mit.edu/). Upon receiving the primers, targets and non-targets were amplified using a temperature gradient to determine melting temperature. Following this, the primers were tested against a variety of non-targets. The primers were used to identify stink bug species in the gut contents of predators once specificity was established. Predators could be assayed for both stink bug species simultaneously.

Field Sampling: In order to obtain a broad base of information on stink bug predators, we used three crops for the studies: 1) cotton (DP1034B2RF), 2) soybeans MG5 (Asgrow 568RR) and 3) soybeans MG7 (Asgrow AG6931RR). All three crops were planted at three locations: the Belflower Farm, Tifton, GA (on 2 June 2011); the Attapulgus Research and Education Center, Attapulgus, GA (on 31 May 2011); and the Southwest Research and Education Center, Plains, GA (on 6 June 2011). The initial planting of cotton and soybeans did not received adequate water, and they were re-planted on 17 June. Aldicarb was applied in furrow at planting at 3.93 kg/ha (3.5 lbs/acre). No other insecticides were applied to the crops throughout the season. On each sample date we made 200 sweeps per crop plot (along two different rows in the plot separated from one another by 6 rows) with a 31 cm diameter net (15” diameter). Sweeping was initiated 5 meters into the crop and along rows at least 5 rows from the plot edge to reduce edge effects. Different rows were sampled on each sample date to prevent prolonged disruption of sampling rows. All arthropods taken in the samples were counted, and all predators and stink bugs were placed in 100% ethanol in preparation for DNA testing. Collected samples were sent to the University of Kentucky for processing. Sampling was initiated in Attapulgus and Plains on 29 July, and on 18 August in Tifton, and was conducted approximately weekly (weather permitting). Sampling in all three locations was terminated by 7 October. Due to the high number of specimens needing to be processed, we are still running DNA analyses and, therefore, we can only present preliminary conclusions here. All assays should be completed by early March.

Results and Discussion

DNA Primer Development and Predator Assays. The *N. viridula* primers were NV-334F:5’- TTTTTATTATTTATTTGGGTTG-3’and NV-566R: 5’-GTCGAACAGACCTAGAAC-3’. The *E. servus* primers were ES-43F: 5’-GTCTGATGTTATTTATATCAGATTTAA-3’ and ES-295R: -5’-AATAAATATTAACAATTTAACCAAAAC-3’. Once specificity was established, we tested predator gut contents for presence of *N. viridula* and *E. servus* DNA, indicating predation on these species. The bands were visualized on a 2% agarose gel to determine presence of either species of stink bug in the gut of the predator. To date, 629 (out of the 1,873 collected; see below) Arthropods have been assayed from the three crop treatments. Predators from the following sample dates have been assayed thus far: 29 July, 26 August, 8 September, 12 September, and 16 September. Table 1 presents the results to date for predator groups in which positive results were obtained.

It is clear from Table 1 that the frequency of predation on stink bugs in the assayed Arthropods was low. This is not surprising, given the overall low populations of stink bugs observed in the fields for most of the season and locations. However, it is also apparent that predation is occurring and that a complex of species is responsible. The highest number of positive responses was in the big-eyed bug, with 5 of 112 bugs testing positive for the presence of Southern green stink bug DNA so far. This was no surprise, as we and others (Ragsdale et al. 1981, Stam et al. 1987) have previously observed big-eyed bugs feeding on stink bug eggs in the field. However, this is a first record for stink bug predation by hooded beetles, and the positive rate for this species was relatively high. It is unclear which stage(s) the hooded beetle attacked, but this observation warrants additional study as hooded beetles can be very common in cotton fields.

Only a single positive predation event has been found for the Brown stink bug thus far, and that was in an assassin bug, and is a first record for *Zelus* spp. attacking stink bugs in the US. It is possible that the disparity in positive response between the Southern green stink bug and Brown stink bug is due to differential population sizes for the two species (with the Brown stink bug being less abundant), but this cannot be clarified until all of the samples are processed. However, the Brown stink bug appears to be much less susceptible to adult parasitoids than is the Southern green stink bug, and it is possible that this differential susceptibility also may extend to predators of the Brown stink bug. We will be able to address this more clearly when the specimens are all examined.

Table 1. Predators surveyed to date and frequency of positive responses.

Predator species	No. evaluated	No. positive	% positives	Stink bug species
Geocoris punctipes – Big-eyed bug	112	5	4.5	*Nezara viridula*
Coleomegilla maculata – Spotted lady beetle	5	2	40	*Nezara viridula*
Notoxus monodon – Hooded beetle	44	3	6.8	*Nezara viridula*
Orius insidiosus – Pirate bug	53	1	1.9	*Nezara viridula*
Zelus sp. – Leafhopper assassin bug	10	1	10	*Euschistus servus*

Stink Bug and Predator Surveys. Stink bug populations and species were highly variable among locations. Populations in all crops were relatively low until September, when populations in soybeans increased, especially in Attapulgus (Fig. 1). The Southern green stink bug was the most abundant, although its numbers were low throughout most of the season in most plots. The Green stink bug, *Chinavia hilaris*, was also observed with regularity, but at lower numbers than either the Southern green or Brown stink bugs, and it is not shown here. Further, we did not develop primers to assess predation on Green stink bugs.

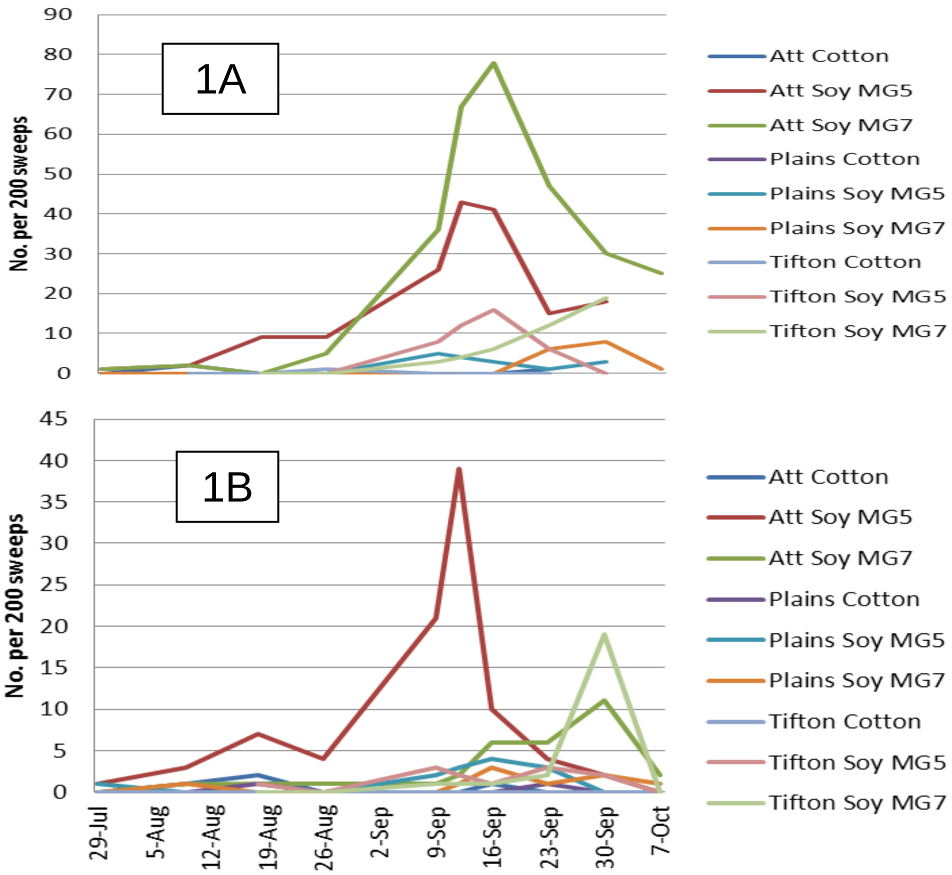

Fig. 1. Abundance of Southern green stink bugs (A) and Brown stink bugs (B) (nymphs and adults) in relation to location and crop. Note the different scales on the y-axes.

We collected a total of 1,873 predators over the period from 29 July to 7 October 2011.Of these, 578 were collected in cotton, 667 in MG5 soybeans, and 569 in MG7 soybeans. Total numbers by crop and location are presented in Fig. 2. The predator complex was dominated by spiders (510 collected), followed by big-eyed bugs (*Geocoris punctipes* and *Geocoris uliginosus*; 327 collected), and pirate bugs (*Orius insidiosus*; 221 collected). Of the two relatively abundant species with the highest positive rates for stink bug DNA, big-eyed bugs were more abundant later in the season, coinciding with the increased stink bug populations in all crops, whereas the hooded beetles were of varying abundance throughout the season. Spiders were abundant throughout the season, but few spiders have been assayed for stink bug DNA as of the present date.

