Table 1. Abiotic conditions in conventional(CVT) and no-till(NT) producer fields during mid-summer, 1999.[1]

	Temperature (°C)					Surface soil	Soil moisture ($kg\ m^{-3}$)		
	canopy (30 cm)	soil (5 cm)	soil (10 cm)	soil (20 cm)	leaf	temp. (°C)	(25 cm)	(50 cm)	(100 cm)
Irrigation (I):									
No	29.8	29.9	29.5	29.6	36.4	41.6	160	172	223
Yes	27.9	27.3	27.1	27.6	34.2	41.6	282	340	345
	**[2]	*	**	**	NS	NS	**	**	**
Tillage (T):									
CVT	28.7	28.6	28.6	28.7	34.7	43.7	278	256	283
NT	28.6	28.1	27.6	28.1	34.8	39.5	215	256	285
	NS	0.07[3]	*	*	NS	0.07	**	NS	NS
Interaction:									
I x T		NS	NS	0.08	0.07	0.21	NS	0.06	*NS

[1] Average hourly temperature between 7 June and 11 July, inclusive. Leaf, soil surface temperatures and soil moisture were measured on plant sampling dates (see text).

[2] NS, *, ** = Not significant or significant at P> 0.05 and P> 0.01, respectively.

[3] Prob. > 'F' value.

Table 2. Effect of on-farm tillage systems on plant water status and leaf greenness.[1]

	RWC[1] (%)	Water Potential (-bars)	Transpiration ($\mu g\ cm^{-2} s^{-1}$)	Diffusive resistance ($s\ cm^{-1}$)	Reflectance values 'L'	'a'	'b'	SPAD value	Leaf chlorophyll ($mg\ g^{-1}$)
Irrigation (I):									
No	73.4	-25.6	10.2	4.4	37.7	-11.2	13.7	44.0	5.2
Yes	82.5	-18.0	14.0	2.1	42.7	-17.1	24.6	34.6	4.6
	0.10[2]	*[3]	NS	NS	*	*	*	0.15	NS
Tillage (T):									
CVT	77.8	-22.0	12.2	3.2	40.4	-14.5	20.0	38.0	4.7
NT	78.2	-21.7	12.1	2.1	40.1	13.8	18.3	40.7	5.1
	NS	NS	NS	0.06	NS	NS	NS	0.20	NS
Interaction:									
I x T	NS	0.14	NS	0.13	NS	NS	NS	NS	NS

[1] RWC = Relative water content percent by weight.

[2] Prob. > 'F' value.

[3] NS, *, ** = Not significant or significant at P> 0.05 and P> 0.01, respectively.

Table 3. Plant leaf blade nutrients from producer conventional (CVT) and no-till (NT) fields, 1999.[1]

	N	P	K	Ca	Mg	S	Total Na	Fe	Mn	Zn	Cu	B	Al
			%						$\mu g/g$				
Irrigation (I):													
No	2.88	0.14	1.58	4.33	0.78	1.31	2813	90.7	90	20.2	9.6	135	237
Yes	3.88	0.52	1.50	3.34	0.52	1.01	1849	77.9	118	30.9	11.0	52	198
	**[2]	**	NS	**	*	**	0.08[3]	NS	0.13	**	0.19	**	0.07
Tillage (T):													
CVT	3.36	0.32	1.46	3.89	0.65	1.20	2123	86.8	100	26.5	10.4	94.8	222
NT	3.40	0.35	1.61	3.78	0.65	1.12	2538	81.8	108	24.7	10.2	92.4	214
	NS	NS	0.20	NS	NS	NS	0.16	NS	NS	*	NS	NS	NS
Interaction:													
I x T	NS	NS	0.25	0.07	0.17	NS	NS	0.18	NS	*	NS	NS	NS

[1] Same leaves as those sampled in Table 2. Nitrate levels (367 $\mu g/g$) were not significantly different.

[2] NS, *, ** = Not significant or significant at P=0.05 or P=0.01, respectively.

[3] Prob. > 'F' value.

Table 4. Agronomic response to conventional (CVT) and no-tillage (NT) in South Texas producer fields in 1999.

	Plant Stand ($X10^4$/ha)	Lint yield (kg/ha)	Lint (%)
Irrigation (I)			
No	12.3	819	39.2
Yes	13.8	978	39.2
	NS[1]	NS	NS
Tillage (T):			
CVT	12.6	823	39.2
NT	13.4	921	39.3
	NS	0.24[2]	0.07
Interaction:			
I x T	*	NS	NS

[1] NS, * = Not significant or significant at P=0.05, respectively.

