# PERFORMANCE AND INSECT CONTROL COST OF BOLLGARD VS CONVENTIONAL VARIETIES IN TENNESSEE

**R. W. Seward and P. P. Shelby**
**University of Tennessee Agricultural Extension Service**
**Jackson, TN**
**S. C. Danehower**
**University of Tennessee Agricultural Extension Service**
**Ripley, TN**

## Abstract

The performance of Bollgard and non-Bollgard (conventional) varieties, based on lint yields/acre, were examined in 9 and 8 county variety trials in 1998 and 1999 respectively. These were planted and managed as on-farm, large plots for weed and insect control. Bollgard varieties produced an 85 lb and 17 lb lint yield/acre increase averaged across all locations in 1998 and 1999, respectively. Yield differences for Bollgard vs non-Bollgard at individual field sites ranged from -29 lbs to +339 lbs in 1998 and -77 lbs to +132 lbs in 1999. Average insect control cost per acre for Bollgard was $65 and $62 versus non-Bollgard at $62 and $46 for 1998 and 1999, respectively. Bollgard varieties performed equal to or better than non-Bollgard varieties in the presence of higher bollworm, tobacco budworm, and European corn borer infestations. In the absence of these insects or when insecticide treatments were effective, conventional varieties performed equal to or better than Bollgard varieties. There were numerical lint yield/acre differences among varieties within a location and among locations in both 1998 and 1999.

## Introduction

Tremendous changes have occurred in the last two years with the adoption of transgenic and specifically Bollgard varieties. Tennessee producers have been slow to adopt these varieties for various reasons until 1999.

In 1996, NuCotn 33 was not considered well adapted for Tennessee and also untested by the Tennessee Agricultural Experiment Station or producers. A few acres were planted in the southern counties, especially in Middle Tennessee where boll weevil eradication was active and tobacco budworm had been a major problem in 1995.

In 1997, herbicide tolerant varieties were more in demand than Bt varieties since Tennessee has not consistently had a bollworm/tobacco budworm problem. An exception has been in some Middle and West Tennessee counties bordering Alabama and Mississippi. Since 1984, the average *Heliothine* insecticide cost per acre has been $8 with yield losses of 2.6% ( Head, 1984-1993; Williams, 1994-1999). Exceptions were 1993, 1995, and 1998 which had average control cost of $17, $35, and $33 with yield losses of 6.7 %, 10.8 % and 5.8 %, respectively. A 10% yield loss equals approximately 95 lbs lint/acre.

Several factors began to change market demand for 1998. The continued label use of Buctril herbicide was in question. Continuing pyrethroid resistance within tobacco budworm was a concern. Boll weevil eradication was scheduled to start a fall diapause program in seven southwest Tennessee counties. Producers were being advised, by eradication personnel and others who had experienced multiple eradication sprays, to plant "as much Bt cotton as possible" during the first two to three years of eradication. Production cost and risk was being re-evaluated. Research and extension personnel as well as crop advisors were all suddenly ill-prepared to recommend Bt varieties due to the limited access and limited testing of varieties which were available and thought suitable for use in Tennessee.

The lack of information and experience created the need to expand on-farm county variety trials which are a cooperative effort between producers, county extension agents and state specialists. Information presented in this paper is a summary of performance and insecticide use from selected sites within this on-farm variety trial program.

## Materials and Methods

### Site Selection, Planting and Management

In 1998 and 1999, seed was obtained directly from interested seed companies. Extension agents and commodity specialists selected field sites based on seed supply, transgenic and/or maturity traits, and planting intentions of the cooperating producer. All field locations, except Lake Co., were upland, non-irrigated, silt loam soil types.

