2002 BELTWIDE COTTON CONFERENCES, ATLANTA, GA – JANUARY 8-12

YIELD, QUALITY, AND ECONOMIC COMPARISON OF SINGLE AND DOUBLE SEED LINE PER BED COTTON PRODUCTION

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Abstract

Three experiments were conducted in Maricopa, Marana, and Glendale, Arizona in 2001 to measure cotton growth, yield, micronaire, and production costs in single and double seed line per bed systems on 32 and 40 inch beds. Canopy development was faster and canopy closure was greater in the double seed line than in the single seed line systems and was greater in the 32 inch than in the 40 inch row systems. At Maricopa, the single line 32 inch system yield of 1571 lbs./A was significantly greater than the yields of the other seed line/row spacing systems. The yields of the single line 40 and the double line 32 inch systems were not significantly different at 1476 and 1411 lbs. of lint/A, respectively, and the yields of the double line 32 and the double line 40 inch systems also were not significantly different at 1411 and 1396 lbs. of lint/A, respectively. There were no significant lint yield differences at the Marana or Glendale location. At Marana, the lint yields were 1063 and 1066 lbs./A for the single and double seed line 40 inch row spacing systems, respectively. At Glendale, the single and double seed line 38 inch row spacing systems yielded 1474 and 1551 lbs. of lint/A, respectively. In all 2001 experiments, there was a trend for reduced micronaire in the double seed line per bed systems compared to the single seed line per bed systems. At Maricopa, the average micronaire was 5.0 and 4.7 for the single and double seed line per bed 32 inch row system, respectively, and 5.2 and 4.9 for the single and double seed line per bed 40 inch row systems, respectively. At Marana, the micronaire was 4.7 and 4.5 for the single and double seed line per bed 40 inch row systems, respectively. At Glendale, the micronaire was 5.1 and 4.6 for the single and double seed line per bed 38 inch row systems, respectively**.** Production costs were similar for the single and double seed line per bed systems. Additional research will be conducted in 2002 to determine the optimum plant populations and in-row plant spacings for double seed line per bed production systems.

Introduction

Cotton production in Arizona is characterized by high input costs. Low cotton prices and continuing input cost increases are forcing producers to explore cost reduction opportunities in order 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 1999 - 2000 compared yield, fiber quality, and production costs of 10 inch UNR systems on the flat (no beds) and conventional 40 inch row system on beds (Husman et al., 2001; Husman et al., 2000; McCloskey et al., 2000). The results were noteworthy in that UNR systems produced 3 to 9 percent more lint while reducing total variable costs by 5 to 12 percent. In addition, the micronaire of the lint produced by UNR systems was 10 to 18 percent lower than the lint micronaire of conventional production systems. These research results appear to encourage adoption of UNR production systems. However, there has been little commercial interest or adoption of UNR systems in Arizona due to the challenging and unforgiving nature of the UNR production system. The primary UNR system challenges are establishing a uniform stand, obtaining adequate weed control, controlling plant height, and providing optimum conditions for stripper harvest. In addition, the quality stigma associated with stripper cotton and potential discounts result in unacceptable risks for Arizona producers.

Researchers at the University of California (UC) have recently been experimenting with a modified UNR cotton production system where two seed lines (i.e., a double seed line) are planted on a bed with a target population of approximately 80,000 plants per acre. Their research found that double seed line per bed systems increased yield 5 to 8 percent compared to conventional systems and reduced production costs $40 to $60 per acre primarily by reducing weed control costs. The double seed line per bed system is a less radical departure from conventional cotton production than UNR systems and may be of more commercial interest if there are system advantages. One advantage of the double seed line system compared to UNR systems is that the crop is harvested with a conventional spindle harvester. In addition, stand establishment, weed control, and management of plant height are similar in conventional and double seed line systems facilitating adoption of the new system. The objectives of the 2001 research conducted in Arizona were to evaluate the double seed line per bed system and compare it to conventional cotton production systems, and to determine if micronaire can be reduced by manipulating plant population and stand geometry in double seed line per bed systems.

Materials and Methods

Three experiments were conducted in 2001 to compare conventional and double seed line per bed systems in terms of canopy development, yield, micronaire and production costs. Test sites included the University of Arizona Maricopa and Marana Agricultural Centers and a third location with a commercial cooperator in Glendale, AZ. Single seed line per bed (conventional) treatments were compared to two seed lines per bed treatments with both 32 and 40 inch row spacing. The Marana experiment compared single and double seed lines on 40 inch beds while the Glendale experiment compared single and double seed lines on 38 inch beds. Seed lines were 7 inches apart in the double line systems.

