STONEVILLE BXN/Bt WITH BOLLGARD®: EFFICACY TRIALS CONDUCTED AT THE NORTHEAST RESEARCH STATION

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Abstract

Field tests were conducted at the St. Joseph and Macon Ridge locations of the Northeast Research Station in 1996 to evaluate conventional cotton varieties and experimental BXN/Bt and or Bt genotypes with Bollgard®. Three conventional varieties (ST 474, ST 495, and ST 125) were include as standards, and compared to seven genotypes which contained genes to metabolize bromoxynil (BXN® system) and/or the Bollgard gene. The varieties and experimental genotypes were tested with (W) and without (WO) applications of insecticides for major pest control. Effectiveness of major pest insect control strategies was determined by counting square damage resulting from bollworm (BW), tobacco budworm (TBW), boll weevil and beet armyworm (BAW) and estimating yields. Analyzed across all treatments, major pest control resulted in significantly less square damage at both the St. Joseph and Winnsboro locations. The genotypes with Bollgard resulted in significantly less square damage as compared to the conventional varieties, except that Bt02, BXN/Bt03, and BXN/Bt06 were not significantly better than ST 474 at the St. Joseph location and BXN/Bt06 was not significantly better than ST 495 at Winnsboro. Major pest control strategies resulted in significantly improved lint yield/acre across all treatments as compared to the untreated control at both locations. At the St. Joseph location, Bt07 produced significantly higher lint yield/acre as compared to all other genotypes. Three experimental lines, BXN/Bt01, BXN/Bt03 and Bt07, produced >1000 lb lint/acre at both locations. Lint yield/acre of conventional varieties was highest for ST 474, followed by ST 495, and ST 132 (tested only at the St. Joseph location).

Introduction

In 1996, transgenic cotton seed with the BXN® system and/or Bollgard® (registered trademark of Monsanto Company) was tested at the St. Joseph and Winnsboro locations of the LSU Agricultural Centers Northeast Research Station. Seed was provided by the Stoneville Pedigree Seed Company. This research, using experimental genotypes with stacked genes represents the first tests of this technology which have been conducted at the Northeast Research Station.

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The BXN system contains a gene that produces an enzyme (nitralase) that gives these transgenic varieties an ability to metabolize bromoxynil. This allows Buctril® herbicide (registered trademark of Rhone-Poulenc Agricultural Company) to be applied in post over-the-top (POT) treatments for control of major broadleaf weeds, i. e. morningglory, cocklebur, velvetleaf and wild poinsettia. The BXN system was introduced to farmers in 1995.

Bollgard cotton varieties are genetically engineered to code for a delta endotoxin of *Bacillus thuringiensis* (Bt) and were commercially introduced in 1996. The Bollgard varieties provide highly effective control of tobacco budworm, pink bollworm, and salt marsh caterpillar, and suppression of several other lepidopterous pests i.e. bollworm, loopers, and beet armyworms.

Commercial introduction of the transgenic BXN systems and the Bollgard varieties has resulted in considerable response as to the desirable and undesirable traits associated with the new technologies. These are briefly summarized as Pro's and Con's. A few Pro's of transgenic BXN systems include: The BXN system allows broad spectrum POT broadleaf weed control. There is near absolute crop safety to BXN genotypes when using Buctril herbicide. This allows maximum timing and rate flexibility in the program. Very rapid weed control response occurs following applications of Buctril. Some of the Con's of the BXN system are: Buctril misses some of the key broadleaf weeds that infest some cotton production regions, i.e. pigweeds and prickly sida (teaweed). There is no grass or sedge activity provided by the herbicide. The system does not eliminate the need for preemergence and/or other postemergence herbicides.

The commercial Bollgard cotton varieties also are associated with several Pro's and Con's of usage in a production system. The Pro's are: The Bollgard cotton provides an insect control device that is highly stable in the plant, and therefore rainfast and/or tolerant to inherited problems often associated with foliar applications of insecticides. Bollgard provides excellent tobacco budworm control and good bollworm control. Bollgard provides selective control/suppression of several other lepidopterous pests such as loopers, salt marsh caterpillar and armyworms. Good seedling vigor is associated with NuCOTN 33b. There is usually a high early season fruit retention rate (80 percent or more of 1st position squares), especially in the pre-bloom and early bloom stages. Some of the Con's associated with Bollgard cotton varieties include: Bollgard varieties are sensitive to non-lepidopterous pests. This has sometimes led to higher insecticide costs in Bollgard vs. conventional varieties. There is a tendency toward rank growth associated with Bollgard varieties. There is poor harvest efficiency associated with NuCOTN 33b. Gin turnout was reduced in some of the back crossed varieties.

