COTTON GROWTH, MATURITY AND YIELD AS INFLUENCED BY NARROW ROW SPINDLE PICKER ROW PATTERNS IN A NON-IRRIGATED ENVIRONMENT; FINAL REPORT

Robert R. Dobbs
N.W. Buehring
North Mississippi Research and Extension Center
Verona, MS
M. H. Willcutt
Mississippi State University
Mississippi State, MS
M.P. Harrison
North Mississippi Research and Extension Center
Verona, MS

Abstract

A two-year (2004-2005) study on a very fine sandy loam soil at Clarksdale, MS and 4-year (2003-2006) studies on silt loam soils at Verona, MS and Falkner, MS evaluated cotton yield, maturity, plant stem diameter and height at harvest response to different row patterns. The row patterns used in the study were 15, 30, and 38-inch row solid cotton, 15-inch rows with a 2x1 skip row (2 rows of cotton with a 30-inch skip), 15-inch row 2x2 skip row (2 rows with a 45-inch skip), 30-inch rows with a 1x1 skip row (cotton in 60-inch rows), 30-inch rows with a 2x1 skip row (2 rows with a 60-inch skip), and 38-inch rows with a 2x1 skip row (2 rows with a 76-inch skip) pattern. Seeding rates were 4 seed/ft of row for all 38-inch rows and 3 seed/ft of row for all 30 and 15-inch row patterns. The 15-inch row solid plant height across locations averaged 2 to 6 inches shorter at harvest; and average plant stem diameters at harvest were up to 0.10 inches smaller. Rotten boll numbers at harvest were low (< 1 boll/10 ft^2) at all locations with only minor differences among row patterns. Maturity based on percent open bolls at defoliation indicated no differences between 15-inch solid rows, 30 and 38-inch solid row patterns. The 15-inch solid rows 2-year yield average of 1195 lb/acre at Clarksdale showed no yield differences between 15, 30 and 38-inch solid row patterns. At Verona and Falkner the 15-inch solid row pattern yields of 1047 and 1278 lb/acre, respectively, were 2% higher than 30-inch solid and 6% higher than 38-inch solid row patterns. The 15-inch 2x2 skip row pattern yields were 91, 94 and 94% of the 15-inch solid row patterns at Verona, Falkner and Clarksdale, respectively. Averaged over locations and years, the 15-inch 2x2 skip row pattern yield was 4, 11 and 13% higher than 30-inch 2x1 skip row, 38-inch 2x1 skip row and (30-inch 1x1 skip) 60-inch solid rows, respectively. The 15-inch 2x1 skip row pattern yield was equal to 15-inch solid rows at Verona and 97% of 15-inch at Clarksdale and Falkner. Averaged over locations and years, the 15-inch 2x1 skip row pattern yield was 13, 15 and 17% higher in yield than 30-inch 2x1 skip row, 38-inch 2x1 skip row, and (60-inch rows) 30-inch 1x1 skip row patterns, respectively.

