CROP PROTECTION AND TILLAGE – FOCUSING MANAGEMENT TO BUILD SUSTAINABLE COTTON SYSTEMS – YEAR III

Tina Gray Teague
Jennifer Bouldin
Calvin Shumway
Steve Green,
University of Arkansas Agricultural Experiment Station, Arkansas State University-Jonesboro,
Richard Warby
Keith Morris
Arkansas State University, Jonesboro, AR
Archie Flanders
University of Arkansas Northeast Research and Extension Center, Keiser, AR,

Abstract

A long term cotton systems study to assess agronomic, economic and environmental impacts of conservation tillage and pest management systems was initiated in NE Arkansas at the Judd Hill Foundation in fall 2007. In this report, we summarize component studies conducted from 2008 through 2010 evaluating the utility of automatic season-long applications of insecticides for tarnished plant bug (*Lygus lineolaris* (Palisot de Beauvois)) control compared to threshold based insecticide applications or no foliar applied insecticides. Plant bug control was assessed across three cotton tillage practices: conventional tillage, no-till or a terminated winter cover crop system.

Yields were significantly impacted by tillage practices in two of the three years. Conventional tillage in 2008 resulted in highest yields. Reduced stand density and lagging early season plant growth was observed in no-till and cover crop systems compared to plants grown using conventional tillage. With changes in planter configuration and favorable spring weather, plant stand was similar among tillage practices in 2009 and 2010. Yields in the cool wet 2009 season were highest when cotton was grown in the terminated wheat cover crop. No yield differences among tillage treatments were observed in 2010. Tarnished plant bug was the dominant pest insect during the three years. Plant bug numbers were similar across all tillage treatments. In 2008, plant bug numbers were very low season long. In 2009 and 2010 plant bug numbers were somewhat higher, with population densities exceeding recommended action thresholds in mid and late season, but feeding injury was limited to fruiting forms that did not contribute to economic yield. Insecticide applications or timing had no significant effects on yield in 2008, 2009 or 2010 ($P>0.35$), and there were no significant insecticide * tillage interactions.

Introduction

Conservation tillage has become a standard practice for most Arkansas cotton producers. Winter cover crops of wheat or rye often are planted in row middles in NE Arkansas to reduce damage associated with wind and blowing sand. Cover crops also enhance weed management, irrigation water infiltration, and early season root health. One concern among producers and their crop advisors is the potential for outbreaks of pest insects such as thrips and plant bugs in low till systems because of increased availability of plant hosts in spring, and the "low spray" environments in the post-boll weevil era. Automatic insecticide applications have been adopted by some producers to address these concerns. An IPM approach endorses scouting, crop monitoring, and spraying pesticides only when needed. As managers examine ways to reduce costs and increase use of their on-farm mechanization and technology investments, they may consider increasing use of preventative approaches for pest control to reduce the management intensive practices of scouting and crop monitoring required for an IPM strategy. In this report, we summarize results from the first three years of a planned multi-year study comparing crop protection practices across different tillage systems.

Materials and Methods

The experiment was established in fall 2007 at the Judd Hill Research Farm in Poinsett County in NE Arkansas. The growing season is May through October, and the latest possible cutout date (that date with a 50% or 85% probability of attaining 850 DD60s from cutout) for this production area is 15 or 3 Aug, respectively (Zhang et al. 1994 , Danforth and O'Leary 1998). The field study was arranged as a split-plot design with 3 tillage systems: 1) conventional, 2) no-till, or 3) no-till + winter cover crop (cover crop), considered main plots. The insect pest control regimes were considered sub-plots (see Table 1 for details). Main plots were 16 rows wide and 450 ft long; sub-plots were 16 rows wide, 75 ft long with 10 ft alleys.

Table 1. Insecticide application descriptions including product, rate, and timings for sub-plot insect control treatments in 2008, 2009 and 2010.

Year	Treatment Description	Pesticide (rate/acre) application date
2008	Early, Mid, & Late season automatic insecticides[1]	Trimax (1.8oz) 18 June, 2 July; Centric (2 oz) + Diamond (9oz) 8 July; Leverage (3.75 oz) 22 July; Centric (2oz) 29 July; Bidrin (3.2 oz) 6 Aug.
	Mid-season automatic insecticides	Centric (2 oz) + Diamond (9oz) 8 July
	Untreated Check	
2009	Early, Mid, & Late season Automatic Insecticides[1]	Centric (2oz) 19 June; Trimax (1.5 oz) 26 June, 8 July; Centric (2oz) 20 July; Bidrin (6 oz) 10 Aug; Bidrin XP (10.6 oz) 18 Aug
	Threshold insecticide application [2]	Centric (2oz) 20 July; Bidrin (6 oz) 10 Aug; Bidrin XP (10.6 oz) 18 Aug
	Untreated Check	
2010	Early, Mid, & Late season automatic insecticides[1]	Centric (2oz) 22 June, 7, 22 July; Bidrin (6 oz) 2 Aug
	Threshold insecticide application[2]	Centric (2oz) 7 July; Bidrin (6 oz) 2 Aug
	Untreated Check	

[1]Automatic insecticide applications were directed at preventing tarnished plant bug and stink bug infestations. All applications were made with a tractor-mounted high clearance sprayer equipped with 8 row boom. Insecticides included were Trimax (imidacloprid), Leverage (imidacloprid/cyfluthrin), Bidrin (dicrotophos), Centric (thiamethoxam), and Diamond (novaluron).

[2] Insecticide was applied for tarnished plant bug control when the insects reached the UA MP144 recommended action threshold of a mean 3 bugs per drop cloth sample.

