

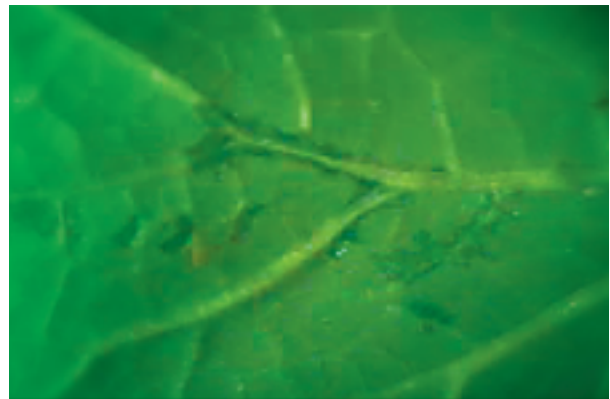
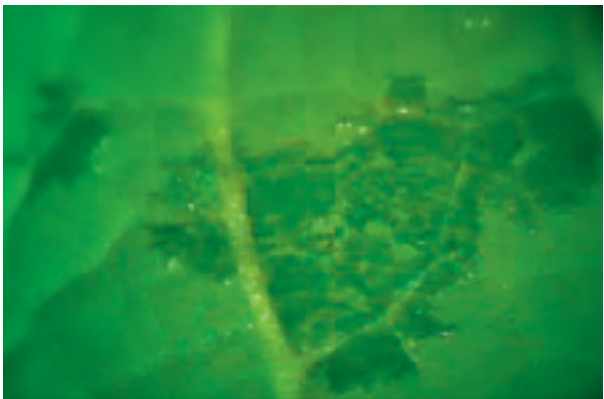
NEW MODE OF ACTION STOPS TARNISHED PLANT BUG FEEDING, IMPROVES COTTON YIELDS



Introduction

Field studies and laboratory research on cotton demonstrate that the unique mode of action in Carbine™ insecticide from FMC quickly stops the damaging feeding behavior of pests such as tarnished plant bugs, aphids and cotton fleahoppers. Unlike traditional cotton insecticides formulated to kill outright, Carbine acts within 30 minutes to render pests incapable of normal movement including piercing cotton fruit and other tender parts to feed. The result: increased boll retention and higher yields.

Field trials in the Delta region of the United States found that Carbine, with its active ingredient flonicamid, causes a malfunction in the insects' central nervous systems that, in turn, causes erratic and irreversible behavior and eventual death. This was confirmed in an electrical feeding study conducted in the laboratory which showed that *Lygus* spp. exposed to treated plants fed an average of 20 minutes, compared with two hours for plant bugs exposed to untreated plants. In field trials, Carbine reduced damage to the cotton fruit by 80 percent and resulted in yield increases from 57 to 228 pounds per acre* compared to competitive treatments.



Insects exposed to Carbine insecticide stop feeding in as little as 20 minutes, compared to up to two hours on untreated plants. Compare the feeding damage on the untreated leaf (left) to that on the leaf treated with Carbine on the right.

Background

Southern cotton growers today face a complex set of pest management challenges including:

- Shifts in the pest spectrum due to the success of boll weevil eradication programs and the advent of *Bt* cotton;
- The need for more selective chemical insect control solutions that preserve beneficial insects and mites; and
- Insect Resistance Management to have an ample set of effective alternatives available.

*All treatments applied three times at seven to 10-day intervals.

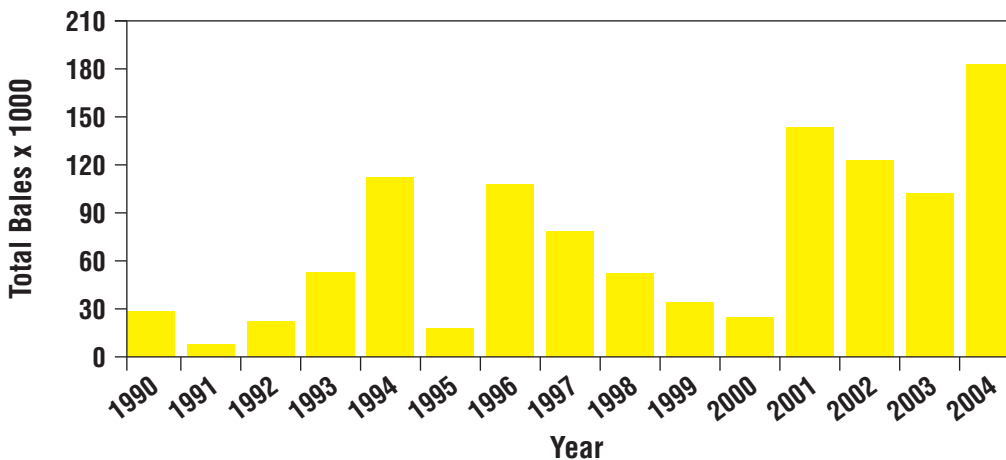
New Mode of Action...

