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 1997 and 1998. In 1997, four Upland cotton varieties including DP 5415, DP 33B, DP 5816, and STV 474 were tested. However because of a non-significant variety difference in the 1997 test, the 1998 test was planted to a single variety (DP 33B). In 1997 and 1998, depletion of plant available soil water (PAW) irrigation treatments consisted of 35%, 50%, 65%, and 80%. 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 1997. In 1998, all PAW depletion treatments again were significantly different with the 35% PAW treatment resulting in the highest average lint yield of 1658 lbs. lint/acre. The 50%, 65%, and 80% PAW treatments resulted in 1534, 1396, and 641 lbs. lint/acre respectively.

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 potential 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 or compensation 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

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production system. The primary objective was to measure lint yield response to different soil moisture depletion levels between irrigation events 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 1997 and 1998 and consisted of four irrigation treatments based on soil moisture depletion levels between irrigation events. The irrigation treatments were 35%, 50%, 65%, and 80% depletion of plant available soil moisture depletion. In 1997 each irrigation treatment consisted of four Upland cotton varieties including DP 5415, DP 33B, STV 474, and DP 5816. However, due to no significant differences within irrigation treatments the 1998 test was planted to DP 33B only.

In 1997, experimental 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 being four rows wide. The experiment consisted of four irrigation treatments replicated four times resulting in a split plot design within a randomized complete block. In 1998, experimental plots were again sixteen rows wide (forty inch spacing), but four hundred feet long. Each sixteen row plot was planted with DP 33B only. Again, the 1998 test consisted of four irrigation treatments and was replicated four times. The test field was pre-irrigated and planted to moisture on April 9, 1997, and April 17, 1998 with a fourteen lbs./acre seeding rate. 1n 1997, all subsequent plot irrigations were accomplished by pumping from an adjacent irrigation ditch with water through six inch aluminum pipe, metered with an in-line McCrometer impeller flow meter, and individual plot water delivered through six inch gated pipe. In 1998, in season irrigation was accomplished using 1.5" siphon tubes and measured using a ditch weir.

Irrigation scheduling was managed 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. In 1997, neutron probe access sites were located in a center row, fifty five feet from each end within the DP 5415 variety. In 1998, neutron probe access sites were located in a center row one hundred and twenty five feet from each end. 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 to field calibrate the neutron probe. The entire field was irrigated at the time of the initial post plant in season irrigation. Gravimetric soil samples were taken for field capacity determination two days after this irrigation. 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 textural based estimation of total available water. Irrigation scheduling was managed 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.

Irrigations were terminated on August 13, 1997, and September 3, 1998 . The defoliant, Ginstar (9 oz.) was applied on September 5 in 1997 and September 26 1998. Defoliation was applied by ground with 18 gallons/acre carrier rate. Harvest was accomplished on September 24 and October 20 in 1997 and 1998 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 fiber quality analysis.

Results and Discussion

In both 1997 and 1998, there were significant yield differences between irrigation treatments (Table 1). The highest lint yields were obtained within the 35% depletion of PAW. There were no fiber quality differences between irrigation treatments (Table 2). Maximum yields resulted when irrigation return intervals during the flowering cycle averaged 7 days in the test site soil type. Irrigation application totals reflect the water volume necessary to refill root zone at time of irrigation events. Due to relatively short irrigation run length, irrigation efficiency is very high (Table 3).

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 not exceed 35% for optimum yield production. Yield potentials of medium maturity varieties is high when water is managed in an optimum manner. When depletion of PAW exceeds 35%, yield decline can be significant.

Both the 1997 and 1998 test results indicate that optimum irrigation management during the primary fruiting cycle is essential to realize yield potential. In 1997, the 35% soil moisture depletion treatment resulted in significantly higher yields than the remaining treatments with an irrigation event return interval of seven days during peak water use on this described soil type. Again in 1998, the highest yields occurred when the rrigation return interval was approximately seven days during peak water use.

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Table 1. 1997 and 1998 Lint Yields (lint lbs/ac) by Irrigation Treatment.

	1997	1998
Irr. Treatment PAW Depletion	**Lint Yield (lbs/ac)**	**Lint Yield (lbs/ac)**
35%	1880 a*	1658 a*
50%	1410 b	1534 b
65%	1123 c	1396 c
80%	248 d	641 d
	LSD = 126; CV = 15.1, OSL = 0.0001	LSD = 123; CV = 4.7, 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 2. 1997 and 1998 Fiber Quality

1997

Irr. Treatment	Grade	Micronaire	Length (inches)	Staple(32nds)	Strength(gms/tex)
35%	21	4.7	1.11	36	27.4
50%	21	4.7	1.09	35	28.0
65%	21	4.6	1.11	36	27.9
80%	21	5.0	1.08	35	26.9

1998

Irr. Treatment	Grade	Micronaire	Length (inches)	Staple(32nds)	Strength(gms/tex)
35%	21	5.0	1.17	37	28.4
50%	21	5.3	1.16	37	31.1
65%	21	5.3	1.14	37	28.9
80%	21	5.2	1.11	36	31.2

Table 3. 1997 and 1998 Irrigation Histories

Irr. Treatment PAW Depletion	Average Irrigation Return Interval	Total Irrigations	Total Water Applied (inches)
1997			
35%	7 days	11	37.0
50%	11 days	8	32.5
65%	14 days	7	32.0
80%	35 days	4	20.5
1998			
35%	7 days	14	47.0
50%	10 days	10	40.0
65%	15 days	8	35.0
80%	31 days	5	23.0