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. An aphicide efficacy test was conducted at the Texas AgriLife Research and Extension Center in Lubbock, Texas. In addition to impact on aphids, the aphicides were evaluated for impact on key aphid predators. At 3 days after treatment (DAT) and 5 days after the pretreament counts were taken, aphids in the untreated plots had increased 96.94%, averaging 54.12 aphids per leaf; slightly over threshold. 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. Convergent lady beetle, *Hippodamia convergens* Guérin-Méneville, and common green lacewing, *Chrysoperla plorabunda* (Fitch), were the most prevalent predators present in the test. Although the data for lacewing larvae were inconclusive, none of the treatments differed from the untreated, aphicide impact on lady beetle larvae was clearer. At 3 DAT, the number of lady beetle larvae did not differ between the Carbine, Bidrin or the untreated plots, while all of the neonicotinoids (Centric, Intruder and Trimax Pro) contained fewer lady beetle larvae than the untreated. Trimax Pro had fewer lady beetle larvae than either Carbine or Bidrin. At 5 DAT, aphid numbers in the untreated were slightly lower than at the 3 DAT evaluation. All of the 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. No significant differences among treatments were observed in lint yield. However a significant correlation between aphids per leaf and lint yield per acre was observed based on non-linear regression. Lint yield decreased as the population increased over 50 aphids per leaf which validates the Texas AgriLife Extension Service threshold.

Introduction

Cotton aphids, *Aphis gossypii* Glover are a common pest of cotton grown in the High Plains of Texas. Cotton aphid outbreaks and density potential can be influenced by a number of key factors: 1) aphids tend to develop higher populations on hairy-leaf cotton varieties as opposed to smooth-leaf varieties, 2) aphid populations tend to be higher in clean-till or conventional-till production systems relative to those planting into small grains or sorghum residue, 3) late planting or late maturing varieties tend to be more prone to developing aphid outbreaks, 4) aphids tend to be more be more prevalent in cotton with a skippy stand or where planted in skip rows, 5) excessive nitrogen fertilizer can result in higher aphid populations, and most importantly and 6) destruction of natural enemies by insecticides targeting other pests.

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. 2008). The low threshold after boll opening is to prevent honeydew accumulation on the lint, resulting in sticky cotton. 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.

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 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. The aphicide treatments and rates are outlined in Table 1. All treatments were applied with a CO_2 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.

Table 1. Aphicide treatments and rates.

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

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

Treatments were applied on 21 August 2008 when the aphid population was approaching 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 row-ft of cotton were shaken onto the drop cloth from each row, and the type and number of predators were counted.

The plots were hand harvested on 19 November using a HB stripper, and the cotton ginned at the Texas AgriLife Research and Extension Center in Lubbock.

All data were analyzed using PROC MIXED and the means were separated using an F protected LSD ($P \leq 0.05$) (SAS Institute 2003).

Results and Discussion

On 21 August, the aphid population was averaging across all plot, 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. There were no statistical differences among treatments at this time (Figure 1).

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) and 5 days after the pretreament counts were collected, aphids in the untreated plots had increased 96.94%, averaging 54.12 aphids per leaf; slightly over threshold. All of the aphicides had fewer aphids than the untreated throughout the plant canopy (Figure 2). 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. Aphids in the mid to lower canopy were less exposed to sun and wind and undoubtedly died slower than those near the terminal.

Convergent lady beetle, *Hippodamia convergens* Guérin-Méneville, and common green lacewing, *Chrysoperla plorabunda* (Fitch), were the most prevalent predators present in the test. Although the data for lacewing larvae were inconclusive, none of the treatments differed from the untreated, aphicide impact on lady beetle larvae was

