Evaluation of Irrigation Termination Effects on Fiber Micronaire and Yield of Upland Cotton, 2001-2002

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Abstract

Arizona has experienced a trend toward increasing fiber micronaire values in recent years resulting in substantial discounts on fiber value. There is some evidence to suggest that irrigation termination management can impact fiber micronaire. Field studies were conducted in 2000 and 2001 at the University of Arizona Maricopa Agricultural Center (MAC; 1,175 ft. elevation) and the Yuma Valley Agricultural Center (YVAC; 150 ft. elevation) to evaluate the effects of three dates of irrigation termination on the yield of several Upland cotton varieties. Three dates of irrigation termination (IT1, IT2, and IT3) were imposed based upon crop development. The earliest irrigation termination date, IT1 was made slightly ahead of an optimum date to provide sufficient soil-water such that bolls set at the end of the first fruiting cycle would not be water stressed and could be fully matured. Thus, the IT1 date was imposed to try to reduce overall micronaire. The second termination (IT2) date provided one additional irrigation over an optimal point for the first cycle fruit set and two irrigations beyond IT1. The final (IT3) date (later September) was staged so that soil moisture would be sufficient for the development of a full top-crop potential. Lint yield and micronaire results have consistently revealed significant differences among the IT treatments. The micronaire values were consistently less than 5.0 for the IT1 treatments. Micronaire and lint yield values increased with later IT dates.

Introduction

One of the advantages associated with a cotton (*Gossypium spp*.) production system in an irrigated desert region such as Arizona, is the availability of a relatively long growing season, or a reliable supply of abundant heat units (HU). Traditionally, cotton production systems in the low (elevation) desert regions of Arizona (<2,000 ft. above sea level) have employed a long, full season approach. Such a long, full season approach would commonly involve a February or March date of planting with final irrigations being applied in September or October (depending on local conditions). Production over this period would include a completion of the first, or primary fruiting cycle, a cutout period (hiatus in blooming), followed by a second fruiting cycle or top-crop. Accordingly, long season, indeterminate varieties were usually best suited to this type of production system. This is one of the reasons that Pima (*G. barbadense* L.) has been well adapted to this region.

Overall, the objective with a reduced season approach to cotton production in the irrigated southwest is to achieve the highest degree of efficiency possible. To do so requires an identification of the point of diminishing returns with respect to a cotton crop. This is based on the assumption that yield potentials

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decline with time in the later stages of the growing season due to natural crop senescence, shorter day lengths, and cooler weather conditions (lower rates of HU accumulations).

Recent research in Arizona has attempted to address this issue by comparing a reduced season approach to that of a more traditional long, or full season system (Silvertooth et al., 1989; Silvertooth et al., 1990; Silvertooth et al., 1991; Silvertooth et al., 1992; and Silvertooth et al., 1993; Silvertooth et al., 1994; Unruh et al., 1995; Silvertooth and Norton, 1996; and Silvertooth and Norton, 1997). Summarizing this work, Unruh and Silvertooth (1997) reported on 12 site-years of data in Arizona comparing various planting and irrigation termination date combinations. The overall results from these studies revealed a most pronounced improvement in yield from an early date of planting and a generally small increase in yield from a late irrigation termination date. Comparing early and late IT treatments with an early date of planting, Unruh and Silvertooth (1997) found an average increase of 83 and 118 lbs. of lint/acre for DPL 90 and Pima S-6, respectively. Large increases in lint yield from a later IT were observed in a few experiments, but usually under conditions of very poor fruit retention over the primary fruiting cycle (up to cut-out).

About 600 HU (86/55 ^{o} F thresholds) are required to develop a late season boll from a bloom to a full sized, hard boll when fiber length development is complete (Silvertooth et al., 1996). Approximately 400 additional HU are then required to complete boll maturation and opening, for a total of 1,000 HUs needed for boll development from bloom to open boll. Therefore, IT treatments are best structured to accommodate development of bolls intended for harvest to the point of full fiber development (600 HU post-anthesis). This commonly translates to a period of approximately 21 days in southern Arizona in August and September. Accordingly, adequate soil moisture must be maintained throughout this three-week period for the last set of bolls intended for harvest. The exact IT date will therefore vary depending upon soil water holding capacities, amounts of water applied per irrigation, weather conditions, and crop condition. For example, if bolls set up to the point of cut-out are designated as those intended for harvest, final irrigations should be made so that adequate soil moisture is maintained for a three week (600 HU) period beyond the time of cut-out. The development of a top-crop usually requires irrigation and pest control for four to six weeks beyond cut-out, which for many systems equates to approximately an extra acre-foot of irrigation water and appropriate pest control to protect the developing fruit load.

In recent years an increasing percentage of the Upland (*G. hirsutum* L.) cotton crop in Arizona has been classified with micronaire (mic) ranges in excess of 4.9, resulting in a discount of the market value of the fiber. In 1999, slightly over 40% of the Arizona Upland cotton crop was classed with mic values greater than 4.9 (Silvertooth, 2001). For example, Group 6 mic values (5.0-5.2) can result in \$0.05/lb. discounts and Group 7 ($\geq$5.3) \$0.10/lb. discounts. With low market values of cotton lint, as have been experienced recently (i.e. ~ \$0.50/lb.), discounts of this magnitude can have a devastating impact on farm revenues. Some economists have estimated that this problem has resulted in a loss of revenue to the Arizona cotton producers of approximately \$13 to 15 million per year in the past several years. However, some cotton marketing professionals in Arizona have indicated that they believe these losses in revenue due to high micronaire are in the range of \$20 to 25 million per year over the past four to five years. Thus, high micronaire is reducing the profitability of Arizona cotton production at this time.

Strategies to reduce micronaire in Arizona must consider three primary factors: 1) genetics, 2) environment, and 3) management. These three factors form a complex set of effects and interactions that determine the micronaire of a crop. The degree of genetic influence on micronaire depends on the different types of varieties that are adapted to the region of influence and the range of environmental conditions within that region. The statement is often made that "only 30% of the cotton micronaire properties are determined by genetics (variety) with 70% determined by agronomic management ". University of Arizona variety trial data from 1996 through 1999 indicate that about 20% of the variation in micronaire in central Arizona was due to the genetic control of the varieties in those tests. In comparison, variation due to varieties was 50% for fiber strength, 36% for fiber length and 17% for lint yield. These data show that the environment and management exert more influence on micronaire than other fiber properties, so no matter what variety is chosen, growers can, and probably will, see wide variations in micronaire values from field to field and year to year. There remains a strong genetic component, however, the average micronaire can be reduced through proper varietal selection.

The relationship between varieties and micronaire is also complicated by the fact that high yield is genetically related to high micronaire. With our current genetic resources, the higher yielding varieties also tend to produce higher micronaire as well. This relationship between yield and micronaire is probably a strong contributing factor to the trends we have observed in micronaire over the last few years. . In Arizona, we have seen a slight increase in average mic values in the early 1990's (~1993) and again in about 1996. A similar trend is apparent with data from the entire U.S. cotton belt. Also, in review of the mic distributions among all cotton producing regions in the U.S., there is a somewhat normal distribution pattern with a peak mic value at approximately 4.9-5.0 and distinct drop above 5.0 (Silvertooth, 2001). These two points support the hypothesis that there is a strong genetic component associated with recent trends in Arizona and U.S. mic values and that varieties have been developed to "push" the mic limits (i.e. 5.0).

There is also ample evidence to support the position that Arizona, particularly the low elevation locations (< 2,000 ft.), has a hot environment that is conducive to high micronaire production (hot conditions for both day and night temperatures). Thus, it appears that in Arizona we are producing a cotton crop in an environment that is conducive to high mic production with varieties that, as a whole, have a tendency toward high mic as well. The relationships associated with high mic and the third primary component (management) is not well understood in the context of desert cotton production.

