

EVALUATION OF TWIN-LINE COTTON PRODUCTION IN ARIZONA - 2002
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Abstract

Twin-line (two seed lines 7.25 in apart per bed) and conventional single seed line per bed cotton production systems were compared at 19 sites across Arizona in 2002 and data analysis was completed in 11 of the experiments. The twin-line system produced more lint than the conventional single-line system at 3 of 11 locations; the yields of the twin-line and single-line systems were 1273 and 1186 lb/acre, 1572 and 1461 lb/acre, and 1309 and 1210 lb/acre, respectively, at the Grasty, Ramona, and Wells sites, respectively. There were no significant differences in yield or fiber micronaire in 5 of the 11 experiments. The twin-line system produced less lint than the conventional system at 3 of 11 locations; yields of the twin-line and single-line systems were 1400 and 1489 lb/acre, 1065 and 1200 lb/acre, and 1271 and 1431 lb/acre, respectively, at the Cooley, Papago, and Wakimoto sites, respectively. Fiber micronaire was reduced in two experiments; the micronaire values were 4.46 and 4.78, and 4.60 and 4.85 in the twin-line and single-line systems, respectively, at the Papago and Grasty sites, respectively. Research will continue in 2003 in order to develop system comparison data for multiple years and to elucidate the reasons for the variable results measured in the 2002 cotton season.

Introduction

Cotton production in Arizona is characterized by high input costs. Low cotton prices and input cost increases are forcing producers to explore opportunities to reduce costs, increase yield or both to be profitable. In addition, significant low desert cotton acreage has produced lint with high fiber micronaire resulting in price discounts that have further eroded profit margins.

Ultra Narrow Row (UNR) cotton production research conducted in Arizona from 1999 to 2000 compared yield, fiber quality, and production costs of a 10 inch UNR system on the flat (no beds) and a conventional 40 inch row system on beds (Husman et al., 2001, Husman et al., 2000; McCloskey et al., 2000). The results were encouraging in that UNR systems produced 3 to 9 percent more lint while reducing variable costs by 5 to 12 percent. In addition, the micronaire of the lint produced by the UNR system was 10 to 18 percent lower than the fiber micronaire of the lint produced in the conventional system. Although these results appear to encourage adoption of the UNR production system, there has been little commercial interest in or adoption of the system in Arizona due to its challenging and unforgiving nature. The most serious problems associated with the UNR system were establishing a high density, uniform plant population, obtaining adequate weed control, controlling cotton plant height, and obtaining adequate defoliation and dessication in preparation for stripper harvest. There was also a perceived quality stigma associated with stripper picked cotton and the potential discounts resulted in unacceptable risks for Arizona producers.

While UNR system research was being conducted at the University of Arizona (UA), University of California (UC) researchers were experimenting with a system where two seed lines (twin-line) were planted on a bed with a target population of 80,000 plants per acre which they referred to as a modified UNR cotton production system. In some of their experiments, they found that the twin-line system increased yield 5 to 8 percent compared to a conventional single-line system and reduced production costs \$40 to \$60 per acre, primarily by reducing weed control costs. The twin-line production system is a less radical departure from conventional cotton production than the UNR system because it can be harvest with a conventional spindle picker. In addition, stand establishment, weed control, and management of plant height are similar in conventional and twin-line systems. Thus, the twin-line system is more likely to be adopted by growers than the UNR system if consistent advantages are associated with the twin-line system.

During the 2001 cotton season, the research focus at the University of Arizona shifted away from the UNR system and towards the twin line system. Three experiments were conducted to compare twin-line and conventional single-line production systems in terms of yield, fiber micronaire, and production costs (Husman, et al., 2002). Lint yields in the single- and twin-line configurations were similar but fiber micronaire was significantly lower in the twin-line system in all 2001 experiments. The twin-line system plantings had double the seeding rate of the single-line systems but required one less cultivation due to earlier canopy closure. Since these cost were similar, there were no differences in total production costs between the single- and twin-line systems. In contrast, University of California researchers report that twin-line costs are less than single-line system costs due to lower weed control costs primarily due to rapid canopy closure and shading. The 2001 Arizona test sites had relatively low weed pressures and therefore weed control costs were the same for both systems.

