Impact of Varying Planting Dates and Tillage Systems on Cotton Growth and Lint Yield Production

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Cotton

ABSTRACT

As economic conditions deteriorated, cotton (*Gossypium hirsutum* L.) producers have looked to improve profit margins by reducing inputs while maintaining yields. Pairing the yield benefits from early planting with the input reductions from conservation tillage might help accomplish those goals. The objective was to determine how growth, lint yield, and fiber quality were impacted by planting cotton early while using minimum tillage. Four cotton cultivars were planted either during the first week in April (Early) or the first week in May (Normal) in 2004 to 2007. Half the plots were conventional tillage and half were minimum tillage. Dry matter partitioning, flowering, root hydraulic conductance, leaf water potential, lint yield, yield components, and fiber quality data were collected. Cultivars differed in leaf water potential, leaf osmotic potential, and root hydraulic conductance. Root hydraulic conductance for the early planting was 21% greater than the normal planting, but no differences were detected between tillage treatments. Early planting increased yields 22% in 2007, but yields did not differ between planting dates any other year. During 2006 and 2007, lint yields were reduced 13% when minimum tillage was employed. No planting date × tillage treatment interactions were detected, so the same response to minimum tillage could be expected regardless of whether the planting occurred in early April or early May. Even though yield reductions were occasionally observed with minimum tillage, the pairing of minimum tillage with early planting could be a viable option for producers because of the input reduction.

Rising input costs, flat market prices for lint, and improved market prices for grain and oil seed crops have reduced both the Mid-south area planted to cotton and the profit margin for the cotton that is produced. The remaining cotton producers are continually searching for production strategies that minimize input usage while maintaining or preferably improving yields. Therefore, this profit margin battle must be fought on two fronts: (i) input reduction and (ii) yield improvement.

Conservation tillage has become an increasingly popular tool that growers have embraced as part of their production strategies. Besides minimizing soil erosion, conservation tillage can promote input savings through reduced usage of tillage equipment. This lower tillage aspect decreases fuel consumption, promotes longer machinery life, allows utilization of reduced horsepower implements, and lowers labor requirements. However, these benefits can be slightly offset by increased chemical weed control costs (Harmon et al., 1989; Segarra et al., 1991). Although input reduction appears certain, an overriding issue associated with conservation tillage is the inconsistency in yield performance. Depending on the experiment, cotton yields from conservation tillage can be reduced or equivalent to conventional tillage (Brown et al., 1985; Stevens et al., 1992; Bauer and Busscher, 1996; Wheeler et al., 1997; Pettigrew and Jones, 2001), or conservation tillage can promote a yield increase (Wiese et al., 1994; Clark et al., 1996; Karlen et al., 1996; Hunt et al., 1997). In many instances, the yield enhancement from conservation tillage does not manifest itself until the field has been in conservation tillage for multiple years (Triplett et al., 1996).

Recently improved yields have been obtained in the Mississippi Delta by planting cotton earlier than has traditionally occurred (Pettigrew, 2002). Although these yield increases have been relatively consistent, overly cold conditions immediately following planting have sometimes prevented the yield increases from materializing (Pettigrew, 2002). Further investigations revealed that while earlier planting might necessitate a slightly higher seed rate (Pettigrew and Johnson, 2005), N fertilization strategies did not need adjustments (Pettigrew and Adamczyk, 2006). Because this is an evolving production strategy, additional investigations may be needed to further optimize the yield benefits achieved with early planting. Nonetheless, early planting does appear to be a simple approach to achieve a yield boost.

A successful pairing of early planting with minimum tillage could be a beneficial production strategy for cotton producers. This strategy would attack both prongs of the improved profit margin goal. Minimum tillage would address the input reduction side while early planting may produce the yield

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Abbreviations: NAWB, nodes above white bloom; ψ_l, leaf water potential; ψ_o, leaf osmotic potential; ψ_t, leaf turgor potential.

improvement desired. However, complicating this potential production technique pairing is the issue of stand establishment. Both early planting (Pettigrew and Johnson, 2005) and no-till (Hicks et al., 1989; Wheeler et al., 1997) have been reported to reduce seedling establishment. Cooler soil temperatures and potential increased seedling disease pressure can individually challenge stand establishment for both no-till (Stevens et al., 1992; Colyer and Vernon, 1993) and early planting (Christiansen and Rowland, 1986; Pettigrew, 2002). The two systems combined together might further exacerbate the problems.