Production practices were similar across all tillage treatments with the following exceptions. In conventional main plots each spring, beds were reshaped and then flattened prior to planting with a DO-ALL fitted with incorporation baskets; also, row middles (water furrows) in conventional tillage plots were cleared with sweep plows prior to first furrow irrigation. No post plant cultivation was used in any tillage regime. For winter cover crops, beds were re-formed in the fall with disk bedders. After seeding, a roller was used to press seed into the bed. Cover crops were first established in October 2007 with Balansa clover (Kaprath Seeds, Inc., Manteca, CA) and wheat mixture seeded at 10 lbs wheat and 8 lbs coated clover seed /acre. Similar practices were used in fall 2008. In both years, combinations of fall rains and cold weather reduced establishment of clover. Only a partial stand of clover was achieved in fall 2007, but the 2008 clover crop was a complete loss. For all practical purposes, the cover crop for 2009 was wheat only. In 2009, rain delays precluded all attempts at seeding clover, and only wheat was planted in November 2009.

Stoneville 4554 B2RF (thiamethoxam (Cruiser) treated seed) was planted on 6 May 2008, 19 May 2009, and 7 May 2010 in the Dundee silt loam soil at 3 to 4 seeds/ft on raised beds spaced at 38 inches. Furrow irrigation was applied weekly depending on rainfall (Table 2).

Table 2. Dates and days after planting (DAP) for furrow irrigations for JH tillage trial, 2008-2010.

2008	date	6-Jun	13-Jun	20-Jun	27-Jun	3-Jul	11-Jul	18-Jul	24-Jul	1-Aug
	(DAP)	31	38	45	52	58	66	73	79	87
2009	date	23-Jun	17-Jul	19-Aug						
	(DAP)	35	59	92						
2010	date	12-Jun	18-Jun	24-Jun	1-Jul	8-Jul	23-Jul	3-Aug	11-Aug	
	(DAP)	36	42	48	55	62	77	88	96	

Crop monitoring was used to document differences in crop development among tillage and crop protection treatments from squaring until physiological cutout. During the first week of squaring, number of plants with visible squares (% plants squaring) was determined by inspecting four sets of 25 consecutive plants across four rows per plot (=100 total plants). Subsequent plant monitoring was done using the COTMAN crop system (Danforth and O'Leary 1998; Oosterhuis and Bourland 2008). Two sets of five consecutive plants in the center rows were monitored weekly using the Squaremap sampling procedure which includes measurement of plant height, number of main stem sympodia, and presence or absence of first position squares and bolls. After 1st flowers, Squaremap sampling of consecutive plants was continued to monitor square and boll retention and sympodial growth. Records of weekly damage assessments and crop response were collected for each crop protection input. End-of-season plant mapping was performed each year using the COTMAP procedure (Bourland and Watson 1990). Ten plants in one row per plot were examined for node number of first (lowest) sympodial branch on the main axis, number of monopodia, and number of bolls on sympodia arising from monopodia. Bolls located on main stem sympodia (1st and 2nd position) were recorded, as well as bolls located on the outer positions on sympodial nodes (>2nd position). The highest sympodium with 2 nodal positions and number of bolls on sympodia located on secondary axillary positions were also noted. Plant height was measured as distance from soil to apex.

Extensive arthropod pest monitoring included direct and indirect sampling. Pitfall traps, sweep nets, and drop cloth samples were made weekly for insects through the season. After defoliation, fifty consecutive bolls from adjacent plants were collected in each treatment plot for HVI quality assessments in 2008 and 2010. Samples in 2009 were obtained from grab samples from the cotton picker basket. All samples were ginned with a laboratory gin and submitted to the Fiber and Biopolymer Research Institute, Texas Tech University, Lubbock. Plots were harvested with a 2 row research cotton picker. All plant monitoring, yield and fiber quality data were analyzed using ANOVA with mean separation using protected LSD.

Results

Weather conditions during the production season for the three years were variable with a relatively "normal" 2008 followed by a cool, wet 2009 and a hot, dry 2010 (Table 3). Spring wet weather affected planter efficiency and cotton seed germination in 2008. Plant stand density was significantly reduced in no-till and the cover crop system compared to the conventional tillage system (Fig 1). The John Deere Max Emerge Air-Flow planter used in 2008; at times closure of the seed furrow was not uniform, resulting in reduced seed-to-soil contact. In 2009 a no-till planter was employed, and despite a rain delayed date of planting, 19 May, no differences in stand establishment were observed among tillage systems. With warm spring temperatures in 2010, no differences among treatments in stand density were observed in 2010.

Table 3. Monthly heat unit accumulations and rainfall for Judd Hill for 2008, 2009, 2010.

	Heat Units (DD60s)[1]			Rain (inches)		
Month	**2008**	**2009**	**2010**	**2008**	**2009**	**2010**
April	75	120	185	5.71	9.51	3.68
May	309	294	423	4.04	9.82	7.10
June	610	619	732	1.4	4.62	0.63
July	581	554	721	1.76	8.25	7.02
August	382	524	730	0.61	3.83	0.30
September	134	391	454	3.17	4.75	0.78
October	127	40	147	2.86	12.38	0.38

[1]`Calculated using average temperature based on daily high and low temperatures.

Squaring initiation was observed earlier among plants in the conventional cotton in 2008 and 2009 compared to cover crop and no-till cotton (Fig 2). Seedbed preparations with re-shaping and flattening beds in the conventional tillage plots appeared to affect soil temperatures in 2008. Temperature sensors (WatchDog button loggers, http://www.specmeters.com/) buried at 6 inch depths among tillage practices indicated higher temperatures in the conventional compared to the no-till and cover crop plots (Teague et al 2009). With above average spring temperatures in 2010, uniform initiation of squaring was observed among tillage treatments.

COTMAN growth curves for main plot tillage treatments in 2008 show that fewer mean no. squaring nodes (±SEM) were produced pre-flower in the cover crop cotton compared to no-till and conventional cotton (Fig 3). Both cover crop and no-till treatments had fewer main-stem sympodia than conventional by 58 DAP (P=0.01). In 2009 and 2010, pace of crop development was advanced related to the standard COTMAN reference curve with squaring initiated prior to 35 DAP. Spring rains delayed planting in 2009 until late May in 2009, and soils were warmer during the critical first 35 to 40 days after planting. With warm spring temperatures in 2010, main stem squaring nodes were similar among tillage treatments season-long.

