Evaluation of Irrigation Termination Effects on Yield and Fiber Quality of Upland Cotton, 2004

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Abstract

A field experiment was conducted in 2004 at the University of Arizona Maricopa Agricultural Center (1,175ft. elevation) to evaluate the effects of five irrigation termination (IT1, IT2, IT3, IT4, and IT5) dates on yield and fiber micronaire of several Upland cotton varieties. In addition, the economic relationships of IT treatments were also evaluated. The first IT treatment (IT1) was made 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 included one or two additional irrigations (beyond IT1). In this experiment, IT2 was structured to provide an additional (one) irrigation before the more optimal date. For the IT3 plots, the intention was to attempt to time termination to match the conventional growers optimal date. The IT4 and IT5 were imposed to attempt to produce a second cycle fruit set and irrigations continued until 27 August and 21 September respectively. In general, lint yield and micronaire results revealed significant differences among the IT treatments. In a similar fashion to 2000-2002 IT experiments, micronaire and lint yield values consistently increased with later IT dates. The best micronaire and lint yield results were achieved with IT4 date, which received 12 in. less irrigation water than IT5. The 12 in. water saved equates to approximately 20% of the total water used under the conventional practice. The average marginal value of water for all Upland varieties in going from IT1 to IT2, IT2 to IT3, IT3 to IT4, and IT4 to IT5 using November 2004 prices and low carrying costs is calculated at $320.07, $150.15, $100.54, and -$28.16 per acre-foot of water. If steeper mike discounts (November 1999), a lower base lint price (45¢/lb.), and higher costs (i.e., more costly insecticide and chemical costs) are imputed to extend the crop, the marginal value of an acre-foot of water for all Upland varieties and replications in going from IT1 to IT2, IT2 to IT3, IT3 to IT4, and IT4 to IT5 is estimated at $164.04, $48.15, $12.97, and -$94.79. Profitability and marginal value of water sometimes vary quite markedly between different varieties and termination dates as well.

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.

The latest Arizona Water Map (Water Resources Research Center) reports that agriculture, municipal, and industrial uses account for 68%, 25%, and 7% of our state's water use. For Maricopa, Pinal, and Pima counties, cotton accounts for the most cropland acreage (43.4% or 187,200 acres on average for 2001 and 2002, *Arizona Agricultural Statistics*). It also accounts for the most water use (39.6% or 0.68 million acre feet) of all crops, imputing consumption as reported in the latest University of Arizona Field Crop Budgets (Teegerstrom) for each county and crop. In spite of rapid urban growth, cotton will play a key role in Arizona's water management for the foreseeable future due to the following: state and city policies have supported open space, sewage sludge can be responsibly disposed of using a cotton rotation, biotechnology makes it possible for cotton to co-exist near urban housing, tribal water right settlements, a generous farm policy towards cotton, and economically attractive recharging through agriculture. However, the question of how to best use a very limited water supply in a cotton production system has yet to be addressed. The need to address this question is also evidenced by the fact that multiple "Governor Drought Task Force" committees asked the PIs this question during the last year.

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 IT management on yield and quality to suggest that IT and/or defoliation can have a significant impact on fiber micronaire. The initial efforts with this project revealed a significant reduction in fiber micronaire as a function of early IT management (Silvertooth et al., 2001; Silvertooth and Galadima, 2002; Silvertooth and Galadima, 2003; and Silvertooth et al., 2003).

In the current research, we proposed to determine the economic impact of growing a very reduced season cotton crop that utilizes much less water than traditional protocols. This very reduced season has never before been researched. The basis for our economic assessment will be field trials of five different irrigation termination (IT) dates and twelve modern varieties. Impacts on revenue (lint yield and quality differences) and production costs will be quantified. A primary benefit of this research is quantifying the marginal value of water for the entire cotton growth cycle, thus, identifying how to manage cotton as part of a possible drought mitigation plan.

The objective of this study was to further investigate the issue of IT management and the subsequent effects on the growth, development, yield, and fiber quality of a group of common Upland (*G. hirsutum* L.) varieties and one American Pima variety and investigate the overall economic relationships.

Materials and Methods

A field experiment was conducted in 2004 at the Maricopa Agricultural Center (MAC; 1,175 ft. elevation) on a Casa Grande sandy loam soil to evaluate the yield, quality, as well as economic effects of early to late IT management. The experimental design was a split plot in a randomized complete block design with three replications. The main treatments consisted of five IT dates, designated as IT1, IT2, IT3, IT4, and IT5. Each main plot consisted of 12, 40-inch rows that extended the full length of the irrigation run (600 ft.). The subunits consisted of 11 Upland varieties and a Pima S-7 variety. Subplots were each 40 feet long within the main plot units. The entire study areas were dry-planted on 26 April and watered-up 27 April. Composite surface 12-inch soil samples were collected from the experimental site prior to any fertilization for complete nutrient analysis. All inputs such as fertilizer, water, and pest control were managed on an as-needed basis.

