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FIBER QUALITY ASSESSMENT BY NODE LOCATION IN TEXAS COASTAL BEND NARROW ROW COTTON

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Abstract

Adjustments of row configurations and in-row plant densities have the potential to alter yield and fiber quality. The effects of two row configurations (single and double rows) and three in-row plant densities on yield distribution and fiber properties were evaluated in Corpus Christi, Texas in 2000 and 2001. Plants were irrigated in 2000 but not in 2001. In 2000, lint yields were about twice the yields in 2001. Fruiting position 1 bolls from nodes 7 and below accounted for from 51 to 65% of the seedcotton yield in 2000 and from 65 to 84% of the seedcotton yield in 2001. In 2001 yield distribution differences were related to in-row plant densities. Fiber from single row 11 plants m^{-1} cotton was longer than fiber from double row 32 plants m^{-1} cotton at all fruiting position 1 node locations in 2000. Similarly, fiber from single row 7 plants m^{-1} cotton was longer than fiber from double row 16 plants m^{-1} cotton at fruiting position 1 nodes 6 and below (2001). Fiber micronafis, an analogue of micronaire was similar for all treatments at fruiting position 1 nodes 8 and below. Changes in micronaire values related to plant density increases may only occur under environmental conditions in which a normal plant density produces plants with disperse yield patterns with less than 50% of the yield concentrated in fruiting position 1 node 7 and below.

Introduction

Row spacing and in-row density alterations have the potential to affect yield and fiber quality. While small yield changes have been reported for changes in population density it has been proposed that optimum population density depends on environment (Bednarz et al., 2000). In a wet growing season row spacing did not affect yield while in a dry season yields for 19-cm and 38-cm row spacings were greater than wider row spacings (Jost and Cothren, 2000). The 19-cm row spacing had more plants with bolls at the first position than those in wider rows (Jost and Cothren, 2000). Plant population increased from 8 plants m^{-2} at the 102-cm row spacing to 46 plants m^{-2} at the 19-cm row spacing (Jost and Cothren, 2000). Although no differences in yield were found by increasing the in-row population in 91-cm rows the contribution of first position bolls to total yield increased with increasing plant density (Bednarz et al., 2000). Fiber micronaire was not affected by row spacing while length and length uniformity decreased in 19-cm rows when compared to 102-cm rows (Jost and Cothren, 2000). A decrease in in-row density increased micronaire at most boll locations when a density of 2 plants m^{-2} was compared to a density of 12 plants m^{-2} (Jones and Wells, 1998). At two Arizona sites double row planting of rows 18 cm apart on 96.5- and 102-cm beds did not decrease yield, fiber length, or fiber length uniformity but did decrease micronaire values (Hussman et al., 2002). Double row planting could be a feasible practice to increase yield by improving the use efficiency of radiation and water (Fernandez et al., 2002). The objective of this study was to evaluate the effects of three in-row plant densities and two row configurations (single and double row) on yield distribution and fiber properties.

Materials and Methods

The experiment was conducted on Victoria clay-Orelia fine sandy loam complex at the Texas A&M University Agricultural Research and Extension Center in 2000 and 2001. Before planting in 2000, 50 kg ha^{-1} of P_2O_5 ; 123 kg ha^{-1} of N, 22 kg ha^{-1} of S and 4 kg ha^{-1} of Zn were applied. Pre-emergence herbicide was also applied. Paymaster 2280 BG/RR and Tamcot Pyramid were planted using a vacuum precision Monosem NG Plus planter on 31 March 2000 and 21 March 2001, respectively. Insect pests were controlled by ground application as needed. Treatments included two row configurations on beds 97 cm apart (single and 30 cm apart double rows that left 67 cm of furrow between beds) and three in-row planting rates within each row configuration (Fernandez et al., 2001 and Fernandez et al., 2002). Plots were four single rows or four double rows wide and 61 m long. The six planting treatments were arranged in a randomized complete block design with four replications. In 2000 plots were irrigated with 150 mm of water applied using a drip irrigation system. Total rainfall in 2000 from planting date to harvest on 25 July 2000 was 140 mm. Total rainfall in 2001 from planting date to harvest on 24 July 2001 was 167 mm.