[2] Prob. > 'F' value.

EFFECTS OF CONVENTIONAL TILLAGE AND NO TILLAGE ON COTTON GAS EXCHANGE AND WATER RELATIONS: STANDARD ROW VS. ULTRA-NARROW ROW SYSTEM

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Abstract

The availability of soil water to crops is considered to be the major limitation to crop production in the U.S. Use of conservation tillage systems enhances soil residue cover, water infiltration and reduces evaporative soil water loss. Our objective was to measure cotton (Gossypium hirsutum L.) leaf level photosynthesis, stomatal conductance, transpiration, and water use efficiency during reproductive growth under different row spacing and tillage conditions on a Norfolk loamy sand (Typic Kandiudults; FAO classification Luxic Ferralsols) in east-central AL. The study used a split-plot design replicated four times with row spacing (standard 40 in row and ultra-narrow row) as main plots and tillage systems (conventional and no-tillage) as subplots. These results indicate that cotton grown with standard row spacing can maintain a higher rate of photosynthesis when soil water was not limiting during the early stages of reproductive growth. At latter stages, no-tillage management may aid in conserving soil water needed during critical reproductive stages such as boll filling when demand for water is high.

Introduction

Plant growth is often reduced under soil water deficits owing to decreases in photosynthesis, stomatal aperture, and water potential (Boyer, 1982). In particular, cotton grown on loamy sand soils are highly susceptible to periods of soil water deficits due to low soil water holding capacity and little surface residue. Furthermore, periods of soil water deficits often occur during critical reproductive stages when demand for water is high. Adoption of conservation tillage systems that maintain high levels of residue cover can help mitigate such problems by enhancing soil C storage and soil water holding capacity, reducing evaporative soil water loss, and improving soil water infiltration (thereby reducing water and nutrient runoff). Other work at Auburn has shown that planting cotton with a grain drill in ultra-narrow rows (UNRC) to be a very promising cotton production system, however, little information exists on the physiological response of cotton in this production system. The objective of this study was to quantify the impact of row spacing (standard vs. ultra-narrow row) and tillage system on gas exchange and water relations of cotton during reproductive growth.

Materials and Methods

This study is a component of a larger farming systems experiment which was established on a site that had been in conventional and conservation tillage for the past 10 years (Reeves et al. 1992; Torbert et al., 1996). The cotton systems evaluated (summer of 1999) were standard row (40 in) and ultra-narrow row (8 in) under conventional and no-tillage using cereal cover crops on a Norfolk loamy sand at the E.V. Smith Research Center of the Alabama Agricultural Experiment Station in east central Alabama, USA. Cotton seeds (PayMaster 1220) were sown on 11 May 1999. The study used a split-plot design replicated four times with row spacing as main plots and tillage systems as subplots. Extension recommendations were used in managing both the soil and crop. Fertilizer application rates were based on standard soil test.

During reproductive growth, leaf level measurements (i.e., photosynthesis, stomatal conductance, transpiration, and water-use efficiency) were made twice a week using a LI-6400 Portable Photosynthesis System (LI-COR, Inc., Lincoln, NE). Measurements were taken at midday on six different randomly chosen leaves (fully expanded, sun exposed leaves at the canopy top) per plot and were initiated one week after first flower (16 July, DOY 197) and terminated on 20 August (DOY 232) ten days before defoliant application. Also during this period, soil water status was monitored at two depths (20 and 40 cm) using time domain reflectometry (data not shown). The study site had a total of 2.86 in of rainfall during the two weeks prior to study initiation. During the study period, one irrigation and six rainfall events occurred: DOY 198 (0.5 in), DOY 204 (0.05 in), DOY 206 (0.57 in), DOY 216 (0.02 in rain, 1.1 in irrigation), DOY 221 (0.06 in), and DOY 222 (0.3 in).

Statistical analyses of data were performed using the Mixed procedure of the Statistical Analysis System (SAS 1996). A significance level of $P < 0.10$ was established *a priori*.

Results and Conclusions

At the beginning of the study (DOY 197, 201, 222) the main effects of row spacing and tillage were often significant. Soil moisture conditions were optimum due to rainfall events prior to and during this period. Photosynthesis, stomatal conductance, and transpiration were higher for cotton grown in standard rows and were lower under no-tillage conditions. No differences were noted for water use efficiency.