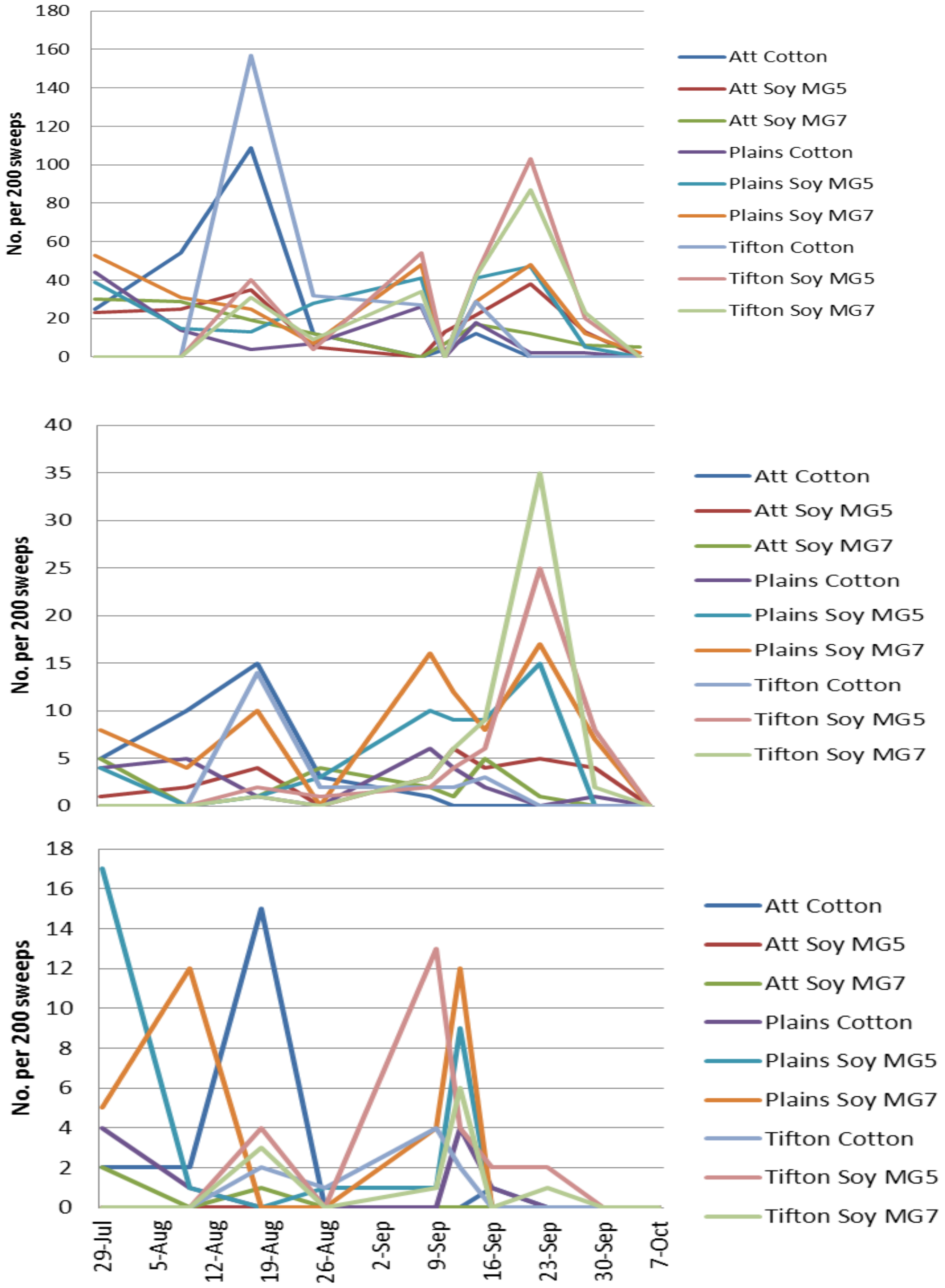

Fig 2. Number of all (Fig. 2A) predatory Arthropods, (Fig. 2B) big-eyed bugs (*Geocoris* spp.), and (Fig. 2C) hooded beetles (*Notoxus monodon*) by location and crop type throughout the sampling period, 2011. Note the different scales on the y-axes.

Conclusions

Although our data are preliminary, it is clear that some abundant predators in cotton attack Southern green and Brown stink bugs, although predation on Brown stink bugs may be reduced relative to that of Southern green stink bugs. Relative predation should be clarified with additional assays. The observation that hooded beetles fed on stink bugs is novel, and provides fodder for additional studies. This beetle is commonly observed in cotton and is known to be a generalist predator, but there has been a lack of clarity on its target prey. The frequency of consumption of stink bugs by big-eyed bugs also is promising, as these predators tend to increase late in the season when stink bugs are building in cotton, and can be quite abundant. Additional studies will elucidate life stages attacked by positive predators and the extent of attack on these life stages. The use of DNA to identify predators of stink bugs is a promising approach to addressing this thorny issue.

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THE MANAGEMENT OF GLYPHOSATE-RESISTANT PALMER AMARANTH IN COTTON USING DEEP-TILLAGE, COVER CROPS, AND HERBICIDES

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Introduction

The production and profitability of cotton has been greatly improved by the development and release of genetically-modified, herbicide-tolerant cultivars, particularly those resistant to glyphosate (http://www.agbioforum.org/v8n23/v8n23a15-brookes.pdf, http://www.pgeconomics.co.uk/index.php). Since its commercial introduction in 1996, glyphosate-resistant (GR) cotton has been grown on an increasing number of acres worldwide; recent data indicates that approximately 70% of the global cotton crop is planted with GR cultivars. The proposed benefits of GR crop technology include: improved weed control (including difficult-to-control flora, such as perennials and volunteer crop plants) and reduced crop injury, which can lead to higher crop productivity. The adoption of GR cultivars has also allowed US cotton growers to engage in conservation tillage (CT). This transition has been especially beneficial for farmers in the SE Coastal Plain, where the soils are sandy, compacted, nutrient-poor, and have low moisture-holding capacities.

Unfortunately, the widespread use of glyphosate across space and time has resulted in the development of GR weeds. In 2004, the existence of GR Palmer amaranth was confirmed at a 250 ha field site in Macon County, Georgia; production at this site had been a monoculture of GR cotton where glyphosate, often applied at reduced rates, was used, singly, for at least seven years. Within three years of its discovery, GR Palmer amaranth became the single greatest threat to the economic sustainability of cotton production. Currently, GR Palmer amaranth infests more than 2 million ha in 10 states (Alabama, Arkansas, Georgia, Louisiana, Missouri, Mississippi, North Carolina, New Mexico, South Carolina and Tennessee).

When acceptable control is not realized and Palmer amaranth is allowed to set seed, population densities can become quite high in infested fields. Current University of Georgia recommendations recommend that growers prevent Palmer amaranth from reaching reproductive maturity as a means of reducing the size of weed seedbank on their farms. A reduction in the total number of germinable seeds reduces the number of individuals that will, subsequently, be subjected to chemical weed management, as well as the potential number of weed management survivors that can then replenish the seedbank. In order to maximize herbicide efficacy and prevent the development of further resistances, cotton growers must consider using additional mechanical (i.e. tillage) and cultural (i.e. cover crops) weed management strategies to limit Palmer amaranth infestations.

Results from a recent (2008-2010) study in Georgia showed that the majority of Palmer amaranth seedlings emerged from depths shallower that 2.5 cm; less than 2% emergence was observed for Palmer amaranth seeds buried at depths greater than 10 cm. Deep soil inversion, or deep tillage, can be used to bury a significant proportion of surface/near surface Palmer amaranth seeds to depths below their optimal germination and emergence zone. Results from a study conducted in 2008 showed that deep tillage, to a depth of 30 cm, reduced GR Palmer amaranth seedbank densities and emerged seedling densities by 40 to 60%, as compared to undisturbed soil. Cover crops can suppress weeds by serving as a physical barrier to emergence, by inhibiting germination via reduced light transmittance and allelopathic effects, and by preventing herbicide loss through runoff and leaching. Results from small-plot experiments (2008-2010) integrating winter rye residue into standard cotton herbicide systems showed that control of GR Palmer amaranth exceeded 90% in row-middles when cover crops were employed. The use of rye, when paired with a Roundup-based, residual herbicide system, significantly increased cotton yields by 43% when compared to cotton strip-tilled into winter weeds.

The objective of this study was to evaluate the use of heavy-residue cover crops, herbicides, and a single deep soil inversion event for control GR Palmer amaranth in large scale, grower-managed, on-farm trials.

