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EFFICACY OF WIDESTRIKE* COTTON AGAINST NON-HELIOTHINE LEPIDOPTERAN INSECTS

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Abstract

Dow AgroSciences, LLC has developed transgenic Bt-cotton expressing insecticidal crystal proteins of *Bacillus thuringiensis* (Bt). Genes for the expression of two proteins (Cry 1Ac and Cry 1F) have been inserted into cotton varieties and together, the trait is known as WideStrike*. Field and bioassay studies since 2001 have shown that WideStrike has excellent efficacy against a broad spectrum of lepidopterans attacking cotton, i.e., Heliothine and non-Heliothine. This presentation addresses efficacy against non-Heliothine insects. The studies reported here demonstrate that WideStrike provided very good or excellent control of the following non-Heliothine insects: *Pectinophora gossypiella, Spodoptera frugiperda, Pseudoplusia includens, Estigmene acrea,* and *Ostrania nubilalis*. In addition, WideStrike provided moderately good control of Agrotis ipsilon.

Introduction

Non-Heliothine insects, although occurring only occasionally, can cause serious defoliation and damage to reproductive organs resulting in a significant yield reduction in cotton. Dow AgroSciences has developed transgenic Bt-cotton expressing dual endotoxins: Cry 1Ac and Cry 1F . The expression of these two proteins together is referred to as WideStrike. Field and bioassay studies were conducted during 2001-2003 to determine the effectiveness of WideStrike in controlling Heliothine and non-Heliothine lepidopterans. These studies have shown excellent and very good control, respectively, of the Heliothine insects tobacco budworm and cotton bollworm (Adamczyk et al. 2002; Pellow et al., 2002; Huckaba et al., 2003; Langston et al. 2004). In addition, very good to excellent efficacy has been established for non-Heliothine lepidopterans during 2001-2003 field seasons (Adamczyk et al., 2002; Langston et al. 2003). Excellent control was obtained with WideStrike against pink bollworm, cabbage looper, soybean looper, saltmarsh caterpillar, and European corn borer and very good control for beet armyworm, fall armyworm, and southern armyworm. Moderate control was obtained for black cutworm. Initial studies of WideStrike efficacy against lepidopterans was presented at the 2003 Cotton Beltwide Meeting (Langston et al., 2003). This presentation addresses additional characterization of WideStrike efficacy against non-Heliothine lepidopterans during 2003.

Materials and Methods

Multiple field and bioassay studies were conducted during 2003 in various locations in the U.S. to determine WideStrike activity against lepidopterans. Field studies are typically split-plot design experiments consisting of insecticide treatments (sprayed and unsprayed for lepidopterans), as main plot treatments and cotton type (WideStrike and non-Bt cotton), as subplot treatments. Trials were typically established in areas with heavy natural lepidopteran infestation, however when natural infestation was minimal, artificial infestation was used. Artificial infestation consisted of infesting cotton with egg masses or larvae. Data collected include larval count, larval weight, larval growth inhibition, and damage to cotton including: defoliation, bract, square and boll damage, and stand reduction. For bioassays, leaves and/or squares from the field were collected and used to determine WideStrike activity using field and/or lab colonies. Larval mortality, growth inhibition, and defoliation were determined.

Results and Discussion

Pink Bollworm (PBW)

A study at Las Cruces, NM in 2003 showed that there were significant differences between WideStrike and non-Bt cotton in PBW larval count per infested boll. WideStrike had significantly fewer larvae compared to non-Bt cotton. Spray application did not appear to reduce PBW infestation in either WideStrike or non-Bt cotton (Fig. 1). In another study at Maricopa, AZ, WideStrike had no larvae attaining the third larval instar (L3) stage or beyond and had no exit holes that indicated adult emergence. Non-Bt cotton had 50-100% of the larvae that had grown to L3 and beyond (Figs. 2-5). Based on these and previous findings, WideStrike had excellent activity against PBW.

Fall Armyworm (FAW)

Three studies were conducted in Greenville, MS, Plymouth, NC, and Jamesville, NC in 2003 by artificially infesting FAW. The study in Greenville, MS showed numerically less bract damage from FAW on WideStrike than on the non-Bt cotton although the differences were not statistically significant ($P<0.05$) (Fig. 6). Studies in Plymouth, and Jamesville, NC demonstrate that WideStrike performed significantly better than non-Bt cotton. There was no bract damage nor bolls showing bract

feeding on WideStrike cotton whereas the non-Bt cotton had substantial injury (Figs. 7&8). These studies in addition to previous data (Langston et al. 2003) indicate that WideStrike has very good efficacy against FAW.

