

Effect of Plant Water Status on Defoliation and Yield of Upland Cotton for Short-Season Production

J.M. Nelson, P.G. Bartels and G. Hart

Abstract

A field study was conducted at the Maricopa Agricultural Center to determine the influence of plant water status at the time of defoliation on the effectiveness of defoliant and yield of short-season cotton. Irrigation termination dates of 14 and 26 August and 10 September were used to achieve different levels of plant water stress at the time defoliant was applied (19 September). Irrigation termination dates had no effect on seedcotton yield for cotton defoliated in September. As the period between the termination irrigation and the date of chemical defoliation was increased, the effectiveness of defoliant was increased. CWSI and plant water potential measurements indicated that the irrigation termination dates resulted in large differences in plant water stress at defoliation time. There was a significant increase in the defoliation percentage as CWSI values increased (from 0.32 to 0.96) and water potential decreased (from -1.5 to -3.5 MPa). Short-season cotton (163 days) produced 4,396 lbs. seedcotton/A as compared to 5,299 lbs./A for a full-season crop (212 days).

Introduction

The use of a short-season production system has increased in Arizona in recent years. A problem area for growers in the management of cotton for short-season production is defoliation. For short-season production, the crop must be defoliated in late August or September when conditions are favorable for vegetative growth and foliage is often very dense. Multiple applications of defoliant are generally required to satisfactorily prepare the crop for harvest.

Although the use of chemicals as conditioners for defoliation has been studied extensively, little research has been done on the management of water to condition the cotton plant for defoliation. In general, excessive water prior to and at the time of defoliation can result in vegetative plants with dense canopies. If the plants are very dry at the time defoliant is applied, there may not be sufficient physiological activity in the leaves to carryout the effects of the defoliant. In addition, if leaves are dried past a certain point, leaf weights may not be great enough to cause blades and petioles to break free of the plant at the abscission layer. However, water stress can increase defoliation because stressed plants produce fewer new leaves and existing leaves age faster. A general recommendation has been to allow one month between the final irrigation and the application of defoliant. The objective of this study was to determine the effect of plant water status at the time of defoliation on the effectiveness of defoliant and yield of short-season cotton. The use of the CWSI (Crop Water Stress Index) and plant water potential as guides to when defoliant will be most effective was evaluated.

Materials and Methods

Seed of DPL 90 cotton was planted on 9 April in moist soil at the Maricopa Agricultural Center. The planting received a total of 68 lbs. of N/A preplant and during the season. Three irrigation treatments to provide

different levels of plant water stress were established by using different irrigation termination dates. Irrigation treatments were as follows:

Treatment	Date of termination irrigation	Days from termination irrigation to defoliation	% depletion of available water
I ₁	14 August	36	84
I ₂	26 August	24	74
I ₃	10 September	9	47
I ₄	10 September	--	--

Treatments I₁ to I₃ were chemically defoliated 19 September. The I₄ treatment was included to represent a full-season crop and was not defoliated until 7 November.

Soil water content in each irrigation treatment was measured weekly with a neutron moisture probe to a depth of 6 feet after the termination irrigation and on the date of defoliation. Canopy temperatures were measured with a hand held infrared thermometer and vapor pressure deficits were determined using an aspirated psychrometer. This information was used to determine the Crop Water Stress Index (CWSI) for cotton in each irrigation treatment (I₁ to I₃) at the time defoliant was applied. The water potential of plants in treatments I₁ to I₃ was measured on 18 September using the pressure chamber technique. One fully mature leaf with petiole was removed from each of 2 plants in each plot between 1:20 and 2:50 PM for water potential determinations.

The cotton was defoliated on 19 September and 14 October, using a tank mix of Dropp at 0.2 lbs. a.i./A, Def at 1.13 lbs. a.i./A and crop oil at 1 pt./A to prepare the crop for harvest. These defoliant were applied using a HiBoy sprayer with a 7 nozzle/row boom and spray volume of 29 GPA. Petiole NO₃-N of plants in I₁ to I₃ treatments was 906, 960 and 1535 ppm on 18 September. Maximum and minimum air temperatures on 19 September were 91 and 71°F, respectively. For the 7 day period after the September defoliation, average maximum and minimum temperatures were 95 and 66°F, respectively. Average maximum and minimum relative humidity for the same period was 75 and 30%, respectively. In the 14 day period after the September defoliation, 322 HU were accumulated. Plots were rated visually for defoliation 7 and 14 days after defoliant were applied. Each irrigation treatment plot was divided into six 30 ft. long subplots for CWSI measurements, water potential measurements and defoliation estimates. Experimental design was a randomized complete block with 4 replications.

The cotton from 30 ft of the center 2 rows/plot was harvested by machine on 24 October from I₁ to I₃ plots and on 4 December from I₄ plots.

Results and Discussion

Irrigation treatments (I₁ to I₃) had no effect on seedcotton yield of cotton defoliated 19 September (Table 1). However, as the period between the final irrigation and chemical termination was increased, the effectiveness of the defoliant was increased. Cotton in the driest treatment (I₁) had the highest natural defoliation (45%) at the time of defoliation, compared to only 35 and 20% for the I₂ and I₃ treatments, respectively. Managing the cotton to provide a 24 day or longer period without irrigation before defoliation resulted in acceptable defoliation in a single application.

Plant water stress measurements show that the irrigation treatments resulted in large differences in water stress at the time of defoliation. The I₁, I₂ and I₃ treatments had average CWSI values of 0.92, 0.59 and 0.38, respectively, when defoliated. Plants in the I₁ treatment exhibited mid-day wilting at the time of defoliation

indicating high water stress. There was a significant ($R^2=0.80$, $P<0.01$) linear increase in the effectiveness of the defoliant treatment as CWSI values increased. CWSI values ranged from 0.32 to 0.96 and defoliation percentages ranged from 43 to 94%. In a similar test in 1989, no relationship was obtained between CWSI and defoliation; however, in that test CWSI values were much lower, ranging from 0.05 to 0.34 (Nelson et al., 1990).

Plant water potential, another measurement of plant water stress, was also influenced by irrigation treatments. The I_1 , I_2 and I_3 treatments had average water potential values of -3.0, -2.2 and -1.8 MPa, respectively, at the time of defoliation. There was a significant ($R^2=0.83$, $P<0.01$) linear increase in the defoliation percentage as plant water potential decreased. Plant water potential ranged from -1.4 to -3.5 MPa.

This study was designed to provide a comparison of yields between short-season and full-season production systems. The short-season crop had a 163 day growing season that accumulated 3,507 HU, while the full-season crop had a 212 day season and 4,308 HU. The short-season cotton produced an average of 4,396 lbs. of seedcotton/A which was significantly less than the 5,299 lbs./A produced by full-season cotton (Table 1).

References

Nelson, J.M., R.E. Briggs and G. Hart. 1990. Effect of irrigation termination date on defoliation and yield of upland cotton for short-season production. Cotton, A College of Agriculture Report. University of Arizona, Series P-81:13-16.

Table 1. Effect of irrigation treatments on defoliation and yield of Upland Cotton.

Treatment	Days from final irrigation to defoliation ¹	(%) Defoliation ²	Seedcotton (lbs./A)
I ₁	36	88 a ³	4,416 b
I ₂	24	70 b	4,361 b
I ₃	9	51 c	4,410 b
I ₄	--	--	5,299 a

¹I₁-I₃ plots were defoliated 19 September and treatment I₄ was defoliated 7 November.

²Defoliation estimates were for 3 October, 14 days after treatment.

³Means followed by the same letter are not significantly different at the 0.05 probability level.