Introduction

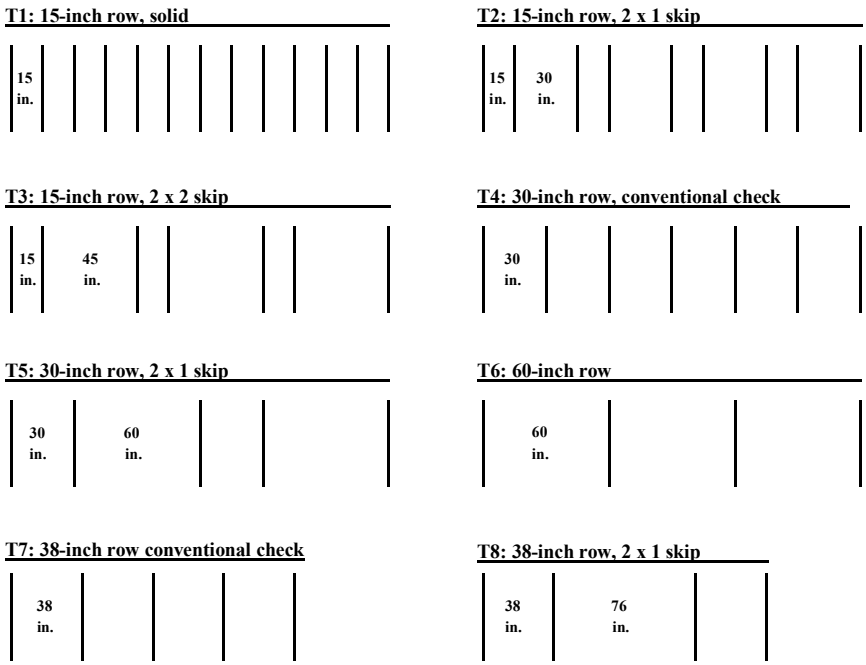
Efficient cotton production for improved net returns is essential for Mississippi cotton growers to maintain a competitive advantage in a global economy. UNR stripper cotton and skip row cotton production systems have been used as means for improving profitability. UNR cotton yields (Atwell 1996; Buehring et al., 2001; Nichols and Snipes 2002; Shurley et al., 2002) and net returns (Parvin et al., 2002; Shirley et al., 2002) were equal or higher than conventional wide rows. However, the $.03 to $.05/lb discount for the fiber's (neps and trash) negative spinning quality; the inability to operate the finger strippers under high humidity or dampness in the rain belt; and the increased trash content have offset these advantages. The increased trash content in the material taken to the gin reduces gin-processing capacity (Brashears 1968; Mayfield 1999; and Anthony et al., 1999 and 2000). HVI fiber quality analysis showed no differences between spindle picker, brush stripper, and finger stripper harvested cotton in 10-inch rows (Anthony et al., 1999 and 2000; Willcut et al., 2001). However, their reports indicated the finger stripper samples had increased neps/gm (spinning flaws in making fabric). Therefore, stripper harvested UNR cotton is most often discounted 3 to 5 cents/lb of lint; plus any reductions for bark, trash, or preparation (Willcutt et al. 2001).

However, new alternative narrow spindle picker production systems offer the potential to offset some of the limitations of the UNR stripper system. Deere and Company's introduction of the new 15-inch row John Deere PRO 12 VRS spindle picker makes possible spindle picker production systems that not only approximate UNR stripper cotton systems, but also have the potential to maximize fiber spinning quality (lower neps and trash than for stripper

harvested lint) while retaining the operational benefits of a spindle picker. This system also allows for possible 15-inch skip row combinations to reduce boll rot potential that can occur with UNR cotton in the rain belt. The objective of this study was to determine the effect of new narrow row (15-inch solid and 15-inch skip row) cotton spindle production systems on end-season plant characteristics and lint yield.

Materials and Methods

Studies were conducted in 2003-2006 on a Marietta silt loam and Falaya sandy loam soil at Verona and Falkner, Mississippi, respectively. A study also was conducted in 2004 and 2005 on a Dubbs very fine sandy loam soil at Clarksdale, MS. Studies at all locations were conducted as a split plot with row pattern as main plot and years as subplot with four replications. Plot size was 20 ft by 120 ft with row patterns as shown in Figure 1. Deltapine DP 449BG/RR cotton cultivar was planted into a spring prepared stale seedbed in early to late May 2003-2006 at Falkner and Verona; and late April to early May 2004-2005 at Clarksdale.



Current recommended agronomic production practices were used at all locations. Seeding rates at all locations and years were 3 seed/ft of row for all 15 and 30-inch rows and 4 seed/ft of row for 38-inch rows. The seed was treated with Centric (thiamethoxam) for early season insect control. Pentia (mepiquat pentaborate) was applied as needed to the entire study to manage cotton growth. Cotton was scouted twice weekly and insecticides were applied as needed.

All cotton plots were harvested in 2003 and 2004 with a John Deere PRO-12 VRS picker unit mounted on a single row picker using a John Deere 4020 tractor as the power unit. In 2005 and 2006, the plots were harvested with a John Deere 9960 picker equipped with two John Deere PRO 12 VRS picker units that were adjustable for each row pattern. Four or 8 rows of the 15-inch solid; four rows of the 15-inch 2x1 skip row and 15-inch 2x2 skip row; and 2 rows of the 60, 30 and 38-inch solid row, and 30 and 38-inch 2x1 skip row of each plot were harvested for yield.

