# EFFECTIVENESS OF INSECTICIDE OVERSPRAYS FOR CONTROL OF BOLLWORM AND STINK BUGS IN THE SOUTHEASTERN USA

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## Abstract

Stink bugs remain the number one insect pest group of Bt cotton in the southeastern USA, and significant numbers of bollworm escape control from Bt proteins, causing economic injury, especially in 2-gene Bt cotton. Oversprays of insecticide on Bt cotton are standard practice in the region and most often result in increased yields due to protection from one or both pests. Pyrethroid insecticides continue to be the standard for control of stink bugs, but susceptibility of bollworm to pyrethroids is declining, and use of alternative, lep-specific insecticides for control of bollworm has increased, particularly in 2-gene Bt cotton. In trials designed to parse out the injury and yield impacts of each pest (bollworm or stink bugs), we found that stink bugs were important across all trials and Bt technologies, while bollworm was exclusively an issue in 2-gene cotton in one out of seven trials. Chlorantraniliprole (Prevathon) was very effective in controlling bollworm where it was an economic pest (NC location) in 2-gene Bt cotton, but the pyrethroid bifenthrin (Brigade) showed some weakness in controlling bollworm, at least in WideStrike and Bollgard 2 cotton, where pressure and/or injury from the pest was significant. The importance of scouting and matching each Bt technology with the appropriate insecticide overspray choice cannot be overstated, and local recommendations for insecticide oversprays in Bt cotton should be followed.

## Introduction

In the southeastern USA, the bollworm, *Helicoverpa zea*, and various species of stink bugs, such as the green stink bug, *Chinavia hilaris* (Say), the southern green stink bug, *Nezara viridula* (L.), and the brown stink bug, *Euschistus servus* (Say), are important insect pests of cotton after initial bloom in the crop. Despite the protection from 2- and 3-gene Bt cotton, such as WideStrike, WideStrike 3, Bollgard 2, Bollgard 3, TwinLink, and TwinLink Plus, cotton can sustain yield losses from bollworm due to resistance development (Reisig et al. 2018) and heavy pressure, particularly in the 2-gene varieties. Although 3-gene Bt cotton is significantly more efficacious against bollworm than 2-gene varieties, it is not immune to injury and losses from bollworm. Because Bt technology provides no control of stink bugs, it is well defined that insecticide use is necessary to protect cotton from the boll-feeding complex of bugs, and the pyrethroid insecticides have been the most effective and widely used materials for many years because they controlled both stink bugs and bollworm escaping control from Bt toxins. The extended residual control of stink bugs with pyrethroids makes that class of chemistry essential for oversprays in the Southeast, where stink bugs are a major insect pest group. However, recently, there is growing evidence that the pyrethroids are becoming less efficacious on bollworm (Musser et al. 2015), potentially compromising the concomitant control of both stink bugs and bollworm with inexpensive pyrethroid insecticides. Data are needed on the importance of several different insecticides relative to control of stink bugs and/or bollworm. In other words, what contribution to control of bollworm and stink bugs do each of several different insecticides provide? We conducted these trials to evaluate the effectiveness of various insecticide regimes applied as oversprays on Bt cotton for bollworm and stink bugs.

## Materials and Methods

Research plots (8 rows by 40-50 ft) were established in a RCBD with 4 replications in Bt cotton fields near Blackville, SC; Rocky Mount, NC; Tifton, GA; and Prattville, AL. Varieties of 2- and 3-gene cotton included

PHY312WRF, PHY444WRF, PHY430W3FE, DP1614B2XF, DP1646B2XF, DP1840B3XF, DP1851B3XF, ST5122GTL, and ST4550GLTP. Varieties and treatments (numbered below) were combined in one trial (NC) or separated into separate trials by variety/technology (2-gene or 3-gene Bt cotton) (SC, GA, AL), and the insecticides dicrotophos (Bidrin 8 EC at 8 fl oz/acre), chlorantraniliprole (Prevathon 0.43 SC at 20 or 27 fl oz/acre) and/or bifenthrin (Brigade 2 EC at 6.4 fl oz/acre) were applied at the time of presumed greatest impact, simulating what a producer or consultant might do if following university recommendations.

1. Untreated control (no insecticide)
2. Prevathon applied during 1st week of bloom (control of bollworm only)
3. Bidrin applied during the 3rd and 5th weeks of bloom (control of stink bugs only)
4. Brigade applied during the 1st, 3rd, and 5th weeks of bloom (control of stink bugs and some bollworm)
5. Prevathon applied at 1st week of bloom and Brigade applied at 3rd and 5th weeks of bloom (control of stink bugs and bollworm)

Plots were sampled for damage indices caused by bollworm (damage to terminals, squares, blooms, and bolls) and stink bugs (damage to bolls). Yield data were taken with a mechanical picker and evaluated to define the importance of each pest. The value of the oversprays were determined by yield comparison with the untreated control. Although all plots were to be protected from other insect pests before and after the windows of control defined for each of the insecticide and pest combinations above, no additional insecticides were used.

