Effect of Plant Water Status on Defoliation of Pima Cotton

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Abstract

A study was conducted at the University of Arizona Maricopa Agricultural Center, Maricopa, AZ in 1994 to determine the influence of plant water status at the time of defoliation on effectiveness of defoliants and yield of Pima cotton. Several irrigation termination dates were used to achieve different levels of plant water stress at the time defoliants were applied. A single application of defoliants did not provide adequate defoliation under the conditions of this test. The earliest irrigation termination date resulted in the highest defoliation percentage. High CWSI values at the time defoliants were applied were related to the highest defoliation percentages, but were not necessarily related to satisfactory defoliation. The CWSI appears to have limited value as a guide to determine when to defoliate Pima cotton.

Introduction

Pima cotton grown in central Arizona has generally been more difficult to defoliate than upland cotton, requiring multiple applications of defoliants to properly prepare the crop for harvest. Although the use of chemicals to promote defoliation has been studied, little research has been done on the management of water to condition the Pima cotton plant for defoliation. In general, excessive water during the season and prior to defoliation can result in vegetative plants with dense canopies and favor regrowth after defoliation. An inadequate supply of water during the season may result in changes in the cotton leaf cuticle and a decrease in the efficiency of defoliation (Oosterhuis et al, 1991). If the plants are very dry at the time defoliants are applied there may not be sufficient physiological activity in the leaves to carry out the effects of the defoliants. In addition, if the leaves are dried past a certain point leaf weights may not be great enough to allow the leaf to break free of the plant at the abscission layer. However, late season 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 defoliants (Silvertooth et al, 1992). The objective of this study was to determine the effect of plant water status at the time of defoliation on the effectiveness of defoliants and yield of Pima cotton. The use of the CWSI (Crop Water Stress Index) as a guide to determine when defoliants will be most effective was evaluated.

Materials and Methods

Field experiments were conducted at the University of Arizona Maricopa Agricultural Center. Seed of Pima S-7 cotton was planted in moist soil on 9 April 1994. Standard practices for fertilization and pest control were followed. Three irrigation treatments to provide different levels of plant water stress during defoliation were established using different irrigation termination dates (Table 1). Each irrigation treatment plot was divided into six, 38 ft. subplots for CWSI measurements, defoliation estimates and yield estimates. Experimental design was a randomized complete block with four replications.

The soil water content in each irrigation treatment was measured with a neutron moisture probe to a depth of six feet just before the defoliants were applied. To assess the actual plant water status, 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 CWSI for cotton in each irrigation treatment at the time defoliants were applied.

Cotton was defoliated on 12 Oct. using Ginstar at 0.09 lb.a.i./acre. The defoliant was applied using a single boom sprayer with nozzles spaced 20 inches apart and a spray volume of 25 gal./acre. A second application of defoliants was made on 7 Nov. using a tank mix of Dropp at 0.15 lb.a.i./acre + DEF at 1.0 lb.a.i./acre + 1 pt/acre crop oil. Petiole NO_3-N content of plants was less than 500 ppm in all treatments in mid-Sept. During the 14 day period after the first application of defoliants only 167 HU were accumulated. During the 14 day period after the first application of defoliants the average maximum and minimum temperatures were 81 and 51°F, respectively. In Sept., 2.29 in. of rain were recorded and 0.47 in. of rain fell on 15 Oct., three days after the first application of defoliant. Plots were rated visually for defoliation and regrowth at 0, 8, 15, 19 and 36 days after the first application of defoliant. The cotton from 38 ft. of the center two rows/plot was harvested by machine on 17 Nov. 1994.

Results and Discussion

None of the irrigation treatments resulted in acceptable defoliation from a single application of the defoliant (Table 2). The best defoliation obtained 15 days after application of the defoliant was 49% in the I_1 treatment. Temperatures were cool during the 14 day period after defoliation and only 167 HU were accumulated during that time. Defoliation has generally been found to be more successful when > 200 HU are accumulated within 14 days after application of defoliants (Silvertooth et al, 1993). After a second application of defoliants on 7 Nov. excellent defoliation was obtained in the I_1 treatment (over 90%). The I_1 treatment resulted in significantly higher defoliation percentages than treatments with shorter intervals between the final irrigation and time of defoliation. Basal regrowth occurred in all treatments but was lowest in the I_1 treatment. Irrigation treatments did not have a significant effect on lint yields (Table 3).

