PIRATE INSECTICIDE-MITICIDE FOR CONTROL OF COTTON INSECTS IN MID-SOUTH COTTON

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Abstract

Forty-five large scale PIRATE Insecticide-Miticide Experimental Use Permit (EUP) trials were conducted in AR, LA, MS, and TN cotton fields comparing PIRATE with commercial insecticides for control of the tobacco budworm, *Heliothis virescens* (F.), and cotton bollworm, *Helicoverpa zea* (Boddie), complex (TBW/CB). Insecticide treatments were broadcast applied by ground and air and were tested alone and tank-mixed with companion insecticides. Results from the PIRATE Program support the strong fit for PIRATE as a new tool for controlling TBW/CB in cotton including organophosphate, carbamate, and pyrethroid resistant TBW. In the comparisons of PIRATE with chemical insecticides for TBW/CB control, PIRATE was equal to or superior to the comparison treatment in 127 of 146 comparisons (87%). PIRATE stand alone at 0.3-0.35 lb (AI)/acre provided good control of TBW/CB. When tank-mixed with a companion insecticide, PIRATE at 0.2-0.25 lb (AI)/acre effectively controlled TBW/CB. Control at these stand alone and tank mix rates of PIRATE was equivalent or superior to competitive insecticides and mixtures.

Introduction

In the Mid-South, a large proportion of cotton yield losses are attributed to the tobacco budworm (TBW), *Heliothis virescens* (F.), and cotton bollworm (CB), *Helicoverpa zea* (Boddie) (Head 1993, Williams 1994, Williams 1995). Control of TBW with pyrethroid insecticides has declined since the mid-1980s. This reduction in efficacy is attributed to pyrethroid-resistant TBW populations (Luttrell et al. 1987, Leonard et al. 1988, Elzen et al. 1992). Recent studies have documented TBW resistance to organophosphate and carbamate insecticides (Elzen et al. 1992, Graves et al. 1993, Elzen et al. 1994, Elzen 1995).

In recent years, particularly 1993 and 1995, beet armyworm (BAW), *Spodoptera exigua* (Hübner), has contributed to yield losses and increased insecticide expenditures (Williams 1994). In 1995, nationwide losses from BAW may reach 550,000 cotton bales (Brandon 1995), a five-fold increase from the 94,521 bale loss in 1993 (Williams 1994).

Increased difficulty in controlling TBW coupled with more frequent BAW infestations have contributed to increased insect control expenditures and decreased cotton yield. For example, in 1995 cotton insect control costs were approximately $60 per acre above average in portions of Mississippi infested with TBW and BAW (Robinson 1995), while the state average yield forecast of 602 lb per acre was 204 lb. or 25% below the estimate for 1994 (Gregory and Kenerson 1995). With approximately 1.46 million acres of cotton in Mississippi, the reduced yield exceeds a value of $200 million, assuming $0.70 per pound of cotton.

Pyrethroid, carbamate, and organophosphate insecticides are key tools for cotton insect control, but repeated applications will likely exacerbate resistance in TBW populations, lead to continued control failures, and deteriorate their usefulness. Growers and cotton consultants in the mid-south need additional tools to manage TBW/CB and BAW infestations. One such tool is PIRATE, a broad-spectrum insecticide being developed by American Cyanamid Company. With full registration expected in 1997, PIRATE has been extensively evaluated under both Experimental Use Permits and Section 18s. In 1995, Section 18s were granted in AL, AR, FL, GA, LA, MS, and TX, and in excess of 200,000 acres were treated with PIRATE.

PIRATE Insecticide-Miticide

PIRATE was discovered and patented by American Cyanamid Company and is a novel insecticide-miticide from the pyrrole class of chemistry. Laboratory and field studies have shown that PIRATE controls a wide spectrum of cotton insect pests including TBW, CB, and BAW (Miller et al. 1990, Farlow et al., 1992, Whitehead et al. 1993, Townsend 1995, Watkins & Reed 1995, Wiley et al. 1995, Whitehead & Treacy 1995). The mode of action and physico-chemical properties of PIRATE contribute to the usefulness of PIRATE for cotton insect pest management.