A complete set of plant measurements were collected inseason from all plots on 14-day intervals to monitor progress of growth and development of the crop. 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 on a daily basis throughout the growing season using an automated Arizona Meteorological Network (AZMET) station sited at the location. The AZMET station is automated and is used to determine the hourly temperature values and the HU accumulations (86/55 ^{o}F thresholds) are calculated by a method presented in Baskerville and Emin (1969) and modified by Brown (1989). The daily HU accumulations are summed up from the time of planting and reported as HUAP.

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 that 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 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 included one or two additional irrigations (beyond IT1). In this experiment, IT2 was structured to provide an additional (one) irrigation before the more optimal date. For the IT3 plots, the intention was to attempt to time termination to match the conventional growers optimal date. The IT4 and IT5 were imposed to attempt to produce a second cycle fruit set and irrigations were continued until 27 August and 21 September respectively. The IT2 treatment received an additional irrigation over IT1 and IT3 received two additional irrigations over IT1 (approximately an acre-feet of additional irrigation water, Table 2). The IT4 and IT5 treatments received 3 and 5 additional irrigations over IT1 respectively (Table 2).

Crop management and treatments are outlined in Figure1 and Table 1. The planting, IT, defoliation, and harvest dates and their respective heat units accumulated after planting (HUAP) are outlined in Table 1. Table 2 also shows the summary of dates and the number and rates of water applied to each IT date. Only the center four rows of each 12-row plot were harvested.

Approximately 20 lbs. 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 lint yield and fiber quality (micronaire) data were subjected to appropriate analysis of variance procedures (Steel and Torrie, 1980 and the SAS Institute, SAS, 1990).

Results and Discussion

Results reveal a consistent pattern with micronaire and lint yield responses in the IT X Variety experiments for the 2004 season. Results are presented in Tables 3-9 and Figures 2-5.

Summarizing the results for the 2004 season, we found that fiber micronaire was significantly the lowest ($p<0.05$) for the first IT treatment and then consistently increased for successive IT treatments (Table 4 and Figure 3). Lint yield results followed the same micronaire trend. Except our attempt to promote a second crop development with IT5 did not produce a significant increase in yield (Figures 4 and 5). In addition, the fifth IT treatment resulted in slightly lower and significant decrease ($p<0.05$) in lint yield for some varieties (BXN49B, DP655BR, DP451BR, STV474, and STV4892B) which might have been caused by a late season storm in the November month prior to harvest which caused some seed cotton to shed (Figure 5). Poor leaf shedding and defoliation was also noticed which sheds some light on what is typically obtained when trying to grow a second top crop late into the season when temperatures significantly begin to drop.

These results clearly support the hypothesis concerning fiber development, micronaire, and late season irrigation management. Results have shown and support previous studies (Silvertooth et al., 2001; Silvertooth and Galadima, 2002; Silvertooth and Galadima, 2003; and Silvertooth et al., 2003) that fiber micronaire can be significantly reduced and held below the discount range (5.0) for most varieties by IT management (Table 6; Figure 2 and 3). Results also show that reasonably higher lint yields were realized with the later IT treatments and support previous findings that the potential of producing significantly higher lint yield with later IT usually comes at the expense of higher fiber micronaire values. The best results in micronaire and lint yield were achieved with an IT4 date, which received 12 in. less irrigation water than IT5 (Table 2; Figures 2, 4, and 5). The 12 in. water saved equates to approximately 20% of the total water used under the conventional practice (Table 2). In general, 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; Silvertooth et al., 2001; Silvertooth and Galadima, 2002; Silvertooth and Galadima, 2003; and Silvertooth et al., 2003).

The marginal value of water for different irrigation termination dates was evaluated by calculating the additional returns and costs, less water, for continuing the cotton crop beyond the first irrigation termination date (i.e., IT-1). Cost assumptions are that harvest and ginning costs for additional lint occur at 10¢/lb., cotton seed is valued at 6.5¢/lb., each flood irrigation requires 0.3 hours per acre of labor and this labor costs $5.75/hour, and the opportunity cost of foregone revenues from extending the season incur at a daily rate of 10%/365. Insecticide, fertilize, defoliation and any remaining costs were added at $0.75 and $3.00 an acre per day for the low (figure 6) and high (figure 7) "carrying cost" illustrations. Low carrying costs reflect a situation where the grower has already invested in Bt cotton and the product is effective so that insect control costs will be minimal. The high carrying cost figure reflects a situation where insect control costs are high like in some years when whitefly populations were difficult to control with the chemical compounds available. Figure 6 also portrays the marginal value of water using November 2004 micronaire and strength premium/discount schedules and a 60¢/lb. base lint price that approximates the floor price cotton producers have under the current farm bill. Figure 7 reflects less favorable conditions for extending the season since it uses the micronaire discount schedule for 1999 when the discount for lint with micronaire ≥ 5.3 was 22.1¢/lb (Tronstad et al.). This compares with only 4.75¢/lb. for micronaire ≥ 5.3 for 2004. If our existing farm program structure were to adversely change, lint prices received may not have the same price support either.

Thus, a lower base lint price of 45¢/lb. is used to reflect a more adverse scenario for extending the season in figure 7.