## Results and Discussion

Because stink bugs and bollworm are major pests of cotton in the southeastern USA that require overspray treatments with insecticide, we addressed several treatment options that growers use for these pests in Bt cotton (WideStrike, WideStrike 3, Bollgard 2, Bollgard 3, TwinLink, and TwinLink Plus). Pyrethroid insecticides have been used for decades to control bollworm in cotton, but they are starting to lose efficacy on the pest (Figure 1).

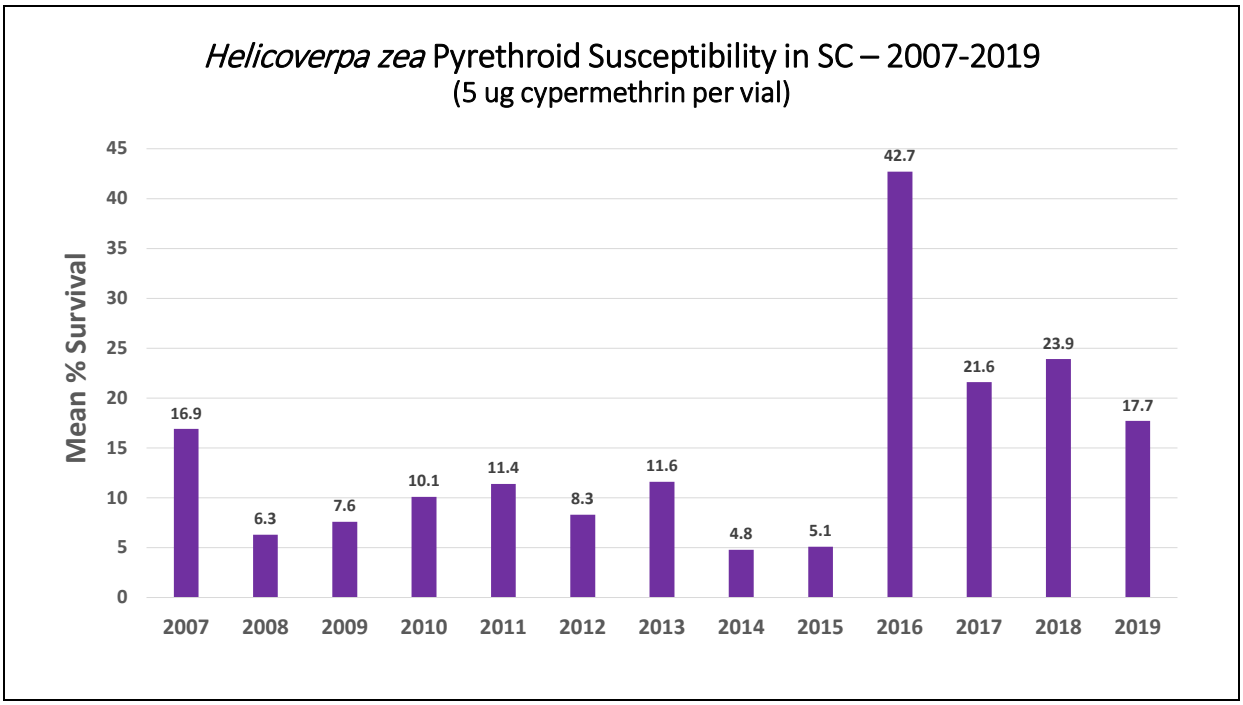


Figure 1. Mean survival of adult bollworm, *Helicoverpa zea*, in laboratory bioassay addressing contact efficacy with the pyrethroid cypermethrin in SC (2007-2019).

However, because of the low cost of pyrethroid insecticides and their excellent control of stink bugs, the pyrethroid bifenthrin was used in our trial as an overspray option. The insecticide chlorantraniliprole was included to provide very good control of bollworm and not stink bugs, and dicrotophos was used to control stink bugs and not bollworm. In our trial, timings of these products used alone or in series were investigated.

Pressure from bollworm was very low in South Carolina, and yield data in untreated plots from 6 trials representing all commercially available Bt technologies reflected the low pressure from bollworm (Figures 2-7). Pressure from stink bugs was moderate, and insecticide protection targeting the complex showed more importance in preserving yields (Figures 2-7). Yields in all trials in all treatments providing protection from stink bugs were higher than untreated yields, and statistical differences were observed in the TwinLink Plus trial, with 415 lb/acre more seedcotton in plots sprayed 3 times with bifenthrin compared with the untreated control (Figure 7). Despite low-to-moderate pressure from stink bugs, the boll-feeding complex of bugs was clearly important.