Soybean Looper (SL)

A study in Greenville, MS showed that a natural infestation of soybean looper was very susceptible to WideStrike. Larval counts 78 days after planting were less than 2 larvae per 100 row ft on WideStrike, which was significantly lower compared to 17 larvae per 100 row ft on non-Bt cotton (Fig. 9). At 107 days after planting, SL pressure increased substantially. At this sampling interval, non-Bt cotton again had a significantly higher larval count at >500 larvae per 100 row ft, while no larvae were found in the WideStrike treatment (Fig. 10). In addition, spray application on non-Bt cotton did not control all the larvae. As a result, WideStrike without insecticide spray provided better SL control than did spray application on non-Bt cotton. These results support previous findings (Langston et al. 2003) and indicate that WideStrike has excellent activity against SL, providing control that is equal to or better than insecticide spray treatments.

Saltmarsh Caterpillar (SMC)

Saltmarsh caterpillar appeared to be very sensitive to WideStrike. Evaluations made 5 days after infestation in a bioassay study in Wayside, MS, showed that there was 100% larval mortality when neonates fed on WideStrike leaves. In contrast, there was 0% SMC mortality on non-Bt cotton. The differences between WideStrike and non-Bt cotton performance was statistically significant ($P \leq 0.05$) (Fig. 11). In another study conducted at Fresno, CA similar results were obtained. Saltmarsh caterpillars used in this study were fed non-Bt cotton for approximately 3-5 days but still at first instar prior to use in the bioassay. Mortality after 5 days was >85% for WideStrike versus 12% for the non-Bt cotton (Fig. 12). These findings demonstrate the excellent performance of WideStrike against SMC.

European Corn Borer (ECB)

Three bioassays were conducted in Wayside, MS and larval mortality was determined 5 days after infestation. In all the studies, ECB neonates were extremely sensitive to WideStrike with 100% mortality (Fig. 13). In these studies, larval mortality was noted as early as 2 days after infestation on WideStrike leaves. In addition, there was no defoliation of WideStrike leaves while defoliation on non-Bt cotton leaves was significantly higher (Fig. 14).

Black Cutworm (BCW)

Two field studies were conducted in 2003. Black cutworm larvae were fed on artificial diet prior to infesting 2^{nd}-3^{rd} instar larvae. In the first study, % stand reduction was moderately lower in WideStrike relative to non-Bt cotton (Fig. 15). Larval weight (L4-L5) measurement in this study showed that BCW larvae gained about 26% weight over 7 days when fed on WideStrike leaves compared to 56% weight gain on non-Bt cotton leaves (Fig. 16). In the second study, the percentage of damaged seedlings was less for the WideStrike treatment (20%) as compared to the non-Bt cotton (75%) without spray application (Fig. 17). In these studies, conventional insecticide treatment (Lorsban pre-emergence + Karate post emergence) appear to provide only a moderate Black cutworm control. In the first study, there was slightly less stand reduction from unsprayed WideStrike compared to Non-Bt cotton with conventional spray treatment. In the second study, seedling damage was similar for WideStrike and conventional treatment on Non-Bt Cotton. These findings suggest that WideStrike can perform equal to or better than standard treatments employed for BCW control.

Summary and Conclusions

Several field and bioassay studies have been conducted to determine efficacy of WideStrike against non-Heliothine lepidopterans since 2001. These studies have demonstrated that WideStrike has very good or excellent activity against a broad range of lepidopterans attacking cotton. WideStrike has excellent efficacy against pink bollworm, cabbage looper, soybean looper, saltmarsh caterpillar, and European corn borer and very good efficacy against Spodopterans including beet armyworm, fall armyworm, and southern armyworm. Furthermore, WideStrike has demonstrated moderate control of black cutworm, a hard to control insect using standard insecticide treatments. Although WideStrike efficacy against black cutworm is moderate, this level of control is comparable to or better than conventional means of controlling this insect. In summary, WideStrike has proven to have broad spectrum activity against lepidopterans attacking cotton (Fig. 18). Registration of WideStrike is expected in 2004 and should be a useful tool in combating insect pest problems for high yielding and quality cotton production.

