Evaluation of Irrigation Termination Management on Yield of Upland Cotton, 1996

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Abstract

A single field study was conducted in 1996 at the Maricopa Agricultural Center (1,175ft. elevation) to evaluate the effects of two dates of irrigation termination on the yield of a common Upland cotton variety (DPL 5415). Planting date was 11 April (667 HU/Jan 1 86/55° F thresholds. Two dates of irrigation termination (IT1 - IT2) were imposed based upon crop development into cut-out, with IT1 (14 August) being provided such that bolls set at the end of the first fruiting cycle would not be water stressed and could be fully matured. The second termination (IT2) date was 10 September, which was staged so that soil moisture would be sufficient for development of bolls set up through the first week of September. Lint yield results revealed no differences between IT1 and IT2.

Introduction

One of the advantages associated with a cotton (*Gossypium spp.*) production system in an irrigated desert region such as Arizona, is the availability of a relatively long growing season, or a reliable supply of abundant heat units (HU). Traditionally, cotton production systems in the low (elevation) desert regions of Arizona (<2,000 ft. above sea level) have employed a long, full season approach. Such a long, full season type of approach would commonly involve a February or March date of planting with final irrigations being applied in September or October (depending on local conditions). Production over this period would include a completion of the first, or primary fruiting cycle, a cut-out period (hiatus in blooming), followed by a second fruiting cycle or top-crop. Accordingly, long season, indeterminate varieties were usually best suited to this type of production system. This is one of the reasons that Pima (*G. barbadense* L.) has been well adapted to this region.

In recent years, production systems which utilize a shorter segment of the total available growing season have become increasingly attractive to Arizona cotton growers. The principle incentives associated with the interest in a reduced season approach primarily include insect pest pressures from pink bollworm (*Pectinophora gossypiella* (Sanders)) and whitefly (*Bemisia tabaci* (Gennadius)), and increasing costs of production (i.e. irrigation water). The inclement weather patterns associated with the summer monsoon season, which causes an increase in humidities (dew point), night temperatures, and an increase in fruit loss and abortion on the crop also serve to limit yield potentials. Overall, the objective with a reduced season approach to cotton production in the irrigated southwest is to achieve the highest degree of efficiency possible. To do so requires an identification of the point of diminishing returns with respect to a cotton crop. This is based on the fact that yield production potentials decline with time in the later stages of the growing season due to natural crop senescence, shorter day lengths, and cooler weather conditions (lower rates of HU accumulations).

Recent research in Arizona has attempted to address this issue of comparing a reduced season approach to that of a more traditional long, or full season system (Silvertooth et al., 1989; Silvertooth et al., 1990; Silvertooth et al., 1991; Silvertooth et al., 1992; and Silvertooth et al., 1993; Silvertooth et al., 1994; Unruh et al., 1995; and Silvertooth and Norton, 1996). Summarizing this work, Unruh and Silvertooth (1997) reported on 12 site-years of data in Arizona comparing various planting and irrigation termination date combinations. The overall results from these studies revealed a most pronounced improvement in yield from an early date of planting and a generally small increase in yield from a late irrigation termination date. Comparing early and late IT treatments with an early date of planting, Unruh and Silvertooth (1997) found an average increase of 83 and 118 lbs. of lint/acre for

DPL 90 and Pima S-6, respectively. Large increases in lint yield from a later IT were observed, but usually under conditions of very poor fruit retention over the primary fruiting cycle (up to cut-out).

