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RESULTS OF FIELD EXPERIMENTS WITH TRANSGENIC COTTON VARIETIES (VIPCOT AND WIDESTRIKE) IN THE TEXAS COASTAL BEND

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Abstract

Separate field experiments were conducted on VipCot (3 years) and Widestrike (1 year) transgenic cotton varieties grown under dryland conditions in the Texas Coastal Bend. Evaluations were made on plant growth and development, caterpillars, impact of insecticide applied to the transgenic and conventional cotton varieties, yield response by spindle picker harvest, and fiber characteristics. Caterpillars encountered included saltmarsh caterpillar,cotton leafperforator, bollworm, tobacco budworm, and omnivorous leafroller. Significantly less damage to cotton squares and bolls was observed in transgenic compared with conventional varieties. Greater lint yields were also observed in the transgenic varieties, especially when compared with nontreated conventional varieties. Selected data from 4 field experiments were chosen for presentation in this report.

Materials and Methods

VipCot Experiment

VipCot 102 (transgenic Bt) was compared with Coker 312 (non-Bt) in 2002 and 2003 and VipCot series 102, 202, and 203 (transgenic Bt varieties) were compared with Coker 312 in 2004 on the Texas Agricultural Experiment Station at Corpus Christi, Texas for effect on caterpillar pests. Seed was planted with cone seed distributors in 4-row (2002 and 2004) or 8-row (2003) plots arranged on 38-inch rows with plot lengths of 30 or 40 feet. Experimental treatments were arranged in a randomized complete block with 4 replications. All experiments were surrounded by 40-ft buffers of nontransgenic cotton to meet USDA and EPA compliance requirements. In the **2002 experiment** appropriate plots were treated with Denim .16E (0.01 lb AI/acre) on July 25 and August 7 with a self-propelled Spider Trac sprayer delivering 7 gpa through 4X hollow cone nozzles at 40 psi traveling at 3.5 mph. In the **2003 experiment** appropriate non-Bt plots were treated with Denim .16 (0.01 lb AI/acre) on June 3 and 18. Karate Z 2.08EC (0.04 lb AI/acre) was applied to the sprayed non-Bt and VipCot treatments on June 24. These 3 treatments were made with the Spider sprayer traveling at 2.5 mph delivering a total spray volume of 9.7 gpa through 4X hollow cone nozzles at a pressure of 40 psi. In the **2004 experiment** Denim .16 (0.015 lb AI/acre) was applied to (1) non-Bt treated plots on June 24 and 28, and July 5 and 19, (2) VipCot 102 treated plots on July 7 and 19, and (3) VipCot 202 and 203 treated plots on July 19. These insecticide treatments were applied with the Spider sprayer traveling at 5.0 mph at a pressure of 40 psi through 4X hollow cone nozzles in a total volume of 5.5 gpa.

Treatments were assessed by (1) counting the number of plants on 10 to 13.75 feet row, depending on test year, in the center rows of plots to determine stand, (2) examining 25 plant terminals/plot for the presence of Heliothine eggs, damaged terminals, and larvae before and after insecticide treatments, (3) examining 25 squares, blooms and bloom tags [2003], and bolls for worm damage and live worms before and after insecticide treatments, (4) estimating percentage leaf damage caused by cotton leafperforator larvae and counting their number [2003], (5) estimating percentage leaf damage by saltmarsh caterpillar [2003], (6) collecting larvae from nontreated non-Bt cotton at intervals during the testing period to determine whether they were bollworm or tobacco budworm, (7) determining plant vigor rating [2004] based on a scale of 1 = excellent growth with good color and early fruiting to 5 = slow growth and delayed fruiting, (8) harvesting cotton [2003 and 2004] with a 1-row spindle picker [3 rows/plot in 2003 and 1-row/plot in 2004], (9) determining characteristics of lint and seed production per boll, and evaluating cotton fiber characteristics in the 2004 experiment, and (10) mapping plants in the 2004 experiment using P-MAP on June 21[early boll set], July 22 [boll maturity], and August 23 [open boll]. Only selected data from the final plant map is presented.