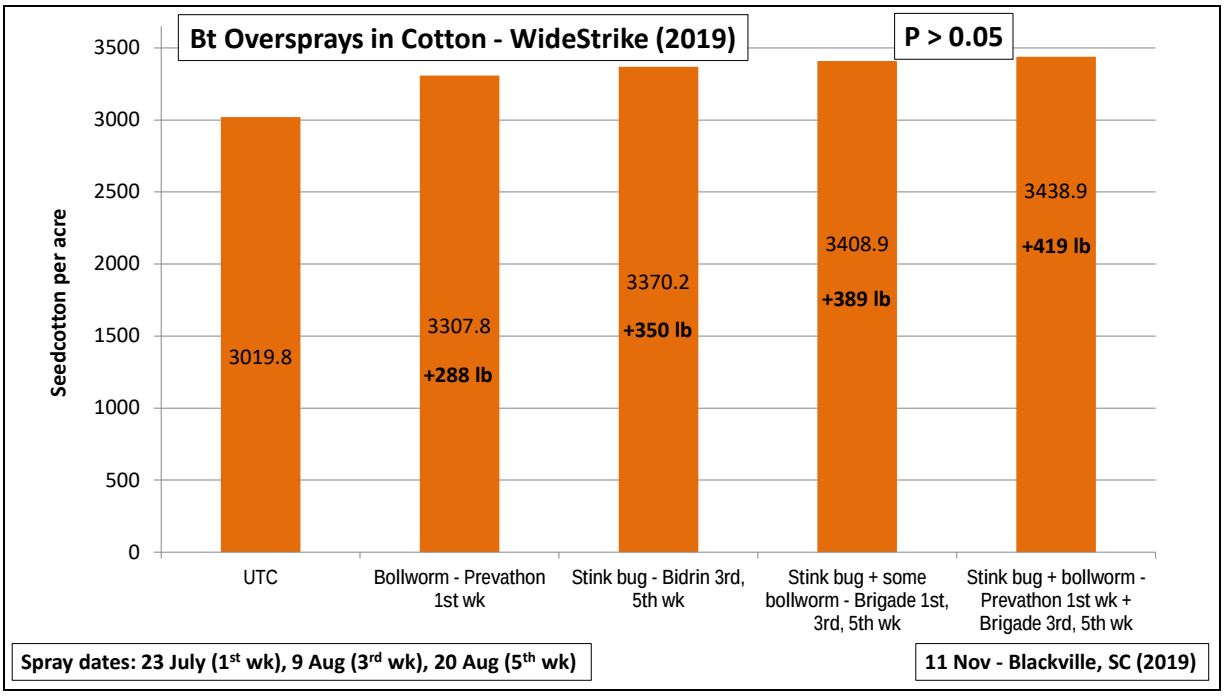


Figure 2. Seed cotton yields after oversprays with chlorantraniliprole (Prevathon) and bifenthrin (Brigade) at various timings by week of bloom in WideStrike cotton in Blackville, SC (2019).

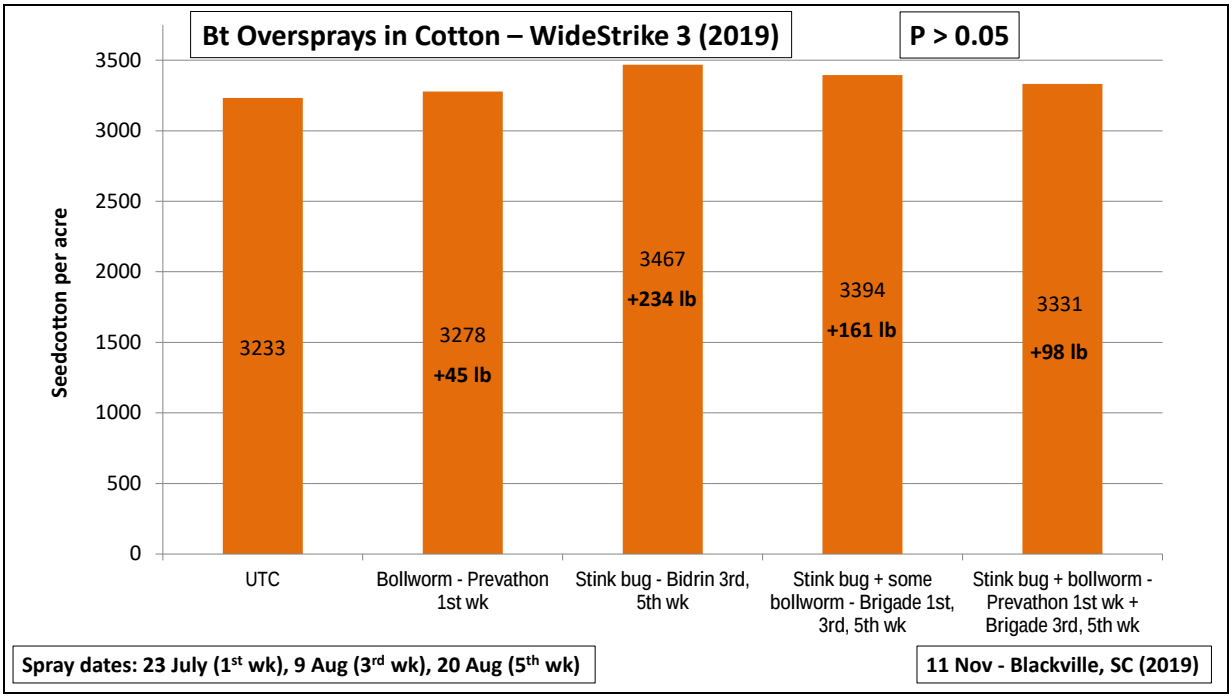

Figure 3. Seed cotton yields after oversprays with chlorantraniliprole (Prevathon) and bifenthrin (Brigade) at various timings by week of bloom in WideStrike 3 cotton in Blackville, SC (2019).

