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The Effects of Narrow-Row and Twin-Row Cotton on Fiber Properties

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ABSTRACT

Planting crops in alternative row patterns such as skip row, twin-row, or narrow-row, in comparison to a conventional 102-cm single row pattern, has been shown to increase root spacing, canopy closure, and yields. Two studies were conducted to assess the effect of alternative row patterns on fiber properties. The objective of the first study was to compare fiber properties for cotton in narrow-row (38-cm solid) and twin-row (25-cm paired on 102-cm beds) at different plant populations to conventional 102-cm solid rows at standard plant population. The objective of the second study was to compare fiber properties for cotton in twin-row (38-cm paired on 102-cm beds) to conventional 102-cm solid rows. In the first study, cotton was planted two years in both non-irrigated and irrigated fields near Stoneville, MS. Each field included the same eleven treatments: 38-cm solid and 25-cm paired rows at five plant populations and 102-cm rows at standard plant population. In the second study, two varieties were each planted two years in an irrigated field near Stoneville, MS. Lint quality samples in both studies were hand-picked from plots, ginned on a 10-saw gin stand, and analyzed by High Volume Instrument (HVI) and Advanced Fiber Information System (AFIS). In the first study, plant populations in the non-irrigated experiment ranged from 106,000 to 215,000 plants/ha in 38-cm rows; 99,000 to 217,000 plants/ha in 25-cm paired rows; and 126,000 plants/ha in 102-cm rows. Plant populations in the irrigated experiment ranged from 93,000 to 220,000 plants/ha in 38-cm rows; 90,000 to 194,000 plants/ha in 25-cm paired rows; and 127,000 plants/ha in 102-cm rows. No meaningful significant differences were found for HVI fiber properties (length, micronaire, strength, uniformity, reflectance, yellowness, or trash) or AFIS fiber properties (upper quartile length, short fiber content, nep count, seed coat nep count, fineness, immature fiber content, or maturity ratio) in comparing 38-cm solid or 25-cm paired rows to 102-cm solid rows in either non-irrigated or irrigated experiments. In the second study, fiber quality analysis showed fewer neps in the 38-cm twin rows. Other properties were favorable for 38-cm twin rows but not consistent for the two years or two varieties tested. The results of fiber quality demonstrate that cotton produced in 38-cm solid and 38-cm twin rows on 102-cm beds was equal to or better than cotton produced in conventional 102-cm rows.

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Increasing cotton farm profits is primarily achieved by increasing crop yields, improving quality, and reducing input costs. Alternative row-crop planting patterns such as skip-row, twin-row, narrow- row, and ultra-narrow-row have been studied for their potential to increase yields over that of conventional, spindle-picked rows (97 to 102 cm). Recent studies have focused on narrow-row cotton production. The recently introduced John Deere PRO-12 VRS spindle-type picker™ (Karnei, 2005) is capable of picking cotton in rows ranging from 38 to 102 cm. Cotton grown in narrow rows (38-cm) and twin rows (25-cm) produced equal or higher yields than cotton grown in conventional (97 to 102 cm) rows (Buehring et al., 2006; Buehring et al., 2009; Harrison et al., 2006; Nichols et al., 2004; Reddy et al., 2009; Reddy and Boykin, 2010; Willcutt et al., 2006; and Wilson et al., 2007). Narrow-row cotton results in earlier canopy closure than conventional rows, and this earlier canopy closure can potentially be achieved without increased seed costs (seeding rates) associated with ultra-narrow-rows. Increased yields in narrow rows (38-cm) were achieved with fewer plants/ha than in conventional rows (Reddy et al., 2009).