Widestrike Experiment

PHY 470 WR transgenic Bt cotton (Widestrike) was compared with PHY 410 R non-Bt cotton in which one of the tested treatments included insecticide applied to both varieties when bollworm numbers reached treatment threshold in the non-Bt cotton, and in which another set of plots of both varieties would be treated when caterpillar numbers

reached threshold in the transgenic Bt cotton. The latter level was never reached, but to have a set of plots treated differently, one insecticide application was applied to a set of plots as a substitute for the planned Bt threshold treatment. These plots were treated following collection of all insect count data with only a possibility of affecting yield.

PHY 410 R and PHY 470 WR cotton varieties were planted on the Texas Agricultural Experiment Station Meaney Annex near Corpus Christi, Texas on April 30, 2004, and then replanted on May 6 due to heavy rainfall. Planting was accomplished with a 4-row blackland type planter with research cone seed distributors. Plots were 4 rows on 38-inch centers by 40-ft long with 4 replications in a randomized complete block design. The entire experiment was surrounded by a 40-ft buffer planted in the PHY 410 R variety to meet USDA and EPA regulatory requirements. Temik 15G (4.0 oz/acre) was applied into the seed furrow at-planting. Tracer 4SC (2.9 oz/acre) was applied July 2 and 15 based on the non-Bt threshold, and July 26 to the same plots as well as plots designated for the Bt threshold (that threshold was never reached). Note: the July 26 treatment was applied after insect counts had been completed and accounts for the lack of any insect measured impact in plots receiving only 1 treatment. Insecticide was applied to all 4 rows in plots with a Spider Spray Trac self-propelled machine traveling at 5.0 mph at a pressure of 40 psi through 4X hollow cone nozzles (2/row) in a total volume of 5.5 gpa.

Treatments were assessed by (1) counting the number of plants on 13.75 ft row on each of the center rows in plots on May 27, (2) rating plots for plant vigor [1 = excellent growth up to 5 = slow growth] on May 27, (3) counting the number of Heliothine eggs, larvae, plant terminal damage, and damaged squares on 25 plants/plot on July 2, 7, 13, and 21, (4) collecting larvae from nontreated non-Bt plots on July 3, 21, and 25 to determine percentage of bollworm and tobacco budworm, (5) examining 25 bolls/plot for caterpillar damage on the same dates as listed in the previous section except for July 7 [few bolls were present], (6) determining nodes above white flower based on 6 plants/plot on July 22, (7) examining 25 plant terminals/plot on July 27 for damage by the omnivorous leafroller, (8) plant mapping (P-MAP) 5 plants/plot after bolls were open on September 10, (9) harvesting 1 of the center rows in plots with a spindle picker and ginning a sample on a 10-saw Eagle laboratory machine for turnout to determine lint yield, and (10) selecting a 40 gram lint sample for fiber characteristic analysis by the International Textile Center at Lubbock, Texas.

Results and Discussion

VipCot Experiment in 2002

Larvae collected 1 day before Denim treatment were 81% tobacco budworm (TBW) compared to bollworm (BW); by 3 DAT-1 the percentage had increased to 88% TBW; and by 3 DAT-2 all larvae collected were TBW. During the testing period, damaged square and boll counts were significantly reduced in the VipCot 102 cotton compared to nontreated non-Bt cotton (Fig. 1). Some of the boll damage in VipCot 102 cotton may have been by fall armyworm. However, in the VipCot 102 treatment that did not receive Denim foliar overspray, damaged fruit counts on 4 inspection dates averaged 4.1%, whereas this damage was reduced to 2.2% by addition of the Denim foliar treatments. Denim also reduced square/boll damage in non-Bt cotton, but the reduction in damage was not as great as found in VipCot 102 cotton.

Cotton leafperforator larval numbers and leaf feeding damage were reduced dramatically in VipCot 102 and non-Bt Denim treated plots. Generally Denim treated cotton had less leaf damage and fewer larvae than the VipCot 102 cotton that was not treated with Denim; however, damage was well within an acceptable range in the nontreated VipCot 102 cotton.