Tables 10 and 11 describe the marginal value of water for each variety and the scenarios described in figures 6 and 7. In addition, the tables also give the standard error of the marginal value of water, obtained from the three replications conducted for each variety. While many of the varieties realized a similar marginal value of water within their replication and irrigation termination date, some also exhibited extreme variability. Also note that outliers for mean marginal values are not the same as outliers for the variance or standard deviation. For example, in going from IT2 to IT3 DP33B has a mean marginal value of water that is within the range for other varieties but its standard error is extreme variety. While limited with only three observations, these standard errors provide a measure for placing confidence intervals around the average marginal values for water obtained.

The average of all varieties for extending the season from IT1 to IT2, IT2 to IT3, IT3 to IT4, and IT4 to IT5 yielded a marginal return to water of $320.07, $150.15, $100.54, and $-28.16 per acre-foot for the November 2004 micronaire discount schedule, a 60¢/lb. base lint price, and low "carrying costs." Except for the last irrigation termination date, cutting the water off before the IT4 irrigation termination date (4181 HUAP) is a fairly costly proposition. All production inputs have already been sunk into the crop so that the marginal return to water is quite high around 3500 HUAP. However, if a drought was causing a squeeze on water availability for urban uses, water at a cost of $100 an acre-foot or even $300 an acre-foot may be a price that cities would be willing to pay for a short period. Also, if market and growing conditions are less favorable to the producer for extending the cotton season as described in figure 7 and table 11, the marginal value of water to the producer is less. For this less favorable scenario, extending the season from IT1 to IT2, IT2 to IT3, IT3 to IT4, and IT4 to IT5 yields a marginal return for water of $164.04, $48.15, $12.97, and -$94.79 per acre foot. Market and growing conditions greatly impact the profitability associated with continuing the cotton season. Furthermore, distinct differences exist between varieties and irrigation termination dates as to the profitability of extending the season. For example, DP388 has a higher marginal value of water in going from IT4 to IT5 using market and production conditions described for figure 7 than figure 6. Continuation of the season resulted in a lowering of overall micronaire and dodged a steep discount for high micronaire cotton received with IT4 for one replication.

Acknowledgements

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

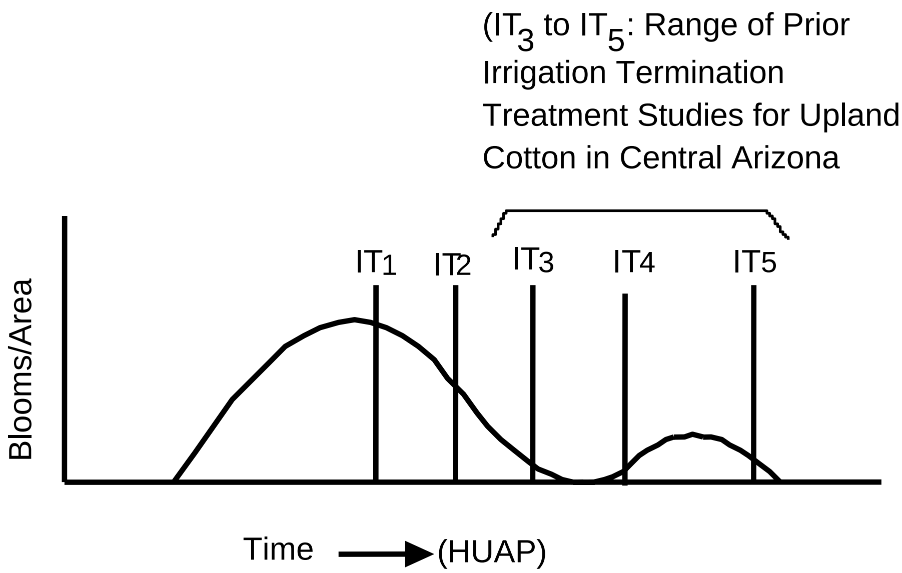

Table 1. Management summary for the irrigation termination X variety experiment, University of Arizona Maricopa Agricultural Center (MAC), 2004. All plots were watered-up on 27 April 2004.

Irrigation Termination Treatment	**Irrigation Termination Dates and HUAP**		**Defoliation Dates and HUAP**		**Harvest Date and HUAP**	
1	22 July	1922	23 August	2895	15 September	3484
2	4 August	2386	9 September	3329	29 September	3777
3	17 August	2744	23 September	3648	13 October	4037
4	27 August	2994	1 October	3813	24 October	4181
5	21 September	3616	28 October	4227	1 December	4407

Table 2. Summary for irrigation application rates and dates for the irrigation termination by variety experiment, MAC, 2004.

Irrigation Termination Treatment	**Irrigation Termination Dates and HUAP**		***Number of Irrigations**	***Total Number of Irrigations**	**Total Water Applied in Inches**
1	22 July	1922	5	7	42
2	4 August	2386	6	8	48
3	17 August	2744	7	9	54
4	27 August	2994	8	10	60
5	21 September	3616	10	12	72

*Two initial irrigations were applied to establish crop stand.

Table 3. Experimental effects and statistical significance from the analysis of variance on micronaire, irrigation termination by variety, MAC, 2004.

Source of Variation (Effect)	OSL (Pr >F)
Irrigation Termination Date	<0.0001
Variety	<0.0001
Irrigation Termination Date * Variety	0.0545

Table 4. Main effect results of micronaire for irrigation termination dates and varieties for cotton planted on 27 April (water-up) MAC, 2004.