The lower fiber micronaire associated with the twin-line system in 2001 was encouraging since Arizona producers have suffered significant price discounts due to high fiber micronaire. If a relatively simple change in stand geometry and plant population could consistently reduce micronaire, there might be significant interest in adopting the twin-line system. Yield increases or reduced costs, of course, would provide additional incentive for growers to adopt the twin-line system. Thus, a statewide, multi-site, research program was conducted in 2002 to compare the yield and fiber quality of lint produced by the twin-line and single seed line per bed production systems on commercial farms and University of Arizona experiment stations.

Materials and Methods

Nineteen experiments were conducted in 2002 to compare yield, fiber micronaire, and canopy development of conventional compared to the twin line production system. Sixteen experiments were located on commercial farms, three on UA experiment stations. The results of 11 experiments are included in this report since data collection has not been completed at all sites. The experiments were located across the entire cotton production region of Arizona as well as Blythe, California in an effort to comprehensively evaluate the twin line production system (Table 1).

The experiments consisted of alternating plots of single-line and twin-line cotton with a minimum of four blocks at each site. Plots ranged from 4 to 12 rows wide and were the length of the field; field lengths ranged from 600 to 1500 feet long across all experimental sites. Prior to planting, the beds were shaped to result in a wide, flat bed top to facilitate the twin-line planting geometry. Twin-line plots were planted using a Monosem twin-line vacuum planter with pairs of planter units spaced 7.25 inches apart centered on the beds. The target plant population for the twin-line plots was 80,000 plants per acre. Conventional single-line plots were planted using the cooperators' planter. All experiments were dry planted and irrigated to germinate the seed and obtain a stand. The row spacings evaluated in the 11 experiments in this report were 40, 38, and 36 in depending on the cooperating grower's standard row spacing (Table 1). The seven cotton varieties evaluated in this report were chosen by the cooperating growers (Table 1).

Canopy closure measurements were made by selecting three subplots in each plot, one area near each end of a plot and one area in the middle of the plot. These areas were then flagged (one flag on each side of the furrow) so that repeated measurements were made in the same locations for the rest of the season. Canopy closure was determined by measuring the distance between the edges of the canopies of two adjacent rows. The edge of each canopy was determined by sighting down the edge of a canopy and measuring from an approximate average location of leaf edges at the edge of the canopy. Subplot measurements were averaged to determine the mean percent canopy closure. Canopy closure measurements were taken approximately every two weeks at the selected locations. Percent groundcover measurements were made by analyzing digital images. An Olympus Camedia C3030 digital camera mounted 2 m above the ground on a pole was used to take pictures in three subplots per plot in all treatments in the Maricopa and Marana experiments. A software package, SigmaScan from SPSS Science Software, was used to digitally analyze and calculate the ratio of green image pixels to non-green pixels which was used to calculate percent ground cover. To determine percent canopy closure from the pictures, three lines were drawn between the outside leaf edges of adjacent rows in each picture. The length of each line was measured and an average distance between rows was calculated to determine the degree of canopy closure at different dates.

Production inputs and cultural practices were managed by the cooperating growers based on their standard farm practices. A goal of this research effort was to implement on-farm experiments and to collect data from commercially managed fields. Plots were harvested using the cooperators' spindle pickers which were 2, 4 and 6 row machines manufactured by either Case-IH or John Deere. Harvest dates ranged from mid-September to mid-November. The seed cotton from each plot was weighed using a boll-buggy equipped with weighing load cells. Subsamples of approximately 12 to 15 pounds of seed-cotton were taken from each plot and ginned at the University of Arizona short-staple gin at the Maricopa Agricultural Center. The percent of lint in each seed-cotton sample from each plot for a single field were averaged and used for calculation of the percent lint in both the single-line and twin-line systems in that field. A subsample of each plot's lint was submitted to the USDA Cotton Classing Office in Phoenix, Arizona for HVI fiber quality analysis.