The seed cotton from the harvested plots was ginned with a mini-gin (state of the art cotton gin, equivalent to a commercial gin) to determine lint yield. Lint moisture determinations were made on all samples after ginning. The lint yield was calculated on a land area basis and adjusted to 6% moisture for all plots before data analysis. Data collected at all locations were: plant height at harvest, plant population at harvest, plant stem diameter at harvest,

rotten bolls at harvest, and lint yield. Percent open bolls at defoliation were collected at Clarksdale and Falkner. All data for each location were analyzed with the Mixed Procedure program using Statistical Analysis System (SAS) software (Littell et al., 1996). When no interactions were detected the data were pooled over years. Means were separated using Fisher's Protected LSD calculated at the 5% significance level.

Results and Discussion

Wet soil conditions in May at Verona and Falkner in 2003 delayed planting until the last days of May. Planting was accomplished at all locations from April 27 to May 10 in 2004 and 2005 and mid-May in 2006. Above normal rainfall during the growing season at all locations in 2003 and 2004 resulted in above average yield. However, at Clarksdale in 2005, only 4.25 inches of rainfall was received from planting through August 26. Hurricane Rita in late September also caused 20 to 30% yield losses (visual estimate). At Verona in 2005, the growing season had highly erratic rainfall with only 27% of normal for May, 17% above normal for June with all rainfall the first 13 days of June, followed by no rainfall from June 14 through July 4. This was followed by a wet July with 85% above normal rainfall; and a 4-week period from August 1 through August 28 with no rainfall. This erratic rainfall appeared to have had a negative effect on growth and yield, especially on 15-inch solid cotton. Falkner had excellent growing conditions all 4 seasons except for dry conditions in mid-August 2005 and 2006. Plant populations at harvest at all locations were good with an 83% emergence rate over all row patterns and years.

Seeding rates of 4 seed/planted row ft in the 38-inch and 38-inch 2x1 skip row pattern at all locations resulted in the 38-inch 2x1 inch skip row population being 67% of the 38-inch solid row pattern. Seeding rates of 3 seed/planted-row ft for all 15-inch and 30-inch row patterns at all locations resulted in different plant densities on a per acre basis for these row patterns. However, on a planted acre basis, the plant populations at harvest for all row patterns, years and locations were higher than 30,000 plants/acre (data not shown). Seibert et al. (2005) reported that populations greater than 13,755 plants/acre in 38-inch row solid had no negative effect on yield. The 15-inch solid across years at all locations had the highest population of 70,000 to 84,000/acre (data not shown). Wilson et al. (2005; 2006) reported that populations for 15-inch solid row pattern from 25,000 to 125,000 had no negative effect on yield.

Verona: Lint yield, plant height and stem diameter showed a year by row pattern interaction. The row pattern yields were inconsistent across years. The 15-inch solid row pattern produced the highest yield of all row patterns in 2003 and 2004 (Table 1). The 38-inch solid row treatment in 2005 and the 15-inch 2x1 skip row pattern treatment in 2006 produced the highest yield. In 2003, the 15-inch solid row pattern yield of 1196 lb/acre was equal to the 15-inch 2x1 skip, but higher than all other row patterns. The 30-inch solid and 15-inch 2x2 skip row pattern treatment yields were equal to 15-inch 2x1 skip row, 60-inch solid and 38-inch solid row patterns. In 2004, yields from the 15-inch 2x1 skip row, 15-inch 2x2 skip row and 30-inch solid row patterns were equal to the 15-inch solid row pattern. The 60-inch solid row 38-inch solid row, 38-inch 2x1 skip row and 30-inch 2x1 skip row patterns produced lower yield than 15-inch solid pattern in both 2003 and 2004.

Table 1. Row pattern influence on lint yield in 2003-2006,and averaged over years, Verona, MS.

