CHANGES IN COTTON YIELD, BOLL DEVELOPMENT, AND GROWTH IN RESPONSE TO LEAF AND TERMINAL REMOVALS AT VARIOUS GROWTH STAGES

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Rationale and Background

Many natural occurrences have the potential to reduce cotton lint yield by causing physical damage to vegetative and reproductive plant tissues. Mechanical damage to foliage, stems, and terminals from crusting, sandblasting, insect damage, animal feeding, and severe weather events can cause significant 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, and the associated crop injury often varies within a given agricultural field or across a farm due to the sporadic nature of the storms. Whether attributed to biotic or abiotic factors, physical damage to terminals has the potential to delay maturity and reduce the yield and/or fiber quality of cotton. Accurate estimation of lint yield loss following a particular stress requires an understanding of the propensity of the cotton plant to recover during the remainder of the growing season. Estimating expected yield loss based on the timing and severity of crop injury is important for the purpose of grower compensation for insurance claims in the event of injury, replanting decisions for producers and consultants, and recommendations from university Extension personnel. Since gaining an understanding of a crop plant's ability to recover from injury is essential for consultants and commodity producers in order to make sound replanting decisions and for accurate estimation of crop loss by insurance providers, the objective of this study was to determine the response of cotton to leaf and terminal removal during various growth stages throughout the growing season.

Materials and Methods

A replicated field trial was conducted at the Pee Dee Research and Education Center located in Florence, South Carolina during the 2013, 2014 and 2015 growing seasons. Treatments consisted of 17 different combinations of leaf and terminal removal based on cotton growth stages. PHY 499 WRF plants were either completely defoliated (100% defoliation) or had half their leaves removed (50% defoliation) by hand at the 4-leaf stage, at matchhead square, at early bloom, and at early bloom plus 2 weeks. Terminals were also removed by hand in combination with the defoliation treatments on half the plots during the same growth stages. An untreated check was also included. Plots were arranged in a randomized complete block design with four replications. Plots consisted of 4 rows, spaced 38 inches apart and were 40 feet long. Data collected included boll size, boll numbers, and a final plant map at the end of the season (plant height, number of nodes, total fruiting sites, vegetative branches, boll location on the main stem nodes and on sympodial branches) from one meter of row. At season's end, plots were machine-harvested with a Case 1822 plot picker. Seed cotton was ginned on a 10-saw gin and gin turnout calculated. Data were evaluated by analysis of variance (SAS Institute Inc., Cary, NC).

Preliminary Results

Table 1. Lint yield, seedcotton, gin turnout, total bolls produced and average boll size of PHY 499WRF in response to removing various amounts of leaves and terminals at different growth stages during the 2013, 2014, and 2015 growing season at the Pee Dee Research & Education Center in Florence, SC.

Leaf Removal Treatment																	
Leaf Removal Growth Stage	Amount of Leaves Removed	Terminal Removed	Lint Yield			Seedcotton			Gin Turnout			Total Bolls			Boll Size		
			2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015	2013	2014	2015
			lbs/acre						%			bolls/m^2			g/boll		
untreated	0% Removed	no	1483	1583	1365	3319	3508	2915	44.8	45.1	46.9		92	93		4.6	4.4
4-leaf	50% Defoliation	no	1402	1784	1228	3155	3938	2596	44.5	45.3	47.3		96	108		4.8	4.1
4-leaf	50% Defoliation	yes	1514	1416	1024	3439	3121	2218	44.1	45.4	46.2		104	76		4.3	4.3
4-leaf	100% Defoliation	no	1320	1066	791	2992	2382	1754	44.1	44.8	45.2		74	96		3.9	3.8
4-leaf	100% Defoliation	yes	796	770	450	1866	1720	1066	42.5	44.8	43.5		70	66		3.6	4.8
Matchhead Square	50% Defoliation	no	1509	1539	1087	3413	3336	2304	44.2	46.2	47.2		78	72		4.8	4.1
Matchhead Square	50% Defoliation	yes	1454	1492	902	3310	3207	1943	44.0	46.5	46.4		84	52		4.6	3.3
Matchhead Square	100% Defoliation	no	1311	842	779	3035	1848	1711	43.1	45.3	45.6		62	56		4.1	4
Matchhead Square	100% Defoliation	yes	780	984	739	1797	2167	1668	43.4	45.2	44.3		66	55		4.1	5.6
Early Bloom	50% Defoliation	no	1273	1340	1009	2837	2958	2184	44.9	45.4	46.2		88	71		4.6	4.2
Early Bloom	50% Defoliation	yes	1347	1368	1007	3112	2958	2106	43.5	46.3	47.8		88	86		4.2	4.8
Early Bloom	100% Defoliation	no	346	769	810	765	1720	1771	45.1	44.8	45.7		50	65		5.4	3.9
Early Bloom	100% Defoliation	yes	624	564	658	1479	1427	1453	41.5	44.1	45.2		56	72		4.1	3.2
Early Bloom + 2 weeks	50% Defoliation	no	1451	1698	921	3224	3654	1917	45.2	46.5	48.1		92	57		4.8	4.7
Early Bloom + 2 weeks	50% Defoliation	yes	1199	1329	1096	2631	2708	2261	45.6	46.3	48.5		84	75		4.6	4.2
Early Bloom + 2 weeks	100% Defoliation	no	346	412	347	886	894	739	42.8	45.4	46.7		58	47		3.1	4
Early Bloom + 2 weeks	100% Defoliation	yes	424	494	309	963	1049	671	44.0	47.2	46.1		50	47		3.0	3.7
LSD (0.05)			340	221	187	778	475	417	1.8	1.2	2.7		20	29		1.1	1.2
CV (%)			26	16	15	26	16	16	3.5	2.1	4.1		22	29		21	20
Trial Mean			1095	1144	854	2484	2505	1840	44.0	45.6	46.3		76	70		4.3	4.3