Materials and Methods

Three fields managed by grower-cooperators were selected to evaluate the effectiveness and adoptability of deep tillage and rye cover crop for managing glyphosate-resistant Palmer amaranth in cotton (2010-2011). Demonstration sites were located in Worth (31° 38'01.65"N, 83° 45'35.36"W), Seminole (30° 57’40.59”N, 84° 53’19.78”W) and Screven (32° 34'59.87"N, 81° 29'39.73"W) Counties. All fields were approximately 10 A (4 Ha) in size and were planted to cotton the previous year (2010). Grower-cooperators and county extension agents described the local Palmer amaranth infestations as moderate to severe; participants also indicated that the pigweed present at each of the study sites was glyphosate-resistant. In 2010, the Worth County site received glyphosate and flumioxazin preplant; fomesafen, diuron, and pendimethalin at planting; and glyphosate plus pyrithiobac and glufosinate at the first and second postemergence (POST1 and POST2) application timings, respectively. In Seminole county, trifluralin was applied preplant; fomesafen was applied at planting; glyphosate was applied POST; and diuron plus glyphosate were applied at layby. At the Screven county site, trifluralin was applied preplant; fomesafen was applied preemergence (PRE); glufosinate plus *S*-metolachlor were applied three times POST; and glyphosate, prometryn, and MSMA were applied at layby.

Three treatments, which included: 1) cotton planted into winter weed residue [bare ground], 2) cotton planted into a winter rye cover crop [no deep-tillage + rye], and 3) cotton planted into a winter rye cover crop on deep-tilled (moldboard plowed) soil [deep-tillage + rye] were established at each site during the 2010-2011 season. At Worth County, deep tillage operations were undertaken and rye planted on November 15, 2010. Rye was fertilized with 20-25 units of nitrogen on February 18, 2011. The cover crop was terminated on April 19, 2011 and subsequently rolled. At Seminole County, rye was planted in the non-tilled treatment on November 2, 2010. The deep-tillage treatment was initiated on December 10, 2010, although rye was not planted until January 11, 2011 because of rain. Rye was fertilized with 20-25 units of nitrogen on February 21, 2011. The cover crop was terminated on May 17, 2011 and subsequently rolled. At Screven County, deep tillage operations were undertaken on January 14, 2011. Rye was planted on January 15, 2011. Rye was fertilized with 20-25 units of nitrogen on February 24, 2011; the cover crop was killed and rolled four to six weeks before cotton planting. Twenty replicated samples (0.5 m by 0.5 m) of rye were harvested from each study site in May of 2011, dried in a greenhouse, and weighed to determine cover crop biomass.

Cotton was planted at all locations by June 1, 2011. Phytogen 565 was planted at the Worth and Screven County sites, FiberMax 1845 was planted in Seminole county. Paraquat, fomesafen, and pendimethalin were applied at all three sites preplant for burndown/residual weed control. An additional preplant/PRE application of diuron was made at the Worth County site; glyphosate and flumioxazin were applied at Screven County preplant/PRE. Glyphosate plus acetochlor (in Worth County), glufosinate followed by pyrithiobac (in Seminole County), and glyphosate (in Screven County) were applied postemergence (POST) on June 16, June 20, and July 1, 2011, respectively. In Seminole County, gramoxone plus diuron was applied at layby (July 11, 2011) using a hooded sprayer. Worth County received diuron plus MSMA, also at layby (July 16, 2011). The Screven County site received a second POST application of glyphosate on August 1, 2011. All herbicides were applied at labeled rates and according to the recommendations of the local county extension agent. Weed counts were conducted at each site multiple (four to six) times during the growing season; observation timings were selected so as to capture Palmer amaranth densities following significant crop production/weed management practices (i.e. preplant/PRE herbicide applications, POST, and layby/POST herbicide applications). Weed densities were obtained by counting all of the weeds present in 25% of the crop production rows assigned to each treatment and then converting the numbers to plants/ha for analysis and presentation.

Results and Discussion

Rye biomass production: For both Screven and Worth Counties, mean dry rye biomass was greater when the cover crop was planted on deep-tilled soil (5700 and 6800 kg/ha, respectively), as compared to the non-tilled soil (2600 and 5400 kg/ha, respectively). Conversely, cover crop biomass production in the deep-tilled treatment (3,000 kg/ha) at the Seminole county site was approximately 80% lower than biomass produced on non-tilled soil. This was due to the fact that the rye planting in the deep-tilled treatment was delayed by more than two months, relative to the non-disturbed treatment, because of rain and cold soil temperatures. The increased rye biomass production in the non-tilled Seminole County treatment, relative to the other sites, was likely due to its longer growing season (beginning on November 2, 2010) and to the fact that the site received almost two times the amount of rainfall (54 cm) throughout the entire production period as did Worth (35 cm) and Screven (29 cm) counties.

Weed densities: At the Worth County site, mean Palmer amaranth densities following preplant/PRE herbicide applications were greater in the no deep-tillage + rye treatment (190 plants/ha) as compared to the bare ground and deep-tillage + rye (0 plants/ha) treatments because of an error in the application of residual herbicides at planting (Figure 1). In Seminole County, the mean number of Palmer amaranth plants/ha observed following preplant/PRE applications were 20, 0, and 10 plants/ha in the bare ground, no deep-tillage + rye and deep-tillage + rye plots, respectively. Most of the plants encountered in the bare ground and the deep-tillage + rye treatments were larger than 50 cm in height and were likely plants that escaped the preplant herbicide burndown, rather than newly germinated seedlings (Figure 2). Mean Palmer amaranth densities were extremely high in both the bare ground (2940 plants/ha) and no deep-tillage + rye (1230 plants/ha) treatments in Screven county; no Palmer amaranth plants were observed in the deep-tillage + rye treatment following preplant/PRE herbicide applications (Figure 3). When averaged over all three sites, mean Palmer amaranth densities following preplant/PRE herbicide applications in the bare ground, no deep-tillage + rye, and deep-tillage + rye treatments were 990, 470, and <10 plants/ha, respectively (Figure 4).

Similar trends in Palmer amaranth density were observed following POST herbicide applications. At Worth County, mean Palmer amaranth densities were greater in the no deep-tillage + rye treatment (260 plants/ha) as compared to the bare ground (30 plants/ha) and deep-tillage + rye (10 plants/ha) treatments. As was suggested previously, mean Palmer amaranth densities were greater in the no deep-tillage + rye treatment as compared to the bare ground and deep-tillage + rye treatments because of an error in the application of residual herbicides at planting, as well as ineffectual control of glyphosate-resistant Palmer amaranth with glyphosate POST (Figure 1). In Seminole County, mean Palmer amaranth densities were higher in the bare ground (520 plants/ha) plot as compared to the no deep-tillage + rye (300 plants/ha) and deep-tillage + rye treatments (90 plants/ha). Glufosinate failed to control glyphosate-resistant Palmer amaranth at the Seminole county site because weeds were overly large (> 25 cm) at the time of application; current University of Georgia recommendations indicate that Palmer amaranth should be no more than 7.5 cm in height when glufosinate is applied in order to maximize control (Figure 2). Similarly, Palmer amaranth densities at the Screven County site were also higher in the bare ground (3490 plants/ha) treatment as compared to no deep-tillage + rye (2560 plants/ha) and deep-tillage + rye (140 plants/ha) (Figure 3). When averaged over sites, mean Palmer amaranth densities following POST herbicide applications in the bare ground, no deep-tillage + rye, and deep-tillage + rye treatments were 1340, 1040, and 80 plants/ha, respectively (Figure 4).

Following layby/POST applications, mean densities of 130, 30, and 20 Palmer amaranth plants/ha were observed in the bare ground, no deep tillage + rye, and deep-tillage + rye plots, respectively, in Seminole County (Figure 2). At Worth County, mean Palmer amaranth densities were highest in the no deep-tillage + rye (120 plants/ha) treatment, followed by the bare ground (20 plants/ha) plot; no Palmer amaranth plants were observed in the deep-tillage + rye treatment following layby/POST herbicide applications (Figure 1). In Screven County mean densities of 1140, 1300, and 80 plants/ha were observed in the bare-ground, no deep-tillage + rye, and deep-tillage + rye treatments, respectively (Figure 3). When averaged across sites, mean Palmer amaranth densities were numerically greatest in the no deep-tillage + rye (480 plants/ha) treatment, followed by the bare ground (430 plants/ha) and deep-tillage + rye (30 plants/ha) plots (Figure 4).

Summary

In 2010-2011, three on-farm field trials (Seminole, Screven, and Worth Counties in Georgia) were established with the assistance of farmer-cooperators and County extension agents. The purpose of the study was to evaluate the effectiveness of an integrated weed management program for controlling GR Palmer amaranth populations. Previous research, conducted at multiple institutions throughout the SE US, have demonstrated the merits of both deep soil inversion and heavy residue cover crops for suppressing/reducing in-field Palmer amaranth populations. Results from large-scale on-farm trials in Georgia showed that the use of deep-tillage plus a rye cover, in combination with herbicides, (deep-tillage + rye) reduced Palmer amaranth densities relative to the rye plus herbicide (no deep-tillage + rye) and herbicide only (bare ground) treatments at every observation period (i.e. followingpreplant/PRE, POST, and layby applications). Participating farmer-cooperators and extension agents indicated that GR Palmer amaranth populations were severe at each of the field sites; results suggest that aggressive tillage/rye/herbicide programs are effective at controlling GR Palmer amaranth in cotton, including GR cotton (Worth and Screven counties).