The mode of action of PIRATE is unique compared with other insecticides. After PIRATE enters an insect through the cuticle or by ingestion, mixed function oxidase enzymes convert PIRATE from a pro-insecticide to the active insecticide (Treacy et al. 1994). Upon activation, PIRATE disrupts the electrochemical gradient that exists across the mitochondrial membrane. Without the gradient, ADP cannot be converted to ATP, a critical cellular energy source; and thus, the insect cannot produce sufficient energy to survive. Cross-resistance between PIRATE and carbamate, cyclodiene, organophosphate, organotin, organochlorine, and pyrethroid insecticides has not been observed in extensive testing of insecticide resistant insect

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pests including tobacco budworm, soybean looper, and two-spotted spider mite (Anonymous 1994).

The active ingredient in PIRATE is highly lipophilic which contributes to excellent rainfastness on foliage, translaminar activity, and immobility in soil. After application to foliage, PIRATE is rapidly absorbed into the leaf resulting in excellent rainfastness. In a recent study, PIRATE was rainfast on cotton 30 minutes after application (personal communication, B. R. Leonard). After absorption into the leaf, PIRATE has good translaminar movement resulting in excellent control of insects feeding on the leaf undersurface such as armyworms, loopers, and mites (Anonymous 1994). PIRATE is stable to hydrolysis which results in excellent stability in the spray tank. Finally, high lipopholicity, low water solubility, and high binding capacity contribute to the immobility of PIRATE in soil. These properties minimize the potential for exposure to non-target organisms. This was demonstrated in the monitoring program associated with the section 18 for PIRATE where no adverse effects on avian or aquatic organisms were observed.

Objectives

In 1994, the Environmental Protection Agency granted American Cyanamid an Experimental Use Permit (EUP) for PIRATE. American Cyanamid initiated large scale PIRATE EUP trials in 1994 and 1995 to compare PIRATE with commercial insecticide standards for control of cotton insect pests, particularly insecticide resistant TBW populations, and to introduce and demonstrate performance of PIRATE to cotton consultants, growers, and University/Extension personnel.

This manuscript summarizes the 1995 PIRATE EUP Demonstration trials conducted on cotton in Arkansas, Louisiana, Mississippi, and Tennessee. These trials compare PIRATE tank mixtures at 0.2-0.25 lb (AI)/acre and PIRATE stand alone at 0.3-0.35 lb (AI)/acre with commercial standards for control of tobacco budworm and cotton bollworm.

Materials and Methods

PIRATE Treatments Tested in Demonstration Trials

Stand alone treatments of PIRATE® 3SC Insecticide-Miticide (American Cyanamid, Princeton, NJ) were tested at 0.3-0.35 lb (AI)/acre. PIRATE 3SC at 0.2-0.25 lb (AI)/acre was also evaluated in tank mixtures with chemical insecticides where both products were targeting tobacco budworm (TBW) and cotton bollworm (CB). Carbamate tank mix partners included Lannate® 1.8L (E. I. du Pont De Nemours and Co., Inc. Wilmington, DE) at 0.125, 0.24-0.25, and 0.4 lb (AI)/acre and Larvin® 3.2F (Rhone Poulenc Agricultural Co., Research Triangle Park, NC) at 0.25-0.267, and 0.64 lb (AI)/acre. Organophosphate tank mix partners included Bolstar® 6EC (Miles Inc., Kansas City, KS), 0.5 and 0.6 lb (AI)/acre and Curacron® 8E (Ciba Geigy Agricultural Division, Greensboro, NC), 0.25, 0.5-0.531, 0.67, and 0.75 lb (AI)/acre. Ovicide tank mix partners included Ovasyn® 1.5E (AgrEvo, North Summerville, NJ), 0.15, 0.2, and 0.25 lb(AI)/acre. Pyrethroid tank mix partners included Ammo® 2.5EC (FMC Corporation, Philadelphia, PA), 0.066 lb (AI)/acre; Asana XL® 0.66EC (E. I. du Pont De Nemours and Co., Inc. Wilmington, DE), 0.044 lb (AI)/acre; Baythroid® 2E (Miles Inc., Kansas City, KS), 0.029, 0.033, and 0.036 lb (AI)/acre; Fury® 1.5E (FMC Corporation, Philadelphia, PA), 0.038 lb (AI)/acre; Karate® 1E (Zeneca Agricultural Products, Wilmington, DE), 0.025, 0.029, 0.03, 0.031, and 0.033 lb (AI)/acre; and Scout X-tra® 0.9E (AgrEvo, North Summerville, NJ), 0.022 and 0.024 lb (AI)/acre.