After defoliation, yield measurements were made by hand picking seedcotton from one of the two central rows in each plot. Plants from 3.01 m row were cut at the base from the second or third row of each plot for plant mapping and determination of seedcotton yield distribution. The cotyledonary node was designated as node zero. Bolls were categorized by fruiting position and seedcotton was ginned by fruiting position on a 10 saw laboratory gin. One half of the fiber from each fruiting position was combined into a bulk fiber sample. Bulk fiber and fiber from individual fruiting positions were analyzed using the Advanced Fiber Information System. (AFIS A2). Some of the AFIS fiber parameters used were mean length, short fiber content (the percent of fibers less than 12.7 mm), coefficient of variation of fiber length, theta, coefficient of variation of theta and micronafis. Perimeter was calculated from theta and cross-sectional area. Analysis of variance was conducted using PROC MIXED in SAS.

Results and Discussion

The objective of producing different in-row populations was accomplished in both years but the doubling of the plant population was only achieved in 2000 (Fernandez et al., 2001, Fernandez et al., 2002). Germination losses prevented plant stands from reaching target populations. When 3.01 meter sections were removed from rows, sections with the fewest skips were taken.

Lint Yield and Seedcotton Yield Distribution

Lint yield showed significant differences among in row planting densities only within the single row configuration in 2000 (Fernandez et al., 2001). In 2000 single row lint yields ranged from 1145 kg ha^{-1} to 1394 kg ha^{-1} and double row lint yields ranged from 1380 kg ha^{-1} to 1445 kg ha^{-1} (Fernandez et al., 2001). In 2001 single row lint yields ranged from 690 kg ha^{-1} to 805 kg ha^{-1} and double row lint yields ranged from 650 kg ha^{-1} to 797 kg ha^{-1} (Fernandez et al., 2002). Lint yield was not significantly different between single and double-row planting but decreased with increasing in-row planting rate within single and double-row planting (Fernandez et al., 2002). Seedcotton yield distribution by node location was expressed as a percentage of the total seedcotton yield from the 3.01 m row harvested in each plot. In 2000, fruiting position 1 (FP1) cotton at the same node locations were compared across treatments. No significant differences were found when the distributions of seedcotton at locations FP1 nodes 5 through 10 were compared across treatments (Table 1). The distribution of seedcotton yield of all other boll locations was compared and single row 11 plants m^{-1} and double row 24 plants m^{-1} contributed a greater percentage to seedcotton yield than other treatments (Table 1). A comparison of within treatment seedcotton yield revealed that the percentage of FP1 seedcotton decreased with increasing node number in all treatments except double row 24 plant m^{-1} treatment (Table 1). Fruiting position 1 node 7 and below accounted for at least 50% of the seedcotton yield. In 2001, FP1 cotton at the same node locations were compared across treatments. At FP1 nodes 5 and below increasing the in-row density increased the contribution of this node to total seedcotton yield (Table 2). At FP1 node 6 the double row 16 plants m^{-1} contributed more to seedcotton yield than single row 7 plants m^{-1} while the percentage of all other locations was greater for single row 7 plants m^{-1} than double row 16 plants m^{-1} (Table 2). A comparison of within treatment seedcotton yield showed that the contribution of FP1 bolls decreased with increasing node number. The contribution of seedcotton from FP1 nodes 5 and below to total seedcotton yield was greater than the contribution of any other fruiting position. In Mississippi and Georgia nodes 8 through 13 and nodes 6 through 12, respectively contributed the most to seedcotton yield (Jenkins et al., 1990, Bednarz et al., 2000). In the Texas Coastal Bend yield distribution was characterized by less than 20% of the yield coming from boll locations other than FP1 node 10 and below. Water deficit conditions (2001) shifted the yield distribution and at the highest in-row densities for single and double rows FP1 node 6 and below contributed around 67% the yield.