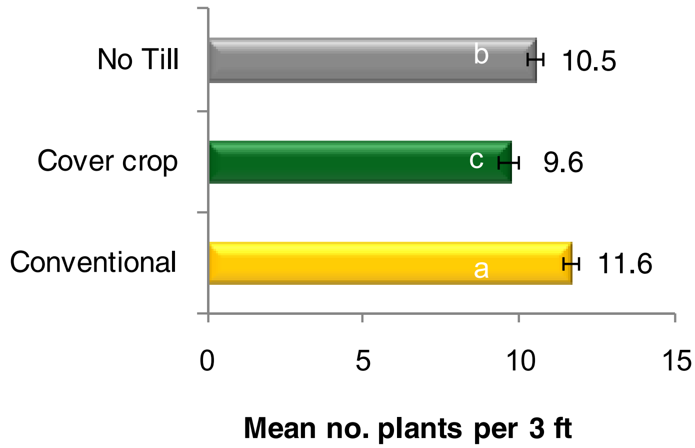

Figure 1. Plant stand density was affected by tillage in 2008 with greater mean no. plants (±SEM) per 3 ft at 24 DAP observed in the conventional system compared to the no-till and cover crop treatments . Plant stand density was not impacted by tillage in the second or third year with overall mean of 10.6 and 11.3 plants per foot for 2009 and 2010, respectively. (data not shown).

Final end-of-season plant mapping results from COTMAP sampling showed few notable differences associated with the insecticide treatment (data not shown). First position retention (%) in 2009 was higher in automatic (43%) and threshold ((43%) compared to the untreated control (37%) (P=0.04)). Similar trends were observed in 2010, first position % boll retention was 31% in the automatic and threshold based protection treatments compared to the untreated control (25%). There were no differences in 2008. Among tillage systems, end of season mapping results are presented in Tables 3, 4, and 5. In 2008, plants grown with cover crops were shorter and produced fewest mainstem sympodia (Table 3). In 2009, no-till cotton plants had highest percentage total bolls occurring in first position; plants from conventional tillage plots had greater % of outer bolls compared to plants from no-till and cover crop system (Table 4). In 2010 % outer bolls again were highest for plants grown using conventional tillage practices; early boll retention also was lowest in conventional tillage cotton (Table 5). In-season Squaremap results from 2010 indicate that higher levels of small boll shed was observed in the conventional compared to no-till and cover crop systems. These retention differences appeared to be related to physiological sheds and not insect feeding injury and could be associated with temperature and soil moisture variability among tillage systems. Lowest levels of first position bolls per plant were observed in the 2010 season.

Plant bug numbers were very low through the 2008 season (Fig 5). In 2009 and 2010 bug numbers increased in the untreated control plots after the onset of flowering, but numbers were maintained below threshold in sprayed plots. Pant bug population densities were moderately low in 2009, but in 2010 nymphs were 3 to 4 times higher than the recommended action threshold. The surge in plant bug numbers in 2010 occurred after physiological cutout (>100 DD60s after NAWF=5); for most plots. First position square retention levels remained above 85% through 73 DAP (data not shown). Detailed analyses of pit fall trap data are still underway for 2010. In the first two years, numbers of generalist predators including spiders and ground beetles were more abundant in no-till and cover crop plots than in conventional tillage plots. Impact of these natural enemies on pest insects is unknown. It is notable that secondary pest outbreaks of spider mites (2008) and aphids (2009) did occur where automatic insecticides were applied. These pest outbreaks likely are related to reductions in natural enemies following sprays of the insect growth regulator (novaluron) in 2008 (mites) and pyrethroids in 2009 (aphids). Additional insecticide (miticide) applications were directed at these secondary outbreaks in both years (in additional treatment plots; data not show), and no yield losses were attributable to these “flared” pests. Other insect pests including thrips, caterpillars and stink bugs did not occur at densities sufficient to pose crop risk in any year.

