IRRIGATION AND CULTIVAR EFFECTS IN NO-TILL, COVER CROP, AND CONVENTIONAL TILLAGE SYSTEMS IN ARKANSAS COTTON

A. M. Mann
University of Arkansas Division of Agriculture
Jonesboro, AR
M. L. Reba
USDA-ARS Delta Water Management Unit
Jonesboro, AR
T. G. Teague
Arkansas State University
University of Arkansas Division of Agriculture
Jonesboro, AR

Abstract

This field experiment was conducted in association with a long term tillage study established in fall 2007 at the Judd Hill Foundation Research Farm in Northeast Arkansas to assess agronomic and environmental impacts of conservation tillage systems. In component studies in 2016 we evaluated performance of three cultivars with and without supplemental irrigation in the established no-till, cover crop/ low till, and conventional tillage systems. Cultivars, selected based on maturity, host plant resistance (HPR) ratings, and levels of leaf pubescence and trichome density. ST 4946 GLB2, ST 5289 GLT, and ST 6182 GLT with high, medium, and low rankings for HPR to tarnished plant bug, respectively. Season-long monitoring of soil moisture, insect pest densities, and plant monitoring was included as well as evaluation of sustainability using the FieldPrint Calculator. We observed that neither irrigation nor tillage affected tolerance/susceptibility to insect pests. First position square shed was low for all treatments. Highest yields were associated with conventional practices with highest overall yields associated with irrigated ST 4946 GLB2. ST 5289 GLT performed best in cover crop system. Later maturing ST 6182 GLT typically had lowest yield in all systems, particularly with irrigation in the no-till system.

Introduction

Cultural control tactics include use of cotton cultivars with host plant resistance (HPR) properties. Use of HPR is both economically efficient and environmentally sound. Use of partially resistant or tolerant cultivars that are properly adapted to a particular production region should be considered a cornerstone in any integrated pest management (IPM) strategy for cotton (Lincoln et al. 1975, Luttrell et al 2015). Other cultural control tactics include use of agronomic practices that promote early maturity, and expand overall crop carrying capacity -- the boll load that reduces fruit retention and slows squaring node production to zero (Hearn and Da Roza 1985). Carrying capacity is limited with poor growing conditions or limited resources (e.g. compacted soils, drought or nutrient deficiency). Pest-induced damage may impact overall crop plant performance, but carrying capacity will affect the compensatory response and extent of plant recovery following insect pest-induced injury (Teague 2016, Sadras and Felton 2010).

The objective in this 2016 experiment was to quantify the impact of tillage system and irrigation practices on performance of three cultivars that had been identified as having a range of HPR properties (Bourland et al., 2016). Cultivars were grown with and without supplemental irrigation in no-till, cover crop/ low till, and conventional tillage systems. We hypothesized that growing conditions could impact plant resilience to stress including water deficit tolerance and/or susceptibility to insect pests.

Materials and Methods

The 2016 small plot study was conducted on the Judd Hill Foundation Research Farm near Trumann in northeast Arkansas. The soil at the field site is classified as Dundee silt loam. The study was arranged in a split-split plot design as 3*3*2 factorial (tillage*irrigation*cultivar) with 3 replications. Tillage treatments were considered main plots and were 1) conventional 2) terminated winter wheat cover crop with conservative tillage, and 3) no-till. The tillage treatments were established in fall 2007 and have been maintained since that time. Tillage main plots were split with either 1) rainfed or 2) furrow irrigated. Tillage main plots were 16 rows wide with irrigated subplots 8 rows wide. Main plots extended the length of the field, 450 ft. Cultivar sub-plots were randomized within main plots and were

120 feet long, separated by 10 feet alleys. Cultivars selected for the study were 1) ST 5289 GLT, 2) ST 4946 GLB2, and 3) ST 6182 GLT. Morphological and HPR traits for the selected cultivars as ranked in the 2015 University of Arkansas Cotton Variety Test are shown in Table 1.

Table 1. Morphological and host plant resistance traits of the three cultivars as they were ranked in the 2015 Arkansas transgenic cotton variety test (Bourland et. al 2016).

Cultivar	Leaf pubescence[a]	Stem pubescence[a]	Bract trichomes[b]	Tarnished plant bug damage[c]	Bacterial blight[d]
	rating	rating	no./cm	% damage	% susceptible
ST 5289 GLT	7.0	7.6	41.7	64	0
ST 4946 GLB2	5.7	5.8	33.6	75	68
ST 6182 GLT	1.6	4.1	23.7	80	80

[a]Leaf and stem pubescence rated at Keiser, AR irrigated test using scale of 1 (smooth leaf) to 9 (pilose, very hairy).

[b] Marginal trichome density of bracts determined on 6 bracts/plot (4 reps) at Keiser, AR irrigated test

[c] Response to tarnished plant bug was determined by examining white flowers (6 flowers/plot/day for 6 days) for presence of anther damage. Plots were 1-row, replicated 8 times.

[d] Varieties were planted in flats (2 replications, 13 seed/plot) in greenhouse, and scratch inoculated with *Xanthomonas axonopodis* pv. malvacearum.

In fall 2015, tillage practices in the conventional and cover crop treatments consisted of using disk bedders to re-form beds after stalks were shredded following the previous season's cotton crop. Wheat was broadcast planted at 10 lb seed/ac in the cover crop treatment main plots in mid-October. After seeding, a field cultivator (do-all) was used to smooth the tops of beds in the cover crop treatment. In spring of 2016, a broadcast application of the herbicide glyphosate was made by air across the entire experiment to "burndown" winter weeds as well as terminate the winter cover crop. In-season production practices were similar across all tillage treatments with the following exceptions used only in conventional tillage treatment: disk bedders were used to re-form beds, tops of beds were flattened with a field cultivator just prior to planting. Cotton was planted using a no-till planter on 6 May 2016. Planter settings were adjusted for each tillage treatment to ensure uniform seed depth and good soil-seed contact. Seeding rate was set at 3 seed/ft and was similar across all tillage treatments. Additional production details are listed below in Table 2.

Table 2. Production details including dates of planting, irrigation, and harvest and application dates for insecticide, growth regulator, and harvest aid--2016, Judd Hill, AR.

Operation	Date	Days After Planting
Date of planting	6 May	
Insecticide	11 July	66
Irrigation	17 June, 1, 11, 20, & 28 July, 4 August	42, 56 ,66, 75, 83, 90
Mepiquat chloride	30 June, 19 & 26 July, 9 August	55, 74, 81, 95
Defoliation/boll opener	13 & 23 September	130, 140
Harvest	5 October	152

The study included monitoring of soil environment, insect pest, and plant development. Soil Temperatures in early season were monitored in the three tillage systems using WatchDog B100 temperature loggers (Spectrum Technologies, Aurora, IL). The sensors were located on top of the bed, one at the soil surface with a radiation shield and at depths of 2 and 5 inches below the soil surface. Measurements were made from 14 days before planting to 46 days after planting (DAP). Soil Moisture was monitored using Watermark (Irrometer, Riverside, CA) sensors with Irrometer dataloggers. Soil moisture sensing stations were installed in each of the tillage and irrigation treatments. For each station, there were two watermarks placed depths of 6 and 12 inches below the soil surface between plants in the top of the bed. Soil moisture was monitored from 34 to 116 DAP.