Irrigation Termination Date	Micronaire
1	39 e
2	42 d
3	44 c
4	46 b
5	49 a
LSD	0.18
OSL**	<0.0001
CV(%)§	8.9
Variety	
SG215BR	48 a
DP451BR	47 ab
STV4892BR	46 abc
ST474	46 abc
DP388	45 abc
DP33B	45 bc
DP655BR	44 bcd
STV4691B	44 bcd
DP5415	44 bcd
DP449BR	44 bcd
BXN49B	41 d
PIMA S-7	37 e
LSD	0.33
OSL	<0.0001
CV(%)	10.4

*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 5. Micronaire results for all varieties by irrigation termination dates, MAC, 2004.

Irrigation Termination 1		**Irrigation Termination 2**		**Irrigation Termination 3**	
Micronaire		Micronaire		Micronaire	
DP 451BR	42	DP 451BR	46	SG 215BR	51
STV 4892B	42	SG 215BR	45	DP 451BR	47
STV 474	41	STV 4892B	44	STV 4892B	47
DP 388	40	DP 5415	43	STV 4691B	46
SG 215BR	40	DP 388	43	DP 655BR	45
STV 4691B	39	STV 474	43	DP 388	45
DP 449BR	39	STV 4691B	42	DP 33B	44
DP 5415	38	DP 33B	41	BXN 49B	44
DP 33B	38	DP 655BR	41	DP 449BR	43
BXN 49B	37	DP 449BR	39	DP 5415	43
DP 655BR	37	BXN 49B	38	STV 474	43
PIMA S-7	37	PIMA S-7	36	PIMA S-7	35

Irrigation Termination 4		**Irrigation Termination 5**	
Micronaire		Micronaire	
SG 215BR	51	SG 215BR	53
STV 474	49	DP 33B	53
DP 451BR	49	STV 474	53
DP 655BR	49	DP 655BR	51
DP 388	49	DP 449BR	51
STV 4892B	47	DP 451BR	50
DP 33B	47	DP 5415	50
DP 449BR	46	STV 4892B	49
STV 4691B	46	DP 388	49
DP 5415	45	STV 4691B	49
BXN 49B	43	BXN 49B	44
PIMA S-7	35	PIMA S-7	42

Irrigation Termination Date * Variety = NS (OSL = 0.0545)

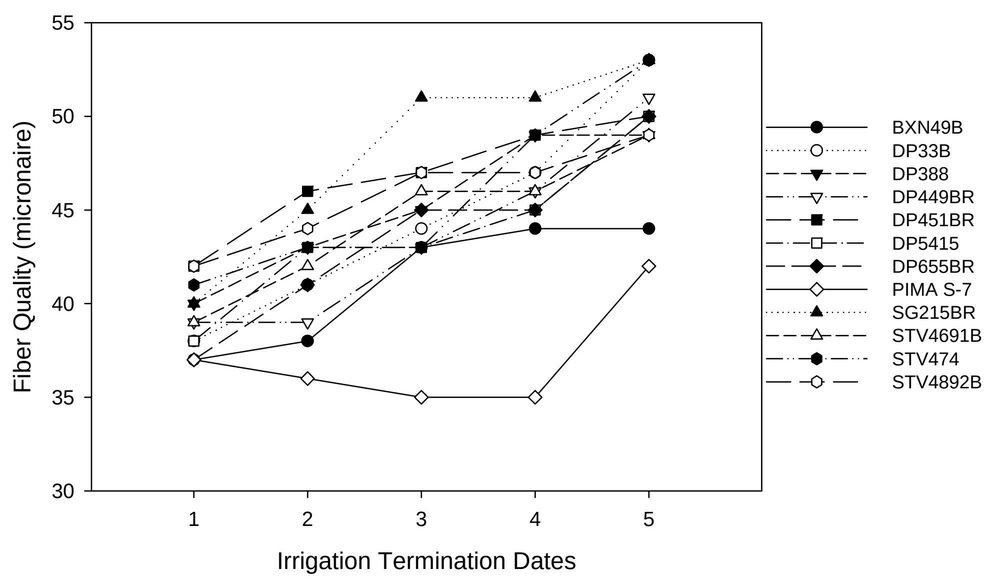

Figure 2. Micronaire values of each variety as affected by irrigation termination dates, MAC, 2004.