Row Pattern	2003	2004	2005	2006	AV
	----------Lint lb/acre----------				
1) 15-inch solid	1196	1044	675	1274	1047
2) 15-inch 2x1 skip	1106	967	758	1371	1051
3) 15-inch 2x2 skip	1039	923	737	1127	956
4) 30-inch solid	1038	987	758	1303	1022
5) 30-inch 2x1 skip	813	844	724	1196	894
6) 60-inch solid	902	759	683	949	823
7) 38-inch solid	922	855	827	1312	979
8) 38-inch 2x1 skip	810	797	669	1064	835
Within year or row pattern LSD .05	149[1]				

[1] The LSD was calculated with an average of the standard errors.

In 2005 the yields were the lowest of all years due to alternating excessive rainfall followed by drought. There was no difference in yield among all row patterns, except the 15-inch solid and 38-inch 2x1 skip row had lower yield than 38-inch solid, which was the highest yielding treatment. The year 2006 had the highest yield of all years and across all row patterns. The early season growing conditions were drier and warmer than the other years resulting in increased growth. The 15-inch 2x1 skip row pattern had the highest yield of 1371 lb/acre, but was not different from 15-inch solid row, 30-inch solid row and 38-inch solid row patterns. The 60-inch solid row pattern had lower yield than all other row patterns, except the 38-inch 2x1 skip row pattern.

Plant height at harvest indicated a row pattern by year interaction. Plant height at maturity was quite variable across years (Table 2). The 15-inch solid row plant height ranged from 0 to 9 inches shorter than plants in 30 and 38-inch solid row patterns. In 2003, 15-inch solid row plant height of 31 inches was lower than plants in the 15-inch 2x2 skip row, 30-inch 2x1 skip row, and 60-inch solid row patterns. In 2004, the 15-inch 2x2 skip row and 38-inch 2x1 skip row plant height was lower than the plants in the 30-inch 2x1 skip row pattern. All other row pattern heights were not different. However, in 2005 and 2006, the plant heights in the 15-inch solid row pattern of 21 and 23 inches were less than plant heights in all other row patterns.

Table 2. Row pattern influence on plant height at harvest in 2003-2006, Verona, MS.

	2003	2004	2005	2006
Row Pattern	----------Plant ht (in)----------			
1) 15-inch solid	31	35	23	21
2) 15-inch 2x1 skip	33	36	29	26
3) 15-inch 2x2 skip	36	33	32	26
4) 30-inch solid	35	37	29	27
5) 30-inch 2x1 skip	36	38	35	29
6) 60-inch solid	37	34	38	29
7) 38-inch solid	35	34	32	28
8) 38-inch 2x1 skip	35	33	32	27
Within year or row pattern LSD .05	4[1]			

[1] The LSD was calculated with an average of the standard errors.

Plant stem diameters at harvest showed a year by row pattern interaction (Table 3). However, the 15-inch solid row pattern most often had the smaller plant stem diameters compared to the other row patterns. The plant stem diameters in the 15-inch solid row pattern averaged 0.40 inches in 2003 and was equal to those in the 15-inch 2x1 skip row pattern but smaller than all other row patterns. In 2004, plant stem diameters in the 15-inch solid row pattern averaged 0.35 inches and was equal to the plant stem diameters in the 15-inch 2x1 skip and 38-inch solid, but smaller than 15-inch 2x2 skip row, 30-inch solid row, 30-inch 2x1 skip row, 38-inch 2x1 skip row, and 60-inch solid row patterns. In 2005, the 15-inch solid row plant stem diameter of 0.30-inch was smaller than 38-inch 2x1 skip row and 60-inch solid row patterns, and equal to all other row patterns. In 2006, the 15-inch solid row plant stem diameter of 0.24 inches was smaller than 30-inch 2x1 skip row, 60-inch solid row and 38-inch solid row, and equal to all other row patterns.

Table 3. Row pattern effect on plant stem diameters at harvest in 2003-2006, Verona, MS.