Insect pest monitoring included evaluations of thrips (*Frankliniella* spp) abundance in early season followed by weekly assessments for tarnished plant bug (*Lygus lineolaris*) during squaring node development through effective flowering. For thrips sampling, ten whole plants were collected at 26 DAP from each tillage main plot. Plants were carefully placed in plastic collection bags in ice chests and transported back to the laboratory for alcohol wash. In the lab, the alcohol wash solution was filtered, and numbers of thrips larvae and adults were counted under a dissecting microscope. For plant bug sampling, drop cloths were used weekly to sample 1.5 feet on 2 adjacent rows in each plot for a total of 3 feet of row per drop cloth sample.

Early season plant monitoring included evaluations of plant stand density, leaf area index (LAI), and first fruiting node (FFN) for cultivar and tillage treatments. Plant stand density assessments were made 12, 20, and 26 DAP by counting the emerged plants in 3 feet of row in two transects across 8 rows of each sub-plot. LAI was measured on leaves from 10 plants at 26 and 40 DAP using a LI-3100C (Li-Cor, Lincoln, NE). First fruiting node was recorded for 10 consecutive plants in the center rows at three sites across tillage main plots on 15 June (40 DAP). In-season plant monitoring was initiated during squaring node development. Standard COTMAN Squaremap sampling protocols included counts of number of main stem squaring nodes, first position square and boll retention and plant height (Oosterhuis and Bourland, 2008). In weekly sampling, scouts inspected two sets of 5 consecutive plants located on adjacent rows in designated rows in the center portion of sub-plots. By the second week of flowering, scouts also began recording nodes above white flower (NAWF). Ten plants with first position white flowers were selected in the two sample rows weekly, and numbers of main stem squaring nodes determined. Days to cutout (mean NAWF = 5) calculations were derived from standard output using the COTMAN software. End of season mapping was performed after defoliation using the COTMAP (Bourland & Watson, 1990) procedure on 5 consecutive plants in two adjacent rows.

Yield determinations were made using a 2 row research cotton picker in designated harvest rows (to avoid confounding effects from thigmonasty, these rows had not been included in the in-season sampling). For fiber quality evaluations, 40 bolls were hand-picked from consecutive plants on consecutive fruiting sites from each treatment plot, ginned with laboratory gin, and sent for HVI fiber quality analysis at the Fiber and Biopolymer Research Institute at Texas Tech University. Data were analyzed using PROC GLM (SAS, Cary, NC) with mean separation with Fisher's protected LSD at $P < 0.05$. Sustainability assessments was completed using the Fieldprint Calculator (https://calculator.fieldtomarket.org/fieldprint-calculator/). Output from the tool was used to summarize sustainability metrics associated with the changes in soil conservation practices and irrigation.

Results and Discussion

The 2016 season was characterized by below average rainfall in June and July (Table 3), with lower than optimal temperatures at the time of planting. Soil temperature monitoring results showed lower mean soil temperature for the soil surface for conventional tillage compared to cover crop and no-till treatments (P<0.01). Temperatures recorded by the sensors buried at 2 inch and 5 inch depth showed significantly higher temperatures (P<0.05) for no-till compared to cover crop and conventional tillage treatments. Differences likely were related to insulating properties of residue on the soil surface (dried vegetation) associated with cover crop and no-till systems compared to relatively clean soil surface of the conventional system. Temperature differences among tillage systems are apparent when cumulative DD60s for each treatment were plotted against time (**Error! Reference source not found.**).

Table 3. Monthly precipitation (inches) measured at the study site for the 2016 season compared with 30 year average for the county.

Month	30 year Average	2016 Rainfall	Departure
	---------------------inches---------------------		
May	5.37	5.23	-0.14
June	3.99	1.82	-2.17
July	4.04	0.96	-3.08
August	2.36	4.84	2.48
Total Season	20.51	12.85	-7.66

Plant stand density varied among cultivar and tillage treatments with higher stand counts in ST 5289 GLT compared to either ST 4946 GLB2 or ST 6182 GLT (P=0.003) (Figure 2 (a)). Reduced stand density was observed in the no-till system (P=0.001) (Figure 2 (b)). Despite use of a no-till planter, the unevenness of no-till beds resulted in reduced soil-seed contact as well as "hair-pinning" which contributed to the reduced plant stand densities.

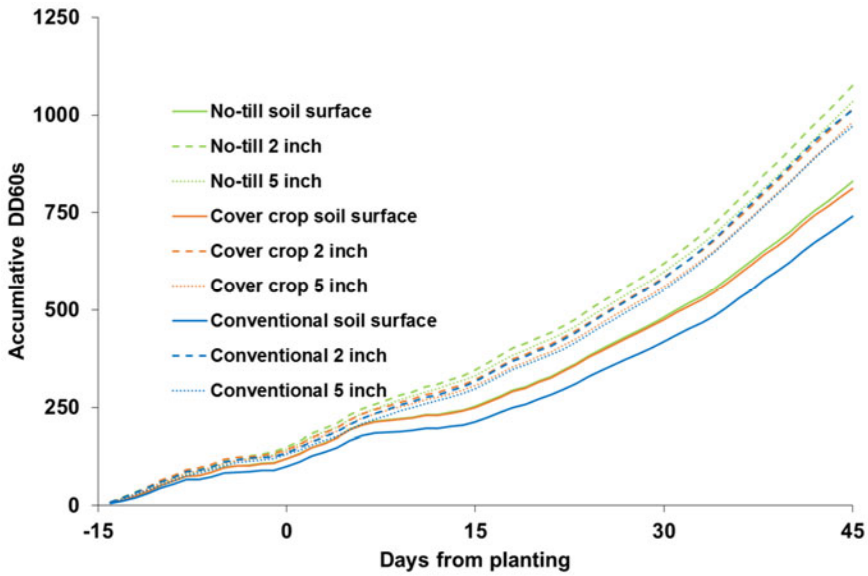

Figure 1. Accumulated DD60s from soil temperature sensor loggers at soil surface and 2 inches below soil surface for conventional, cover crop, and no-till tillage systems--2016, Judd Hill, AR.

Early season plant development was quantified with leaf area measurements. Plants in the no-till had significantly lower LAI values than plants in cover crop or conventional tillage system treatments (P=0.009) (Figure 3); however, by 40 DAP, there were no significant difference measured among tillage main plot treatments (data not shown).