Results and Discussion

In the 2002 experiments, the twin-line system produced more lint than the conventional single-line system at 3 of 11 locations; the yields of the twin-line and single-line systems were 1273 and 1186 lb/acre, 1572 and 1461 lb/acre, and 1309 and 1210 lb/acre, respectively, at the Grasty, Ramona, and Wells sites, respectively (Table 2). There were no significant differences in yield in 5 of the 11 experiments. The twin-line system produced less lint than the conventional system at 3 of 11 locations; yields of the twin-line and single-line systems were 1400 and 1489 lb/acre, 1065 and 1200 lb/acre, and 1271 and 1431 lb/acre, respectively, at the Cooley, Papago, and Wakimoto sites, respectively (Table 2). Three 2001 experiments that compared twin-line and single-

line systems on 40 and 38 in beds were similarly inconsistent with respect to yield differences between the two system although no yield reductions were reported for the twin-line system. In a 2001 experiment at the Maricopa Agricultural Center, the twin-line system produced significantly more lint than the single-line system (1476 versus 1396 lb/acre) but at the Marana Agricultural Center and at the Glendale experiment on a commercial farm, the lint yields of the two systems were not significantly different (Husman et al., 2002).

The results of the 2002 experiments were similar to the 2001 experiments with respect to yield differences between the systems as noted above. Consistent yield increases or decreases with the twin-line system were not expected by the authors due to the tremendous ability of cotton plants to compensate for a wide range of plant populations. However, the experiments in 2002 were the first to measure lower yields in the twin-line system than in the single-line systems. In the 2002 experiments where twin-line yields were reduced, it was observed that a substantial amount of cotton was unable to be harvested on the lowest main-stem fruiting branches. In general, the 2002 season was quite favorable for both early season fruit set and retention on low fruiting branches, and for season long productivity. The highly favorable crop conditions provided the greatest challenge with respect to a cotton picker's ability to efficiently harvest the bottom crop in the twin-line system. In a couple cases, what appeared to be a picker based challenge was easily addressed by lowering the heads closer to the bed surface and tightening the doors.

Another problem which may have occurred but cannot be verified is the consistency of Monosem planter unit spacing which was designed to plant pairs of seed lines 7.25 inches apart. As mentioned previously, the 2002 experiments evaluated the twin-line system on several different row-spacing configurations. As a result, the planter units were moved several times during the planting period as the planter was moved from farm to farm. In some cases, the final seed lines were wider than 7.25 inches suggesting that there may have been cases where the planter units were not spaced as closely as possible and the incorrect spacing was not detected prior to planting. In addition, in cases where the bed-top was not flat or wide enough there may have been slumping or movement of the seed resulting in a twin-line spacing greater than 7.25 inches. These problems would definitely reduce spindle picker efficiency, particularly with the low fruit set experienced in 2002. These explanations for the reduced yield in the twin-line system first reported in 2002 are speculative in nature but identify issues that will be addressed in 2003.