Fiber Properties

Increasing in-row density did not alter mean fiber length in either single or double rows (Table 3 and 4). In 2000, mean fiber length for single rows was 23.7 mm and 23.1 mm for double rows (P=0.004). In 2001, mean fiber length for single rows was 20.8 mm and for double rows was 20.0 mm (P=0.001). Single rows had longer upper quartile lengths than double rows in both years (data not shown) showing the same trend seen in mean fiber lengths. In 2000, the percentage of fibers less than 12.7 mm in length (SFC) did not change with row configuration or in-row density (Table 3). In 2001, SFC was 6.7% in double rows and 5.8% in single rows (P=0.003). Neither row spacing or in-row density changes consistently altered fiber length uniformity when expressed as mean length coefficient of variation (L(w) CV) (Tables 3 and 4). Fiber maturity is defined as the degree of cell wall thickening relative to the diameter of the fiber. A measure of fiber maturity that is independent of fiber perimeter is theta. Theta is the ratio of the cross-sectional area of the fiber wall to the area of a circle having the same perimeter. After boll opening fibers dry out and collapse the degree of collapse from the original circular shape is dependent on the thickness of the cell wall. In 2000, the theta value for single rows was 0.422 and 0.409 for double rows (P = 0.014). No differences were found between single and double rows in 2001. Micronafis, the AFIS analogue of micronaire was not affected by row spacing or in-row density (Tables 3 and 4). Maturity uniformity was expressed as the theta coefficient of variation (theta CV). Changes in theta CV were associated with in-row density changes in double rows in 2000 (Table 3). In 2000 the perimeter for double row cotton was 53.4 µm and for single row cotton was 52.7 µm (P=0.001). In 2001, the perimeter for double row cotton was 56.0 µm and for single row cotton was 55.7 µm (P=0.026). In 2000, single row cotton at the lowest in-row density had the smallest perimeter.

Fiber Properties by Node Location

Under irrigated conditions (2000) the longest fiber at first position bolls nodes 5 through 10 was found in single row low in-row density cotton and the shortest fiber was found in double row high in-row density cotton (Table 5). Mean length ranged from 24.4 mm to 23.6 mm across first position bolls within the single row low in-row density cotton and from 23.4 mm to 22.4 mm across first position bolls within the double row high in row density cotton. Under water deficit conditions (2001) the longest fibers were found at first position bolls nodes 5 and 6 in single row low in-row density cotton and the shortest fiber was found in double row high density cotton (Table 6). Mean length ranged from 21.1 mm to 22.6 mm across first position bolls within the single row low in-row density cotton and from 19.3 mm to 21.3 mm across first position bolls within the double row high in-row density cotton. Changes in row spacing and in-row density did not alter micronafis values for first position bolls nodes 5 through 8 under irrigated and rainfed conditions (Table 7 and 8). When micronafis values were compared within a row spacing and density treatment, fiber micronafis values declined from first position node 5 through node 10 (Table 7 and 8).

Conclusions

In both single and double row cotton yield was concentrated in FP1 bolls below node 10. Water deficit conditions (2001) shifted a larger percentage of the yield to FP1 bolls node 5 and below and in row density changes were evident. Fiber lengths were longer in single row cotton. Double row configuration increased perimeter fiber perimeter in 2000 but not in 2001. Neither row configuration nor in-row density changes altered theta CV or micronafis values. Changes in micronaire values related to plant density changes may only occur under environmental conditions in which a normal plant density produces plants with a more disperse yield pattern with less that 65% of the yield concentrated in FP1 bolls at node 8 and below.

Disclaimer

Mention of a trade name, product or specific equipment does not constitute a guarantee or warranty by USDA and does not imply approval of a product to the exclusion of others that may be suitable.

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Table 1. Seedcotton yield distribution for single(S) and double(D) row cotton (Paymaster 2280 BG/RR) in 2000.