A randomized complete block design with four replications was used in all experiments. Plots were 8 rows wide by field length, which was 800, 1250, and 600 feet at Maricopa, Glendale, and Marana, respectively. The Maricopa and Glendale experiments were planted using two International 900 plate planters that were combined into a double tool bar system with 8 offset planter units to form a 4 row, double seed line configuration. The Marana site used a double tool bar system with 4 International 215 unit planters in a 2 row configuration for the double seed line system. The same planters were used to plant the single line systems at all locations by removing the rear toolbar and moving the planter units to the center of the beds.

Prior to planting, the beds were shaped to facilitate planting the double line system. All experiments were dry planted and irrigated to germinate the cotton seed. The seeding rates were 20, 20, and 28 pounds per acre with the double line systems at Maricopa, Marana, and Glendale, respectively. The single line seeding rates were 10, 10, and 14 pounds per acre at Maricopa, Marana, and Glendale, respectively. Planting dates were April 17 at Maricopa, April 16 at Marana, and May 8 at Glendale. DP451BR was planted at Maricopa and Marana while DP458BR was planted at Glendale. Percent canopy closure and cover measurements were made periodically at Maricopa and Marana (Table 5). Irrigation, fertilization, and pest control were managed using standard farm practices at all locations (Table1).

Plots were harvested October 18, 24, at Marana and Maricopa respectively. The Glendale site was harvested November 30. The center 4 rows of each 8 row plot were harvested for yield estimate purposes. A 4 row CaseIH 2155 was used at Maricopa and Glendale while a 2 row CaseIH 782 was used at Marana. The seed cotton from each plot was weighed using a boll buggy equipped with load cells. The 4 replicates were combined into a single module from each system and ginned separately for turnout. Samples for fiber quality were taken at the gin in a commercial manner and classed at the USDA Cotton Classing Office, Phoenix, AZ. At the Maricopa site, sub samples were taken from each plot to determine fiber micronaire.

Results and Discussion

At the Maricopa test site, the single line 32 inch system resulted in significantly greater lint yields than any of the other seed line row spacing treatments with 1571 lbs. lint per acre. Yield of the single line 40 inch row and double line 32 inch row treatments were not significantly different. The double lines on 32 and 40 inch rows were not significantly different (Table 2). There were no significant lint yield differences at the Marana or the Glendale locations. Lint yield at Marana was 1063 and 1066 lbs. per acre for the single and double line treatments on 40 inch rows respectively (Table 3). In Glendale 1474 and 1551 lbs. of lint per acre were produced in the single and double line treatments on 38 inch rows, respectively (Table 4). While a consistent yield increase when using a double line per bed system would be a bonus, the lack of such an increase was not unexpected due to cotton's ability to compensate across a broad range of plant populations. In general, yields were comparable in both the single and double line configuration. The exception was the significantly higher yield produced in the single line 32 inch row spacing at Maricopa.

As mentioned previously, high micronaire and price discounts are becoming an increasing problem in the low desert elevations of Arizona. A major focus of this research was to determine whether changes in plant population and stand geometry can be used to reduce micronaire. In all 2001 experiments, there was a trend in micronaire reduction from the single line to the double line per bed system. At Maricopa, the average micronaires are 5.0 and 4.65 for the single and double line on 32 inch rows, respectively, while the average micronaires were 5.17 and 4.85 for the single and double lines on 40 inch rows respectively. The Marana location micronaire was 4.7 and 4.5 for the single and double line on 40 inch rows, respectively. The Glendale location micronaire was 5.08 and 4.63 for the single and double line on 38 inch rows , respectively (Table 2). These trends in micronaire reduction are consistent with results from the 1999-2000 UNR experiments.

In the 1999 - 2000 UNR experiments, micronaire was consistently reduced. For example, in 1999, micronaire was reduced from 5.0 in the conventional 40 inch row configuration to 4.5 in the UNR system. In 2000, micronaire was reduced from 4.9 in the 40 inch rows to 4.0 with the UNR system respectively. While the UNR system is of minimal commercial interest in Arizona, double line seed per bed system may be of commercial interest if micronaire can be culturally managed by manipulating plant population and/or stand geometry.

