

EFFICACY OF INSECTICIDES TARGETING COTTON APHIDS AND IMPACT ON KEY APHID PREDATORS

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Abstract

Cotton aphids, *Aphis gossypii* Glover are a common pest of cotton grown in the High Plains of Texas. The objectives of this two-year study included: 1) to determine the efficacy of commonly used aphicides at mitigating aphid populations in cotton, 2) to determine which aphicides have the least detrimental impact on key aphid predators, and 3) to collect data to support or refute the current aphid action threshold. The aphid population was higher and more persistent in 2009 than in 2008. Bidrin, Carbine and Intruder reduced the mean aphid population below threshold at 3 DAT in both years. In 2009, Centric did not reduce the mean aphid population below threshold until 14 DAT, suggesting that this product should be applied when aphids just reach the 50 per leaf threshold and the population is increasing as demonstrated in 2008. In 2008, Trimax Pro did not perform as well as the other insecticides as exhibited by the 182 percent increase in aphid numbers between the three and five day post-treatment counts. In 2009, the aphid population in the Trimax Pro treatments were well above threshold at 7 DAT. In 2008, Bidrin and Carbine did not significantly differ in percent reduction of lady beetle larvae compared to the untreated check, while Centric, Intruder and Trimax Pro had fewer lady beetle larvae than the untreated check. In 2009, Carbine was the only treatment that did not differ from the untreated check. The differences in results may be attributed to spray coverage as the plant canopy in 2008 was dense compared to 2009. The lady beetle population was above the suggested 0.2 per one foot of row density in both years, but we did not observe a rapid decrease in the aphid population in 2009. Although more data is needed, this test suggests that yield loss begins to occur when the aphids average 25 to 50 per leaf. Thus our current action threshold of 50 aphids per leaf appears to be fairly accurate.

Introduction

Cotton aphids, *Aphis gossypii* Glover are a common pest of cotton grown in the High Plains of Texas. Where aphid outbreaks occur, natural enemies such as lady beetles are undoubtedly one of the most important natural factors for reducing aphid numbers below economically damaging levels. The University of Arkansas has developed a decision making process that incorporates lady beetle counts for determining when to treat for aphids (Chappell et al. 2005). Key predators are not only important in suppressing aphid populations below threshold, but are also important in preventing resurgence of aphids post treatment and assisting in control following treatment.

The Texas AgriLife Extension Service action threshold for initiating an insecticide application targeting aphids in cotton is 50 aphids per leaf prior to boll opening and 10 aphids per leaf thereafter (Kerns et al. 2009). The low threshold after boll opening is to prevent honeydew accumulation on the lint, resulting in sticky cotton.

The objectives of this study are to determine the efficacy of commonly used aphicides at mitigating aphid populations in cotton. To determine which aphicides have the least detrimental impact on key aphid predators and to collect data to support or refute the current aphid action threshold.

Materials and Methods

This test was conducted at the Texas AgriLife Research and Extension Center in Lubbock, Texas. Cotton 'DeltaPine 174 RF' was planted on 4 June 2008 and 9 June 2009 on 40-inch rows and irrigated using furrow run irrigation. Plots were 4-rows wide × 25-feet long. Plots were arranged in a randomized complete block design with 4 replicates. An aphid outbreak was induced by overspraying the entire test area with Karate 1EC (lambda cyhalothrin) at 4.0 fl-oz per acre on 18 July and 7 August in 2008, and on 23 and 29 July and 4 August 2009. The

aphicide treatments and rates are outlined in Table 1. All treatments were applied with a CO₂ pressurized hand boom calibrated to deliver 10 gallons/acre. The boom consisted of 2 hollow cone TX-6 nozzles per row spaced at 20 inches.

Treatments were applied on 21 and 28 August in 2008 and 2009, respectively, when the aphid population was approaching or had exceeded the action threshold of 50 aphids per leaf.

The aphid population was estimated by counting the number of aphids per leaf. Ten 3 to 4 node terminal and ten mid to lower canopy leaves were randomly sampled per plot.