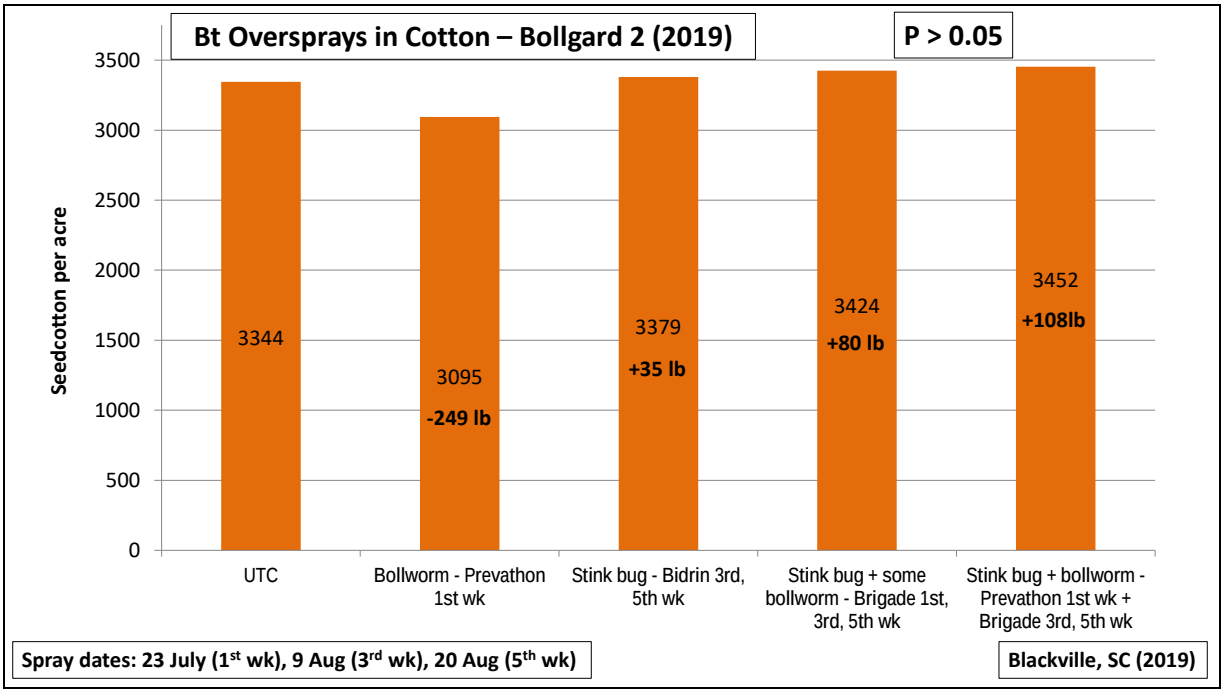


Figure 4. Seed cotton yields after oversprays with chlorantraniliprole (Prevathon) and bifenthrin (Brigade) at various timings by week of bloom in Bollgard 2 cotton in Blackville, SC (2019).