Row Pattern	2003	2004	2005	2006
	----------stem diameter (in)----------			
1) 15-inch solid	0.40	0.35	0.30	0.24
2) 15-inch 2x1 skip	0.39	0.39	0.30	0.27
3) 15-inch 2x2 skip	0.47	0.43	0.29	0.27
4) 30-inch solid	0.50	0.41	0.33	0.28
5) 30-inch 2x1 skip	0.53	0.45	0.32	0.32
6) 60-inch solid	0.53	0.51	0.35	0.33
7) 38-inch solid	0.50	0.39	0.30	0.29
8) 38-inch 2x1 skip	0.48	0.40	0.38	0.28
Within year or row pattern LSD .05	0.04			

Falkner: Lint yield, percent open bolls at defoliation and plant height at harvest showed differences among row patterns with no year by row pattern interaction (Table 4). The 4-year average lint yields ranged from 1005 lb/acre for the 60-inch solid row pattern to 1278 lb/acre for the 15-inch solid row pattern. The 15-inch solid row, 15-inch 2x1 skip row, 38-inch solid row, and 30-inch solid row pattern yields were not different and ranged from 1199 to 1278 lb/acre. These yields were higher than 38-inch 2x1 skip row, and 60-inch solid row. The 15-inch 2x1 skip row, 15-inch 2x2 skip row, and 38 and 30-inch solid row patterns showed no yield differences.

Table 4. Lint yield, percent open bolls at defoliation and plant height at harvest response to row pattern, averaged over years (2003-2006), Falkner, MS.

Row Pattern	Lint Lb/acre	% Open Bolls	Harvest Pl ht (in)
1) 15-inch solid	1278	50	32
2) 15-inch 2x1 skip	1245	44	36
3) 15-inch 2x2 skip	1179	47	36
4) 30-inch solid	1256	52	37
5) 30-inch 2x1 skip	1139	54	39
6) 60-inch solid	1005	56	39
7) 38-inch solid	1199	58	37
8) 38-inch 2x1 skip	1023	40	39
LSD .05	98	10	3

Maturity based on percent bolls open at defoliation, indicated no difference between the 15-inch solid row pattern and all other row patterns (Table 4). However, the 60-inch solid rows had the highest percent open (56%) and were higher than 15-inch 2x1 skip and 38-inch 2x1 skip row patterns with no difference among other row patterns. The 15-inch solid had 50% open in comparison to 52 and 58% for 30 and 38-inch solid, respectively. The number of rotten bolls/acre showed no year by row pattern interaction and there were no differences among row patterns (data not shown). Plant height at harvest for the 15-inch solid row pattern was lower than all other row patterns (Table 5). The plant heights ranged from 32 inches for the 15-inch solid row to 39 inches for 30-inch, 38-inch and 60-inch solid row patterns.

Table 5. Plant stem diameter at harvest as influenced by row pattern in 2003-2006, Falkner, MS

Row Pattern	2003	2004	2005	2006
	----------Stem diameter (in)----------			
1) 15-inch solid	0.44	0.34	0.31	0.24
2) 15-inch 2x1 skip	0.49	0.42	0.37	0.29
3) 15-inch 2x2 skip	0.54	0.47	0.38	0.29
4) 30-inch solid	0.59	0.44	0.41	0.29
5) 30-inch 2x1 skip	0.58	0.50	0.48	0.31
6) 60-inch solid	0.67	0.55	0.49	0.34
7) 38-inch solid	0.53	0.42	0.37	0.29
8) 38-inch 2x1 skip	0.59	0.48	0.48	0.30
Within year or row pattern LSD .05		0.05[1]		

[1]The LSD was calculated as an average of the standard errors.

Plant stem diameters at harvest were highly variable across years with larger diameters in 2003 and 2004 while 2005 and 2006 showed smaller diameters. In 2003, the 15-inch solid row and 15-inch 2x1 skip row pattern plant stem diameters of 0.44 and 0.49 inches were lower than all of the other row patterns. In 2004, the 15-inch solid row plant stem diameter of 0.34 inches was lower than all other row patterns with no difference among the other row patterns. In 2005, the 60-inch solid row, 38-inch 2x1 skip row and 30-inch 2x1 skip row pattern plant stem diameters of 0.48 inches were larger than all other row patterns with no differences among the other row patterns. In 2006, the 15-inch solid row plant stem diameter of 0.24 inches was equal to 15-inch 2x1 skip row, 15-inch 2x2 skip row and 30 and 38-inch solid row patterns, but smaller than 60-inch solid row, 30-inch 2x1 skip row, and 38-inch 2x1 skip row patterns.