It remains unclear whether early planting can be paired with minimum tillage and continue to successfully deliver the previously documented yield benefits. Therefore, the objectives of this study were to determine how the combination of early planting and minimum tillage compared with some of the more traditional production systems (later planting and conventional tillage) in terms of cotton growth and development, lint yield production, and fiber quality for multiple varieties.

MATERIALS AND METHODS

Field studies were conducted near Stoneville, MS from 2004 through 2007 on a Dundee silty clay loam (fine-silty, mixed, active, thermic Typic Endoaqualfs) to determine how planting date interacted with tillage management. The experimental area had conventional tillage cotton planted on it before initiation of the study. To facilitate the tillage treatments, all rows in the experimental area were bedded up on the existing rows (1.02-m centers) during the fall of 2003 following shredding of the cotton stalks. Each spring the rows in the conventional tillage plots were rebedded during early March, about 1 mo before planting. Glyphosate was also applied preplant to the entire experimental area during early March to kill existing vegetation. Just before planting the conventional plots, the top half of the bed was knock off with a "do-all" implement consisting of a rolling cultivator, with a spiked toothed harrow and leveling bar. With the minimum tillage plots, the cotton stalk stubble was knocked down by lightly "scratching" approximately a 10-cm planting zone strip on the top of the bed with the do-all implement just before planting. During the fall following completion of harvest, a mixed fertilizer consisting of 29 kg P ha^{-1}, 112 kg K ha^{-1}, and 11 kg S ha^{-1} was applied across the entire experimental area. Following the fertilizer application, all rows in the conventional tillage plots were rebedded. Before planting each year, 112 kg N ha^{-1} as a urea ammonium nitrate solution was knifed-in on both sides of each row for the entire experimental area.

Planting date objectives were addressed by planting during approximately the first week of April (Early) and the first week of May (Normal). Four cotton cultivars were planted on 2 April and 4 May in 2004; 5 April and 3 May in 2005; 3 April and 3 May in 2006; and 3 April and 1 May in 2007. The cotton cultivars used were 'DPL 444BR', 'DPL 555BR' (Delta and Pine Land, Scott, MS), 'STV 4892BR' (Stoneville Pedigree Seed Co., Stoneville, MS), and 'FM 960BR' (Bayer Crop Sciences, Leland, MS). For seedling disease suppression and early season insect control, 0.87 kg ha^{-1} PCNB (pentachloronitrobenzene), 0.22 kg ha^{-1} etridiazole (5-ethoxy-3-trichloromethyl-1,2,4-thiadiazole), and 0.87 kg ha^{-1} disulfoton (O,O-diethyl S-[2-(ethylthio)ethyl] phosphorodithioate) were applied in furrow during planting. All plots were planted with JD 7300 vacuum planter (John Deere, East Moline, IL) equipped for no-till planting (added fluted coulters and increased pressure on springs) and seeded at a rate of approximately 110,000 seeds ha^{-1}. Planter depth settings were adjusted depending on the tillage treatment being planted to ensure proper depth placement of the seed for each tillage treatment. Preemergence applications of fluometuron and metolachlor, each at 1.12 kg ha^{-1}, were made immediately after planting. Glyphosate was applied at 0.75 kg ha^{-1} at the first and fourth true leaf stages of development using a hooded sprayer. Fluometuron and glyphosate, 0.56 and 0.75 kg ha^{-1}, respectively, were applied postdirected at layby.

Plant heights and vegetative growth were controlled in 2005 and 2006 through applications of the plant growth regulator mepiquat pentaborate. The early planted plots received an application of 43 g mepiquat pentaborate ha^{-1} on 17 June 2005. Both planting dates received 72 g mepiquat pentaborate ha^{-1} on 14 June 2005. The normal planted plots also received an additional 43 g ha^{-1} on 23 June 2005. In 2006, the early planted plots had 57 g mepiquat pentaborate ha^{-1} applied on 7 June. That initial application was followed by an application of 57 g mepiquat pentaborate ha^{-1} to all plots on 22 June 2006. Finally, 57 g ha^{-1} of mepiquat pentaborate was applied to the normal planted plots on 6 July 2006. No mepiquat pentaborate treatments were made in either 2004 or 2007. Plots were furrow irrigated as needed each year to minimize moisture deficit stress. Insects were controlled as needed.