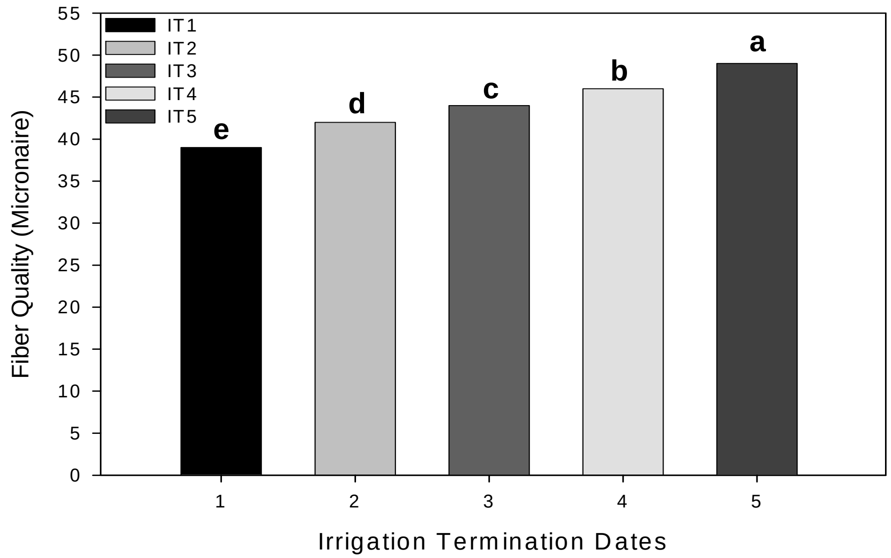

Figure 3. Mean micronaire values for all varieties as affected by irrigation termination dates, MAC, 2004.

Table 6. Micronaire results of each variety as affected by irrigation termination date, MAC, AZ, 2004.

Irrigation Termination Date	**BXN 49B**	**DP 33B**	**DP 388**	**DP 449BR**	**DP 451BR**	**DP 5415**	**DP 655BR**	**Pima S-7**	**SG 215BR**	**STV 4691B**	**STV 474**	**STV 4892B**
1	37 b	38 c	40 c	39 d	42 b	38 c	37 d	37 b	40 c	39 c	41 b	42
2	38 b	41 bc	43 bc	39 d	46 a	43 bc	41 cd	36 b	45 b	42 bc	43 b	44
3	43 a	44 bc	45 ab	43 c	47 a	43 bc	45 bc	35 b	51 a	46 ab	43 b	47
4	44 a	47 ab	49 a	46 b	49 a	45 ab	49 ab	35 b	51 a	46 ab	49 a	47
5	44 a	53 a	49 a	51 a	50 a	50 a	51 a	42 a	53 a	49 a	53 a	49
LSD*	4.2	7.4	4.5	3.1	4.2	5.7	5.2	3.1	3.9	4.8	5.0	NS
OSL**	0.1450	0.0127	0.0070	<0.0001	0.0164	0.0168	0.0011	0.0075	0.0002	0.0100	0.0024	0.1573
CV (%)§	5.5	8.8	5.3	3.4	4.7	6.9	6.2	4.5	4.3	5.7	5.8	7.4

*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 7. Experimental effects and statistical significance from the analysis of variance on lint yield, irrigation termination by variety, MAC, 2004.

Source of Variation (Effect)	OSL (Pr >F)
Irrigation Termination Date	<0.0001
Variety	<0.0001
Irrigation Termination Date * Variety	0.0042

Table 8. Yield results (lbs. lint/acre) by variety for each irrigation termination date for cotton planted on 26 April (water-up), MAC, 2004.

Irrigation Termination Date	BXN 49B	DP 33B	DP 388	DP 449BR	DP 451BR	DP 5415	DP 655BR	Pima S-7	SG 215BR	STV 4691B	STV 474	STV 4892B
1	688 c	444 c	696 c	575 d	777 c	452 c	352 c	89 d	613 b	665 b	709 c	805 b
2	843 c	842 bc	838 c	856 c	1081 b	800 b	906 b	196 d	848 ab	916 b	886 bc	945 b
3	1336 a	1198 ab	1357 b	1240 b	1248 ab	795 b	842 b	503 c	1197 ab	1302 a	1046 b	1224 a
4	1416 a	1398 a	1571 ab	1579 a	1506 a	1207 a	1539 a	710 b	1265 ab	1373 a	1577 a	1390 a
5	1141 ab	1515 a	1709 a	1666 a	1413 ab	1360 a	1461 a	1267 a	1332 a	1408 a	1404 a	1275 a
LSD*	326.0	468.1	313.5	207.9	224.6	491.7	239.4	200.2	452.6	309.3	266.8	217.2
OSL**	0.0035	0.0042	0.0002	<0.0001	0.0005	0.0174	<0.0001	<0.0001	0.0269	0.0019	0.0004	0.0013
CV (%)§	15.9	13.0	13.5	9.3	9.9	8.3	11.9	19.2	12.9	14.5	12.6	10.2

*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 9. Yield results for all varieties by irrigation termination dates, MAC, 2004.

Irrigation Termination 1		**Irrigation Termination 2**		**Irrigation Termination 3**	
lbs. lint/acre		lbs. lint/acre		lbs. lint/acre	
STV 4892B	805 a	DP 451BR	1081 a	DP 388	1357 a
DP 451BR	777 ab	STV 4892B	945 ab	BXN 49B	1336 a
STV 474	709 abc	STV 4691B	916 ab	STV 4691B	1302 a
DP 388	694 abc	DP 655BR	906 ab	DP 451BR	1248 a
BXN 49B	688 abc	STV 474	886 b	DP 449BR	1240 a
STV 4691B	665 abc	DP 449BR	856 b	STV 4892B	1224 a
SG 215BR	613 bcd	SG 215BR	847 b	DP 33B	1198 a
DP 449BR	574 cd	BXN 49B	843 b	SG 215BR	1197 a
DP 5415	452 de	DP 33B	842 b	STV 474	1046 ab
DP 33B	444 de	DP 388	838 b	DP 655BR	842 b
DP 655BR	352 e	DP 5415	800 b	DP 5415	795 bc
PIMA S-7	89 f	PIMA S-7	196 c	PIMA S-7	503 c
LSD*	172.2	LSD*	186.9	LSD*	337.3
OSL**	<0.0001	OSL**	<0.0001	OSL**	0.0005
CV (%)§	15.7	CV (%)§	13.3	CV (%)§	17.9

