YIELD RESPONSE OF COTTON TO IN-ROW DEEP TILLAGE AND FURROW IRRIGATION IN A CORN/COTTON ROTATION ON A SILTY CLAY LOAM SOIL

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Abstract

The overall study was designed to determine the necessity of deep tillage and/or irrigation in a cotton/corn cropping system. A 6-yr field study was conducted from 1999 through 2004 on a 30 acre field containing poorly drained to somewhat-poorly drained alluvial silty clay loam soils. The field was divided in half so cotton could be alternated with corn on each half, thus establishing a 1:1 cotton/corn rotation. The treatment plots were strip plots 20 feet wide and 650 feet long. The study was established in a randomized complete block design with a factorial arrangement of treatments and five replicates. This poster focuses on the results of the cotton component.

Materials and Methods

The study provided three water management practices, 1) a non-irrigated, 2) a low-level irrigated, and 3) a high-level irrigated for all tillage practices. The tillage practices included deep tillage every year, no deep tillage every year, deep tillage alternate years ahead of the cotton and deep tillage alternate years ahead of the corn in all water management practices. All twelve treatments are listed in Table 1.

Table 1. List of tillage/irrigation treatments in a deep tillage/irrigation study at the Delta Research and Extension Center satellite farm, Tribbett, MS

Treatment	Irrigation	Deep Tillage	
NI-NS-E	non-irrigated	non-subsoiled	every year
NI-NS-A	non-irrigated	non-subsoiled	alternate years
NI-S-A	non-irrigated	subsoiled	alternate years
NI-S-E	non-irrigated	subsoiled	every year
LL-NS-E	low-level irrigated	non-subsoiled	every year
LL-NS-A	low-level irrigated	non-subsoiled	alternate years
LL-S-A	low-level irrigated	subsoiled	alternate years
LL-S-E	low-level irrigated	subsoiled	every year
HL-NS-E	high-level irrigated	non-subsoiled	every year
HL-NS-A	high-level irrigated	non-subsoiled	alternate years
HL-S-A	high-level irrigated	subsoiled	alternate years
HL-S-E	high-level irrigated	subsoiled	every year

In-row subsoil tillage was performed with a 6-shank, low-till parabolic subsoiler to a depth of 14 to 16 inches, in the subsoiled plots. A water furrow was cultivated in ahead of irrigation to help control weeds and insure water flowed down the intended middles.

Irrigations for all HL- (HL-NS-E, HL-S-E, HL-NS-A, and HL-S-A) treatment were initiated and watered for a shallow-rooted system, while all LL- (LL-NS-E, LL-S-E, LL-NS-A, and LL-S-A) were initiated and watered for a deeper-rooted system. Soil water potential was monitored at 6-inch increments down to 24 inches to determine when to initiate irrigations in HL-NS-A and LL-NS-A. All HL- treatments were initiated when the easily available water was depleted from the top 12 inches of the soil profile, as determined when the soil water potential averaged –50 to –70 kPa at the 12-inch depth. All LL- treatments were initiated when the rooting profile down to 24 inches was depleted of its easily available water as determined by soil water potential readings. A roll-out pipe system was used to furrow water the irrigated plots. Total water pumped ranged from 4.2 to 13.8 inches with the average difference between LL- and HL- treatments being 2.6 inches.

Results and Discussion

Lint yields.

Treatment lint yields for all years and treatment averages are found in Table 3. A summary of lint yield interaction means is found in Table 4 and a summary of lint yield main effect means can be found in Table 5.

Over the 6-yr study, fall deep tillage under non-irrigated conditions (NI-S-E and NI-S-A) increased non-irrigated (NI-NS-E and NI-NS-A) lint yields in 1999 and 2002 but decreased yields in 2001 and 2004 (Table 3). Fall deep tillage under irrigated conditions (LL-S-E, LL-S-A, HL-S-E, and HL-S-A) decreased cotton lint yields in the wetter years of 2001 and 2004 (Table 3), otherwise it did not increase yields over the non-subsoiled irrigated treatments (LL-NS-E, LL-NS-A, HL-NS-E, and HL-NS-A).

Deep tillage for the prior year decreased cotton lint yields in the non-irrigated and irrigated treatments (NI-S-E, NI-NS-A, LL-S-E, LL-NS-A, HL-S-E, and HL-NS-A) in 2004 and the irrigated treatments (LL-S-E, LL-NS-A, HL-S-E, and HL-NS-A) in 2003 (Table 3). In all other years, deep tillage the prior year (NI-S-E, NI-NS-A, LL-S-E, LL-NS-A, HL-S-E, and HL-NS-A) had no effect on lint yields.