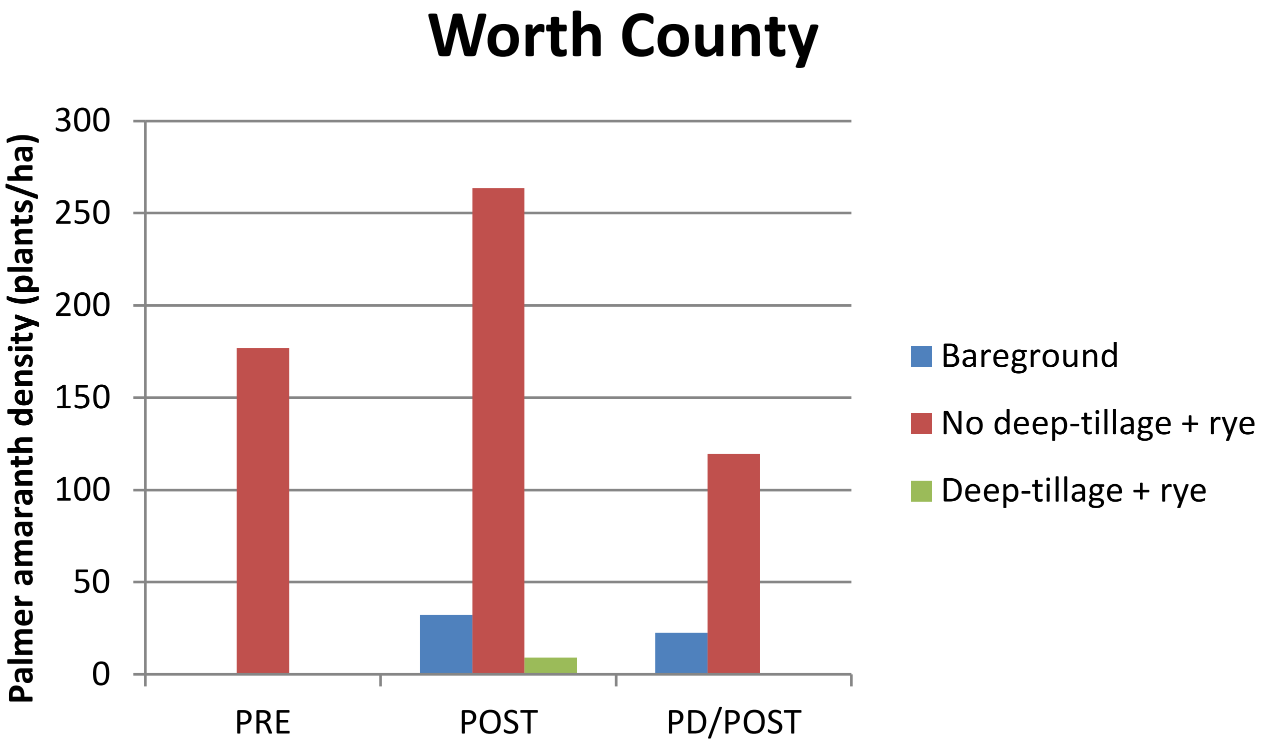

Figure 1. Mean Palmer amaranth densities (plants/ha) in Worth County following preplant/PRE [PRE], postemergence [POST], and layby/POST [PD/POST] herbicide applications in the bare ground, no deep-tillage + rye, and deep-tillage + rye treatments.

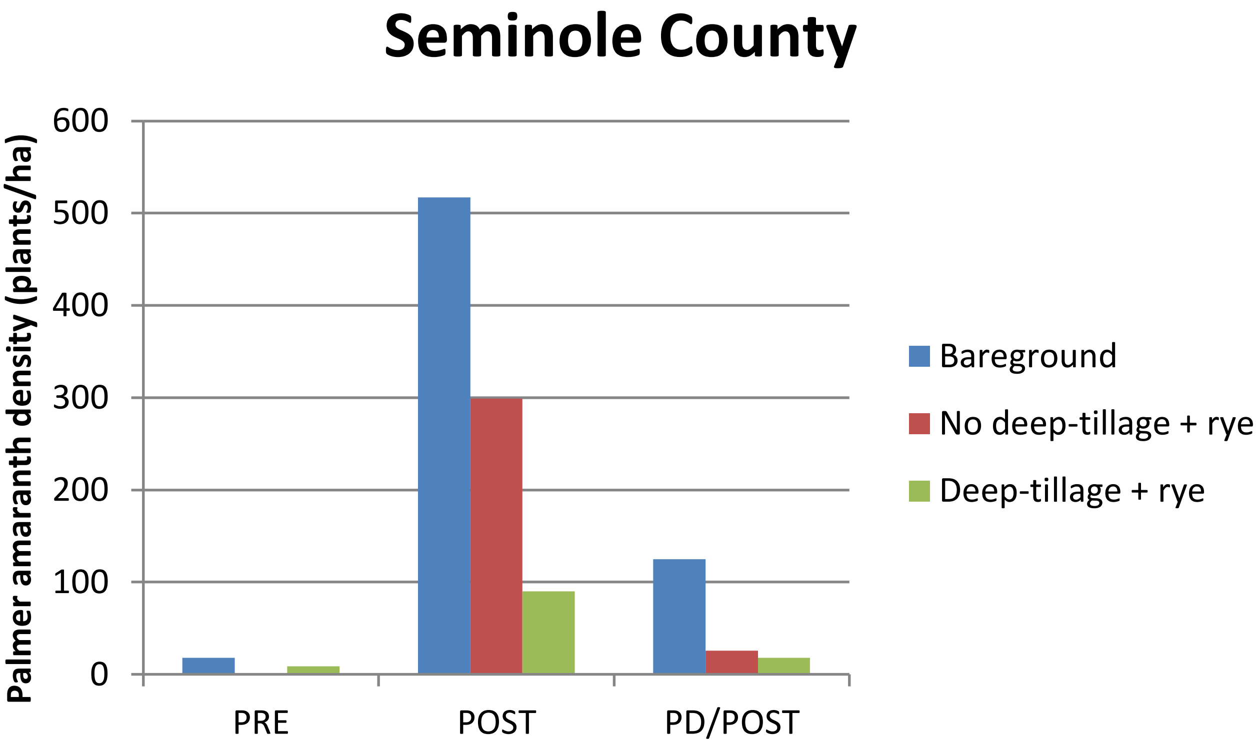

Figure 2. Mean Palmer amaranth densities (plants/ha) in Seminole following preplant/PRE [PRE], postemergence [POST], and layby/POST [PD/POST] herbicide applications in the bare ground, no deep-tillage + rye, and deep-tillage + rye treatments.

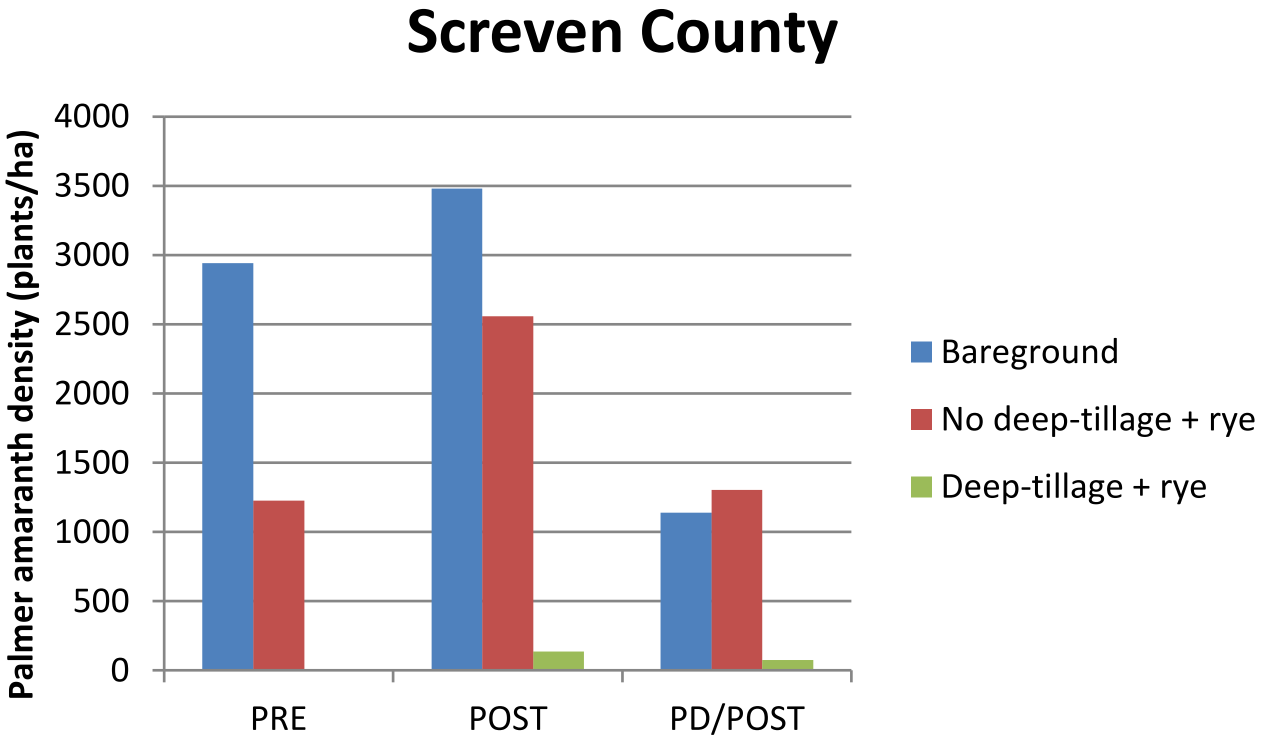

Figure 3. Mean Palmer amaranth densities (plants/ha) in Screven County following preplant/PRE [PRE], postemergence [POST], and layby/POST [PD/POST] herbicide applications in the bare ground, no deep-tillage + rye, and deep-tillage + rye treatments.