Based on an analysis of data from several cotton growing areas in Arizona, it appears that there is indeed a relationship associated with location and variety and fiber mic. From this data there also appears to be a relationship between fiber mic and management, in that certain growers within given areas tend to have a very high percentage of their crop classed with high mic and another set of growers in the same area have a very low percentage of their crop with low mic using basically the same group of varieties.

There is evidence from earlier studies conducted in Arizona (Silvertooth et al., 1989; Silvertooth et al., 1990; Silvertooth et al., 1991; Silvertooth et al., 1992; and Silvertooth et al., 1993; Silvertooth et al., 1994; Unruh et al., 1995; Silvertooth and Norton, 1996; and Silvertooth and Norton, 1997) to study the effects of ITon yield and quality to suggest that IT and/or defoliation can have a significant impact on fiber mic. The initial efforts with this project revealed a significant reduction in fiber micronaire as a function of early IT management (Silvertooth et al., 2001).

It is the purpose of this research project to better delineate the contributions associated with genetics, environment, and management on fiber micronaire. The objective of this study was to further investigate the issue of IT management and the subsequent effects on the growth, development, yield, and micronaire of a group of common Upland varieties.

Methods and Materials

This study was conducted in 2000 and 2001 at the Maricopa Agricultural Center (MAC; 1,175 ft.) on a Casa Grande sandy loam soil and the Yuma Valley Agricultural Center (YVAC; 150 ft. elevation) in 2001. The experimental design at both sites was a split plot in a randomized complete block design with four replications. The main treatments consisted of three IT dates, designated as IT1, IT2, and IT3. Each main plot consisted of 12, 40-inch rows that extended the full length of the irrigation run (600 ft.). The subunits consisted of 13 Upland varieties at MAC and five varieties at YVAC. Subplots were 12, 40-inch rows wide and 40 feet in length. The entire study areas were dry planted and watered-up at both sites. All inputs such as fertilizer, water, and pest control were managed on an as-needed basis.

A complete set of plant measurements were collected from all plots on 14-day intervals. Measurements taken included: plant height, number of mainstem nodes, first fruiting branch, total number of aborted sites (positions 1 & 2), number of nodes above the top (1st position) fresh flower (NAWF), canopy closure, and number of blooms per unit area. Climatic conditions were also monitored using an Arizona Meteorological network (AZMET) stations located at both sites.

Irrigation termination treatments were imposed in relation to the crop fruiting cycle in a manner similar to that described in Figure 1. In tracking crop development, the crop was approaching cut-out, normally considered as having NAWF $\leq$ 5, as evidenced by an average NAWF ~ 6 among all varieties. The first IT treatment (IT1) was made on 25 July with the intention of terminating irrigations somewhat pre-maturely. Based upon current UA recommendations for IT to complete a single cycle fruit set, the more optimal date of IT would have been about 5 August. In this experiment, IT2 was structured to provide an additional (one) irrigation beyond the more optimal date. In this case, IT2 was made on 17 August. For the IT3 plots the intention was to attempt a second cycle fruit set and irrigations were continued until 15 September. The IT2 treatment received two additional irrigations over IT1 and IT3 received four additional irrigations over IT1 (approximately two acre-feet of additional irrigation water).

The planting, IT, defoliation, and harvest dates are outlined in Tables 1-3. Only the center four rows of each 12-row plot were harvested.

Approximately 20 lb. seed cotton subsamples were collected from each plot at harvest. These subsamples were ginned for turnout estimates and submitted to the USDA Cotton Classing office in Phoenix, AZ for HVI analysis. All mic and lint yield data were subjected to appropriate analysis of variance procedures (Steel and Torrie, 1980 and the SAS Institute, SAS, 1990).

Results

Results reveal a consistent pattern in terms of micronaire and lint yield responses in the IT X Variety experiments for both the 2000 and 2001 seasons. I am providing with this report the full set of summarized results available at this point in the project. The IT X Variety results for 2000 and 2001 are presented in Tables 1-28 and Figures 1-13. The summary of the field survey component of the project is provided in Tables 29-30 and Figure 14.

Summarizing the most recent results for the 2001 season, we found that fiber micronaire was significantly lower in the first IT treatment at MAC and YVAC (less than 5.0). In 2001 at MAC the third IT treatment (promoting a top-crop development) did not provide a significant increase in yield as it did in 2000. However, at YVAC the third IT treatment did result in slightly higher, but not significantly ($P<0.05$) lint yields with the top-crop.

These results clearly support the hypothesis concerning fiber development, micronaire, and late season irrigation management. Results have consistently shown for two seasons that fiber micronaire can be significantly reduced and held below the discount range (5.0) for most varieties by IT management. In each case thus far, reasonable lint yields have still been realized with the earlier IT treatments. However, these studies have also demonstrated the potential of producing a significantly higher lint yield with later IT, usually at the expense of higher fiber micronaire ($\geq$ 5.0) values.

These results are consistent with earlier work on this topic (Silvertooth et al., 1989; Silvertooth et al., 1990; Silvertooth et al., 1991; Silvertooth et al., 1992; and Silvertooth et al., 1993; Silvertooth et al., 1994; Unruh et al., 1995).

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Fig. 1. General irrigation termination points in relation to the fruiting cycle.

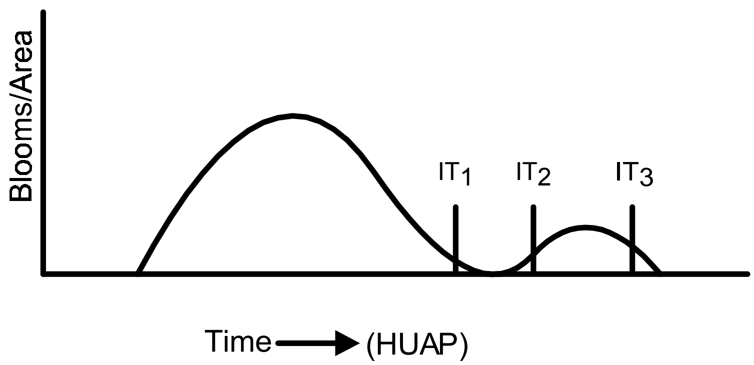

Table 1. Management summary for irrigation termination by variety experiment (all plots were watered up on 6 April), MAC, 2000.

Treatment	Irrigation Termination Date	Defoliation Date	Harvest Date	Irrigation Added
1	25 July	12 August	15 September	0
2	17 August	15 September	4 October	2
3	15 September	12 October	5 December	4

Table 2. Management summary for irrigation termination by variety experiment (all plots were watered up on 17 April), MAC, 2001.

Treatment	Irrigation Termination Date	Defoliation Date	Harvest Date	Irrigation Added
1	1 August	24 August	12 September	0
2	24 August	14 September	3 October	2
3	20 September	26 October	21 November	4

Table 3. Management summary for irrigation termination by variety experiment (all plots were watered up on 21 March), YVAC, 2001.

Treatment	Irrigation Termination Date	Defoliation Date	Harvest Date	Irrigation Added
1	12 July	16 August	4 September	0
2	27 July	5 September	24 September	2
3	20 September	19 October	14 November	4

Table 4. Irrigation termination dates and varieties, irrigation termination dates by variety study, MAC, 2000 (6 April planting and water-up).

