# A SUMMARY OF INSECTICIDE EFFICACY AGAINST COTTON APHIDS DURING THE LAST DECADE IN LOUISIANA

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## Abstract

Chemical control strategies remain the primary IPM tactics to manage the cotton aphid, *Aphis gossypii* Glover, in Louisiana cotton. Historically, populations of this pest have demonstrated the ability to develop resistance to recommended insecticides. To monitor product efficacy, research and extension entomologists conduct field trials screening commercial and experimental insecticides against cotton aphid to validate performance. This report summarizes the results of those trials during the previous ten years. Currently, those products providing the most consistent levels of satisfactory control are generally included in the neonicotinoid class of chemistry (acetamiprid, imidacloprid, thiamethoxam). A novel product, flonicamid, was recently registered for use on cotton and currently is only the alternative to the neonicotinoids for cotton aphid management in cotton.

## Introduction

Louisiana cotton, *Gossypium hirsutum* L., fields are subjected to a complex of arthropod pests that are capable of reducing the economic value of this crop (Bagwell 2005, Williams 2006). Several species of aphids can be found on cotton plants, but the melon or cotton aphid, *Aphis gossypii* Glover, is the primary aphid pest across the U.S. cotton belt. This insect is generally an occasional or secondary pest, but infestations can reach levels that influence normal plant development, especially during periods of excessive environmental stress. Cotton aphids in Louisiana are typically a problem during the pre-flowering to early-flowering stages of plant development. During flowering stages, the entomopathogenic fungus, *Neozygites fresenii,* regulates cotton aphid populations across Louisiana (Steinkraus et al. 1995). Epizootics normally develop during late June to mid-July and effectively eliminate any subsequent problems with this pest for the remainder of the season.

Heavy infestations of cotton aphid are usually induced with agronomic and pest management practices applied to cotton fields (Slosser et al. 1989, Leonard and Lorenz 2007). These factors interact concurrently with local environmental conditions, and no single event is usually responsible for inducing cotton aphid outbreaks. Chemical control is the primary means of managing cotton aphid, but the use of non-selective insecticides that disrupts natural biological control agents has been commonly associated with the occurrence of infestations in cotton. Prior to the

1940's, cotton aphid was associated with applications of the inorganic insecticide, calcium arsenate, used against the boll weevil, *Anthonomus grandis grandis* Boheman. In the mid-1980's, treatable infestations in many areas were associated with frequent applications of pyrethroids for caterpillar pest control or malathion used in boll weevil eradication programs.

For as long as insecticides have been used against cotton aphid, there have reports of inconsistent insecticide performance against cotton aphid. The significance of cotton aphid as a cotton pest during the previous two decades was associated with the development of insecticide resistance in populations across numerous states (Grafton-Cardwell 1991, Kerns and Gaylor 1992, O'Brien and Graves 1992). As recently as 2002, there was no registered insecticide capable of providing satisfactory control of this pest. Fortunately, the neonicotinoids (acetamiprid, imidacloprid, and thiamethoxam) were registered on cotton shortly after that and have, until the present time, provided acceptable control. However, during 2006-2007, many cotton fields in Louisiana and Mississippi experienced less than satisfactory control of cotton aphids with these products (Leonard and Lorenz 2007). During the 2006 season, Louisiana and Mississippi were awarded emergency approvals (EPA, FIFRA Section 18) for carbofuran (Furadan 4F) to control cotton aphids due to restricted quantities of the novel aphicide, flonicamid (Carbine 50WP). Presently, only a limited number of recommended products (neonicotinoids and flonicamid) have remained consistently effective against this pest. The objective of this report is to briefly summarize the results of insecticide screening trials in Louisiana against cotton aphids during the previous decade.

## Materials and Methods

The performance of twelve insecticides or insecticide combinations in selected formulations and rates were evaluated for efficacy against cotton aphids during the previous ten years (Table 1). A non-treated control was included in all trials to confirm cotton aphid infestation levels during the sample period.

Table 1. Insecticides evaluated against cotton aphid during 1999-2008.

| Common Name | Trade Name (s) | Formulation (s) |
|---|---|---|
| Dicrotophos | Bidrin | 8EC |
| Bifenthrin | Capture, Discipline | 2EC |
| Flonicamid | Carbine | 50DF, 50SG, 50WG |
| Thiamethoxam | Centric, Actara | 25WG, 40WG, 40WP |
| Dimethoate | Dimethoate | 4EC |
| Pymetrozine | Fulfill | 50WP |
| Carbofuran | Furadan | 4F |
| Acetamiprid | Intruder, Assail | 0.789SL, 70WP |
| Imidacloprid | Trimax Pro, Provado | 4F, 4SC, 4.44L, 75WG |
| Lambda (Λ)-Cyhalothrin | Karate | 2.08SC |
| Λ-Cyhalothrin+ Thiamethoxam | Endigo | 2.08CS + 40WG |
| Imidacloprid + Cyfluthrin | Leverage | 2.7SC |

All studies were performed at the Macon Ridge Research Station (LSU AgCenter) near Winnsboro, LA (Franklin Parish), during the period 1999-2008 (Plate 1).


Plate 1. LSU AgCenter's Macon Ridge Research Station.