The experimental design was a randomized complete block with a split-plot treatment arrangement and four replicates. Main plots consisted of the two tillage treatments and the two planting dates arranged factorially. Cultivars were the subplots. Plot size was four rows wide (1 m rows) by 12.2 m long. Main plots and subplots were randomly assigned the first year of the study. Thereafter, individual cultivar-tillage-planting date combinations were assigned to the same experimental units each year.

Dry matter harvests were taken on 26 through 29 July in 2004, 18 through 21 July in 2005, 17 through 20 July in 2006, and 16 through 20 July in 2007. Dry matter harvests were performed on plants in one of the two outside border rows of each plot. On each harvest date, the aboveground portions of plants from 0.3 m of row were harvested and separated into leaves, stems and petioles, squares, and blooms and bolls. Leaf area index was determine by passing the leaves through a LI-3100 leaf area meter (LI-COR, Lincoln, NE) and main stem nodes were counted. Samples were dried for at least 48 h at 60°C, and dry weights were recorded.

Beginning at the initial sign of blooming, weekly counts of white blooms (blooms at anthesis) per plot were conducted to document the blooming rate throughout the season. The number of main stem nodes above a sympodial branch that had a white bloom at the first branch fruiting position (NAWB) were also counted weekly on three plants per plot to document the progressive reproductive development up the stem and crop maturity.

Root hydraulic conductance was measured on two plants per plot using the Dynamax HPFM high pressure flow meter

(Dynamax, Houston, TX) for reps 1 to 3 during the years 2005 through 2007. Selected plants had their stems cut approximately 8 cm above the ground surface, followed soon thereafter by attachment of the coupling and tubing from the HPFM flow meter onto the remaining stem and root system. A measurement consisted of increasing the water pressure applied to the system from 0 to approximately 500 kPa while monitoring the flow rate, and was typically completed within 4 min. The slope of the changing water flow rate through the system plotted vs. the changing applied pressure equals the hydraulic conductance of the root system (Tyree et al., 1994). Measurements were made on 27 through 29 June in 2005, on 28 through 30 June in 2006, and on 3, 5, and 6 July in 2007. All measurements were collected between 0900 h and 1200 h CDT.

Water relations data were collected at approximately 1300 h CDT on 19 through 22 July in 2004, on 25 July through 1 August in 2005, on 24 through 27 July in 2006, and 31 July through 3 August in 2007. Components of leaf water potential (ψ_l) for the youngest fully expanded leaf per plot (fourth or fifth leaf from the top of the plant) were determined for leaves from three plants per plot with leaf cutter thermocouple psychrometers (JRD Merrill Specialty Equipment, Logan, UT). After rapidly cutting and inserting the leaf disk in the chamber, the samples were equilibrated for 3 h in a 30°C water bath and then the ψ_l was measured. At least five ψ_l readings were taken on each leaf disk following the period of equilibration. Stable readings from the three psychrometers per plot were averaged together for subsequent statistical analysis. Following the ψ_l determinations, the samples were frozen overnight at –20°C, then allowed to reequilibrate for another 3 h in the 30°C water bath, and the leaf osmotic potential (ψ_o) was determined. Leaf turgor (ψ_t) was calculated as the difference between ψ_l and ψ_o.

Cotton was defoliated using a two step process beginning in early-to-mid-September each year. The first step consisted of an application mixture of 0.035 kg thidiazuron ha^{-1} and 0.0175 kg diuron ha^{-1} and the second step followed 2 wk later with an application mixture of 0.035 kg thidiazuron ha^{-1}, 0.0175 kg diuron ha^{-1}, and 1.68 kg ethephon ha^{-1}. Defoliation was initiated for all plots when approximately 65% of the bolls in the normal planted plots had opened. Approximately 2 wk after defoliation, the two center rows of each plot were mechanically spindle-picked and weighed. After defoliation, but before the mechanical harvest, a 50-boll sample was hand harvested from each plot for use in determination of yield components. Boll mass was determined from these 50-boll samples by dividing the weight of seed cotton by the number of bolls harvested. These samples were then ginned and weighed to calculate lint percentage which was used to calculate lint yield from the total of the mechanically harvested and hand harvested seed cotton. The number of bolls produced per unit ground area was calculated from the boll mass and total seed cotton weights. Average seed mass was determined from 100 nondelinted seeds per sample and reported as weight per individual seed. Lint samples from each plot were sent to Starlab Inc. (Knoxville, TN) for fiber quality determinations. Fiber strength was determined with a stelometer. Span lengths were measured with a digital fibrograph. Fiber maturity and fiber perimeter were calculated from arealometer measurements. Rd (reflectance), +b (yellowness), and length uniformity were determined by HVI instrumentation.