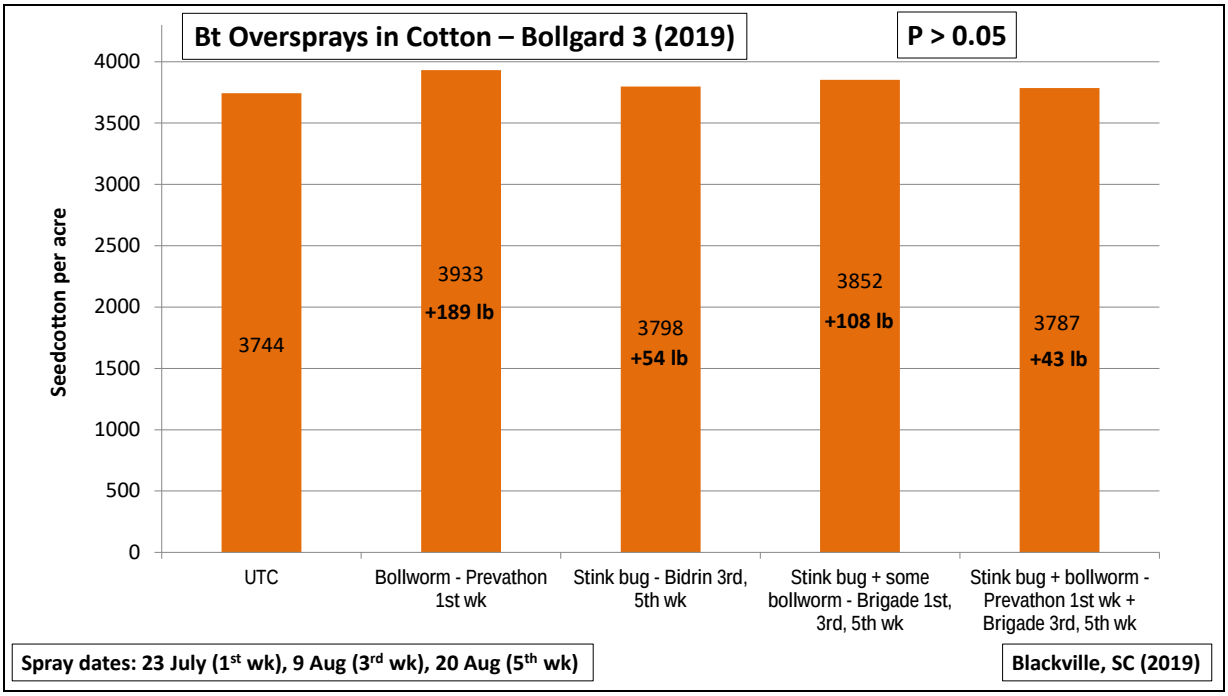


Figure 5. Seed cotton yields after oversprays with chlorantraniliprole (Prevathon) and bifenthrin (Brigade) at various timings by week of bloom in Bollgard 3 cotton in Blackville, SC (2019).

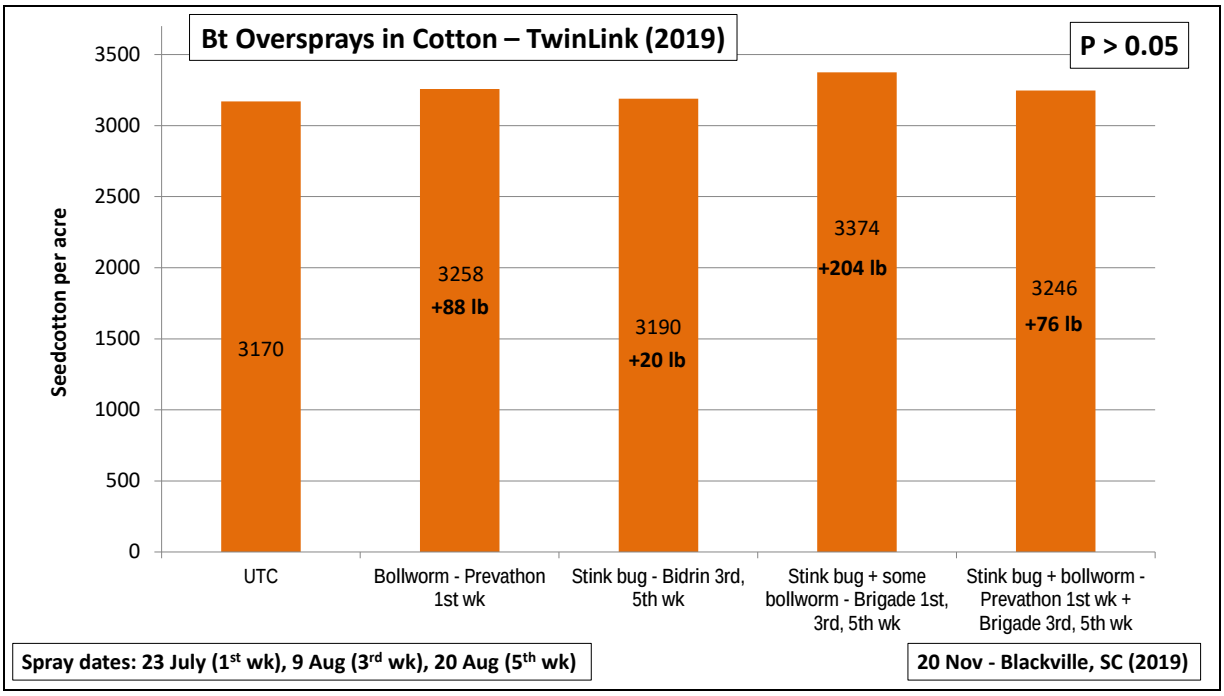


Figure 6. Seed cotton yields after oversprays with chlorantraniliprole (Prevathon) and bifenthrin (Brigade) at various timings by week of bloom in TwinLink cotton in Blackville, SC (2019).