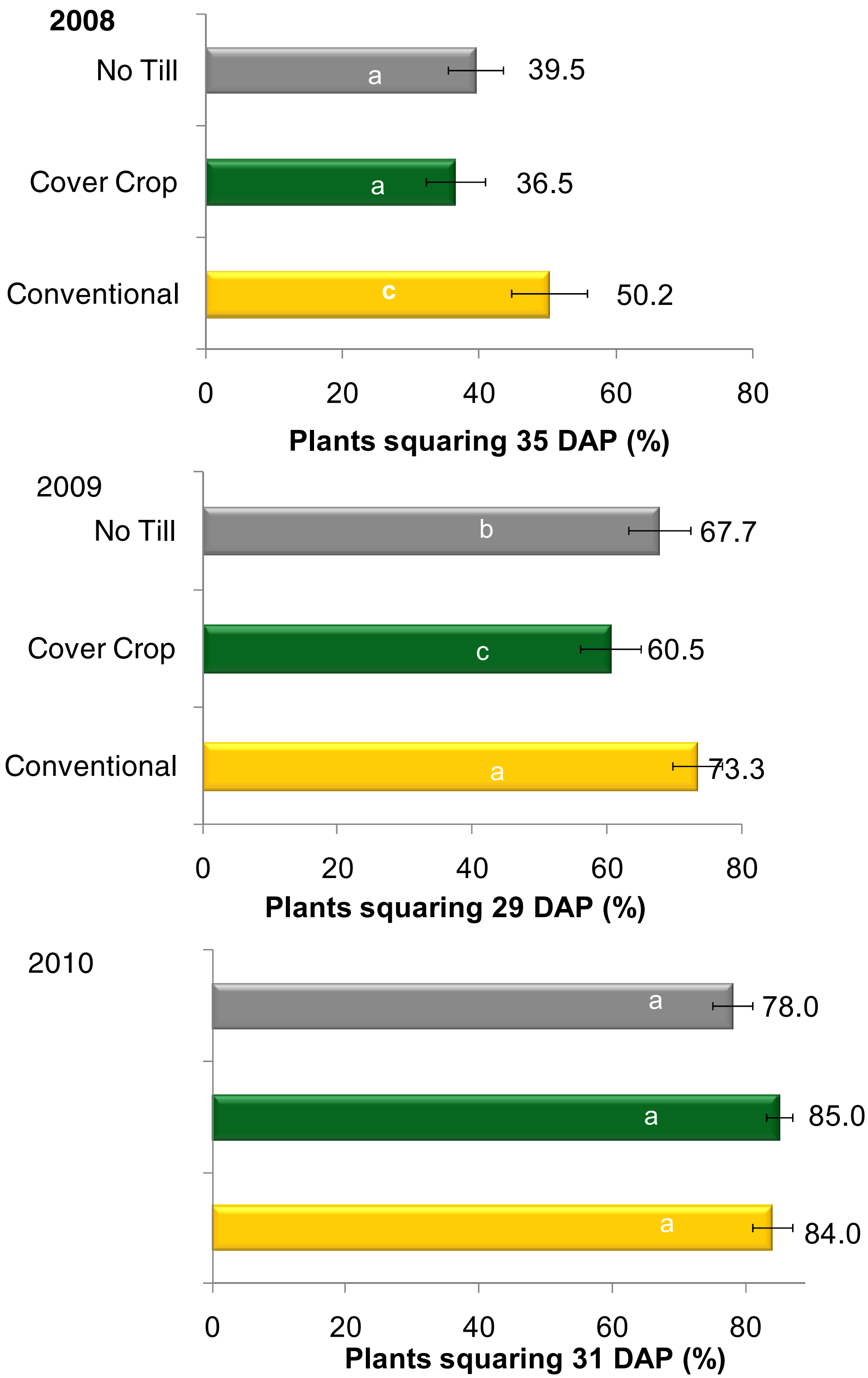

Figure 2. Plants grown using conventional tillage practices had highest mean % of plants (±SEM) squaring in early season compared to plants in no-till and cover crop systems in 2008 and 2009. Squaring levels were determined at 35 DAP in 2008, 29 DAP in 2009, and 31 DAP in 2010.

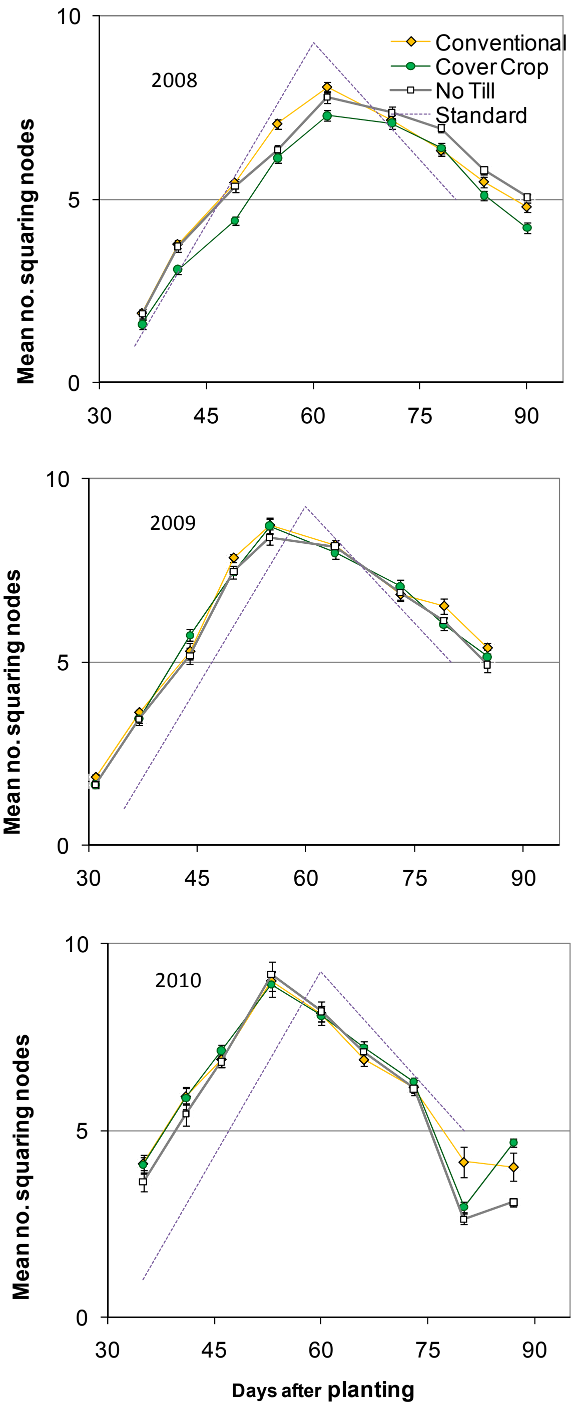

Figure 3 . COTMAN growth curves for main plot tillage treatments in 2008 (top) show that fewer mean no. squaring nodes (±SEM) were produced pre-flower in the cover crop system compared to no-till and conventional systems. Both cover crop and no-till treatments had fewer main-stem sympodia than conventional by 58 DAP (P=0.01). Date of planting was 3 May. In 2009 and 2010, COTMAN growth curves for main plot tillage treatments show that pace of crop development was advanced related to the standard curve with squaring initiated prior to 35 DAP. Warmer soil temperatures - associated with the rain delayed date of planting (19 May) in 2009 and warm temperatures at planting (7 May) in 2010 - increased the pace of development of main stem squaring nodes. Nodal development was similar among tillage systems season-long