Shifting Pest Spectrum

The industry reaped significant benefits from eradication of the boll weevil, the rise of *Bt* cotton that controls the bollworm/budworm pest complex and the development of target-specific insecticides. One significant response to these advances in insect control was that many cotton growers were able to cut production expenses by reducing the frequency of insecticide sprays for these pests. However, this reduction in traditional spraying allowed other insect species to arise as new threats to profitable cotton production.

With a reduced threat from insecticides and the demise of other insects, a new generation of pests including *Lygus lineolaris* (tarnished plant bug), *Acrosternum hilare* and *Euschistus servus* (from the stink bug species) filled a void in nature and attacked Southern cotton with increased frequency.

Of these pests, the tarnished plant bug emerged as the most economically significant. According to Louisiana State University, the total loss in cotton attributed to the tarnished plant bug rose to 1.07 percent from 1996 to 2002, compared with 0.41 percent in 1990 to 1995, before the introduction of *Bt* cotton. Accordingly, the cost per acre to control the tarnished plant bug rose to \$12.02 from \$3.19 during the same period. More recent information indicates that across the Mid-South states during the 15-year period of 1990-2004, the tarnished plant bug has infested 77 to 99 percent of that region's cotton acreage (Leonard and Price, 2006).¹ During those years, 44 to 93 percent of the infested acres were treated with one or more insecticide applications. For the past four years, chemical control strategies against tarnished plant bug were applied to more than 65 percent of the Mid-South cotton acres. Cotton yield loss estimates from this pest during 2001-2004 were generally higher than those observed since 1990 (Head 1991-1993, Williams 1994-2005).



Cotton yield losses (bales x 1000) from tarnished plant bug in the Mid-South Region (Arkansas, Louisiana, Mississippi); adapted from cotton insect losses reports, 1991-2005 Proceedings Beltwide Cotton Conferences (Leonard and Price, 2006).

Controlling the plant bug is especially difficult because it can live on hundreds of host plants surrounding cotton. Louisiana State University reports that the tarnished plant bug has “the broadest feeding niche of any of the arthropod pests” and in the Delta can live on 169 hosts representing 36 plant families.²

Increasing Insect Resistance

Over the years, cotton growers repeatedly used significant amounts of different insecticides to control worms and the boll weevil. Surviving populations of the tarnished plant bug grew increasingly resistant to these chemistries, reducing their efficacy.

New Mode of Action...

As these natural and manmade factors converged, the tarnished plant bug emerged as a significant threat to Southern cotton. Consider the damage to cotton inflicted by tarnished plant bugs allowed to continue feeding:

“... It is during the period between square initiation and early bloom that cotton is most susceptible to economic damage by TPB (Black 1973; Tugwell et al. 1976). Feeding is accompanied by injection of salivary enzymes into the plant, and it is the disruptive effects of these digestive enzymes on the plant tissue, rather than the amount of tissue consumed, that is responsible for most of the damage inflicted by TPB.”³

Left uncontrolled, these pests will take up residence in a cotton field well into the late-season maturation process.

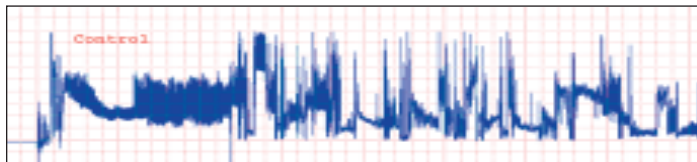
New, More Effective Insect Control Protects Yield

In years past, effective insect control in cotton was considered synonymous with “fast knockdown,” or a quick killing of the targeted pest(s). But many of the older, traditional chemistries required up to two hours to kill pests, during which time the insects, such as tarnished plant bugs, kept feeding, damaging fruit, leaving it susceptible to disease and attacks by other pests, and causing significant fruit abortion.

