Effect of Planting Date and Plant Density on Yield and Fiber Qualities of Varieties of Differing Maturity

Chism Craig, University of Tennessee

Introduction

Tennessee cotton producers are re-evaluating the current planting window recommended by the University of Tennessee. Rarely do producers plant their entire crop within the recognized short planting window due to inclement weather. Oftentimes a portion of the crop is planted outside of our current "planting window". Although Tennessee will continue to have a short growing season, data for current planting date recommendations were obtained before widespread adoption of short-season, transgenic varieties and boll weevil eradication. Up-to-date information is needed to determine if advances in cotton production have lengthened the planting window for Tennessee producers. In addition to planting date concerns, the cost associated with the widespread adoption of transgenic varieties has forced producers to significantly reduce their seeding rates. Reduced seeding rates along with poor emergence due to disease and weather often leave a less than optimum plant stand. Information is needed to determine the plant populations needed for optimum yields and fiber quality. Previous research has shown differences in yield and fiber quality for varieties planted at several densities across several dates. Agronomic and economic data are needed to evaluate these new transgenic varieties when planted on a wide range of dates at several plant densities.

Materials and Methods

A field study was initiated at the West Tennessee Experiment Station (WTES) in Jackson, TN in 2003. In 2004, experiments were conducted again at the WTES in Jackson, TN and at the Milan Experiment Station (MES) in Milan, TN to evaluate two transgenic varieties (DP 555 BG/RR and PM 1218 BG/RR) at three plant densities (1, 3 and 5 plants/ft.) planted at three contrasting dates (Late April, Early May and Late May). Plant stands were hand-thinned to the desired plant population at the two leaf stage for each planting date. Cotton was managed according to University of Tennessee Extension guidelines. Each planting date received a one time application of 16 oz of mepiquat chloride at early bloom to control excessive plant growth. Insecticide applications were made at weekly intervals to ensure no confounding effects from insect injury. A one time application of defoliant plus boll opener was applied at 60% open boll and the center two rows of each plot were harvested once with a spindle picker. Seedcotton from each plot was weighed and an approximately eight pound subsample was collected from each plot for ginning and subsequent fiber analysis. A fiber sample from each plot was sent to the USDA-AMS classing office in Memphis, TN for HVI analysis. Data from each planting date were subjected to analysis of variance procedures via SAS (v.8) PROC GLM and mean separation procedures were conducted using Fisher's Protected LSD ($p=0.05$).

Results

Due to a location interaction, each planting date was analyzed separately for 2004. At Jackson, yields from planting date one were 10 and 20% greater than yields from planting dates two and three respectively (Table 5). Fiber quality of cotton planted later in the season also declined. The decrease in yield and overall decline in fiber quality resulted in a lower overall crop value for cotton planted in Mid-May and early June (Table 5). Plant density effects on yield were significant but more subtle. Yield from one plant per foot was satisfactory but significantly less than either three or five plants per foot. Overall micronaire values were significantly lower

from cotton with five plants per foot, although no values were in the discount range. No other density effects were seen for any other fiber quality parameters (Table 5). Cotton planted later in the season tended to grow taller with fewer nodes but reached five nodes above white flower (NAWF5) faster. Plant density effects on plant height and node were minimal but delays in maturity, as indicated by days to NAWF5, were seen at populations of one plant per foot (Table 6).

At the Milan location, yields from planting date one were 7 and 27% greater than yields from planting dates two and three respectively (Table 11). Fiber quality of cotton planted later in the season did not decline, probably because of the weather conditions encountered later in the season. Early planted cotton was not harvested on time and therefore weathered more than the second or third planting date. The latest planted cotton was only partially open during the period of frequent rain. Although the fiber quality from later plantings resulted in better loan values, crop values were still significantly lower due to decreased lint yields. Like Jackson, plant density effects on yield were significant but subtle. Yield from one plant per foot was again satisfactory but significantly less than three plants per foot. Overall fiber quality was not affected by plant density at Milan (Table 11). Both planting date and plant density had significant effects on crop maturity. Earlier plantings took longer to reach cutout (NAWF5), probably due to greater heat unit accumulation during the reproductive phase in later plantings. Plant density effects on plant height and node were minimal but delays in maturity, as indicated by days to NAWF5, were seen at populations of one plant per foot (Table 12).