References

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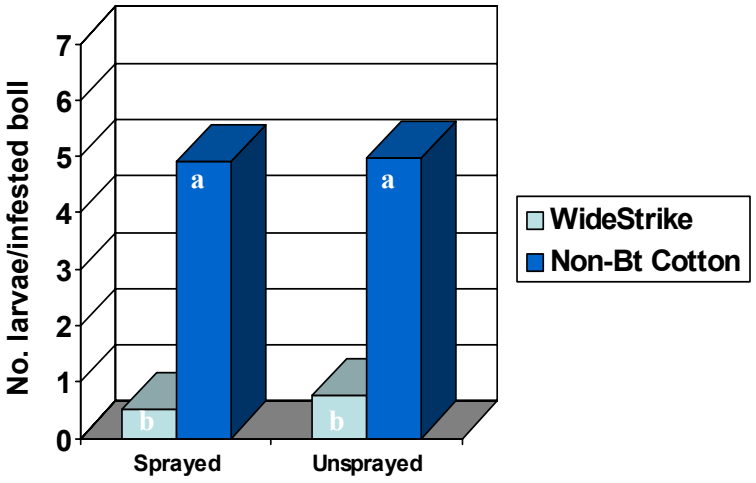

Figure 1. WideStrike Efficacy against Pink Bollworm (*Pectinophora gossypiella),* Natural Infestation, Las Cruces, NM. 2003.

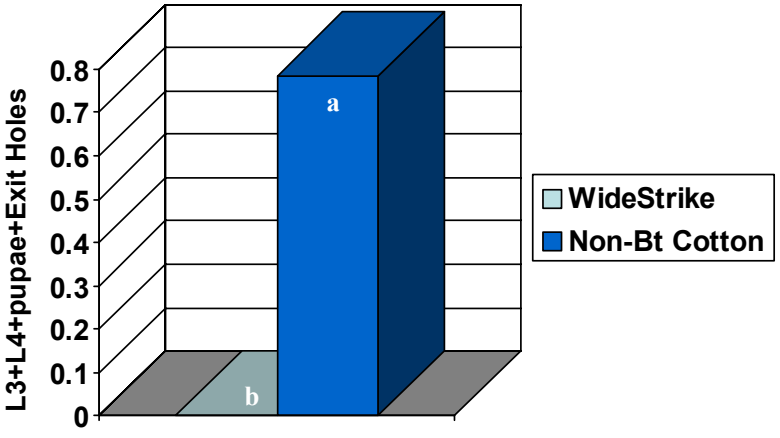

Figure 2. WideStrike Efficacy against Pink Bollworm (*Pectinophora gossypiella),* Artificial Infestation, Maricopa, AZ. 18 August, 2003.

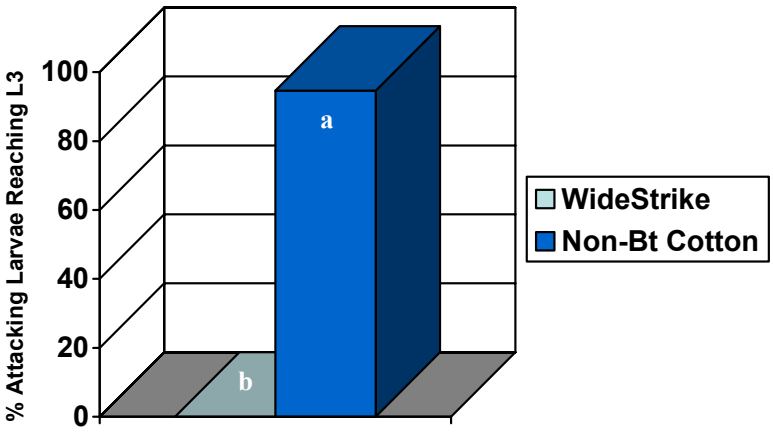

Figure 3. WideStrike Efficacy against Pink Bollworm (*Pectinophora gossypiella),* Artificial Infestation, Maricopa, AZ. 18 August, 2003.