Strategies associated with IT timing have been developed from the earlier studies previously mentioned. From that work it has been found that 600 HU (86/55 ° F thresholds) are required to develop a late season boll from a bloom to a full sized, hard boll when fiber length development is complete (Silvertooth et al., 1996). Approximately 400 additional HU are then required to complete boll maturation and opening, for a total of 1,000 HUs needed for boll development from bloom to open boll. Therefore, IT treatments are best structured to accommodate development of bolls intended for harvest to the point of full fiber development (600 HU post anthesis). This commonly translates to a period of approximately 21 days in southern Arizona in August and September. Accordingly, adequate soil moisture must be maintained throughout this three week period for the last set of bolls intended for harvest. The exact IT date will therefore vary depending upon soil water holding capacities, amounts of water applied per irrigation, weather conditions, and crop condition. For example, if bolls set up to the point of cut-out are designated as those intended for harvest, final irrigations should be made so that adequate soil moisture is maintained for a three week (600 HU) period beyond the time of cut-out. The development of a top-crop usually requires irrigation and pest control for four to six weeks beyond cut-out, which for many systems equates to approximately an extra acre-foot of irrigation water and pest control to protect the developing fruit load.

The results of these projects have shown that in general, optimum agronomic yields can often be achieved with a reduced season approach, providing that a reasonable level of fruit retention (FR) is maintained through the completion of the first fruiting cycle (cut-out). If overall FR levels (accounting for the first two fruiting positions of all fruiting branches) are greater than approximately 40% at cut-out, we have found that extending irrigations and pest control several weeks beyond cut-out to accommodate a top-crop (second fruiting cycle) will yield a range of approximately 50 to 160 lbs. lint/acre above an early IT set to complete boll development established at cut-out. This commonly requires additional irrigations four to six weeks beyond the earliest IT. On the other hand, if FR is low at cut-out (40% or less), a much greater increase in yield can be realized (200 to 400 lbs. lint/acre) from a later IT. In the past few seasons, a great deal of interest has been generated towards the issue of optimal IT management when crop conditions have been considered as poor at the time of cut-out. Therefore, the questions associated with IT remain critical in the management of an irrigated cotton crop toward optimal efficiencies and profit to the operation.

The objective of this study was to further investigate the issue of IT management and the subsequent effects on the growth, development, and yield of a common Upland (Gossypium hirsutum L.) variety. Continual development of research information relative to this issue is important for the development and refinement of recommendations provided by the University of Arizona Cooperative Extension.

Methods and Materials

This study was conducted in 1996 at the Maricopa Agricultural Center (1,175 ft.) on a Casa Grande sandy loam soil. The experimental design was a two treatment randomized complete block design with four replications. The treatments consisted of two IT dates, designated as IT1 and IT2. Each plot consisted of 8, 40 inch rows that extended the full length of the irrigation run (600 ft.). The entire study area was dry planted and watered-up on 11 April 1996 with DPL 5415. All inputs such as fertilizer, water, and pest control were managed on an as-needed basis.

A complete set of plant measurements were collected from the site on 14 day intervals. Measurements taken included: plant height, number of mainstem nodes, first fruiting branch, total number of aborted sites (positions 1 & 2), number of nodes above the top (1st position) fresh bloom, canopy closure, and number of blooms per unit area. Climatic conditions were also monitored using an Arizona Meteorological network (AZMET) site located on the station.

Field monitoring information indicated crop progression into the later stages of the first fruiting cycle by the week of 7 August. Therefore, the IT1 plots were provided the last irrigation on 14 August to accomplish complete fiber length development for bolls set the week of 7 August. Plots associated with IT2 were given the last irrigation on 10 September. All irrigations were provided on an as-need basis, based on soil moisture evaluations. The center 4 rows from each plot were harvested on 3 December to obtain seedcotton estimates. Gin turn-out averages for each treatment were used to calculate lint yield.

Results

Crop vigor, as noted by height to node ratios (HNR) shown in Figure 1, were observed to be relatively low (below the middle baseline developed in Arizona (Fletcher et al., 1994; Silvertooth, 1994; and Silvertooth et al., 1996) in this study throughout the course of the season. With the reasonable FR levels experienced in this experiment (Figure 1), recovering crop vigor was difficult. However, a premature cut-out was not experienced, which is a common result from having a crop with a good fruit load and lower than normal vigor. FR levels were nearly 50% as the crop reached cut-out.

Lint yield results are shown in Table 1. Lint yield differences were not found to be significant ($P<0.05$) between IT1 and IT2.