Materials and Methods

Plots were replicated four times in a RCB design with a split plot arrangement of treatments and were eight rows (40 in spacing) x 45 ft. Transgenic cotton seed and seed of the non-transgenic parent lines (ST 474, ST 495 and ST 132) were planted on 16 May, on a Commerce silt loam soil which was fertilized with 90 lb N/acre. Cotton seed was planted with a John Deere 7100 series planter which was equipped with 10 in seed cones mounted to replace the seed hoppers. The seeding rate was 4 seed/row ft. Granular in-furrow treatments were applied with 8 in belt cone applicators mounted to replace the standard granular applicators. In-furrow spray treatments were applied with a CO_2 charged spray system through 25015 flat fan nozzles (one/row) positioned in front of the press wheels. The spray tips were turned to spray across the furrow and were calibrated to deliver 5 GPA finished spray. All plots received 0.5 lb AI/acre Temik 15G and 0.75 lb AI/acre Terraclor Super X 2E at planting. Insecticide control measures were applied to treatments when bollworms and tobacco budworms first deposited eggs in July, and continued on an as needed basis for control of bollworm, tobacco budworm and beet armyworm (BW/TBW/BAW) square damage. The test was conducted in the presence of high boll weevil population densities and BAW infested the plots in late Jul, Aug and Sep. At St. Joseph, control of boll weevils and tarnished plant bugs was initiated on an “as needed” basis using five selective tank mixtures as follows: Methyl Parathion 4E, 0.33 lb AI/acre (11 Jul); Vydate 3.77CLV, 0.25 lb AI/acre (30 Jul); Methyl Parathion 4E, 0.33 lb AI/acre + Orthene 90S, 0.33 lb AI/acre (6 Aug); Methyl Parathion 4E, 0.33 lb AI/acre + Dimethoate 4E, 0.25 lb AI/acre (13 Aug); and Baythroid 2E, 0.045 lb AI/acre (11Sep). In addition to the five selective overspray treatments listed above, the W/spray strategies received the following insecticide treatments: Karate 1E, 0.03 lb AI/acre (22 Jul); Karate 1E, 0.03 lb AI/acre (25 Jul); Karate 1E, 0.03 lb AI/acre (30 Jul); Karate 1E, 0.03 lb AI/acre (5 Aug); Karate 1E, 0.03 lb AI/acre (8 Aug); Curacron 8E, 1.0 lb AI/acre + Pirate 3E, 0.2 lb AI/acre + Vydate 3.77CLV, 0.25 lb AI/acre (15 Aug); and Curacron 8E, 1.0 lb AI/acre + Pirate 3E, 0.2 lb AI/acre + Methyl Parathion 4E 0.25 lb AI/acre (26 Aug). All treatments were sprayed with Baythroid 2E, 0.045 lb AI/acre on 11 Sep. Ten plant terminals and 25 squares/plot were examined for BW/TBW/BAW eggs, live larvae, worm damage and boll weevil damage on 24, 30 Jul, and 2, 8, 13 and 20 Aug except that terminals were not examined on 20 Aug. Only the seasonal means for square damage are reported herein. At the Winnsboro location, a similar series of treatments was used for control of major pests these are listed as follows: Methyl Parathion 4E, 0.25 lb AI/acre + Karate 1EC 0.033 lb AI/acre (19 Jul); Methyl Parathion 4E, 0.25 lb AI/acre + Karate 1EC 0.033 lb AI/acre (26 Jul);Methyl Parathion 4E, 0.25 lb AI/acre + Karate 1EC, 0.033 lb AI/acre (8 Aug); Methyl Parathion 4E, 0.25 lb AI/acre + Karate 1EC, 0.033 lb AI/acre + Larvin 3.2F 0.25 lb AI/acre (16 Aug); Methyl Parathion 4E, 0.25 lb AI/acre + Karate 1EC 0.033 lb AI/acre + Curacron 8EC 0.5 lb AI/acre (22 Aug); Methyl Parathion 4E, 0.25 lb AI/acre + Curacron 8EC + Larvin 3.2F 0.4 lb AI/acre (14 Sep). The center four rows of the plots were harvested on 14 Oct and 10 Oct, respectively, at the St. Joseph and Winnsboro locations. Plots were harvested using a John Deere spindle type picker. Yields were converted to lb lint/acre.