Red numbers are significantly lower than the untreated check at the 0.05 level of probability.
Green numbers are significantly greater than the untreated check at the 0.05 level of probability.

Table 2. Plant stand, plant height, total nodes, number of monopdial branches and total boll production and location of PHY 499WRF in response to removing various amounts of leaves and terminals at different growth stages during the 2014 and 2015 growing seasons at the Pee Dee Research & Education Center in Florence, SC. Data averaged over years.

Leaf Removal Treatment													
Leaf Removal Growth Stage	Amount of Leaves Removed	Terminal Removed	Plant Stand	Plant Height	Total Nodes	Monopod. Branches	Monopod. Bolls	Sympodial Bolls 1st Pos.	Sympodial Bolls 2nd Pos.	Sympodial Bolls 3rd Pos.	Total Bolls Nodes 6-10	Total Bolls Nodes 11-15	Total Bolls Nodes 16-20
			plts/m	cm/plt	no/plt			Bolls/plant					
untreated	0% Removed	no	11	75	18	1	0.5	6.4	1.7	0.6	4.8	3.4	0.6
4-leaf	50% Defoliation	no	13	72	17	1	0.6	5.6	1.7	0.9	4.5	2.7	0.4
4-leaf	50% Defoliation	yes	12	78	16	3	3.0	4.8	1.3	0.3	2.5	2.8	0.3
4-leaf	100% Defoliation	no	11	74	19	2	0.7	5.2	2.0	0.6	3.0	3.7	1.0
4-leaf	100% Defoliation	yes	12	76	17	3	3.5	4.5	1.4	0.7	3.1	3.1	0.4
Matchhead Square	50% Defoliation	no	10	70	17	2	1.0	5.7	1.7	0.5	4.2	3.2	0.4
Matchhead Square	50% Defoliation	yes	11	59	15	3	3.8	4.1	1.3	0.8	4.1	1.5	0.6
Matchhead Square	100% Defoliation	no	12	72	18	2	0.3	4.1	0.8	0.4	2.6	2.2	0.3
Matchhead Square	100% Defoliation	yes	12	50	13	2	3.0	2.8	1.1	1.3	3.8	1.0	0.4
Early Bloom	50% Defoliation	no	12	72	18	2	0.7	5.3	1.5	0.6	4.3	2.5	0.5
Early Bloom	50% Defoliation	yes	11	71	17	2	1.8	5.1	1.7	0.5	4.3	2.9	0.8
Early Bloom	100% Defoliation	no	12	70	18	2	0.5	4.4	1.1	0.3	2.8	2.2	0.3
Early Bloom	100% Defoliation	yes	10	70	17	2	0.8	4.1	0.8	1.0	2.6	2.4	0.4
Early Bloom + 2 weeks	50% Defoliation	no	11	70	17	2	0.9	5.3	1.4	0.3	4.3	2.1	0.4
Early Bloom + 2 weeks	50% Defoliation	yes	12	70	16	1	0.8	4.7	1.7	0.7	4.6	2.0	0.2
Early Bloom + 2 weeks	100% Defoliation	no	12	74	18	2	0.4	3.6	0.8	0.4	2.8	1.4	0.6
Early Bloom + 2 weeks	100% Defoliation	yes	9	71	16	2	0.9	3.9	1.2	0.6	3.4	1.8	0.1
LSD (0.05)			NS	11	2	1	1.9	1.3	0.9	0.7	1.5	1.1	NS
CV (%)			22	12	10	42	100.4	20.9	50.5	98	31.1	36.8	109.8
Trial Mean			11	70	17	2	1.4	4.7	1.4	0.6	3.0	2.4	0.5

Red numbers are significantly lower than the untreated check at the 0.05 level of probability.
Green numbers are significantly greater than the untreated check at the 0.05 level of probability.

Figure 1. Untreated Check vs 50% Defoliation at the 4-leaf Stage.

Figure 2. Untreated Check vs 100% Defoliation at the Matchhead Square Stage.