Varieties	**Maturity Type**
BXN47	Medium
DP428B	Short-medium
DP422BR	Short
DP33B	Full
DP20B	Early
DP388	Medium
STV474	Medium
STV4691B	Medium
SG125BR	Short
SG747	medium
DP655BR	Full
DP451BR	medium
DP5415	Full
Irrigation Termination Dates	
Date 1 (25 July)	(3162 HU/Jan. 1)
Date 2 (17 August)	(3765 HU/Jan. 1)
Date 3 (15 September)	(4623 HU/Jan. 1)

Table 5. Irrigation termination dates and varieties, irrigation termination dates by variety study, MAC, 2001 (17 April planting and water-up).

Varieties	**Maturity Type**
BXN47	Medium
DP428B	Short-medium
DP422BR	Short
DP33B	Full
DP458BR	Early
DP388	Medium
STV474	Medium
STV4691B	Medium
SG215BR	Short
SG747	medium
DP655BR	Full
DP451BR	medium
DP5415	Full
Irrigation Termination Dates	
Date 1 (1 August)	(3200 HU/Jan. 1)
Date 2 (24 August)	(3843 HU/Jan. 1)
Date 3 (20 September)	(4554 HU/Jan. 1)

Table 6. Irrigation termination dates and varieties, irrigation termination dates by variety study, YVAC, AZ, 2001 (21 March planting and water-up).

Varieties	Maturity Type
SG501BR	Short
SG747	medium
STV474	medium
DP22BR	short
DP451BR	medium
Irrigation Termination Dates	
Date 1 (12 July)	(2783 HU/Jan. 1)
Date 2 (27 July)	(3195 HU/Jan. 1)
Date 3 (20 September)	(4763 HU/Jan. 1)

Table 7. Experimental effects and statistical significance from the analysis of variance on micronaire, irrigation termination by variety study, MAC, 2000.

Source of Variation (Effect)	OSL (Pr >F)
Irrigation Termination Date	0.0032
Variety	0.0012
Irrigation Termination Date * Variety	0.5247

Table 8. Main effect results of micronaire for irrigation termination dates and varieties, MAC,2000.

Irrigation Termination Date	Micronaire
1	4.58 b*
2	5.23 a
3	5.18 a
LSD	0.16
OSL**	0.0032
CV(%)§	6.99
Variety	
DP655BR	5.32 a
DP5415	5.20 ab
DP422BR	5.17 ab
DP33B	5.17 ab
DP388	5.13 ab
BXN47	5.12 abc
DP451BR	5.02 abc
STV474	4.97 abc
DP428B	4.93 abcd
STV4691B	4.82 bcd
SG747	4.81 bcd
DP20B	4.73 cd
SG125BR	4.54 d
LSD	0.40
OSL	0.0012
CV(%)	8.6

*Least Significant Difference – means followed by the same letter are not significantly different according to a Fishers mean separation test at 0.05 level.
**Observed Significance Level.
§Coefficient of Variation

Table 9. Micronaire results for all varieties by irrigation termination dates, MAC, 2000.

Irrigation Termination Date 1 (24 July)	**Micronaire**
DP 655BR	5.07
DP 5415	4.97
DP 388	4.87
DP 33B	4.80
DP 451BR	4.77
BXN 47	4.70
DP 428B	4.53
DP 422BR	4.53
STV 4691B	4.47
STV 474	4.43
SG 125BR	4.17
SG 747	4.13
DP 20B	4.10
Irrigation Termination Date 2 (15 August)	
DP 422BR	5.53
DP 655BR	5.50
DP 5415	5.43
BXN 47	5.40
DP 33B	5.33
SG 747	5.20
DP 451BR	5.17
STV 474	5.17
DP 428B	5.13
DP 388	5.13
STV 4691B	5.13
DP 20B	5.00
SG 125BR	4.83
Irrigation Termination Date 3 (15 September)	
DP 422BR	5.43
DP 388	5.40
DP 655BR	5.40
DP 33B	5.37
STV 474	5.30
BXN 47	5.27
DP 5415	5.20
DP 428B	5.13
DP 451BR	5.13
DP 20B	5.10
SG 747	5.10
STV 4691B	4.87
SG 125BR	4.63

Irrigation Termination Date * Variety = NS (OSL = 0.5247)

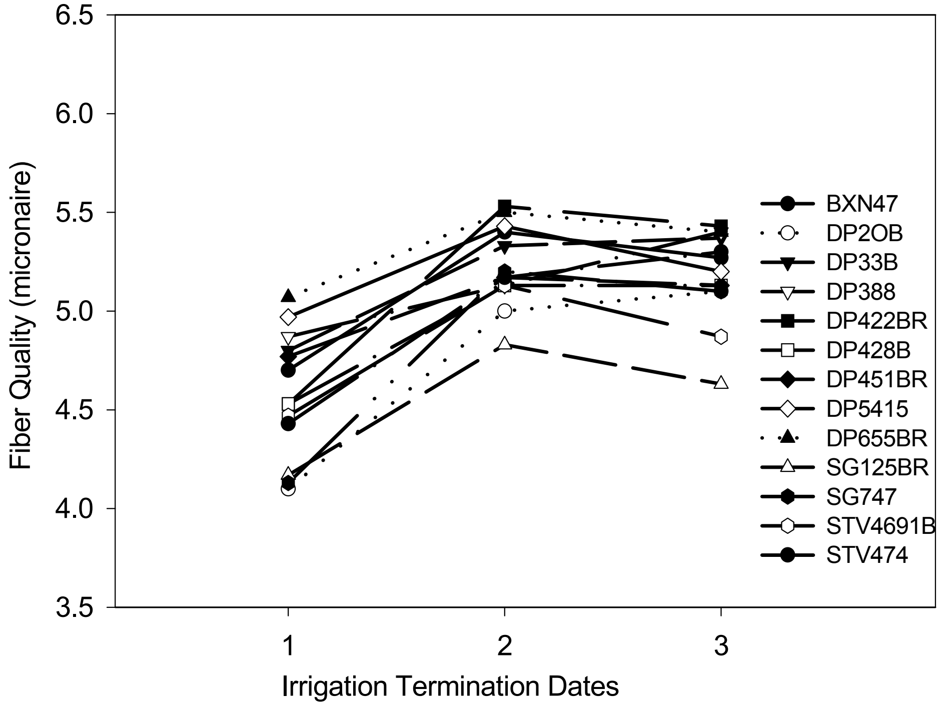

Fig. 2. Micronaire values as affected by irrigation termination date for each variety, MAC, 2000.

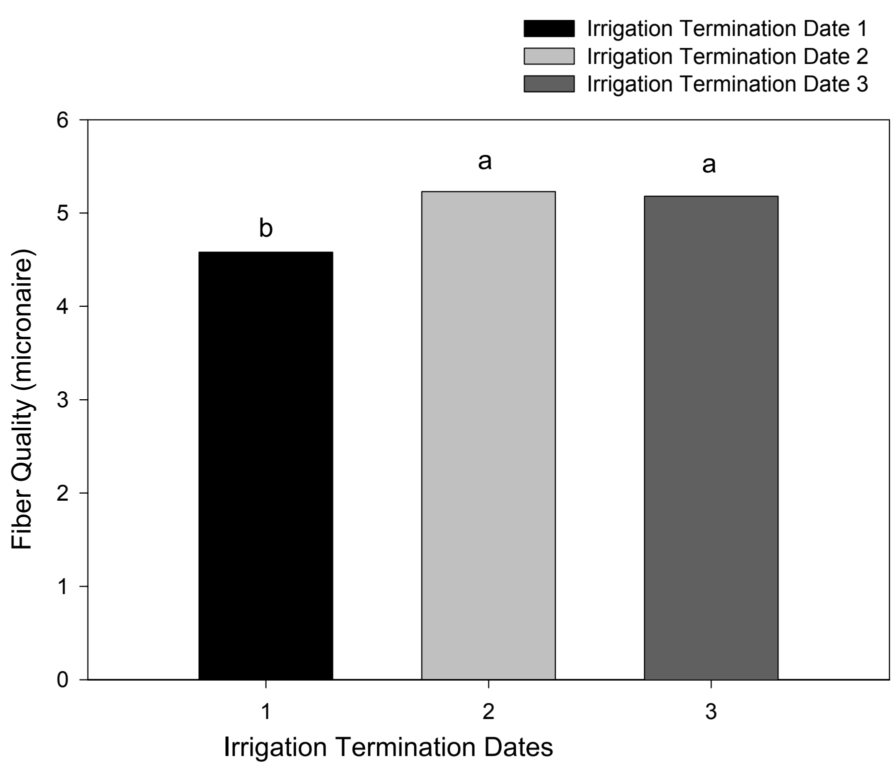

Fig. 3. Mean micronaire values as affected by irrigation termination dates for all varieties, MAC, 2000.