These results are consistent with earlier work on this topic (Silvertooth et al., 1989; Silvertooth et al., 1990; Silvertooth et al., 1991; Silvertooth et al., 1992; and Silvertooth et al., 1993; Silvertooth et al., 1994; Unruh et al., 1995). A yield increase of up to approximately 140 lbs. lint/acre are common from top-crops developed from fields with satisfactory FR levels (approximately 45% FR) at the completion of the first fruiting cycle, which was experienced in this same experiment in 1995.

Continual investigation of topics such as this are valuable for the validation and refinement of Extension guidelines and recommendations, such as those distributed regionally on a weekly basis (Brown et al., 1992; Brown et al., 1993; Brown et al., 1994; Fletcher et al., 1994; Silvertooth, 1994; Brown et al., 1995; and Brown et al., 1996). Further validation and demonstration of these techniques on grower-cooperator fields have also been conducted in recent years (1993-1996) which are also extremely valuable in the refinement and extension at a production level. These demonstrations have provided results that are very consistent with experiment station projects. In the current economic climate, improving upon production efficiencies are critical to the survival of cotton farms in Arizona. With a crop like cotton in a climate such as we have in Arizona, the identification of the point of diminishing returns is an important point of consideration for the efficient management of the crop.

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Table 1. Lint yield means for each irrigation termination treatment, DPL 5415, Maricopa, AZ, 1996.

Irrigation Termination Date	Lint Yield lbs. Lint/acre
14 August	1361 a*
10 September	1300 a
LSD†	NS
OSL‡	0.1408
C.V. (%)§	3.27

*Means followed by the same letter are not significantly different according to pairwise comparisons using a Fisher's LSD.

† Least significant difference

‡ Observed significance level

§ Coefficient of variation

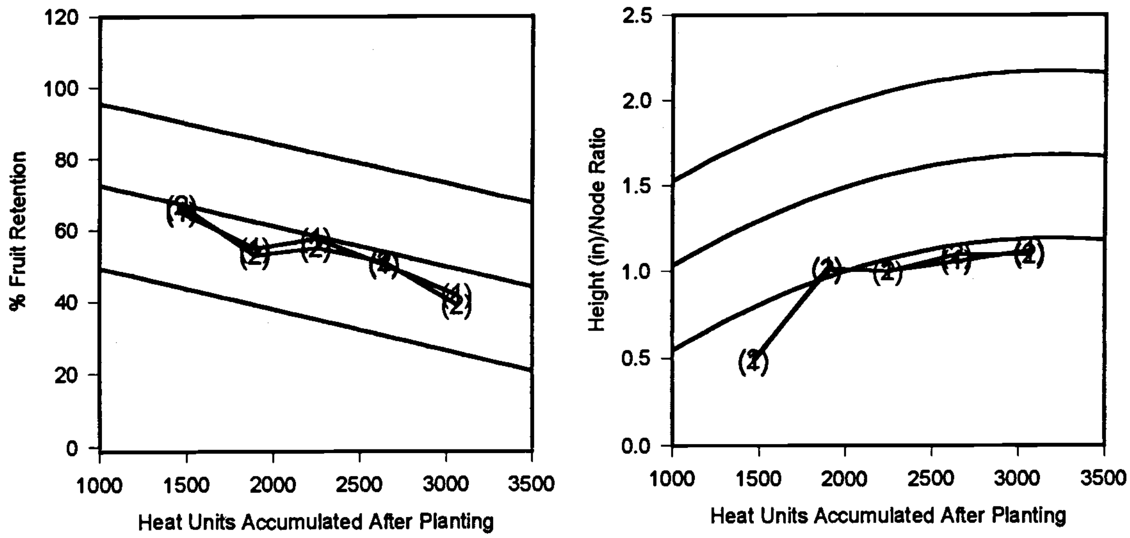

Figure 1. Fruit rentention and height to node ratio levels, irrigation termination study, MAC, 1996.