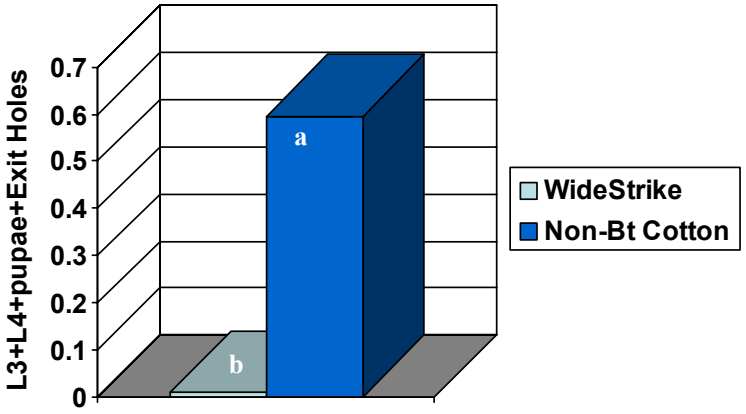

Figure 4. WideStrike Efficacy against Pink Bollworm (*Pectinophora gossypiella),* Artificial Infestation, Maricopa, AZ. 8 September, 2003.

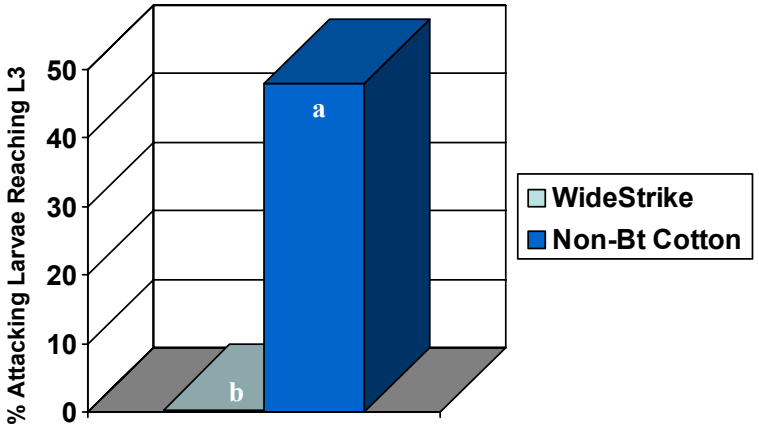

Figure 5. WideStrike Efficacy against Pink Bollworm (*Pectinophora gossypiella),* Artificial Infestation, Maricopa, AZ, 8 September, 2003.

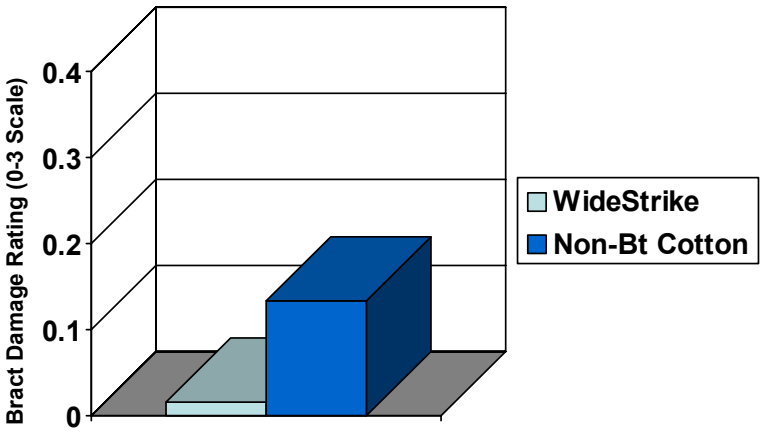

Figure 6. WideStrike Cotton Efficacy against Fall Armyworm (*Spodoptera frugiperda)*, Artificial Infestation, Greenville, MS, 2003.

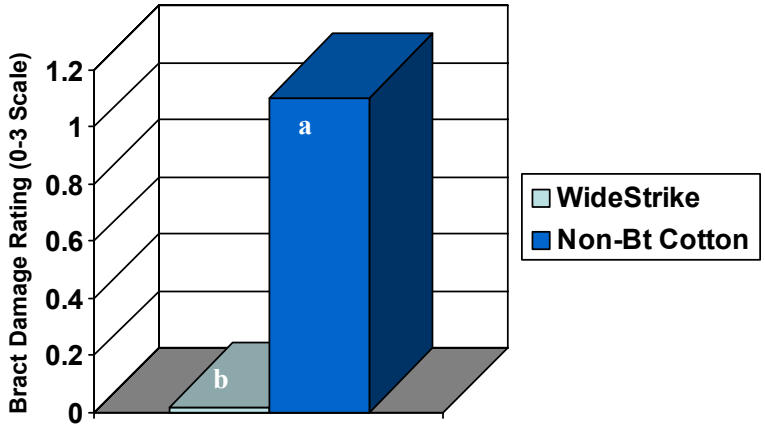

Figure 7. WideStrike Cotton Efficacy against Fall Armyworm, (*Spodoptera frugiperda)*, Artificial Infestation, Plymouth, NC, 2003.