Table 10. Micronaire results by variety for each irrigation termination date, MAC, AZ, 2000.

Irrigation Termination Date	BXN 47	DP 20B	DP 33B	DP 388	DP 422BR	DP 428B	DP 451BR	DP 5415	DP 655BR	SG 125BR	SG 747	STV 4691B	STV 474
1	4.70	4.10	4.80	4.87	4.53	4.53	4.77	4.97	5.07	4.17	4.13	4.47	4.43
2	5.27	5.00	5.33	5.13	5.53	5.13	5.17	5.43	5.50	4.83	5.20	5.13	5.17
3	5.40	5.10	5.37	5.40	5.43	5.13	5.13	5.20	5.40	4.63	5.10	4.87	5.30

Irrigation Termination Date * Variety = NS (OSL = 0.5247)

Table 11. Experimental effects and statistical significance from the analysis of variance on lint yield, irrigation termination by variety, MAC, 2000.

Source of Variation (Effect)	OSL (Pr >F)
Irrigation Termination Date	0.0272
Variety	0.0529
Irrigation Termination Date * Variety	0.0452

Table 12. Yield results (lbs. lint/acre) by variety for each irrigation termination date for cotton planted on 6 April, MAC, AZ, 2000.

Irrigation Termination Date	BXN 47	DP 20B	DP 33B	DP 388	DP 422BR	DP 428B	DP 451BR	DP 5415	DP 655BR	SG 125BR	SG 747	STV 4691B	STV 474
1	1245	1271	1131 b	1233	1283	1194 b	1359	1131	1042 b	1093 b	1385 b	1448	1334 b
2	1441	1614	1614 a	1525	1550	1617 a	1534	1527	1385 ab	1578 a	1225 b	1708	1347 b
3	1626	1741	1855 a	1531	1677	1829 a	1842	1601	1690 a	1728 a	1829 a	1855	1702 a
LSD*	NS	NS	449	NS	NS	370	NS	NS	450	423	413	NS	274
OSL**	0.2212	0.0664	0.0260	0.115	0.1466	0.0211	0.1149	0.1904	0.0402	0.0302	0.338	0.1243	0.0334
CV (%)§	15.3	11.4	12.9	4.3	12.9	10.6	13.6	19.2	14.5	127	12.3	11.1	8.3

*Least Significant Difference – means followed by the same letter within a column are not significantly different according to a Fishers mean separation test at the 0.05 level.
**Observed Significance Level.
§Coefficient of Variation.

Table 13. Yield results for all varieties by irrigation termination dates, MAC, 2000.

Irrigation Termination Date 1 (24 July)	Lint Yield (lbs. lint/acre)
STV4691B	1448 a
SG747	1385 ab
DP451BR	1359 ab
STV474	1334 abc
DP422BR	1283 abcd
DP20B	1270 abcd
DP388	1245 abcde
BXN47	1245 abcde
DP428B	1194 bcde
DP5415	1131 cde
DP33B	1131 cde
SG125BR	1093 de
DP655BR	1042 e
LSD*	204
OSL**	0.0099
CV (%)	9.7
Irrigation Termination Date 2 (15 August)	
STV4691B	1708
DP428B	1619
DP33B	1613
DP20B	1613
SG125BR	1578
DP422BR	1550
DP388	1537
DP451BR	1535
DP5415	1527
BXN47	1441
DP655BR	1385
STV474	1347
SG747	1225
LSD*	NS
OSL**	0.0991
CV (%)	11.1
Irrigation Termination Date 3 (15 September)	
DP33B	1855
ST4691B	1855
DP451BR	1842
DP428B	1829
SG747	1829
DP20B	1741
SG125BR	1728
ST474	1702
DP655BR	1690
DP422BR	1677
BXN47	1626
DP5415	1601
DP388	1544
LSD*	NS
OSL**	0.2218
CV (%)§	8.5

*Least Significant Difference (LSD)
**Observed Significance Level at the 0.05 level.
§Coefficient of Variation

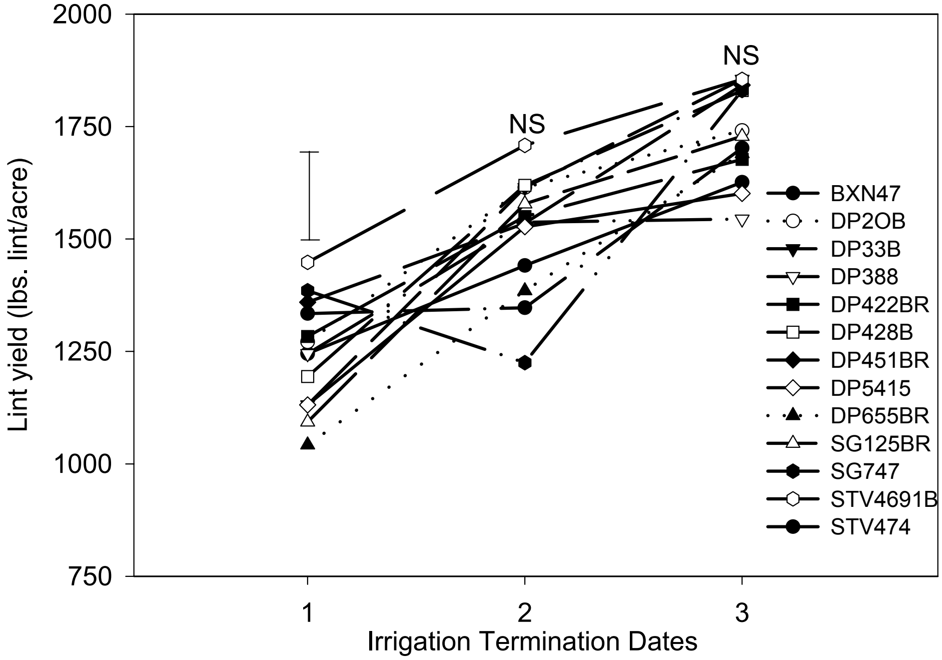

Fig. 4. Lint yield as affected by irrigation Termination Dates for each variety, MAC, 2000.