Discussion

Data from one year and two locations suggest that cotton should be planted in late April and early May to realize maximum yields. The absence of boll weevils and protection from late season worms may allow for greater boll production in later plantings but days suitable for harvest in November are limited. Yield loss and the general decline in fiber quality resulted in lower overall crop values for cotton planted in late May and early June. Uniform, hand thinned plant populations showed lower but acceptable lint yields for plant populations of one plant per foot. However, obtaining uniform stands with lower seeding rates is extremely difficult. In addition, the delays seen in crop maturity may possibly delay harvest and therefore lower yields. Although planting to a thin stand is not advisable, yields of thin but uniform stands were acceptable and may be satisfactory with the lower yield potential of later plantings.

Table 1. P values for selected plant growth variables from the Variety x Planting Date x Plant density studyWTES, Jackson, TN, 2004.

	Gin Turnout	Lint Yield	Plant Height	Total Nodes	Bolls per Meter	Days to NAWF 5
Planting Date	**<0.0001**	**<0.0001**	**<0.0001**	0.1799	0.1118	**<0.0001**
Plant Density	0.0543	**0.0135**	0.8103	**0.0275**	**0.0056**	**<0.0001**
Variety	**<0.0001**	**0.0004**	**0.0117**	**0.0002**	**0.0263**	**<0.0001**
Plant Density x Variety	0.0565	0.3725	0.8402	0.2239	**0.0385**	0.9319
Planting Date x Variety	**0.0136**	**0.0021**	0.2433	0.2809	0.2678	**0.0204**
Planting Date x Density	0.3211	0.1821	0.2063	0.7026	0.2725	0.4791
Planting Date x Density x Variety	**0.0487**	0.9838	0.1283	0.1729	**0.0224**	0.2031

Tennessee Agricultural Experiment Station data of Craig et al. (2004)

Table 2. P values for selected fiber characteristics from the Variety x Planting Date x Plant density study, WTES, Jackson, TN, 2004.

	Color	Mike	Fiber Length	Fiber Strength	Uni-formity	Net Loan Value	Crop Value
Planting Date	**<0.0001**	**0.0043**	**<0.0001**	**<0.0001**	**0.0006**	**<0.0001**	**<0.0001**
Plant Density	0.4984	**0.0434**	0.0601	0.3156	0.1873	0.5358	**0.0225**
Variety	**0.0045**	**<0.0001**	**<0.0001**	**<0.0001**	**0.0001**	**<0.0001**	**<0.0001**
Plant Density x Variety	0.7561	0.4377	0.8483	0.6329	0.6140	0.0961	0.2834
Planting Date x Variety	**0.0176**	**<0.0001**	**0.0038**	0.1704	0.5275	**<0.0001**	**0.0461**
Planting Date x Density	0.0708	0.0557	0.6553	0.4207	0.6307	**0.0139**	0.1265
Planting Date x Density x Variety	0.7598	0.7647	0.0722	0.1174	0.3609	0.4109	0.9191

Tennessee Agricultural Experiment Station data of Craig et al. (2004)

Table 3. Yield, fiber quality and crop value means of PM 1218 BG/RR and DP 555 BG/RR planted on different dates at different plant densities, WTES, 2004.

Planting Date	Variety	Density	Lint Yield	Mike	Length	Strength	Uni-formity	Net Loan Value†	Crop Value
		pl./ft.	lb./ac.	units	inches	g/tex	%	¢/lb.	$/A
28-Apr	DP 555 BG/RR	1	1910	42.8	1.13	29.1	81.5	57.20	1092.28
28-Apr	DP 555 BG/RR	3	1876	41.3	1.12	29.1	81.8	57.15	1071.72
28-Apr	DP 555 BG/RR	5	1887	41.0	1.12	29.2	81.8	56.76	1071.06
28-Apr	PM 1218 BG/RR	1	1650	42.3	1.09	26.8	82.3	56.23	928.13
28-Apr	PM 1218 BG/RR	3	1671	42.0	1.07	26.2	82.3	55.08	920.84
28-Apr	PM 1218 BG/RR	5	1635	41.8	1.07	27.0	82.3	54.70	894.55
13-May	DP 555 BG/RR	1	1589	46.0	1.13	29.5	82.5	51.11	808.61
13-May	DP 555 BG/RR	3	1685	45.0	1.11	29.0	82.0	51.46	864.76
13-May	DP 555 BG/RR	5	1629	43.3	1.11	29.0	81.5	53.59	869.88
13-May	PM 1218 BG/RR	1	1431	43.3	1.09	27.2	82.5	49.19	702.07
13-May	PM 1218 BG/RR	3	1664	41.8	1.09	26.9	83.0	51.73	858.33
13-May	PM 1218 BG/RR	5	1547	40.5	1.09	27.2	82.3	50.74	780.68
2-Jun	DP 555 BG/RR	1	1330	37.3	1.09	26.3	80.8	53.78	715.82
2-Jun	DP 555 BG/RR	3	1435	39.0	1.09	26.8	81.0	53.96	775.34
2-Jun	DP 555 BG/RR	5	1463	36.5	1.11	27.8	81.0	53.74	787.61
2-Jun	PM 1218 BG/RR	1	1313	45.0	1.05	25.3	82.3	47.88	627.85
2-Jun	PM 1218 BG/RR	3	1506	46.5	1.04	25.4	82.3	48.44	729.94
2-Jun	PM 1218 BG/RR	5	1447	46.5	1.03	25.1	81.3	46.39	671.67