Summary

When analyzed across all treatments, applications for the control of major pests resulted in significantly less BW/TBW/BAW damaged squares at both the St. Joseph and Winnsboro locations of the Northeast Research Station. Significantly less boll weevil damaged squares was recorded at the St. Joseph location (Tables 1 and 2).

A comparison of the effects of the conventional and experimental genotypes on major pest control indicates the experimental genotypes with Bt, reduced worm damaged square counts at both locations. Low square damage was associated with BXN/Bt04 and BXN/Bt05. BXN/Bt06 had the highest damage among the transgenic genotypes at both locations (Tables 3 and 4). At the St. Joseph location, Bt02, BXN/Bt03, and BXN/Bt06 did not significantly improve square damage as compared to ST 474. However, at the Winnsboro location, all experimental genotypes with Bt significantly reduced square damage as compared to the conventional varieties. The differences between locations may have been caused by very high bollworm and moderate beet armyworm population densities that infested the plots at St. Joseph.

When analyzed across all treatments, insecticide applications applied for major pest control resulted in significant lint yield increases at both locations. Lint yield/acre for major pest control was 1116 lbs vs. 749 lbs in the untreated control at St. Joseph and lint yield/acre was 1010 lbs in the major pest control plots vs. 820 lbs in the untreated control plots at Winnsboro (Tables 5 and 6).

The effects of the conventional and experimental genotypes on yield for the St. Joseph and Winnsboro locations are shown in Tables 7 and 8, respectively. For ease of observation, a numerical rank is assigned for each table. BXN/Bt01, BXN/Bt03 and Bt07 produced exceptional yields at both locations, yielding equal to or greater than 1000 lbs of lint/acre and produced significantly more lint/acre as compared to the conventional varieties at the St. Joseph location. Bt07 produced significantly more lint/acre than all other genotypes at the St. Joseph location. At the Winnsboro location, four of the experimental genotypes (BXN/Bt01, BXN/Bt03, BXN/Bt05 and Bt07) resulted in significantly higher yields than the other varieties and genotypes except for ST 474.

A summary of the effects of major pest control X genotypes is presented in Figs 1 and 2. The conventional varieties W/major pest control produced 1046 and 1081 lb lint/acre, respectively, at the St. Joseph and Winnsboro locations. The lint yield/acre for conventional varieties WO/major pest control was 637 vs. 700 lb lint /acre, respectively, and constitutes 63% and 54% yield increases due to major pest control strategies that were used for controlling pests on the conventional varieties. The experimental Bt genotypes W/major pest control produced 1145 and 990 lb lint/acre, respectively, at the St. Joseph and Winnsboro locations. The lint yield/acre for experimental Bt genotypes W/O major pest control was 797 vs. 855 lb lint/acre, respectively, and constitutes 44 and 16% yield increases due to the major pest control strategies which were used on the experimental genotypes.

Table 1. Effect of Spray Strategies on Square Damage Across Conventional and Bollgard® Cotton Genotypes (St. Joseph, LA).

	Square Damage/25	
Treatment	BW/TBW/BAW	Boll Weevil
Major Pest Control	0.63*	1.42*
Untreated Control	0.95	2.65

Means within a column with an asterisk are significantly different (P = 0.05;DMRT) .

Table 2. Effect of Spray Strategies on Square Damage Across Conventional and Bollgard®l Cotton Genotyoes (Winnsboro, LA).

	Square Damage/25	
Treatment	BW/TBW	Boll Weevil
Major Pest Control	0.37*	2.16
Untreated Control	0.66	2.19

Means within a column with an asteric are significantly different (P = 0.05;DMRT) .

Table 3. Effect of Conventional and Bollgard® Cotton Genotypes on Major Pest Control (St. Joseph, LA).