Saltmarsh caterpillar leaf feeding damage was significantly reduced in VipCot 102 cotton and non-Bt cotton treated with Denim. Denim appeared to be of equal effectiveness to VipCot 102 cotton; however, numbers may not have been high enough to obtain an accurate assessment.

Although yield data could not be obtained due to required stalk destruction date for the region, the VipCot 102 plots had an outstanding boll load. Denim treated plots also had a good boll load, but it was not equal to the VipCot 102 cotton.

VipCot Experiment in 2003

The bollworm comprised 93, 91, and 88% of the caterpillar population on June 15, 24 and 28, respectively, compared with tobacco budworm. Bollworm numbers exceeded treatment threshold in the non-Bt cotton on 7 of 8 inspection dates but barely reached treatment threshold in the VipCot plots (season average counts are shown in Fig. 2). Damaged square counts were also significantly reduced in sprayed non-Bt cotton. Boll damage averaged 10.3% in nontreated non-Bt cotton which was significantly greater than that in other treatments. VipCot 102 produced significantly more lint than the non-Bt cultivar. Furthermore, treated non-Bt cotton yielded more lint than did the nontreated non-Bt cultivar.
The Syngenta VipCot transgenic cotton was effective in reducing bollworm damage and subsequently produced more lint than the non-Bt cultivar.

VipCot Experiment in 2004
Bollworm made up 90.6, 87.5 and 32.0% of the larval population compared with tobacco budworm on July 3, 13, and 22, respectively, as determined by larval collections in plots. Subsequent larval numbers were relatively high in non-Bt nontreated cotton on 6 of the 7 inspection dates, but their numbers were reduced significantly on most inspection dates in Denim treated non-Bt plots (Fig. 3). Similar results were observed in season average square damage. Boll damage was also similar, but boll damage in nontreated VipCot 102 cotton did not separate statistically from Denim treated non-Bt cotton. Plant vigor ratings on 3 dates revealed generally less vigor in VipCot 202 compared with the other varieties.

Significantly more lint was produced in VipCot 102, Denim treated VipCot 102, and Denim treated non-Bt cotton compared to treated VipCot 202 and 203, and nontreated non-Bt cotton (Fig. 4). Furthermore, the nontreated VipCot 202 yield was numerically lower. These results (lower yield) in VipCot 202 and 203 were unexpected given the reduced bollworm damage observed in these varieties. The VipCot 202 and 203 varieties used here must be lacking agronomically. These 2 varieties also exhibited lower boll weights and generally lower seed weight. Differences in fiber characteristics were only observed in micronaire and staple length readings. Micronaire was generally unacceptable (high) for all varieties (data not shown). VipCot 202 had significantly shorter staple than the other varieties.

Increased lint production in VipCot 102 was therefore related to more lint/boll and equal or more bolls in fruiting positions 1 and 2 (Fig. 4). The percentage boll retention in positions 1 and 2 was also highest in VipCot 102.

Widestrike Experiment 2004
Bollworm made up 95.5%, 28.6%, and 0.0% of the larval population compared to tobacco budworm on July 3, 21, and 25, respectively. Except for 1 date (July 13), statistically fewer Heliothine larvae were counted in Widestrike plots on each inspection date. Except for the pretreatment count in the treatment where 3 Tracer applications were made, larval numbers were not different from that found in the Widestrike cotton. These findings were reflected in the season averages (Fig. 5). Recall that counts in plots receiving 1 Tracer treatment were made before the treatment was applied except for omnivorous leafroller damage which was counted the next day and would not have had time to affect the terminal damage. In the season average data, fewer damaged squares occurred in the Widestrike plots, and it was also reduced in non-Bt cotton where 3 Tracer treatments were applied. Boll damage was statistically the same in all Widestrike cotton and the non-Bt cotton receiving 3 Tracer treatments. Omnivorous leafroller terminal damage was reduced best by Widestrike and 3 Tracer treatments.

Statistically higher yields occurred in Widestrike plots, but that yield was not statistically better than what was produced where 3 Tracer treatments were applied to the non-Bt cotton (Fig. 6). The number of bolls harvested from fruiting position 1 was significantly greater in Widestrike plots compared to non-Bt cotton except where non-Bt cotton was treated 3 times with Tracer. Numerically there was a trend for higher numbers of bolls at fruiting positions 2 and 3 in non-Bt cotton. Increased boll load at fruiting positions 2 and 3 in the non-Bt cotton was probably an attempt to compensate from loss of fruit at position 1.