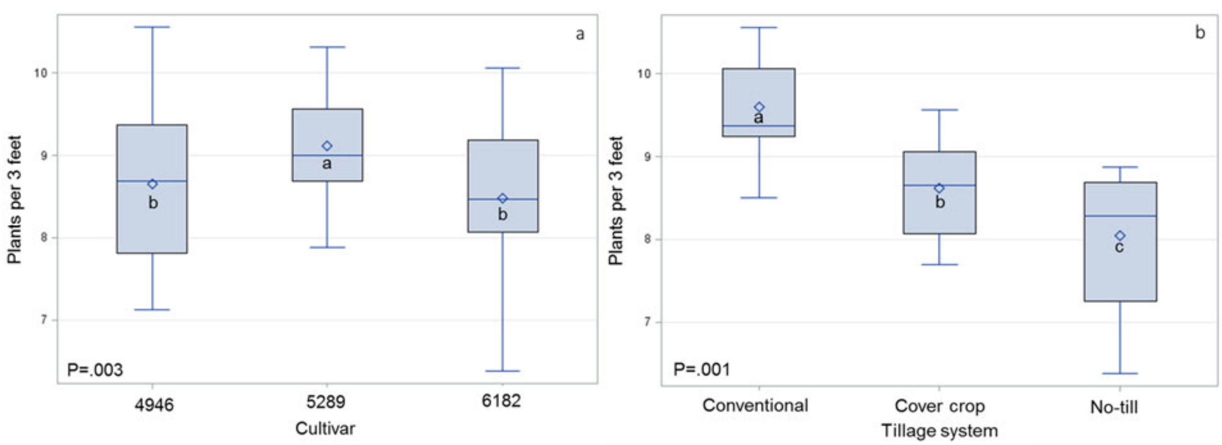

Figure 2. Plant stand density for cultivar (a) and tillage (b) treatments determined at 1 June (26 DAP). Boxes represent 50% quartile; diamonds within the box depict means, and the line is the median value. Means with similar letters do not differ significantly using Fisher's protected LSD--2016, Judd Hill, AR.

COTMAN growth curves prior to 60 DAP were to the right of the standard target development curve indicating a delay in the onset of sympodial development. This was particularly true for no-till plants (Figure 4). For the standard target development curve, first squaring nodes are expected by 35 days after planting. Cool temperatures will delay emergence and subsequently, the initiation of the first squares. Temperatures in the first two weeks after planting were suboptimal in 2016, ranging from 49 to 59°F, and those cool temperatures impacted early season plant growth. First flowers were observed by 66 DAP in all treatments. During the effective flowering period, cloudy, overcast weather conditions likely affected boll retention and plant maturity. Values for NAWF did not decline as would be expected (compared to standard target development curve) after 60 DAP. The maturity delay was very apparent in NAWF measures for plants in no-till treatments. Mean no. days from planting to physiological cutout was 5 to 18 days later in irrigated no-till compared to other systems (Table 4).

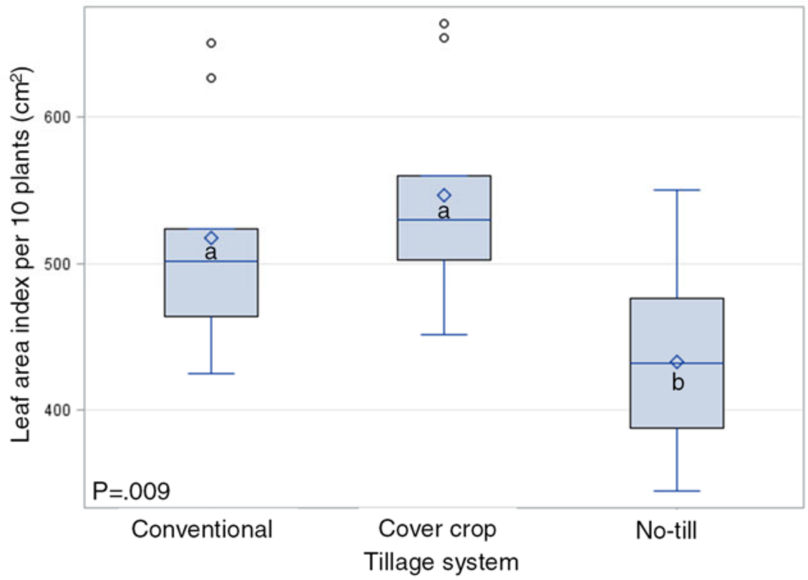

Figure 3. Mean LAI for plants collected in different tillage systems determined at 1 June (26 DAP). Boxes represent 50% quartile; diamonds within the box depict means, and the line is the median value. Means with similar letters do not differ significantly using Fisher's protected LSD--2016, Judd Hill, AR.

Soil moisture measurements from sensors positioned at 6 and 12 inches below the soil surface generally showed consistently high availability of soil water in the no-till treatments (Figure 5). Sensor data also suggest that infiltration following irrigation was incomplete in the conventional and cover crop systems. Surface sealing in the water furrows likely reduced irrigation infiltration resulting in greater levels of runoff. Irrigation frequency was based on measures in the conventional treatment, and the irrigation schedule may have been excessive for plants in the no-till treatment, perhaps affecting performance and yield.

Neither irrigation nor tillage treatments significantly affected abundance of plant bugs or thrips. Typically, in the Midsouth, the recommended action level for thrips is 20-50 thrips per 10 plants. Thrips infestation levels in the ST 4946 GLB2 in both conventional and no-till were within the recommended action level with mean thrips numbers of 36 and 23 per 10 plants, respectively (Figure 6). Thrips numbers in ST 5289 GLT in the conventional tillage treatment also reached the action level. Thrips population densities in the cover crop cotton did not exceed the action threshold for any cultivars. No foliar insecticides were applied for thrips infestations other than at planting seed-treatments (Aeris).

Tarnished plant bug numbers were below the action levels in all treatments throughout the season. Extension recommendations in pre-cutout cotton suggest an action threshold of a field average of 3 tarnished plant bugs per drop cloth sample (5 ft of row); following cutout the action threshold increases to 6 plant bugs per sample (Studebaker 2016). There were no significant differences or interactions observed for plant bug sample data among tillage, cultivar, or irrigation treatments (data not shown). Pre-flower square shed is primarily associated with insect feeding injury. There were no observations in any treatments of pre-flower first position square retention levels lower than 90%. First position square retention remained high through cutout. Higher square shed levels were noted for ST 6182 GLT in samples taken from 52-74 DAP (Figure 7).