Treatment	Square Dam Damage/25 BW/TBW/BAW
ST 474	1.17abc
ST 495	1.32a
ST 132	1.22ab
BXN/Bt01	0.60d
Bt02	0.72cd
BXN/Bt03	0.75cd
BXN/Bt04	0.43d
BXN/Bt05	0.38 d
BXN/Bt06	0.80 bcd
Bt07	0.50d

Means within a column with the same letter are not significantly different (P = 0.05;DMRT) .

Table 4. Effect of Conventional and Bollgard® Cotton Genotypes on Major Pest Control (Winnsboro, LA).

Treatment	Square Damage/25 BW/TBW/BAW
ST 474	0.89a
ST 495	0.83ab
BXN/Bt01	0.33d
Bt02	0.38d
BXN/Bt03	0.45cd
BXN/Bt04	0.31d
BXN/Bt05	0.35d
BXN/Bt06	0.64bccd
Bt07	0.42cd

Means within a column with the same letter are not significantly different (P = 0.05;DMRT) .

Table 5. Effect of Spray Strategies on Yield in Conventional and Bollgard®l Cotton Genotypes (St. Joseph, LA).

Treatment	Yield (Lint/acre)
Major Pest Control	1116
Untreated Control	749 *

Means within a column with an asteric are significantly different (P = 0.05;DMRT) .

Table 6. Effect of Spray Strategies on Yield in Conventional and Bollgard® Cotton Genotypes (Winnsboro, LA).

Treatment	Yield (lb Lint/acre)
Major Pest Control	1010
Untreated Control	820 *

Means within a column with an asteric are significantly different (P = 0.05;DMRT) .

Table 7. Effect of Conventional and Bollgard® Cotton Genotypes on Yield (St. Joseph, LA).

Treatment	Yield (lb Lint/acre)	Rank
ST 474	955cd	(5)*
ST 495	896de	(7)
ST 132	672g	(10)
BXN/Bt01	1064b	(2)
Bt02	989bcd	(4)
BXN/Bt03	1041bc	(3)
BXN/Bt04	906de	(6)
BXN/Bt05	823ef	(8)
BXN/Bt06	753fg	(9)
Bt07	1220a	(1)

*Designates the rank of yield from highest (1) to lowest (10).
Means within a column with the same letter are not significantly different (P = 0.05;DMRT) .

Table 8. Effect of Conventional and Bollgard® Cotton Genotypes on Yield (Winnsboro, LA).

Treatment	Yield (lb Lint/acre)	Rank
ST 474	966ab	(4)*
ST 495	815cd	(8)
BXN/Bt01	1031a	(1)
Bt02	826cd	(7)
BXN/Bt03	1000a	(3)
BXN/Bt04	749d	(9)
BXN/Bt05	933a	(5)
BXN/Bt06	896bc	(6)
Bt07	1020a	(2)

*Designates the rank of yield from highest (1) to lowest (9).
Means within a column with the same letter are not significantly different (P = 0.05;DMRT) .

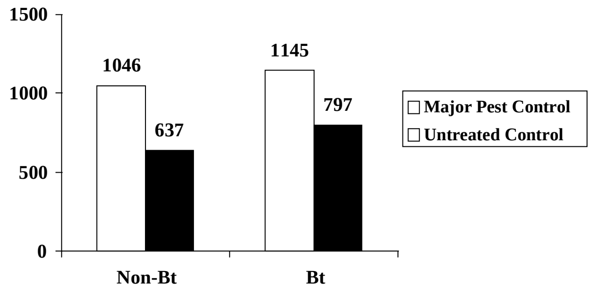

Figure 1. Effect of insecticide strategy and genotype on yield (St. Joseph, LA).

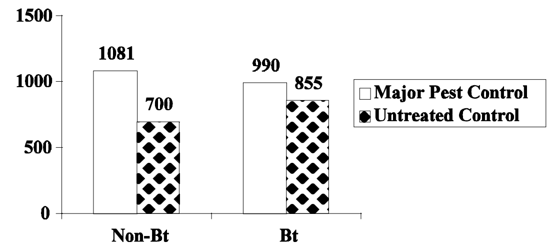

Figure 2. Effect of insecticide strategy and genotype on yield (Winnsboro,