Irrigation Efficiencies and Lint Yields of Upland Cotton Grown at the Maricopa Agricultural Center, 1997

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Abstract

A field trial was conducted at the Maricopa Agricultural Center to observe the effects of four irrigation efficiencies (65%, 75%, 85%, and 95%) on the lint yield produced from two upland cotton varieties (DP 5409 and SG 125). Nitrogen requirements for the crop were determined using pre-season soil samples and in-season petiole samples in conjunction with crop monitoring data collected at weekly intervals. AZSCHED was used as a guide to the irrigation timing and amount of water applied during the season. This year there was a lint yield response to the different irrigation efficiencies, and a slight difference in yield between the two varieties. Lint yields were significantly lower in the 95 % irrigation efficiency plots. Lint Yields ranged from 1448 # lint/acre (SG125 at 75 %) to 1220 # lint/acre (DP5409 at the 65 % irrigation efficiency).

Introduction

Water management and conservation can significantly reduce costs associated with cotton production. Improving irrigation efficiency on any particular field can conserve a large amount of water over the growing season. An efficient irrigation system will provide enough water to meet the growing requirements of the crop without any yield loss due to water stress while also providing enough extra water to leach salts past the root zone.

Increasing the efficiency of irrigations can be a costly and difficult endeavor. In 1991, at the Maricopa Agricultural Center (MAC), the first (pre-)irrigation required up to 10 acre-inches/acre of water to completely wet the seedbed (Sheedy and Watson 1992). In that particular field the soil water holding capacity is 1.6" per foot, so the pre-irrigation water actually saturated the soil profile to a depth of 6'. Residual water present in the soil profile before the pre-irrigation is replaced and becomes unavailable for crop use. The practical root zone of the cotton crop until the first post emergence irrigation is about 2' deep, so the water that saturated the soil from 2' to 6' deep can be considered excess application of over 6". This excess results in less than 50 % irrigation efficiency.

Reducing the amount of water applied at the first irrigation of the season would save money and reduce the potential for loss of fertilizer salts due to leaching. An increased irrigation efficiency is often the result of an improvement in irrigation application uniformity. We have employed different methods in recent years in attempts to improve the uniformity and efficiency of the first irrigation. In 1990, a tractor was driven up and down the furrows to compact the soil and allow the water to run the length of the field unimpeded by large dirt clods present in the furrows (Scherer et. al. 1991). An increased water flow at the head end of the field was used to improve irrigation efficiency in 1992 (Sheedy and Watson 1993). The use of torpedoes can improve uniformity and thus reduce the amount of water required in an irrigation (Schwankl et. al. 1992). Short runs also allow a more uniform distribution of water across the field. These approaches, of course, applies to a laser leveled field in a basin irrigation setting.

Crop monitoring and plant growth characteristics can be used as a tool to follow the nutrient requirements and the overall health of the crop. Guidelines for different crop characteristics have been available from previous cotton reports (Silvertooth et. al. 1993). These guidelines are independent of the cotton variety grown and provide baselines and thresholds for the expected growth and development of cotton. The observations of Height:Node (H:N) ratios and petiole nitrate analysis are useful in the timing of fertilizer applications. As the season progresses, the nodes above white bloom (NAWB) and the fruit retention are recorded. The number of NAWB's indicate cutout and help in deciding the terminal irrigation (Silvertooth 1994). Regular monitoring of the crop would signal a trend in the crop growth and alert the grower to needed management decisions as well as provide the basis for these decisions.

In 1997, two upland cotton varieties were grown in a field at MAC. These two varieties were irrigated at four irrigation efficiencies to observe the effect of differing amounts of applied water on the crop growth characteristics and lint yield.

Materials and Methods

A split plot design was used to compare lint yields from DP 5409 and SG 125 grown at four irrigation efficiencies (65%,75%,85% and 95%). For each efficiency, there was a different amount of water applied to the crop at irrigation time. Lower efficiencies, of course had a greater amount of water applied than the higher efficiency treatments. Timing and amount of irrigation was determined by using the computer model AZSCHED.

The previous crop on this field was a pasture of barley used for grazing sheep. Pre-season soil samples showed a need for additional nitrogen fertilizer. On February 4, nitrogen was applied as ammonium sulfate (21-0-0) at a rate of 40 #N/acre. Field preparations were completed on March 17 1997. Before pre-irrigation, a tractor was used to compact each furrow bottom. On March 20, the field was pre-irrigated with an average of 6 acre-inches of water and on April 7, the upland cotton varieties were planted at a rate of 8-10 # seed/acre.

Each plot was 400' long and six (40") beds wide. Ten additional irrigations were scheduled during the growing season up to August 8th. The following irrigations were based on the AZSCHED computer program. In the past AZSCHED has called for irrigations when the soil depletion of available water was actually greater than 50%. This is an indication of crop stress. To remedy any crop stress, in 1991 the irrigation was performed at least one day before the day AZSCHED had scheduled. It was hoped that any crop stress could be avoided in this manner. Water was measured and applied by the use of an in-line meter and gated poly-pipes.