The general methods and experimental protocol for measuring insecticide efficacy against cotton aphid in was similar among all field trials. Cotton seed were planted into a Gigger-Gilbert silt loam soil in plots that consisted of 4 rows (centered on 40 inches) and 45-50 feet in length. Treatments were placed in a RCB design with 4-5 replications. All cultural practices and IPM strategies recommended by the Louisiana Cooperative Extension Service were used to optimize plant development and manage non-target insects across the test sites. The only exception to normal management included using 1-2 applications of acephate (0.33 lb AI/acre) and/or cypermethrin (0.03 lb AI/acre) on cotton plants during the early squaring stages of plant growth to induce cotton aphid outbreaks.

To reduce variation in sampling cotton aphids within field plots, 25 plant terminals infested with cotton aphids were marked with a yellow 'snap-on' tag prior to insecticide application. Insecticides usually were applied to plots during the late-squaring to early-flowering stages of plant development. All treatments were applied with a CO2-charged spraying system calibrated to deliver 10 GPA through TX-6 hollow cone nozzles (2 per row) at 30 psi. At 7 DAT, 10 tagged plant terminals (plant terminal region + all leaves including the first one larger than a quarter) were removed from plants, placed in glass jars, sealed, and transported to the laboratory. These samples were processed using whole-plant washing procedures to remove insects, and all surviving aphids were counted using a dissecting microscope. Insecticide efficacy was evaluated by recording the total number of aphids per sample of 10 terminals. The results for each insecticide in a specific trial were converted to percent control relative to the non-treated control. Means across all trials as well as the lowest and highest relative control levels are reported for each insecticide treatment.

## Results and Discussion

The efficacies of twelve insecticides at multiple rates against cotton aphid are reported in Table 2. Results for insecticide treatments could not be directly compared across all trials because of considerable variability in frequencies of tests for products. Sample sizes (trial numbers) for these products ranged from one (dimethoate) to 12 (carbofuran).

Although all of these tests were conducted at a single location (Macon Ridge Research Station, Winnsboro, LA) during 1999-2008, insecticide performance was inconsistent (Table 2). In many instances, a predictable dose response for selected insecticides was not observed. Those products that contained neonicotinoids (thiamethoxam, and acetamiprid), a neonicotinoid combination (Endigo) or flonicamid at one or more rates provided the highest (>80%) and most consistent mean levels of control. Other products such as imidacloprid, bifenthrin, carbofuran, dicrotophos, pymetrozine, lambda-cyhalothrin, and a neonicotinoid combination (Leverage) generally did not provide > 80% mean levels of control at one or more rates. The dimethoate treatments were only evaluated in a single test, but a strong rate response was observed with the highest rate actually providing >80% control. The efficacies of these insecticides ranged from <10% to >90% at 7 DAT. In some tests, performance against cotton aphids was satisfactory. However, with limited alternatives in the presence of persistent infestations, instances of unsatisfactory control are likely to increase. Presently, the available products are providing acceptable control in most situations, but the future duration of satisfactory performance cannot be accurately predicted.

The history of insecticide resistance in cotton aphid should provide ample warning of the potential problems with all of these products in the near future. A coordinated survey of neonicotinoid susceptibility in cotton aphid populations has been initiated, but should be expanded across the cotton belt. Those results should be used to develop and implement logical IRM strategies for this pest.

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Table 2. Evaluation of insecticides against cotton aphid (percent control) during 1999-2008.

| Insecticide | Formulation (s) | Rate (s) | Mean | High | Low |
|---|---|---|---|---|---|
| Bidrin | 8EC | 0.33 | 80.2 | 95.9 | 64.5 |
| | | 0.45 | 71.7 | 99.2 | 19.2 |
| Capture | 2EC | 0.05 | 53.6 | 96.8 | 23.4 |
| Carbine | 50DF, 50SG, 50WG | 0.027-0.038 | 69.1 | 95.8 | 34 |
| | | 0.044-0.053 | 82.4 | 98.5 | 73.6 |
| | | 0.071-0.088 | 79.6 | 93.6 | 54.9 |
| Centric | 25WG, 40WG, 40WP | 0.023-0.037 | 81.2 | 98.9 | 53.1 |
| | | 0.04-0.05 | 84.2 | 97.6 | 64.8 |
| Dimethoate | 4EC | 0.1 | 85.9 | 85.9 | 85.9 |
| | | 0.2 | 68.3 | 68.3 | 68.3 |
| | | 0.3 | 11.3 | 11.3 | 11.3 |
| Fulfill | 50WP | 0.084 | 71.5 | 86.1 | 56.0 |
| | | 0.134 | 59.4 | 59.4 | 59.4 |
| Furadan | 4F | 0.05 | 65.1 | 96.2 | 8.9 |
| Intruder | 70WP | 0.025-0.035 | 76.1 | 99.1 | 10.4 |
| | | 0.044-0.06 | 87.1 | 96.8 | 67.5 |
| Trimax Pro | 4F, 4SC, 4.44L, 75WG | 0.018-0.024 | 61.8 | 89.6 | 33.9 |
| | | 0.031-0.047 | 74.8 | 95.4 | 46.9 |
| Karate-Z | 2.08SC | 0.04 | 49.2 | 59.9 | 43.7 |
| Endigo | 2.08CS + 40WG | 0.037+0.029 | 91.6 | 93.7 | 90.5 |
| Leverage | 2.7SC | 0.08 | 73.1 | 90.8 | 48.7 |