In the data summary, carbamates and organophosphates are separated into low and high rates. 'Low rates' include Larvin, Curacron, and Bolstar at less than or equal to 0.5 lb (AI)/acre and Lannate at less than or equal to 0.25 lb (AI)/acre. Any rate above the low rate threshold is considered the 'high rate.'

Comparison Treatments Tested in Demonstration Trials

PIRATE was compared with stand alone and tank mixture treatments. Stand alone treatments included carbamate (Lannate 1.8L at 0.3 and 0.45 lb [AI]/acre and Larvin 3.2F at 0.6, 0.64, and 0.8 lb [AI]/acre) and organophosphate (Bolstar 6EC at 0.6 and 1.0 lb [AI]/acre and Curacron 8E at 1.0 lb [AI]/acre) insecticides. Tank mixtures focused on pyrethroids mixed with one or more ovicidal (Ovasyn), carbamate, organophosphate, or *Bacillus thuringiensis* (*Bt*) insecticides. *Bt*-based insecticides included Condor OF® (Ecogen, Inc., Langhorne, PA), Design® (Ciba Geigy Agricultural Division, Greensboro, NC), Dipel ES® (Abbott Laboratories, North Chicago, IL), and MVP® (Mycogen Corporation, San Diego, CA). Mixtures of carbamate and organophosphate insecticides were also tested.

Demonstration Trial Methodology

During 1995, aerial (2-5 gpa) and ground applications (4-10 gpa) of PIRATE were extensively evaluated for control of the tobacco budworm and cotton bollworm complex (TBW/CB). Each EUP Demonstration trial was conducted on a cotton field ranging in size from approximately 20 to 80 acres in size.

PIRATE EUP cooperators consisted of cotton consultants and University/ Extension personnel from the Mid-South states of AR, LA, MS, and TN. Each cooperator chose the farmers and fields for the trial and selected the comparison treatment(s), method of application, and timing of the applications. The field selected for each trial was partitioned into two or more similar blocks. All blocks were treated identically except for insecticide treatments. In each block, cotton terminals and squares were sampled for TBW and CB eggs, larvae, and larval feeding damage.

Field counts (pre and post treatment application) were conducted by cotton consultants and at some locations by American Cyanamid personnel. Consultants provided a summary of crop phenology, application information, insect counts, and comments. A total of 45 trials (24 aerial and 21 ground-applied) were completed and summarized (Table 1).

Control of TBW/CB larvae was the criteria used for assessing treatment performance. To calculate percentage control of TBW/CB larval populations, the mean number of larvae counted after application (post treatment) was divided by the mean number of eggs and larvae (i.e., biological units) before application (pretreatment); the resulting value was subtracted from one and then multiplied by 100 (French 1995). If the difference in larval control between two treatments did not exceed 15%, performance of treatments was considered equal. From the 45 Demonstration trials, 146 product compari-sons were made. The number of comparisons exceeds the number of Demon-stration trials, because some trials consisted of more than two treatments or more than one application. Data were also summarized across all trials as control of TBW/CB larvae and as surviving TBW/CB larvae observed 2-7 days post treatment. Because the PIRATE and comparison treatments were not always applied at each application date and some trials consisted of more than two treatments, sample size reported in Table 9 may differ from the number of paired comparisons reported in Tables 2-8.

Results and Discussion

Demonstration Trial Overview

Across all comparisons, the performance of PIRATE stand alone and tank mixture treatments for control of the tobacco budworm and cotton bollworm complex (TBW/CB) was equal to or superior to competitive treatments in 127 out of 146 comparisons (Table 2). PIRATE was superior to competitive treatments in 31% of the comparisons, whereas the competitive treatment was superior to PIRATE in only 13% of the comparisons.

