UPLAND COTTON LINT YIELD RESPONSE TO SEVERAL SOIL MOISTURE DEPLETION LEVELS

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Abstract

Upland cotton lint yield response to several soil moisture depletion levels was measured in 1996 and 1997 for four Upland cotton varieties including DP 5415, DP 33B, DP 5816, and STV 474. In 1996, depletion of plant available soil water (PAW) irrigation treatments consisted of 35%, 50%, 75%, and 90%. In 1997, treatments were 35%, 50%, 65%, and 80% depletion of PAW. In 1996, the 35% and 50% treatments were significantly different than the 75% and 90% treatments (P<0.05) and resulted in the highest lint yields of 1374 and 1438 ibs. lint/acre respectively. A lint yield reduction was measured with the 75% and 90% PAW treatments of 713 and 329 lbs. lint/acre, respectively. The 75% and 90% treatments were significantly different than the 35% and 50% treatments and were significantly different from each other. In 1997, all PAW depletion treatments were significantly different with the 35% PAW treatment resulting in the highest average lint yield of 1880 lbs. lint/acre. The 50%, 65%, and 80% PAW treatments resulted in 1410, 1123, and 248 lbs. lint/acre respectively. There was no significant (P<0.05) difference between varieties within all PAW treatments in 1996 or1997.

Introduction

The Arizona cotton production system is unique when compared with the majority of the United States cotton belt. Due to the semi-arid climate and high summer temperatures, all the cotton acres are irrigated. Due to high input costs, high lint yields are needed in order for farms to remain competitive and profitable. The low desert of Arizona has a long, growing season, which is an advantage compared with the remainder of the cotton belt. Historically, Arizona production systems have capitalized on the production potential of full season varieties, commonly resulting in high yields. However, as a result of increasing late season insect pressures, increasing costs of production, and static cotton prices, Arizona cotton producers have generally shifted toward a reduced season production approach in contrast to the historical full season system.

Low desert producers have adopted a late season insect avoidance strategy with an attempt to produce maximum economic yield versus maximum agronomic yields. However, the increasing input costs and static cotton prices continue to require high lint yield production in order to survive economically. In addition to late season insect avoidance strategies, a second production change is the use of cotton varieties which are earlier with respect to maturity than historically produced varieties. The earlier maturity varieties tend to have a stronger and more compacted primary fruit cycle than the historically produced longer maturity varieties. High yield potential exists with the currently used earlier maturity varieties but tend to offer less late season production opportunity and mandate utilization of highly efficient production inputs during the primary flowering cycle.

Since the shift toward earlier maturity varieties, producers have observed that optimum in season water management is critical if high yields are to be realized consistently. This experiment was designed to evaluate lint yield response to specific soil moisture depletion levels between irrigation intervals from planting through cut out, representative of a single fruit set production system. The primary objective was to measure lint yield response to soil moisture depletion levels of four popular varieties.

Materials and Methods

The experiment was conducted at the University of Arizona Maricopa Agricultural Center on a Casa Grande sandy loam soil in 1996 and 1997 and consisted of four irrigation treatments based on soil moisture depletion levels between irrigation events. In 1996, the irrigation treatments were 35%, 50%, 75%, and 90% depletion of plant available soil moisture depletion.. In 1997, irrigation treatments were modified to include 35%, 50%, 65%, and 80% plant available soil moisture depletion in order to more accurately identify the critical level of soil moisture depletion responsible for yield reduction. Within each irrigation treatment, there were four Upland cotton varieties including DP 5415, DP 33B, and STV 474, and DP 5816.

Plots were sixteen rows (forty inch spacing) wide and one hundred seventy feet long. Each sixteen row irrigation treatment main plot contained the four varieties, each subplot four rows wide. The experiment consisted of four irrigation treatments replicated four times resulting in a split plot design within a randomized complete block. The test field was pre-irrigated and planted to moisture on April 2, 1996 and April 9, 1997 with a fourteen lbs./acre seeding rate. All subsequent plot irrigations were accomplished by pumping from an adjacent irrigation ditch delivered through six inch aluminum pipe, metered with an in-line McCrometer impeller flow meter, with individual plot water delivery through six inch gated pipe.

