Recoverability of Upland Cotton Following Terminal Removal at Various Growth Stages

Jason Sweeney[1], Michael A. Jones[1], and Mark Zarnstorff[2]

[1]Clemson University, PDREC, Florence, South Carolina

[2]National Crop Insurance Services, Overland Park, Kansas

RATIONALE AND BACKGROUND

Many natural occurrences have the potential to reduce crop yield by causing physical damage to vegetative and reproductive plant tissues. Mechanical damage to terminals due to crusted soils , sandblasting, insect damage, animal feeding, and severe weather events can potentially cause yield limiting damage to stems and foliage at various stages of crop development. More specifically, severe weather events such as hail storms, have been observed to cause light to severe damage to many crops including cotton. Injury associated with these storms is often variable within a field or across a farm, due to their sporadic nature. Accurate assessment of yield loss following a particular stress requires an understanding of the propensity of the crop to recover during the remainder of the growing season. Estimating the expected yield loss based on the timing and nature of crop injury is important for the purpose of grower compensation and replanting decisions for both insurance providers and extension personnel.

The objective of this study was to determine the response of cotton to terminal removal at different stages of cotton growth and development.

Figure 2. Photo taken during terminal removal below node 8 at node 12 in 2011 at PDREC in Florence, SC (top). 7 days after Node 8 at 12 treatment showing plant setback and debris (bottom).

Figure 2. Comparison of untreated row 1 and treated row 2. 7 days after terminal removal below Node 8 at 12 (top), and at harvest (bottom) in 2012 at PDREC in Florence, SC.

Table 1. The significance of the main effects and interactions within the experiment displayed by F-Ratio and P-Value. P-Values labeled with an asterisk contributed to a significant treatment effect at the 0.05 level of probability.

Significance of Experimental Components		
Source	F Ratio	P-Value
Year	64.59	<.0001*
Irrigation	0.93	0.35
Terminal Removal	4.94	<.0001*
Year*Terminal Removal	2.11	0.02*
Year*Irrigation	0.20	0.66
Terminal Removal*Irrigation	0.62	0.82
Year*Terminal Removal*Irrig.	1.22	0.30

Table 2. Lint yield of PHY 499WRF following terminal removal treatments in 2011 and 2012 at PDREC in Florence, SC illustrated as percent of untreated check. Values in red are significantly different from the untreated check at 0.05 level of probability. Values averaged over irrigated and dryland conditions due to lack of significance in irrigation. Treatment notation: Ex: "Node 2 at 2" = plants cut between nodes 1 and 2 when the 2nd leaf was almost fully developed, but the length between nodes 2 and 3 being < .5" long.

	2011		2012	
Treatment	Lint Yield (lbs/acre)	% of Untreated	Lint Yield (lbs/acre)	% of Untreated
Untreated	1068	100	1768	100
Node 2 at 2	903	84.6	1764	99.8
Node 2 at 4	883	82.7	1627	92.0
Node 4 at 4	939	87.9	1751	99.0
Node 4 at 8	815	76.3	1533	86.7
Node 6 at 8	990	92.7	1627	92.0
Node 8 at 8	960	89.9	1652	93.4
Node 8 at 12	782	73.2	1352	76.5
Node 10 at 12	861	80.6	1514	85.6
Node 12 at 12	987	92.4	1559	88.2
Node 12 at 16	974	91.2	1271	71.9
Node 14 at 16	1096	102.6	1633	92.4
Node 16 at 16	1059	99.2	1754	99.2

Table 3. Total bolls, number of fruiting sites, fruit retention, positioning of bolls on mainstem nodes and sympodia, and other plant growth parameters following terminal removal treatment as determined through end-of –season plant mapping on October 20, 2011 and December 5, 2012. All parameters displayed by year due to a significant interaction between terminal removal treatment and year for most parameters. Values in red are significantly different compared to the untreated check at α = 0.05 in its respective year. P-values less than 0.05 denote significant year*terminal removal interaction. For all terminal removal treatments, plants were cut by hand below the first designated nodal position at the growth stage denoted by the second growth stage given. For example, for the "4 at 8" terminal removal treatment, plants were cut between nodes 3 and 4 when the 8th leaf was fully developed, but the node between the 8th and 9th leaf being < 5" long.