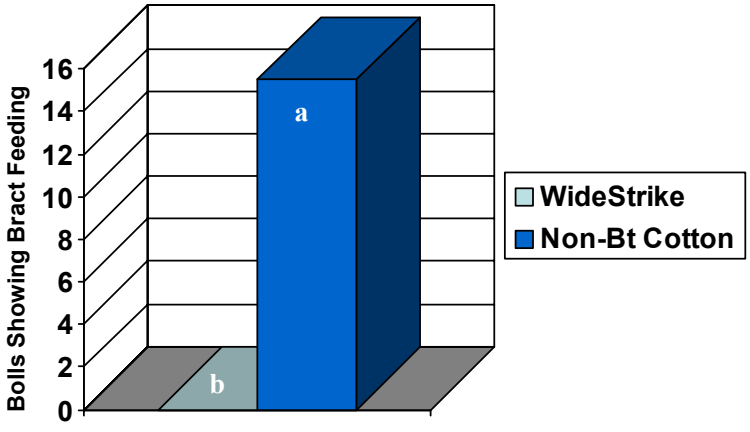

Figure 8. WideStrike Cotton Efficacy against Fall Armyworm (*Spodoptera frugiperda*) Artificial Infestation, Jamesville, NC, 2003.

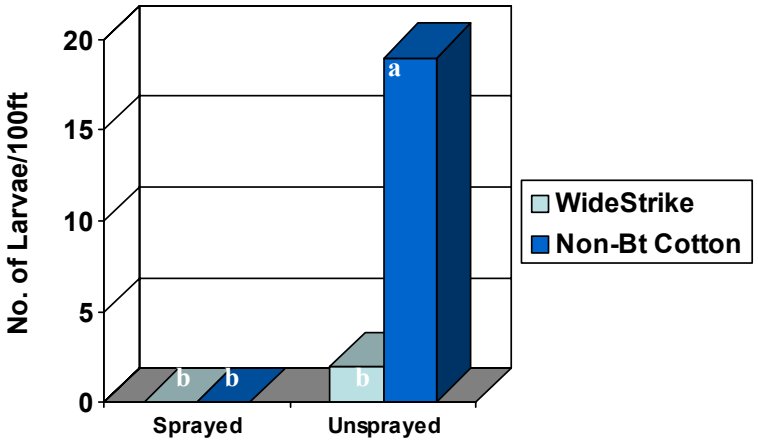

Figure 9. Control of soybean looper (*Pseudoplusia includens),* 78 days after planting, Natural infestation, Greenville, MS, 2003.

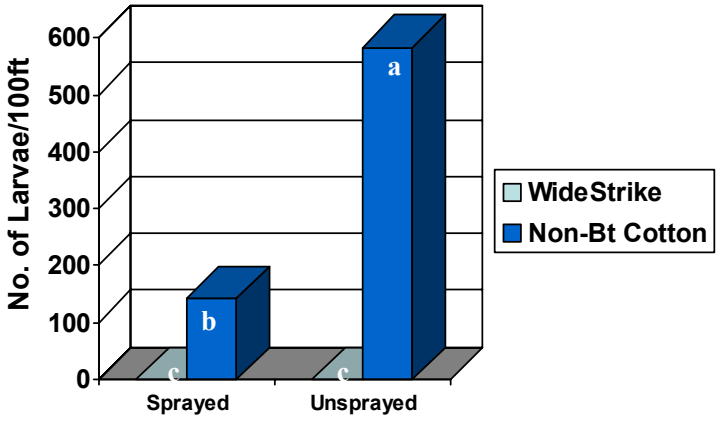

Figure 10. Control of soybean looper (*Pseudoplusia includens),* 107 days after planting, Natural infestation, Greenville, MS, 2003.

