Comparison of Reduced Irrigation Strategies in Cotton

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Summary

The highest lint yields in 1984 came from three irrigation treatments having a final irrigation on August 30. Terminating the crop three weeks earlier resulted in a 12% yield reduction on the average. The highest returns/acre came from the three high yield treatments and a 2X1 skip row treatment. On a three year average, the highest income came from treatments where the early June or the early September irrigation, but not both, were eliminated.

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Periodic shortages of surface irrigation water, increased pumping costs, and potential restrictions on water use as a result of the new Arizona Ground Water Management Act, all suggest that it is important to develop strategies for using less than traditional amounts of irrigation water for cotton.

Tests were conducted on the Marana Agricultural Center in 1981, 1982, 1983 and 1984 to evaluate reduced irrigation strategies. The 1983 test was not harvested because of flood damage. Two techniques for reducing water use were utilized. One method was to eliminate early and/or late irrigations. July and early-August irrigations followed normal farm practice, as previous research has shown that irrigation during heavy boll set was the most important for high lint yields. The other technique was to utilize skip-row planting, 2X2 or 2X1, with irrigation of the center furrow only. This skip-row practice was shown to make the best use of a limited water supply for cotton in the San Joaquin Valley.

Variations in early season irrigations consisted of delaying the first irrigation from early to mid or late June. The final irrigation was applied in mid-August or about 1 September. There were 7 total treatments in 1981 and 8 in the other years. Deltapine 55 was grown in 1981, DPL 41 and DPL 62 were grown in 1982, and DPL 62 and McNair 235 were grown in 1984.

1984 Test

The test was conducted on field E-3 of the University of Arizona Marana Agricultural Center. There were eight irrigation treatments in this test. The amount of water, the irrigation schedule, and monthly precipitation are given in Table 1. Treatments 7 and 8 were 2X1 and 2X2 skip row plantings, respectively.

The experimental design was a split plot, with eight irrigation treatments as main plots; and two varieties, DPL 62 and McNair 235, replicated five times as subplots. Plots were six 40-inch rows wide, and 50 feet long, except treatment 7, which was four rows wide. The test was planted on 20 April. The center two rows of each plot were spindle harvested into bags on 23 October. A second harvest combining all subplots of a main plot was made on 21 November.

Lint, seed, and seed cotton yields for first harvest and second harvest are given for the eight irrigation treatments in Table 2. Value of lint and seed and cost of ginning are also given in Table 2.

Early irrigations were heavier than in previous years and summer precipitation was somewhat higher than previous years. The plant two skip one treatment gave the most lint per inch of water, while the 2X2 skip row treatment was much less efficient.

Elimination of the 31 May irrigation had little effect on lint yield. Elimination of both 31 May and 12 June irrigations reduced lint yield only 77 pounds/acre (Table 2). However, elimination of the 30 August irrigation significantly reduced lint yield, except when 31 May and 12 June irrigations were also eliminated. Variety response to irrigation was not significantly different, even though McNair 235 is a relatively early variety and DPL 62 is a full season variety. For the whole test, DPL 62 averaged 29 more pounds of lint/acre than did McNair 235.

When income/acre (return above costs excluding ownership and management costs) was determined, treatment 3 which had the first irrigation on 12 June and the last on 30 August, gave the highest income (Table 3). The 2X1 skip row (treatment 7) had $7.00/acre less income. Treatment 1, which had the first irrigation on 31 May and the last on 30 August had $22.00/acre less. The 2X2 skip row treatment had the lowest income. Expenses in this analysis were based upon the 1984 Crop Budgets for Pima County by Scott Hathorn and Jim Armstrong. Adjustments were made as appropriate for treatment differences in irrigation, seed, fertilizer, picking, and hauling costs. Actual ginning costs were used. Income was determined from actual lint and seed prices received. Expenses and income will vary from farm to farm, and as a result a range of water costs and lint prices are considered below.

Three Year Average

The irrigation treatment giving the highest lint yield varied from year to year, but treatment 1 (no irrigations deleted) on the average gave the highest yield (Table 4). Treatments 2 and 3, which had a single early or the late irrigation deleted, produced nearly as well. Skip row treatments were lowest in yield with 2X2 much lower in yield.

The 2X1 skip row had the highest water use efficiency on the average (Table 4). Treatment 6 (deletion of 2 early and 1 late irrigation) was second and treatments 2 and 3 were third and fourth in average water use efficiency.