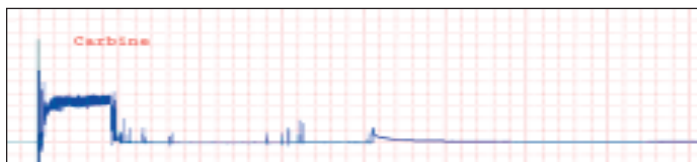
The active ingredient in Carbine™ insecticide gives cotton growers a powerful tool that stops insects’ destructive feeding behavior to increase yields. Carbine, which received EPA registration in late 2005, is a unique insecticide that offers a different mode of action named A-Type Potassium Channel Active. The active ingredient in Carbine blocks the insect’s potassium channel and causes rapid, uncontrolled release of neurotransmitters and loss of nervous system control, which is characterized by shaking, difficulty in coordinated movement and flaccid stylets. This renders the plant bug incapable of feeding and eventually leads to its death or makes it vulnerable to parasites, predators and pathogens.

Laboratory test studies using an electrical feeding monitor evaluated the amount of time in which feeding cessation occurred. In this setting, tarnished plant bugs exposed to plants treated with Carbine fed an average 20 minutes, compared with two hours for those feeding on untreated plants. This reduced damage to plants by 86 percent.

Untreated



Carbine Treated

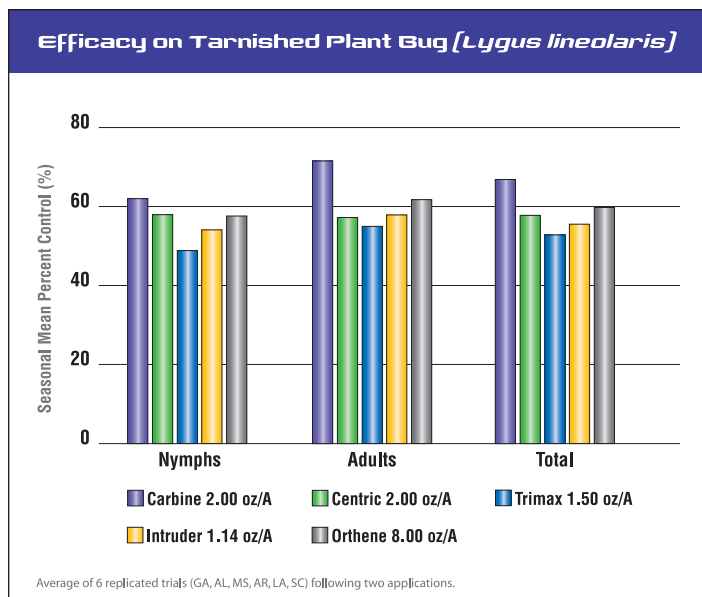


← 6 Hrs →

Carbine stops destructive feeding behavior by piercing, sucking insects in as little as 20 minutes. This protects vulnerable plant tissue, improving boll retention and boosting yields.

New Mode of Action...

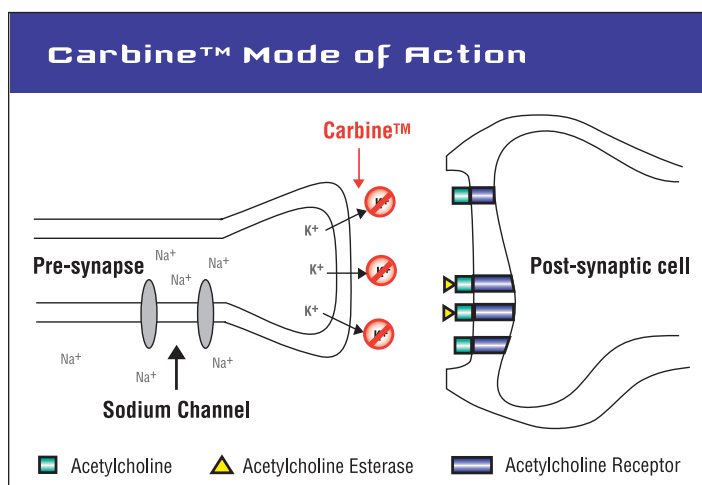
In 2005, field studies conducted during the growing season showed that plant bugs began to lose their ability to feed within 30 minutes of their exposure to Carbine. The consequent reduction in plant damage resulted in greater square retention and cotton yield increases of 57 to 228 pounds* per acre compared to non-treated fields.



Carbine™ insecticide provides superior control of tarnished plant bugs at both the nymph and adult stages. And because its unique chemistry is soft on beneficial insects, Carbine is an excellent fit in Integrated Pest Management programs.