Para-meter	Plant Height		Total Nodes		Veg. Branches		1st Fruit. Branch		Veg Bolls		Sympodia Position						Mainstem Nodes								Total Fruiting Bolls		Total Fruiting Sites		Fruit Retention	
											1st Pos.		2nd Pos.		3rd Pos. >		5&Under		6 to 10		11 to 15		16 to 20							
	cm/plnt		no./plnt		no./plnt		node/plnt		bolls/m²		bolls/m²		bolls/m²		bolls/m²		bolls/m²		bolls/m²		bolls/m²		bolls/m²		bolls/m²		bolls/m²		%	
Year	'11	'12	'11	'12	'11	'12	'11	'12	'11	'12	'11	'12	'11	'12	'11	'12	'11	'12	'11	'12	'11	'12	'11	'12	'11	'12	'11	'12	'11	'12
TRT																														
UNT	55.4	68.4	15.6	18.2	1.9	1.5	7.3	7.7	1.7	2.1	40.0	50.2	5.7	12.1	0.9	1.9	1.3	<.01	30.1	36.3	13.9	24.2	0.4	3.1	45.2	64.2	119	133.7	38.0	49.1
2 at 2	51.7	66.5	13.6	15.6	2.5	1.6	7.6	7.7	13.6	25.8	32.2	45.1	3.6	10.1	0.3	0.5	0.4	0.7	25.4	29.1	10.2	24.6	<.01	1.8	34.8	55.7	94.8	104.8	38.9	54.1
2 at 4	55.0	67.2	13.7	15.9	2.3	1.8	7.3	7.5	11.7	20.2	39.7	45.3	3.6	8.5	<.01	0.5	0.7	<.01	28.6	30.2	8.1	23.0	<.01	1.2	36.9	53.6	86.3	100.6	43.1	55.9
4 at 4	60.5	69.8	14.4	16.9	2.3	1.3	7.6	8.1	9.3	19.2	35.6	47.4	2.9	11.1	0.4	1.9	0.1	<.01	29.6	28.4	11.8	31.6	<.01	2.1	38.8	60.3	84.6	117.4	45.8	52.6
4 at 8	56.0	69.8	12.3	16.8	2.8	1.5	6.8	8.4	16.2	14.2	27.9	45.3	2.2	12.3	0.2	1.3	1.1	<.01	23.0	23.8	8.4	32.4	0.1	3.0	40.0	58.9	81.8	102.0	47.4	58.9
6 at 8	62.7	60.1	14.1	15.3	2.0	1.7	8.2	8.6	10.6	24.6	30.3	32.2	4.3	5.5	0.2	0.9	0.9	<.01	21.5	19.0	12.2	17.1	<.01	2.6	33.1	38.8	80.4	75.3	40.6	45.4
8 at 8	47.5	37.4	12.3	10.9	2.2	2.4	7.5	8.0	17.3	44.1	22.6	18.2	5.7	3.6	1.8	0.4	0.7	<.01	25.0	12.1	4.7	9.5	<.01	0.3	30.6	21.9	78.3	42.1	39.6	35.5
8 at 12	36.9	26.7	9.8	9.8	1.7	2.6	6.9	7.0	29.8	49.7	19.9	6.0	6.2	5.3	2.7	2.7	1.2	<.01	21.0	14.2	5.4	<.01	0.1	0.0	27.9	14.5	48.8	24.7	57.3	60.5
10 at 12	35.2	32.3	10.2	9.3	1.3	1.7	7.0	7.2	5.3	29.3	20.0	20.3	5.3	10.4	1.3	9.5	1.3	<.01	24.0	39.0	2.6	1.9	0.0	0.0	26.6	40.5	62.7	76.5	44.0	52.8
12 at 12	40.9	42.7	11.4	11.5	1.6	1.5	7.1	8.0	5.4	8.8	26.1	29.0	8.8	13.7	4.8	6.1	0.8	<.01	31.1	35.7	7.8	13.4	0.0	0.0	73.4	57.0	93.4	90.1	49.9	53.6
12 at 16	47.7	42.8	11.6	11.5	1.8	1.5	7.2	8.2	2.3	8.7	30.1	28.4	7.7	7.3	0.6	2.7	0.1	<.01	26.7	27.7	7.3	11.2	0.0	0.0	43.9	38.5	83.3	72.2	52.5	54.4
14 at 16	52.7	56.4	13.0	13.3	1.8	1.0	7.4	7.4	2.2	2.7	35.1	46.1	8.4	13.7	0.8	1.4	0.5	<.01	35.4	35.4	13.7	22.1	<.01	<.01	43.9	57.0	96.9	109.1	45.4	52.5
16 at 16	52.7	62.0	14.4	14.4	1.8	1.5	7.5	7.9	5.3	6.3	35.1	46.6	8.6	16.7	1.1	3.0	0.9	<.01	28.1	35.8	17.0	30.7	0.1	0.4	45.2	66.2	109	133.8	42.0	49.8
P-Value	<.0001		<.0001		0.0069		0.1481		0.0746		0.0056		0.0465		0.0039		0.3376		0.0078		<.0001		0.0658		0.0128		0.0281		0.5242	