Net returns per acre are presented in Table 5 based upon 1984 costs and returns, except that lint prices are varied from $.50 to $1.00 per pound and water costs are varied from $1.00 to $10.00 per acre inch. The 1984 2X1 skip row treatment results are included in the comparison in Table 5. Subplot data indicate that 1981 yields for skip row treatments would have been much higher, if water distribution had been evenly distributed for the length of the field. For high water costs, the 1984 2X1 skip row treatment was most profitable at all lint prices considered. Dropping one irrigation (either early or later season) resulted in the highest net return for all water costs and lint prices, except that losses are minimized using the 2X1 skip row application for a low lint price of $.50 and higher water cost of $10/acre inch.

It is clear that elimination of two or more irrigations on upland cotton (Treatments 4, 5, and 6) was not profitable at any of the three lint prices for any of three water costs at Marana, Arizona. Higher lint yields than the 2 to 2.25 bales we obtained would not likely improve the relative economics of these treatments. The 2X2 skip row treatment was even poorer economically at the yield level we experienced, and most likely would be at higher yield levels. Thus, if a substantial water shortage should occur, reduction in acreage is a better option than an appreciable reduction in water application. Irrigation treatments 1, 2, 3, and 7 in these tests should be tested further.

Table 1. Inches of water applied/acre to upland cotton having eight irrigation treatments at Marana, Arizona in 1984.

	Irrigation Treatments							
	1	2	3	4	5	6	7	8
	- - - - - - - - inches of water applied/acre - - - - - - - -							
Preplant	12	12	12	12	12	12	12	12
May 31	5.5	5.5						
June 12	6.0	6.0	6.0	6.0			2.0	1.5
July 2	6.0	6.0	6.0	6.0	6.0	6.0	2.0	1.5
Aug. 9	6.0	6.0	6.0	6.0	6.0	6.0	2.0	1.5
Aug. 30	6.0		6.0		6.0		2.0	1.5
Irrigation	41.5	35.5	36.0	30.0	30.0	24.0	20.0	18.0
Precipitation	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Total	51.5	45.5	46.0	40.0	40.0	34.0	30.0	28.0
Pounds of lint/inch of water	21.65	21.49	24.24	23.68	25.95	28.97	32.27	23.32

Precipitation (inches)

April 20-30	.13
May	.06
June	.04
July	4.49
August	3.09
Sept	1.19
October	1.02
TOTAL	10.02

Table 2. Seed cotton, seed, and lint yield of upland cotton receiving eight different irrigation treatments and lint income, seed income, and ginning costs for cotton grown at Marana, Arizona in 1984.

Irrigation Treatment*	1st Pick 10-23-84	2nd Pick 11-21-84	Total	1st Pick @ .6092/lb	2nd Pick @ .6023/lb	Total
	Lbs lint/acre			Lint Value/acre		
1. X X X X X	987 a**	128 a	1115 a	$601.28	$77.09	$678.37
2. X X X X	885 ab	93 a	978 ab	539.14	56.01	595.15
3. X X X X	986 a	129 a	1115 a	600.67	77.70	678.37
4. X X X	837 b	110 a	947 b	509.90	66.25	576.15
5. X X X	908 ab	130 a	1038 ab	553.15	78.30	631.45
6. X X	865 ab	120 a	985 ab	526.96	72.28	599.24
7. 2 X 1	875 ab	93 a	968 ab	533.05	56.01	589.06
8. 2 X 2	590 c	63 a	653 c	359.43	37.94	397.37
	867	108	975			
	16%	19%	9%			

	Lbs Seed/acre		Seed Value/acre @ .055/lb	@ .0575/lb	
1.	1480	192	$81.40	$11.04	$92.44
2.	1327	140	72.99	8.05	81.04
3.	1479	194	81.35	11.14	92.49
4.	1255	165	69.03	9.49	78.52
5.	1362	195	74.91	11.21	86.12
6.	1297	180	71.34	10.35	81.69
7.	1312	140	72.16	8.05	80.21
8.	885	95	48.68	5.46	54.14

	Lbs Seed Cotton/acre		Ginning Cost/acre @ .0275/lb.		
1.	2957	378	$81.32	$10.40	$91.72
2.	2651	275	72.90	7.56	80.46
3.	2954	381	81.24	10.50	91.74
4.	2508	325	68.97	8.94	77.91
5.	2720	384	74.80	10.56	85.36
6.	2592	354	71.28	9.74	81.02
7.	2622	275	72.11	7.56	79.67
8.	1768	186	48.62	5.12	53.74

* Each X indicates a post-plant irrigation. Irrigation dates were 31 May, 12 June, 2 July, 9 August, and 30 August.

** Mean lint yields within a column are not significantly different at the 0.05 confidence level if followed by the same letter, according to Duncan's Multiple Range Test.