Irrigation scheduling was accomplished by measuring soil moisture with a Campbell Pacific 503 DR Hydroprobe. Several days after stand establishment, two neutron probe access tubes were installed in every plot to a depth of six feet. Neutron probe access sites were located in a center row, fifty five feet from each end within the DP 5415 variety. Gravimetric soil samples moisture samples and corresponding depth neutron probe measurements were collected for each depth at the time of neutron access tube installation and used for both field capacity determination and neutron probe calibration. Gravimetric soil samples were collected from 0-30 cm and continued on subsequent 20 cm increments to 190 cm.

Due to measured field capacity variability, each plot was assigned a measured field capacity for each sampling increment. Each plot received irrigation refill volume requirements on an independent basis relative to water holding capacity and calculated plant available water. Soil samples were taken at each neutron access site and each depth increment and analyzed for particle size distribution. The textural triangle was used for soil texture determination with available soil water determined by texture (USDA). The allowable soil moisture depletion was calculated by multiplying the treatment depletion threshold, (35%, 50%, 65%, and 80%) by the numerically determined total available water value. Irrigation scheduling was accomplished by measuring soil moisture content in each plot two days after each irrigation (gravity drainage assumed complete) with subsequent soil moisture measurements at least every other day until the targeted soil moisture depletion was attained. The active root zone was estimated and expanded when water use occurred in the next 20 cm. measurement increment since the previous irrigation event. When the targeted soil moisture depletion threshold was attained, irrigation water was delivered and measured the same day with the volume necessary to refill the soil profile of depletion measurement for each plot.

Nitrogen fertilizer and pest control was managed on a liberal basis with intents of eliminating yield affecting production variables (Tables 1 and 2). Plant mapping measurements were made every other week from June through mid-August within each irrigation treatment on all varieties. Measurements included plant height, number of mainstem nodes, height to node ratio, and nodes above top white bloom..

Cutout occurred across all treatments by late July in both 1996 and 1997. Cutout is defined as measurement of nodes above top white bloom of five or less. Irrigations were terminated on August 10, 1996 and August 13, 1997. Defoliation (9 oz. Ginstar) was applied on September 5 in 1996 and 1997. Defoliation was applied by ground with 18 gallons/ acre carrier rate. Harvest was accomplished on September 18 and September 24 in 1996 and 1997 respectively.

The center two rows of each four row subplot within each irrigation treatment was harvested with a spindle picker. Harvested seed cotton was weighed using a hanging electronic balance. The seed cotton was then sub-sampled and ginned for lint percent. The lint samples were then submitted to the USDA Cotton Classing Office in Phoenix, Az. for High Volume Instrument (HVI) measured fiber lint quality characteristic measurement (Table 3).

Results and Discussion

In 1996, the 35% and 50% soil moisture depletion treatments resulted in the highest and statistically similar lint yields across all treatment combinations (Table 4). There were no significant variety yield differences by irrigation treatment (Table 5). Lint yields were the highest within the 35% and 50% depletion of PAW across all varieties. Yields declined precipitously within all tested varieties within the 75% and 90% PAW depletion irrigation treatments.

In 1997, all soil moisture depletion treatment yield responses were significantly different (Table 6). There were no significant variety differences within irrigation treatments (Table 7). The highest lint yields were obtained by all varieties within the 35% soil moisture depletion of PAW treatment.

Summary

The results of these experiments indicate that there is not an irrigation management response difference between varieties. All tested varieties responded in a similar manner with in each irrigation regime. The results of the two year experiment indicate that depletion of PAW should be managed within a range of 35 -50%. Yield potentials of earlier maturity varieties currently produced when managed for a primary fruiting cycle are high when water is managed in an optimum manner. When depletion of PAW exceeds 50%, yield decline is significant.

Both the 1996 and 1997 test results indicate that optimum irrigation management during the primary fruiting cycle is essential to realize yield potential . The highest yields occurred in 1996 when the peak irrigation return interval was approximately ten days. In 1997, the 35% soil moisture depletion treatment resulted in significantly higher yields than the remaining treatments with a resultant irrigation return interval of seven days. Again, the seven and ten day peak irrigation interval is representative of an optimum irrigation management strategy targeting for a 35-50% depletion of plant available soil moisture.