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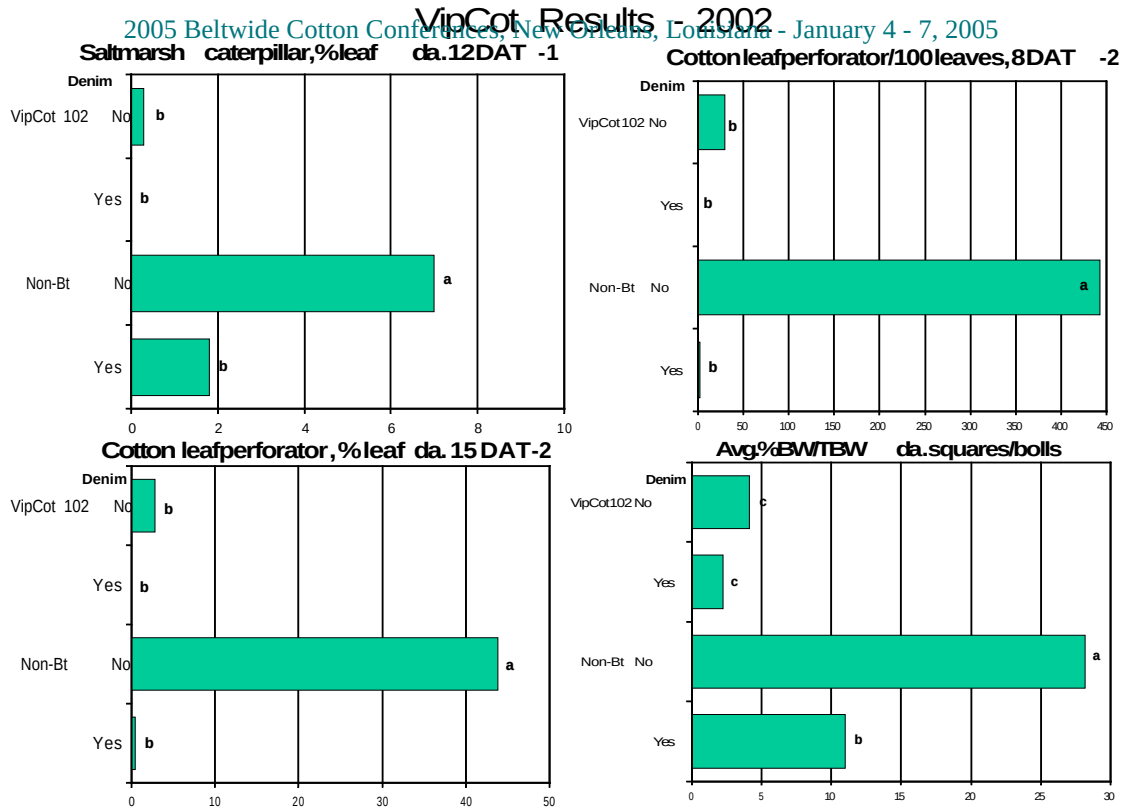

Fig. 1. Caterpillar damage in VipCot 102 compared with a non -Bt cotton cultivar. P = 0.05