Fiber quality is an important factor determining commodity price, and it is important that fiber quality for cotton grown in alternative row patterns is comparable to that of cotton grown in a conventional row pattern. Buehring et al. (2009) studied spindle-picked cotton in multiple years and locations and reported minor differences in HVI and AFIS fiber properties (specifically micronaire, fiber length, reflectance, yellowness, and maturity ratio) between several row patterns including 38-cm and 97-cm solid rows. The minor differences were found in one location only and were not consistent from one year to the next. Using the same John Deere PRO-12 VRS to harvest both 38- and 97-cm rows, their economic analysis showed the 38-cm solid rows had lower whole-farm net revenue than 97-cm solid rows due to the smaller harvester swath width which reduced area coverage per hour. Nichols et al. (2004) showed in some cases fiber length and micronaire were lower for 38-cm rows than for 102-cm rows, but this difference was not consistent across the three years and multiple cotton varieties tested. Information relating plant population to fiber properties for narrow-row and twin-row is lacking.

Reddy et al. (2009) compared 38-cm solid and 25-cm paired rows at different plant populations to conventional 102-cm rows in non-irrigated and irrigated experiments. Lint yields in the non-irrigated experiment were reported to be 32% higher for 38-cm rows at 106,000 plants/ha than 102-cm rows at 126,000 plants/ha, but significant differences were not reported for 25-cm paired rows. Lint yields in the irrigated experiment were reported to be 32% higher for 38-cm rows at 105,000 plants/ha in comparison to 102-cm rows at 127,000 plants/ha, but significant differences were not reported for 25-cm paired rows. Increased yields in the 38-cm rows at lower plant populations were reported to correlate with more open bolls harvested per plant. Reddy and Boykin (2010) compared 38-cm twin rows on 102-cm beds (95,000 plants/ha) to conventional 102-cm rows (110,000 plants/ha) in an irrigated environment and reported 6% higher lint yield for the 38-cm twin rows.

This study reports the comparison of fiber quality of cotton grown in narrow-row and twin-row patterns with a standard-row pattern. The first objective of the study was to compare fiber properties of cotton grown in 38-cm solid and 25-cm paired rows at varying plant populations with conventional 102-cm rows in an irrigated and non-irrigated environment. The second objective was to compare fiber properties of cotton grown in 38-cm twin rows on 102-cm beds with cotton grown in 102-cm rows under an irrigated environment. Detailed results including canopy closure and yield have been published elsewhere (Reddy et al., 2009 and Reddy and Boykin, 2010) and will not be included in this report.

MATERIALS AND METHODS

Non-irrigated narrow-row and twin-row cotton experiment. Cotton was grown in a non-irrigated field of Dundee silt clay loam soil near Stoneville, MS during 2006 and 2007. Plots were prepared for planting in 25-cm paired, 38-cm solid, and 102-cm solid rows, and the variety DP164B2RF (Deltapine, Memphis, TN) was planted on April 19, 2006 and on April 30, 2007. For additional planting and field maintenance details, refer to Reddy et al. (2009). Cotton in 25-cm paired and 38-cm solid rows was planted at five seeding rates to achieve plant populations above and below the recommended plant population for conventional 102-cm solid rows (Table 1). Plant populations were determined at harvest by counting plants in 1 m of the two center rows at three locations in each plot. Cotton planted in 102-cm solid rows was included as a standard cotton production system to compare fiber properties of cotton planted in 25-cm paired and 38-cm solid rows. The experiment was conducted in a randomized complete block design with four replications. Each treatment consisted of ten 38-cm (15-in) rows, four 25-cm (10-in) paired rows on a 102-cm (40-in) center (8 rows total), or four single rows spaced 102 cm apart. Plots were 15.2 m long and maintained weed free using both pre-emergence and post-emergence herbicide programs and weeds that escaped chemical management were hand hoed. Seed cotton was handpicked from 1-m sections in the two center rows at three locations in each plot. Seed cotton was ginned on a 10-saw laboratory gin (Continental Eagle, Prattville, AL), and one lint sample was taken from each plot for fiber quality measurements by High Volume Instrument (HVI) at the USDA Cotton Classing Office, Dumas, AR, and by AFIS (Advanced Fiber Information System, Uster Technologies, Knoxville, TN). Earlier studies have shown that treatment differences in fiber quality for tests utilizing a laboratory scale gin stand typically mimic that of conventional ginning machinery (Boykin, 2008). Data were analyzed using Proc Mixed (SAS v9.2, Cary, N.C., 2008). There were eleven experimental treatments including 25-cm paired rows at five target populations, 38-cm solid rows at five target populations, and 102-cm solid rows at one target population. Results were analyzed in this way to compare experimental treatments to the conventional 102-cm solid row treatment.