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Table 1. 1996 and 1997 Nitrogen Application Dates and Rates

Date	1996 Application	Date	1997 Application
3/12	15 gal/ac UAN32	3/21	30 gal/ac UAN32
5/10	15gal/ac UAN32	5/21	15 gal/ac UAN32
6/18	15gal/ac UAN32	6/16	15 gal/ac UAN32

Table 2. 1996 and 1997 Insect Control Dates and Rates

Date	1996 Application	Date	1997 Application
6/18	Vydate 1 lb/ac	6/16	Temik 11 lbs/ac
6/18	Temik 11 lbs/ac	6/23	Vydate 34 oz/ac
6/25	Endosulfan 2 pts/ac	7/15	Applaud .5 lbs/ac
6/25	Ovasyn 1.33 pts/ac	7/23	Lorsban 1.5 pt/ac
7/8	Applaud .5 lbs/ac	7/23	Orthene 1 lb/ac
7/22	Orthene	7/23	Karate 40 oz/ac
7/22	Lockon	8/12	Lorsban 1 qt/ac
8/5	Vydate	8/12	Vydate 34 oz/ac

Table 3. 1996 and 1997 HVI Values

1996 HVI Treatment	Grade	Micro	Length	Staple	Strength
35%	36	4.7	115.25	37	29.9
50%	36	5.0	115	36.75	30.75
75%	31.25	5.3	111.75	35.75	29.4
90%	28.75	5.3	109.5	35	29.27

1997 HVI Treatment	Grade	Micro	Length	Staple	Strength
35%	26	4.7	111	35.75	27.42
50%	21	4.7	108.75	35	28.02
65%	23.5	4.6	111	35.5	27.92
80%	23.75	5.0	107.75	34.5	26.92

Table 4. 1996 Lint Yields (lint lbs/ac) by Irrigation Treatment.

Irrigation Treatment	35% (PAW)** V.WET	50% (PAW) WET	75% (PAW) MED	90% (PAW) DRY
Lint Yield (lbs./A)	1374 a*	1438 a	713 b	329 c
LSD = 131				
CV = 19.1				
OSL = 0.0001				

* MEANS Followed by the same letter are not significantly different following a significant SAS Analysis of Variance Test.
** PAW = Plant Available Water
LSD = Least Significant Difference
CV = Coefficient of Variation
OSL = Observed Significance Level

Table 5. Variety by Irrigation Treatment Interaction 1996.

Variety	Lint (lbs/A)	Trt (PAW)**
DP 5415	1545	50%
STV 474	1540	35%
STV 474	1503	50%
DP 33B	1447	50%
DP 5415	1420	35%
DP 33B	1414	35%
DP 5816	1254	50%
DP 5816	1120	35%
DP 5415	778	75%
DP 33B	701	75%
DP 5816	701	75%
STV 474	673	75%
DP 5415	374	90%
DP 33B	335	90%
DP 5816	328	90%
STV 474	279	90%
P<0.05		
CV = 19.1		
OSL = 0.3980		

* Means followed by the same letter are not significantly different following a SAS Significant Analysis of Variance test.
CV = Coefficient of Variation
OSL = Observed Significance Level
* *PAW = Plant Available Water

Table 6. 1997 Lint Yields (lint lbs/ac) by Irrigation Treatment.

Irrigation Treatment	35% (PAW)** V.WET	50% (PAW) WET	65% (PAW) MED	80% (PAW) DRY
Lint Yield (lbs./A)	1880 a*	1410 b	1123 c	248 d

LSD = 126
CV = 15.1
OSL = 0.0001

* MEANS Followed by the same letter are not significantly different following a significant SAS Analysis of Variance Test.
** PAW = Percent Available Water
LSD = Least Significant Difference
CV = Coefficient of Variation
OSL = Observed Significance Level

Table 7. Variety by Irrigation Treatment Interaction 1997.

Variety	Lint (lbs/A)	Trt (PAW)**
STV 474	2053	35%
DP 33B	1923	35%
DP 5415	1800	35%
DP 5816	1745	35%
STV 474	1459	50%
DP 33B	1416	50%
DP 5816	1409	50%
DP 5415	1354	50%
DP 33B	1179	65%
STV 474	1155	65%
DP 5415	1113	65%
DP 5816	1047	65%
DP 5816	275	80%
STV 474	260	80%
DP 33B	236	80%
DP 5415	221	80%

$P<0.05$
CV = 15.1
OSL = 0.8336

* Means followed by the same letter are not significantly different following a SAS Significant Analysis of Variance.
CV = Coefficient of Variation
OSL = Observed Significance Level
** PAW = Plant Available Water