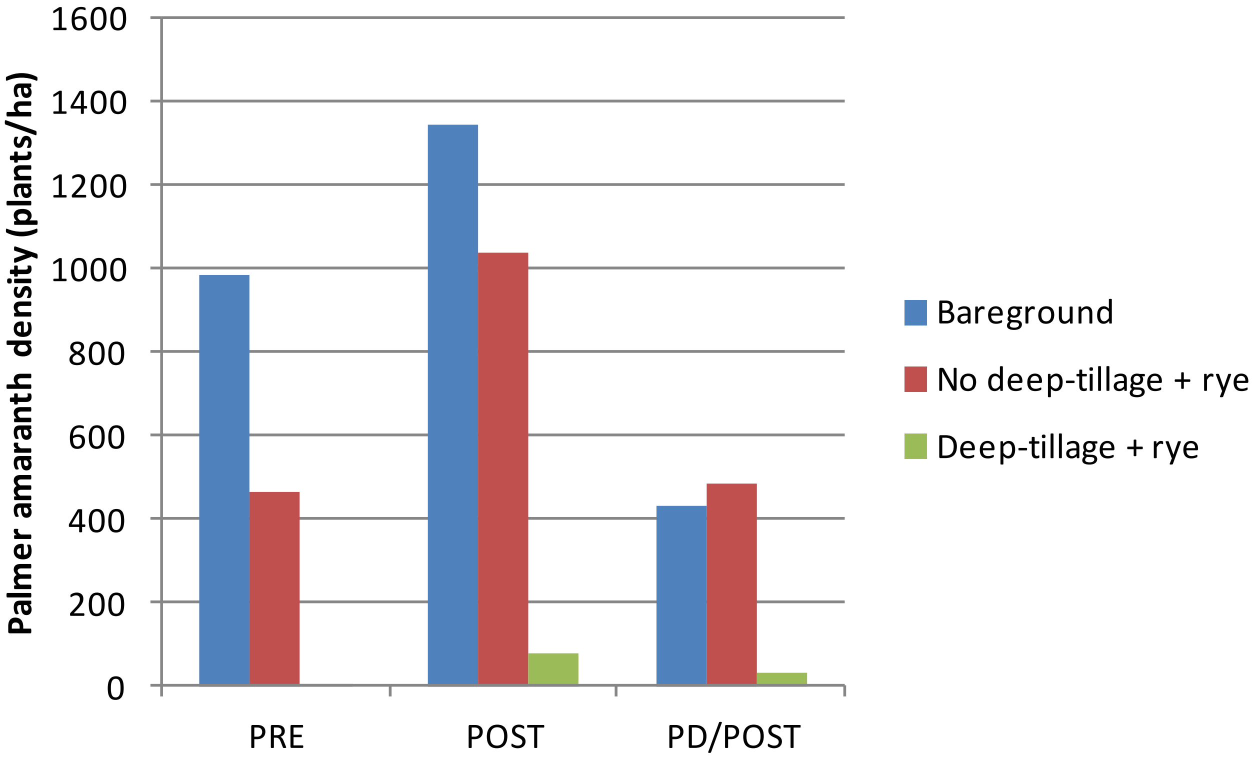

Figure 4. Mean Palmer amaranth densities (plants/ha) averaged across all three experimental following preplant/PRE [PRE], postemergence [POST], and layby/POST [PD/POST] herbicide applications in the bare ground, no deep-tillage + rye, and deep-tillage + rye treatments.

ALLELOPATHY: HOPE OF HYPE?

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Introduction

Rye has been regularly used as an organic mulch (either plowed under or no-tilled in to) in a number of crop production systems where it has been shown to simultaneously increase soil organic matter and reduce erosion. When sufficient biomass is achieved, rye cover suppresses weeds by serving as a physical barrier to emergence and by inhibiting germination through reduced light transmittance and, purportedly, allelopathy.

Many previously published studies conducted to assess the allelopathic potential of rye against weeds have used young, green, living, greenhouse-grown tissue as a source of chemical extracts. Few studies have quantified the suppressive potential of rye tissue grown under natural conditions and at a number of development stages. Comparisons between studies are often difficult to make because of differences in: initial extract concentration, individual seed dose, seed size, rye developmental stage, etc. The usefulness of rye as a 'natural herbicide' would be supported if its allelopathic activity is maintained during the peak germination period of spring and/or summer annuals, like Palmer amaranth. The objective of this study was to evaluate the inhibitory effects of field grown rye, collected at different phenological stages, on both Palmer amaranth (i.e. weed control) and cotton seed (i.e. crop safety) germination.

Materials and Methods

Winter rye (Wrens Abruzzi) was grown on the UGA Ponder farm in Ty Ty, GA (2010-2011) and harvested at different 3 growth stages (tillering [V3-5], stem elongation [V6-8], and heading [V10.5]). Biomass samples were dried at 50°C for 4 day in an oven. After drying, 10 g of tissue from each sample was extracted for 24 hr in 100 ml of dH2O (1:10 wt:vol), ground in a blender, filtered and diluted to create 1, 0.5, 0.25, 0.125 and 0.0625 X strength solutions. A control (0% extract, dH2O) was also included for comparison. Five replications of 1) 25 Palmer amaranth seeds (in 2 ml of extract contained in a 47 mm diameter Petri dish on a cellulose pad) and 2) 10 cotton seeds (in 4 ml of extract contained in a 90 mm diameter Petri dish on 2 disks of Whatman filter paper) were incubated at 25-30 C for 7 days, after which germination evaluated. The entire study was replicated twice.

Results and Discussion

In general: 1) cumulative germination of both species generally decreased with increased extract concentration, relative to the non-treated control (0X); 2) younger rye tissue (V3-V5 and V6-8) was more inhibitory than more mature tissue (V 10.5); and 3) large-seeded cotton was typically less affected by rye extracts than small-seeded Palmer amaranth (Figures 1 and 2). The lowest concentration extracts (0.0625X to 0.25X) developed from rye harvested at the V3-5 and V6-8 stages actually promoted, instead of inhibited, seed germination for Palmer amaranth in this study. This phenomenon is called hormesis and is defined as a favorable response to a small/low dose/exposure to a toxin or other stressor. Greater than 50% reduction in Palmer amaranth seed germination was not observed except when extract concentrations reached the 0.5X (for V3-5 rye) or 1X (for V3-5 and V6-8 rye). Half- (0.5X) and full-strength (1X) concentrations from V10.5 rye reduced Palmer amaranth seed germination approximately 15-25%, relative to the control. Cotton seed germination was reduced between 20-80%, relative to the control, when quarter- (0.25X) to full-strength extracts were developed from rye harvested at the V3-5 and V6-8 stages. In general, extracts collected from rye that was in the process of heading (V10.5) did not reduce cotton germination at any concentration relative to the control.

Our initial results suggest that rye can be inhibitory, but only when extract concentrations are extremely high and when fresh, young tissues are used. These stages of phenological development would typically occur during the winter months in Georgia, at a time when Palmer amaranth is neither germinating nor emerging, thereby limiting the usefulness of allelopathy as a biocontrol agent. Furthermore, it is unlikely to assume, at this time, that growers would be able to macerate, solubilize, and incorporate rye tissues sufficiently in order to reach the projected concentrations necessary for the inhibition of seed germination and seedling growth and development.

Allelopathy is notoriously difficult to study and many bioassays may be limited in their abilities to accurately estimate the toxicity of plant residues. Greenhouse studies, while easy to initiate, don’t account for the effects of microorganisms, plant stress, weather, and other environmental conditions that influence the production, uptake, metabolism, and degradation of allelochemicals. Conversely, it can be difficult to evaluate the activity of complex secondary plant products in field studies. Although rye is useful for managing weeds, it has not been proven, conclusively, that allelopathy, independent of physical suppression, has played a substantial role. More studies, conducted in the laboratory, as well as in the field, and under multiple growing conditions, will be required to elucidate the effectiveness of rye as an allelopathic agent for weed control.