Fiber micronaire was reduced in two of the eleven 2002 experiments; the micronaire values in the twin-line and single-line systems were 4.46 compared to 4.78, and 4.60 compared to 4.85, respectively, at the Papago and Grasty sites, respectively (Table 2). Fiber micronaire was below the discount threshold of 5.0 in both systems at the Papago and Grasty sites as it also was at 7 of the other sites in 2001. At 9 of the 11 experimental sites, there were no significant differences in fiber micronaire between twin-line and single-line systems. This contrasted markedly with the 2001 experiments where fiber micronaire was lower in the twin-line system compared to the conventional single-line systems in all three experiments (Husman et al., 2002). The micronaire reductions measured in 2001 were attributed to earlier canopy closure and shading in the twin-line system compared to the single-line system. Similar to the 2001 experiments, percent ground cover (Table 3) and canopy closure (Table 4a and 4b) increased more rapidly and earlier in the twin-line system compared to the single-line system. Incoming light was reduced on a per plant basis which resulted in a reduced carbohydrate production and allocation to bolls, particularly those at the base of the plant. Shading has been shown to increase fiber length and reduce micronaire (Eaton and Ergle, 1954). In 2002, commercial production of high micronaire cotton was much less prevalent than in recent previous years. Good fruit set and uniform retention on main-stem fruiting branches resulted in strong carbohydrate demand that may have reduced the potential for high micronaire in a manner similar to shading. As a result, we suggest that the potential of the twin-line system to reduce micronaire and the magnitude of the reduction was also decreased in the system comparison experiments in 2002 consistent with commercial experiences. In addition, Arizona had the good fortune of quite optimum cotton production weather with fewer heat stress events than is customary which resulted in fewer high micronaire problems.

Summary

While the results from the 2002 twin-line vs. conventional single-line production research program were not as definitive as the 2001 results, we suggest that seasonal environmental differences may produce conditions that favor one system over another, particularly in terms of fiber micronaire. The current line of thought is that in years with more heat related stress events that result in reduced fruit load and boll retention, the twin-line system may offer more compensation opportunity due to the higher plant population. Often, high micronaire is associated with crops that have fruiting gaps which result in excessive carbohydrate allocation to the older bolls until new, young fruit compete for carbohydrates. A consistent yield increase is not an expectation of the twin-line system compared to the conventional single-line system. The yield of the twin-line system can be reduced by reductions in picker efficiency as well as by other factors such as very high plant densities. Careful management of the spacing between pairs of seed-lines on a bed is critical if the twin-line system is to be fairly evaluated. Research will continue in 2003 in an effort to increase the database of twin line production research results and measure factors that may affect the relative productivity of the twin-line system.

References

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Table 1. Arizona 2002 twin-line testing program: cooperators, planting dates, varieties, and row widths.

Region	Grower	Planting		Row width
		date	Variety	(in)
Blyth	Jack Seiler	3/22/02	DP451BR	40
Western	Larry Hancock	3/27/02	DP422BR	40
	Del Wakimoto	3/28/02	STBXN47	40
Central	Mike Cooley	4/18/02	DP33B	38
	Paul Grasty	4/10/02	ST4892BR	38
	Papago - Cecil Borboa	4/19/02	DP388	38
	Romona - Karl Button	4/11/02	ST4892BR	38
	Dean Wells	4/10/02	ST4892BR	38
	Univ. of AZ Maricopa Ag. Center	4/2/02	DP451BR	40
Eastern	Steve Daley	4/23/02	SG215BR	36
	Univ. of AZ Marana Ag. Center	4/8/02	DP451BR	40

Table 2. Cotton yield and fiber micronaire from single-seed line and double-seed line per bed planting configurations. Values are means; * or ** indicates a significant difference at P=0.5 or P=0.01, respectively, between single and double seed line per bed means within a row (i.e., at a location).

Farm	Location	Lint Yield (lb/A)		Fiber Micronaire	
		1 line/bed	2 lines/bed	1 line/bed	2 lines/bed
Cooley	Pinal County	1489	1400**	4.65	4.68
Daley	Safford, AZ	940	812	4.6	4.75
Grasty	Casa Grande, AZ	1186	1273*	4.85	4.60*
Hancock	Parker Valley, AZ	1530	1509	4.85	4.78
UA Maricopa Ag. Center	Maricopa, AZ	1411	1499	4.98	4.85
UA Marana Ag. Center	Marana, AZ	1185	1166	4.98	5.0
Papago	Eloy, AZ	1200	1065**	4.78	4.46*
Ramona	Sacaton, AZ	1461	1572*	5.38	5.38
Seiler	Blythe, CA	1701	1668	4.68	4.45
Wakimoto	Ft. Mohave, AZ	1431	1271**	5.10	4.95
Wells	Casa Grande, AZ	1210	1309**	5.08	4.6