Not a Neonicotinoid

Carbine belongs to the pyridinecarboxamide class of chemistry – IRAC Classification 9C. Research has shown that Carbine is not active in any of the target sites associated with other described insecticide classes including neonicotinoid chemistries.



Carbine is active on the A-Type Potassium Channel, unlike other cotton insecticides. With its unique chemistry and mode of action, Carbine provides cotton growers with an excellent resistance management tool.

Insect Resistance Management (IRM) Tool

Because of its unique mode of action, Carbine is an excellent choice for Insecticide Resistance Management programs. It has no known cross-resistance with other classes of insecticides, which reduces resistance selection pressure.

*All treatments applied three times at seven to 10-day intervals.

New Mode of Action...

Carbine™ insecticide is the ideal partner for Insect Resistance Management programs, offering superior control of key pests such as the tarnished plant bug, while preserving the efficacy of other insecticides.

Excellent for IPM

Many features of Carbine make it an excellent fit in Integrated Pest Management programs. It is soft on beneficial insects (such as assassin bugs, big-eyed bugs, damsel bugs, pirate bugs, lacewings, lady beetles, parasitic wasps and honeybees) and mites (including wolf spiders and crab spiders). Consequently, the use of Carbine permits beneficial arthropods to continue assisting in the control of plant bugs or aphids that have escaped treatment, as well as other cotton pests, such as *Heliothines*, armyworms or loopers.

In addition, Carbine has a superior environmental profile. It degrades rapidly in the soil through microbial activity, meaning it poses very little risk of groundwater contamination.

The environmental profile of Carbine and its excellent fit in Integrated Pest Management programs make it the right choice for today's cotton growers.

Technical Information

The 50WG formulation of Carbine dissolves rapidly and completely in water. The product is available in 4 x 3.5 lb. jug packaging that is easy for application personnel to handle and mix.

Use Recommendations

Targeted Pests	Ounces Carbine™ 50WG/Acre	Comments
Tarnished Plant Bug (<i>Lygus lineolarus</i>) Western Plant Bug (<i>Lygus hesperus</i>) Cotton Fleahopper (<i>Pseudatomoscelis seriatus</i>)	1.7 – 2.8	Begin applications as populations reach economic thresholds according to local economic guidelines. The low rate can be used early season for low pest densities or when tank mixing with other products registered for target insect control. Use the high rate for large pest populations, dense foliage, and longer residual. Rapidly growing cotton will need retreatment. Scout fields often and retreat as necessary to maintain pest populations below damaging levels.
Cotton Aphids	1.4 – 2.8	

- Thorough spray coverage of plant foliage is essential for optimal control.
- Use a minimum of 5 gallons per acre by ground and 3 gallons per acre by air.
- Finished spray volumes should be increased under extreme pest populations or dense plant foliage.
- One container of Carbine 50WG will treat 20 acres at 2.8 ounces per acre.

Conclusions

Carbine insecticide from FMC provides an effective answer to several pest management needs of the cotton production industry.

New Mode of Action...

Unlike traditional chemistries designed to “knock down” or kill insects outright, the unique mode of action of Carbine™ insecticide quickly stops the destructive feeding behavior of key cotton pests such as the tarnished plant bug. This increases boll retention resulting in higher yields, which is vital for profitable cotton production.

Carbine is also an important partner in Insect Resistance Management programs. With a different mode of action and no known cross-resistance to other insecticides, Carbine reduces resistance selection pressure on other insecticides.

In addition, Carbine is a selective chemistry with minimal impact on beneficial insects and mites, making it a solid fit for Integrated Pest Management programs. Carbine degrades rapidly in the soil, offering little risk of groundwater contamination.

Carbine is an effective, fast-acting and environmentally responsible tool to help Delta cotton growers protect their crops from the destructive feeding behavior of pests such as the tarnished plant bug.

SOURCES

1. “Status of Chemical Control Strategies Against *Lygus Lineolaris*,” B.R. Leonard and P. Price, LSU AgCenter, Winnsboro, LA 2005.
2. “Tarnished Plant Bug Problems and Weed Host Control,” Richard Costello, Eugene Burris, Gordon Snodgrass and William Scott. Published by the Louisiana State University Agricultural Center 2004.
3. “Biology and Damage of the Tarnished Plant Bug, *Lygus Lineolaris*, In Cotton” M.B. Layton, Department of Entomology and Plant Pathology, Mississippi State University Extension Service. Published 2003.