The micronaire reductions experienced in the UNR and double line per bed cotton may be due to earlier canopy closure and shading when compared to a conventional single row per bed configuration (Table 5). Incoming light is reduced on a per plant basis which results in a reduction of photosynthate and carbohydrate production and allocation to the bolls. Shading has been shown to increase fiber length and reduce micronaire (Eaton and Ergle, 1954).

There were no differences in production costs between the single and double line systems (Table 6). The double line systems required doubling the planting seed rate and required one less cultivation due to earlier canopy closure. In essence, these differences canceled each other from a cost perspective. The University of California reports cost reductions in the form of weed control primarily due to more rapid canopy closure and shading. The Arizona test site fields had relatively low weed pressures and therefore weed control practices were the same within both the single and double line per bed systems.

Summary

The double line per bed system results in major physiological canopy architecture change when compared to a more conventional single line system. Changes in light interception, photosynthesis rates and carbohydrate production on a per plant or per unit area are substantial from a physiological perspective. It appears that relatively simple plant population and stand geometry manipulation does offer some opportunity to culturally manage the high micronaire problem Arizona is currently experiencing. The double seed line planting configuration is a system change that would appear to be commercially viable due to the use of existing equipment and management experience perspective.

Research will continue in 2002 in an effort to develop data relative to plant population and in seed line plant spacing. A double line Monosem precision planter has been purchased to accurately control plant spacing within the seed line with intent of additional improvement in light interception and canopy closure for micronaire management purposes. This planter will be used to initiate comparative single/double line research with several commercial cooperators in Arizona in order to gain commercial based data, experience and viability feedback.

References

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Table 1. Production Summary for Maricopa, Marana, and Glendale Double Seed Line Studies 2001.

	Maricopa 32" Beds	**Maricopa 40" Beds**	**Marana 40" Beds**	**Glendale 38" Beds**
Planting Date	4/17/01	4/17/01	4/16/01	5/8/01
Irrigations	11	11	9	11
Total Irrigation In/A	61.5	61.5	28.1	50
Nitrogen (lbs/A)	216	216	100	88
Insecticide Apps.	4	4	3	2
Harvest Date:	10/24/01	10/18/01	10/12/01	11/30/01

Table 2. 2001 Lint Yield and Fiber Quality by Row Spacing System, Maricopa.

	Lint (lbs/A)	Micronaire	Staple	Strength	Uniformity
Single 32"	1571a	5.00ab	36	25.2	80.7
Double 32"	1411bc	4.65c	36	25.2	81.5
Single 40"	1476b	5.17a	36	26.2	81.0
Double 40"	1396c	4.85b	36	26.0	81.0
P	0.0022	0.0048			
%CV	3.27				
LSD	76.51	0.1749			

SAS Proc GLM (ANOVA), LSD mean separation.
Means followed by the same letter are not significantly different at the 0.05 level.

Table 3. 2001 Lint Yield and Fiber Quality by Row Spacing System, Marana.

	Lint (lbs/A)	Micronaire	Staple	Strength	Uniformity
Single 40"	1063a	4.7	35	23.9	80.5
Double 40"	1067a	4.5	36	26.5	80.0
P	0.9647				
%CV	7.67				
LSD	287				

SAS Proc GLM (ANOVA), LSD mean separation.
Means followed by the same letter are not significantly different at the 0.05 level.

Table 4. 2001 Lint Yield and Fiber Quality by Row Spacing System, Glendale.

	Lint (lbs/A)	Micronaire	Staple	Strength	Uniformity
Single 38"	1474a	5.08a	35	29.7	unavailable
Double 38"	1551a	4.63b	34	30.1	unavailable
P	0.3738				
%CV	7.03				
LSD	239				

SAS Proc GLM (ANOVA), LSD mean separation.
Means followed by the same letter are not significantly different at the 0.05 level.

Table 5. 2001 Plant Population and Percent Canopy Closure, Maricopa and Marana.