First position boll abscission increased around 75 DAP (Figure 8). This physiological shed was variable among treatments, but highest shed levels were observed for irrigated plants in the no-till tillage. Physiological boll shed during the first 2 weeks of flowering often is reflected by changes in slope of COTMAN growth curve after flowers. A reduced slope is interpreted as an indication of lower metabolic stress from boll loading and represents a crop maturity delay (Bourland et al 2008). Growth curves for plants in the no-till treatment followed this pattern. Physiological boll shed, documented in-season using COTMAN retention data along with by changes in slope of the NAWF growth curve, also was evident in results from end-of-season plant mapping with COTMAP (Table 5 and Table 4).

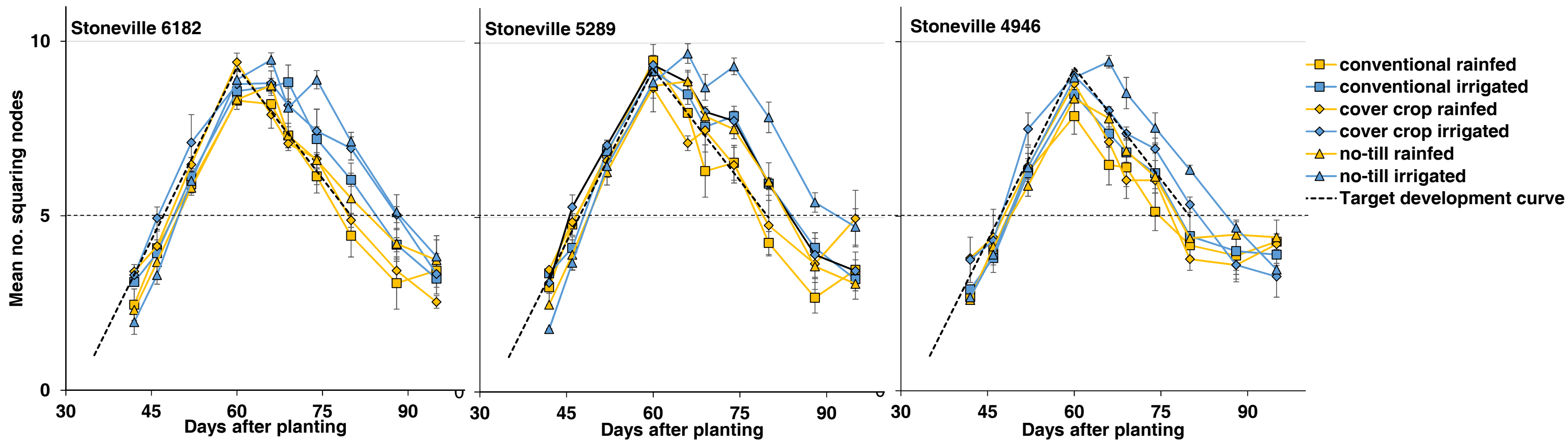

Figure 4. COTMAN growth curves for the three cultivars showing irrigation and tillage system treatments--2016, Judd Hill, AR.

Table 4. Mean no. days from planting to physiological cutout (NAWF=5) for the three cultivars in rainfed or irrigated tillage treatments[a] -- 2016, Judd Hill, AR.

Tillage System	Rainfed			Irrigated		
	ST 4946	ST 5289	ST 6182	ST 4946	ST 5289	ST 6182
Conventional	73	75	76	77	84	80
Cover Crop	74	77	76	77	82	86
No-till	76	81	80	86	91	88

[a]Tillage, irrigation, and cultivar effects were significant (P<0.01); there were no significant interactions.

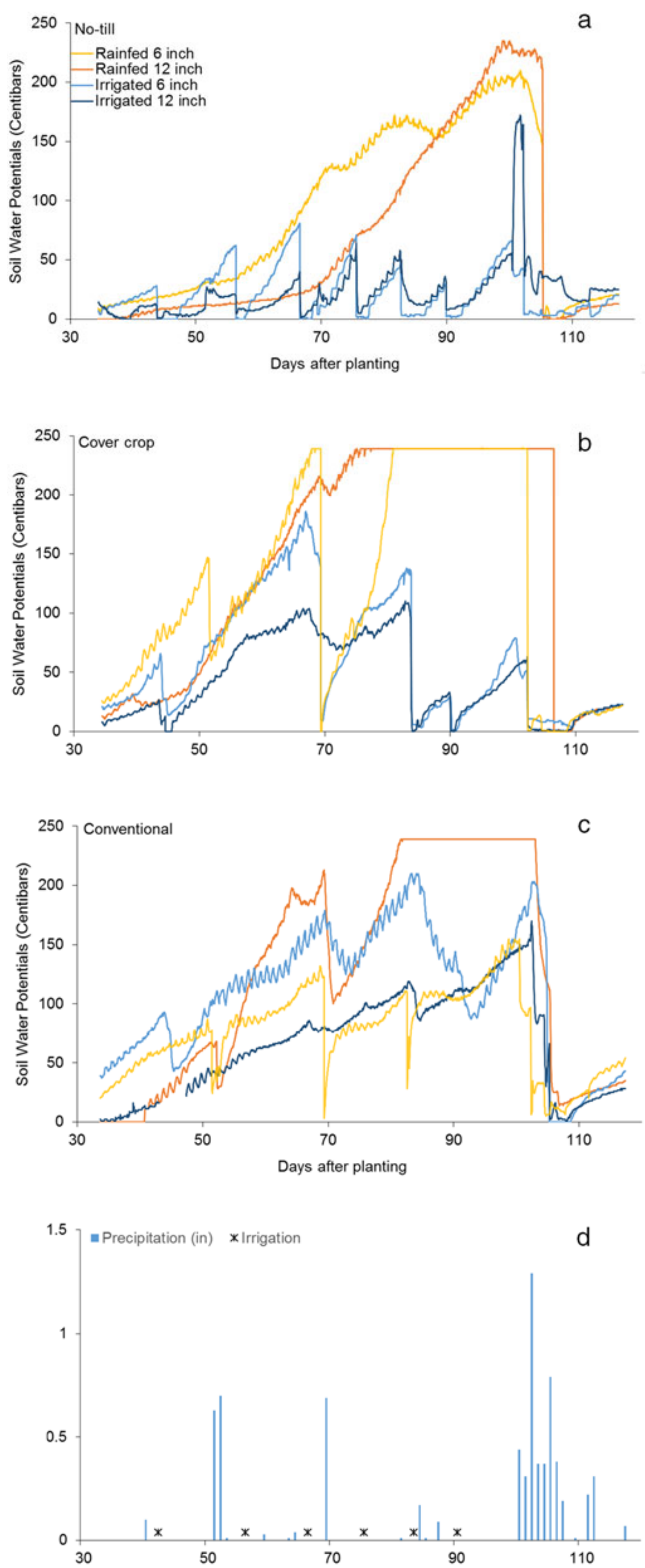

Figure 5. Season-long soil moisture monitoring using Watermark sensors at two depths with rainfed and irrigated treatments in the no-till (a), cover crop (b), and conventional (c) tillage main plots. Precipitation and irrigation events also are shown (d); 2016, Judd Hill, AR.