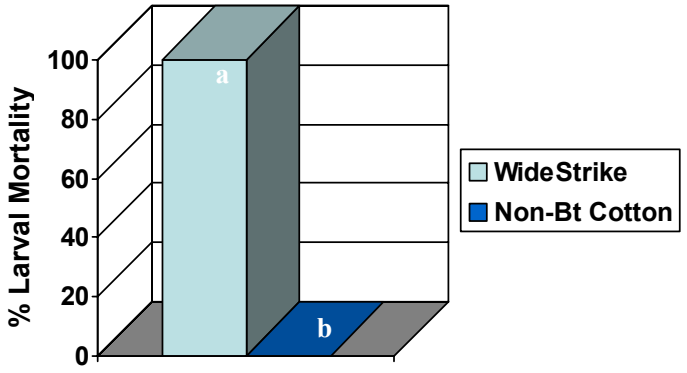

Figure 11. WideStrike Efficacy against neonate Saltmarsh Caterpillar (*Estigmene acrea)*, 5Days after infestation, Field/lab Bioassay, Wayside, MS. 2003.

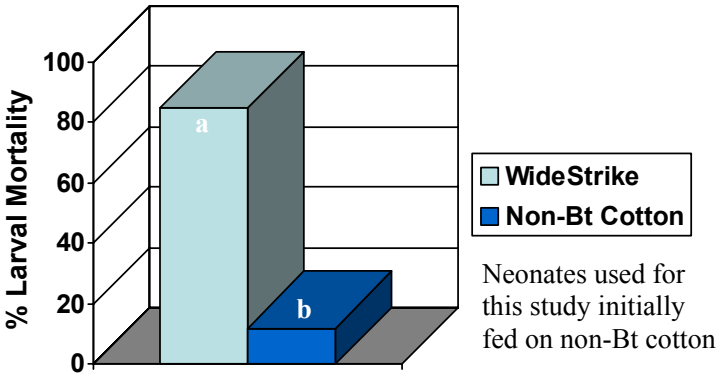

Figure 12. WideStrike Efficacy against Saltmarsh Caterpillar (*Estigmene acrea*), 5Days after infestation, Field/lab Bioassay, Fresno, CA. 2003.

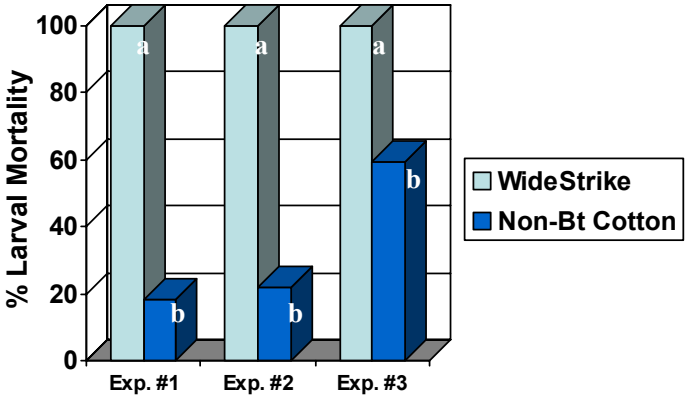

Figure 13. WideStrike Efficacy against neonate European Corn Borer, (*Ostrinia nubilalis*), 5Days after infestation (5DAI), Field/lab Bioassay Wayside, MS. 2003.

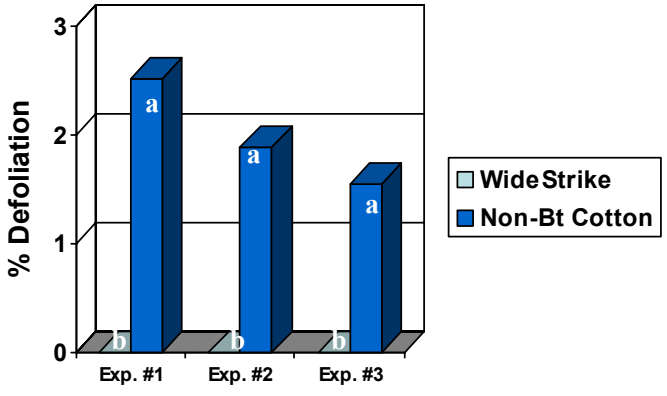

Figure 14. WideStrike Efficacy against neonate European Corn Borer (*Ostrinia nubilalis),* 5Days after infestation, Field/lab Bioassay Wayside, MS. 2003.