Table 1. Treatment means and statistics for HVI fiber properties found in the non-irrigated experiment. Values were averaged over 2006 and 2007.

Row width	Cotton population (plants/ha)	Length (cm)	Micronaire	Strength (kN*m/kg)	Uniformity (%)	Reflectance	Yellowness	Trash (%)
38-cm solid	106,000	2.80	4.03	279	81.1	75.7	7.56	0.57
	111,000	2.83	3.86	273	80.3	76.2	7.67	0.55
	130,000	2.75	4.00	272	80.1	75.8	7.51	0.76
	170,000	2.80	4.01	279	81.3	76.3	7.45	0.65
	215,000	2.74	4.08	279	80.8	76.2	7.77	0.67
25-cm pair	99,000	2.79	4.03	285	80.9	76.9 [Z]	7.71	0.61
	117,000	2.75	3.98	276	80.7	76.0	7.61	0.70
	142,000	2.84	3.81	287	80.9	76.5	7.45	0.64
	164,000	2.77	4.03	277	80.4	75.6	7.59	0.65
	217,000	2.80	3.95	286	81.3	76.7	7.61	0.72
102-cm	126,000	2.82	4.00	289	81.0	75.5	7.56	0.66
LSD		0.09	0.27	22	1.3	1.4	0.43	0.22

[Z] value significantly different ($p<0.05$) from conventional 102-cm solid row spacing

Irrigated narrow-row and twin-row cotton experiment. Cotton was grown in an irrigated field of Dundee silt loam soil near Stoneville, MS during 2006 and 2007. Field preparation and maintenance, cotton cultivar, planting dates, experimental treatments, and data collection were the same as the non-irrigated, narrow-row and twin-row study with two exceptions. Plots were 24.4 m long, and cotton was irrigated as needed based on visual observation: three times in 2006 and eight times in 2007.

Twin-rows vs. single-row on 102-cm beds experiment. Cotton was grown in an irrigated field of Dundee silt clay loam soil near Stoneville, MS during 2007 and 2008. Plots were prepared for planting in 38-cm twin rows or single-row on 102-cm beds, and planted with DP117B2RF and DP164B2RF on April 23, 2007 and April 23, 2008. For additional planting and field maintenance details, refer to Reddy and Boykin (2010). Harvesting, ginning, and fiber quality analysis were the same as the non-irrigated narrow-row and twin-row study. Plant populations at harvest were 110,000 plants/ha for 102-cm rows and 95,000 plants/ha in 38-cm twin rows. Cotton in conventional 102-cm rows was the standard for evaluating fiber properties of cotton in 38-cm twin-rows.