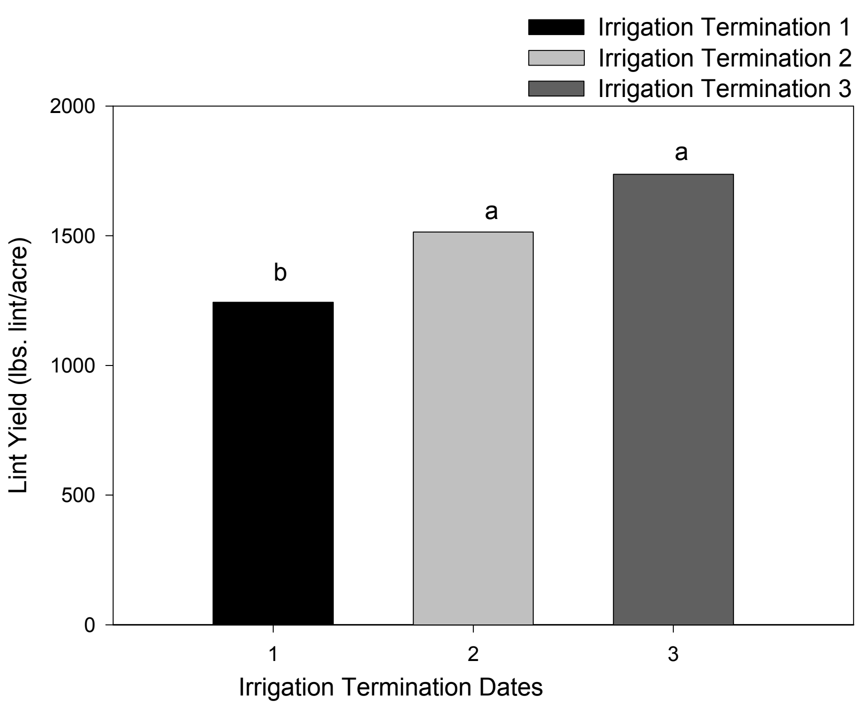

Fig. 5. Mean lint yield as affected by irrigation termination dates for all varieties, MAC, 2000.

Table 14. Experimental effects and statistical significance from the analysis of variance on micronaire, irrigation termination by variety, MAC, 2001.

Source of Variation (Effect)	**OSL (Pr >F)**
Irrigation Termination Date	0.0010
Variety	<0.0001
Irrigation Termination Date * Variety	0.0160

Table 15. Main effect results of micronaire for irrigation termination dates and varieties for cotton planted on 17 April (water-up) MAC, 2001.

Irrigation Termination Date	**Micronaire**
1	4.74 b*
2	5.07 a
3	5.19 a
LSD	0.14
OSL**	0.0160
CV(%)§	6.28
Variety	
STV474	5.33 a
SG747	5.33 a
BXN47	5.11 ab
SG215BR	5.08 ab
DP451BR	5.08 ab
DP428B	5.07 ab
STV4691B	5.00 b
DP388	5.00 b
DP33B	4.97 bc
DP458BR	4.88 bcd
DP422BR	4.84 bcd
DP5415	4.70 cd
DP655BR	4.61 d
LSD	0.40
OSL	<0.0001
CV(%)	8.6

*Least Significant Difference – means followed by the same letter are not significantly different according to a Fishers mean separation test at 0.05 level.
**Observed Significance Level.
§Coefficient of Variation

Table 16. Micronaire results for all varieties by irrigation termination dates, MAC, 2001.

Irrigation Termination Date 1 (1 August)	Micronaire
SG 747	5.13 a*
STV 474	5.07 a
SG 215BR	4.97 ab
DP 388	4.97 ab
DP 428B	4.93 ab
BXN 47	4.90 abc
DP 451BR	4.86 abc
STV 4691B	4.73 abcd
DP 33B	4.60 bcde
DP 422BR	4.67 cde
DP 458BR	4.37 de
DP 655BR	4.37 de
DP 5415	4.23 e
LSD*	0.4567
OSL**	0.0033
CV (%)	5.72
Irrigation Termination Date 2 (24 August)	
SG 747	5.57 a
STV 474	5.47 ab
BXN 47	5.30 abc
SG 215BR	5.27 abc
DP 451BR	5.17 abcd
DP 33B	5.07 bcd
STV 4691	5.03 cd
DP 422BR	5.00 cd
DP 428B	5.00 cd
DP 458BR	4.93 cd
DP 5415	4.93 cd
DP 388	4.80 de
DP 655BR	4.43 e
LSD*	0.4047
OSL**	0.0009
CV (%)	4.73
Irrigation Termination Date 3 (20 September)	
STV 474	5.47 a
DP 458BR	5.33 ab
SG 747	5.30 abc
DP 428B	5.27 abc
DP 33B	5.23 abc
STV 4691	5.23 abc
DP 388	5.23 abc
DP 451BR	5.20 abcd
BXN 47	5.13 abcde
DP 422BR	5.07 bcde
DP 655BR	5.03 cde
SG 215BR	5.00 de
DP 5415	4.93 e
LSD*	0.2759
OSL**	0.0254
CV (%)§	3.12

*Least Significant Difference (LSD)
**Observed Significance Level at the 0.05 level.
§Coefficient of Variation

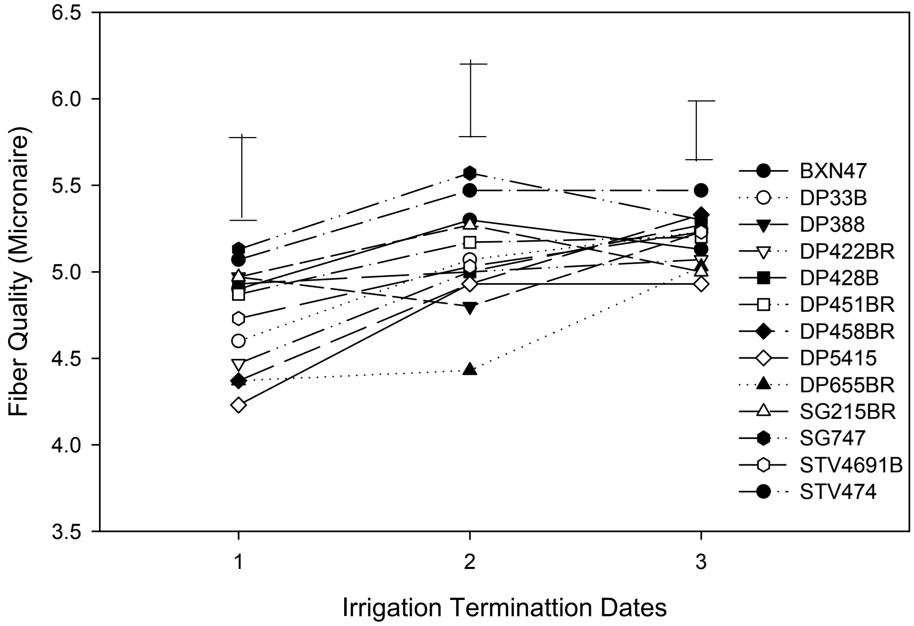

Fig. 6. Micronaire values as affected by irrigation termination date for each variety, MAC, 2001.

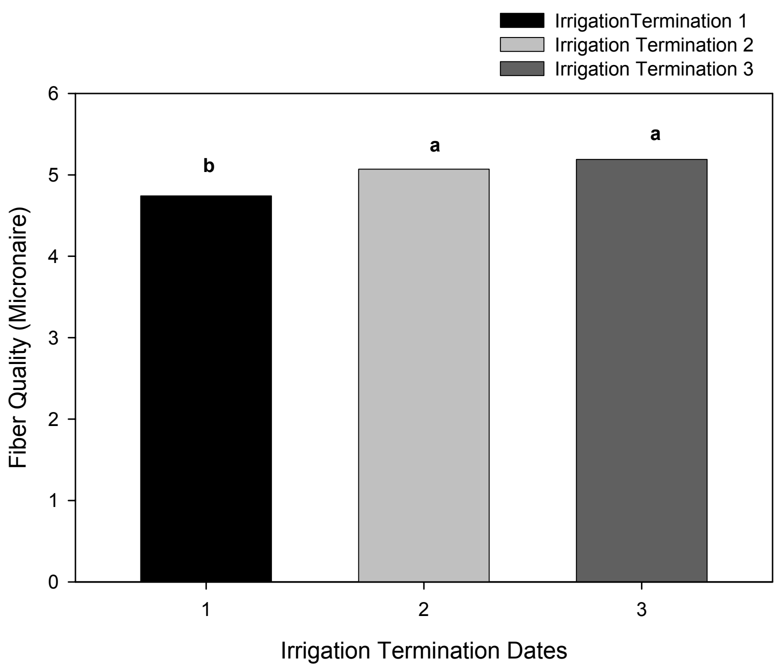

Fig. 7. Mean micronaire values as affected by irrigation termination dates for all varieties, MAC, 2001

Table 17. Micronaire results by variety for each irrigation termination date for cotton planted on 17 April (water-up), MAC, 2001.