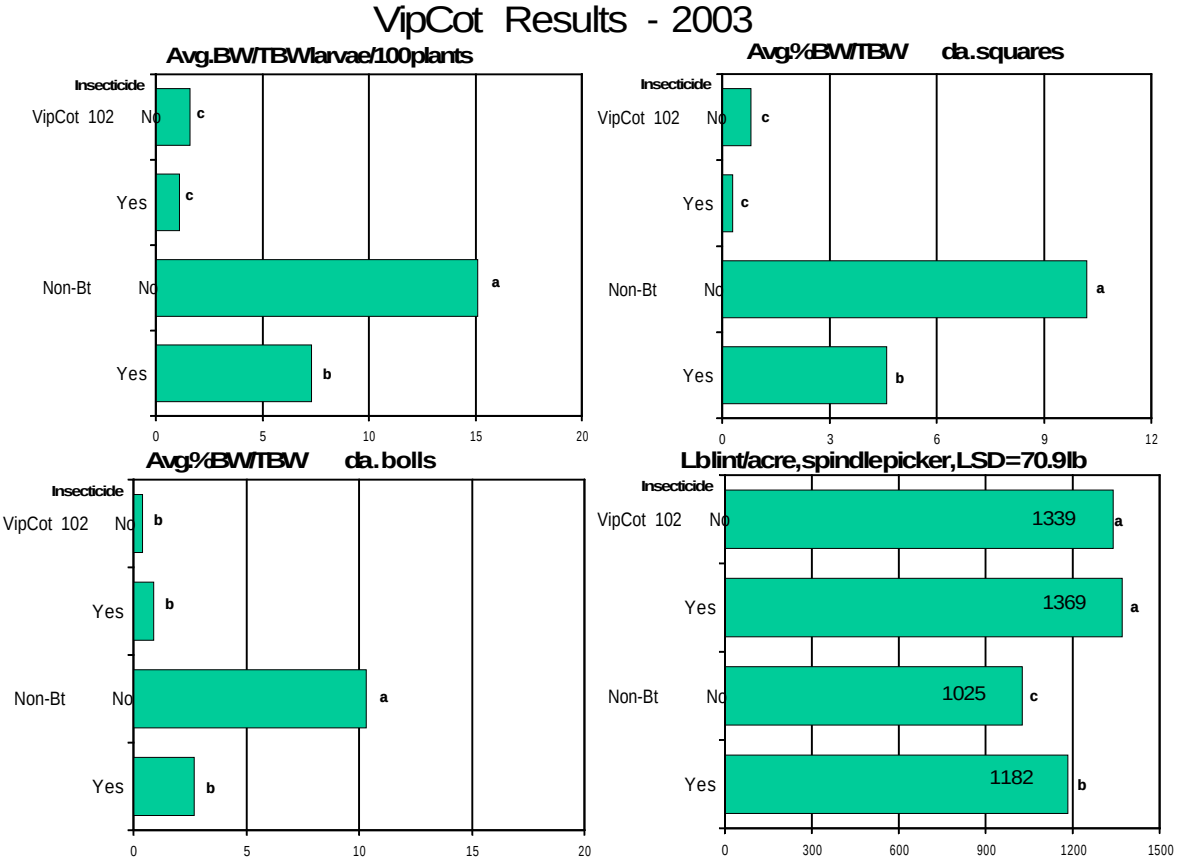

Fig. 2. Bollworm (BW) and tobacco budworm (TBW) larvae, damaged squares and bolls, and lint produced in VipCot 102 compared with a non -Bt cotton cultivar. P = 0.05