Ammonium sulfate was side dressed to the crop at a rate of 45# N/a on May 6 and June 11. Defoliant was applied on September 3 and the crop was harvested on September 22. The two middle rows of each plot were harvested for yield. Subsamples of seed cotton from each plot were taken to determine lint yield and gin turnout.

Observations of plant growth characteristics were taken on a weekly basis to monitor the growth and development of the cotton crop. Petiole samples were analyzed for nitrates at MAC with use of an ion selective electrode. Height to node ratios and fruit retention levels were also recorded at the same time.

Results and Discussion

Results and data of the yield trial are presented in Table 1 and Figures 1 thru 5.

Lint Yield and Irrigation Efficiencies(Table 1)

There was a difference in lint yield and seed cotton yield due to the irrigation efficiencies, and a slight difference in lint production between the two cotton varieties DP 5409 and SG 125. The least amount of seed cotton and lint produced was from DP 5409 at the 65% irrigation efficiency which produced 3484 # seed cotton and 1202 # lint /acre. The largest amount of lint produced was from SG 125 (1448 # lint and 4138 # seed cotton /acre) when irrigated at a 75 % irrigation efficiency. Actual irrigation efficiencies, ranged from 60 % to 75 %. The inherent inefficiency of early season irrigation is the main cause for lower the than targeted irrigation efficiencies of 65 % to 95 %.

Crop Monitoring (Figures 1, 2, and 3)

Cotton petioles were collected at weekly intervals for preparation of nitrate analysis. Height to node ratios and fruit retention levels were obtained at the same time. Fertilizer applications were timed in accordance with petiole nitrate levels and height to node ratios (Figures 1,2, and 3). Height to node ratios as well as fruit retention levels remained well within the upper and lower thresholds during the season, so there were no great shifts between vegetative or stressed growth. Petiole nitrate levels remained within the adequate range but dropped below this level towards the end of the season. Overall, the results of this year's crop monitoring showed a healthy crop with little or no stress recorded and yields greater than in previous years.

References

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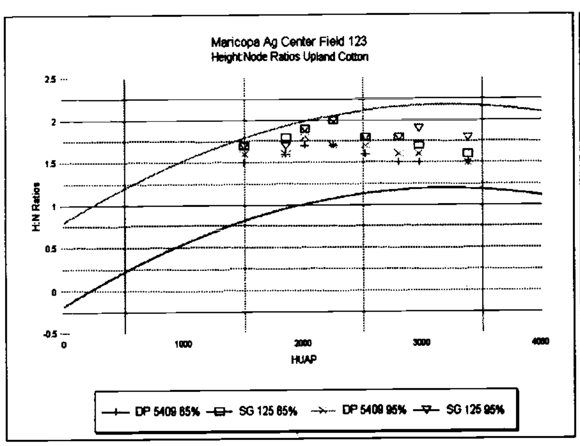
Table 1. Yield and Water Data for Each Treatment and Variety

Variety and Irrigation Efficiency	In-Season Irrigation (inches)	Rain (inches)	Average Total Applied Water	1997 Actual Irrigation Efficiency	AZSCHED Estimated Consumptive Use	Seed Cotton** (#/acre)	Lint Yield** (#/acre)
SG 125 - 75 %	41.7	.3	42.0	66 %	27 "	4138 a	1448 a
DP 5409 - 95 %	36.4	.3	36.7	75 %	27 "	4029 a	1410 a
SG 125 - 85 %	38.5	.3	38.8	71 %	27 "	4029 a	1410 a
SG 125 - 95 %	36.4	.3	36.7	75 %	27 "	4029 a	1410 a
SG 125 - 65 %	45.0	.3	45.3	60 %	27 "	3974 a	1391 a
DP 5409 - 85 %	38.5	.3	38.8	71 %	27 "	3920 a	1372 a
DP 5409 - 75 %	41.7	.3	42.0	66 %	27 "	3811 ab	1334 ab
DP 5409 - 65 %	45.0	.3	45.3	60 %	27 "	3484 b	1220 b

* Values followed by the same letter are not significantly different at the 5 % probability level. LSD=351.
** Values followed by the same letter are not significantly different at the 5 % probability level. LSD=123.

Figures 1 and 2. Height:Node Ratios and Fruit Retention Levels for DP 5409 and SG 125.



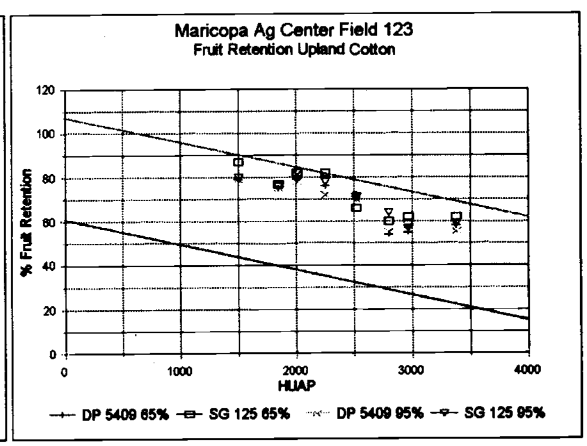


Figure 3. Petiole Nitrate Results for DP 5409 and SG 125 for the 65 % and 95 % Irrigation Efficiencies.