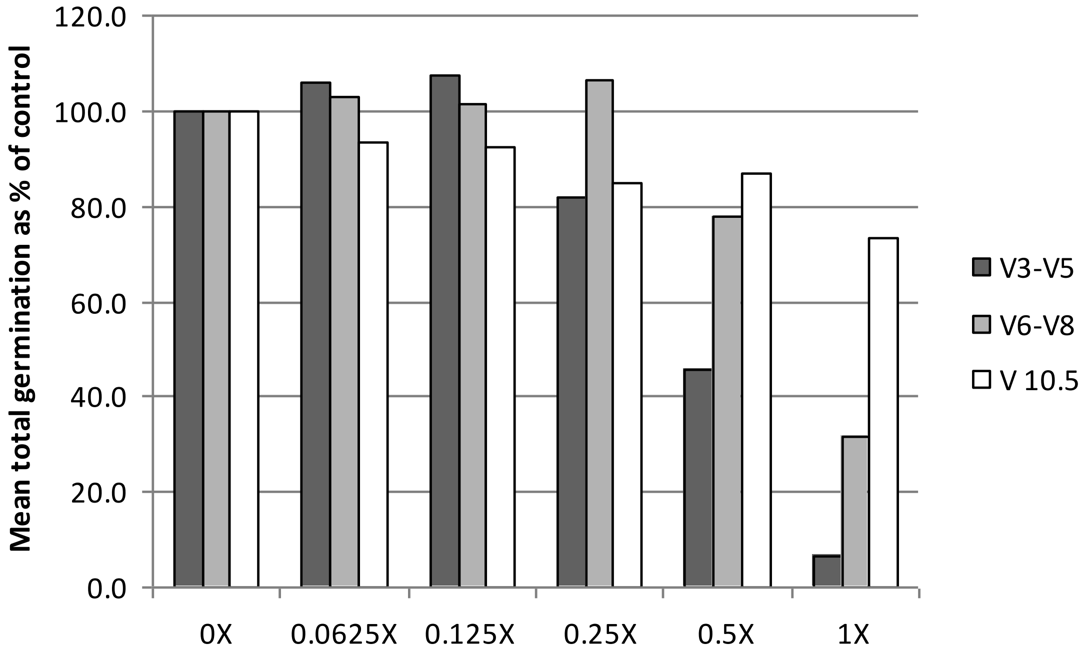

Figure 1. Palmer amaranth germination (as a percent (%) of the control) in response to varying concentrations of rye extract harvested from plants of increasing age and phenological development (V3-5, V6-8, and V10.5).

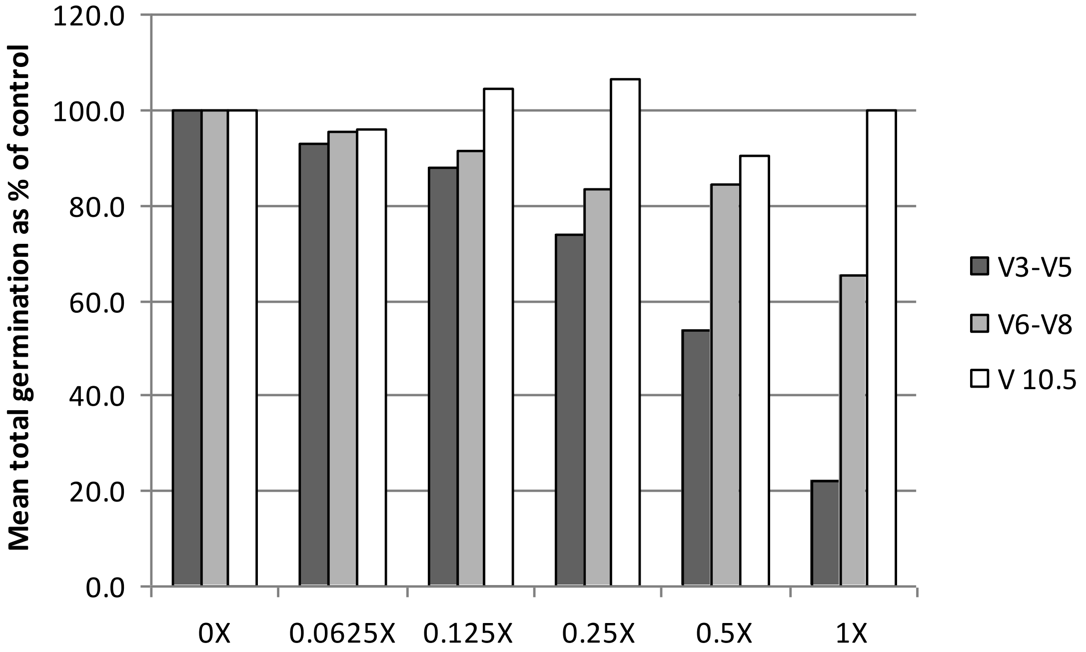

Figure 2. Cotton germination (as a percent (%) of the control) in response to varying concentrations of rye extract harvested from plants of increasing age and phenological development (V3-5, V6-8, and V10.5).

THE EFFECT OF TILLAGE ON PALMER AMARANTH EMERGENCE PHENOLOGY AND GROWTH

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Introduction

The adoption of glyphosate-resistant (GR) cotton cultivars has allowed many US cotton growers to adopt conservation tillage (CT). This transition has been especially beneficial for farmers in the SE Coastal Plain, where the soils are sandy, compacted, nutrient-poor, and have low moisture-holding capacities. Proposed advantages of CT systems include improved soil tilth and reduced erosion potential. A significant drawback of CT has been, historically, increased weed pressure, which necessitates an increased reliance on herbicides for effective weed control. The establishment of GR Palmer amaranth, which infests more than 2 million ha in 10 US states, has likely been enhanced by the use of CT for a number of reasons, including:

1) weed seed density is generally high when soil disturbance is low,
2) amaranth seed germination is typically promoted by light, the intensity of which is greatest near the soil surface, and
3) pigweed seedlings do not readily emerge from soil depths greater than two inches; limited opportunities for incorporation would concentrate Palmer amaranth seeds in their optimal germination and emergence zone.

Mechanical soil disturbance (i.e. tillage and cultivation) can significantly impact weed seed germination, seedling emergence, and the subsequent size and composition of resultant aboveground weed communities. Results from published literature often demonstrate differing responses to tillage; in some situations, pigweed emergence is enhanced by soil disturbance, in other instances, pigweed emergence is reduced. The objective of this study was to evaluate the role of cultivation, as well as the timing of cultivation events, on the emergence phenology and growth of Palmer amaranth.

Materials and Methods

A study was conducted at the Ponder Farm in TyTy, GA, in 2011 to evaluate the type and timing of soil disturbance on Palmer amaranth emergence. The experimental area consisted of 40 plots that were 6 feet wide and 25 feet long (1.8 m wide by 7.6 m long). Treatments consisted of a factorial combination of two levels of soil disturbance (no tillage [NT] or two-passes of a vertical tine rototiller [CULT]) and five disturbance timings (cultivation on April 1, April 15, May 1, May 15, or June 1). Each treatment combination was replicated four times. Palmer amaranth emergence in four randomly placed 1.6 feet by 1.6 feet quadrats (0.5 m by 0.5 m) per plot was recorded every 2-5 days for up to 30 days following the disturbance events. The daily growth, in inches, of 10 randomly selected plants per plot was also evaluated for the same time period.

Results and Discussion

Palmer amaranth emergence for both NT and CULT began on the same day within each timing of disturbance treatment (Table 1). Refsell and Hartzler (2009) also reported that tillage did not affect the initial time of emergence of common waterhemp, a pigweed species common to the Midwestern US.

Conversely, cumulative Palmer amaranth emergence was a function of disturbance. For all five timings, total pigweed densities, on a per m^2 basis, were numerically greater in the CULT treatment as compared to NT (Table 2). The germination response of amaranth species as influenced by tillage has been mixed, according to published literature; Ogg and Dawson (1984) and Peachy et al (2004) observed greater pigweed emergence in tilled plots as compared to non- or minimally-disturbed systems, whereas Refsell and Hartzler (2009) and Oryokot et al. (1997) reported the reverse. The disparities among studies could be the result of a number of factors including differences in: the type and timing of cultivation/tillage employed, the timing of weed emergence counts, and environmental parameters, such as temperature and rainfall or irrigation.

There was a tendency for more rapid growth of pigweed that emerged later in the growing season as compared to earlier (Table 3). Palmer amaranth seedlings that emerged between April 10 and May 10 reached heights of 3 and 6 inches in 14-16 and 19-21 days (from emergence), respectively. Plants that emerged between late May and mid June reached heights of 3 and 6 inches in 7-8 and 11-12 days (from emergence), respectively. Additional research is required in Georgia to better quantify the effects of tillage timing (and associated environmental variables like temperature and soil moisture) and intensity on Palmer amaranth emergence and growth throughout the cotton production season.