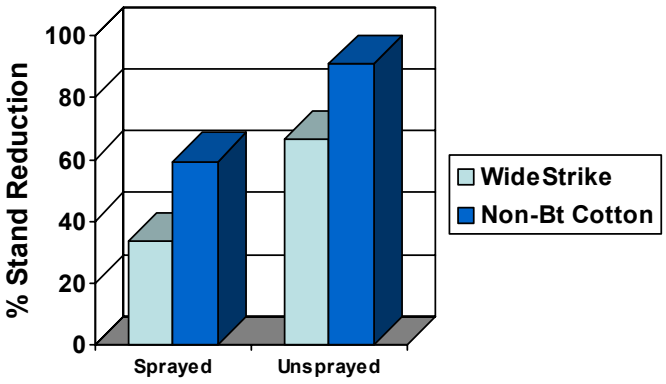

Figure 15. Percent Cotton Stand Reduction by Black Cutworm (*Agrotis ipsilon*), 14 Days after infestation, Artificial Infestation, Field Trials, 2003

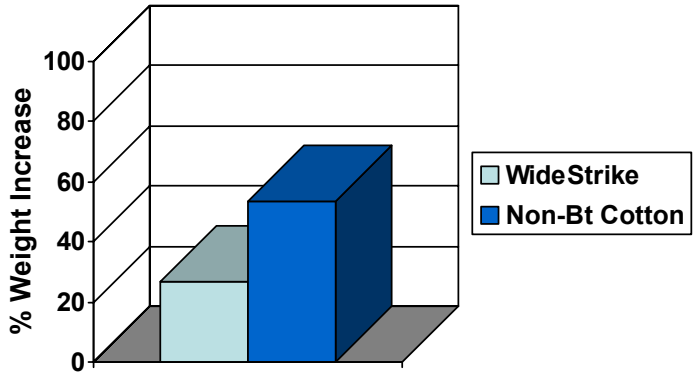

Figure 16. Black Cutworm (*Agrotis ipsilon*) % Weight Increase, 7 Days after infestation, Laboratory Bioassay using 2-3 Leaf Stage Cotton and L4-L5 Instar, 2003

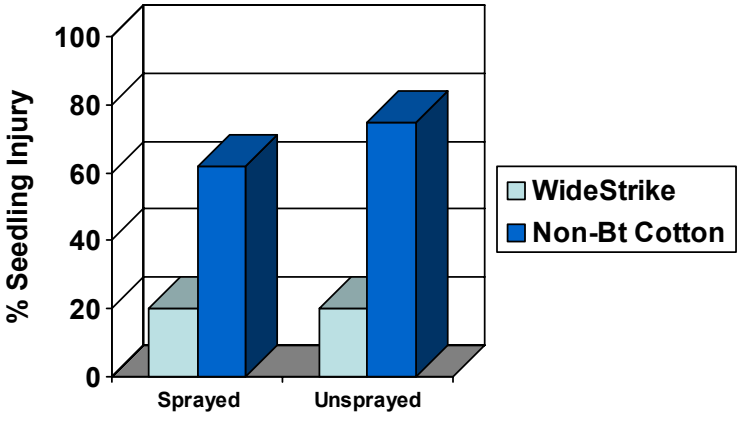

Figure 17. Percent Cotton Injury by Black Cutworm, (*Agrotis ipsilon*), 2Days after infestation, Artificial Infestation, Field Trials, Fresno, CA. 2003

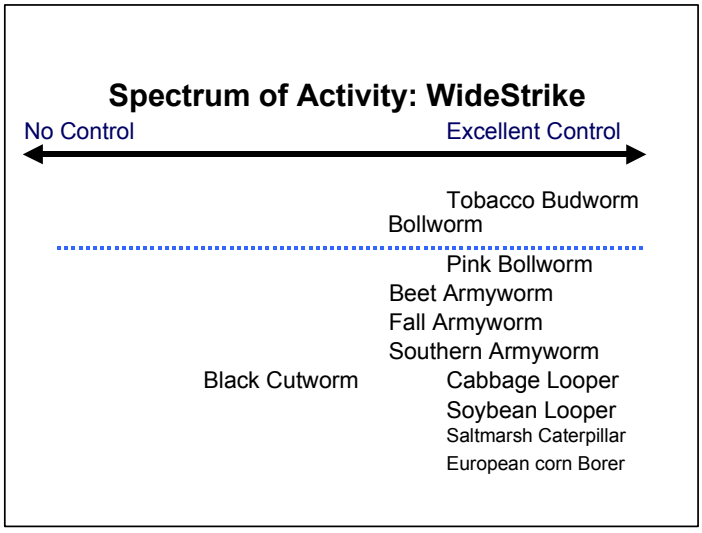

Figure 18. Spectrum of Activity: WideStrike.