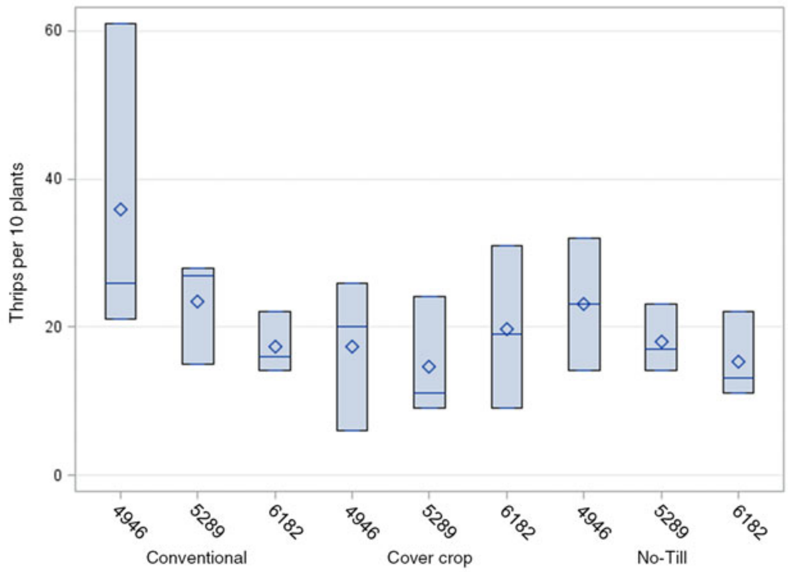

Figure 6. Mean number of thrips per 10 cotton plants (whole plant wash) collected on 1 June (26 DAP) for cultivar and tillage system treatments. Boxes represent 50% quartile; diamonds within the box depict means and the line is the median value--2016, Judd Hill, AR.

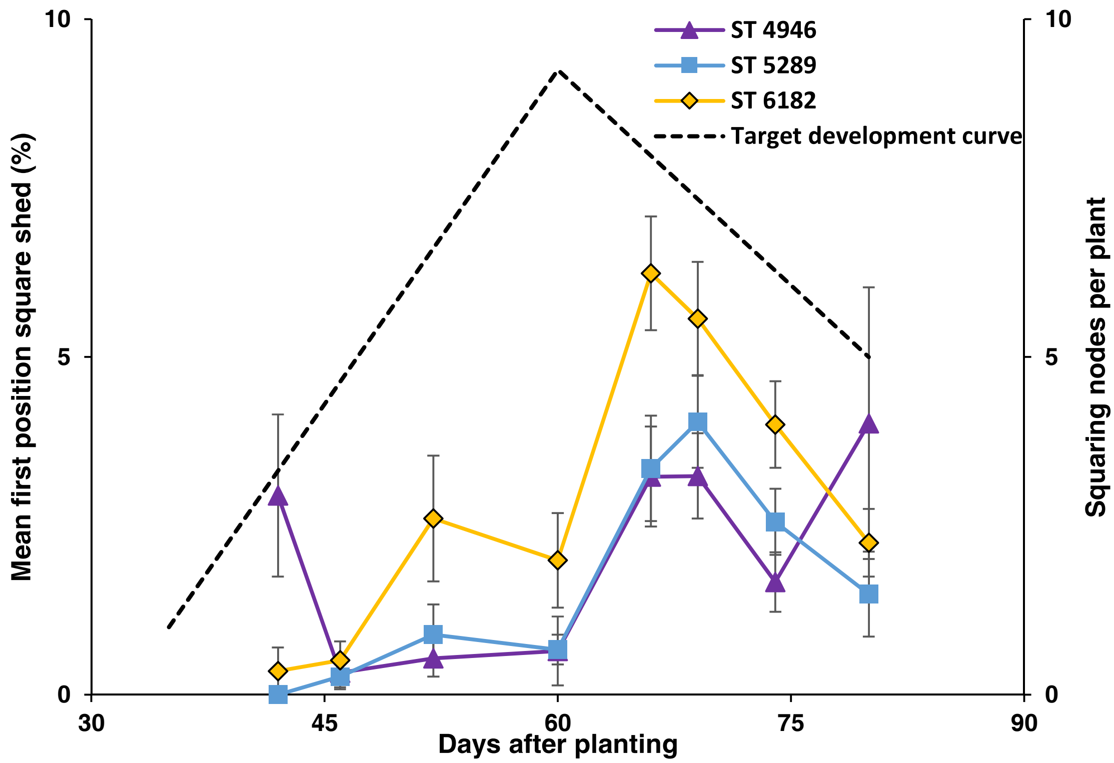

Figure 7. Mean (±SEM) first position square shed (%) for cultivar treatments; the COTMAN target development curve also is included for reference--2016, Judd Hill, AR.

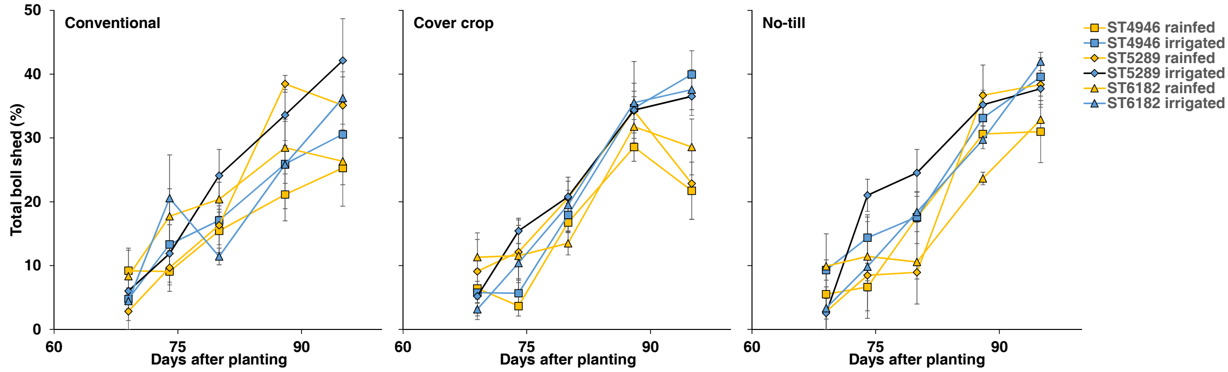

Figure 8. Boll shed percentages, calculated from COTMAN Squaremap sampling, were based on retention of the first position bolls on two sets of five consecutive plants sampled using COTMAN Squaremap protocol.