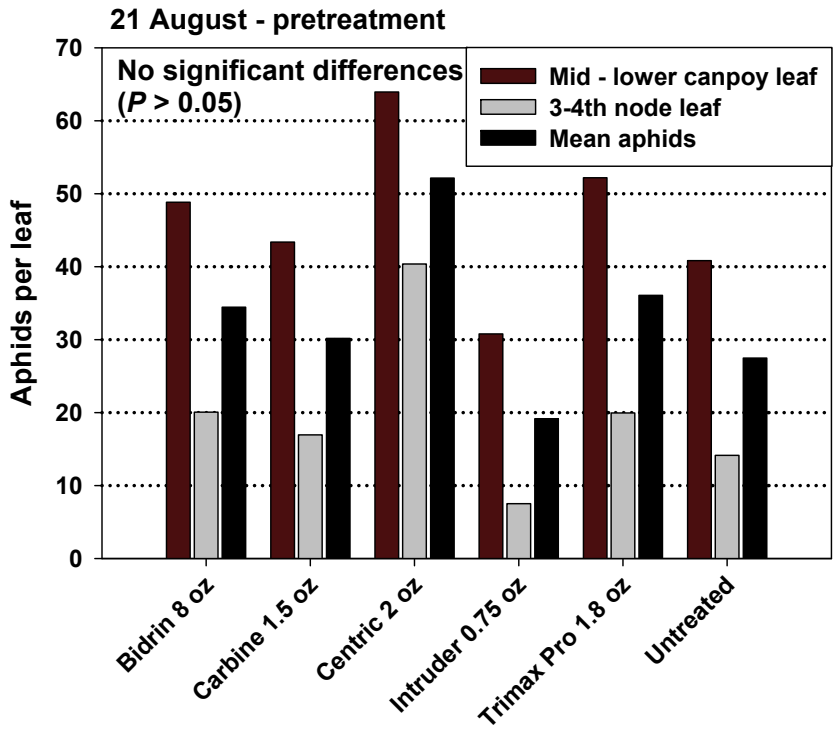

Figure 1. Number of cotton aphids per leaf, 3 DAT. Same colored bars capped with the same letter are not significantly different based on an F protected Mixed Procedure (LSD, $P < 0.05$).

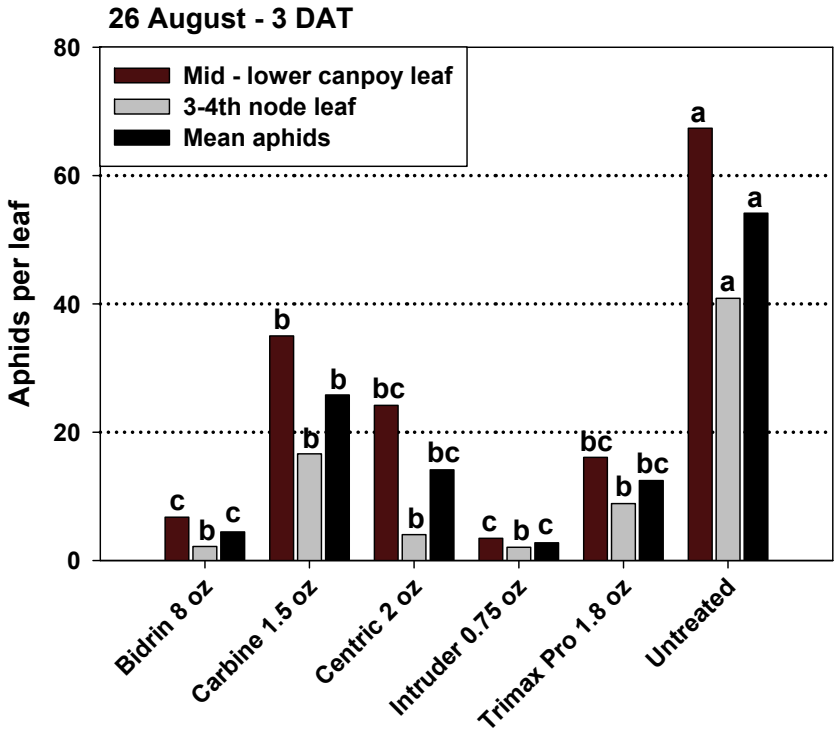

Figure 2. Number of cotton aphids per leaf, 3 DAT. Same colored bars capped with the same letter are not significantly different based on an F protected Mixed Procedure (LSD, $P < 0.05$)

clearer (Figure 3). At 3 DAT, the number of lady beetle larvae did not differ between the Carbine, Bidrin or the untreated plots, while all of the neonicotinoids (Centric, Intruder and Trimax Pro) contained fewer lady beetle larvae than the untreated. Trimax Pro had the fewer lady beetle larvae than either Carbine or Bidrin. Because of its broad spectrum of activity, Bidrin was expected to adversely impact lady beetle larvae. The reason they survived the Bidrin treatment is unclear but may be due to the rapid dissipation of Bidrin and its translaminar activity.