PIRATE was compatible with all tank mixtures tested in the PIRATE EUP trials. No mixing problems with PIRATE were reported by crop consultants, commercial applicators, or growers. After mixing in the spray tank, no clumping, settling in the spray tank, or clogging of nozzle tips was observed.

Product Performance: PIRATE Stand Alone

PIRATE stand alone at 0.3-0.35 lb (AI)/acre outperformed competitive treatments in 33% comparisons (Table 3). In 81% of the comparisons, PIRATE was superior or equal to the comparison treatment. PIRATE was more frequently superior to an organophosphate or carbamate insecticide applied stand alone compared with pyrethroid or organophosphate and carbamate tank mixtures.

Product Performance: PIRATE Tank Mixtures

As an overview, PIRATE at 0.2-0.25 lb (AI)/acre tank mixed with an organophosphate, carbamate, or pyrethroid insecticide was superior to the comparison treatment in 32 of 97 comparisons (Table 4, 5, and 6). Control of TBW/CB larvae ranged from 84% to 92% except for PIRATE mixed with a low rate of carbamate insecticide (Table 9). Larvae surviving post treatment ranged from 2% to 6% (Table 10).

When tank mixed with the low rate of a carbamate insecticide (Larvin, <0.5 lb [AI]/acre or Lannate, <0.26 lb [AI]/acre), PIRATE was equal to the competitive treatment in 11 of 17 comparisons (65%) and superior in 6 of 17 comparisons (35%) (Table 4). The competitive treatment was not judged superior to the PIRATE mixture in any of the comparisons. Similar results were found with PIRATE tank mixed with the high rate of organophosphate insecticides (Bolstar, 0.6 and 1.0 lb [AI]/acre, and Curacron, 1.0 lb [AI]/acre) except the competitive treatment was superior in 3 of 18 comparisons (Table 5). Most PIRATE tank mixtures with pyrethroid insecticide were compared to a pyrethroid tank mixture (Table 6), and the PIRATE tank mixture outperformed the pyrethroid tank mixture in 32% of the 44 comparisons.

PIRATE mixed with Ovasyn at 0.15-0.25 lb (AI)/acre was less efficacious or equal to the pyrethroid tank mixture in all seven of the comparisons (Table 7). However, the efficacy for PIRATE + Ovasyn was consistently high with a median of 92% control (Table 9).

Product Performance: PIRATE Stand Alone vs. PIRATE Tank Mixtures

PIRATE stand alone performance was generally equivalent to PIRATE tank mixtures across all 25 comparisons (Table 8). PIRATE stand alone at 0.35 was not compared with PIRATE tank mixed at 0.2 nor was PIRATE stand alone at 0.3 compared with PIRATE tank mixed at 0.25.

Control of TBW/CB Across Trials

Percent control of TBW/CB larvae was highest for PIRATE tank mixed with Ovasyn (93%), the high rate of carbamate or organophosphate insecticide mixed with PIRATE (91-92%), and a mixture of carbamate (high rate) and organophosphate (89%) (Table 9). PIRATE tank mixed with a pyrethroid or organophosphate (low rate) insecticide provided 84-85% control. Median control for PIRATE mixed with the low rate of a carbamate or organophos-phate insecticide, a carbamate or organophosphate stand alone, and PIRATE stand alone ranged from 77-81%. The lowest control (71-75%) was observed with pyrethroid stand alone, pyrethroid tank mixtures, and organophosphate tank mixtures.

Survival of TBW/CB Across Trials

Larval survival post treatment was lowest (2%) for PIRATE mixed with the high rate of an organophosphate insecticide or Ovasyn (Table 10). PIRATE tank mixtures with a

pyrethroid, low rate of an organophosphate, and high rate of a carbamate had a median larval survival of 4%. All other treatments including PIRATE stand alone (7.4%) had 6-10% surviving larvae.

Summary

Results from the 45 PIRATE EUP trials conducted in the Mid-South demonstrate that PIRATE will be an effective insect pest management tool in mid-south cotton production. PIRATE was successfully applied by ground and air with no handling, mixing, or application complaints. Large-scale applications of PIRATE tested alone (0.3-0.35 lb AI/acre) or when tank-mixed (0.2-0.25 lb AI/acre) with a companion insecticide were efficacious against TBW/CB including resistant TBW. Of the 146 comparisons of PIRATE with commercial insecticides for TBW/CB control, PIRATE was equal to or superior to the comparison treatment in 129 comparisons (87%).