Irrigation Termination Date	BXN 47	DP 33B	DP 388	DP 422BR	DP 428B	DP 451BR	DP 458BR	DP 5415	DP 655BR	SG 215BR	SG 747	STV 4691B	STV 474
1	4.90 b	4.60 b	4.97	4.47 b	4.93	4.87	4.37 c	4.23 b	4.37	4.97	5.13	4.73	5.07
2	5.30 a	5.07 a	4.80	5.00 a	5.00	5.17	4.93 b	4.93 a	4.43	5.27	5.57	5.03	5.47
3	5.13 a	5.23 a	5.23	5.07 a	5.27	5.20	5.33 a	4.93 a	5.03	5.00	5.30	5.23	5.47
LSD*	0.1999	0.4627	NS	0.1511	NS	NS	0.3294	0.5926	NS	NS	NS	NS	NS
OSL**	0.0130	0.0420	0.1008	0.0007	0.2034	0.4937	0.0032	0.0476	0.1013	0.1172	0.2139	0.878	0.1234
CV (%)§	1.73	4.11	3.65	1.38	3.86	6.81	2.98	5.56	6.66	2.86	4.66	4.00	3.90

*Least Significant Difference – means followed by the same letter within a column are not significantly different according to a Fishers mean separation test at the 0.05 level.
**Observed Significance Level.
§Coefficient of Variation.

Table 18. Experimental effects and statistical significance from the analysis of variance on lint yield, irrigation termination by variety, MAC, 2001.

Source of Variation (Effect)	OSL (Pr >F)
Irrigation Termination Date	0.0126
Variety	0.0006
Irrigation Termination Date * Variety	0.0011

Table 19. Yield results (lbs. lint/acre) by variety for each irrigation termination date for cotton planted on 17 April (water-up), MAC, 2001.

Irrigation Termination Date	BXN 47	DP 33B	DP 388	DP 422BR	DP 428B	DP 451BR	DP 458BR	DP 5415	DP 655BR	SG 215BR	SG 747	STV 4691B	STV 474
1	1302	1215 b	1258	1320	1306	1421	1156 b	953	955 b	1414	1474	1306	1271
2	1416	1625 a	1506	1581	1256	1419	1671 a	1295	1397 a	1493	1399	1467	1232
3	1211	1380 ab	1301	1385	1409	1540	1647 a	1508	1420 a	1643	1476	1503	1330
LSD*	NS	449	NS	NS	NS	NS	154	NS	389	NS	NS	NS	NS
OSL**	0.2116	0.0297	0.1012	0.1403	0.5668	0.2563	0.0012	0.0760	0.0493	0.1392	0.8697	0.3551	0.4790
CV (%)§	8.8	8.2	8.2	9.01	12.6	5.9	4.6	16.9	13.6	7.3	13.8	10.9	7.1

*Least Significant Difference – means followed by the same letter within a column are not significantly different according to a Fishers mean separation test at 0.05 level.
**Observed Significance Level.
§Coefficient of Variation.

Table 20. Yield results for all varieties by irrigation termination dates, MAC, 2001.

Irrigation Termination Date 1 (1 August)	**Lint Yield (lbs. lint/acre)**
SG747	1474 a*
DP451BR	1421 ab
SG215BR	1414 ab
DP422BR	1320 bc
DP428B	1306 bc
STV4691B	1306 bc
BXN47	1302 bc
STV474	1271 bcd
DP388	1258 bcd
DP458BR	1214 cd
DP33B	1156 d
DP655BR	955 e
DP5415	953 e
LSD*	150
OSL**	<0.0001
CV (%)	7.1
Irrigation Termination Date 2 (24 August)	
DP458BR	1671 a*
DP33B	1625 a
DP422BR	1581 a
DP388	1505 a
SG215BR	1493 a
STV4691B	1467 a
DP451BR	1419 a
BXN47	1415 a
SG747	1399 a
DP655BR	1397 a
DP5415	1295 a
DP428B	1256 a
STV474	1232 a
LSD*	NS
OSL**	0.0669
CV (%)	11.3
Irrigation Termination Date 3 (20 September)	
DP458BR	1647 a*
SG215BR	1643 a
DP451BR	1540 ab
DP5415	1508 abc
STV4691B	1503 abc
SG747	1476 abc
DP655BR	1420 abcd
DP428B	1409 bcd
DP422BR	1385 bcd
DP33B	1380 bcd
STV474	1330 bcd
DP388	1302 cd
BXN47	1211 d
LSD*	228
OSL**	0.0197
CV (%)§	9.4

*Least Significant Difference (LSD)
**Observed Significance Level at the 0.05 level.
§Coefficient of Variation

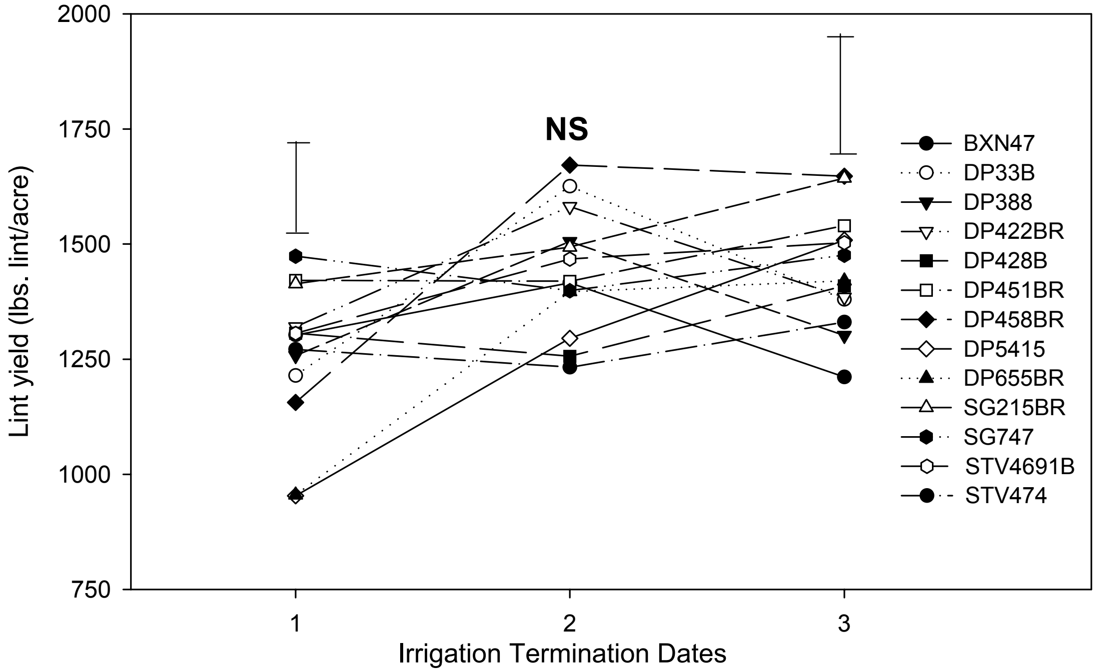

Fig. 8. Lint yield as affected by irrigation termination dates for each variety, MAC, 2001.