Predators were estimated utilizing a 36-inch x 40-inch black drop cloth. Drop cloths were laid between the rows and approximately 1.5 ft-row of cotton were shaken onto the drop cloth from each row, and the type and number of predators were counted. Only lady beetle larvae data are presented. The % reduction in lady beetle larvae relative to the untreated was estimated using Henderson-Tilton's equation.

The plots were harvested on 19 November in 2008 using an HB hand stripper. A 1/1000th acre section was harvested from the middle two rows of each plot. Samples were ginned at Texas AgriLife Ginning Facility in Lubbock. In 2009 yield data was not taken due to herbicide damage compounded by an early freeze.

All count data were analyzed using PROC MIXED and the means were separated using an F protected LSD ($P \leq 0.05$) (SAS Institute 2003). The 2008 yields were correlated with aphid densities using an exponential decay linear regression model.

Table 1. Aphicide treatments and rates.

Treatment	Active Ingredient	Rate (product/ac)
1) Untreated	--	--
2) Bidrin 8	Diclotophos	8.0 fl-oz
3) Carbine 50WG	Flonicamid	1.5 oz
4) Centric 40WG	Thiamethoxam	2.0 oz
5) Intruder 70WSP	Acetamprid	0.6-0.75 oz*
6) Trimax Pro 4.44SC	Imidacloprid	1.8 fl-oz

All treatments included crop oil concentrates at 1.0% v/v.

* Rate for Intruder was 0.75 oz in 2008 and 0.6 oz in 2009.

Results and Discussion

Aphids - 2008

On 21 August, the aphid population was averaging across all plots, 46.66, 19.82 and 33.24 aphids per leaf on the mid to lower canopy leaves, 3 to 4th node leaves, and averaged across both leaf locations respectively (Figure 1A). There were no statistical differences among treatments at this time. Although the aphid population was not at the treatment threshold, since the population appeared to be rapidly increasing treatments were initiated on 23 August. On 26 August, 3 days after treatment (DAT), aphids in the untreated plots had increased to slightly over threshold (Figure 1B). All of the aphicides had fewer aphids than the untreated throughout the plant canopy. There were no differences among the aphicides for aphids on the 3 to 4th node leaves, but Bidrin and Intruder had fewer aphids on the mid to lower canopy leaves than Carbine. Carbine was not expected to exhibit full activity at 3 DAT since this chemistry acts as an anti-feedent and requires time for the aphids to starve and/or desiccate. At 5 DAT, aphid numbers in the untreated were slightly lower than at the 3 DAT evaluation (Figure 1C). All of treatments had significantly fewer aphids than the untreated; however, Trimax Pro did not differ from the untreated in the number of aphids infesting the mid to lower canopy. Based on the mean number of aphids from both leaf locations, Trimax Pro did not perform as well as the other aphicides. Aphid numbers in the Trimax Pro plots on the mid to lower canopy leaves increased 181.62% from 3 DAT to 5 DAT. None of the other treatments exhibited an increase in aphid numbers. The increase in aphids in the Trimax Pro plots may have been due to its impact on lady beetles. By 10 DAT, the aphid population had declined considerably across the entire test, and none of the treatments were exceeding threshold (Figure 1D).

