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IMPACT OF BOLL FEEDING BUGS ON LINT YIELD AND FIBER QUALITY

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Abstract

Untreated and bug treated plots were established at four locations to evaluate the impact of boll feeding bug damage on lint yield and fiber quality. Bug populations varied by location and yield increases of 2, 7, 16, and 33 percent were observed based on machine harvest. Prior to commercial harvest first position bolls were handpicked by node at each location, ginned on a table top gin, and submitted to Cotton Incorporated for fiber quality analysis (AFIS). Mean fiber length, coefficient of variation of fiber length, upper quartile fiber length, and percent short fiber content may all be impacted by excessive boll feeding bug damage. Significant differences in fiber quality parameters at individual nodes were most commonly observed where the yield increase associated with insecticide treatment was the greatest. Mean fiber lengths and upper quartile lengths were generally reduced where excessive boll feeding bug damage occurred. The coefficient of variation of fiber length and percent short fiber content were generally increased where excessive boll feeding bug damage occurred. Additional studies are needed that consider machine picker efficiency and commercial ginning practices. Perhaps a mechanical picker will not harvest many of the bug damaged locks that were handpicked in this study.

Introduction

Boll feeding bugs have become primary insect pests of cotton in Georgia due in large part to the reduction of broad spectrum insecticide applications during recent years. Successful elimination of the boll weevil and the widespread adoption of Bt cotton have allowed producers to significantly reduce mid and late season insecticide applications. Prior to these events, broad spectrum insecticides such as pyrethroids were commonly used to control boll weevil, tobacco budworm, and corn earworm. These pyrethroid applications coincidentally controlled and suppressed stink bug numbers below damaging levels. The predominant boll feeding bugs in Georgia cotton include the southern green stink bug and the brown stink bug. Additional boll feeding bugs occasionally observed include the green stink bug, dusky brown stink bug, tarnished plant bug, clouded plant bug, leaf-footed bug, and other stink bug species. Collectively this group of pests comprises the boll feeding bug complex.

Stink bugs damage developing cotton bolls by piercing the boll wall and feeding on or near the developing seed. In addition to physical damage to the seed (the fiber is part of the seed), pathogens may also be introduced during feeding or enter the boll through insect wounds causing individual locks or the entire boll to rot and be unharvestable. Yield losses from bug damage to bolls have been documented in various studies (Cassidy and Barber 1939, Toscano and Stern 1976, Barbour et al. 1990, and Greene et al. 2001). In no-choice feeding studies, stink bugs reduced seedcotton yield in bolls that had accumulated less than 550 heat units (Greene et al. 2001 and Willrich eat al. 2003). In most states, thresholds for boll feeding bugs in cotton, such as stink bugs, have been adapted from Greene et al. 2001 and are based on 1 stink bug per 6 row feet or 10-20 percent medium sized bolls (the diameter of a quarter) displaying internal signs of feeding when stink bugs are present.

Relatively few studies have examined influences of boll feeding bugs on fiber quality (Toscano and Stern 1976, Barbour et al. 1990). Stink bugs prefer to feed on bolls ranging in age from 7-27 days after anthesis (Willrich et. al. 2004). Fibers develop to maturity in bolls in about 45 days beyond anthesis. Most fiber elongation occurs during the first 3 weeks following anthesis and is measured as staple length, whereas fiber deposition or thickening occurs during the second 3 weeks and is measured as micronaire. Other fiber measures including color, strength, trash, leaf grade, and uniformity may all impact prices received by producers.

Methods

Untreated and bug treated plots were established at four locations to evaluate the impact of boll feeding bugs on lint yield and fiber quality. All plots were scouted weekly by examining 25 medium sized bolls for internal signs of feeding, warts or callous growths on the inner surface of the boll wall and/or stained lint. At first open boll, first position bolls were harvested by node and examined for internal injury. Bolls were considered injured if one wart or callous growth on the inner surface of the boll wall and/or stained lint was observed (Bundy et al. 2000). Prior to machine harvest, first position bolls were hand picked by node on an adjacent section of row in each plot. Seedcotton samples were ginned on a table top gin (no cleaners) and lint samples were submitted to Cotton Incorporated for fiber quality analysis (AFIS). Plots were machine harvested for determining yields. Data were analyzed using a two-tailed t-test with unequal variance.