A standard protocol was used for planting and management within a field trial. Cooperating producers were asked to manage Bollgard and non-Bollgard, with respect to insects, independently. Varieties were grouped by their transgenic traits: combination genes of Bollgard and Roundup (BR), Bollgard alone (B), Roundup alone (RR), and conventional (C). Planting order of a group and varieties within a group was random. All field sites were planted by the producer during the first two weeks of May in 1998 and 1999. Varieties were planted in non-replicated, 4 or 8 row strips the length of a field, which ranged from 500 - 1500 linear feet. Madison county in 1999 was the only exception in that BR and B varieties were planted in 4 replications of 4 row strips. Herbicide programs were used according to conventional, BXN or Roundup tolerant varieties. All field sites were monitored for insects by a scout or consultant. Insecticide treatments were recommended on established treatment

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1055-1057 (2000)
National Cotton Council, Memphis TN

thresholds for Tennessee cotton production (Seward and Lentz, 1998-1999) but the ultimate decision was made by the producer. All Bollgard and non-Bollgard varieties were treated for non-*Heliothine* pests as needed.

**Harvesting**

All field sites were defoliated based on maturity of yield-contributing bolls. Maturity was determined by DD60 heat units (700-850), nodes above cracked boll, and "sharp knife" technique for examining bolls. Cotton was harvested using the producers' harvesting equipment except for the Hardeman site in 1998 which was hand picked. Seed cotton weights were taken on each variety using portable, digital scales placed under the cotton trailer or "boll buggy" tires. Lint yields were calculated using field area measurements harvested and gin turnout percentages from the official variety tests conducted by the Tennessee Agricultural Experiment Station (Gwathmey et.al., 1998-1999). Only one field site, Lake county in 1999, was harvested, ginned by variety, and lint yields calculated from local gin turnout percentages.

## Results

**1998**

One Bollgard/Roundup(BR), 6 Bollgard(B), 1 Roundup(RR), and 6 conventional(C) varieties were planted in 9 county locations. Lint yields in all locations were above the state average of 589 lbs/acre (Table 1).Moisture was limited in Fayette and Haywood counties during early bloom stage. Average yields were 934, 811, 732 and 726 for BR, B, RR and C varieties, respectively. Bollgard (BT) varieties had an average yield increase of 85 lbs over non-Bollgard (NBT). Lint yields were numerically different among varieties within a location and among locations. Yield differences for Bollgard vs non-Bollgard varieties ranged from -29 lbs /acre in Tipton Co. to +339 lbs in Gibson Co. (Table 2).

Cost of insect control, including technology fees, for BT varieties ranged from $35 in Crockett Co. to $88 in Lauderdale Co. Insect control cost for NBT ranged from $15 in Crockett Co. to $95 in Lauderdale Co. Average cost was $65 and $62 per acre for BTand NBT, respectively (Table 2).

**1999**

Eight Bollgard/Roundup (BR), 6 Bollgard(B), 2 Roundup(RR) and 3 conventional(C) varieties were planted in 8 county locations. Seven of eight trials averaged across all varieties produced yields above the state average of 504 lbs/acre (Table3). Moisture was a limiting factor in most locations with Lauderdale Co. being extremely dry. Average yields were 628, 638, 630 and 605 for BR, B, RR and C varieties, respectively. Bollgard (BT) varieties had an average yield increase of 17 lbs over non-Bollgard (NBT). Lint yields were numerically different among varieties within a location and among locations. Yield differences for Bollgard vs non-Bollgard ranged from -77 lbs/acre in Giles Co. to +132 lbs in Madison Co.(Table 4).

Cost of insect control, including technology fees, for BT varieties ranged from $34 in Crockett Co. to $109 in Dyer Co. Insect control cost for NBT ranged from $6 in Giles Co. to $94 in Fayette Co. Average cost was $62 and $46 per acre for BT and NBT, respectively (Table 4).

## Discussion

Insect infestations and population densities varied from county to county and year to year. Insect control cost included all insects except thrips. Boll weevil was a major pest in most locations in 1998 and 1999. Fayette, Hardeman and Tipton counties were in Zone 1 of the active boll weevil eradication program and received 8-10 "diapause" applications of malathion starting the first week of August in 1998. In 1999, the Fayette Co. location received 10 malathion sprays for the season. Giles Co. is in southern, Middle Tennessee which is free of boll weevil. Bollworm (*Helicoverpa zea*) and tobacco budworm (*Heliothis virescens*) infestations were considered above average in 1998 and average in 1999 when compared to the 15-year average in Tennessee. Bollworm was estimated to be 60% of the population during both years but exceeded this ratio in northern counties where more corn is planted. Bollgard varieties were oversprayed for bollworms in Hardeman Co. once while Dyer Co. received sprays each time non-Bollgard varieties were treated in both years. Infestations were threshold and sub-threshold levels in some cases.Tobacco budworm infestations were generally higher in the most southern counties, especially in 1998. Although *Heliothine* populations were lower in 1999, economic infestations of aphids, spider mites and stink bugs were above average. European corn borer (ECB) was a significant pest in northern West Tennessee counties in 1998, causing unforeseen boll damage and yield losses. Bollgard provided very good control of ECB and contributed to yield increases, especially in the Gibson county site in 1998. ECB was at low levels and not a factor in 1999.