Irrigation Termination 4		**Irrigation Termination 5**	
lbs. lint/acre		lbs. lint/acre	
DP 449BR	1578 a	DP 388	1709
STV 474	1577 a	DP 449BR	1667
DP 388	1571 a	DP 33B	1515
DP 655BR	1539 a	DP 655BR	1461
DP 451BR	1506 ab	DP 451BR	1413
BXN 49B	1416 ab	STV 4691B	1407
DP 33B	1398 ab	STV 474	1404
STV 4892B	1390 ab	DP 5415	1360
STV 4691B	1373 ab	SG 215BR	1332
SG 215BR	1265 ab	STV 4892B	1276
DP 5415	1206 b	PIMA S-7	1267
PIMA S-7	710 c	BXN 49B	1141
LSD*	326.4	LSD*	NS
OSL**	0.0009	OSL**	0.1976
CV (%)§	13.9	CV (%)§	16.2

*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 at the 0.05 level

§Coefficient of Variation

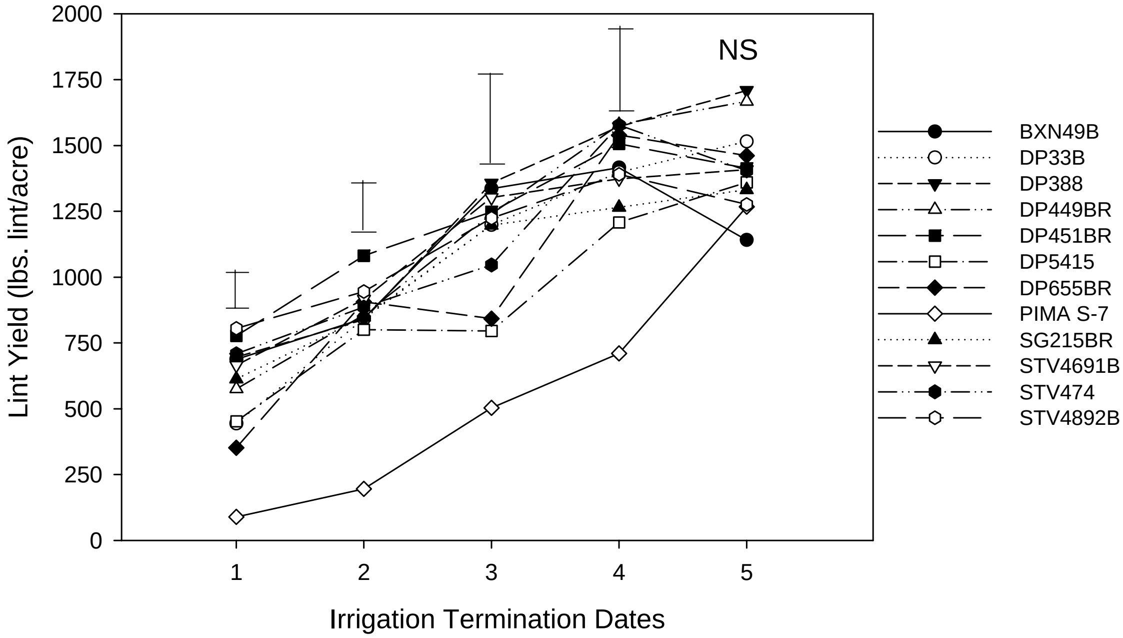

Figure 4. Lint yield as affected by irrigation termination dates, MAC, 2004.