	Plants	Node Location						
	per	FP1, 5	FP1,6	FP1,7	FP1,8	FP1,9	FP1,10	All other
Row	meter				%			
S	11	14 a AB*	19 a A	18 a A	14 a AB	10 a AB	7 a B	18 aA
S	13	21 a A	22 A a	20 a A	14 a AB	9 a B	6 a B	8 bB
S	18	15 a AB	22 a A	23 a A	17 a AB	12 a BC	6 a BC	5 bC
D	22	17 a AB	20 a A	19 a A	17 a AB	12 a AB	8 a B	7 bB
D	24	16 a A	18 a A	18 a A	16 a A	15 a A	8 a A	11 aA
D	32	18 a AB	23 a A	24 a A	18 a AB	12 a BC	7 a C	4 bC

FP1 = fruiting position 1

*Values in the same column followed by the same lower case or values in the same row followed by the same uppercase letter are not significantly different at the P = 0.05 level.

Table 2. Seedcotton yield distribution for single(S) and double(D) row cotton (Tamcot, Pyramid) in 2001.

	Plants	Node Location						
	per	FP1, 5	FP1,6	FP1,7	FP1,8	FP1,9	FP1,10	All other
Row	meter				%			
S	7	27 dA*	20 cB	18 abB	9 aC	5 aC	2 aD	19 aB
S	9	32 cdA	24 bcB	15 abC	6 aD	4 aD	3 aD	16 abC
S	13	45 aA	22 cB	12 bC	5 aD	2 aD	1 aD	13 bC
D	12	31 cdA	23 bcB	18 aBC	7 aD	2 aD	4 aD	14 abC
D	15	34 bcA	28 abB	15 abC	6 aDE	2 aE	2 aE	11 bCD
D	16	38 bA	30 aB	16 abC	6 aDE	2 aE	2 aDE	8 cD

FP1 = fruiting position 1

*Values in the same column followed by the same lower case or values in the same row followed by the same uppercase letter are not significantly different at the P = 0.05 level.

Table 3. AFIS fiber properties for single(S) and double(D) row cotton (Paymaster 2280 BG/RR) in 2000.

	Plants	Fiber Properties					
	per	L(w)	SFC(w)	L(w)CV			Perimeter
Row	meter	mm	%	%	Theta CV	Micronafis	µm
S	11	24.0*a	4.0 a	26.1 ab	38.9 ab	3.17 b	52.6 d
S	13	23.8 a	4.1.a	25.9 b	38.8 ab	3.46 a	52.7 cd
S	18	23.4 ab	4.4 a	26.4 a	39.9 ab	3.00 b	52.8 cd
D	22	23.4 ab	4.4 a	26.4 ab	40.3 a	3.08 b	53.1 bc
D	24	23.1 b	4.5 a	26.3 ab	39.8 ab	3.02 b	53.4 ab
D	32	22.9 b	4.5 a	26.2 ab	38.5 b	3.12 b	53.7 a

*Values in the same column followed by the same lower case or values in the same row followed by the same uppercase letter are not significantly different at the P = 0.05 level.

Table 4. AFIS fiber properties for single(S) and double(D) row cotton (Tamcot Pyramid)) in 2001.

	Plants	Fiber Properties					
	per	L(w)	SFC (w)	L(w) CV	Theta CV		Perimeter
Row	meter	mm	%	%	%	Micronafis	µm
S	7	21.2*a	5.1 b	24.4 b	32.1 a	5.44 a	55.6 ab
S	9	20.8 ab	6.2 a	25.7 a	32.8 a	5.39 a	55.7 b
S	13	20.4 bc	6.2 a	25.2 ab	32.3 a	5.57 a	55.9 ab
D	12	20.2 bc	6.5a	25.5 ab	33.3 a	5.41 a	56.0 ab
D	15	20.1 bc	6.8 a	25.5 ab	33.0 a	5.38 a	56.2 a
D	16	19.7 c	6.9 a	25.4 ab	31.7 a	5.52 a	55.9 ab

*Values in the same column followed by the same lower case or values in the same row followed by the same uppercase letter are not significantly different at the P = 0.05 level.

Table 5. AFIS mean fiber length for fiber from first position bolls (Paymaster 2280 BG/RR) from single (S) or double (D) row cotton in 2000.