The additional water stored in the soil profile due to the mechanical fracturing of the soil with fall deep tillage was not beneficial in most years on this silty clay loam soil. Lack of significant positive responses under non-irrigated conditions may be explained by less soil compaction due to less traffic in the previous year's corn production and/or possibly benefits of the corn/cotton crop sequence masking the benefits normally obtained with deep tillage. Negative yield responses occurred in wettest years of 2001 and 2004. Additionally in 2004 backwater flooding occurred near early bloom which prolonged saturated conditions leading to poor soil aeration in the root zone which reduced root activity and subsequent nitrogen uptake causing the largest yield reduction to deep tillage. The cotton lint yield results also showed no consistent positive benefit was obtained with fall deep tillage in the prior crop year (Table 5). Thus, deep tillage in this cropping system on these soils would not be recommended for the cotton component. Deep tillage the prior crop year should only be considered if it is beneficial for the corn grown that season for the established cropping sequence.

When in-season rainfall (June – August) was greater than the 30-yr normal (Table 2), irrigation with and without deep tillage (LL-NS-E, LL-S-E, LL-NS-A, LL-S-A, HL-NS-E, HL-S-E, HL-NS-A, and HL-S-A) did not increase and in some cases decreased cotton lint yields (Table 5). This occurred in 2001, 2002, and 2004, indicating that the irrigation scheduling regime was inappropriate for this poorly drained silty clay loam field in these wetter years. Irrigation increased lint yield with and without deep tillage when in-season rainfall was below normal in 1999, 2000, and 2003. The yield response in 2000 to irrigation was lower than in 1999 and 2003, due partly to the higher than normal maximum air temperature in July and August. Irrigation under non-subsoiled conditions (LL-NS-E, LL-NS-A, HL-NS-E, and HL-NS-A) resulted in the highest average yield for the 6-yr study (Table 3).

The main differences found among the HL- (HL-NS-E, HL-S-E, HL-NS-A, and HL-S-A) and LL- (LL-NS-E, LL-S-E, LL-NS-A, and LL-S-A) treatments were that during the three years irrigation increased yields (Table 5), two of those the LL- treatments yielded better than the HL-treatments, indicating that a later irrigation initiation date and less total water applied was more appropriate for this silty clay loam soil. This effect did not occur in the third year. Here irrigation increased yields but there was an interaction effect in which the average of the LL-S-E and LL-S-A treatments yielded less than the average of the LL-NS-E and LL-NS-A, and of the HL-NS-E and HL-NS-A treatments (Table 4). In the wetter years of 2002 and 2004 there was no difference among the HL- and LL- treatments. In 2001 the LL- treatments yielded less than the HL- treatments. Thus, there is no clear advantage among the HL- and LL- treatments.

Table 2. Average maximum air temperature and rainfall by month for the growing season of cotton, Delta Research and Extension Center satellite farm, Tribbett, MS

	Average maximum air temperature (°F) [z]						30-yr
Month	1999	2000	2001	2002	2003	2004	normal [y]
May	84.4	85.0	85.8	82.6	84.3	83.2	83.1
June	89.3	89.7	88.4	89.2	86.6	87.1	90.1
July	93.3	94.4	92.4	92.9	91.5	90.1	92.5
August	96.2	98.1	90.6	92.6	93.5	89.4	91.7
	Rainfall (in)						
January [z]	13.8	3.5	6.4	9.4	1.4	3.6	5.4
February [z]	1.3	1.6	8.6	3.7	7.6	8.2	4.5
March [z]	4.0	7.7	4.9	8.6	2.5	2.1	5.6
April [z]	6.3	11.1	4.0	3.3	3.8	4.1	5.4
May [x]	5.7	6.9	5.1	2.8	2.6	7.3	5.3
Total	31.1	30.8	29.0	27.8	17.9	25.3	26.2
June [x]	7.8	3.7	4.3	2.5	6.3	13.5	4.0
July [x]	0.6	0.3	4.6	5.1	1.0	3.5	3.9
August [x]	0.6	0.0	6.5	4.0	1.0	3.1	2.0
Total	9.0	4.0	15.4	11.6	8.3	20.1	9.9

[z] National Weather Service, Cooperative Weather Network, Stoneville, MS located 8 miles northwest of study site.

[y] NOAA/NESDIS/NCDC. 2002. Monthly station normals of temperature, precipitation, and heating and cooling degree days 1971-2000 (22 Mississippi). Climatography of the United States No. 81. Asheville, North Carolina. pp26.

[x] Rain gage located at study site, Tribbett, MS.