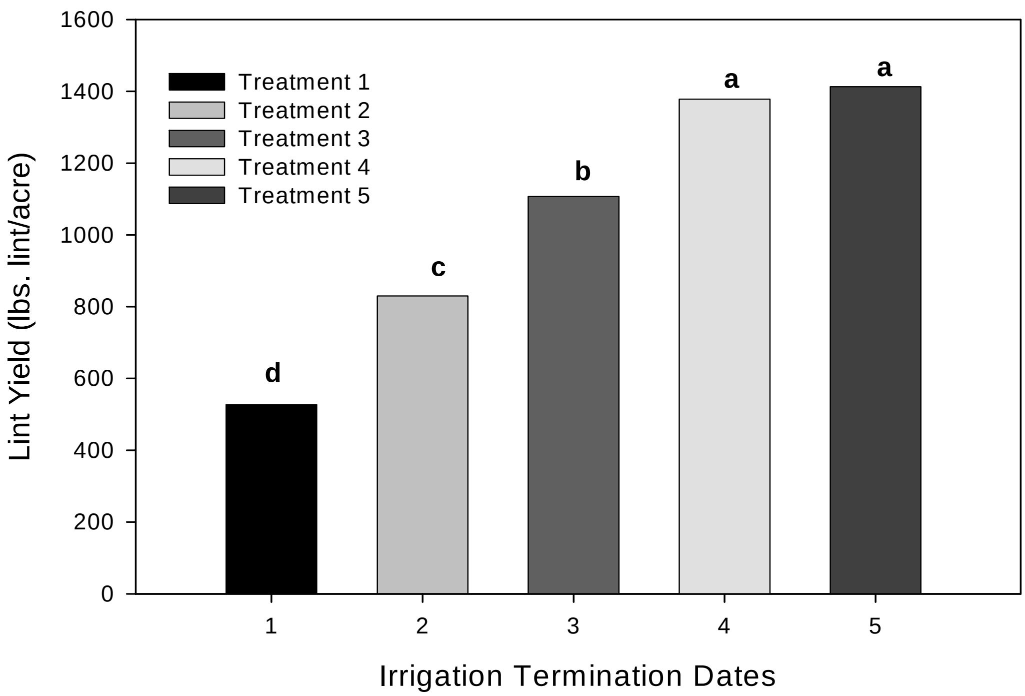

Figure 5. Mean yield results of all varieties as affected by irrigation termination dates, MAC, 2004.

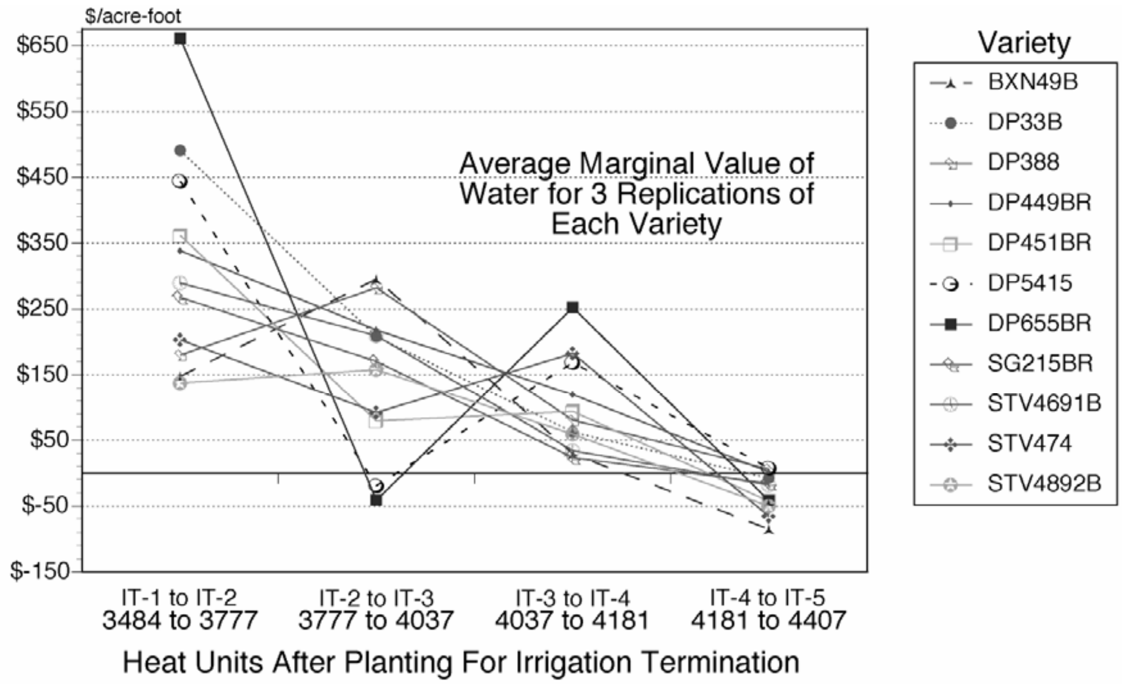

Figure 6. Marginal value of water using Nov. 04 mike discounts, 60¢/lb. base lint value, and low "carrying costs" for continuing the crop.