Clarksdale: The maturity (percent open bolls at defoliation), plant stem diameter at harvest, and rotten bolls showed no differences among years and row pattern with no year by row pattern interaction (Table 6). The 15-inch solid row pattern, which had 61% open bolls, was not different from 30-inch solid, 38-inch solid, 30-inch 2x1 skip row, 15-inch 2x1 skip row and 15-inch 2x2 skip row patterns. However, it was higher than the 38-inch 2x1 skip row and 60-inch solid row patterns. These results were similar to that reported by Gwathmey and Steckel, (2006) that wide skip rows delayed maturity.

Lint yield showed a year by row pattern interaction. All row pattern yields in 2005 were lower than 2004. The lower yields were due to drought conditions (4.25 inches rainfall during the growing season) in 2005 and 20 to 30% losses from hurricane Rita. This was in contrast to 2004, which had excellent growing conditions, and no hurricane losses. The 15-inch solid, 30-inch solid, 38-inch solid and 15-inch 2x1 skip row patterns showed no yield differences in 2004. However, the 30-inch solid row pattern had the highest yield of 1397 lb/acre and was higher than 30-inch 2x1 skip row patterns, 60-inch solid, 38-inch 2x1 skip row and 15-inch 2x2 skip row patterns. In 2005, the 15-inch and 38-inch solid row pattern yields of 1035 and 1030 lb/acre, respectively, were not different but were higher than 60-inch solid and 38-inch 2x1 skip row patterns.

Table 6. Lint yield and plant height at harvest in 2004 and 2005, and percent open bolls at defoliation, plant stem diameter at harvest and boll rot as influenced by row pattern, averaged over years, Clarksdale, MS.

	Lint lb/acre			Harvest Pl ht (in)		% Open	Stem dia	Bolls Rot/A
Row pattern	2004	2005	Av.	2004	2005	boll	(in)	(x 1000)
15-inch solid	1355	1035	1195	34	30	61	0.35	4.8
15-inch 2x1 skip	1311	977	1144	36	31	64	0.40	5.2
15-inch 2x2 skip	1261	995	1128	32	32	56	0.42	2.2
30-inch solid	1397	972	1185	32	32	61	0.43	3.5
30-inch 2x1 skip	1168	1004	1086	29	36	54	0.51	2.5
60-inch solid	1149	886	1018	32	39	46	0.52	1.3
38-inch solid	1358	1030	1194	33	34	55	0.40	2.6
38-inch 2x1 skip	1273	843	1058	33	34	47	0.42	1.8
Within R. Pattern LSD .05		111			6 LSD .05	11	0.04	1.3
Within Year LSD .05		111			6			

The number of rotten bolls at harvest was low and ranged from 1300 to 5200 bolls/acre (Table 6). The 15-inch 2x1 skip row pattern had the highest number of rotten bolls and was not different from 15-inch solid rows and 30-inch solid row pattern. The 60-inch solid row had the lowest number of rotten bolls with 1300/acre. This was not different from 15-inch 2x2 skip row, 30-inch 2x1 skip row, 38-inch solid row and 38-inch 2x1 skip row patterns. Plant height at harvest was similar for both years, except the 30-inch 2x1 skip row and the 60-inch solid row patterns were taller in 2005 than 2004. In 2004, the 15-inch 2x1 skip row pattern plants were taller than those in 30-inch 2x1 skip row pattern, but not different from the other row patterns. The 15-inch solid row plant heights in 2005 were similar to all other row patterns, except the 60-inch solid row plants which were taller than plants in the 15-inch solid row treatment.