Bryan and Tyler Locations:
Two on-farm trials were conducted in Irwin County GA and included plots which were 18 rows wide and at least 800 feet in length replicated three times. Each location was treated once based on a 20 percent internal boll injury threshold. At the Bryan location, DP 458 BR was treated with Fury on August 4 (approximately the fifth week of bloom). At the Tyler location, DP 451 BR was treated with Karate on July 27 (approximately the fourth week of bloom). Percent first position bolls injured at first open boll were determined and seedcotton samples from first positions were collected on two five row feet sections in each plot.

EXPO Location:
A third location was established at the Sunbelt Agricultural Exposition (EXPO) in Colquitt County GA. Plots were 12 rows wide, 40 feet in length, and replicated 4 times. FM 960 B2R was planted on May 6, 2004. Bidrin was applied in the treated plots July 9, 20, and 29 based on a 20 percent internal boll injury threshold. Percent first position bolls injured were determined and seedcotton samples from first positions were collected on a 10 feet row section in each plot per plot.

Scout School Location:
The fourth location was established in Tift County GA at the Coastal Plain Experiment Station. A small block of DP 444 BR cotton, 8 rows wide and 200 feet in length, was planted on March 26 for use in a cotton scout training program conducted in June. The area was split in half and the treated portion of the small block received scheduled Bidrin applications on June 25, July 3, 9, 16, and 23 to minimize stink bug injury. Percent first position bolls injured were quanitified on three ten row feet sections in each treatment. Seedcotton samples of first position bolls were collected on six ten row feet sections in each treatment.

Results and Discussion

Stink bug infestations were heavy, especially during mid-late bloom, at the scout school location. Bidrin applications were applied on a weekly schedule (June 25, July 3, 9, 16, and 23) to minimize stink bug damage in the treated plot. Percent of internal injury in medium sized bolls ranged from 8-12 percent in the treated plot during weekly scouting evaluations. Percent internal injury in the untreated was in excess of 60 percent during mid-late July. Lint yields were significantly increased by 33 percent in the treated plot (1852 lbs/acre) compared with the untreated (1392 lbs/acre). The percent of first position bolls exhibiting internal symptoms of stink bug feeding were significantly higher in the untreated plot compared with the treated at all nodes except node six (Table 1). Mean fiber lengths by weight were significantly greater at nodes 5 and 10-14 in the treated plot. The coefficients of variation of fiber length were significantly greater at nodes 5 and 10-14 in the untreated plot. Upper quartile fiber lengths were significantly longer in treated plots at nodes 5-6 and 10-14. Percent short fiber contents were significantly higher in untreated plots at nodes 5-6 and 10-14.

A single application of Karate was applied on July 27 (approximately the fourth week of bloom) when scouting indicated 19 percent internal boll injury at the Tyler location. The treated plots remained below the 20 percent threshold for the remainder of the season, whereas the untreated exceeded 40 percent internal injury on three sampling dates during August. Considerable weathering and delays in harvest occurred at this location due to multiple rainfall events. Lint yields were significantly increased by 16 percent in the treated plot (866 lbs/acre) compared with the untreated (744 lbs/acre). Stink bug damaged bolls were significantly greater on nodes 11-13 and 15-17 in the treated plots compared with the untreated plots (Table 2). Mean fiber length was significantly longer in the treated plots on nodes 9-16 and 18. The coefficients of variation of fiber lengths were significantly greater in untreated plots at nodes 9-16. The upper quartile fiber lengths were significantly greater at nodes 9-12 in the treated plots. Percent short fiber contents were significantly higher at nodes 8-16 in the untreated plots.

Table 1. Percent internal boll injury and selected AFIS fiber quality measures of first position bolls in untreated and cotton treated five times with Bidrin, Scout School location Tift County GA (33 percent yield increase in treated plot).