## Summary

In summary, the overall performance of Bollgard cotton during 1998 and 1999 was positive. Bollgard varieties produced an 85 lb and 17 lb lint yield/acre increase averaged across all locations in 1998 and 1999, respectively. Results indicate that Bollgard varieties may produce a wide range of yield responses in comparison to non-Bollgard depending on insect pressure. Bollgard performed equal to or better than non-Bollgard in the presence of higher bollworm, tobacco budworm, and European corn borer infestations. In the absence of these insects or when insecticide treatments were

effective, conventional varieties performed equal to or better than Bollgard varieties. Including the technology fees, cost of insect control was similar to or slightly above that of conventional varieties. In areas where bollworm, tobacco budworm and European corn borer have a higher probability of occurring, Bollgard varieties may provide higher net returns, along with significant risk and resistance management benefits.

## Acknowledgments

The authors express their thanks to the cooperating producers who made exceptions in their planting, in-season and harvesting schedules to produce these trials. Thanks are extended to the extension agents who coordinate, assist with planting, in-season recommendations and harvesting. Also, the financial support provided by Cotton Incorporated and the Tennessee state support committee is acknowledged with thanks.

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Table 1. Cotton lint yields ( lbs./acre) for selected variety trials. 1998.

| Variety | Fayette | Hard-eman | Tipton | Laud-erdale | Hay-wood | Croc-kett | Gibson | Dyer | Giles |
|---|---|---|---|---|---|---|---|---|---|
| PM1220BR | 681 | 1124 | 861 | 967 | 811 | 993 | 1023 | 973 | 975 |
| PM1215B | 865 | 1039 | 856 | 856 | 956 | 898 | 1328 | 1015 | 797 |
| DP428B | 597 | 926 | 783 | 752 | - | 749 | 835 | 765 | 737 |
| DP33B | 709 | - | 847 | 651 | 515 | 867 | 908 | 820 | - |
| DP32B | 629 | 882 | - | 758 | 356 | 855 | 895 | 816 | 873 |
| DP20B | 630 | 842 | 739 | 695 | 646 | 737 | 936 | 852 | 920 |
| DP50B | 586 | 869 | 682 | 814 | 570 | 722 | 900 | 729 | 654 |
| PM1220RR | 476 | 662 | 754 | 749 | - | 830 | 773 | 815 | 801 |
| SG404 | 654 | 879 | 719 | 671 | 609 | 784 | 692 | 757 | 779 |
| ST373 | 464 | 717 | 926 | 829 | 698 | 943 | 647 | 720 | 777 |
| DP5409 | 799 | 804 | 795 | 721 | 596 | 794 | 647 | 720 | 692 |
| ST474 | 471 | 957 | 772 | 767 | 637 | 851 | 540 | 755 | 798 |
| ST47 | 642 | 713 | 965 | 688 | 714 | 782 | 562 | 668 | - |
| SG125 | 446 | 945 | 840 | 702 | 606 | 814 | 589 | 656 | 761 |

Lint Yield Average: Bollgard Varieties = 811 lbs.
Non-Bollgard Varieties = 726 lbs.