There were no differences in mean first fruiting node (FFN) associated with tillage treatment; however, ST 4946 GLB2 had a higher FFN compared to ST 5289 GLT and ST 6182 GLT (P<0.001) (Table 5). ST 4946 GLB2 produced fewest total sympodia and effective sympodia (Table 5). This cultivar also had fewest numbers of outer bolls (retained bolls in 3rd position or higher) and generally higher levels of early boll retention (first and second position bolls on mainstem sympodia). For tillage main effects, fewer sympodia were produced by plants in conventional tillage system compared to the cover crop and the no-till system (Table 6). Early boll retention measures ranged from 27% to 45% among treatment with greatest variation associated with irrigated, no-till production of ST 6182 GLT. (Figure 9).

Table 5. Results from final, end-of-season plant mapping using COTMAP; cultivar sub-plots-- 2016, Judd Hill, AR.

	Cultivar				
	ST 4946	ST 5289	ST 6182	*P>F*	*LSD_{05}*
1st Sympodial Node	6.5	6.0	5.9	*<0.01*	*0.2*
No. of Monopodia	1.6	1.4	1.7	*0.06*	
Highest Sympodia with 2 Nodes	11.5	13.2	12.0	*0.01*	*1.1*
Plant Height (inches)	32.5	32.8	37.7	*0.05*	*4.6*
No. of Effective Sympodia	6.6	7.7	6.9	*0.01*	*0.8*
No. of Sympodia	14.7	16.3	15.0	*0.01*	*1.1*
No. of Sympodia with 1st Position Bolls	3.9	4.2	3.7	*0.06*	
No. of Sympodia with 2nd Position Bolls	0.4	0.7	0.5	*0.03*	*0.3*
No. of Sympodia with 1st & 2nd Bolls	0.7	0.6	0.7	*0.88*	
Total Bolls/Plant	6.2	6.9	6.3	*0.27*	
% Total Bolls in 1st Position	74.3	71.4	70.3	*0.35*	
% Total Bolls in 2nd Position	16.8	18.7	18.7	*0.57*	
% Total Bolls in Outer Position	0.5	2.2	2.9	*0.01*	*1.5*
% Total Bolls on Monopodia	8.3	7.6	8.1	*0.93*	
% Boll Retention - 1st Position	31.2	29.9	29.3	*0.50*	
% Boll Retention - 2nd Position	9.1	10.1	10.0	*0.74*	
% Early Boll Retention	44.0	42.1	39.1	*0.14*	
Total Nodes/Plant	20.2	21.3	19.9	*0.06*	
Internode Length (inches)	1.6	1.6	1.9	*<0.01*	*0.2*

Table 6 Results from final, end-of-season plant mapping using COTMAP; tillage main plots-- 2016, Judd Hill, AR.

	Tillage System				
Category	Conventional	Cover crop	No-till	*P>F*	*LSD_{05}*
1st Sympodial Node	6.1	6.1	6.1	*0.93*	
No. of Monopodia	1.6	1.6	1.5	*0.23*	
Highest Sympodia with 2 Nodes	11.4	12.6	12.7	*0.11*	
Plant Height (inches)	31.4	35.8	35.8	*0.01*	*2.5*
No. of Effective Sympodia	6.9	7.0	7.3	*0.42*	
No. of Sympodia	14.5	15.6	16.0	*0.04*	*1.1*
No. of Sympodia with 1st Position Bolls	4.0	4.0	3.82	*0.80*	
No. of Sympodia with 2nd Position Bolls	0.5	0.6	0.6	*0.51*	
No. of Sympodia with 1st & 2nd Bolls	0.7	0.7	0.6	*0.83*	
Total Bolls/Plant	6.4	6.6	6.4	*0.95*	
% Total Bolls in 1st Position	73.6	71.6	70.9	*0.67*	
% Total Bolls in 2nd Position	17.3	18.2	18.7	*0.82*	
% Total Bolls in Outer Position	2.0	1.8	1.8	*0.98*	
% Total Bolls on Monopodia	7.1	8.3	8.7	*0.36*	
% Boll Retention - 1st Position	32.4	29.8	28.3	*0.22*	
% Boll Retention - 2nd Position	10.0	9.8	9.4	*0.95*	
% Early Boll Retention	42.9	42.8	39.4	*0.45*	
Total Nodes/Plant	19.6	20.7	21.1	*0.06*	
Internode Length (inches)	1.6	1.7	1.7	*0.09*	

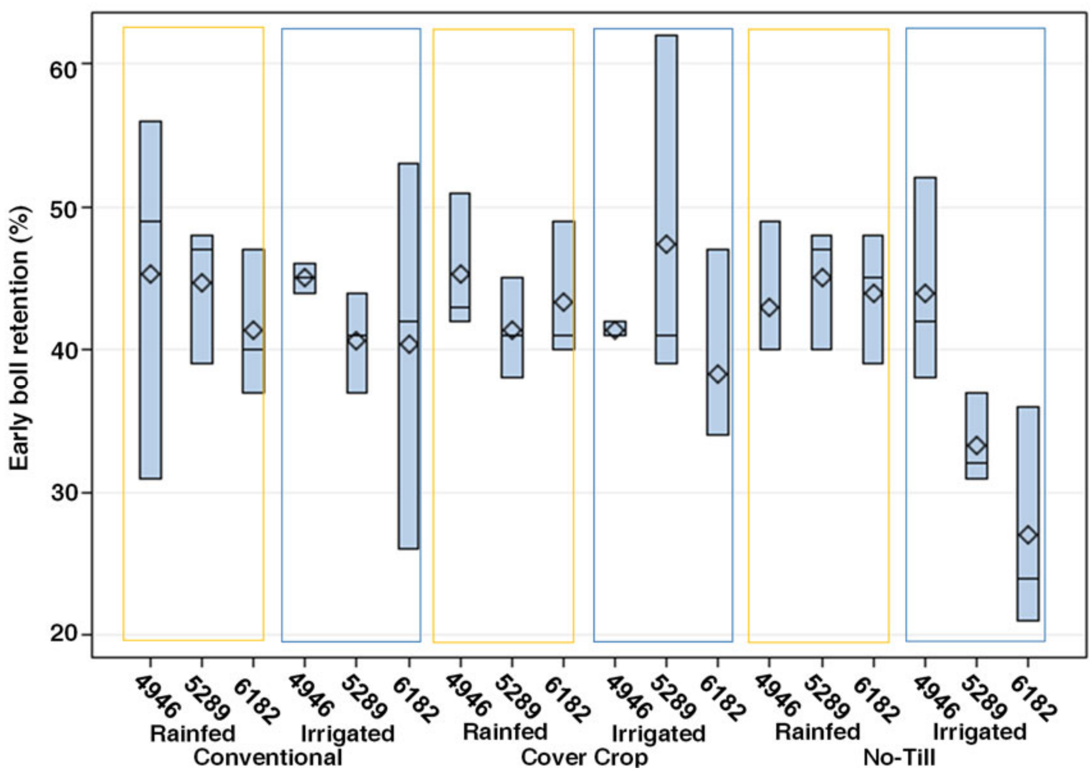

Figure 9. Mean early boll retention (% retention of first and second position bolls in the lowest 5 mainstem sympodia) of 2016 cultivar*irrigation*tillage effects. Boxes represent 50% quartile; diamonds depict means, and the line is the median value.

