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Irrigating San Joaquin Valley Pima Cotton with Changing Crop Management Needs

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Pima cotton, Gossypium barbedense*, has different water use patterns than traditionally grown Upland cotton plantings,* Gossypium hirsutum*, previously used for irrigation studies. This research develops deficit irrigation strategies and points out opportunities for improving water use efficiency leading to higher productivity per unit of water applied. The study emphasizes the value of integrating water management decisions with other key crop management decisions during the productions season.*

Since the 2007 growing season, California growers produced more Pima cotton, *Gossypium barbedense*, than it's traditional Upland, *Gossypium hirsutum*, counterpart. And though Pima cotton was first grown experimentally in California during the 1920's, it wasn't until 1991 that large-scale acreage was approved for planting following changes in the one-variety law established by the San Joaquin Valley Cotton Board. Since that time, market conditions favoring extra-long staple (ELS) Pima cotton have led to Pima cotton acreage increases until the past two years.

Recent market conditions have remained relatively strong for Pima when compared with other agricultural commodities including Upland cotton types with declining acreage primarily caused by grower's access to irrigation water. There is considerable caution and concern in the industry to produce and emerging crop in which very little is know about its water requirements and impacts when less that a full allocation of water is applied. Options to reduce applied irrigation water without adversely impacting crop productivity are needed.

Pima cotton's more indeterminate growth habit has led growers and researchers to suspect that its water use characteristics were different from those of the more traditional plant types and work began in 2005 to document changes in crop water use. The work conducted in this study is

A grower and project cooperator interested in conserving water on-farm, Jeff Yribarren is seen here with Pima cotton.

aimed at developing additional crop water use information for Pima cotton, validate the water stress guidelines that have been proposed for the crop, increase irrigation management extension outreach activities, and document the value and potential for deficit irrigation practices as a method for improving water use efficiency.

One key element that separates irrigation management of cotton from that of other crops is cotton's ability to undergo modest water deficits without experiencing large yield or quality losses. While peak productivity comes from nearly meeting the full water requirement of the crop, it is common that the amount of water applied greatly surpasses the amount of water required by the crop. These inefficiencies in applied water combined with improper timing of irrigation events, results in low water use efficiency.

Field trials were conducted on west side Fresno County farms and at the West Side Research and Extension Center (WSREC) near Five Points, CA. During the 2005 and 2006 production season, we conducted our studies on three farm sites; and from 2007 through 2008, we focused our activities at the WSREC site. Our most recent studies incorporated a range of applied irrigation volumes in three irrigation treatments which enabled us to evaluate water deficit treatments alongside low water stress irrigation treatments that were intended to optimize yield. Preirrigation activities in late winter allowed ideal water availability at planting with about 12 inches of water typically applied to refill the soil water profile left in deficit due to the previous crop. Additional in-season irrigations of approximately 6 inches each were applied to the field including two, three and four post-plant irrigations that represented the range of water stress conditions desired.

Whether at a grower or research station site, good planting conditions were accompanied by optimal plant stands. Though weather varied from year to year, good growing conditions existed with generally high yields experienced with the exception of the 2008 season. More aggressive management practices were required in response to very high sustained lygus populations, resulting in final yields between 2.2 and 2.9 bales during this one year.

Interestingly, the irrigation deficit treatments imposed in 2008 had the least impact on yield of all study years with mild to moderate irrigation deficits actually improving crop performance. After careful evaluation of plant mapping data and soil water and plant water stress measurements, we found the treatment receiving the most water, a 4 in-season irrigation treatment, had significantly lower yields than all other treatments, including the high stress irrigation treatment that received only one in-season irrigation. The irrigation treatment receiving only 2 in-season irrigation treatments, had the best numeric yields though there was no statistical difference between the one, two and three in-season irrigation treatments when evaluated with all varieties.

The deficit irrigated cotton retained more early fruit whereas the treatments irrigated with adequate water supplies retained more bolls later in the season with a "near wash" in the results. We inferred from this experience that there measurable benefits to an early water stress condition under conditions of high lygus pressure and due to the yield limiting circumstances, 2. 2 to 2.9 bales per acre, we believe that under high lygus count conditions, growers can use delayed irrigation management strategies to improve yields and reduce water application costs. Furthermore, it was clear that initiating early irrigation on the well watered treatment had a negative impact on yield due to lower retention of early fruiting bodies.

The timing, duration and magnitude of water stress as measured by the pressure chamber was found to be a very useful tool in scheduling irrigation events and determining when crop water stresses are significant enough to impact yield. Though less so in 2008, cumulative leaf water potential readings confirmed that the timing of the two in-season irrigation events assisted in minimizing crop losses that result from excessive water stress. Determining the appropriateness of the

deficit irrigation treatment timing was also confirmed by the yield results obtained.

For each of the three cotton types evaluated in this study, Pima, Upland and the inter-specific Pima-Upland hybrid, water deficit treatments performed exceedingly well when compared to the irrigation treatment that followed UCCE irrigation management guidelines. Yield losses from the most water stressed irrigation treatment (receiving only one post plant irrigation) amounted to only 100 pounds of lint per acre whereas the low stress treatment receiving 4 post-plant irrigations lost an average of 255 pounds of lint per acre when compared to the most productive treatment.

This trend somewhat reverses findings from past years in that the UC irrigation guideline treatment (3 in-season irrigations) typically performs best or equal to the high water treatment, with the deficit irrigation treatments yield declining based on the duration and intensity of the stress observed during the season. In this study we found the deficit irrigation treatments performing at least as well as the guideline treatment and relatively small production declines under sustained and severe drought conditions.

The most recent study year events lead us to make different conclusions than have been drawn in the previous several study years. This year we conclude that while irrigation guidelines can help to point out prescribed best water management practices for crops, water managers must also be mindful of the need to modify those practices based on the available field management issues. Irrigation amounts and timing can interact significantly with insect pest management and production decisions should be based on these interactive factors.

These findings are intended to assist growers, irrigation managers and irrigation districts with the tools they need to increase water use efficiency in Pima cotton production systems. Deficit irrigation practices in cotton can be developed as a method for improving water use efficiency leading to higher productivity per unit of water applied.

Collaborative Efforts

This project is part of a larger activity to improve irrigation management in cotton and elevate our understanding of crop water use in Pima cotton as compared with Upland cotton types. At the early stages of this activity we consulted with and gained support from the Westlands Water District and the United States Bureau of Reclamation. We would like to thank Kevin Collins of Borba Farms and Tom Fairless of Fairless Farms for their time and resources while conducting field activity on their farms. We also acknowledge the invaluable financial support of CPCSD and the consultations of UC Biometeorology Specialist Rick Snyder.

Related Publications

Daniel Munk, Jonathan Wroble and Robert Hutmacher. Crop Responses to Water Deficits in High Yielding Pima and Acala Cotton. 2007 Beltwide Cotton Production Conferences. ncc.confex.com/ncc

Daniel Munk and Jonathan Wroble Contrasting Fruit Retention Characteristics of High Yielding Pima and Acala Cotton. 2007 Beltwide Cotton Production Conferences. ncc.confex.com/ncc

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