Statistical analyses were performed by ANOVA (PROC MIXED; SAS Institute, 1996). Because the planting dates, tillage treatment, and cultivars were returned to the same field position each year, year was considered a repeated measure sub-subunit in the analysis. Planting date means, tillage treatment means, and cultivar means were averaged across years and each other when statistical interactions were not detected. Planting date, tillage treatment, and cultivar means were separated by use of a protected LSD at $P \leq 0.05$.

RESULTS AND DISCUSSION

Varying weather conditions during the 4 yr of this study provided distinct growing environments each year (Table 1). Milder temperatures and ample rainfall through June characterized the 2004 season. The 2005 season will be remembered most for the two tropical weather systems (Hurricanes Katrina and Rita) that impacted the area with heavy rains and wind during late August and mid-September. The bulk of the growing season in 2006 was characterized by hot, dry conditions with ample amounts of sunshine. An extended cloudy and rainy pattern during early-to-mid-July in 2007 impacted crop development and field operations.

These year to year variations in weather conditions interacted with both planting date and tillage treatments to affect lint yield and yield components. Years also interacted with tillage treatments for some of the dry matter partitioning traits. Therefore, lint yield and yield component means for planting date and tillage treatment, and dry matter partitioning means for tillage treatment were presented by individual years rather

Table 1. Monthly weather summary for 2004 to 2007 at Stoneville, MS.†

Month	2004	2005	2006	2007
	Precipitation, cm			
April	10.5	11.5	18.7	8.6
May	18.4	5.4	7.3	3.2
June	31.6	1.9	4.6	9.9
July	7.8	10.6	4.5	19.7
August	5.5	12.6	4.0	8.7
September	0.1	17.9	6.9	11.8
October	18.1	0	21.9	10.7
	Thermal units‡			
April	107	93	174	85
May	249	214	239	253
June	317	326	337	346
July	362	383	392	342
August	315	415	423	446
September	275	325	229	296
October	203	123	113	153
	Solar radiation , MJ m^{-2}			
April	671	633	592	615
May	663	714	687	698
June	644	721	760	718
July	672	634	720	634
August	657	677	682	705
September	571	566	596	516
October	380	535	464	441

† All observations made by NOAA, Mid-South Agric. Weather Service, and Delta Research and Extension Center Weather, Stoneville, MS.

‡ [(Max. temp + Min. temp.)/2] – 15.5°C.

Table 2. Dry matter partitioning data collected during late blooming period as affected by an early April (Early) and early May (Normal) planting date. Data were averaged across cultivars, tillage treatments and the years 2004 to 2007.

Planting date	Plant height	Main stem nodes	Height to node ratio	Leaf area index	Specific leaf weight	Total dry weight	Harvest index‡
	cm	nodes plant^{-1}	cm node^{-1}		g m^{-2}		
Early	100	23	4.36	4.46	51.7	667	0.23
Normal	100	20	4.93	3.62	51.4	458	0.11
LSD (0.05)	ns†	1	0.12	0.51	ns	84	0.02
$P > F$	0.85	0.01	0.01	0.01	0.64	0.01	0.01

† ns = not significantly different at the P = 0.05 level.

‡ Harvest index = reproductive dry weight/total dry weight.

than averaged across all the years. Means for all other data were averaged across years due to the lack of significant year interactions. Furthermore, no planting date, tillage, or cultivar interactions were detected for any of the traits measured. Therefore planting date means were averaged across tillage treatments and cultivars; and tillage treatment means were averaged across planting dates and cultivars.