Table 3. Income, production expenses, and return from eight irrigation treatments designed to evaluate reduced water rise on upland cotton on the Marana Agricultural Center, Arizona in 1984.

Income and Production Costs/Acre	Irrigation Treatment 1	2	3	4	5	6	7	8
	Income							
Lint value	$678.37	$595.15	$678.37	$576.15	$631.45	$599.24	$589.06	$397.37
Seed value	92.44	81.04	92.49	78.52	86.12	81.69	80.21	54.14
Total income	770.81	676.19	770.86	654.67	717.57	680.93	669.27	451.51
	Expenses							
Irrigation @ $2.00/acre inch	83.00	71.00	72.00	60.00	60.00	48.00	40.00	36.00
Irrigation labor	7.00	5.98	6.07	5.06	5.06	4.05	3.37	3.03
Planting seed	7.24	7.24	7.24	7.24	7.24	7.24	4.83	3.62
Layby fertilizer	22.31	22.31	22.31	22.31	22.31	22.31	7.44	5.58
Picking	82.53	82.53	82.53	82.53	82.53	82.53	55.02	41.27
Hauling @ .00598/lb.	19.94	17.50	19.94	16.94	18.57	17.62	17.32	11.68
Ginning (Table 2)	91.72	80.46	91.74	77.91	85.36	81.02	79.67	53.74
Other production costs*	208.31	208.31	208.31	208.31	208.31	208.31	208.31	208.31
Total Production Costs	522.05	495.33	510.14	480.30	489.38	471.08	415.96	363.23
Income less costs	248.76	180.86	260.72	174.37	228.19	209.85	253.31	88.28

* Seedbed preparation, weed control, insect control, etc.

Table 4. Three year average of lint yield, water use efficiency, and return/acre for eight irrigation treatments on upland cotton on the Marana Agricultural Center, Arizona.

Irrigation Treatments	Year				Year			
	1981	1982	1984	Mean	1981	1982	1984	Mean
	- - - - lbs. lint/acre - - - -				- - - Rank of lint yield - - -			
1. X X X X X	1148 a	1000 c	1115 a	1088	1	3	1	1
2. X X X X	1017 a	1124 b	1115 a	1085	4	2	1	3
3. X X X X	1080 a	1187 a	1121 ab	1130	2	1	5	2
4. X X X	1076 a	878 d	1038 ab	997	3	5	3	5
5. X X X	-	999 c	947 b	973	-	4	7	4
6. X X	1017 a	850 d	985 ab	951	4	6	4	6
7. 2X1	752 b	777 e	968 ab	832	6	7	6	7
8. 2X2	730 b	629 f	653 c	671	7	8	8	8
C.V.	20%	2%	9%					
	Inches of Water, Irrigation and Precipitation				- - - Lbs lint/inch of water - - -			
1.	40.8	35.7	51.5		28.2	28.0	21.7	26.0
2.	36.3	31.7	45.5		29.8	37.4	21.5	29.6
3.	33.2	33.7	46.0		30.7	33.4	24.2	29.4
4.	-	29.7	40.0		-	33.6	23.7	28.7
5.	36.5	31.7	40.0		29.5	27.7	26.0	27.7
6.	32.0	27.7	34.0		31.8	30.7	29.0	30.5
7.	23.4	23.0	30.0		32.2	33.8	32.3	32.8
8.	22.5	21.4	28.0		32.5	29.4	23.3	28.4

Table 5. Income from upland cotton produced under 8 irrigation regimes (three year average) using 1984 cost figures, except three lint prices and three water prices are used. Tests conducted at Marana, Arizona.

Treatment No.	Irrigations	Lint @ $0.50/lb			Lint @ $0.75/lb			Lint @ $1.00/lb		
		water cost								
		$1.00/in	$5.00/in	$10.00/in	$1.00/in	$5.00/in	$10.00/in	$1.00/in	$5.00/in	$10.00/in
		return/acre*								
1	X X X X X	$166	$-2	-$211	$438	$270	$ 61	$710	$542	$333
2	X X X X	169	23	-160	439	293	110	710	564	381
3	X X X X	170	22	-162	441	294	109	713	565	380
4	X X X	119	-17	-186	362	227	57	605	470	300
5	X X X	129	-15	-195	378	234	54	627	483	303
6	X X	112	-13	-169	350	225	69	587	463	307
7	2X1	105	3	-124	313	211	84	521	419	292
7a	2X1 (1984)	167	47	-103	410	289	139	651	531	381
8	2X2	44	-50	-168	212	118	-1	380	285	167

* Does not include ownership and management costs.