Treatment	Node	Percent Internal Boll Injury	L (w) [in]	L (w) CV [%]	UQL (w) [in]	SFC (w) [%]
Treated	5	3	1.05	33.0	1.25	6.9
Untreated	5	25	1.02	34.5	1.22	7.7
Prob t		*0.0215*	*0.0003*	*0.0469*	*0.0096*	*0.0690*
Treated	6	18	1.02	35.8	1.24	9.3
Untreated	6	25	1.01	34.2	1.21	7.7
Prob t		*0.2529*	*0.2148*	*0.0553*	*0.0066*	*0.0247*
Treated	7	8	1.02	35.1	1.23	8.3
Untreated	7	30	1.01	35.2	1.21	8.4
Prob t		*0.0059*	*0.2012*	*0.4573*	*0.0828*	*0.4786*
Treated	8	32	1.04	34.2	1.24	7.6
Untreated	8	49	1.04	33.9	1.23	7.1
Prob t		*0.0450*	*0.5000*	*0.3356*	*0.3046*	*0.2247*
Treated	9	8	1.03	34.1	1.23	7.6
Untreated	9	47	1.01	35.5	1.22	9.0
Prob t		*0.0001*	*0.1522*	*0.0996*	*0.1559*	*0.1146*
Treated	10	18	1.05	33.2	1.25	7.2
Untreated	10	60	1.00	36.1	1.20	9.4
Prob t		*0.0035*	*0.0027*	*0.0167*	*0.0012*	*0.0147*
Treated	11	10	1.00	35.4	1.21	8.8
Untreated	11	68	0.93	39.3	1.15	12.8
Prob t		*0.0001*	*0.0003*	*0.0063*	*0.0001*	*0.0010*
Treated	12	2	1.04	32.7	1.22	6.8
Untreated	12	74	0.95	37.9	1.15	11.6
Prob t		*0.0001*	*0.0032*	*0.0005*	*0.0052*	*0.0015*
Treated	13	1	1.02	34.0	1.20	7.6
Treated	13	83	0.93	39.4	1.14	12.8
Prob t		*0.0001*	*0.0001*	*0.0013*	*0.0001*	*0.0021*
Treated	14	5	1.02	32.4	1.21	6.5
Untreated	14	82	0.92	42.6	1.16	15.7
Prob t		*0.0001*	*0.0057*	*0.0110*	*0.0096*	*0.0135*

A single application of Fury was applied on August 4 (approximately the fifth week of bloom) at the Bryan location. Percent internal boll injury of medium size bolls was 40 percent prior to treatment. Threshold levels were not met for the remainder of the season in treated plots and remained near 40 percent in the untreated plots. Lint yields were significantly increased by 7 percent in the treated (807 lbs/acre) compared with the untreated (751 lbs/acre). Percent first position internal boll injury at first open boll was significantly greater at nodes 11-12, 15-17, and 19-20 (Table 3). Mean fiber lengths were significantly longer at nodes 12 and 13 in the treated plots. The coefficients of variation of fiber length were significantly greater at nodes 10, 13, and 16 in the untreated plots. Upper quartile lengths were significantly longer at nodes 12 and 13 in the treated plots but significantly shorter compared with the untreated at node 20. The percents short fiber content were significantly greater in the untreated plots at nodes 13 and 16.

A complex of plant bugs and stink bugs infested the EXPO location. Three applications (July 9, 20, and 29) were applied based on the 20 percent internal boll injury threshold. Approximately 20 percent internal boll injury was observed in both untreated and treated plots on each application date with the exception of July 20 when about 40 percent boll injury was observed in the untreated. Following the third application, percent boll injury was low in both untreated and treated plots. In spite of three insecticide treatments we failed to observe much separation in boll injury in the treated and untreated plots. Perhaps this was due to the small plot design and plot-to-plot movement of both plant bugs and stink bugs. No significant differences were observed in yield between the treated (1189) and untreated plots (1165). However a 2 percent numerical increase was observed in the treated plot compared with the untreated. No significant differences were observed in percent internal boll injury or mean fiber lengths of first position bolls in the untreated and treated plots (Table 4). The coefficients of variation, upper quartile fiber lengths, and percents short fiber content were only significantly different at one node.

Table 2. Percent internal boll injury and selected AFIS fiber quality measures of first position bolls in untreated and cotton treated once with Karate, Tyler location Irwin County GA (16 percent yield increase in treated plot).