As the plants were going through the period of late blooming, planting date impacted most of the components of dry matter partitioning (Table 2). Although plant heights did not differ between the two planting dates, plants from the early planting plots had 15% more main stem nodes than the normal planted plants resulting in a 12% lower height to node ratio for the early planted plants. Furthermore, a 23% greater leaf area index contributed to the 46% greater total aboveground plant dry weight produced by the early planted plots at this time. However, the greater harvest index of the early planted plants indicated that increased reproductive growth also had contributed to the elevated total dry weight production of the early planted plants compared to the normal planted plants at this time. These dry matter partitioning results for plant date are similar to those reported previously (Pettigrew, 2002; Pettigrew and Adamczyk, 2006).

Most dry matter partitioning traits were not affected by the two tillage treatments (Table 3). When a tillage effect did occur, it often times was not consistent across all years of the study, resulting in significant year × tillage treatment interactions. In fact, tillage treatment differences were not observed for any dry matter partitioning traits during the first 2 yr, 2004 and 2005. However in 2006, plants grown with minimum tillage were 10% shorter than plants grown with conventional tillage. This trend was also observed in 2007, but the difference was only significant at the $P > F$ level of 0.07. These shorter minimum tillage plants did not result from the production of fewer main stem nodes but apparently from shorter internodes, leading to a lower height-to-node ratio with minimum tillage in 2006 and 2007. There was also a 13% increase in harvest index observed for the minimum tillage plots compared to the conventional tillage in 2006, but not in any of the other years. None of the other dry matter partitioning traits differed between the two tillage treatments. Similar plant height and height-to-node ratio results were reported by Pettigrew and Jones (2001) for conventional tillage and no-tillage plots.

Planting date effects on blooming patterns were similar to previous reports (data not shown) (Pettigrew, 2002; Pettigrew and Adamczyk, 2006). Each year, the early planted plots started blooming first, reached a peak blooming rate, and cutout (NAWB = 5) (Bourland et al., 1992) before the normal planting. No differences were detected between tillage treatments for blooming rate (data not shown). Similarly, no

Table 3. Dry matter partitioning data collected during the late blooming period as affected by two tillage systems (conventional tillage and minimum tillage) for the years 2004 through 2007. Data were averaged across cultivars and planting dates.

Year	Tillage treatment	Plant height	Main stem nodes	Height to node ratio	Leaf area index	Specific leaf weight	Total dry weight	Harvest index†
		cm	nodes plant^{-1}	cm node^{-1}		g m^{-2}		
2004	conventional	140	23	6.06	6.10	42.2	771	0.06
	minimum till	143	24	6.04	6.94	40.9	885	0.07
	LSD (0.05)	ns‡	ns	ns	ns	ns	ns	ns
	$P > F$	0.27	0.12	0.80	0.14	0.11	0.20	0.69
2005	conventional	79	20	4.04	2.57	54.1	385	0.21
	minimum till	77	20	3.93	2.76	54.4	402	0.22
	LSD (0.05)	ns	ns	ns	ns	ns	ns	ns
	$P > F$	0.57	0.79	0.27	0.44	0.80	0.57	0.66
2006	conventional	78	21	3.80	2.75	63.6	530	0.30
	minimum till	70	20	3.57	2.57	66.2	534	0.34
	LSD (0.05)	6	ns	0.20	ns	ns	ns	0.03
	$P > F$	0.01	0.14	0.03	0.71	0.12	0.97	0.01
2007	conventional	108	22	4.95	4.45	44.9	498	0.06
	minimum till	104	22	4.79	4.22	46.2	496	0.07
	LSD (0.05)	ns	ns	0.10	ns	ns	ns	ns
	$P > F$	0.07	0.95	0.01	0.30	0.31	0.93	0.11

† Harvest index = reproductive dry weight/total dry weight.

‡ ns = not significantly different at the P = 0.05 level.

Table 4. Leaf water potential and root hydraulic conductance as affected by either an early April (Early) and early May (Normal) planting date; or by two tillage systems (conventional tillage and minimum tillage). Planting date means were averaged across cultivars, tillage systems, and the years 2004 to 2007. Tillage means were averaged across cultivars, planting dates and the years 2004 to 2007. Root hydraulic conductance measures were collected only during 2005 to 2007.