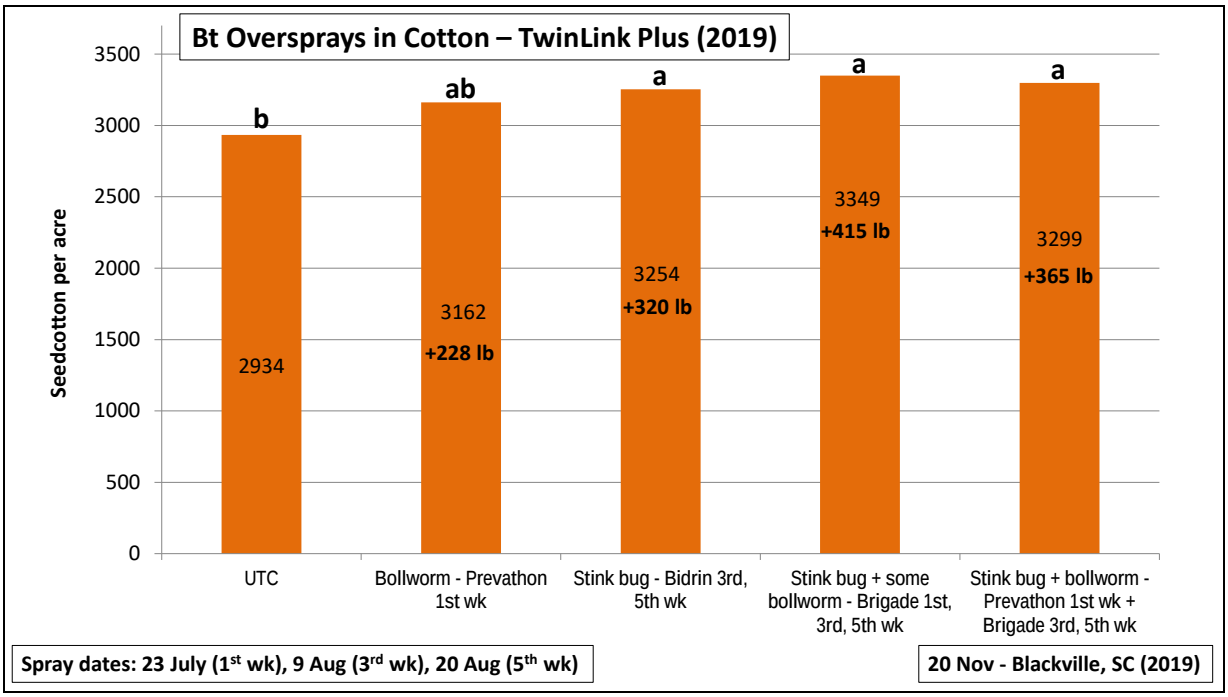


Figure 7. Seed cotton yields after oversprays with chlorantraniliprole (Prevathon) and bifenthrin (Brigade) at various timings by week of bloom in TwinLink Plus cotton in Blackville, SC (2019).

Our trial treatments with all technologies, except for TwinLink and TwinLink Plus, were duplicated in one trial in North Carolina, where pressure from bollworm was high (Figure 8), but pressure from stink bugs was low (Figure 9). Bolls damaged by bollworm exceeded 60% in WideStrike cotton and almost 50% in Bollgard 2 cotton – both 2-gene Bt cotton technologies.

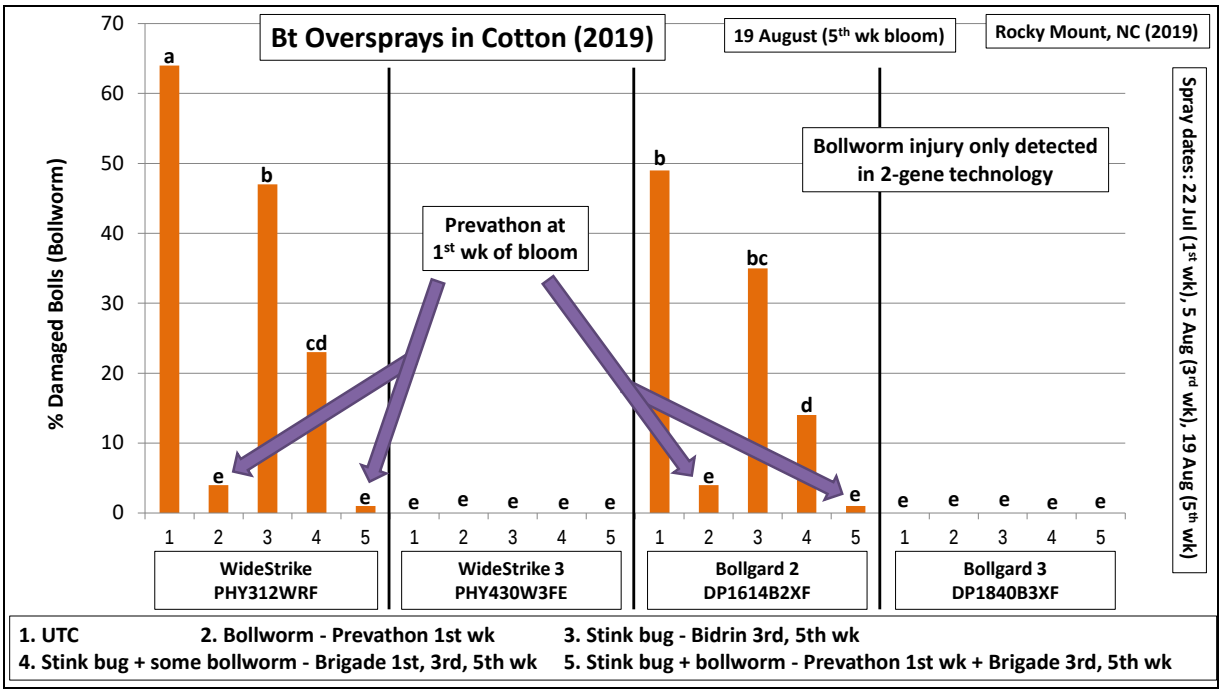


Figure 8. Mean percent bolls damaged by bollworm in Bt cotton technologies after oversprays with chlorantraniliprole (Prevathon) and bifenthrin (Brigade) at various timings by week of bloom in NC (2019).