Treatment	Node	Percent Internal Boll Injury	L (w) [in]	L (w) CV [%]	UQL (w) [in]	SFC (w) [%]
Treated	7	44	0.86	39.9	1.07	15.8
Untreated	7	25	0.84	39.4	1.05	15.6
Prob t		*0.2107*	*0.4180*	*0.4575*	*0.3669*	*0.4853*
Treated	8	55	0.87	36.4	1.07	12.5
Untreated	8	45	0.82	40.7	1.03	17.5
Prob t		*0.2796*	*0.0936*	*0.0235*	*0.2074*	*0.0218*
Treated	9	40	0.91	35.2	1.11	10.7
Untreated	9	56	0.82	41.0	1.02	17.5
Prob t		*0.1513*	*0.0112*	*0.0474*	*0.0079*	*0.0490*
Treated	10	33	0.90	34.2	1.09	10.1
Untreated	10	42	0.80	39.8	1.01	16.8
Prob t		*0.2949*	*0.0071*	*0.0187*	*0.0206*	*0.0110*
Treated	11	45	0.92	33.4	1.10	8.9
Untreated	11	77	0.80	38.7	0.98	15.8
Prob t		*0.0382*	*0.0022*	*0.0204*	*0.0052*	*0.0075*
Treated	12	42	0.95	31.5	1.13	7.4
Untreated	12	82	0.87	37.6	1.07	13.1
Prob t		*0.0378*	*0.0161*	*0.0003*	*0.0427*	*0.0068*
Treated	13	36	0.96	30.4	1.13	6.3
Untreated	13	78	0.86	38.3	1.07	14.2
Prob t		*0.0067*	*0.0183*	*0.0030*	*0.0602*	*0.0134*
Treated	14	38	0.95	31.4	1.13	7.2
Untreated	14	66	0.88	36.9	1.07	12.6
Prob t		*0.0698*	*0.0113*	*0.0047*	*0.0840*	*0.0044*
Treated	15	39	0.95	31.8	1.13	7.8
Treated	15	90	0.90	34.8	1.09	10.7
Prob t		*0.0025*	*0.0412*	*0.0441*	*0.0923*	*0.0344*
Treated	16	34	0.96	31.7	1.14	7.5
Untreated	16	88	0.90	35.3	1.09	11.1
Prob t		*0.0143*	*0.0321*	*0.0109*	*0.1030*	*0.0170*
Treated	17	58	0.93	34.0	1.13	9.6
Untreated	17	93	0.90	34.3	1.09	10.7
Prob t		*0.0323*	*0.1876*	*0.4350*	*0.1674*	*0.2771*
Treated	18	87	0.97	34	1.17	8.8
Untreated	18	72	0.91	35.4	1.11	11.2
Prob t		*0.0955*	*0.0452*	*0.1232*	*0.0628*	*0.0668*
Treated	19	50	1.01	32.4	1.21	7.2
Untreated	19	44	0.94	36.1	1.15	10.8

Prob t		*0.4668*	*0.1616*	*0.1465*	*0.1350*	*0.1340*

Table 3. Percent internal boll injury and selected AFIS fiber quality measures of first position bolls in untreated and cotton treated once with Fury, Bryan location Irwin County GA (7 percent yield increase in treated plot).

Treatment	Node	Percent Internal Boll Injury	L (w) [in]	L (w) CV [%]	UQL (w) [in]	SFC (w) [%]
Treated	8	48	0.92	34.4	1.13	9.3
Untreated	8	25	0.93	36.3	1.14	10.4
Prob t		*0.1832*	*0.4858*	*0.1204*	*0.4242*	*0.2825*
Treated	9	32	0.91	33.9	1.09	9.5
Untreated	9	52	0.89	36.1	1.09	11.9
Prob t		*0.1822*	*0.3222*	*0.1484*	*0.4763*	*0.1620*
Treated	10	43	0.89	33.6	1.07	9.7
Untreated	10	53	0.87	36.4	1.07	12.3
Prob t		*0.3069*	*0.2354*	*0.0483*	*0.5000*	*0.0897*
Treated	11	44	0.87	34.3	1.04	10.9
Untreated	11	74	0.87	35.3	1.06	11.7
Prob t		*0.0199*	*0.4744*	*0.2854*	*0.2482*	*0.3029*
Treated	12	48	0.89	34.0	1.08	9.9
Untreated	12	79	0.85	36.4	1.04	12.8
Prob t		*0.0292*	*0.0384*	*0.0965*	*0.0425*	*0.0679*
Treated	13	50	0.90	34.5	1.09	10.1
Untreated	13	75	0.84	37.3	1.04	13.6
Prob t		*0.0836*	*0.0021*	*0.0042*	*0.0102*	*0.0028*
Treated	14	39	0.90	35.0	1.09	10.6
Untreated	14	63	0.88	36.1	1.07	11.9
Prob t		*0.0695*	*0.1376*	*0.2143*	*0.2418*	*0.1707*
Treated	15	51	0.92	34.4	1.10	9.9
Untreated	15	89	0.92	35.0	1.11	10.5
Prob t		*0.0318*	*0.5000*	*0.3193*	*0.3258*	*0.3270*
Treated	16	36	0.93	33.3	1.11	8.8
Treated	16	77	0.89	35.8	1.08	11.3
Prob t		*0.0070*	*0.0669*	*0.0037*	*0.1387*	*0.0141*
Treated	17	34	0.93	35.4	1.13	10.3
Untreated	17	68	0.89	35.7	1.08	11.5
Prob t		*0.0267*	*0.0780*	*0.4103*	*0.0510*	*0.1638*
Treated	18	23	0.93	34.5	1.12	10.0
Untreated	18	43	0.90	36.4	1.10	11.7
Prob t		*0.1011*	*0.1542*	*0.2444*	*0.1480*	*0.2562*
Treated	19	5	0.90	36.0	1.10	11.4
Untreated	19	67	0.90	35.9	1.10	11.1
Prob t		*0.0017*	*0.4534*	*0.4605*	*0.4559*	*0.4478*
Treated	20	0	0.89	34.1	1.07	10.1
Untreated	20	75	0.92	34.5	1.11	9.8
Prob t		*0.0288*	*0.1452*	*0.4231*	*0.0299*	*0.4438*
Treated	21	8	0.87	38.1	1.07	13.9
Untreated	21	50	0.90	36.4	1.10	11.6
Prob t		*0.2780*	*0.2484*	*0.1773*	*0.1555*	*0.1811*