VipCot Results - 2004

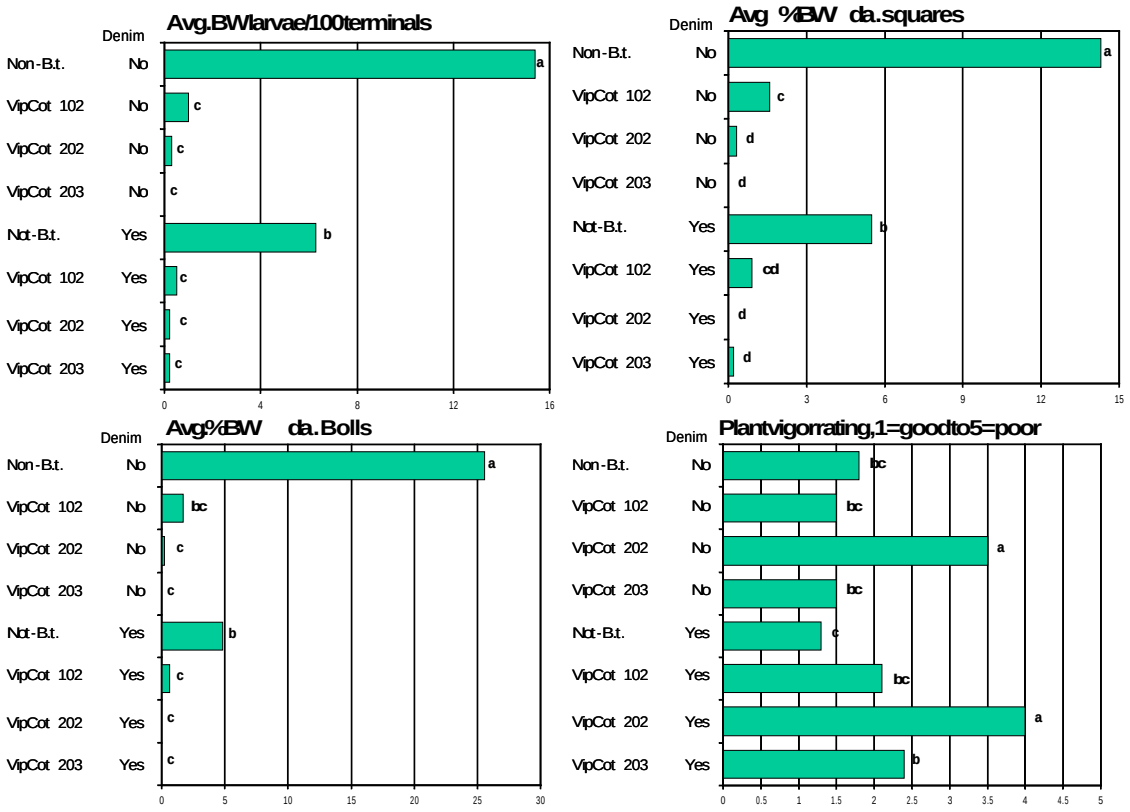

Fig. 3. Bollworm larval numbers, square and boll damage, and pl ant vigor ratings in VipCot cotton cultivars compared with a non -Bt cotton cultivar. P = 0.05