Yields were significantly influenced by cultivar, tillage and irrigation practices. The highest yields were observed with conventional tillage practices with the highest yield overall in irrigated, conventional tillage with cultivar ST 4946 GLB2 (Figure 10). ST 4946 GLB2 produced the highest yield in conventional as well as no-till while ST 5289 GLT performed best in cover crop system. ST 6182 GLT, the cultivar with the lowest HPR ratings, typically had lowest yield in all systems.

Results from HVI fiber quality assessments indicated significant differences in micronaire, uniformity, strength and elongation among cultivars and irrigation treatments (Table 7). Micronaire readings were in the base range among all treatments.

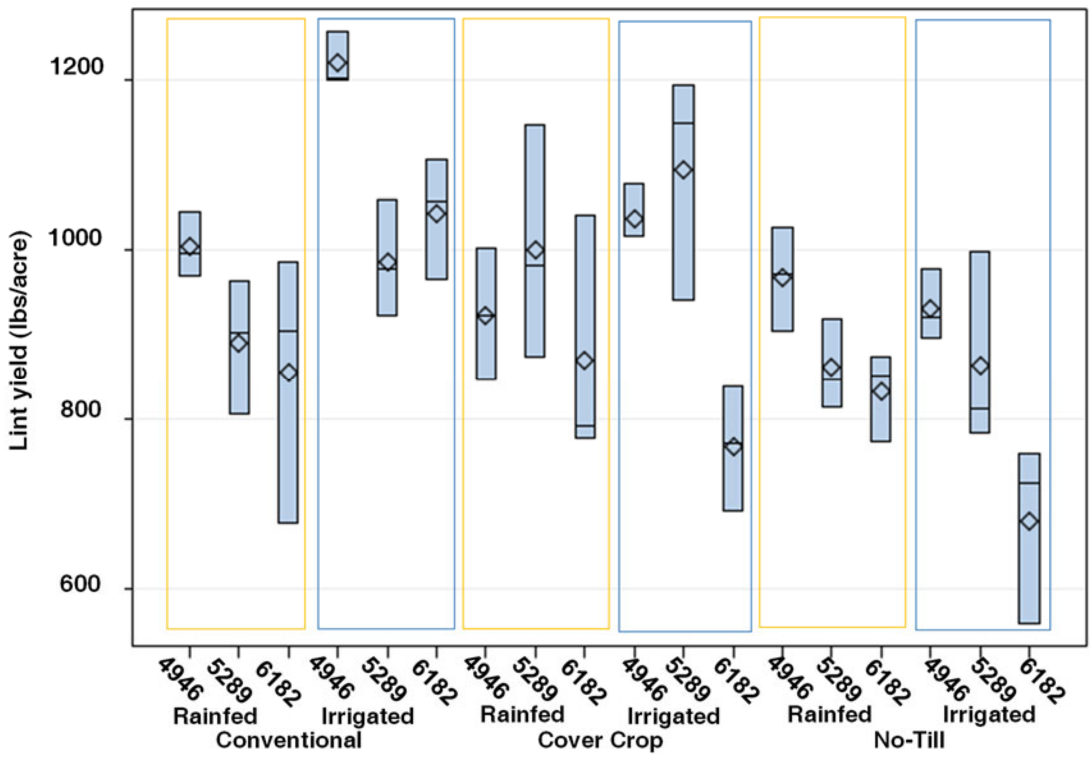

Figure 10. Mean lint yield (lbs/acres) for 2016 cultivar*irrigation*tillage effects. Lint yields presented were calculated on a 41% turnout across all treatments. Boxes represent 50% quartile; diamonds depict means, and the line is the median value.

Table 7. Fiber quality assessments (HVI[a]) for 40-boll collections in cultivar, irrigation, and tillage treatments--2016, Judd Hill, AR.

Treatment[b]		Micronaire	Length	Uniformity	Strength	Elongation
Cultivar	ST 4946	4.93	1.15	84.32	34.88	7.19
	ST 5289	4.76	1.16	83.03	30.31	5.77
	ST 6182	4.49	1.17	83.40	30.90	6.35
Irrigation	Rainfed	4.88	1.13	82.91	31.45	6.33
	Irrigated	4.57	1.19	84.26	32.61	6.54
Tillage	Conventional	4.94	1.14	83.04	31.86	6.48
	Cover crop	4.55	1.18	83.93	32.42	6.34
	No-till	4.68	1.17	83.79	31.81	6.48
Cultivar	*P>F*	*0.01*	*0.63*	*0.01*	*<0.001*	*<.0001*
	LSD_{05}	*0.3*		*0.8*	*1.1*	*0.2*
Irrigation	*P > F*	*0.01*	*<0.0001*	*<0.0001*	*0.15*	*0.32*
	LSD_{05}	*0.27*	*0.03*	*0.78*		
Tillage	*P > F*	*0.09*	*0.08*	*0.16*	*0.45*	*0.31*

[a] HVI assessments made at the Fiber and Biopolymer Research Institute, Texas Tech University, Lubbock, TX.
[b]No significant treatment interactions.

Sustainability indices for tillage and irrigation treatments generated using the Field Print Calculator indicates a negative impact of irrigation on land use, irrigation, energy use, greenhouse gas, and water quality runoff indices compared to rainfed production (Figure 11). Indices for the tillage practices showed significant improvement on soil conservation and water quality with cover crop and no-till compared to conventional tillage. No-till also showed an additional benefit with enhanced soil carbon index.