MATERIALS AND METHODS

A replicated field trial was conducted at the Pee Dee Research & Education Center located in Florence, SC in 2011 and 2012. Treatments consisted of 12 different levels of terminal removal based on nodal development. Terminals were removed by hand at intermediate stages at node 2, 4, 6, 8, 12, and 16. An untreated check was also included, and treatments were imposed on dryland and irrigated cotton. Plots consisted of 4 rows, spaced 38 inches apart and were 40 feet long. Phytogen 499WRF was planted on May 18th in 2011 and May 3rd in 2012 with a John Deere 1700 Vacuum planter at a rate of 4 seed per row foot. Plots were arranged as split plots in a randomized complete block design with four replications. Irrigated or dryland conditions were main plots, and the terminal removal treatments were sub-plots. Data collected included above-ground plant dry matter (data not included) at peak bloom (and cracked boll in 2012), and a final plant map at the end of the season (plant height, number of nodes, total fruiting sites, vegetative branches, boll location on main stem nodes and sympodia). At season's end, the middle two rows of each four row plot was machine-harvested with a Case 1822 2-row picker. Seedcotton was ginned on a 10-saw gin and gin turnout calculated, and fiber quality determined by HVI analysis at Star Lab (Knoxville, TN). Data were evaluated by analysis of variance (SAS Institute Inc., Cary, NC).

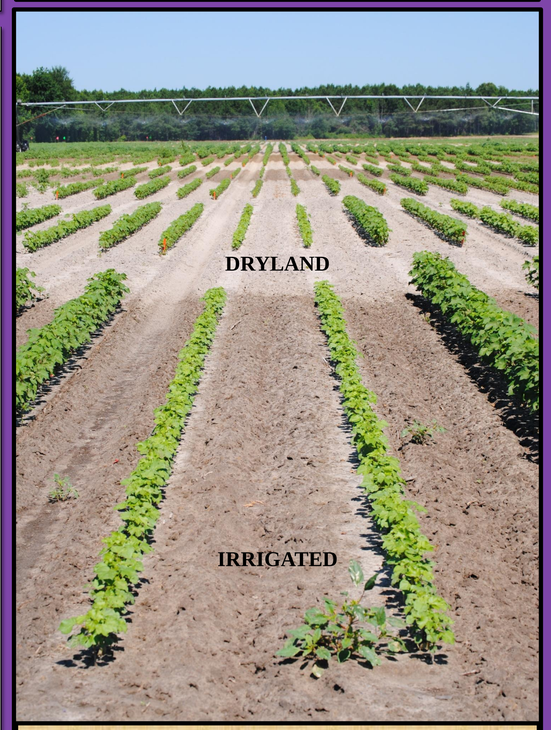

Figure 1. Photo of irrigated and dryland main-plot conditions taken on June 27th, 2012 during 1st irrigation e of .75 in/acre at PDREC in Florence, SC.

SUMMARY

1. No Terminal Removal by Irrigation interactions were found for any parameter in this study.
2. Both yield and plant growth characteristics were affected by differences between growing season, as moisture and heat units varied across years (data not shown). Difference in growing seasons is evidenced by a 700 lb/A increase in lint yield for untreated plots from 2011 to 2012 (Table 2).
3. Lint yield was reduced in both years following terminal removal below node 4 at the 8 leaf stage, and below nodes 8 and 10 at the 12 leaf growth stage. In 2012, yield also declined in response to terminal removal below node 12 at both the 12 and 16 leaf growth stages (Table 2).
4. Yield decline was associated with a decrease in 1st position bolls up to 88% in the most severe removal treatments, a decrease in overall fruiting sites, as well as a decrease in boll number in the upper portion of the plant above the site of injury, compared to untreated checks (Table 3).
5. Plants subjected to early season removal treatments such as terminal removal below node 2 at the 2 and 4 leaf stages were able to recover following injury due to a dramatic increase in vegetative boll number (Table 3). Conversely, plants subjected to midseason removal treatments at the 12 leaf stage lost the majority of their fruiting potential when the terminal was removed along with sympodia (Table 3). Since fruit production had already been initiated when the terminal removal treatments were imposed, reverting back to vegetative growth did not occur.

Funding and support provided by NCIS and Cotton Inc.