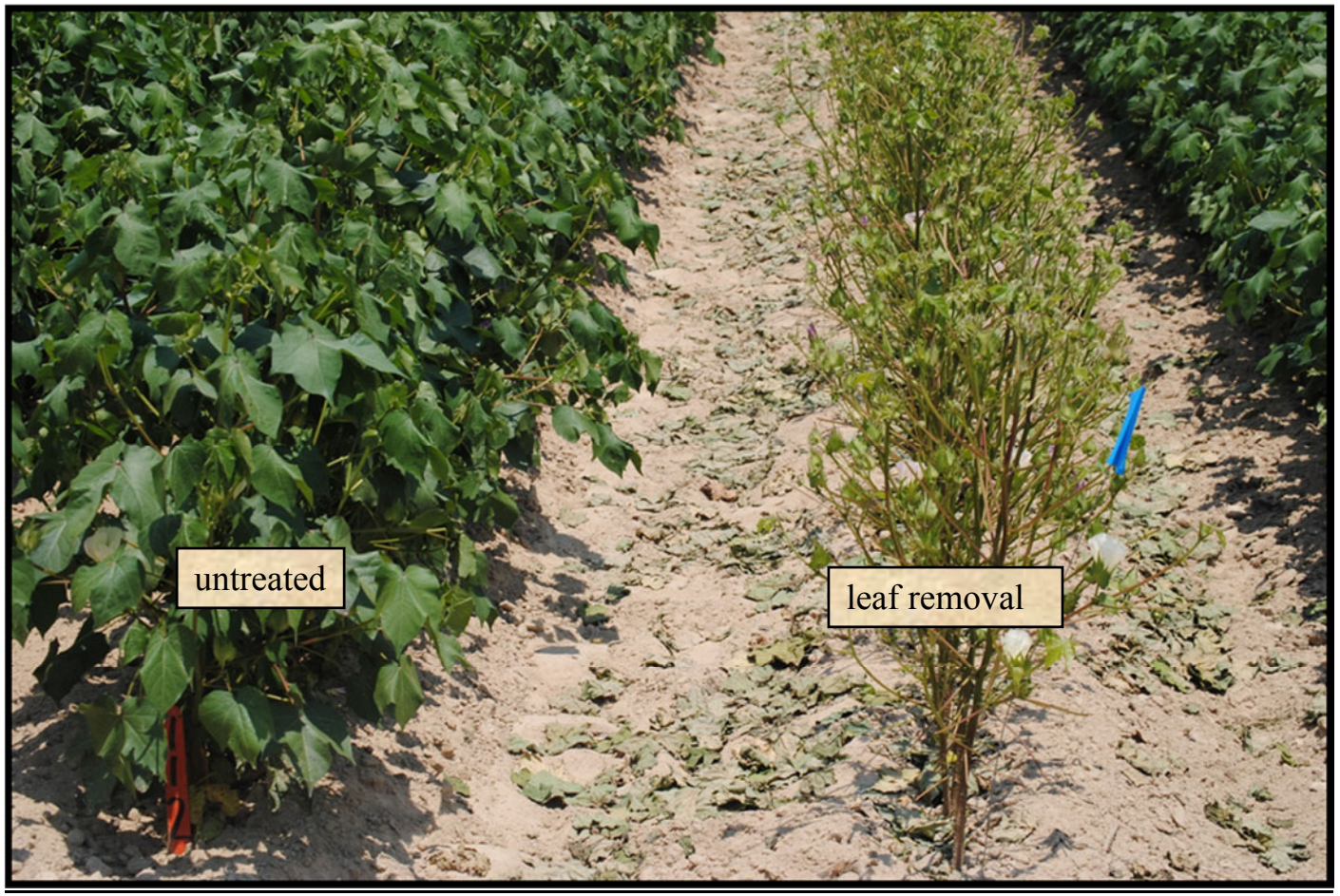

Figure 3. Untreated Check vs 100% Defoliation at the Early Bloom Stage.

Figure 4. Untreated Check vs 50% Defoliation at the Early Bloom plus 2 Weeks Stage.

Summary

1) Lint yields were similar in all three years of this study with 1483, 1583, and 1365 lbs/acre produced in the untreated check plots in 2013, 2014, and 2015, respectively (Table 1).

2) Cotton plants appeared to be able to compensate for terminal loss before early bloom (4-leaf and matchhead square) when only 50% of the foliage was removed in 2013 and 2014, but yields were reduced with 50% defoliation and terminal removal in 2015 at these early growth stages. Lint yields were only significantly reduced before early bloom in 2014 and 2015 when plants were completely defoliated and when plants were completely defoliated and terminals removed in all three years (Table 1).

3) Lint yields were more drastically impacted when leaves and terminals were removed after early bloom, especially when plants were completely defoliated (Table 1). Yield decreases appeared to be the result of reduced boll production in most plots and by reduced boll size when plants were defoliated in other plots (Table 1).

4) Leaf and terminal removals appeared to influence the internal partitioning of carbohydrates within bolls, but differences varied among years. Gin turnout was reduced by the complete defoliation of plants at the 4-leaf stage in 2013 and 2015, at early bloom in 2013, and at early bloom plus 2 weeks in 2013, but was increased by some leaf removal treatments in 2014 (Table 1).

5) Plants compensated to terminal and foliage loss by increasing the development of monopodial branches during the growing season; however, most of the plants subjected to leaf removal developed significantly fewer mature bolls at first position sympodial branch locations and at nodal positions lower on the main stem (Table 2).