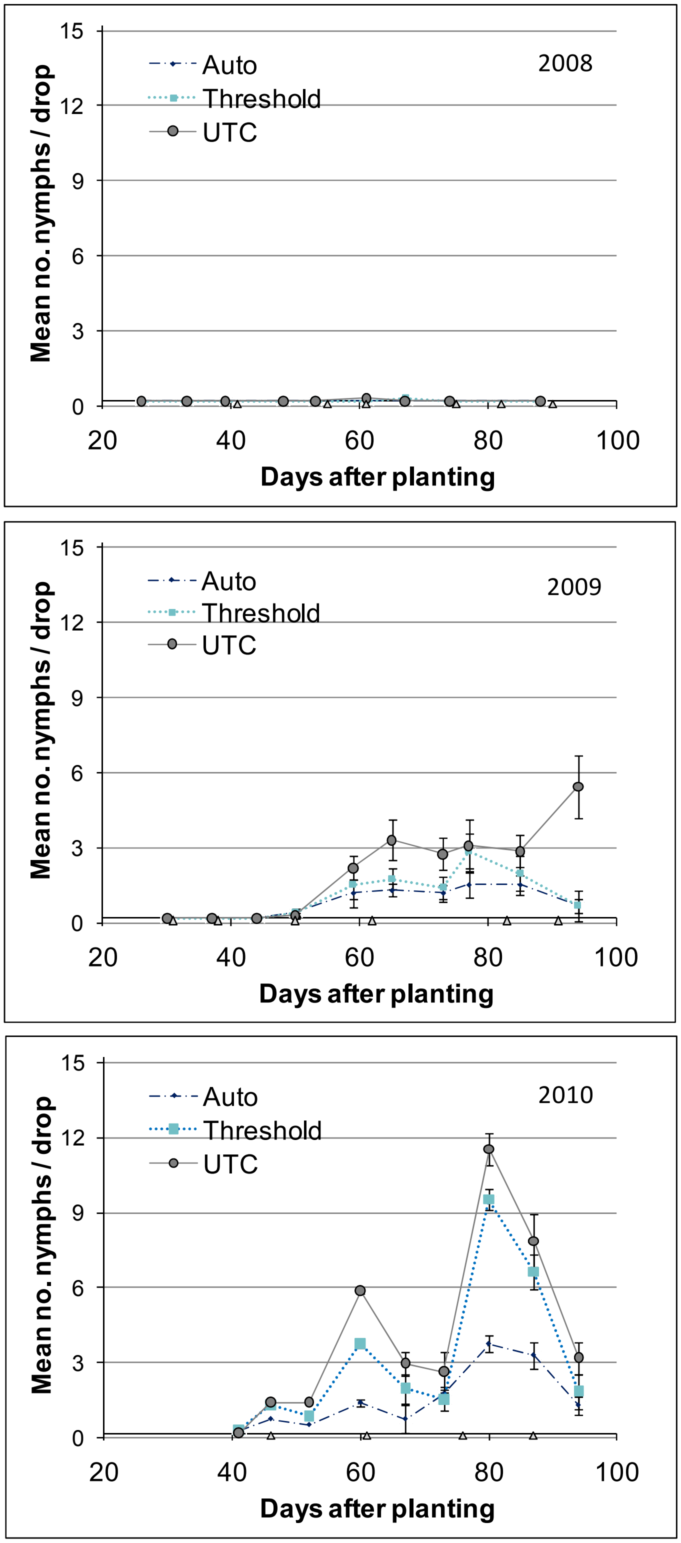

Figure 4. Tarnished plant bug nymphs (mean ±SEM) observed per drop cloth sample in weekly monitoring for the 2008, 2009, and 2010 seasons. Insecticide application dates are indicated on x-axis. Plant bug numbers were very low through the 2008 season. In 2009 and 2010 plant bug numbers increased after flowers and again after cutout but were maintained below threshold in the automatic sprayed treatments.

Table 4. Results from final end-of-season plant mapping using COTMAP for tillage main plot effects- 2008[1].

Category	Mean per plant for management treatment				
	Conventional	Cover Crop	No-till	*P>F*	*LSD_{05}*
1st Sympodial Node	6.9	7.3	6.5	*0.11*	
No. Monopodia	2.7	2.7	2.2	*0.08*	
Highest Sympodia with 2 nodes	11.0	8.4	10.2	*0.17*	
Plant Height (inches)	45.4	36.2	40.0	*0.05*	*6.9*
No. Effective Sympodia	10.8	9.6	10.3	*0.17*	
No. Sympodia	15.7	12.8	14.5	*0.05*	*2.4*
No. Symp. with 1st Position Bolls	5.3	4.5	5.3	*0.36*	
No. Symp. with 2nd Position Bolls	1.2	1.3	1.2	*0.87*	
No. Symp. with 1st & 2nd Bolls	1.6	0.9	1.2	*0.33*	
Total Bolls/Plant	10.3	9.2	9.6	*0.66*	
% Total Bolls in 1st Position	67.5	59.4	67.5	*0.46*	
% Total Bolls in 2nd Position	26.6	23.4	25.0	*0.71*	
% Total Bolls in Outer Position	2.7	3.8	1.0	*0.32*	
% Total Bolls on Monopodia	2.8	12.8	6.5	*0.06*	
% Total Bolls on Extra – Axillary	0.3	0.6	0.0	*0.23*	
% Boll Retention - 1st Position	43.4	41.9	44.6	*0.59*	
% Boll Retention - 2nd Position	25.9	25.7	24.1	*0.96*	
% Early Boll Retention	49.0	45.7	53.7	*0.59*	
Total Nodes/Plant	21.6	19.2	20.0	*0.06*	
Internode Length (inches)	2.1	1.9	2.0	*0.14*	

[1] means of 10 plants per plot.

Table 5. Results from final end-of-season plant mapping using COTMAP for tillage main plot effects- 2009[1].