Plant water stress measurements indicated that irrigation treatments resulted in differences in water stress at the time of defoliation. Average CWSI values ranged from 0.49 in the I_3 treatment to 0.70 in the I_1 treatment (Table 3). As the CWSI values increased there was a significant increase in the defoliation percentages. Correlation coeficients for the relationship at 0, 8, 15, and 19 days after application of defoliants were r=0.78**, r=0.78**, r=0.72**, and r=0.77**, respectively.

Under the conditions of this test, it appears that defoliation of Pima cotton is most effective when the interval between the final irrigation and defoliation is one and one half months or longer. High CWSI values were related to the highest defoliation percentages indicating that defoliation is more effective when plants are under water stress when defoliants are applied. Similar results were obtained in a 1993 test at the Maricopa Agricultural Center (Nelson and Hart, 1994). However, in these tests high CWSI values were not necessarily related to satisfactory defoliation (≥75% leaf drop). Apparently, other factors such as the nitrogen status of the plant and weather at the time defoliants are applied and kind of defoliant used can influence the defoliation results. These tests and that of Silvertooth et al, 1990, indicate that the CWSI has limited value as a guide to determine when to defoliate Pima cotton.

References

Nelson, J.M., and G. Hart. 1994. Effect of plant water status on defoliation and yield of Pima cotton. Cotton, A College of Agriculture Report. University of Arizona, Series P96:76-79.

Oosterhuis, D.M., R.E. Hampton and S.D. Wullschleger. 1991. Water deficit effects on the cotton leaf cuticle and the efficiency of defoliants. J.Prod.Agric. 4:260-265.

Silvertooth, J.C., S.H. Husman, P.W. Brown and J. Burnett. 1993. Cotton defoliation evaluations, 1992. Cotton, A College of Agriculture Report. University of Arizona, Series P-94:44-55.

Silvertooth, J.C., S.H. Husman, S.W. Stedman, P.W. Brown and D.R. Howell. 1992. Defoliation of Pima cotton, 1991. Cotton, A College of Agriculture Report. University of Arizona, Series P-91:289-301.

Silvertooth, J.C., S.W. Stedman and J. Tollefson. 1990. Interaction of Pima cotton defoliation and crop water stress index. Cotton, A College of Agriculture Report. University of Arizona, Series P-81:32-34.

Table 1. Irrigation treatments description and available soil water at the time defoliants were applied.

Treatment[1]	Date of termination irrigation	Days from final irrigation to defoliation[2]	% Depletion of available water
I_1	27 Aug.	46	70
I_2	16 Sept.	26	55
I_3	5 Oct.	7	38

[1] Treatments I_1, I_2 and I_3 were irrigated on 27 Aug. On 16 Sept. treatments I_2 and I_3 were irrigated and on 5 Oct. only the I_3 treatment was irrigated.
[2] Cotton was defoliated on 12 Oct. and 7 Nov.

Table 2. Effect of irrigation treatments on defoliation of Pima S-7 cotton.

Irrigation treatment	Days from final irrigation to defoliation	% Defoliation				
		0 days	8 days	15 days	19 days	36 days[1]
I_1	46	39a[2]	41a	49a	58a	91a
I_2	26	30b	33b	36b	41b	79b
I_3	7	28b	30b	37b	40b	76b

[1] Plots were rated for defoliation just prior to harvest on 17 Nov.
[2] Means in columns followed by the same letter are not significantly different at the 0.05 probability level.

Table 3. Effect of irrigation treatments on CWSI and lint yield of Pima S-7 cotton.

Irrigation treatment	Days from final irrigation to defoliaton	CWSI[1]	Lint yield (lbs./acre)
I_1	46	0.70a[2]	1586a
I_2	26	0.64a	1624a
I_3	7	0.49b	1587a

[1] Measurements taken just prior to application of defoliants.
[2] Means in columns followed by the same letter are not significantly different at the 0.05 probability level.