UPLAND COTTON LINT YIELD RESPONSE TO VARIED SOIL MOISTURE DEPLETION LEVELS

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Abstract

Upland cotton lint yield response to varied soil moisture depletion levels was measured in 1996 and 1997 for four Upland cotton varieties including Delta and Pine 5415, NuCotn 33B, 5816, and Stoneville 474. In 1996, soil moisture depletion treatments consisted of 35%, 50%, 75%, and 90% maximum allowable depletion (MAD) while in 1997, treatments were 35%. 50%, 65%, and 80% MAD. In 1996, the 35% and 50% treatments resulted in the highest statistically similar ($p<.05$) varietal averaged lint yields of 1374 and 1438 lbs./acre respectively with a corresponding statistically significant lint yield reduction for the 75% and 90% MAD treatments of 713 and 329 lbs. lint/acre respectively. The 1997 treatments were statistically significant with the 35% MAD treatment resulting in the highest varietal average lint yield of 1880 lbs. lint/acre. The 50%, 65%, and 80% MAD treatments resulted in 1410, 1123, and 248 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 semiarid climate and resultant high summer temperatures, the cotton crop is 100% irrigated with resultant high input costs and high mandatory lint yields to remain competitive and profitable. The low desert of Arizona has a long, full growing season which is the major advantage when compared with the remainder of the belt. Historically, Arizona has capitalized on the full season production potential and has produced extremely high yields. However, as a result of increasing late season insect pressures and resultant increasing control costs and also relatively static cotton prices, Arizona cotton producers have generally shifted toward a reduced season production approach in contrast to historical full season, maximum yield production.

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 to survive economically. In addition to late season insect avoidance strategies, a second significant change is the use of more determinate Upland cotton varieties as compared to historically used full season, indeterminate lines. The more determinate varieties tend to have a stronger and more compacted primary fruit set than the more indeterminate lines. The indeterminate varieties offer more late season compensation potential as a result of a stronger secondary fruit set potential. High yield potential exists with the currently used medium 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 medium maturity varieties, producer observation and experience has suggested that the newer varieties are more water stress sensitive, less forgiving, and require more intensive management. This experiment was designed to evaluate lint yield response to incremental managed soil moisture depletion levels between irrigation intervals from planting through cutout representative of single fruit set production. The primary objective was to measure lint yield response difference to soil moisture depletion levels of three current popular medium maturity varieties contrasted against a more indeterminate selection.

Materials and Methods

The experiment was conducted at the University of Arizona Maricopa Agricultural Center in 1996 and 1997 and consisted of four irrigation treatments based on managed allowable soil moisture depletion levels between irrigation events. In 1996, the irrigation treatments were 35%, 50%, 75%, and 90% available soil moisture depletion. In 1997, irrigation treatment thresholds were modified to include 35%, 50%, 65%, and 80% available soil moisture depletion in order too 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 Delta and Pine 5415, NuCotn 33B, and Stoneville 474 representing determinate, medium maturity characteristics and Delta and Pine 5816 representing a full season, more indeterminate selection.

Plots were 16 rows (40 inches) wide and 170 feet long. Each 16 row irrigation treatment plot contained the four varieties, each being 4 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 14 lbs./acre seeding rate. All subsequent plot irrigations were accomplished by pumping from an adjacent irrigation ditch, and delivered through 6 inch aluminum pipe, metered with an in-line McCrometer impeller flow meter, with individual plot water delivery through 6 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 6 feet. Neutron probe access sites were located in a center row

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within the Delta and Pine 5415 variety. Gravimetric soil samples and corresponding depth neutron probe measurements were collected at 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 The initial 30 cm increment was used in an effort to minimize recognized near surface error of the neutron probe device.

Due to measured field capacity variability, each plot was assigned a measured field capacity by sampling increment. Each plot was managed on an independent basis relative to water holding capacity and in-season irrigation management according to test protocol. Soil samples were taken to determine soil properties, soil texture was found to be sandy loam, and therefore available soil moisture was by definition 66% of field capacity. 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 by plot two days after each irrigation (gravity drainage complete) with subsequent soil moisture measurements at least every other day until targeted soil moisture depletion was attained. The active root zone was estimated and expanded when water use exceeded 0.05 inches since the previous irrigation event on corresponding measurement units of 20 cm. When the targeted soil moisture depletion threshold was attained, irrigation water was delivered and measured the same day. Due to known variability and non-uniform distribution plots received the measured soil moisture deficit plus an additional 0.5 - 1.0 inch to assure a root zone refill versus maximizing irrigation efficiency.

100 pounds Urea (46 pounds nitrogen/acre) was applied on a pre-plant broadcast basis and incorporated into beds when listed. 15 gallons (54 pounds nitrogen/acre) of Uran 32 was water run on the first in-season full field irrigation. (Table 1)

Pest management was accomplished by using University of Arizona sampling and treatment threshold recommendations. Twice weekly whitefly, lygus, and pink Bollworm counts were made from May through August. Pesticide applications were made when pest monitoring thresholds were met (Table 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 decreasing to five or less as well as accumulated heat units after planting in excess of 2500. 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 by ground with a 18 gallons per acre carrier rate. Harvest was accomplished on September 18 and September 24 in 1996 and 1997 respectively.