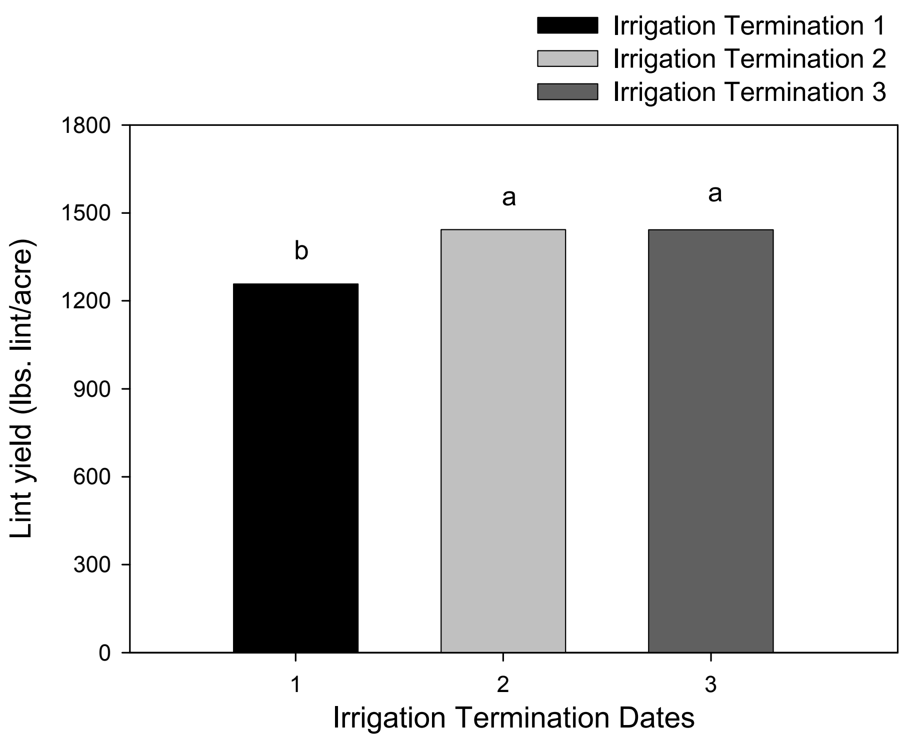

Fig. 9. Mean lint yield as affected by irrigation termination dates for all varieties, MAC, 2001.

Table 21. Experimental effects and statistical significance from the analysis of variance on micronaire, irrigation termination by variety, YVAC, 2001.

Source of Variation (Effect)	OSL (Pr >F)
Irrigation Termination Date	0.0190
Variety	0.0018
Irrigation Termination Date * Variety	0.3980

Table 22. Main effect results of micronaire for irrigation termination dates and varieties, for cotton planted (water-up) on 21 March YVAC, 2001

	Irrigation Termination Date	Micronaire
	1	4.91 b
	2	5.09 a
	3	4.99 a
LSD*		0.1164
OSL**		0.0190
CV(%)§		5.63
	Variety	
	SG 747	5.22 a
	STV 474	5.18 a
	SG 501BR	4.98 b
	DP 451BR	4.85 bc
	DP 422BR	4.77 c
LSD		0.3243
OSL		0.0018
CV(%)		4.58

*Least Significant Difference (LSD)
**Observed Significance Level at the 0.05 level.
§Coefficient of Variation

Table 23. Micronaire results for all varieties by irrigation termination dates, YVAC, 2001.

Irrigation Termination Date 1 (12 July)	Micronaire
SG 747	5.23
STV 474	5.00
DP 451BR	4.87
SG 501BR	4.75
DP 422BR	4.68
Irrigation Termination Date 2 (22 July)	
STV 474	5.35
SG 747	5.22
SG 501BR	5.13
DP 422BR	4.92
DP 451BR	4.82
Irrigation Termination Date 3 (20 August)	
STV 474	5.18
SG 747	5.15
SG 501BR	5.05
DP 451BR	4.88
DP 422BR	4.70

Irrigation Termination Date * Variety = NS (OSL = 0.3980)

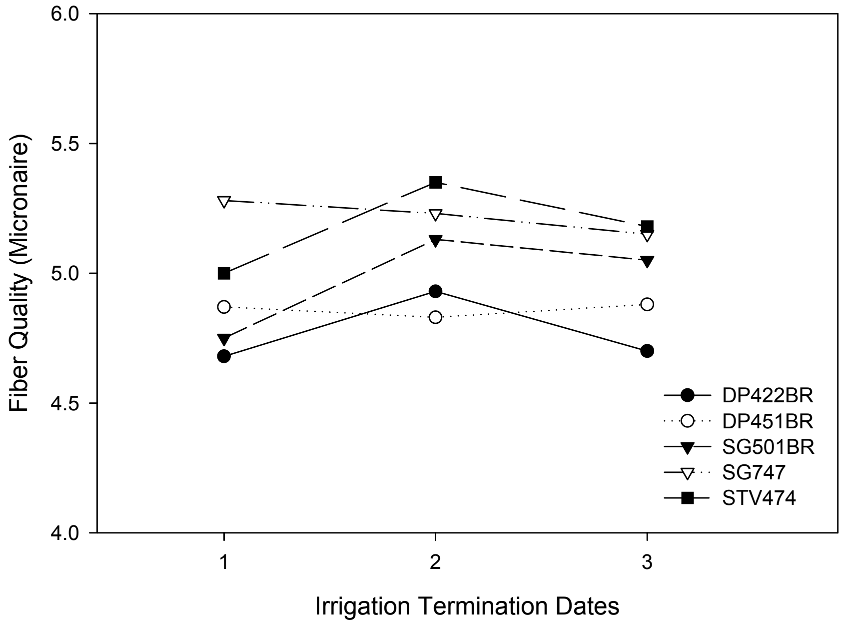

Fig. 10. Micronaire values as affected by irrigation termination date for each variety, YVAC, 2001.

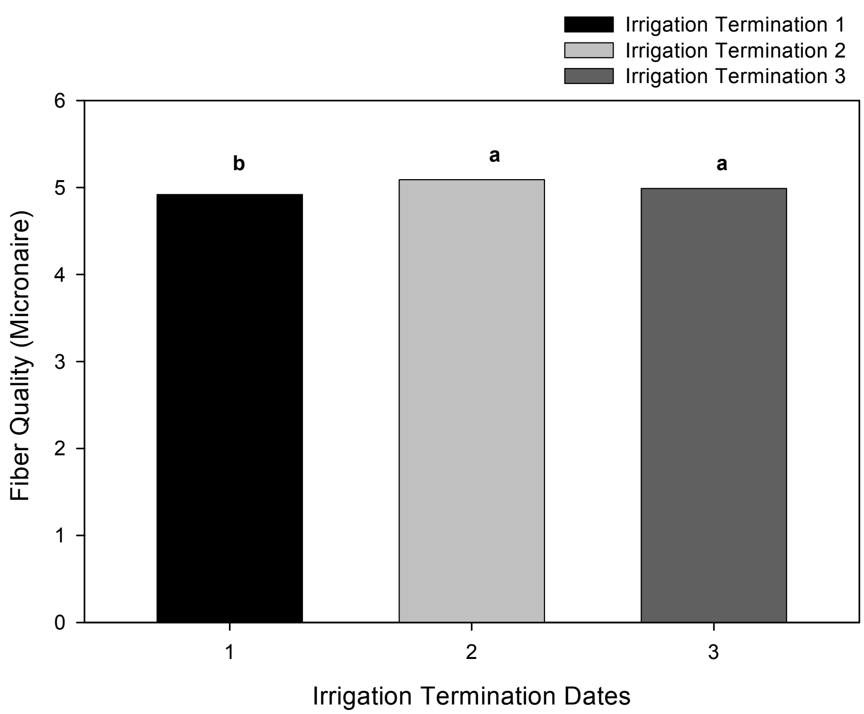

Fig. 11. Mean micronaire values as affected by irrigation termination dates for all varieties, YVAC, 2001.