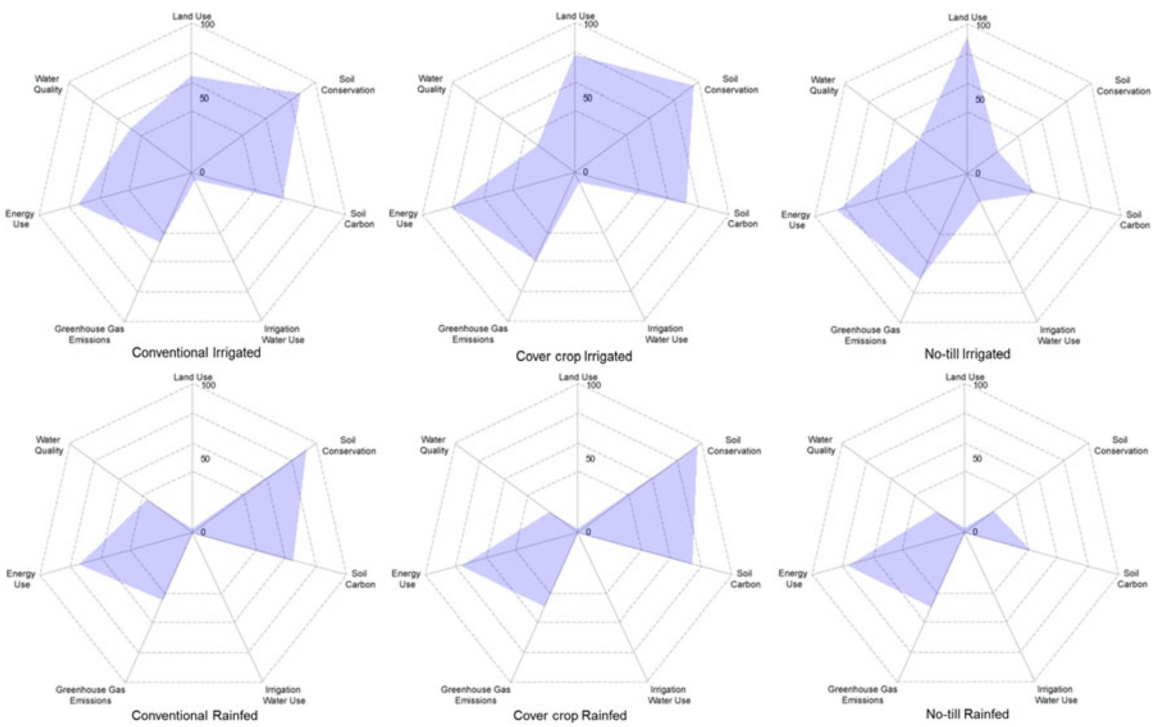

Figure 11. Output from the Fieldprint Calculator includes spidergrams which provide relative indices on a scale of 1 to 100 that represent the resource use or impact per unit of output in each of five resource areas. Lower values closer to the center of the spidergram indicate a lower impact on each resource; the smaller the total area of the Fieldprint on the spidergram, the smaller the overall resource impact.

Conclusions

The objective of this 2016 experiment was to quantify the impact of tillage system and irrigation practices on performance of three cultivars with a range of HPR properties. We hypothesized that growing conditions could impact plant resilience to stress including water deficit tolerance and/or insect pest susceptibility. Insect pests were not a limiting factor in this study year. Tarnished plant bug population density and pre-flower first position square shed were low for all treatments season long. Thrips numbers reached action threshold for cultivars in conventional and no-till treatments; however, highest infestation levels were also noted for the cultivar and tillage system with highest yield. Reductions in boll retention observed in late season were due to physiological boll shed, not insect induced square shed.

Regrettably, we did not document late season disease symptoms in this field trial, but in other areas of the 35 acre Judd Hill research site, high levels of Verticillium wilt (caused by the soilborne fungus, *Verticillium dahlia*) resulted in significant production losses. Foliar diseases including Target Spot (caused by the fungus *Corynespora cassiicola*) were also considered atypically severe for Northeast Arkansas in 2016. Variation in earliness and productivity among cultivars in this trial likely was related to variable disease susceptibility among the three cultivars as well as the growing environment associated with each tillage system and irrigation practice. Highest and lowest productivity was observed in irrigated treatments; however, infiltration differences among tillage systems resulted in different soil moisture. Consistently high soil moisture levels in the irrigated, no-till treatment was conducive for disease development.

Understanding how growing environment and production practices interact at a system level will promote use of practices that will help improve overall cotton performance and yield stability. An integrated approach in pest management will allow producers to reduce reliance on costly chemical control and improve cotton sustainability. Use of the Fieldprint Calculator tool can provide benchmark to document progress in reducing negative environmental impact. The experiment will be repeated in 2017 with expanded evaluation of yield stability as a part of the long term tillage study at the Judd Hill Foundation Farm.

Acknowledgements

This research is a part of the cotton sustainability research program supported through CORE funding from Cotton Incorporated, the University of Arkansas Division of Agriculture, (USDA National Institute of Food and Agriculture (project ARK02355)) Arkansas State University, and the Judd Hill Foundation.

References

Bourland, F., Beach, A., Kennedy, C., Martin, L., Rouse, A., & Robertson, B. 2016. Arkansas Cotton Variety Test 2015. Arkansas Agricultural Experiment Station Research Series 632.

Bourland, F.M., D.M. Oosterhuis, N.P. Tugwell, M.J. Cochran and D.M. Danforth. 2008. Interpretation of crop growth patterns generated by COTMAN. *In:* D.M. Oosterhuis and F.M. Bourland (ed). COTMAN Crop Management System. U. of Ark Agric. Exp. Sta., Fayetteville, AR.

Bourland, F.M. and C.E. Watson, Jr. 1990. COTMAP, a technique evaluating structure and yield of cotton. Crop Sci. 39: 224-226.

Hearn, A.B. and G.D. da Roza. 1985. A simple model for crop management applications for cotton (*Gossypium hirsutum* L.). Field Crops Res., 12: 49-69.

Lincoln, C., W.P. Boyer, F. D Miner. 1975. The evolution of insect pest management in cotton and soybean: past experience, present status and future outlook in Arkansas. Environ. Entomol. 4:1-7.

Luttrell, R.L., T.G. Teague, M.J. Brewer. 2015. Cotton insect pest management. *In:* D. Fang (Ed.), Cotton. (Agronomy Monograph no. 24, 2nd edition). American Society of Agronomy, Inc., Crop Science Society of America, Inc., Soil Science Society of America, Inc., Publishers, Madison, WI, USA.

Oosterhuis, D. M., & Bourland, F. M. 2008. COTMAN Crop Management System. University of Arkansas Division of Agriculture and Cotton Incorporated.

Sadras, V.O. and G. Felton. 2010. Mechanisms of cotton resistance to arthropod herbivory. pp. 213-228 *In:* J. McD. Stewart, D.M. Oosterhuis, J.J. Heitholt, and J.R. Mauney. (Eds.), Physiology of Cotton. Springer, N.Y.

Studebaker, G. 2016. 2015 Insecticide Recommendations for Arkansas. MP144, University of Arkansas Division of Agriculture. http://www.uaex.edu/publications/pdf/mp144/mp144.pdf Accessed 19 January 2017.

Teague, T.G. 2016. Plant-insect interactions and cotton development. pp. 27-65 *In:* J. Snider and D.M. Oosterhuis (Eds.), Linking Physiology to Management. Cotton Foundation Reference Book Series Number Nine. The Cotton Foundation. Cordova, TN, USA.