Following this period, soil water depletion was rapid due to extensive boll development and lack of rainfall. During this time (DOY 208, 211, 215), the main effects of tillage and row spacing by tillage interactions were significant for photosynthesis, stomatal conductance, and transpiration. In general, these measures were highest in the standard row system under no-tillage, lowest in the standard row system under conventional tillage, and somewhat intermediate for the ultra-narrow system regardless of tillage system. Differences in water use efficiency were only noted on DOY 215; main effect of row spacing was significant indicating the this measure was increased only in the standard row system.

Measurements taken on DOY 217 and 222 followed irrigation/rainfall events. On DOY 217, the main effects of tillage were significant for all variables. Under no-tillage, photosynthesis, stomatal conductance, and transpiration were increased; no differences were noted on DOY 222. Differences in water use efficiency were noted on both dates; main effects of row spacing and tillage were significant indicating the this measure was increased in the standard row system and under conventional tillage.

Measurement taken on DOY 225, 230, and 232 show similar patterns as observed on DOY 217. At all dates, photosynthesis, stomatal conductance, and transpiration were increased under no-tillage. Main effects of tillage were significant on DOY 230 for water use efficiency (i.e., higher under no-tillage). On DOY 232, the main effects of row spacing was significant (i.e., water use efficiency increased in the standard row system).

These preliminary results indicate that cotton grown with standard row spacing can maintain a higher rate of photosynthesis when soil water was not limiting during the early stages of reproductive growth. At latter stages, no-tillage management may aid in conserving soil water needed during critical reproductive stages such as boll filling when demand for water is high.

Disclaimer

The use of companies, tradenames, or company names does not imply endorsement by USDA-ARS or Auburn University.

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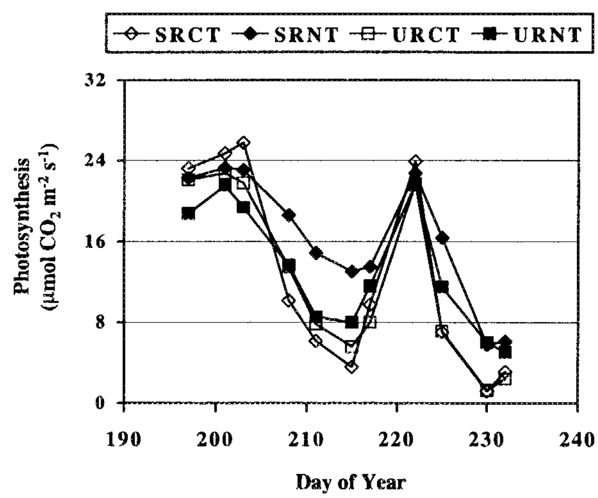

Figure 1. Photosynthesis for cotton during reproductive growth as affected by row spacing (standard row = SR; ultra-narrow row = UR) and tillage (conventional tillage = CT; no-tillage = NT).

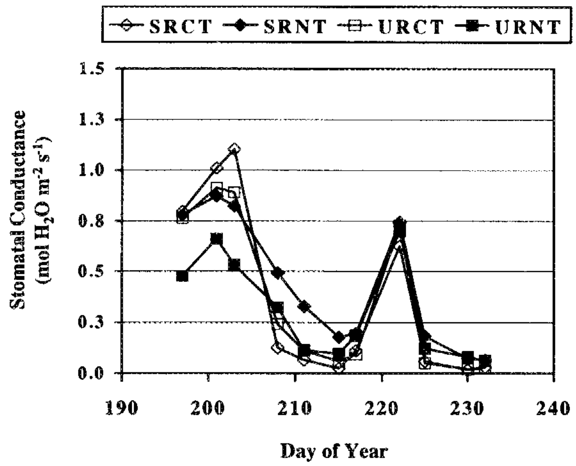

Figure 2. Stomatal conductance for cotton during reproductive growth as affected by row spacing (standard row = SR; ultra-narrow row = UR) and tillage (conventional tillage = CT; no-tillage = NT).

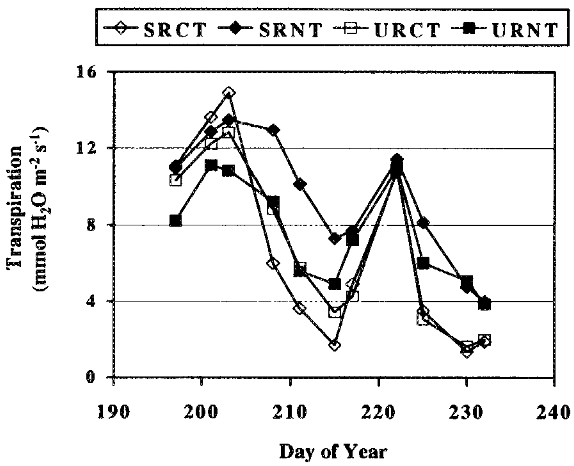

Figure 3. Transpiration for cotton during reproductive growth as affected by row spacing (standard row = SR; ultra-standard row = UR) and tillage (conventional tillage = CT; no-tillage = NT).