Category	Mean per plant for management treatment				
	Conventional	Cover Crop	No-till	*P>F*	*LSD_{05}*
1st Sympodial Node	7.1	7.2	6.8	*0.13*	
No. Monopodia	2.0	2.1	1.9	*0.49*	
Highest Sympodia with 2 nodes	11.6	10.9	11.0	*0.25*	
Plant Height (inches)	43.0	42.1	42.6	*0.86*	
No. Effective Sympodia	10.1	9.6	9.6	*0.12*	
No. Sympodia	15.0	14.4	14.3	*0.26*	
No. Symp. with 1st Position Bolls	4.9	5.2	4.8	*0.29*	
No. Symp. with 2nd Position Bolls	1.3	1.4	1.2	*0.51*	
No. Symp. with 1st & 2nd Bolls	1.2	0.8	0.9	*0.28*	
Total Bolls/Plant	10.1	9.2	8.6	*0.16*	
% Total Bolls in 1st Position	61.6	65.4	67.4	*0.05*	*4.56*
% Total Bolls in 2nd Position	24.5	22.9	23.6	*0.70*	
% Total Bolls in Outer Position	6.1	3.7	3.7	*0.01*	*1.25*
% Total Bolls on Monopodia	7.6	8.0	5.3	*0.10*	
% Total Bolls on Extra – Axillary	0.1	0.0	0.0	*0.44*	
% Boll Retention - 1st Position	41.1	41.2	39.7	*0.65*	
% Boll Retention - 2nd Position	21.4	19.3	18.7	*0.42*	
% Early Boll Retention	44.3	40.7	38.7	*0.13*	
Total Nodes/Plant	21.1	20.6	20.2	*0.22*	
Internode Length (inches)	2.0	2.1	2.1	*0.34*	

[1] means of 10 plants per plot.

Table 6. Results from final end-of-season plant mapping using COTMAP for tillage main plot effects- 2010[1].

Category	Mean per plant for management treatment: Conventional	Cover Crop	No-till	*P>F*	LSD_{05}
1st Sympodial Node	5.8	5.8	5.8	*0.87*	
No. Monopodia	1.5	1.5	1.6	*0.97*	
Highest Sympodia with 2 nodes	14.0	13.9	12.2	*0.09*	
Plant Height (inches)	47.1	47.4	43.2	*0.13*	
No. Effective Sympodia	8.7	8.6	7.9	*0.19*	
No. Sympodia	18.3	18.3	16.5	*0.06*	1.69
No. Symp. with 1st Position Bolls	4.3	4.3	4.5	*0.87*	
No. Symp. with 2nd Position Bolls	1.0	0.9	0.9	*0.76*	
No. Symp. with 1st & 2nd Bolls	0.7	0.6	0.8	*0.70*	
Total Bolls/Plant	7.3	7.1	7.5	*0.78*	
% Total Bolls in 1st Position	68.0	70.8	72.4	*0.57*	
% Total Bolls in 2nd Position	22.2	21.2	20.9	*0.92*	
% Total Bolls in Outer Position	5.9	3.4	2.4	*0.02*	1.95
% Total Bolls on Monopodia	3.9	3.8	3.9	*0.99*	
% Total Bolls on Extra – Axillary	0.0	0.8	0.4	*0.06*	0.63
% Boll Retention - 1st Position	27.7	27.3	32.0	*0.12*	
% Boll Retention - 2nd Position	11.7	11.3	13.4	*0.60*	
% Early Boll Retention	39.1	40.9	46.8	*0.06*	6.27
Total Nodes/Plant	23.1	23.1	21.3	*0.07*	
Internode Length (inches)	2.1	2.1	2.0	*0.75*	

[1] means of 10 plants per plot.

Significantly higher yields were associated with the conventional tillage system compared to the no-till and cover crop in 2008 (Fig. 4). In 2009, however, the cover crop system resulted in a significant increase in yield compared to the no-till and conventional systems. No differences in yield among tillage systems were observed in 2010. Yield differences in 2008 most likely were related to crop stand establishment and to plant growth in the first 35 days after planting. Field preparation in the conventional tillage system resulted in a seedbed that was more favorable for germination and seedling establishment in the cool, wet May conditions compared to the stale seedbeds in the no-till and cover crop treatments. Changes in planter configuration in 2009 as well as delayed date of planting (because of rains) resulted in uniform stand among treatments and warmer soil conditions for early season plant development. The COTMAN growth curves show uniform plant growth among tillage systems in 2009. A possible explanation for the 2009 yield differences is unknown. A hot, dry 2010 resulted in an early maturing crop.

Pest conditions were such that the insecticide programs offered no agronomic benefit in any of the three tillage systems in any year. Tarnished plant bug numbers exceeded recommended thresholds in 2009 & 2010; however, feeding injury did not result in yield loss even in 2010 when late season bug numbers in the untreated and threshold treatment were 3 to 4 times higher plots than recommended action thresholds. The late season surge of bugs in 2010 came after physiological cutout + 116 DD60s -- mean date of physiological cutout in 2010 was 26 July, 76 days after planting. Feeding injury from the post cutout infestation of plant bugs in 2010 likely affected only upper canopy squares and bolls and other late season fruiting forms that did not contribute to yield. COTMAN crop termination guides in Arkansas recommend terminating late season control for new infestations of plant bugs at cutout + 250 DD60s (Teague et al 2007). The research findings from 2010 provide supporting validation for the COTMAN insect control termination guide for tarnished plant bugs.

Yield component and HVI lint quality analyses showed no differences among tillage system or plant bug control for lint quality parameters including % lint, micronaire, length, uniformity, strength, or elongation in 2008 and 2009 (data not shown). In 2010, fiber length was significantly higher in non-insecticide treated cotton (mean=1.18) compared to threshold (1.16) and automatic insecticide treatments (1.15).

Concurrent component studies associated with this long term systems study include extensive soil and water runoff sample collections and analysis. Results thus far indicate few differences in soil properties among tillage systems after three years. Bulk density for soil after three years in cover crop and conventional plots was lower than no-till by 0.05 g/cm3. Soil health properties are slow to change, but soil enzyme activities are early indicators of changes in soil health. Of analyses conducted, only acid phosphatase enzyme activity and organic matter content have showed any statistical differences among tillage practices. After three years, soil organic matter levels from samples from cover crop plots were higher than from the no-tillage and the conventional tillage plots. The acid phosphatase enzyme is involved in the phosphorus soil nutrient cycle. Soil microorganisms control the phosphorus nutrient cycle, and an impact on this enzyme shows that the microorganisms responsible for this transformation are more active in soil samples from in the cover crop system compared to samples from the conventional tillage plots. Water quality assessments of run-off from rain and irrigation from field plots over the three year period have shown that total suspended solids were consistently lower in edge of field collections from cover crop system compared to no-till and conventional tillage plots. Fewer total events of toxicity in runoff water from cover crop and no-till plots were measured compared to samples from conventional tillage. In 2010, root health measurements across tillage treatments were initiated. Measurements of variations in root architecture were measured at 40 days after planting. Results from these analyses are not yet completed. Abundance of thrips, spider mites, aphids, bollworm, cutworm and other common pests have not been measurably changed by tillage. Pitfall trap sampling results indicate increased abundance of ground beetles and spiders in no-till and cover crop systems compared to conventional system. In economic comparisons of each system, preliminary cost estimates indicate inputs in the conventional and cover crop systems to be $11.75 to $14.00 more per acre than no-till.