The experiment was conducted in a split-split plot arrangement of treatments in a randomized complete block design with row pattern as main plots, cultivar as subplots, and herbicides as sub-subplots with four replications. Plots were 13.7 m long and consisted of either four 38-cm twin rows on 102-cm centers or four 102-cm single rows. The two cultivars were DP117B2RF and DP164B2RF. The four herbicide treatments were fluometuron (Cotoran 4L®, Griffin L.L.C., Valdosta, GA) plus *S*-metolachlor (Dual II Magnum®, Syngenta Crop Protection, Greensboro, NC) applied pre-emergence (PRE) followed by glyphosate (Roundup WeatherMAX®, Monsanto Company, St. Louis, MO) applied early POST (EPOST); PRE and EPOST followed by mid-season POST (MPOST); PRE, EPOST, and MPOST followed by late POST (LPOST); and EPOST, MPOST, and LPOST. Fluometuron rates were 1.12 kg ai/ha, *S*-metolachlor rates were 1.12 kg ai/ha, and glyphosate rates were 0.84 kg ae/ha. The PRE herbicide treatments were applied immediately after planting, and the EPOST, MPOST, and LPOST treatments were applied 4, 7, and 9 wks after planting, respectively. Cotton was furrow irrigated six times in 2007 and seven times in 2008. Picking, ginning, and fiber quality analysis were as described above in the non-irrigated narrow-row and twin-row cotton study. Data were analyzed using Proc Mixed (SAS v9.2, Cary, N.C., 2008).

RESULTS AND DISCUSSION

Non-irrigated narrow-row and twin-row cotton. Averaged over two years, plant populations at harvest ranged from 106,000 to 215,000 plants/ha in the 38-cm solid rows; a range that extended below and above 126,000 plants/ha in conventional 102-cm solid rows (Table 1). Similarly, the 25-cm paired row plant populations ranged from 99,000 to 217,000 plants/ha.

Lint yields were higher for 38-cm solid rows with plant populations ≤ 130,000 plants/ha in comparison to conventional 102-cm solid rows with 126,000 plants/ha, but differences were not found for the 25-cm paired rows (Reddy et al., 2009). Fiber quality determined by HVI and AFIS testing was examined to compare conventional 102-cm rows to experimental 38-cm solid and 25-cm paired rows, especially 38-cm solid rows with plant populations ≤ 130,000 plants/ha which produced more lint. None of the experimental treatments differed significantly from conventional 102-cm rows for HVI length, micronaire, strength, uniformity, yellowness, or trash (Table 1). There was a slight yet statistically significant increase observed in HVI reflectance for 25-cm paired row at 99,000 plants/ha compared to conventional 102-cm rows (Table 1), but there was no explanation as to why this occurred. None of the experimental treatments differed significantly from conventional 102-cm rows for AFIS upper quartile length, short fiber content, nep count, seed coat nep count, fineness, immature fiber content, or maturity ratio (Table 2). The fiber quality data indicate that cotton produced in 38-cm rows and 25-cm paired rows was comparable to cotton grown in conventional 102-cm rows.

Irrigated narrow-row and twin-row cotton. Averaged over two years, plant populations at harvest ranged from 93,000 to 220,000 plants/ha in the 38-cm solid rows and from 90,000 to 194,000 plants/ha in 25-cm paired rows; ranges which extended below and above 127,000 plants/ha in conventional 102-cm solid rows (Table 3). Lint yields were significantly higher in the 38-cm solid rows with plant populations ≤ 124,000 plants/ha than in the conventional 102-cm solid rows with 127,000 plants/ha, but differences were not found for the 25-cm paired rows (Reddy et al. 2009). Results of HVI testing showed that lint from conventional 102-cm solid rows did not differ significantly from 38-cm solid and 25-cm paired rows at different plant populations for length, strength, uniformity, reflectance, yellowness, or trash (Table 3). Micronaire was significantly lower for 38-cm solid rows with 220,000 plants/ha than 102-cm solid rows. Otherwise, micronaire for the 38-cm solid and 25-cm paired rows at different plant populations did not differ from 102-cm solid rows. Results of AFIS testing showed that lint from conventional 102-cm solid rows did not differ significantly from 38-cm solid and 25-cm paired rows at different plant populations for upper quartile length, short fiber content, nep count, or seed coat nep count (Table 4). Fineness, immature fiber content, and maturity ratio differed significantly for 38-cm solid rows with 220,000 plants/ha than 102-cm solid rows. Otherwise, fineness, immature fiber content, and maturity ratio for the 38-cm solid and 25-cm paired rows at different plant populations did not differ from 102-cm solid rows. It was not clear why micronaire, fineness, and maturity data differed for this one treatment. These results indicate that increased yields with 38-cm solid rows with plant populations ≤ 124,000 plants/ha in an irrigated environment did not compromise fiber quality.