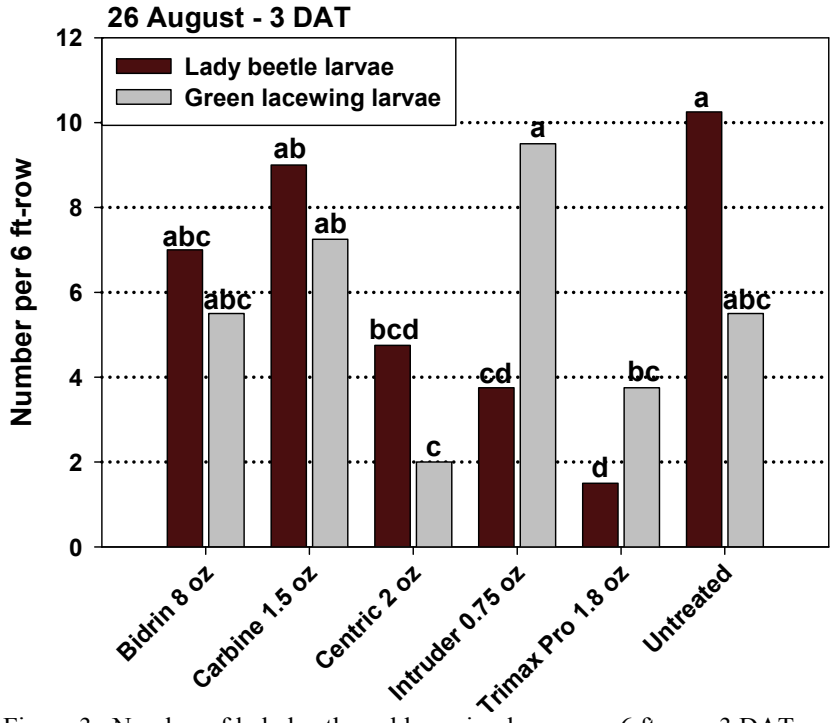

Figure 3. Number of lady beetle and lacewing larvae per 6 ft-row, 3 DAT. Same colored bars capped with the same letter are not significantly different based on an F protected Mixed Procedure (LSD, $P < 0.05$).

The University of Arkansas (Chappell et al. 2005) 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. The untreated plots of this test were averaging 2.56 and 0.28 lady beetle larvae and adults, respectively, per 1 ft-row, at 3 DAT. Based on the high number of lady beetle larvae present, within a week we expected to see a reduction in aphid numbers due to predation, particularly in the untreated plots and where lady beetle larvae were selectively conserved.

At 5 DAT, aphid numbers in the untreated were slightly lower than at the 3 DAT evaluation (Figure 4). All of the 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 5). However, aphid numbers on the mid to lower canopy leaves and averaged across both leaf locations were greater in the Trimax Pro plots relative to the other treatments, including the untreated. Aphids in the Trimax Pro plots did not differ from the untreated on the 3 to 4 the node leaves but were significantly greater than the other aphicides.