Lint yield increases in the treated plots ranged from 2 percent at the EXPO location, 7 and 16 percent at the Bryan and Tyler locations, to 33 percent at the Scout School location. These yield responses are indicative of the differences in boll feeding bug populations which infested the untreated and treated plots based on weekly infield scouting procedures. Percent of bolls with internal injury at first open boll are relatively high at some nodes in both untreated and treated plots and may appear similar among different locations. However, a boll was considered injured if a single wart or callous growth was observed. The range of boll injury varied from a single wart or callous growth, to multiple feeding sites and rotten locks. Thus it will be difficult to correlate fiber quality differences to actual boll injury between locations using this methodology. Perhaps the number of callous growths should be counted or some measure to quantify the extent of boll injury should be considered in future investigations.

Table 4. Percent internal boll injury and selected AFIS fiber quality measures of first position bolls in untreated and cotton treated three times with Bidrin, EXPO location Colquitt County GA (2 percent yield increase in treated plot).

Treatment	Node	Percent Internal Boll Injury	L (w) [in]	L (w) CV [%]	UQL (w) [in]	SFC (w) [%]
Treated	7	61	1.01	37.2	1.25	11.1
Untreated	7	69	0.95	40.1	1.20	14.1
Prob t		*0.1842*	*0.1988*	*0.1921*	*0.1428*	*0.2213*
Treated	8	55	1.03	35.7	1.26	9.9
Untreated	8	73	0.98	39.3	1.24	12.9
Prob t		*0.2192*	*0.0546*	*0.0157*	*0.2221*	*0.0002*
Treated	9	50	1.02	35.6	1.26	10.0
Untreated	9	79	1.00	37.9	1.24	11.8
Prob t		*0.0549*	*0.1873*	*0.1114*	*0.1457*	*0.1261*
Treated	10	42	1.02	35.9	1.25	1.04
Untreated	10	71	1.01	35.6	1.24	10.0
Prob t		*0.1155*	*0.4256*	*0.4398*	*0.3326*	*0.3785*
Treated	11	26	0.97	36.9	1.21	11.6
Untreated	11	59	0.95	39.0	1.20	13.3
Prob t		*0.0644*	*0.1942*	*0.1530*	*0.2886*	*0.1937*
Treated	12	24	0.99	36.9	1.22	10.8
Untreated	12	45	0.97	36.9	1.20	11.2
Prob t		*0.0997*	*0.0756*	*0.4921*	*0.0282*	*0.3442*
Treated	13	26	0.97	37.3	1.19	11.8
Untreated	13	47	0.98	36.3	1.20	10.8
Prob t		*0.1985*	*0.4022*	*0.2757*	*0.3590*	*0.2095*
Treated	14	30	1.02	35.2	1.24	9.5
Untreated	14	37	1.00	35.9	1.21	10.4
Prob t		*0.3058*	*0.3332*	*0.4376*	*0.2143*	*0.4102*

Significant differences in fiber quality measures of first position bolls at individual nodes tended to be more common where yield responses where greatest. These data suggest that bolls damaged by boll feeding bugs negatively impact fiber lengths, uniformity of fiber lengths, and short fiber content. However, other factors must be considered since seedcotton was handpicked and ginned on a table top gin with no lint cleaners.

Seedcotton harvested for fiber quality analysis was handpicked; all locks were harvested regardless of the extent of damage. We would expect machine picking efficiency would be lower, ie. many of the locks which had bug damage may not be harvested. Therefore we may expect the differences in fiber quality to be less dramatic. Additionally, these seedcotton samples were ginned on a table top gin with no lint cleaners. Perhaps in a commercial ginning environment results may differ. However based on these data, excessive boll feeding bug damage can negatively influence fiber quality and consideration should be given to fiber quality when establishing thresholds for boll feeding bugs.

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