†Base price of 52.50 cents/lb lint adjusted for color, leaf, staple, micronaire, strength, and uniformity.
Calculated by the 2004 Cotton Loan Valuation Program, based on the 2004 upland cotton wharehouse loan rates.
Tennessee Agricultural Experiment Station data of Craig et al. (2004)

Table 4. Plant height, total nodes and days to NAWF5 means for PM 1218 BG/RR and DP 555 BG/RR planted on different dates at different plant densities, WTES 2004.

Planting Date	Variety	Density	Plant Height	Total Nodes	Days to NAWF5
		pl./ft.	in.	no.	no.
28-Apr	**PM1218**	**1**	41.6	17.6	83
28-Apr	**PM1218**	**3**	40.5	15.5	81
28-Apr	**PM1218**	**5**	40.7	16.1	80
28-Apr	**DP555**	**1**	41.1	18.9	86
28-Apr	**DP555**	**3**	43.9	18.2	84
28-Apr	**DP555**	**5**	42.8	17.8	85
13-May	**PM1218**	**1**	44.6	16.4	75
13-May	**PM1218**	**3**	44.2	16.7	74
13-May	**PM1218**	**5**	43.9	15.6	74
13-May	**DP555**	**1**	46.3	18.1	79
13-May	**DP555**	**3**	44.2	15.9	77
13-May	**DP555**	**5**	42.6	17.0	77
2-Jun	**PM1218**	**1**	51.1	16.3	73
2-Jun	**PM1218**	**3**	51.1	16.7	69
2-Jun	**PM1218**	**5**	50.9	16.2	69
2-Jun	**DP555**	**1**	52.5	18.1	77
2-Jun	**DP555**	**3**	52.1	16.3	75
2-Jun	**DP555**	**5**	54.1	18.1	75

Tennessee Agricultural Experiment Station data of Craig et al. (2004)

Table 5. Yield, fiber quality and crop value of PM 1218 BG/RR and DP 555 BG/RR by date and plant density, WTES, 2004.

Planting Date	Lint Yield	Mike	Length	Strength	Uni-formity	Net Loan Value†	Crop Value
	lb./ac.	units	inches	g/tex	%	¢/lb.	$/A
28-Apr	1771 a	41.8 b	1.10 a	27.9 a	82.0 a	56.19 a	996.43 a
13-May	1591 b	43.3 a	1.10 a	28.1 a	82.3 a	51.30 b	814.06 b
2-Jun	1416 c	41.8 b	1.07 b	26.1 b	81.4 b	50.70 b	718.04 c

Density	Lint Yield	Mike	Length	Strength	Uni-formity	Net Loan Value†	Crop Value
	lb./ac.	units	inches	g/tex	%	¢/lb.	$/A
1/foot	1537 b	42.8 b	1.09	27.4	82.0	52.56	812.46 b
3/foot	1640 a	42.6 b	1.09	27.2	82.0	52.97	870.16 a
5/foot	1601 ab	41.6 a	1.09	27.5	81.7	52.65	845.91 ab

Means within a column sharing the same letter do not differ significantly, LSD (0.05).

†Base price of 52.50 cents/lb lint adjusted for color, leaf, staple, micronaire, strength, and uniformity.

Calculated by the 2004 Cotton Loan Valuation Program, based on the 2004 upland cotton wharehouse loan rates.

Tennessee Agricultural Experiment Station data of Craig et al. (2004)

Table 6. Plant height, total nodes and days to NAWF5 for PM 1218 BG/RR and DP 555 BG/RR by date and plant density, WTES, 2004.