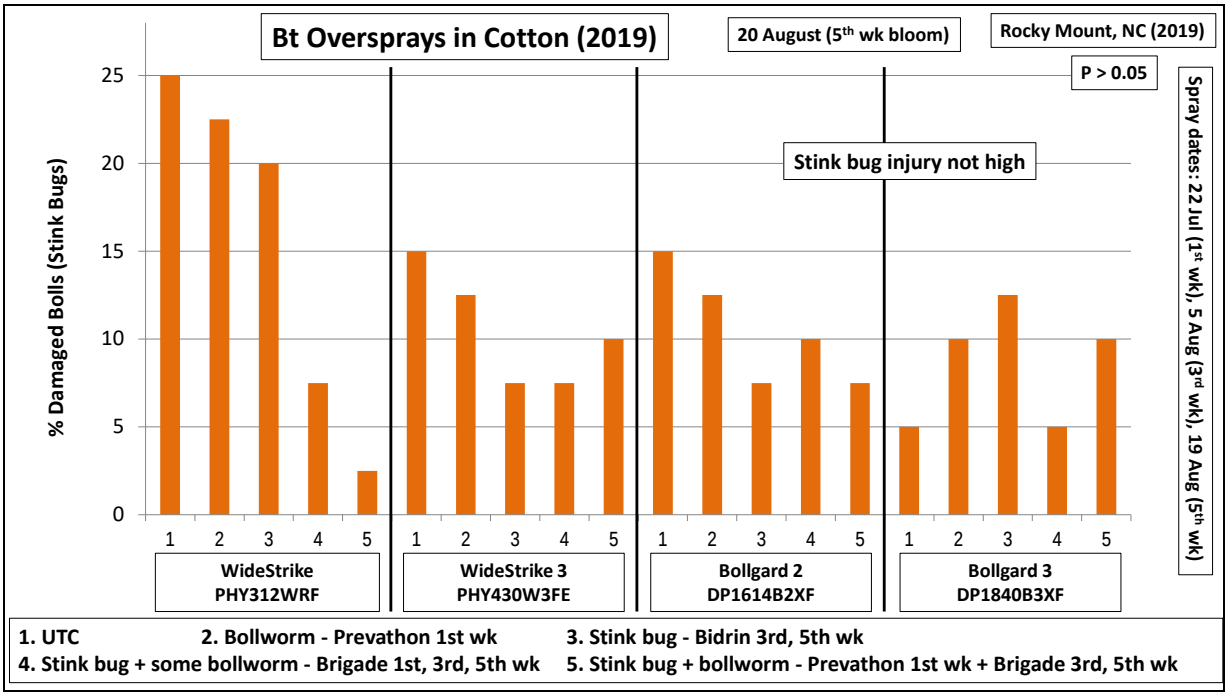


Figure 9. Mean percent bolls damaged by stink bugs in Bt cotton technologies after oversprays with chlorantraniliprole (Prevathon) and bifenthrin (Brigade) at various timings by week of bloom in NC (2019).

This resulted in significant yield losses due to bollworm (Figure 10). Significant yield was preserved with protection from bollworm alone (Prevathon) in 2-gene Bt cotton (WideStrike and Bollgard 2). Bollworm was much less of an issue in 3-gene Bt cotton (WideStrike 3 and Bollgard 3), where very little injury (Figure 8) and larvae were detected.