Table 2. Treatment means and statistics for selected AFIS fiber properties found in the non-irrigated experiment. Values were averaged over 2006 and 2007.

Row width	Cotton population (plants/ha)	Upper quartile length, cm[Z]	Short fiber content, %[Z]	Nep count, per g lint	Seed coat nep count, per g lint	Fineness, mTex	Immature fiber content, %	Maturity ratio
38-cm solid	106,000	2.83	10.7	263	10.0	166	8.19	0.869
	111,000	2.83	11.7	332	11.4	161	9.01	0.850
	130,000	2.91	9.9	231	9.4	166	8.01	0.871
	170,000	2.86	10.4	243	10.6	168	7.90	0.876
	215,000	2.83	11.0	254	11.1	166	8.39	0.866
25-cm pair	99,000	2.85	11.1	273	9.3	165	8.53	0.863
	117,000	2.84	10.0	228	7.6	166	8.01	0.873
	142,000	2.88	11.0	277	10.1	164	8.53	0.861
	164,000	2.87	9.9	232	10.5	168	7.74	0.879
	217,000	2.91	9.4	229	9.9	166	7.91	0.873
102-cm	126,000	2.86	10.9	259	8.6	165	8.29	0.866
LSD		0.09	1.8	91	5.2	4	0.98	0.020

[Z] weight based length measurements

Table 3. Treatment means and statistics for HVI fiber properties found in the irrigated experiment. Values were averaged over 2006 and 2007.

Row width	Cotton population (plants/ha)	Length (cm)	Micronaire	Strength (kN*m/kg)	Uniformity (%)	Reflectance	Yellowness	Trash (%)
38-cm solid	93,000	2.95	4.05	316	82.2	77.1	7.23	0.80
	105,000	2.92	4.08	304	81.9	76.9	7.33	0.69
	124,000	2.94	4.01	310	81.8	77.1	7.06	1.03
	167,000	2.94	4.06	306	81.5	77.2	7.23	0.92
	220,000	2.96	3.95 [Z]	311	81.6	77.7	7.40	0.84
25-cm pair	90,000	2.88	4.20	302	81.4	77.7	7.40	0.62
	115,000	2.91	4.25	313	82.0	77.5	7.25	0.80
	136,000	2.93	4.23	303	81.6	77.6	7.25	0.67
	155,000	2.93	4.11	307	82.3	77.0	7.11	0.84
	194,000	2.96	4.21	316	81.9	77.1	7.02	0.85
102-cm	127,000	2.94	4.25	305	81.9	76.8	7.13	0.85
LSD		0.06	0.26	12	0.9	1.2	0.43	0.26

[Z] value significantly different ($p<0.05$) from conventional 102-cm solid row spacing

Table 4. Treatment means and statistics for selected AFIS fiber properties found in the irrigated experiment. Values were averaged over 2006 and 2007.

Row width	Cotton population (plants/ha)	Upper quartile length, cm [Y]	Short fiber content, % [Y]	Nep count, per g lint	Seed coat nep count, per g lint	Fineness, mTex	Immature fiber content, %	Maturity ratio
38-cm solid	93,000	3.09	8.7	185	7.5	166	7.94	0.881
	105,000	3.08	8.5	196	11.3	168	7.64	0.889
	124,000	3.10	8.6	216	10.9	166	8.26	0.879
	167,000	3.06	8.8	203	10.5	166	7.97	0.883
	220,000	3.11	8.8	228	8.8	163 [Z]	8.54 [Z]	0.869 [Z]
25-cm pair	90,000	3.03	9.2	188	10.0	168	8.11	0.883
	115,000	3.05	8.9	196	11.0	170	7.76	0.889
	136,000	3.07	8.5	177	8.3	169	7.60	0.889
	155,000	3.06	8.9	186	11.6	168	7.69	0.888
	194,000	3.04	9.5	216	9.0	167	8.11	0.879
102-cm	127,000	3.08	8.4	181	9.5	169	7.45	0.891
LSD		0.07	1.2	65	4.6	5	1.04	0.020