Planting Date	Plant Height	Total Nodes	Days to NAWF5
	in.	no.	no.
28-Apr	41.8 c	17.3	83.3 a
13-May	44.3 b	16.6	76.0 b
2-Jun	52.0 a	16.9	73.1 c

Density	Plant Height	Total Nodes	Days to NAWF5
pl./ft.	in.	no.	no.
1/foot	46.2	17.5 a	78.9 a
3/foot	46.0	16.5 b	76.9 b
5/foot	45.8	16.8 b	76.7 b

Means within a column sharing the same letter do not differ significantly, LSD (0.05).

Tennessee Agricultural Experiment Station data of Craig et al. (2004)

Table 7. P values for selected plant growth variables from the Variety x Planting Date x Plant density study MES, Milan, TN, 2004.

	Gin Turnout	Lint Yield	Plant Height	Total Nodes	Bolls per Meter	Days to NAWF 5
Planting Date	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**0.0522**	**<0.0001**
Plant Density	0.8982	**0.0056**	**0.0078**	**<0.0001**	0.9627	**<0.0001**
Variety	**0.0267**	0.5539	0.9595	**<0.0001**	**0.0004**	**<0.0001**
Plant Density x Variety	**0.0172**	0.7583	0.9217	0.1758	0.6333	0.1758
Planting Date x Variety	**<0.0001**	**<0.0001**	0.9208	**0.0367**	0.1768	**0.0367**
Planting Date x Density	0.9853	0.5496	**0.0041**	0.8036	0.6620	0.8036
Planting Date x Density x Variety	**0.0410**	0.4974	0.4479	0.4486	0.4523	0.4486

Table 8. P values for selected fiber characteristics from the Variety x Planting Date x Plant density study, MES, Milan, TN, 2004.

	Color	Mike	Fiber Length	Fiber Strength	Uni-formity	Net Loan Value	Crop Value
Planting Date	**<0.0001**	**<0.0001**	0.5589	**<0.0001**	**0.0004**	**0.0001**	**<0.0001**
Plant Density	0.5400	0.5507	0.9179	0.3410	0.7185	0.9499	**0.0097**
Variety	0.7077	**<0.0001**	**<0.0001**	**<0.0001**	**0.0072**	**<0.0001**	**0.0141**
Plant Density x Variety	0.7996	0.2382	0.6367	0.6035	0.0849	0.8940	0.7684
Planting Date x Variety	0.2765	**<0.0001**	**<0.0001**	**0.0088**	**0.0450**	**0.0009**	**<0.0001**
Planting Date x Density	0.9413	**0.0433**	0.9177	0.5425	0.2209	0.2671	0.4171
Planting Date x Density x Variety	0.8643	0.2174	0.7425	0.6652	0.8521	0.3051	0.2874

Table 9. Yield, fiber quality and crop value means of PM 1218 BG/RR and DP 555 BG/RR planted on different dates at different plant densities, MES, 2004.

Planting Date	Variety	Density	Yield	Mike	Length	Strength	Uni-formity	Net Loan Value†	Crop Value
		pl./ft.	lb./ac.	units	inches	g/tex	%	¢/lb.	$/A
29-Apr	DP 555 BG/RR	1	1302	46.1	1.09	27.5	81	50.95	663.50
29-Apr	DP 555 BG/RR	3	1414	45.5	1.09	27.7	82	50.43	713.14
29-Apr	DP 555 BG/RR	5	.	.	.	.	.	.	.
29-Apr	PM 1218 BG/RR	1	1115	46.0	1.06	26.1	82	50.16	557.89
29-Apr	PM 1218 BG/RR	3	1308	43.1	1.05	25.8	82	50.04	653.36
29-Apr	PM 1218 BG/RR	5	.	.	.	.	.	.	.
20-May	DP 555 BG/RR	1	1239	41.5	1.10	27.8	82	54.91	680.21
20-May	DP 555 BG/RR	3	1341	45.3	1.10	28.1	82	54.58	731.80
20-May	DP 555 BG/RR	5	1253	44.8	1.10	28.9	82	54.80	688.63
20-May	PM 1218 BG/RR	1	1137	46.9	1.07	26.9	82	52.35	598.84
20-May	PM 1218 BG/RR	3	1165	49.5	1.06	26.3	82	50.48	587.54
20-May	PM 1218 BG/RR	5	1181	47.5	1.06	26.2	82	52.34	619.00
2-Jun	DP 555 BG/RR	1	809	35.3	1.12	25.6	81	53.51	432.71
2-Jun	DP 555 BG/RR	3	819	36.1	1.12	25.7	81	54.19	443.75
2-Jun	DP 555 BG/RR	5	816	35.5	1.12	25.8	81	53.50	436.28
2-Jun	PM 1218 BG/RR	1	1047	43.8	1.05	24.9	82	51.03	534.72
2-Jun	PM 1218 BG/RR	3	1115	44.5	1.05	24.5	82	50.81	566.83
2-Jun	PM 1218 BG/RR	5	984	45.8	1.03	24.8	81	49.55	487.33

. Denotes missing values.