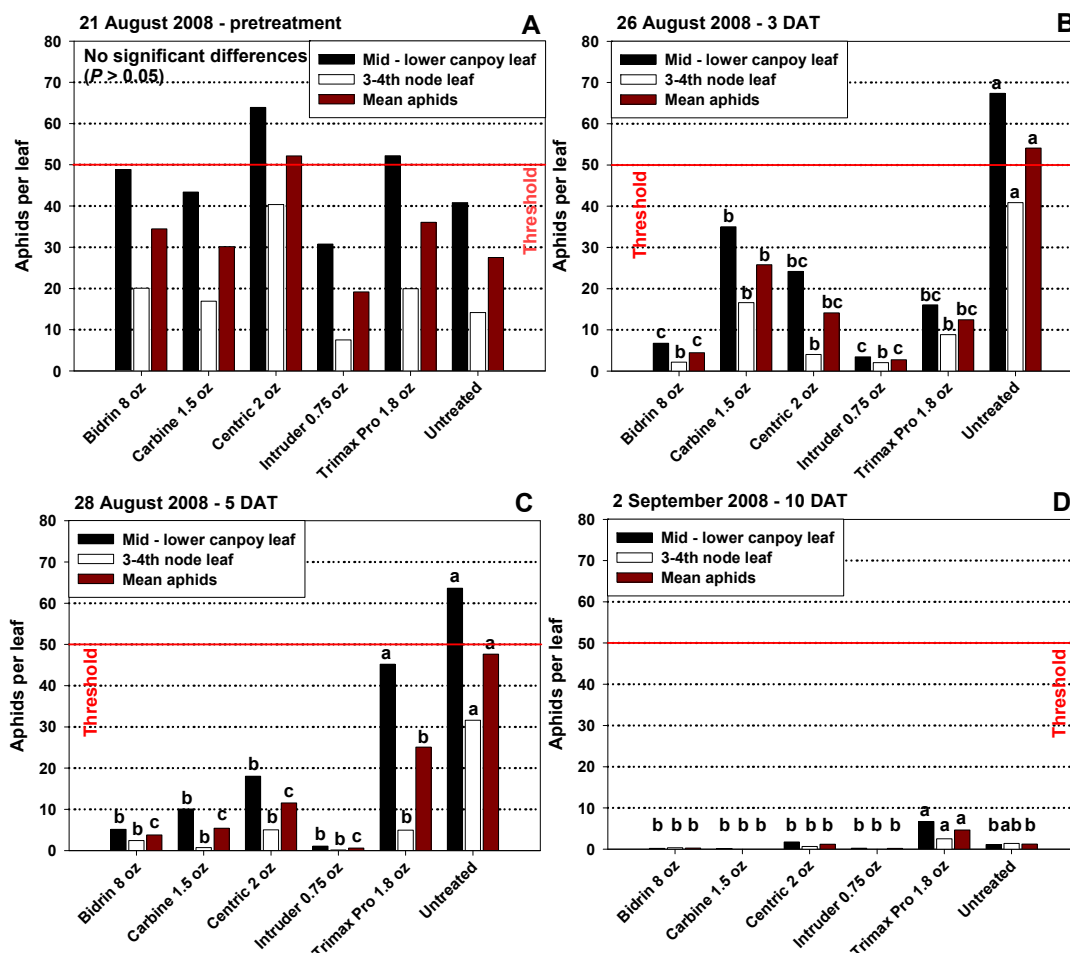


Figure 1. Number of cotton aphids per leaf in 2008 before application (A), 3 DAT (B), 5 DAT (C), and 10 DAT (D) during 2008. Same colored bars capped with the same letter are not significantly different based on an F protected Mixed Procedure (LSD, $P < 0.05$).

Aphids - 2009

In 2009, the aphid populations were substantially greater than in 2008. On 28 August, the aphid population was averaging across all plots, 110.48, 166.07 and 138.28 aphids per leaf on the mid to lower canopy leaves, 3 to 4th node leaves, and averaged across both leaf locations respectively (Figure 2A). There were no statistical differences among treatments at this time. Bidrin, Intruder and Carbine reduced the aphid population below threshold at 3 DAT, and all of the treatments were significantly lower than the untreated (Figure 2B).

By 7 DAT, similarly to 2008, aphids in the Carbine continued to decrease while aphids in the Intruder-treated plots remained low and static (Figure 2C). Aphids in the Bidrin, Centric and Trimax Pro plots increased slightly from 3 to 7 DAT. Bidrin increased to near threshold while Centric and Trimax Pro remained well above threshold. At 14 DAT the aphid population had crashed across all treatments (Figure 2D).

Although we could not detect any differences among treatments in yield in 2008, we were able to demonstrate a significant relationship between aphid density at 5 DAT and yield (Figure 3). Although more data is needed to alleviate spuriousness, these data suggest yield loss began to occur when the aphids averaged 25 to 50 per leaf. Thus our current action threshold of 50 aphids per leaf appears to be fairly accurate.