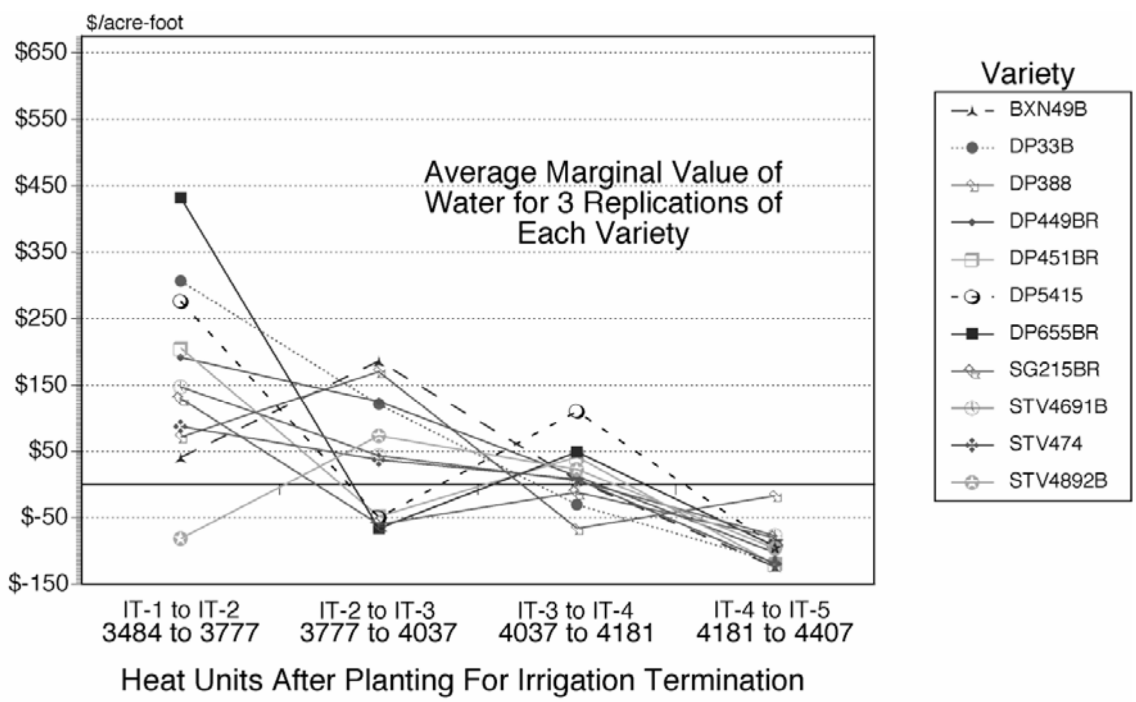

Figure 7. Marginal value of water using Nov. 99 mike discounts, 45¢/lb. base lint value, and high "carrying costs" for continuing the crop.

Table 10. Average Marginal Value ($/acre-foot) and Standard Deviation (values in parentheses) of 3 Replications for Each Variety on Continuing the Cotton Season for Different Irrigation Termination (IT) Protocols: Nov. 2004 Mike Discounts, 60¢/lb. Base Lint Price, and Low "Carrying Costs."

Season Continued	Upland Variety										
	BXN49B	DP33B	DP388	DP449BR	DP451BR	DP5415	DP655BR	SG215BR	STV4691B	STV474	STV4892B
IT1 to IT2	$147.53	$490.50	$180.26	$338.46	$361.38	$444.43	$660.80	$267.67	$289.30	$203.22	$137.21
	($191.98)	($100.30)	($115.96)	($134.00)	($65.62)	($240.83)	($95.33)	($179.08)	($54.97)	($105.39)	($226.96)
IT2 to IT3	$295.38	$207.97	$281.98	$218.07	$79.22	-$18.86	-$41.24	$170.21	$209.27	$92.03	$157.56
	($39.89)	($336.40)	($54.77)	($126.59)	($105.09)	($64.12)	($22.96)	($246.90)	($43.97)	($26.56)	($78.78)
IT3 to IT4	$29.18	$61.94	$80.41	$119.66	$94.07	$168.48	$252.45	$23.88	$34.19	$182.59	$59.04
	($134.63)	($123.98)	($98.98)	($78.56)	($122.23)	($45.53)	($59.15)	($103.69)	($128.92)	($124.93)	($24.78)
IT4 to IT5	-$84.82	-$7.17	$5.90	$1.41	-$42.79	$7.71	-$41.41	-$15.39	-$17.85	-$65.39	-$50.00
	($39.45)	($26.94)	($83.45)	($30.26)	($53.83)	($105.58)	($59.27)	($63.72)	($62.50)	($42.97)	($41.36)

Table 11. Average Marginal Value ($/acre-foot) and Standard Deviation (values in parentheses) of 3 Replications for Each Variety on Continuing the Cotton Season for Different Irrigation Termination (IT) Protocols: Nov. 1999 Mike Discounts, 45¢/lb. Base Lint Price, and High "Carrying Costs."

Season Continued	Upland Variety										
	BXN49B	DP33B	DP388	DP449BR	DP451BR	DP5415	DP655BR	SG215BR	STV4691B	STV474	STV4892B
IT1 to IT2	$40.41	$306.49	$71.37	$191.49	$205.30	$276.14	$431.84	$129.03	$147.18	$87.03	-$81.86
	($152.59)	($70.01)	($78.39)	($102.90)	($44.69)	($179.97)	($75.64)	($130.24)	($48.54)	($74.84)	($36.36)
IT2 to IT3	$185.87	$120.72	$170.18	$124.80	-$48.50	-$49.80	-$66.10	-$60.17	$42.85	$36.80	$73.01
	($27.52)	($244.87)	($43.68)	($96.91)	($97.56)	($44.20)	($22.03)	($60.85)	($110.59)	($21.78)	($140.18)
IT3 to IT4	$5.73	-$30.63	-$66.56	$11.63	$41.00	$109.54	$48.60	-$12.22	$5.89	$7.66	$22.03
	($97.73)	($124.67)	($84.61)	($60.16)	($108.13)	($29.46)	($92.07)	($34.74)	($111.92)	($166.82)	($129.32)
IT4 to IT5	-$124.51	-$117.12	-$17.42	-$103.21	-$120.43	-$92.44	-$93.26	-$80.51	-$77.60	-$119.73	-$96.45
	($66.99)	($37.65)	($99.57)	($46.17)	($87.84)	($54.61)	($64.19)	($27.74)	($72.98)	($70.49)	($47.97)