Table 3. Percent cotton ground cover and canopy closure of single-seed line and double-seed line per bed cotton planting configurations at the Maricopa and Marana Agricultural Centers of the University of Arizona. Values are means; * or ** indicates a significant difference at P=0.5 or P=0.01, respectively, between single and double seed line per bed means within a row (i.e., for a particular days after planting [DAP] at a location).

Farm	Row Spacing (in)	DAP	Ground Cover (%)		Canopy Closure (%)	
			1 line/bed	2 lines/bed	1 line/bed	2 lines/bed
Maricopa	40	63	19.6	24.1**	30.9	46.2**
		76	30.6	38.3**	42.8	58.5**
		83	38.8	46.3*	52.1	64.1**
		91	51.6	61.9**	63.6	73.7**
Marana	40	51	6.2	12.9**	15.3	31.4**
		77	38.9	49.1**	55.2	68.5**
		91	60.4	63.8	73.6	79.6**

Table 4a. Percent cotton canopy closure between rows in single-seed line and double-seed line per bed planting configurations at the Cooley, Grasty and University of Arizona Maricopa Agricultural Center experiment locations. Values are means; * or ** indicates a significant difference at P=0.5 or P=0.01, respectively, between single and double seed line per bed means within a row (i.e., for a particular days after planting [DAP] at a location).

Farm	Row Spacing (in)	DAP	Canopy Gap (in)		Canopy Closure (%)	
			1 line/bed	2 lines/bed	1 line/bed	2 lines/bed
Cooley	38	57	26.9	18.7**	29.2	50.9**
		76	14.6	8.3**	61.5	78.0**
		110	1.5	0.2	96.1	99.6
Grasty	38	61	27.0	20.2**	28.9	46.7**
		77	20.7	14.2**	45.6	62.7**
		89	15.0	9.3**	60.5	75.4**
		103	7.8	3.8	79.4	90.1
		118	3.4	0.0**	91.0	100**
UA Maricopa Ag. Center	40	63	29.2	21.3**	27.1	46.7**
		77	25.0	17.5**	37.5	56.2**
		91	18.9	10.5**	52.7	73.8**
		107	9.3	3.5**	76.7	91.2**
		119	7.8	0.2**	80.4	99.4**

Table 4b. Percent cotton canopy closure between rows in single-seed line and double-seed line per bed planting configurations at the University of Arizona Marana Agricultural Center, Papago, and Roger experiment locations. Values are means; * or ** indicates a significant difference at P=0.5 or P=0.01, respectively, between single and double seed line per bed means within a row (i.e., for a particular days after planting [DAP] at a location).

Farm	Row Spacing (in)	DAP	Canopy Gap (in)		Canopy Closure (%)	
			1 line/bed	2 lines/bed	1 line/bed	2 lines/bed
UA Marana Ag. Center	40	61	28.3	20.6**	29.2	48.5**
		77	18.9	12.6**	52.6	68.6**
		91	16.4	10.2**	59.0	74.6**
		105	12.3	7.7**	69.3	80.8**
		116	10.2	5.3**	74.6	86.7**
		127	9.8	5.0**	75.6	87.5**
Papago	38	53	29.5	22.4**	22.4	41.1**
		67	24.4	19.1**	35.7	49.7**
		91	17.4	13.9**	54.3	63.4**
		104	13.6	9.9**	64.1	73.9**
		125	11.3	6.7**	70.3	82.5**
Rogers	38	59	27.0	20.2**	28.9	46.7**
		76	19.7	10.8**	48.3	71.5**
		97	15.0	7.9**	60.5	79.2**