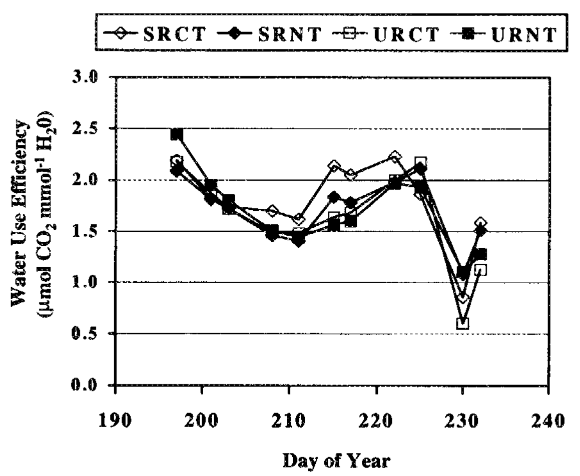

Figure 4. Water use efficiency for cotton during reproductive growth as affected by row spacing (standard row = SR; ultra-narrow row = UR) and tillage (conventional tillage = CT; no-tillage = NT).

CONSERVATION TILLAGE FIELD COMPARISONS FOR 18 SITES IN SOUTH TEXAS

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Abstract

Adoption of conservation tillage for cotton production in South Texas has increased dramatically over the past few years but there are still many producers unaware of the benefits. The climatic conditions and soil types of South Texas are quite different from the Southeast United States where other producers have been successful with conservation tillage cotton. A greater knowledge of the benefits and risks of conservation tillage practices under a subtropical, semi-arid environment can help producers better evaluate tillage practices as a component of their farming operation. The objectives of this study were to compare the effects between conventional moldboard tillage and conservation tillage on cotton yields, production costs and net returns. Economics of cotton production and lint yields as affected by tillage in a semi-arid, subtropical environment, were examined over a three year period on eighteen different producer fields. Six producer fields in 1997, five fields in 1998, and seven fields in 1999 were split and one-half of each was farmed using conventional tillage practices and one-half of each field was farmed using conservation tillage practices. Seeding rate, fertilizer, irrigation, insect management, and other production factors were the same for both tillage systems. Average cotton lint yields in the conservation tillage fields in 1997, 1998, and 1999 were 137, 87, and 110 pounds greater than in the conventional tillage fields. In 1997 five of the six sites had equivalent or greater yields, four of five fields examined in 1998 had equivalent or greater yields, and in 1999 six of seven fields had equivalent or greater lint yields when conservation tillage was compared to conventional moldboard tillage. Production costs were $55-65/acre less in the conservation tillage fields and net returns averaged $129, $118, and $70/acre more with conservation tillage in 1997, 1998, and 1999 compared with the conventional tillage methods. Results of this three year study apply to cotton following grain sorghum. Conservation tillage cotton was produced with lower input costs and had equal or greater economic returns than the conventional moldboard plow tillage system.

Introduction

An obstacle to cotton production with conservation tillage has been the lack of information available to producers on relative yield data and economics of using conservation tillage for South Texas compared with conventional tillage. Traditionally producers use the moldboard plow and disk tillage system to destroy crop residue from the previous crop and to prepare a seedbed for the next crop. The moldboard plow was the most common method used to destroy post-harvest cotton stalks which can serve as food source for boll weevil populations which overwinter in South Texas. Conservation tillage production practices leave most of the previous crop residue on the soil surface to provide a mulch for the soil, increase water infiltration rates into the soil, and decrease wind and water erosion. Even with these apparent benefits many producers are reluctant to adopt these practices due to a lack of knowledge of the risks and economic benefits for cotton production. The objectives of this study were to compare the effects of conventional tillage and conservation tillage on cotton yields and production costs. Results from these studies will be used to provide farmers with guidelines for implementing conservation tillage.

Materials and Methods

Cotton lint yield and production economics as affected by tillage in a semi-arid subtropical environment were examined. Six cotton producer fields in 1997, five fields in 1998, and seven fields in 1999 were split into halves. One-half of each field was farmed using conventional tillage practices and the other half was farmed using conservation tillage practices. Field size was from 18 to 30 acres. The previous crop from all fields was grain sorghum. Following harvest of the grain sorghum in June, the crop was terminated with an over the