Planting date	Tillage system	Leaf water potential	Leaf osmotic potential	Leaf turgor potential	Root hydraulic conductance
		MPa			kg s^{-1} MPa^{-1}
Early		−1.48	−1.70	0.21	5.8×10^{-5}
Normal		−1.47	−1.67	0.21	4.8×10^{-5}
LSD (0.05)		ns †	ns	ns	9.0×10^{-6}
P > *F*		0.75	0.51	0.78	0.03
	conventional	−1.47	−1.67	0.20	5.4×10^{-5}
	minimum till	−1.49	−1.70	0.22	5.2×10^{-5}
	LSD (0.05)	ns	ns	ns	ns
	P > *F*	0.72	0.36	0.36	0.45

† ns = not significantly different at the *P* = 0.05 level.

differences were detected in NAWB counts between the two tillage treatments (data not shown). These lack of NAWB differences between tillage treatments contrast with the previous work of Pettigrew and Jones (2001) who reported that no-till plots had a delayed maturity resulting in a higher NAWB counts than conventional tilled plots.

The moisture status of the plants was assessed by determining the mid-day leaf water, osmotic and turgor potentials; and by measuring the morning root hydraulic conductance. Neither planting date nor tillage system had any effect on leaf water potential and its two components, leaf osmotic potential and leaf turgor potential (Table 4). On the other hand, plants in the early planted plots had a 21% greater root hydraulic conductance than plants in the normal planted plots. No differences were detected between tillage treatments for root hydraulic conductance.

Cultivar differences were detected in leaf water potential, leaf osmotic potential, and root hydraulic conductance (Table 5). DPL 555BR had a higher mid-day leaf water potential than either DPL 444BR or STV 4892BR, but not FM 960BR. DPL 555BR also had a higher leaf osmotic potential than any of the other cultivars. No cultivar differences were detected in leaf turgor potential. The below ground portion of the plants presented a different story as STV 4892BR had at least a 22% greater root hydraulic conductance than any of the other cultivars.

Table 5. Cultivar effects on leaf water potential components and root hydraulic conductance Cultivar means were averaged across planting dates, tillage systems, and the years 2004 to 2007. Root hydraulic conductance measurements were collected only during 2005 to 2007.

Cultivar	Leaf water potential	Leaf osmotic potential	Leaf turgor potential	Root hydraulic conductance
	MPa			kg s^{-1} MPa^{-1}
DPL 444BR	−1.50	−1.74	0.25	5.1×10^{-5}
DPL 555BR	−1.41	−1.59	0.18	5.1×10^{-5}
FM 960BR	−1.47	−1.68	0.21	4.8×10^{-5}
STV 4892BR	−1.52	−1.73	0.20	6.2×10^{-5}
LSD (0.05)	0.08	0.05	ns†	8.0×10^{-6}
P > *F*	0.03	0.01	0.17	0.01

† ns = not significantly different at the *P* = 0.05 level.

Planting date affected lint yield production in only one of the 4 yr on this study (Table 6). In that year, 2007, early planted plots yielded 22% more than the normal planted plots. Previously, early planting has also been shown to provide yield benefits (Pettigrew, 2002; Pettigrew and Adamczyk, 2006) but

Table 6. Lint yield and yield components as affected by an early April (Early) and early May (Normal) planting date for the years 2004 through 2007. Data were averaged across cultivars and tillage treatments.

Year	Planting date	Lint yield	Boll mass	Boll no.	Lint percentage	Seed mass	Lint index	Seed no.
		kg ha^{-1}	g	bolls m^{-2}	%	mg	mg seed^{-1}	seed boll^{-1}
2004	early	1019	4.65	52	41.7	98	70	28
	normal	831	4.55	44	41.7	96	68	28
	LSD (0.05)	ns †	ns	ns	ns	ns	ns	ns
	P > *F*	0.14	0.55	0.09	0.89	0.26	0.38	0.91
2005	early	1182	4.64	60	42.8	94	70	28
	normal	1107	4.67	59	41.0	97	67	29
	LSD (0.05)	ns	ns	ns	0.8	ns	2	ns
	P > *F*	0.31	0.69	0.84	0.01	0.09	0.02	0.51
2006	early	1354	4.36	73	42.3	92	67	28
	normal	1409	3.87	86	42.3	92	67	24
	LSD (0.05)	ns	0.30	12	ns	ns	ns	2
	P > *F*	0.53	0.01	0.04	0.86	0.73	0.72	0.01
2007	early	1234	4.05	71	43.1	89	67	27
	normal	1014	3.74	63	43.4	86	65	25
	LSD (0.05)	135	0.23	7	ns	2	ns	1
	P > *F*	0.01	0.01	0.05	0.37	0.05	0.14	0.01

† ns = not significantly different at the *P* = 0.05 level.