†Base price of 52.50 cents/lb lint adjusted for color, leaf, staple, micronaire, strength, and uniformity.

Calculated by the 2004 Cotton Loan Valuation Program, based on the 2004 upland cotton wharehouse loan rates.

Tennessee Agricultural Experiment Station data of Craig et al. (2004)

Table 10. Yield, fiber quality and crop value means of PM 1218 BG/RR and DP 555 BG/RR planted on different dates at different plant densities, MES, 2004.

Planting Date	Variety	Density	Plant Height	Total Nodes	Days to NAWF5
		pl./ft.	in.	no.	no.
29-Apr	DP 555 BG/RR	1	42.9	19.8	89.5
29-Apr	DP 555 BG/RR	3	46.6	18.6	88.8
29-Apr	DP 555 BG/RR	5	.	.	.
29-Apr	PM 1218 BG/RR	1	42.8	18.1	87.0
29-Apr	PM 1218 BG/RR	3	46.3	17.0	85.4
29-Apr	PM 1218 BG/RR	5	.	.	.
20-May	DP 555 BG/RR	1	36.8	16.5	74.0
20-May	DP 555 BG/RR	3	39.3	15.3	73.0
20-May	DP 555 BG/RR	5	42.2	14.7	72.0
20-May	PM 1218 BG/RR	1	37.4	14.7	70.7
20-May	PM 1218 BG/RR	3	39.6	13.1	68.2
20-May	PM 1218 BG/RR	5	40.9	12.7	67.4
2-Jun	DP 555 BG/RR	1	42.6	18.7	73.5
2-Jun	DP 555 BG/RR	3	42.2	17.4	71.3
2-Jun	DP 555 BG/RR	5	39.3	15.8	70.0
2-Jun	PM 1218 BG/RR	1	41.5	15.7	69.8
2-Jun	PM 1218 BG/RR	3	42.3	13.9	68.6
2-Jun	PM 1218 BG/RR	5	41.4	14.2	66.4

Tennessee Agricultural Experiment Station data of Craig et al. (2004)

Table 11. Yield, fiber quality and crop value of PM 1218 BG/RR and DP 555 BG/RR by date and plant density, MES, 2004.

Planting Date	Yield	Mike	Length	Strength	Uni-formity	Net Loan Value†	Crop Value
	lb./ac.	units	inches	g/tex	%	¢/lb.	$/A
29-Apr	1287 a	44.9 b	1.07	26.7 b	82	50.43 c	648.74 a
20-May	1204 b	46.2 a	1.08	27.1 a	82	52.93 a	639.01 a
2-Jun	935 c	40.2 c	1.08	25.2 c	81	52.09 b	485.43 b

Density Level	Yield	Mike	Length	Strength	Uni-formity	Net Loan Value	Crop Value
pl./ft.	lb./ac.	units	inches	g/tex	%	¢/lb.	$/A
1	1117 b	43.9	1.08	26.4	81	51.78	577.63 b
3	1210 a	44.0	1.07	26.3	82	51.55	621.84 a
5	1067 b	43.2	1.07	26.4	82	52.40	560.52 b

Means within a column sharing the same letter do not differ significantly, LSD (0.05).

†Base price of 52.50 cents/lb lint adjusted for color, leaf, staple, micronaire, strength, and uniformity. Calculated by the 2004 Cotton Loan Valuation Program, based on the 2004 upland cotton wharehouse loan rates.

Tennessee Agricultural Experiment Station data of Craig et al. (2004)

Table 12. Plant height, total nodes and days to NAWF5 for PM 1218 BG/RR and DP 555 BG/RR by date and plant density, MES, 2004.

Planting Date	Plant Height	Total Nodes	Days to NAWF5
	in.	no.	no.
29-Apr	44.6 a	18.4 a	87.5 a
20-May	39.3 c	14.5 c	70.9 b
2-Jun	41.5 b	15.9 b	70.0 b

Density Level	Plant Height	Total Nodes	Days to NAWF5
pl./ft.	in.	no.	no.
1	40.8 a	17.6 a	78.9 a
3	43.1 a	16.0 b	77.0 b
5	41.1 b	14.5 c	69.8 c

Means within a column sharing the same letter do not differ significantly, LSD (0.05).

Tennessee Agricultural Experiment Station data of Craig et al. (2004)