Conclusions

Use of Balansa clover as a re-seeding legume cover crop does not appear to fit the production season for NE Arkansas. Despite our best efforts, over three years, we were unable to achieve an acceptable stand of clover in the fall. Variable weather resulted in delayed planting in 2007 and again in 2008. Cold and wet weather resulted in a failed stand in 2008. Fall rains precluded planting in 2009, and in fall 2010, seeding the legume was canceled because it was too dry. Historically, NE Arkansas producers have relied on wheat, rye or oats for winter cover crops. Even with weather related delays, producers still have limited success planting cereal cover crops during the winter or even early spring if protection from blowing sand is needed. Balansa clover is not a practical choice for this purpose. Also, with increased weed management challenges associated with glyphosate resistant Palmer amaranth, legume cover crops appear not to be compatible with fall and winter chemical weed control tactics currently employed by area producers. Cereal crops will fit in many of these management systems.

Insect pest conditions through the three year project were such that the insecticide programs offered no agronomic benefit in any of the three tillage systems in any year. Tarnished plant bug numbers exceeded recommended action thresholds in 2009 and 2010; however, feeding injury did not result in yield loss. Secondary pest outbreaks associated with automatic sprays included spider mites in 2008 and aphids in 2009. Overall, results indicate that the current insect pest thresholds are quite conservative for the NE Arkansas region, and preventative applications are not necessary or appropriate.

A sustainable cotton system incorporates an IPM strategy which does not include automatic, preventative foliar applications of insecticides. Such applications result in unneeded additional expense and pose risks for environmental contamination. Automatic applications increase risk of pest resurgence and secondary pest outbreaks, and they can lead to selection of resistant pest populations. Crop monitoring, scouting, and applying chemical control options only when needed are a distinguishing characteristic of the cotton culture of Arkansas where IPM has a long and prominent history. IPM is a key component in a sustainable cotton system and coupled with conservation tillage practices can substantially reduce farm contributions to non-point pollution of rivers and streams.