Table 7. Lint yield and yield components as affected by two tillage systems (conventional tillage and minimum tillage) for the years 2004 through 2007. Data were averaged across cultivars and planting dates.

Year	Tillage	Lint yield	Boll mass	Boll no.	Lint percentage	Seed mass	Lint index	Seed no.
		kg ha^{-1}	g	bolls m^{-2}	%	mg	mg seed^{-1}	seed boll^{-1}
2004	conventional	976	4.64	50	42.0	98	70	28
	minimum till	874	4.56	46	41.5	96	68	28
	LSD (0.05)	ns†	ns	ns	ns	ns	ns	ns
	P > *F*	0.40	0.68	0.41	0.25	0.26	0.10	0.84
2005	conventional	1183	4.62	62	41.9	95	68	28
	minimum till	1107	4.69	57	41.9	96	69	29
	LSD (0.05)	ns	ns	ns	ns	ns	ns	ns
	P > *F*	0.31	0.37	0.20	0.80	0.90	0.70	0.42
2006	conventional	1502	4.16	86	42.4	92	67	26
	minimum till	1262	4.07	73	42.2	92	67	26
	LSD (0.05)	191	ns	ns	ns	ns	ns	ns
	P > *F*	0.02	0.52	0.06	0.49	0.91	0.60	0.72
2007	conventional	1185	3.94	70	42.9	87	65	26
	minimum till	1062	3.85	63	43.6	87	67	25
	LSD (0.05)	ns	ns	ns	0.6	ns	ns	ns
	P > *F*	0.07	0.42	0.09	0.03	0.94	0.14	0.06

† ns = not significantly different at the *P* = 0.05 level.

the increased yield response in these earlier studies were more consistent than that demonstrated in the current study. In both 2006 and 2007, the early planting produced on average 10% larger bolls than the normal planting. This larger boll mass for the early planting in these 2 yr was partially attributed to an increased number of seed produced per boll by the early planting. Seed mass of the early planted bolls in 2007 was also 4% greater than the normal planted plants, further contributing to the larger boll mass for the early planted plants. The number of bolls produced for the two planting dates varied between the years, 2006 and 2007. In 2006, the normal planted plots produced 18% more bolls, while the early planting produced 13% more bolls in 2007. Even though the normal planted plots produced more bolls in 2006, these were smaller bolls and thus a significant yield difference was not observed between planting dates that year. In 2005, plants in the early planted plots exhibited greater lint percentage and lint index than the normal planted plants but these yield component increases did not result in any significant yield differences between planting dates that year.

No differences between tillage treatments were detected in the first 2 yr of this study (Table 7). Minimum tillage plots yielded on average 13% less than the conventional tillage plots in 2006 and 2007. In 2006, the yield difference between tillage treatments was significant at the 0.02 level, while the difference was only significant at the 0.07 level in 2007. The only yield component impacted by tillage treatments was lint percentage in 2007. In that year, bolls from the minimum tillage plots had a 2% greater lint percentage than the conventional tillage plots, but this improved lint percentage did not translate into a yield increase.

Few fiber quality traits were affected by either planting date or tillage treatment. Early planting increased the fiber elongation by 3% compared to fiber from the normal planted plots (Table 8). Fiber produced in the early planted plots were also 3% weaker but with a 3% greater micronaire than fiber from the normal planted plots. Fiber from the normal planted plots, on the other hand, tended to be slightly yellower than the early planted plots as reflected by the 5% greater +b value for the normal planted plots. None of the fiber quality traits were affected by tillage treatments (Table 9).

Although early planting only produced a yield increase during 1 yr of the study, it did not cause a yield reduction in any year either. Therefore, no yield penalty was forthcoming when planting as early as we did in this study, but the expected yield benefit was also not as consistent as had been reported in earlier studies (Pettigrew, 2002; Pettigrew and Adamczyk, 2006). Because the yield penalty due to minimum tillage was consistent across both planting dates, there were no interactions between planting date and tillage treatments. Growers should not anticipate a harsher yield penalty associated with minimum tillage while planting early than they would when planting during a more traditional window of time.

Table 8. Fiber quality traits as affected by an early April (Early) and early May (Normal) planting date for the years 2004 through 2007. Data were averaged across cultivars, tillage treatments, and years.