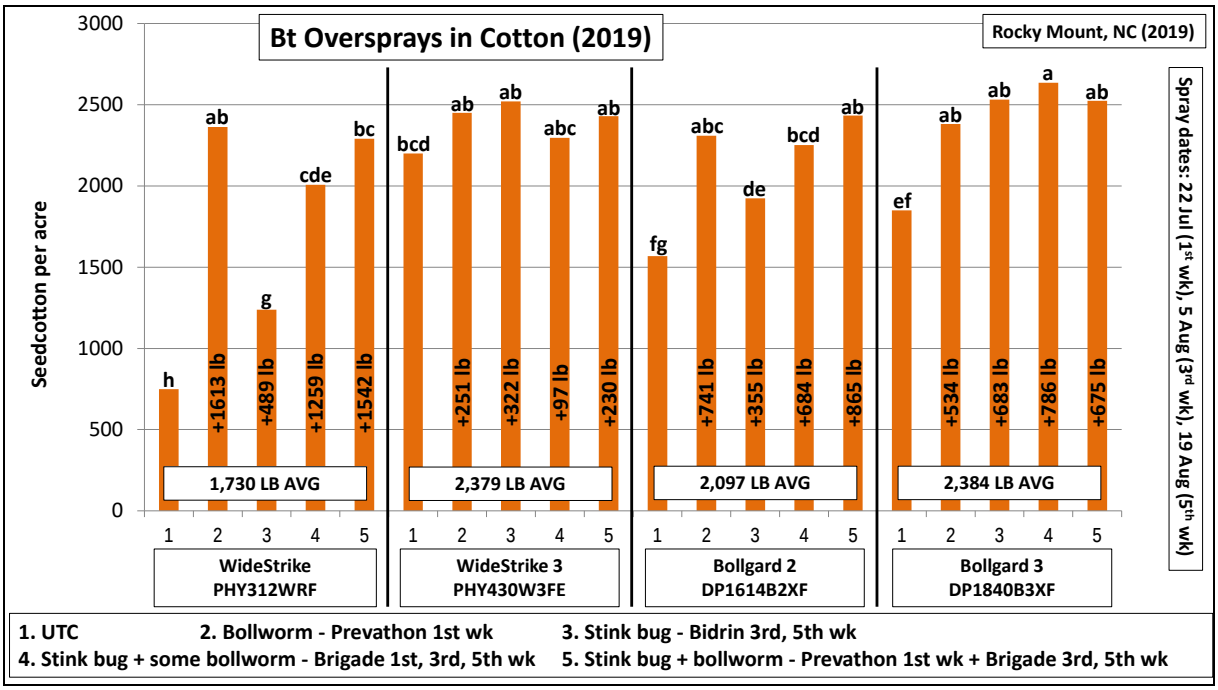


Figure 10. Seed cotton yields after oversprays with chlorantraniliprole (Prevathon) and bifenthrin (Brigade) at various timings by week of bloom in NC (2019).

Pressure from bollworm was very low at trial locations in Georgia and in Alabama, but populations of stink bugs were moderately important. Yield data from one trial in Georgia (Figure 11), showed numerical yield increases with the use of insecticide, particularly when stink bugs were targeted exclusively.

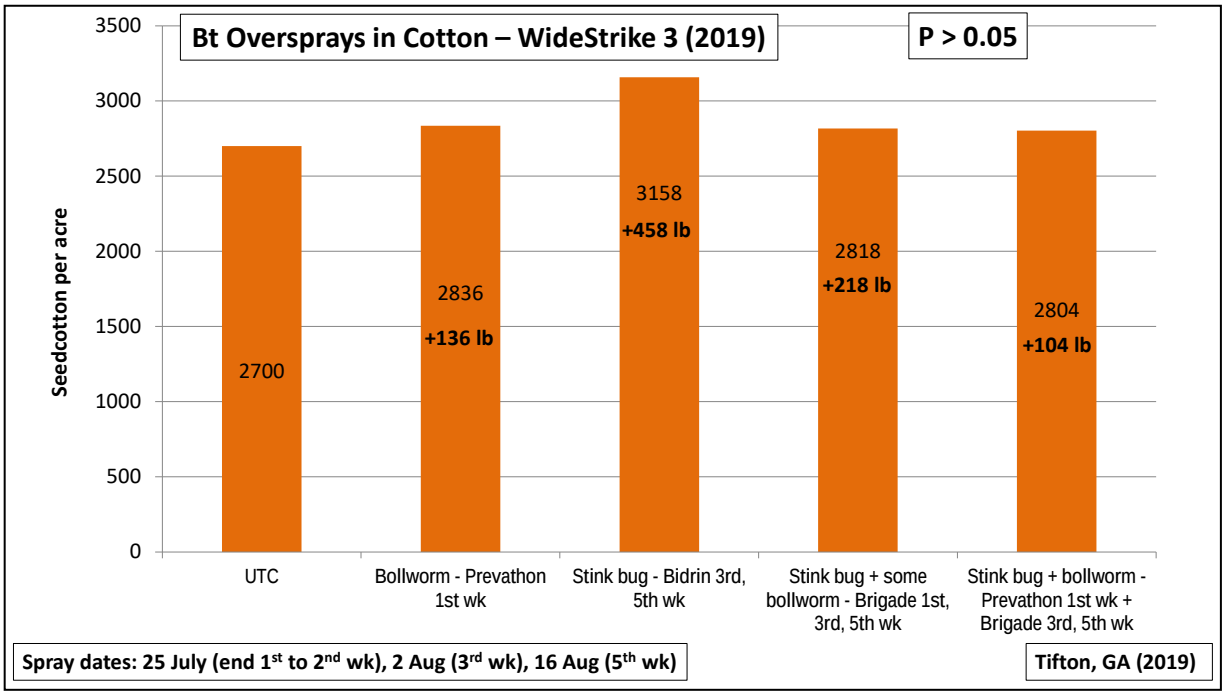


Figure 11. Seed cotton yields after oversprays with chlorantraniliprole (Prevathon) and bifenthrin (Brigade) at various timings by week of bloom in GA (2019).

## Summary

Overall, insecticide oversprays for bollworm and/or stink bugs were necessary to preserve yields in our trials, and appropriate use of materials (pyrethroids or chlorantraniliprole alone or in combination) was entirely dependent on what pests (stink bugs and/or bollworm) were economically important. This highlights the importance of scouting and proper detection of insect issues in the crop. Use of scouting reports (moth activity, egg deposition, fruit injury, etc.) and appropriate treatment thresholds is critical to adequate protection from yield losses due to bollworm (Reisig et al. 2019) and stink bugs as major insect pests of cotton in the Southeast. The first two weeks of bloom are critical for control of bollworm, and the 3rd through 5th weeks of bloom remain important for controlling stink bugs. Pyrethroids continue to be a viable and economic option for control of stink bugs and some populations of bollworm that escape control provided by Bt cotton, but some use of lep-specific chemistry is likely warranted, especially in 2-gene Bt cotton in locations with a history of heavy pressure from bollworm. Because bollworm is developing resistance to Bt proteins and pyrethroid insecticides, and stink bugs are universally important in cotton in the region, selection of proper insecticide oversprays for these pests is critical for optimal control and protection of yield.

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