[Z] value significantly different ($p<0.05$) from conventional 102-cm solid row spacing

[Y] weight based length measurements

Twin row vs. single-row cotton. Lint yields were 6% higher in the 38-cm twin rows than in the conventional 102-cm solid rows (Reddy and Boykin 2010). Fiber quality results were averaged over herbicide treatments because they did not pertain to this study and there were no interactions with row patterns. Overall (averaged over years, cultivars, and herbicide treatments), micronaire, strength, and reflectance measured by HVI were higher (Table 5), and nep count and seed coat nep count by AFIS were lower (Table 6) for 38-cm twin rows than for 102-cm solid rows. Overall row spacing differences were not found for length, uniformity, yellowness, or trash by HVI or for upper quartile length, short fiber content, fineness, immature fiber content, or maturity ratio by AFIS. Results separated by year showed some of these differences were not consistent between years. In 2007, micronaire was greater for 38-cm twin rows, but no other properties differed significantly (Tables 5 and 6). In 2008, fiber length, strength, uniformity, reflectance, and upper quartile length were higher; and short fiber content and seed coat nep count were lower for 38-cm twin rows, but no other properties differed significantly (Table 5 and Table 6). Separated by cultivar, strength and reflectance were higher for DP117B2RF, seed coat nep count was lower for DP117B2RF, and nep count was lower for DP164B2RF for 38-cm twin rows. Lower nep counts in the 38-cm twin rows was the only difference that was consistent for both years and both varieties. This difference in nep counts did not seem to correlate with any other treatment differences commonly associated with neps such as fineness and maturity, so it was unclear why lower nep counts were found in the 38-cm twin rows. These results indicate that increased yields with 38-cm twin rows did not compromise fiber quality. In some cases, especially nep counts, fiber properties were better for 38-cm twin rows, but most of these differences were not consistent for the two test years or two varieties.

CONCLUSION

The first study compared fiber properties of cotton grown in 25-cm paired and 38-cm solid rows at different plant populations to cotton grown in conventional 102-cm solid rows with results specific to non-irrigated Dundee silt clay loam soil and irrigated Dundee silt loam soil in the lower Mississippi River Valley alluvial flood plain. The second study compared fiber properties of cotton grown in 38-cm twin rows on 102-cm beds to cotton grown in conventional 102-cm single rows to under irrigated Dundee silt clay loam soil in the lower Mississippi River Valley alluvial flood plain. Cotton grown in 25-cm paired rows and 38-cm narrow rows produced equal or higher lint yields compared to cotton grown in 102-cm rows (Reddy et al., 2009) and fiber quality analyses with HVI and AFIS showed no differences among row patterns. In a second study, cotton grown in irrigated 38-cm twin rows on 102-cm beds produced higher lint yield than cotton grown in 102-cm single rows (Reddy and Boykin, 2010) and fiber quality analyses with HVI and AFIS showed fewer neps in the 38-cm twin rows. Increased neps in the 102-cm rows was an indication of immature fibers, but those overall differences were not significant. Other fiber properties such as fiber length, micronaire, strength, uniformity, reflectance, short fiber content, and seed coat neps were favorable for 38-cm twin rows but not consistent for the two years or two varieties tested. Fiber quality results demonstrated that cotton produced in 38-cm solid and 38-cm twin rows on 102-cm beds is equal or better compared with cotton produced in conventional 102-cm rows.

Table 5. Treatment means and statistics for HVI fiber properties of cotton grown in 38-cm twin rows and 102-cm single row.