Planting date	Fiber elongation	Fiber strength	Span Length		Length uniformity†	Micronaire	Fiber maturity	Fiber perimeter	Rd	+b
			2.5%	50%						
	%	kN m kg^{-1}	cm		%		%	µm	%	
Early	6.1	203	2.86	1.39	82.7	4.29	82.0	49.4	71.9	7.6
Normal	5.9	209	2.88	1.40	82.8	4.19	80.6	49.5	72.6	8.0
LSD 0.05	0.1	3	ns ‡	ns	ns	0.09	ns	ns	ns	0.2
P > *F*	0.01	0.01	0.08	0.24	0.20	0.02	0.08	0.74	0.06	0.01

† Length uniformity, Rd (reflectance), and +b (yellowness) by HVI instrumentation.

‡ ns = not significantly different at the *P* = 0.05 level.

Table 9. Fiber quality traits as affected by two tillage systems (conventional tillage and minimum tillage) for the years 2004 through 2007. Data were averaged across cultivars, planting dates, and years.

Tillage system	Fiber elongation	Fiber strength	Span length 2.5%	Span length 50%	Length uniformity†	Micronaire	Fiber maturity	Fiber perimeter	Rd	+b
	%	kN m kg^{-1}	cm		%		%	μm	%	
Conventional	6.0	206	2.88	1.40	82.8	4.25	80.9	49.6	72.5	7.7
Minimum till	6.0	206	2.87	1.39	82.8	4.23	81.7	49.2	71.9	7.9
LSD 0.05	ns‡	ns	ns	ns	ns	ns	ns	ns	ns	ns
$P > F$	0.80	0.99	0.63	0.60	0.92	0.62	0.30	0.14	0.08	0.07

† Length uniformity, Rd (reflectance), and +b (yellowness) by HVI instrumentation.

‡ ns = not significantly different at the P = 0.05 level.

The yield reductions seen with minimum tillage the last 2 yr of this study were similar to that reported previously with earlier research performed at this location (Pettigrew and Jones, 2001). However, the maturity differences observed between tillage treatments in the Pettigrew and Jones (2001) research was not observed during the current work. The main tillage difference between the current study and the Pettigrew and Jones (2001) research was that conservation tillage in the earlier study was no-till into a burned-down wheat (*Triticum aestivum* L.) cover crop and winter weeds, whereas the current study used minimum tillage into just burned-down winter weeds. It is not entirely clear if the wheat cover crop component in the Pettigrew and Jones (2001) study could explain the different maturity responses between their study and ours, even though wheat straw has been reported to exert allelopathic effects on cotton seedlings (Hicks et al., 1989). Although Triplett et al. (1996) reported that yield benefits from conservation tillage may not show up until after multiple years in the system, we still suffered a yield reduction from minimum tillage even after 4 yr in the system. Differences in the approach taken toward conservation tillage may help explain some of the differences between our results and those of Triplett et al. (1996).

Previous studies indicated that conservation tillage used soil moisture more efficiently and lead to increased crop transpiration (Harmon et al., 1989; Baumhardt and Keeling, 1993; Lascano et al., 1994; Daniel et al., 1999). However, we were not able to detect any tillage treatment differences in our estimates of plant water status, leaf water potential, and root hydraulic conductance. Differences in root hydraulic conductance were detected for planting date and cultivar. Plants from the early planting had a higher root hydraulic conductance and STV 4892BR exhibited a higher root hydraulic conductance than any of the other cultivars. We are not aware of any other reports demonstrating a planting date or cultivar effect on cotton root hydraulic conductance. Cultivar differences were also detected in leaf water potential and leaf osmotic potential with DPL 555BR possessing higher leaf water potential and higher leaf osmotic potential than the other cultivars.

In conclusion, although its yield boost was not as consistent as previously demonstrated, early planting still appears to be a justifiable risk, even for a production system incorporating minimum tillage. Although minimum tillage is occasionally accompanied with a yield depression, the input reductions previously reported with its use could still make it a justifiable production component. Therefore, a combination of early planting and minimum tillage might present a viable production option to growers hoping to reduce inputs while maintaining yield production. Furthermore, geneticists might be able to make use of the cultivar differences in root hydraulic conductance, leaf water potential, and leaf osmotic potential reported in this research to achieve goals of designing cultivars for improved performance under dryland conditions.

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