Conclusion

The 15-inch solid rows were shorter in height and had smaller plant stem diameters than 30 or 38-inch solid rows with no major differences in boll rot and maturity. Averaged over years, the 15-inch solid rows showed 2 and 6% higher yield than 30 and 38-inch rows in North Mississippi (Verona and Falkner), respectively, with no differences for the North Mississippi delta (Clarksdale) region. The 15-inch skip row patterns showed 3 to 22% higher yield potential than wide skip row patterns.

Acknowledgement

The research was funded in part by Cotton Incorporated, Mississippi State Support Cotton Inc., and John Deere and Company. The authors also acknowledge Keith Morton Farms Incorporated, Ripley, MS and Heaton Farms, Clarksdale, MS in support of this research.

References

Anthony, W. S., W. D. Mayfield, and T. D. Valco. 2000. Results of 1999 Ginning Studies of Ultra Narrow Cotton. p. 476-478. Proceedings 2000 Beltwide Cotton Conference.

Anthony, W. S., W. D. Mayfield, and T. D. Valco. 1999. Results of 1998 Ginning Studies of Ultra Narrow Row Cotton. p. 1484-1488. Proceedings 1999 Beltwide Cotton Conference.

Atwell, S. D. 1996. Influence of Ultra Narrow Row on Cotton Growth and Development. p. 1187-89. Proceedings 1996 Beltwide Cotton Conference.

Brashears, A. P., I. W. Kirk, and E. B. Hudspeth, Jr. 1968. Effects of Row Spacing and Population on Double Row Cotton. Texas Agr. Exp. Station MP872.

Buehring, N. W., M. H. Willcutt, G. R. Nice, and R. R. Dobbs. 2001. UNR Cotton Response to Seeding Rates. p. 125-127. In 2000 North Mississippi Research and Extension Center Annual Report. Mississippi Agricultural and Forestry Experiment Station Information Bulletin 375.

Gwathmey, C. A. and L. E. Steckel. 2006. Crop Maturity Differences Associated with Yield Compensation in Skip-Row Cotton. p. 1871. In 2006 Proceedings Beltwide Cotton Conference.

Mayfield, W. 1999. Overview of Ultra Narrow Row Cotton Situation from a Ginner's Perspective. p. 414-416. Proceedings 1999 Beltwide Cotton Conference.

Littell, R. C., G. A. Milliken, W. W. Stroup and R. D. Wolfinger, 1996. SAS Systems for Mixed Models (software). SAS Institute Inc., Cary, NC.

Nichols. S. P., C. E. Snipes, and M. A. Jones. 2002. Evaluation of Varieties and Plant Population in Ultra Narrow Cotton in Mississippi. Proceedings 2002 Beltwide Cotton Conference. CD-ROM.

Parvin, D. W., J. Gentry, F. T. Cooke, and S. W. Martin. 2002. Three Years Experience with Ultra Narrow Row Cotton Production in Mississippi, 1999-2001. Proceedings 2002 Beltwide Cotton Conference. CD-ROM.

Seibert, J. B., A. M. Stewart and B. R. Leonard. 2005. Plant Population and Intra-Row Seeding Configuration Effects on Cotton Growth and Yield. p. 1949. Proceedings 2005 Beltwide Cotton Conference. CD-ROM.

Shurley, D. W., M. J. Bader, C. W. Bednarz, S. M. Brown, G. Harris, and P. M. Roberts. 2002. Economic Assessment of Ultra Narrow Row Cotton Production in Georgia. Proceedings 2002 Beltwide Cotton Conference. CD-ROM.

Willcutt, M. H., E. Columbus, T. D. Valco, and P. Gerard. 2001. Cotton Lint Qualities as Affected by Harvester Type in 10 and 30-inch Production Systems. Proceedings 2001 Beltwide Cotton Conference.

Wilson, D. G., K. Edmisten, A. C. York. 2005. Effect of Plant Population Densities on 15-inch Row Cotton. p. 1995. Proceedings 2006 Beltwide Cotton Conference. CD-ROM.

Wilson, D. G. Jr., A. C. York and K. Edmisten. 2006. Planting Date and Population Effects on 15-inch Cotton. p. 1861. Proceedings 2006 Beltwide Cotton Conference. CD-ROM.