VipCot Results - 2004

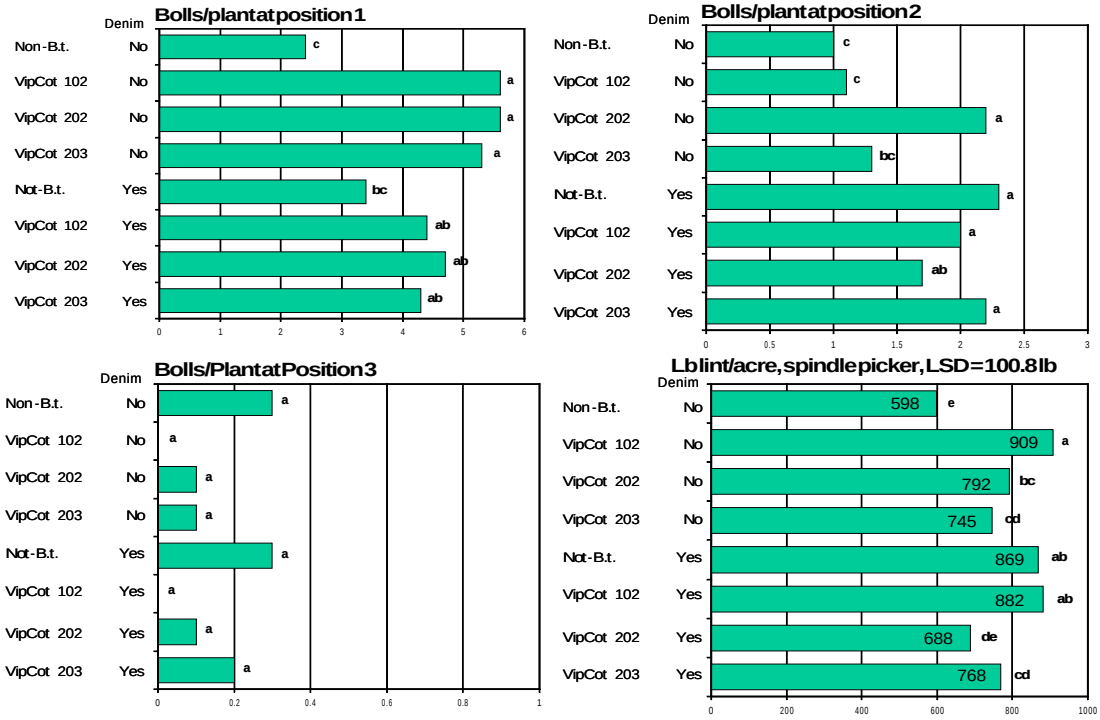

Fig. 4. Boll production at harvest by fruiting position and lin t yield in VipCot cotton cultivars compared with a non - Bt cotton cultivar. P = 0.05

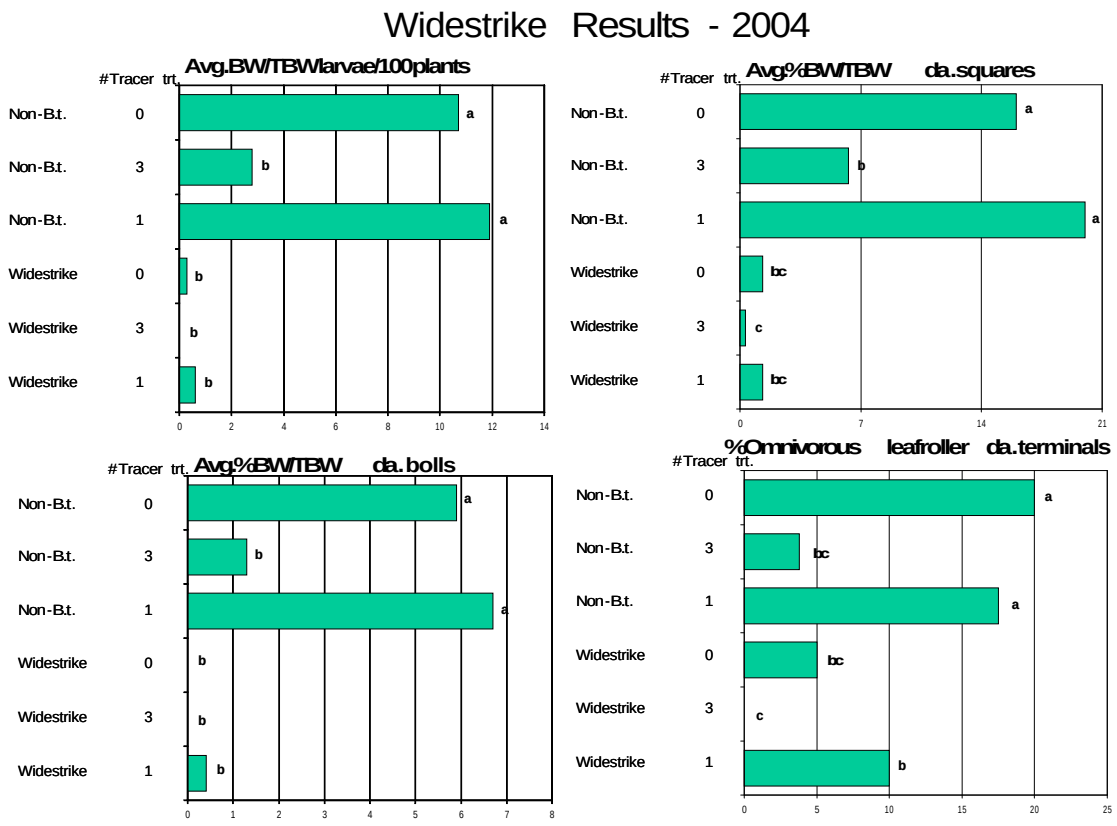

Fig. 5. Bollworm/tobacco budworm larvae, damaged squares, damaged bolls and omnivorous leafroller damage in PHY 470 WR transgenic Bt cotton (Widestrike) and PHY 410 R non-Bt cotton. P = 0.05

Fig. 6. Boll production at harvest by fruiting position and lint yield in PHY 470 WR transgenic Bt cotton (Widestrike) and PHY 410 R non-Bt cotton. P = 0.05.