Table 2. Average lint yields and insecticide cost/acre of Bollgard and Non-Bollgard varieties by location. 1998.

| Variety | Fayette | Hard-eman | Tipton | Laud-erdale | Hay-wood | Croc-kett | Gib son | Dyer | Giles |
|---|---|---|---|---|---|---|---|---|---|
| BT | 671 | 974 | 795 | 785 | 642 | 831 | 975 | 853 | 826 |
| RR | 476 | 662 | 754 | 749 | - | 830 | 773 | 815 | 801 |
| Non-BT | 564 | 716 | 824 | 625 | 643 | 828 | 636 | 727 | 755 |
| BT vs Non-BT | 107 | 231 | -29 | 160 | -1 | 3 | 339 | 126 | 71 |
| **Insecticide Cost*** | | | | | | | | | |
| BT | $63 | $59 | $81 | $88 | $51 | $35 | $85 | $81 | $39 |
| Non-BT | $56 | $91 | $81 | $95 | $68 | $15 | $68 | $61 | $20 |

Average Cost: BT = $65
Non-BT = $62
Average Lint Yield Increase: BT vs Non-BT = 85 lbs.
*Includes BT tech fee.

Table 3. Cotton lint yields (lbs./acre) for selected variety trials. 1999.

| Variety | Fayette | Lauderdale | Madison | Crockett | Gibson | Dyer | Lake | Giles |
|---|---|---|---|---|---|---|---|---|
| PM1220BR | 906 | 426 | 725 | 607 | 699 | 922 | 924 | 664 |
| PM1218BR | 933 | 418 | 786 | 572 | 711 | 914 | - | - |
| PM1560BR | 769 | 314 | 593 | 517 | 510 | 823 | - | - |
| DP409BR | 760 | 292 | 648 | 501 | 498 | 708 | 772 | - |
| DP450BR | 883 | 338 | 608 | 518 | 556 | 740 | 699 | 439 |
| DP451BR | 703 | 319 | 588 | 569 | 464 | 771 | 701 | 626 |
| SG125BR | 801 | 364 | 626 | 498 | 453 | 712 | 775 | 630 |
| SG501BR | 816 | 337 | 681 | 446 | 568 | 680 | - | - |
| DP20B | 902 | 302 | 649 | 556 | 542 | 733 | 780 | 648 |
| DP32B | 923 | 387 | 679 | 559 | 568 | 732 | 791 | 657 |
| DP33B | 923 | 463 | 652 | 611 | 496 | 718 | 698 | 655 |
| DP428B | 786 | 237 | 652 | 523 | 525 | 708 | 712 | 589 |
| DP448B | 914 | 336 | 702 | 601 | 608 | 709 | 761 | - |
| PM1560B | 798 | 278 | 706 | 562 | 540 | 738 | 726 | 624 |
| DP436R | 783 | 342 | 541 | 496 | 489 | 750 | 758 | 645 |
| PM1220RR | 860 | - | 608 | 459 | 524 | 851 | - | - |
| ST373 | 888 | 270 | 529 | 445 | 512 | 684 | - | 642 |
| ST474 | 817 | 322 | 501 | 493 | 502 | 767 | 841 | 791 |
| DP388 | 860 | 373 | 481 | 574 | 563 | 735 | 760 | - |

Lint Yield Average: Bollgard Varieties = 632 lbs.
Non-Bollgard Varieties = 615 lbs.

Table 4. Average lint yields and insecticide cost/acre of Bollgard and Non-Bollgard varieties by location. 1999.

| Variety | Fayette | Lauderdale | Madison | Crockett | Gibson | Dyer | Lake | Giles |
|---|---|---|---|---|---|---|---|---|
| BT | 844 | 343 | 664 | 545 | 552 | 757 | 758 | 615 |
| RR | 822 | 342 | 574 | 477 | 506 | 800 | 758 | 645 |
| Non-BT | 842 | 327 | 532 | 493 | 518 | 757 | 786 | 692 |
| BT vs Non-BT | 2 | 16 | 132 | 52 | 34 | 0 | -28 | -77 |
| **Insecticide Cost** | | | | | | | | |
| BT | $94 | $65 | $56 | $34 | $39 | $109 | $65 | $38 |
| Non-BT | $94 | $58 | $42 | $14 | $19 | $89 | $48 | $6 |

Average Cost: BT = $65 Non-BT = $46

Average Lint Yield Increase: BT vs Non-BT = 17 lbs.

*Includes BT tech fee