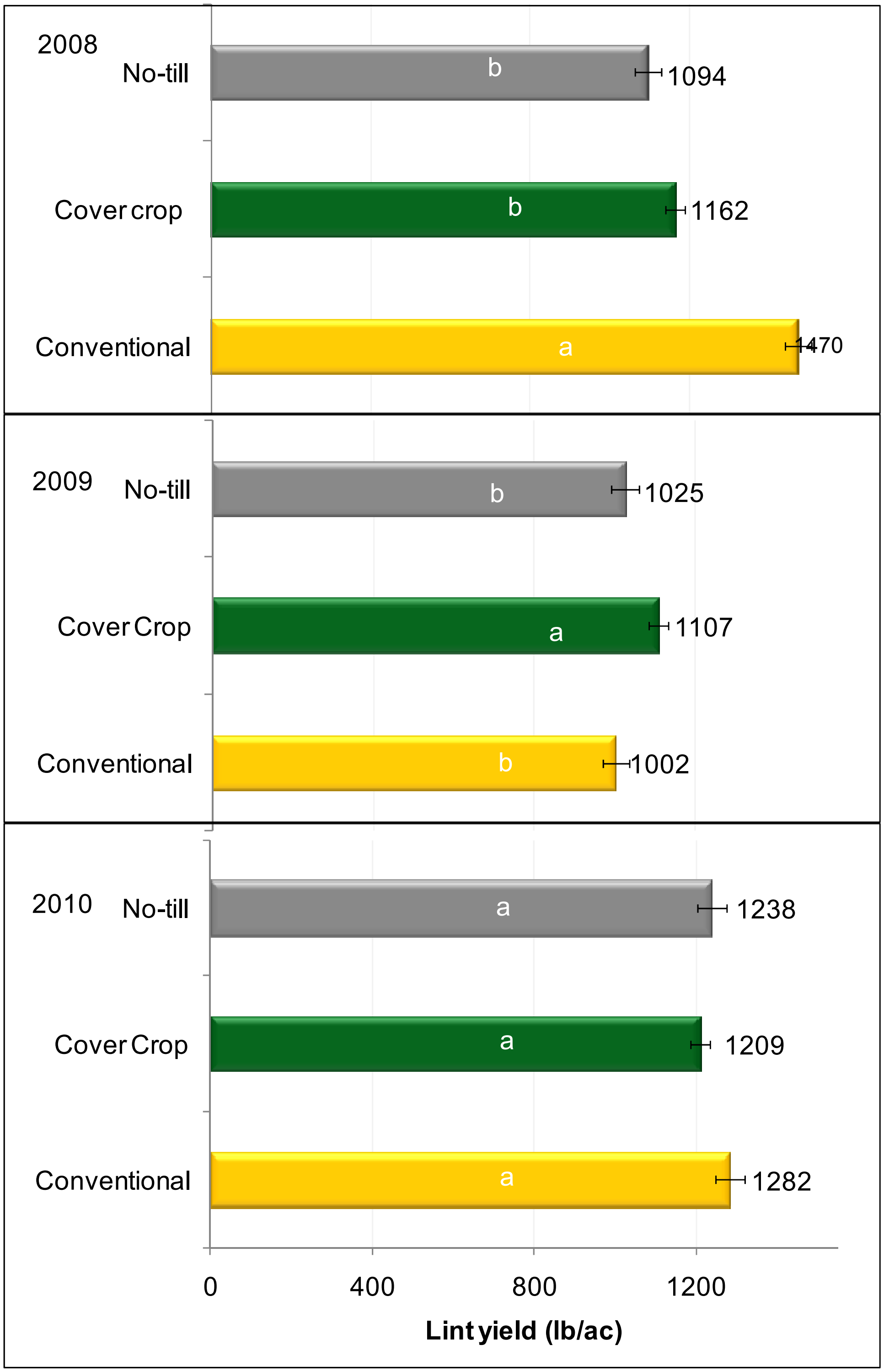

Figure 5. Yields in 2008 were significantly reduced in no-till and cover crop system compared to the conventional system ($P<0.01$; $LSD_{05}=183$). For 2009, highest yields were harvested from cover crop cotton compared to cotton grown with conventional and no-till practices ($P=0.01$; $LSD_{05}=38$). There were no differences among treatments in 2010.

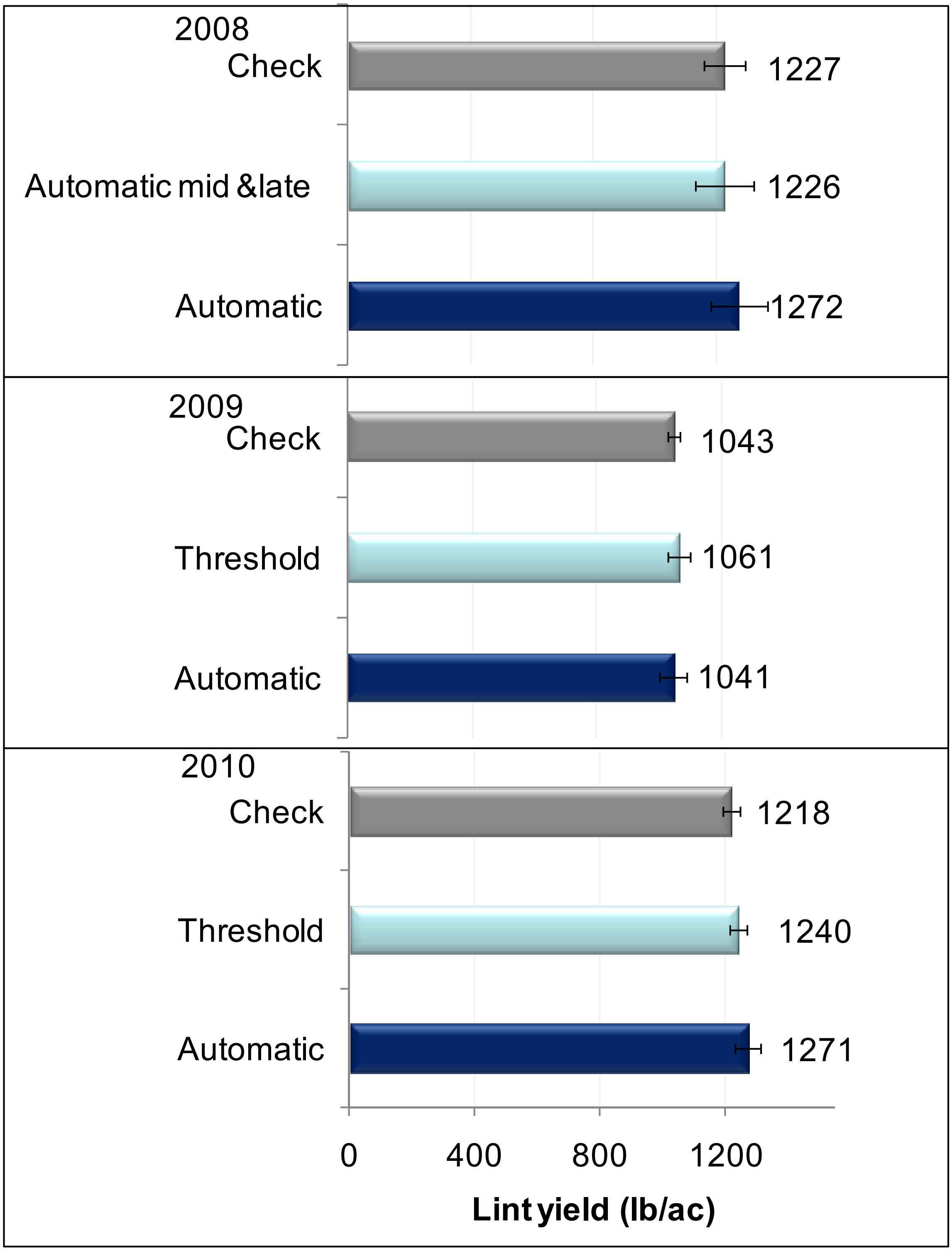

Figure 6. Insecticide applications or timing had no significant effects on yield in 2008, 2009 or 2010 (P>0.35), and there were no significant insecticide * tillage interactions.

References

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

Danforth, D.M. and P.F. O'Leary (eds.) 1998. COTMAN expert system 5.0. User's Manual. University of Arkansas Agricultural Experiment Station, Fayetteville.

Oosterhuis, D.M. and F.M. Bourland (eds). 2008. COTMAN Crop Management System University of Arkansas Agricultural Experiment Station, Fayetteville.

Teague, T.G., J. Smith, D.M. Danforth and P.F. O'Leary. 2008. Manually applied infestations of tarnished plant bug nymphs in late season cotton to identify the final stage of crop susceptibility pp. 1239-1250 in: Proceedings of the 2008 Beltwide Cotton Conferences, National Cotton Council, Memphis, TN.

Teague, T.G., V.S. Green, J.L. Bouldin, C.R. Shumway, and L. Fowler. 2009. Tillage and pest control – Where should we focus management in building a sustainable cotton system? pp 137-147 in: Derrick M. Oosterhuis (ed), Summaries of Arkansas Cotton Research 2008, Arkansas Agricultural Experiment Station Research Series 573.

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