Row	Plants per meter	Node Location					
		≤ 5	6	7	8	9	10
		mm					
S	11	24.4 a	24.1 a	24.1 a	23.9 a	23.6 a	23.6 a
S	13	24.1 a	23.6 a	23.9 ab	23.9 a	23.6 a	23.1 ab
S	18	23.9 ab	23.9 a	23.9 abc	23.4 ab	23.4 ab	23.4 ab
D	22	23.6 ab	23.9 a	23.6 ab	23.4 ab	23.1 ab	23.1 ab
D	24	23.6 ab	23.6 a	23.1 bc	23.4 ab	23.1 ab	22.6 b
D	32	23.4 b	22.9 b	22.9 c	23.1 b	22.6 b	22.4 b

*Values in the same column followed by the same lower case or values in the same row followed by the same uppercase letter are not significantly different at the P = 0.05 level.

Table 6. AFIS mean fiber length for fiber from first position bolls (Tamcot, Pyramid) from single(S) or double(D) row cotton in 2001.

Row	Plants per meter	Node Location					
		≤ 5	6	7	8	9	10
		mm					
S	7	21.5 a*	21.1 a	21.2 a	21.6 a	22.6 a	21.6 a
S	9	20.1 b	20.3 ab	20.8 a	20.6 a	21.1 a	22.6 a
S	13	19.8 b	20.1 ab	20.1 a	21.3 a	21.3 a	23.1 a
D	12	20.6 ab	20.1 ab	20.3 a	20.3 a	22.1 a	21.8 a
D	15	19.6 b	19.3 b	20.3 a	21.3 a	21.6 a	21.3 a
D	16	19.3 c	19.3 b	20.1 a	21.1 a	21.3 a	21.3 a

*Values in the same column followed by the same lower case or values in the same row followed by the same uppercase letter are not significantly different at the P = 0.05 level.

Table 7. Micronafis values for fiber from first position bolls (Paymaster 2200 BG/RR) from single(S) or double(D) row cotton in 2000.

Row	Plants per meter	Node Location					
		≤ 5	6	7	8	9	10
S	11	3.49 aA*	3.49 aA	3.28 aA	2.79 aB	2.57 bB	2.37 bB
S	13	3.61 aA	3.62 aA	3.32 aAB	3.09 aB	2.47 bC	2.60 abC
S	18	3.36 aA	3.31 aA	3.10 aAB	2.74 aBC	2.64 abBC	2.38 bC
D	22	3.41 aA	3.38 aA	2.99 aAB	2.90 aB	2.45 bB	2.42 abB
D	24	3.50 aA	3.21 aAB	3.11 aAB	3.00 aAB	2.60 bC	2.89 aBC
D	32	3.37 aA	3.20 aAB	2.93 aAB	3.20 aAB	3.21aAB	2.72 abB

*Values in the same column followed by the same lower case or values in the same row followed by the same uppercase letter are not significantly different at the P = 0.05 level.

Table 8. Micronafis values for fiber from first position bolls (Tamcot, Pyramid) from single(S) and double(D) row cotton in 2001.

Row	Plants per meter	Node Location					
		≤ 5	6	7	8	9	10
S	7	5.64aA*	5.64 aA	5.61 aA	5.27 aAB	4.74 aB	4.49 aB
S	9	5.74 aA	5.60 aA	5.45 aA	5.15 aB	4.60 abB	4.75 aB
S	13	5.76 aA	5.81 aAB	5.67 aAB	5.20 aC	5.06 aBC	4.88 aC
D	12	5.78 aA	5.83 aA	5.50 aA	5.40 aAB	4.89 aB	4.95 aB
D	15	5.61 aA	5.90 aA	5.78 aA	5.45 aA	4.07 bB	4.50 aB
D	16	5.58 aA	5.79 aA	5.60 aAB	5.31 aAB	4.38 abC	4.99 aB

*Values in the same column followed by the same lower case or values in the same row followed by the same uppercase letter are not significantly different at the P = 0.05 level.