SIMULATING HAIL DAMAGE ON COTTON FRUITING BRANCHES IN ARIZONA G. Wang R.K. Asiimwe Maricopa Ag Center, School of Plant Sciences, University of Arizona Maricopa, AZ P. Andrade-Sanchez Maricopa Ag Center, Department of Ag and Biosystem Engineering, University of Arizona Maricopa, AZ M. Zarnstorff National Crop Insurance Services Overland Park, KS

<u>Abstract</u>

Hail damage occurs each year in many areas where cotton is grown and accurate estimations of crop yield loss are important for taking management actions and adjusting hail insurance claims. Insurance adjusters use a step-by-step procedure from National Crop Insurance Services to assess the effects of hail damage on cotton. The assessment includes estimations of cotton yield reductions by stand loss (plant totally or partially destroyed and main stem growth point lost), by fruiting branch removal, and by boll loss at different growth stages. Current data on the yield loss estimation was developed from field experiments in southern states. The information is not applicable to southwestern states such as Arizona and California, in which cotton is grown in a much longer growing season. In this study, we estimated cotton yield loss by different levels of fruiting branch removal at different growth stages in Arizona. If the main growth point is undamaged during hail storm during the eight fruiting branches to sixteen fruiting branches stage, growers could recover 80% to 100% of their cotton yield under growing conditions in Arizona. However, management practices might need to be adjusted after hail damage to increase cotton boll setting on top branches.

Introduction

Hail damage occurs each year in many areas where cotton is grown, and accurate estimations of crop yield loss are important for taking management actions and adjusting hail insurance claims. Insurance adjusters use a step-by-step procedure from National Crop Insurance Services (NCIS) to assess the effects of hail damage on cotton. The assessment includes estimations of cotton yield reductions by stand loss (plant totally or partially destroyed and apical growing point was damaged), by fruiting branch damage, and by boll and lock loss at different growth stages (NCIS, 1997). Current data on the yield loss estimation was developed from field experiments in southern states (NCIS, 1997). The information is not applicable to southwestern states such as Arizona and California, in which cotton is grown in a much longer growing season.

In this study, we estimated cotton yield loss by different levels of fruiting branch removal at three growth stages in Arizona. Seed cotton weight from different sections of cotton fruiting branches was also measured by plant mapping to investigate cotton plant regrowth after hail damage.

Materials and Methods

The experiment was conducted at University of Arizona Maricopa Agricultural Center at Maricopa, AZ. The cotton variety 'Deltapine 164 B2RF' was planted in dry soil and irrigated on April 4, 2008. Bed width was 40 inches, inrow spacing was 3.8 inches, and planting depth was 0.5 inches. The management of cotton (irrigation, fertilization, and pest management) followed grower production practices at the research station. Cotton fruiting branch removal was conducted when cotton plants had 8 fruiting branches (R8, first flower stage) on June 20, 2008, 12 fruiting branches (R12) on July 7, 2008, and 16 fruiting branches (R16) on July 21, 2008. At each growth stage, five different treatments including 0, 25, 50, 75, or 100% of fruiting branches removal were applied (Table 1). Hail damage was simulated by cutting fruiting branches that were longer than 1 inch from the top of cotton plants using pruners. The experiment was a split-plot design within a randomized complete block design with four replications. The main plots were growth stages and the split plots were damage levels. The final irrigation was applied on September 2, 2008 and defoliants were applied on September 30, 2008. Five plants from each plot were sampled randomly for mapping analysis on November 3, 2008. Each of five plants was separated into three parts: lower main stem section, mid-section, and top main stem section. The lower main stem section included all vegetative branches (node 1-5). The mid-section included nodes on which the treatments were applied, which included node 6-13, 6-17, and 6-21 for R8, R12, and R16 treatments, respectively. The top main-stem section included the new nodes that cotton plant produced after the fruiting branch removal treatment. Boll number and seed cotton weight from each section were recorded. The two middle rows were harvested on November 10, 2008 by a two-row cotton picker and seed cotton was weighed for yield. After harvest, plant numbers in a three-meter row were counted in each plot to establish plant density.