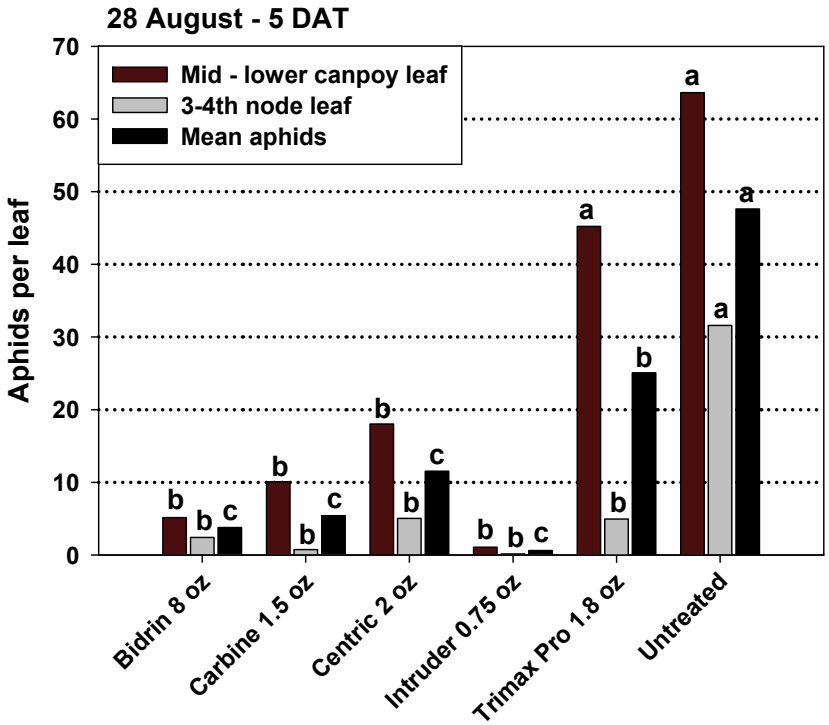

Figure 4. Number of cotton aphids per leaf, 5 DAT. Same colored bars capped with the same letter are not significantly different based on an F protected Mixed Procedure (LSD, $P < 0.05$).

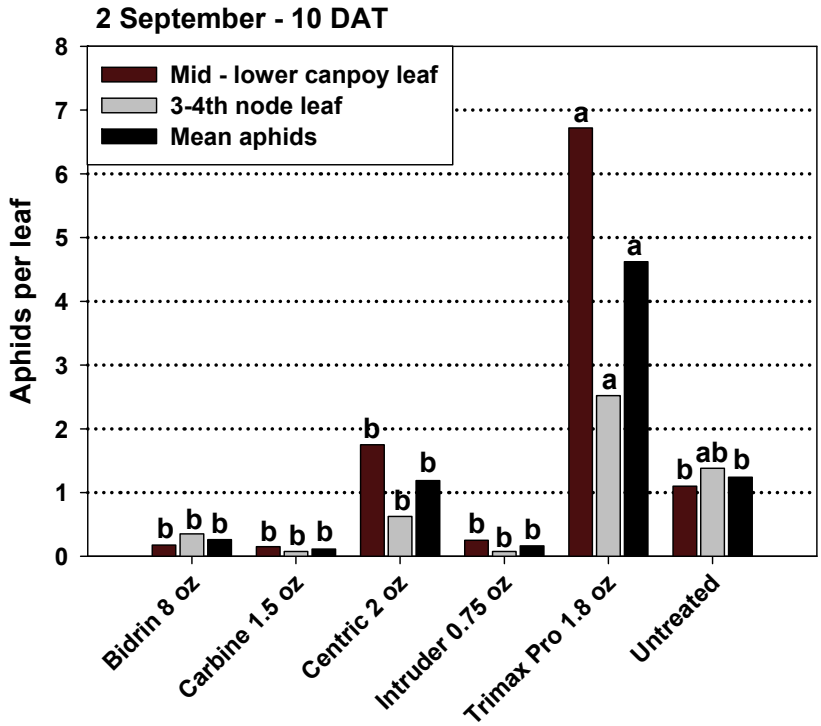

Figure 5. Number of cotton aphids per leaf, 10 DAT. For total aphids, bars capped with the same letter are not significantly different based on an F protected Mixed Procedure (LSD, $P < 0.05$).