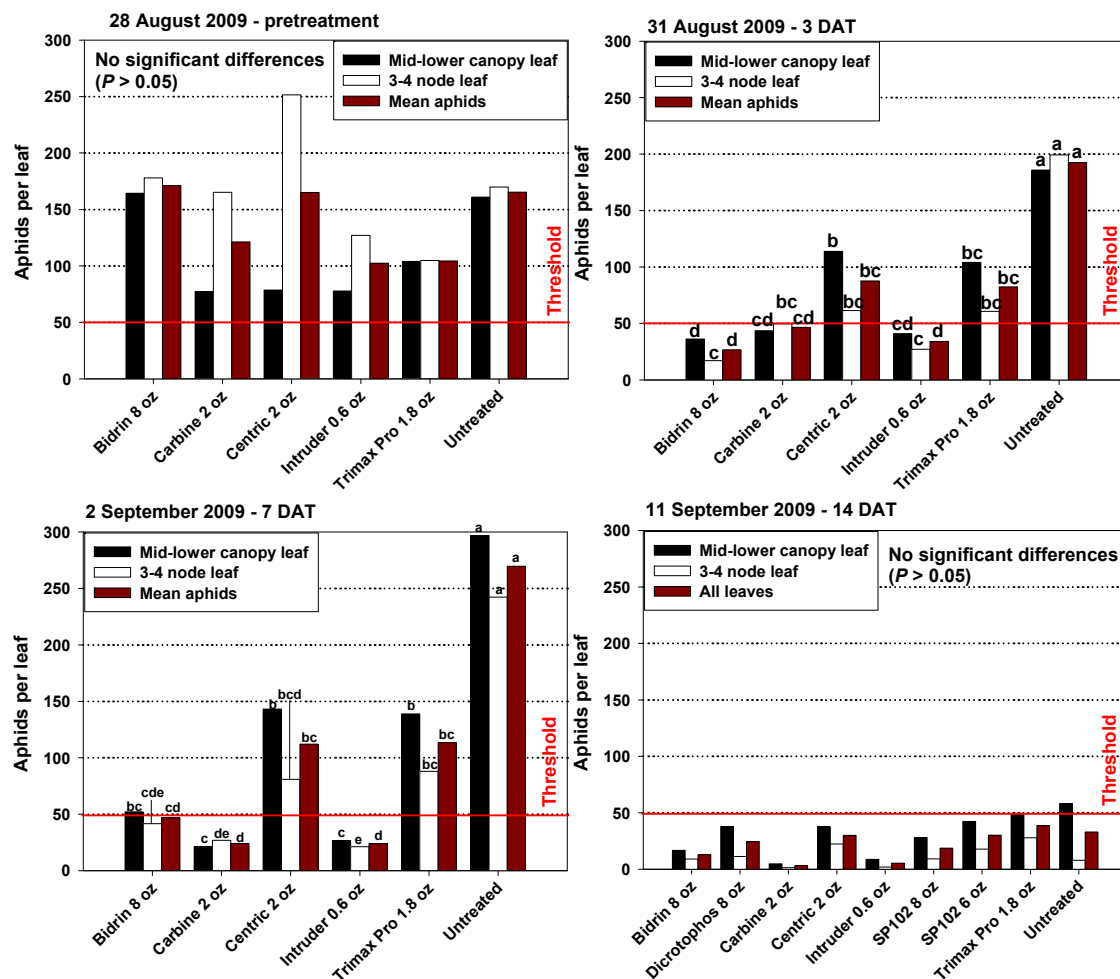


Figure 2. Number of cotton aphids per leaf in 2009 before application (A), at 3 DAT (B), 7 DAT (C) and 14 DAT (D); Same colored bars capped with the same letter are not significantly different based on an F protected Mixed Procedure (LSD, $P < 0.05$).

Lady Beetles

Convergent lady beetle, *Hippodamia convergens* Guérin-Ménéville was the most prevalent predator present in these tests both years. Before treatment, lady beetle larvae averaged 9.28 and 4.08 per 6 ft-row in 2008 and 2009 respectively. In 2008 at 3 DAT, lady beetle larvae did not suffer significant mortality in the Carbine or Bidrin treatments relative to the untreated plots, while all of the neonicotinoids (Centric, Intruder and Trimax Pro) contained fewer lady beetle larvae than the untreated (Figure 6). In 2009, perhaps because the lady beetle population was 50% lower than in 2008, differences were less clear and Carbine was the only treatment that did not differ from the untreated (Figure 6). The reason Bidrin caused significant mortality in 2009 but not in 2008 may be due to plant height and canopy density. The cotton in 2009 was smaller than in 2008 and inner canopy coverage may have been better in 2009.