Table 1. The number of fruiting branches and the specific nodes removed for different damage levels at each growth	th
stage. The removal started from the top branch with a length longer than 1 inch.	

Removal treatment	R8	R12	R16
0	0 (no removal)	0 (no removal)	0 (no removal)
25%	2 (node 12-13)	3 (node 15-17)	4 (node 18-21)
50%	4 (node 10-13)	6 (node 12-17)	8 (node 14-21)
75%	6 (node 8-13)	9 (node 9-17)	12 (node 10-21)
100%	8 (node 6-13)	12 (node 6-17)	16 (node 6-21)

Results and Discussion

The overall average of cotton plant density was 11.4 plant/m for this study. The growth stage at which fruiting branches were removed had no significant effect on cotton yield (p=0.32), while percentage removal of fruiting branches affected cotton yield significantly. The interaction of growth stage and fruiting branch removal was not significant (p=0.72). Compared to the control, the effect of removing 25% of fruiting branches on the higher node (node 12-13 for R8, 15-17 for R12, and 18-21 for R16) on cotton yield was not significant at all three growth stages (Table 2). Removal of all fruiting branches (100%) caused 17.0%, 18.5%, and 20.1% yield loss for R8, R12, and R16 stages, respectively. These results indicate that cotton plants can compensate for fruiting branch loss to a significant degree under long growing season conditions.

Removal treatment	R8	R12	R16
0	5041.7 a*	5238.6 a	5118.5 a
25%	4840.0 ab	5022.5 ab	5017.7 a
50%	4523.1 bc	4844.8 b	4883.2 a
75%	4355.1 cd	4700.8 b	4475.1 b
100%	4182.2 d	4268.6 c	4091.0 c
Average	4588.4	4815.1	4717.1

Table 2. Cotton yield (lbs/A) affected by different fruiting branches removed at each growth stage

*In the same column, values followed by different letters are significantly different at p=0.05.

When cotton fruiting branches were cut at R8 (first flower stage), the relationship between cotton yield and percentage of fruiting branch removal is shown in Figure 1. For removal at stage R8, it can be seen that for removing every 10% of fruiting branches, approximately 88 lbs (1.7%) of yield was reduced. Removing every 10 percent of fruiting branches at the R12 and R16 growth stages caused 91 (1.7%) and 104 lbs (2.0%) seed cotton yield loss, respectively.

At stage R8, removing fruiting branches did not affect the production of vegetative branches and top branches (Figure 2). The difference in total seed cotton weight was caused by boll number and weight difference in the midsection branches, indicating that cotton plants did not respond to fruiting branch removal by changing growth in other parts of the plant significantly.



Fig 1. Relationship of fruiting branch removal (FBR) and cotton yield at different growth stage (From top: stage R8, stage R12, and stage R16).



Fig 2. Effects of fruiting branch removal on cotton boll setting at different growth stage (From top: stage R8, stage R12, and stage R16).

When fruiting branches were removed at the stage R12, cotton boll numbers and weights on the top branches were affected significantly. The treatments with 50%, 75%, and 100% fruiting branch removal significantly increased open boll numbers and boll weights and reduced unopened boll numbers compared to the control and the 25% removal. Removing 3 small branches near apical point of the plants (25% removal) did not affect boll number or boll weights compared to the control. The boll numbers on each node of the top branches were increased as a result of fruiting branch removal.

At stage R16, the treatment with 25% fruiting branch removal did not affect cotton growth except for boll numbers per node on top branches. The treatments with 50%, 75%, and 100% fruiting branch removal at the R16 stage had a similar effect on the cotton top branch growth as the same treatments at the R12 stage, except that the difference between all treatments were more significant at the R16 stage. Compared to the control, cotton weights in the mid-section branches from five plants in the 100% removal treatment was reduced from 219.0 g to 7.1 g. At the same time, boll number and boll weight of the top section in the 100% removal treatment were two times larger than the control treatment. As a result, the reduction in the total boll weight was only 89.2g. This indicates some degree of compensation among cotton plants in response to fruiting branch removal from the mid-section branches.

References

NCIS, 1997. Cotton loss instructions. National Crop Insurance Services, Inc.