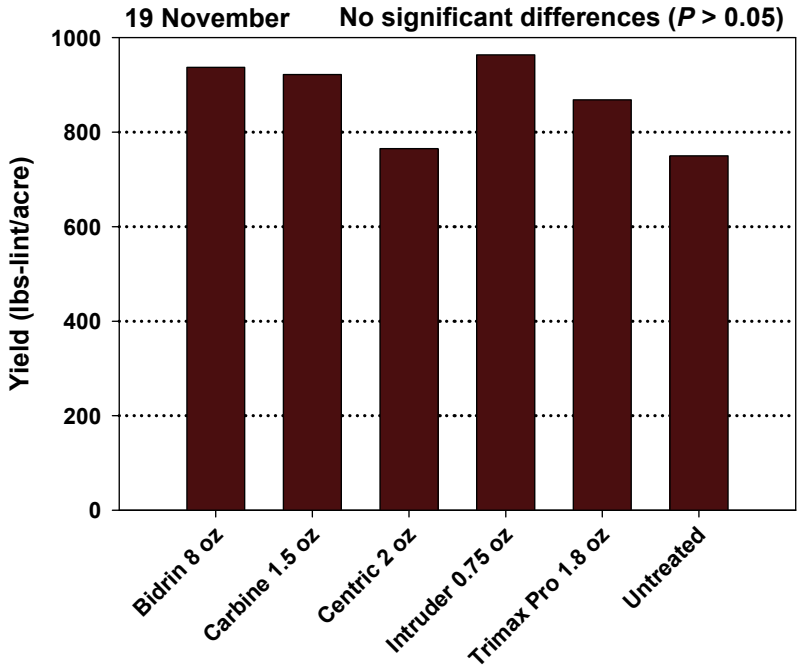

Figure 6. Yield of cotton treated with various aphicides. No significant differences were detected based on an F protected Mixed Procedure (LSD, $P < 0.05$).

No significant differences between treatments were observed in lint yield (Figure 6). However, figure 7 shows a significant correlation between aphids per leaf and lint yield per acre. This trend was evident at 5 DAT, after the aphidices had sufficient time to act and before the population crashed. Lint yield decreased as the population increased over 50 aphids per leaf which validates the Texas AgriLife Extension Service threshold.

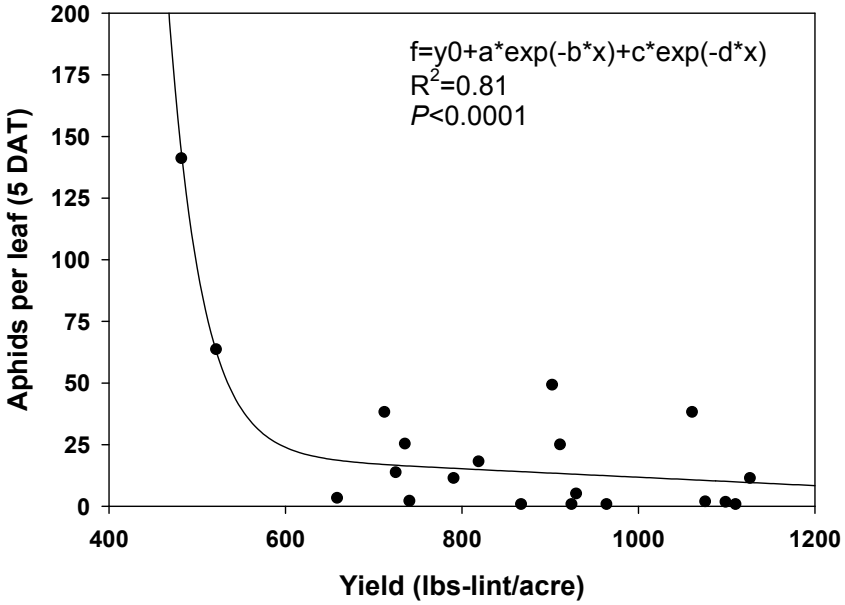

Figure 7. Non-linear regression depicting the trend towards lower yields with increasing aphid numbers at 5 DAT.

Conclusion

All of the aphicides evaluated exhibited activity toward cotton aphid infesting Texas High Plains cotton. Bidrin and Intruder appeared to be the fastest acting materials, exhibiting good efficacy at 3 DAT, while Carbine and to a lesser extent Centric and Trimax Pro were slower acting. Trimax Pro appeared to be the lest effective material evaluated,

All of the neonicotinoids (Centric, Intruder and Trimax Pro) were harsh towards lady beetle larvae. The fact that Trimax Pro was somewhat weaker towards cotton aphids relative to the other aphicides, along with its detrimental impact on lady beetle larvae compounded its inability to reduce the aphid populations relative to the other aphicides.

Although we were not able to detect any significant differences among treatments in yield, there was a significant trend towards lower yields with increasing aphid numbers at 5 DAT. Lint yield decreased as the population increased over 50 aphids per leaf which validates the Texas AgriLife Extension Service threshold.

Acknowledgements

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