Table 24. Micronaire results by variety for each irrigation termination date, YVAC, 2001.

Irrigation Termination Date	DP 422BR	DP 451BR	SG 501BR	SG 747	STV 474
			Micronaire		
1 (12 July)	4.68	4.87	4.75	5.28	5.00
2 (27 July)	4.93	4.83	5.13	5.23	5.35
3 (20 September)	4.70	4.88	5.05	5.15	5.18

Irrigation Termination Date * Variety = NS (OSL = 0.3980)

Table 25. Experimental effects and statistical significance from the analysis of variance on lint yield, irrigation termination by variety, YVAC, 2001.

Source of Variation (Effect)	OSL (Pr >F)
Irrigation Termination Date	0.2801
Variety	0.5930
Irrigation Termination Date * Variety	0.1026

Table 26. Main effect results of yield for irrigation termination dates and varieties for cotton planted (water-up) on 21 March, YVAC, 2001.

Irrigation Termination Date	lbs. lint/acre
1 (17 July)	1816
2 (27 July)	1818
3 (20 September)	1942
LSD	NS
OSL**	0.2801
CV(%)§	10.9
Variety	
DP451BR	1843
STV474	1892
DP422BR	1801
SG747	1936
SG501BR	1890
LSD	NS
OSL	0.5930
CV(%)	11.7

*Least Significant Difference – means followed by the same letter are not significantly different according to a Fishers mean separation test at 0.05 level.
**Observed Significance Level.
§Coefficient of Variation

Table 27. Yield results by variety for each irrigation termination date for cotton planted on 21 March, YVAC, 2001.

Irrigation Termination Date	DP 422BR	DP 451BR	SG 501BR	SG 747	STV 474
	lbs. lint/acre				
1 (17 July)	1785	1626	1888	1966	1817
2 (27 July)	1691	1858	1741	1936	1866
3 (20 September)	1928	2044	2040	1992	1908

Irrigation Termination Date * Variety = NS (OSL = 0.1026)

Table 28. Micronaire results for all varieties by irrigation termination dates, YVAC, 2001.

Irrigation Termination Date 1 (12 July)	Lint Yield (lbs. lint/acre)
SG 747	1966
SG 501BR	1888
STV 474	1817
DP 422BR	1785
DP 451BR	1626
Irrigation Termination Date 2 (22 July)	
STV 474	1936
SG 747	1866
SG 501BR	1858
DP 422BR	1741
DP 451BR	1691
Irrigation Termination Date 3 (20 August)	
STV 474	2044
SG 747	2040
SG 501BR	1992
DP 451BR	1927
DP 422BR	1908

Irrigation Termination Date * Variety = NS (OSL = 0.1026)

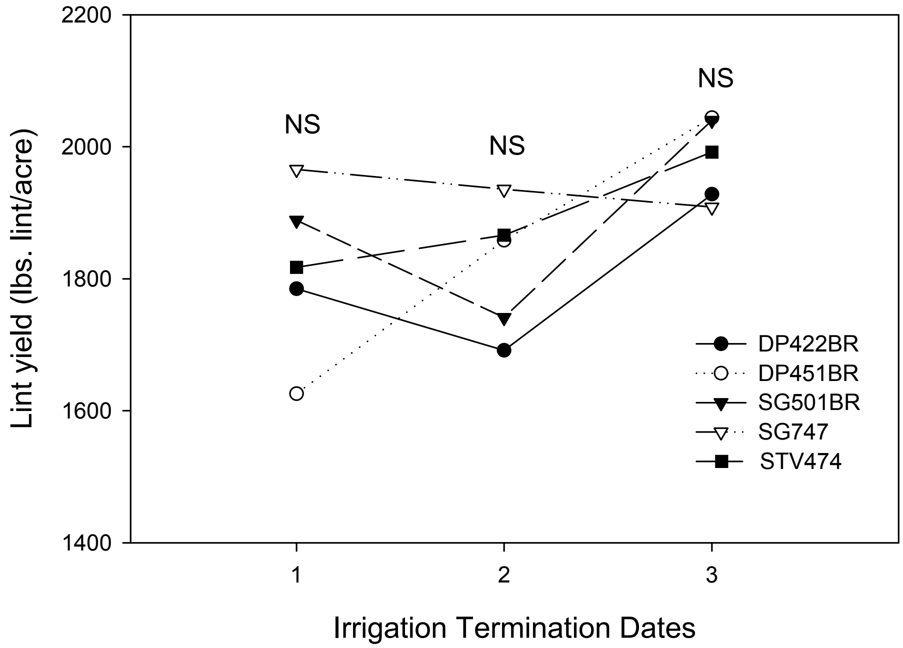

Fig. 12. Lint yield as affected by irrigation termination dates for each variety, YVAC, 2001.

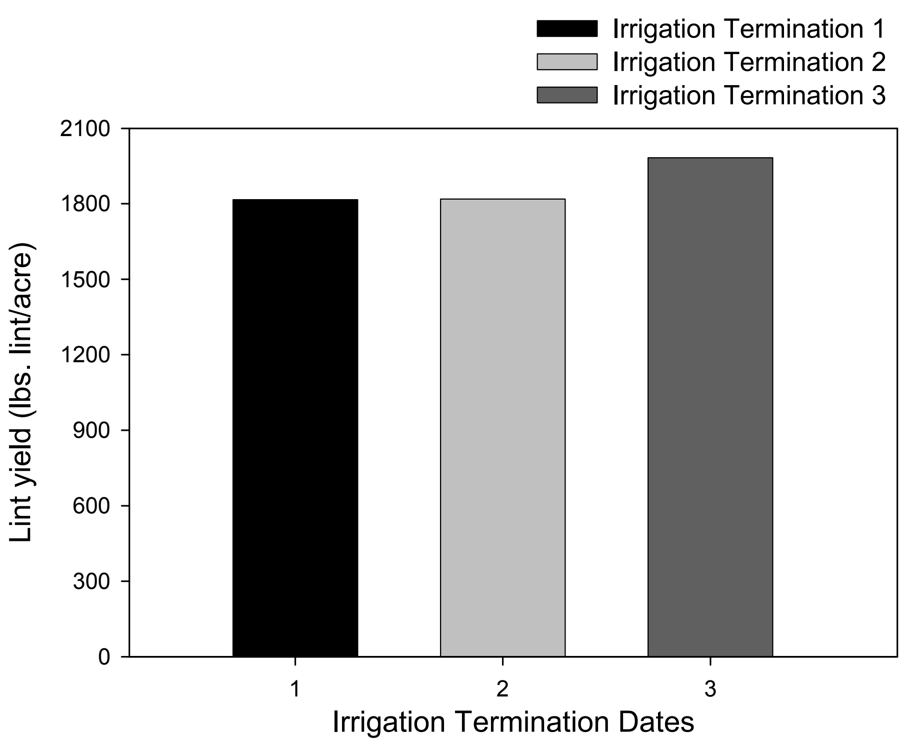

Fig. 13. Mean lint yield as affected by irrigation termination dates for all varieties, YVAC, 2001.