The University of Arkansas suggests that at least 0.2 lady beetle larvae or 0.3 lady beetle adults per 1 ft-row may be sufficient to biologically manage an aphid infestation (Chappell et al. 2005). Lady beetle larvae averaged 2.58 and 1.04, while the adults averaged 0.28 and 0.25, in 2008 and 2009 respectively at 0 DAT. Although the numbers of adults were similar between years, there were fewer larvae in 2009; but still above the suggested 0.2 per 1 ft-row density. However, we did not observe the rapid decrease in the aphid population in 2009.

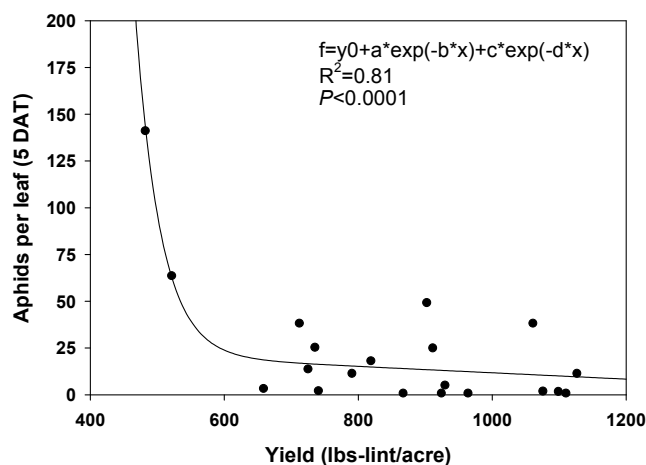


Figure 3. Linear relationship in 2008 of cotton aphid density at 5 DAT and yield.

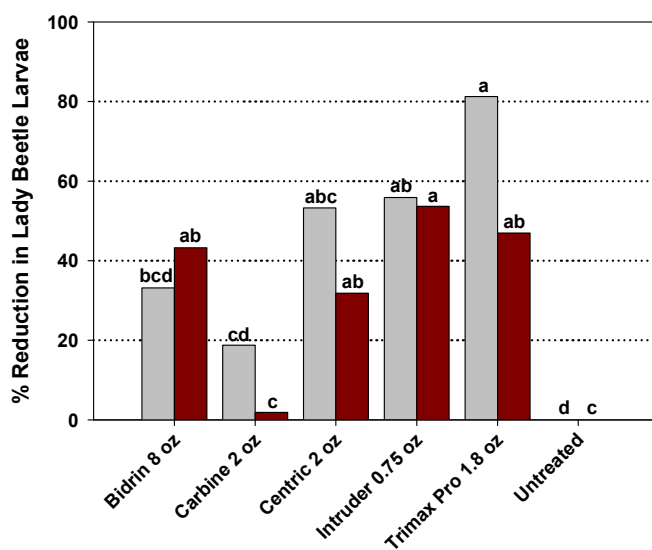


Figure 4. Percentage reduction in lady beetle larvae based on a Henderson-Tilton's equation. Same colored bars capped with the same letter are not significantly different based on an F protected Mixed Procedure (LSD, $P < 0.05$).

Summary

The aphid population was higher and more persistent in 2009 than in 2008. Bidrin, Carbine and Intruder reduced the mean aphid population below threshold at 3 DAT in both years. In 2009, Centric did not reduce the mean aphid population below threshold until 14 DAT suggesting that this product should be applied when aphids just reach the 50 per leaf threshold and the population is increasing as demonstrated in 2008. In 2008, Trimax Pro did not perform as well as the other insecticides as exhibited by the 182% increase in aphid numbers between the three and five day post-treatment counts. In 2009, the aphid population in the Trimax Pro plots were well above threshold at 7 DAT.

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Acknowledgements

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