Preliminary results from this study suggests that shallow cultivation may not influence the day in which the first Palmer amaranth germinates, but cultivation does increase the number of plants germinating under springtime conditions when compared to no tillage. It is not uncommon for growers in some production systems to cultivate soil prior to planting in order to stimulate weed seed germination; emerged weeds are subsequently killed, usually using a herbicide, to ensure a clean seedbed prior to crop planting. Cultivation could instead prove harmful to farmers if subsequent weed emergence is not managed in a timely fashion. Results from a cotton grower survey conducted in Georgia suggests that between-row cultivation is increasing in use as a means for managing Palmer amaranth that have escaped chemical control measures. Failure to monitor cotton fields for newly emerging ‘flushes’ of weeds following cultivation events could significantly impact crop productivity. Furthermore, the rate at which weeds develop is dependent on the timing of their emergence; growers should pay close attention to emerging weed populations to ensure that weed growth doesn’t outpace management efforts.

Literature cited

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Oryokot, J.O.E., S.D. Murphy, and C.J. Swanton. 1997. Weed Science 45;120-126.

Peachey, R.E., R.D. William and C. Mallory-Smith. 2004. Weed Technology 18:1023-1030.

Refsell, D.E. and R.G. Hartzler. 2009. Weed Technology 23: 129-133.

Table 1. Date of first Palmer amaranth emergence in no tillage (NT) and roto-tilled (CULT) treatments initiated in 2011.

Timing of disturbance	Date of first recorded emergence	Date of first recorded emergence
	NT	CULT
April 1	April 11	April 11
April 15	May 8	May 8
May 1	May 8	May 8
May 15	May 27	May 27
June 1	June 15	June 15

Table 2. Average cumulative Palmer amaranth density (standard error) in no tillage (NT) and roto-tilled (CULT) treatments approximately 30 days after disturbances were initiated in 2011.

Timing of disturbance	Palmer amaranth per m^2 NT	Palmer amaranth per m^2 CULT
April 1	2.3 (0.75)	7.3 (4.03)
April 15	9.0 (3.34)	72.8 (15.56)
May 1	32.8 (11.32)	41.8 (8.47)
May 15	16.5 (5.2)	68.0 (8.66)
June 1	5.5 (2.90)	46.3 (19.46)

Table 3. Date on which mean plant height per treatment reached 3 and 6 inches, as well as the time (expressed in days from emergence) for plants to reach heights of 3 and 6 inches.

Timing of disturbance	Date of first recorded emergence	Date to reach 3" in height	Time, in days, from emergence to reach 3" in height	Date to reach 6" in height	Time, in days, from emergence to reach 6" in height
April 1	April 11	April 25	14	May 2	21
April 15	May 8	May 24	16	May 27	19
May 1	May 8	May 24	16	May 27	19
May 15	May 27	June 4	8	June 7	11
June 1	June 15	June 22	7	June 27	12

EFFECTS OF COMPENSATORY GROWTH ON PALMER AMARANTH BIOMASS ACCUMULATION AND COTTON YIELD

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Introduction

Palmer amaranth is a highly competitive weed of field corn, peanut, soybean and, especially, cotton. Biotypes resistant to glyphosate have been confirmed in nearly every county in GA. Palmer amaranth establishment success is due, in part, to the presence of a deep taproot, which helps it to penetrate compacted soils, thereby gaining access to water and nutrients more effectively than many commonly grown crops. The presence of a taproot can also make it difficult to remove Palmer amaranth by hand. Growers, extension agents, and university research personnel have observed instances where: 1) previously pulled Palmer amaranth plants have re-rooted and become reestablished in a field and 2) plants that have been cut back (using hoes or machetes) have re-sprouted from dormant buds and resumed normal growth. Current GA recommendations for Palmer amaranth management stress the need to remove all plants from a field prior to their achieving reproductive maturity in an effort to mitigate the size of the soil seedbank. Plants that escape removal can flower and produce progeny that, in turn, can severely impact the following year's crop. The objective of this study was to evaluate the potential of Palmer amaranth to grow and develop following stem and leaf removal occurring during a simulated hand-weeding failure.

Materials and Methods

This study was conducted in four fields planted to glufosinate-tolerant cotton in Tifton, Ty Ty, and Plains, GA in 2011. A density of ten Palmer amaranth plants per plot (minimum of 20 ft in length and four rows wide) were established in the center two rows of each experimental unit (five plants per row). Plots were maintained weed free (except for the selected Palmer amaranth) by hand-weeding. At the start of Palmer amaranth flowering (June to August), plots were randomly assigned to one of four defoliation treatments: 1) no defoliation [Intact], 2) removal of all Palmer amaranth stem and leaf tissue to the soil line [Soil], 3) removal of all palmer amaranth stem and leaf tissue to a height of one inch above the soil line [1"], and 4) removal of all Palmer amaranth stem and leaf tissue to a height of six inches above the soil line [6"]. The timing of the removal events generally coincided with layby herbicide operations and activities of weed removal crews in growers fields at-large. We propose that most of the hand-weeding in commercial fields occurs following POST and POST-directed herbicide failures. Each treatment was replicated three to six times at each site. Plant heights were recorded regularly throughout the remainder of the growing season. Floral tissue from female plants (both inflorescences and seed) were harvested when seeds were 50 to 75% mature, but before plant senescence. Tissue was air dried in a greenhouse and the seed from each plant sieved through18, 20, 35, and 40 mesh screens. Following the removal of all chaff, total seed mass and number were determined. Cotton was harvested from the center two rows of each plot and yield determined.

Results and Discussion

Averaged across all sites, Palmer amaranth plants were approximately 55 inches in height when the defoliation treatments were initiated. By six weeks after cutting (WAC), the intact plants were, on average, almost 85 inches tall (Figure 1). Averaged over all locations, plants cut back to the soil line, and 1” and 6” above the soil line were, approximately, one, 25, and 50 inches in height 6 WAC (Figure 1). Palmer amaranths that were allowed to grow and develop normally produced an average of 394,000 seeds/plant; plants cut back to the soil line, and 1” and 6” above the soil line produced an average of 22,000, 36,000, and 129,000 seeds/plant, respectively (Figure 2). Cotton yield was significantly reduced by the presence of Palmer amaranths that were allowed to compete with the crop throughout the entirety of the growing season. Average cotton yield was between 2,500 and 3,000 lb/acre in plots where Palmer amaranths had been physically defoliated at the time of flowering; cotton yields of 1,500 lb/acre were recovered from plots where Palmer amaranth plants were left intact (Figure 3).

Palmer amaranth can be difficult to remove by hand weeding. Growers and university personnel have observed hand-weeding and mechanical removal failures in which previously pulled Palmer amaranth plants have re-rooted and become re-established and/or plants that have been cut/pruned back have re-sprouted from latent buds. Results from this field study show that Palmer amaranth plants cut back (all stem and leaf tissue removed) to one and six inches above the soil line are able to successfully regrow and achieve reproductive maturity. Although none of the defoliated plants achieved the same size as their intact counterparts, they were still able to produce significant amounts seed, including a few plants that had been cut back to the soil line. Current control recommendations urge cotton growers to remove Palmer amaranth plants escaping early season control measures by hand to try and reduce the size of the residual seedbank. Growers need to be aware that ineffectual salvage attempts could negate efforts designed to manage the size of Palmer amaranth populations in the field.

Figure 1. Average plant height (across four locations), in inches, of Palmer amaranths that were left intact, cut back at flowering to the soil line [soil], or cut back to one [1”] and six [6”] inches above the soil line as recorded throughout the growing season.