Table 3. Lint yield of cotton grown in a deep tillage/furrow irrigation study on a silty clay loam soil at the Delta Research and Extension Center satellite farm, Tribbett, MS

	Lint yield (lb $acre^{-1}$)							Standard
Treatment [z]	1999	2000	2001	2002	2003	2004	Average	deviation
NI-NS-E	615	567	878	1083	926	1483	925	335
NI-NS-A	557	598	846	1129	1002	1406	923	325
NI-S-A	651	610	792	1203	1005	1317	930	293
NI-S-E	654	608	801	1166	1000	1215	907	259
LL-NS-E	1008	754	798	1026	1403	1349	1057	271
LL-NS-A	987	756	817	1075	1336	1230	1034	227
LL-S-A	970	774	775	1044	1352	1198	1019	230
LL-S-E	957	746	745	1069	1223	1036	962	189
HL-NS-E	907	693	828	1091	1395	1359	1045	288
HL-NS-A	885	684	820	1045	1332	1214	997	247
HL-S-A	927	711	798	1029	1368	1183	1003	245
HL-S-E	874	722	806	987	1276	1088	959	202
MSD (Kratio=100)	74	48	57	97	73	83		
LSD (*P*=0.05)	83	52	52	92	82	91		
Prob. > F	0.0001	0.0001	0.0021	0.0009	0.0001	0.0001		
C.V. (%)	7.8	6.0	5.1	6.7	5.3	5.7		

[z] NI (non-irrigated); LL (low-level irrigated); HL (high-level irrigated); NS (non-subsoiled); S (subsoiled); E (every year); and A (alternate years).

Table 4. Summary of interactions of cotton lint yields in a deep tillage/furrow irrigation study on a silty clay loam soil at the Delta Research and Extension Center satellite farm, Tribbett, MS

		Lint yield (lb acre^{-1})							
Interaction means									Standard
Irrigation x fall deep tillage present crop year [z]		1999	2000	2001	2002	2003	2004	Average	deviation
NI	NS	586	582	862	1106	964	1445	924	315
LL	NS	998	755	808	1051	1370	1290	1045	239
HL	NS	896	688	824	1068	1364	1287	1021	257
NI	S	652	609	797	1184	1003	1266	919	264
LL	S	964	760	760	1056	1288	1117	991	203
HL	S	901	716	802	1008	1322	1135	981	215
LSD (P=0.05)		58	37	37	65	58	64		
Prob. > F		0.058	0.603	0.2600	0.0150	0.0151	0.8215		
Irrigation x deep tillage prior crop year [z]									
NI	NS	633	588	835	1143	965	1400	927	300
LL	NS	989	764	787	1035	1378	1273	1038	241
HL	NS	917	702	813	1060	1381	1271	1024	256
NI	S	606	603	823	1148	1001	1311	915	280
LL	S	972	751	781	1072	1280	1133	998	203
HL	S	880	703	813	1016	1304	1151	978	216
LSD (P=0.05)		58	37	37	65	58	64		
Prob. > F		0.890	0.563	0.9103	0.2129	0.0038	0.5281		

[z] NI (non-irrigated); LL (low-level irrigated); HL (high-level irrigated); NS (non-subsoiled); S (subsoiled).

Table 5. Summary of main effects of cotton lint yields in a deep tillage/furrow irrigation study on a silty clay loam soil at the Delta Research and Extension Center satellite farm, Tribbett, MS

	Lint yield (lb acre^{-1})							Standard deviation
Deep tillage system means [z]	1999	2000	2001	2002	2003	2004	Average	
Present crop year								
NS	827	675	831	1075	1232	1340	997	269
S	839	695	786	1083	1204	1173	963	225
LSD (P=0.05)	34	21	21	37	33	37		
Prob. > F	0.465	0.068	0.0001	0.6723	0.0951	0.0001		
Prior crop year								
NS	847	685	812	1079	1242	1315	996	264
S	819	686	806	1079	1195	1198	964	231
LSD (P=0.05)	34	21	21	37	33	37		
Prob. > F	0.112	0.923	0.5796	0.9758	0.0074	0.0001		
Irrigation system means [z]								
NI	619	596	829	1145	983	1355	921	284
LL	981	758	784	1054	1329	1203	1018	219
HL	899	702	813	1038	1343	1211	1001	233
LSD (P=0.05)	41	26	26	46	41	46		
Prob. > F	.0001	.0001	.0042	.0001	.0001	.0001		

[z] NI (non-irrigated); LL (low-level irrigated); HL (high-level irrigated); NS (non-subsoiled); S (subsoiled).