The center 2 rows of each 4 row varietal subplot within each irrigation treatment was machine spindle picker harvested. Harvested seed cotton was weighed using a hanging electronic balance. The seed cotton was then subsampled and ginned for lint percent with lint 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 statistically similar lint yields across all tested variety selections (Table 4). Stoneville 474 had the highest numeric yield (1540 lbs./acre) in the 35% depletion treatment but differed statistically only from DP 5816 (1120 lbs./acre). DP 5415 had the highest numeric lint yield in the 50% depletion treatment (1545 lbs./acre) but differed statistically only from DP 5816 (1254 lbs./acre). The 75% and 90% depletion treatments were significantly different from each other as well as the 35% and 50% treatments within all varieties in 1996. These results indicate that there is not a maturity class soil moisture depletion response but does support a lesser primary fruit set yield capability of the indeterminate (DP 5816) versus the more determinate varieties (DP 5415, STV 474, and DP NuCotn 33B).

In 1997, all soil moisture depletion treatment yield responses were significantly different from each other with no varietal lint response difference within irrigation treatments with the exception of the 35% depletion treatment (Table 5). Stoneville 474 produced significantly higher lint yields within the 35% treatment (2053 lbs./acre) and was significantly higher than all remaining tested varieties. Again, there was no clear distinction relative to maturity class yield response within any soil moisture depletion treatments.

In 1996, total applied water was 42.5, 40.5, 28.5, and 21 acre inches/acre for the 35%, 50%, 75%, and 90% soil moisture depletion treatments respectively. In 1997, 37.0 32.5, 32, and 20.5 acre inches/acre were applied to meet the soil moisture depletion thresholds of 35%, 50%, 65%, and 80% respectively (Table 6). Applied water volumes are reflective of small plot sizes that are capable of realizing extremely high irrigation efficiency potential and should not be interpreted as commercially realistic for optimum yield production.

Summary

The results of these experiments indicate that there is not an irrigation management response difference between indeterminate and determinate Upland cotton maturity classes. Both the indeterminate and more determinate varieties responded in a positive manner when soil moisture was managed not to exceed a range of 35% - 50% allowable soil moisture depletion. The indeterminate variety (DP 5816) did result in numerically lower yields within the optimum irrigation treatments presumably due to the differing primary fruit cycle yield potential.

Both the 1996 and 1997 test results indicate that optimum and intensive irrigation management during the primary fruit set period is essential to realize the potential of both tested maturity class distinctions. The highest yields occurred in 1996 when the peak irrigation return interval was approximately 10 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.

The results of these experiments indicate that there is not a maturity class irrigation response difference. The medium maturity varieties possess tremendous yield response potential when critical input considerations of water, nitrogen, and pest control are managed in a highly efficient optimum manner. The major shift in low desert Upland cotton production is the general utilization of a reduced season approach to minimize late season insect control and resultant input costs. Use of the reduced season production approach where maximization of the primary fruit set potential is the goal, offers a significant reduction in late season profitable production secondary fruit set compensation opportunity. In order to capitalize on the reduced season approach in todays cotton economic climate input efficiency and management optimization is critical to realize sustained economic viability.

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Table 1. 1996 and 1997 Nitrogen Application Dates and Rates.

	1996		1997
Date	**Application**	**Date**	**Application**
3/12	20 lbs/ac UN32	3/21	100 lbs/ac UN32 Preplant
4/1	40 lbs/ac UN32	5/21	50 lbs/ac UN32
4/16	50 lbs/ac UN32	6/16	Side dress 50 lbs/ac UN32
6/18	Side Dress 45 lbs/ac UN32		

Table 2. 1996 and 1997 Insect Control Dates and Rates

	1996		1997
Date	**Application**	**Date**	**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

Treatment	**Grade**	**Micro**	**Length**	**Staple**	**Strength**
1996 HVI					
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					
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 Variety and Irrigation Treatment.

Variety	35%	50%	75%	90%
D&PL 5415	1420 ab	1545 a	778 c	374 d
STV 474	1540 a	1503 ab	673 c	279 d
D&PL NuCotn 33B	1414 ab	1447 ab	701 c	335 d
D&PL 5816	1120 b	1254 b	701 c	328 d
Average Yield	**1374 a**	**1438 a**	**713 b**	**329 c**

Means followed by the same letter are not significantly different at P<.05 using a Fishers' LSD.
LSD = 262.36 OSL= 0.0458 C.V.= 19.12

Table 5. 1997 Lint Yields (lint lbs/ac) by Variety and Irrigation Treatment.

Variety	35%	50%	65%	80%
D&PL 5415	1800 b	1354 c	1113 d	221 e
STV 474	2053 a	1459 c	1155 d	260 e
D&PL NuCotn 33B	1923 b	1416 c	1179 d	236 e
D&PL 5816	1745 b	1409 c	1047 d	275 e
Average Yield	**1880 a**	**1410 b**	**1123 c**	**248 d**

Means followed by the same letter are not significantly different and P<.05 using a Fishers' LSD
LSD=228.8867 OSL=0.2188 C.V.=15.13882

Table 6. 1996 and 1997 Total Water Applied by Treatment.

Irrigation Treatment	1996 Total Water Applied (inches)	Irrigation Treatment	1997 Total Water Applied (inches)
35%	**42.5**	35%	**37**
50%	**40.5**	50%	**32.5**
75%	**28.5**	65%	**32**
90%	**21**	80%	**20.5**