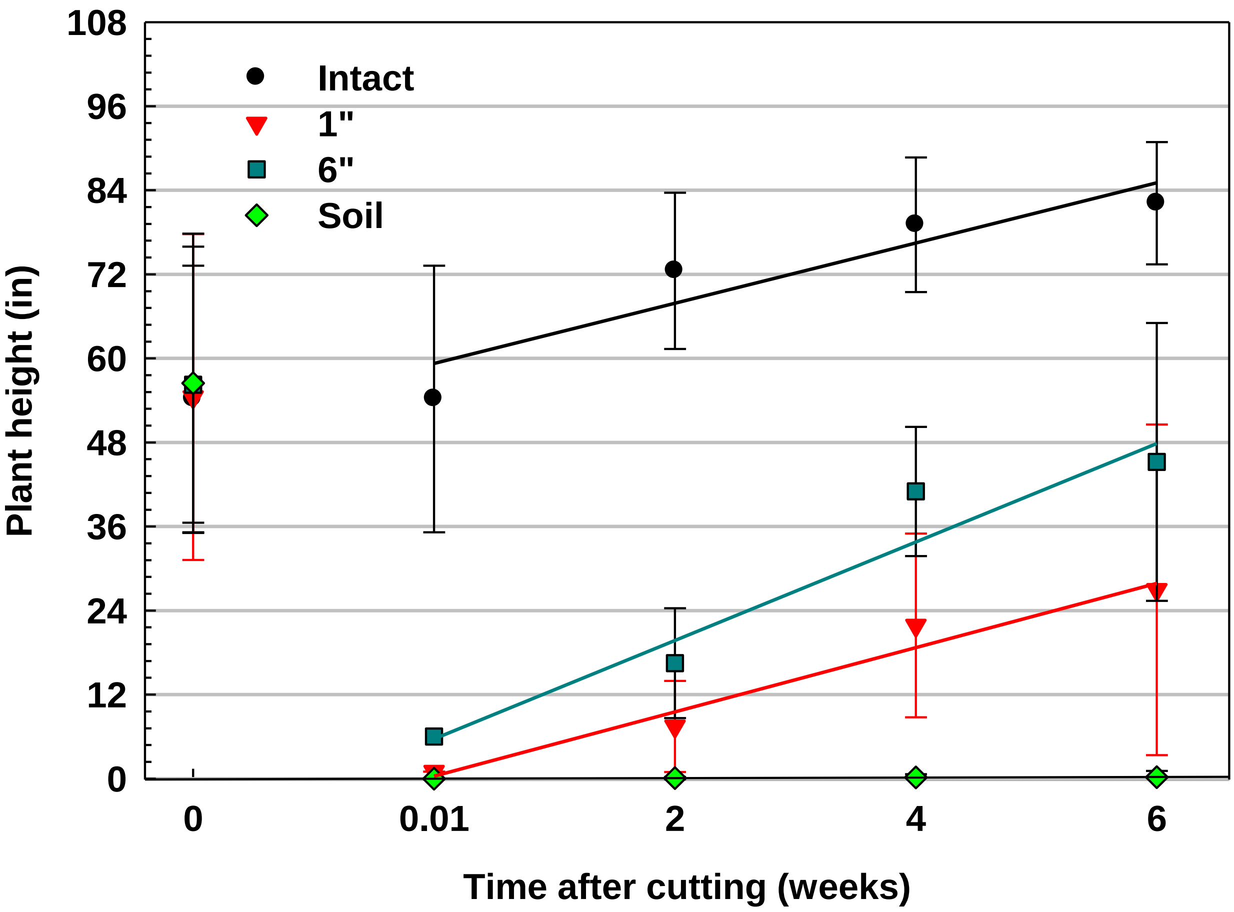


Figure 2. Average (across four locations) seed produced/plant, in grams, by Palmer amaranth plants that were left intact, cut back at flowering to the soil line [soil], or cut back to one [1'] and six [6"] inches above the soil line

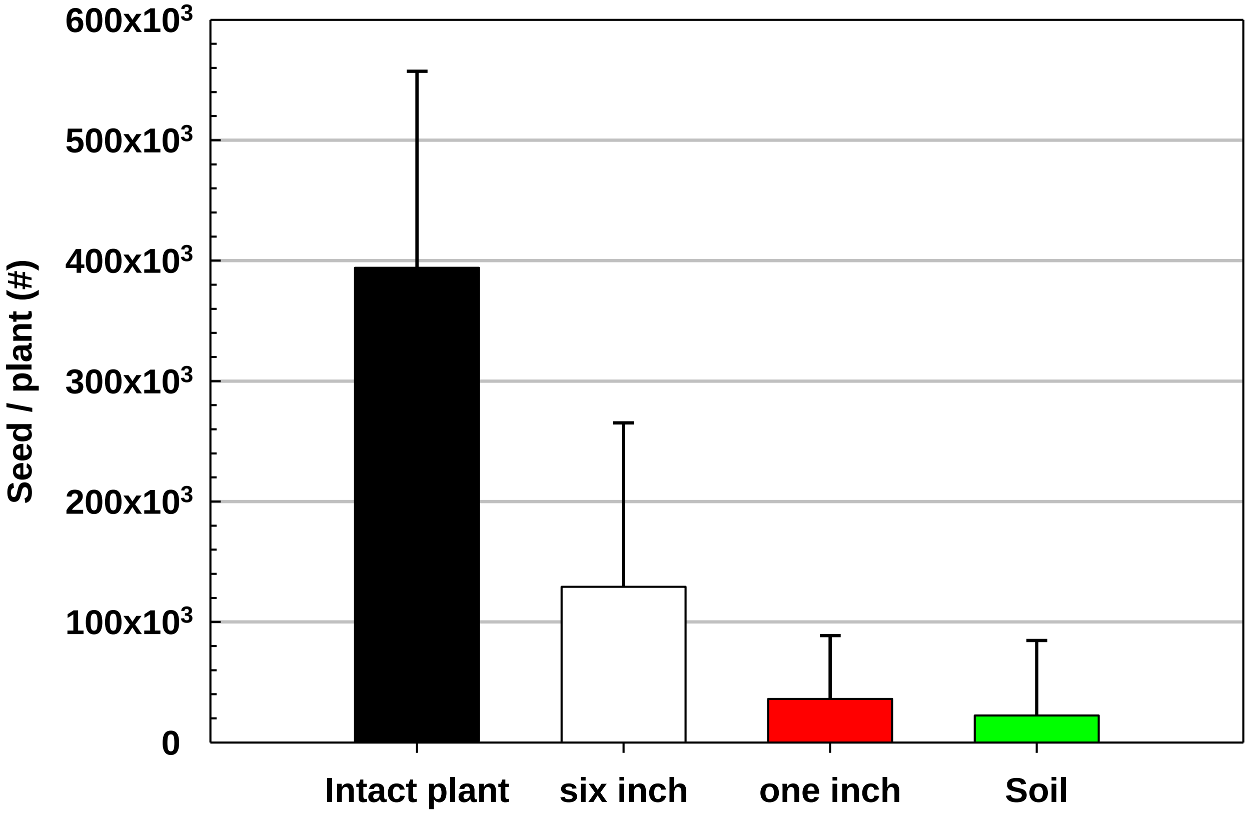
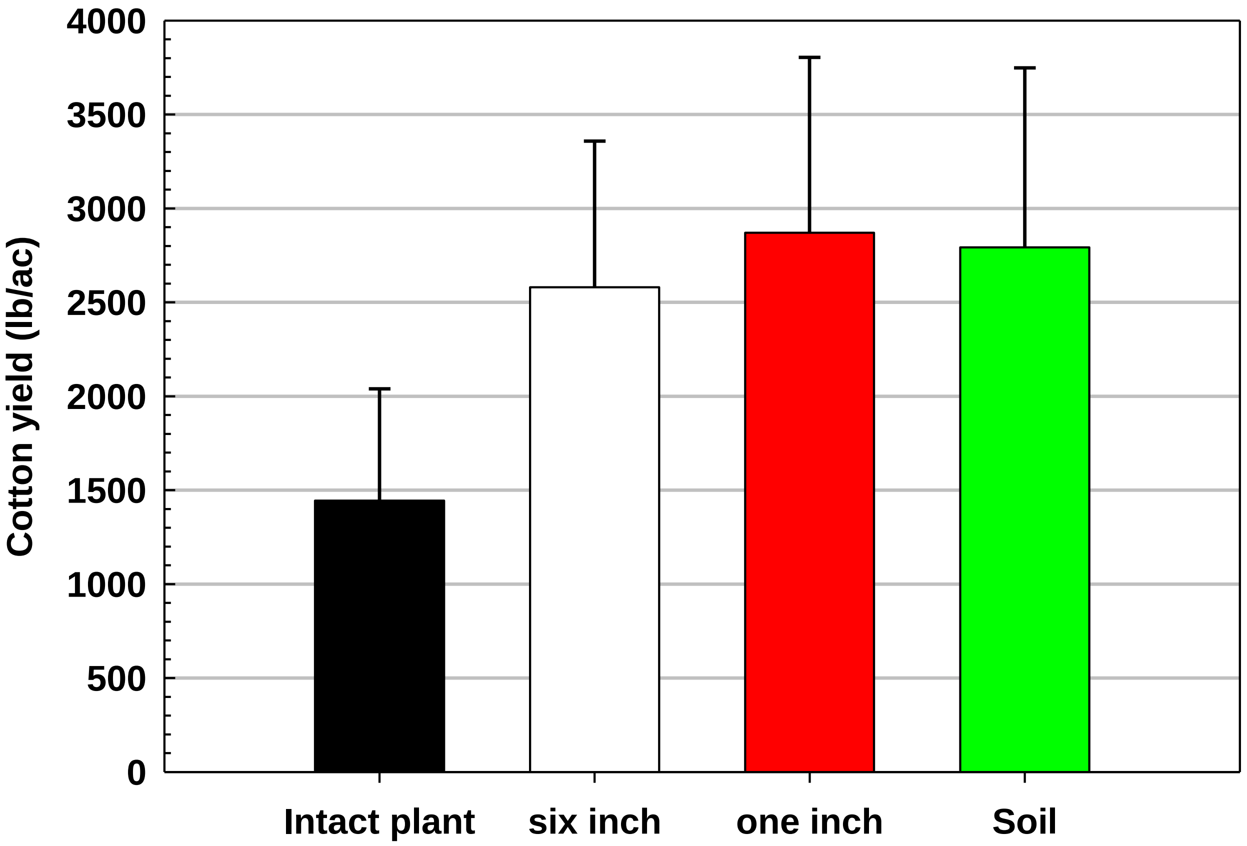


Figure 3. Average (across four locations) cotton yields, in lb/A, when Palmer amaranth plants were left intact, cut back at flowering to the soil line, or cut back to one and six inches above the soil line



AUTHORS