Marana	**Plant Population**	**7-Jun**	**21-Jun**	**28-Jun**	**4-Jul**	**10-Jul**	**20-Jul**
Single 40"	29000	26	43b	52b	55b	72b	81a
Double 40"	69000	37	49a	59a	68a	79a	87a
P			0.0191	0.04	0.0017	0.0343	0.0767
LSD			4.923	5.884	6.284	6.410	6.622
Maricopa		4-Jun	21-Jun	29-Jun	7-Jul		
Single 32"	43000	28b	59c	73c	93b		
Double 32"	71500	41a	80a	91a	100a		
Single 40"	34500	23b	43d	60d	82c		
Double 40"	60875	42a	68b	83b	98a		
P		0.0004	0.0001	0.0001	0.0001		
LSD		9.198	5.48	5.198	4.481		

1. Means followed by the same letter are not significantly different at the 0.05 level. SAS Proc GLM (ANOVA), LSD mean separation.

Table 6. Budget for Double and Single Line Cotton in 2001-Maricopa and Marana.

ITEM/ DESCRIPTION	Twin Line 40	Single Line 40	Twin Line 40	Single Line 40
Area	**Maricopa**	**Maricopa**	**Marana**	**Marana**
Management Level	**Average**	**Average**	**Average**	**Average**
Water Source	**Maricopa - Stanfield**	**Maricopa - Stanfield**	**Cortaro - Marana**	**Cortaro - Marana**
Irrigation System	**Flood Furrow**	**Flood Furrow**	**Flood Furrow**	**Flood Furrow**
Units	**Pounds**	**Pounds**	**Pounds**	**Pounds**
Yield (units/acre)	1,396	1,476	1,066	1,063
COSTS				
Growing Cost	**($/acre)**	**($/acre)**	**($/acre)**	**($/acre)**
Labor	$95.00	$97.19	$78.44	$82.83
Machine Operation	$51.92	$54.11	$47.00	$51.39
Irrigation	$43.08	$43.08	$31.44	$31.44
Chemicals & Application	$135.64	$135.64	$173.60	$173.60
Fertilizer	$42.05	$42.05	$48.60	$48.60
Insecticide	$80.61	$80.61	$75.63	$75.63
Herbicide	$12.98	$12.98	$49.37	$49.37
Other Chemicals	$0.00			
Machinery Fuel & Repairs	$72.14	$73.64	$66.01	$70.87
Diesel	$30.04	$30.71	$26.99	$29.07
Repairs	$42.10	$42.93	$39.02	$41.80
Irrigation Water w/o Assessment	$180.34	$180.34	$85.00	$85.00
Seed/Transplants/Other	$67.14	$54.92	$64.36	$53.40
Total Growing Cost	$550.26	$541.73	$467.41	$465.70
Harvest and Post-harvest Cost				
Labor	$14.55	$14.55	$13.16	$13.16
Machine Operation	$14.55	$14.55	$13.16	$13.16
Other Labor	$0.00	$0.00		
Chemicals & Application	$17.90	$17.90	$17.90	$17.90
Defoliant	$17.90	$17.90	$17.90	$17.90
Machinery Fuel & Repairs	$69.06	$69.06	$42.79	$42.79
Diesel	$9.01	$9.01	$6.07	$6.07
Repairs	$60.05	$60.05	$36.72	$36.72
Custom & Other Materials	$11.85	$12.53	$9.05	$9.02
Ginning & Assessment	$124.82	$131.89	$95.67	$95.41
Harvest and Post-harvest Cost	$238.18	$245.93	$178.57	$178.28
Operating Overhead	$5.11	$5.11	$5.08	$5.08
Operating Interest	$9.80	$9.61	$10.67	$10.60
Total Variable Cost	$803.35	$802.38	$661.73	$659.66
Ownership Cost				
Cash Overhead	$77.58	$77.65	$63.47	$63.68
Capital Allocations	$127.16	$127.99	$96.62	$98.79
Land Ownership	$175.00	$175.00	$170.00	$170.00
Management Services	$64.27	$64.19	$52.93	$52.76
Total Ownership Costs	$444.01	$444.83	$383.02	$385.23
Total Costs	$1,247.36	$1,247.21	$1,044.75	$1,044.89
BREAK-EVEN PRICE	**($/unit)**	**($/unit)**	**($/unit)**	**($/unit)**
to Cover Growing Cost	$0.39	$0.37	$0.44	$0.44
to Cover Total Variable Cost	$0.58	$0.54	$0.62	$0.62
to Cover Ownership Cost	$0.32	$0.30	$0.36	$0.36
to Cover Total Cost	*$0.89*	*$0.85*	*$0.98*	*$0.98*