Treatment		Length (cm)	Micronaire	Strength (kN*m/kg)	Uniformity (%)	Reflectance	Yellowness	Trash (%)
Row width								
38-cm twin		2.93 A[Z]	4.40 A	309 A	82.6 A	77.5 A	8.4 A	0.20 A
102-cm		2.92 A	4.32 B	303 B	82.3 A	76.9 B	8.5 A	0.21 A
LSD		0.02	0.07	5	0.36	0.5	0.4	0.03
Row width	**Year**							
38-cm twin	2007	2.97 A	4.19 B	318 A	82.4 AB	77.1 AB	8.4 A	0.24 AB
102-cm	2007	2.99 A	4.05 C	318 A	82.5 AB	77.5 A	8.5 A	0.24 A
38-cm twin	2008	2.90 B	4.60 A	300 B	82.7 A	77.9 A	8.5 A	0.15 C
102-cm	2008	2.86 C	4.59 A	289 C	82.0 B	76.3 B	8.6 A	0.18 CB
LSD		0.03	0.10	7	0.51	0.7	0.6	0.04
Row width	**Variety**							
38-cm twin	DP117B2RF	2.91 B	4.50 A	317 A	82.7 A	75.9 B	8.5 A	0.21 AB
102-cm	DP117B2RF	2.90 B	4.44 A	308 B	82.6 A	74.8 C	8.7 A	0.25 A
38-cm twin	DP164B2RF	2.95 A	4.29 B	300 C	82.4 AB	79.2 A	8.3 A	0.18 CB
102-cm	DP164B2RF	2.94 A	4.19 B	299 C	82.0 B	79.0 A	8.3 A	0.17 C
LSD		0.03	0.10	7	0.51	0.7	0.6	0.04

[Z] value with same letter not significantly different

Table 6. Treatment means and statistics for selected AFIS fiber properties of cotton grown in 38-cm twin rows and 102-cm single rows.

Treatment		Upper quartile length, cm[Y]	Short fiber content, %[Y]	Nep count, per g lint	Seed coat nep count, per g lint	Fineness, mTex	Immature fiber content, %	Maturity ratio
Row width								
38-cm twin		3.02 A[Z]	9.0 A	137 B	6.5 B	173 A	6.9 A	0.898 A
102-cm		3.02 A	9.1 A	157 A	7.9 A	171 A	7.1 A	0.893 A
LSD		0.02	0.5	18	1.1	1.5	0.3	0.007
Row width	**Year**							
38-cm twin	2007	3.08 A	8.7 B	158 AB	7.3 AB	170 B	7.3 AB	0.895 A
102-cm	2007	3.11 A	8.3 B	178 A	7.2 AB	168 B	7.5 A	0.891 A
38-cm twin	2008	2.96 B	9.2 B	116 B	5.8 B	175 A	6.4 C	0.900 A
102-cm	2008	2.92 C	9.9 A	137 AB	8.5 A	174 A	6.7 CB	0.895 A
LSD		0.03	0.7	25	1.6	2.1	0.4	0.009
Row width	**Variety**							
38-cm twin	DP117B2RF	2.99 B	8.8 AB	116 C	5.7 B	173 A	6.7 B	0.904 A
102-cm	DP117B2RF	2.99 B	8.8 B	121 C	7.8 A	172 AB	6.7 B	0.902 A
38-cm twin	DP164B2RF	3.04 A	9.1 AB	158 B	7.4 A	172 AB	7.1 AB	0.892 B
102-cm	DP164B2RF	3.04 A	9.5 A	194 A	7.9 A	171 B	7.5 A	0.884 B
LSD		0.03	0.7	25	1.6	2.1	0.4	0.009

[Z] **value with same letter not significantly different**

[Y] **weight based length measurements**

DISCLAIMER

Mention of a trade names or commercial products in the publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U. S. Department of Agriculture.

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