The PIRATE rate range for TBW/CB control (0.2-0.35 lb AI/acre) exceeds the effective rates for control of soybean and cabbage loopers (0.1-0.2 lb AI/acre), beet and fall armyworms (0.15-0.2 lb AI/acre), and two-spotted spider mites (0.15 lb AI/acre) (Miller et al. 1990, Farlow et al. 1992, Whitehead et al. 1993, Wiley et al. 1995). Thus, PIRATE applications targeting TBW/CB will be successful against a wide range of insect pests and mites that commonly infest cotton.

The utility of the new mode of action offered with PIRATE is clearly indicated by the positive results from the 1995 EUP Program against TBW/CB and broad spectrum of efficacy against many cotton insect and mite pests. PIRATE can successfully address the currrent and critical problem of insecticide resistant TBW populations while maintaining excellent control of other cotton insect pests. These attributes demonstrate the value of PIRATE as a tool for insect pest management in Mid-South cotton production.

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Table 1. Application methods in 1995 PIRATE EUP trials conducted in mid-south cotton.

	Ground		
	Aerial	Applied	TOTAL
Arkansas	7	1	8
Louisiana	7	12	19
Mississippi	9	8	17
Tennessee	1	0	1
TOTAL	24	21	45

Table 2. Performance summary of PIRATE compared with commercial standards for control of tobacco budworm and cotton bollworm in mid-south cotton, 1995 PIRATE EUP trials.

	Which product was superior?			Total # of
	PIRATE	Comp. Trt.	Equal	comparisons
PIRATE stand alone	14	8	20	42
(as %)	33%	19%	48%	100%
PIRATE tank mixtures	32	11	61	104
(as %)	31%	11%	58%	100%
TOTAL	**46**	**19**	**81**	**146**
(as %)	32%	13%	55%	100%

Table 3. Performance of PIRATE (0.3-0.35 lb [AI]/acre) compared with commercial standards for control of tobacco budworm and cotton bollworm in mid-south cotton, 1995 PIRATE EUP trials.

	Which product was superior?			Total # of
	PIRATE	Comp. Trt.	Equal	comparisons
PIRATE stand alone				
vs. Pyrethroid TM	8	6	13	27
vs. OP or Carb. SA	5	1	4	10
vs. OP and Carb. TM	1	1	3	5
TOTAL	**14**	**8**	**20**	**42**
(as %)	33%	19%	48%	100%

TM = tank mixture; SA = stand alone; OP and Carb. = organophosphate and carbamate insecticides, respectively; OP or Carb. SA = Curacron 8E, Bolstar 6E, or Larvin >0.5 lb (AI)/acre, or Lannate > 0.25 lb (AI)/acre.

Table 4. Performance of PIRATE (0.2-0.25 lb [AI]/acre) tank mixed with low rates of carbamate insecticides compared with commercial standards for control of tobacco budworm and cotton bollworm in mid-south cotton, 1995 PIRATE EUP trials.

	Which product was superior?			Total # of
	PIRATE	Comp. Trt.	Equal	comparisons
PIRATE + low rate Carb.				
vs. pyrethroid TM	2	0	6	8
vs. OP or Carb. SA	1	0	5	6
vs. OP and Carb. TM.	3	0	0	3
TOTAL	**6**	**0**	**11**	**17**
(as %)	35%	0%	65%	100%

Low rate Carb. = Larvin <0.51 lb (AI)/acre and Lannate <0.26 lb (AI)/acre; TM = tank mixture; SA = stand alone; OP and Carb. = organophosphate and carbamate insecticides, respectively; OP or Carb. SA = Curacron 8E, Bolstar 6E, or Larvin >0.5 lb (AI)/acre, or Lannate > 0.25 lb (AI)/acre.

Table 5. Performance of PIRATE (0.2-0.25 lb [AI]/acre) tank mixed with organophosphate insecticides compared with commercial standards for control of tobacco budworm and cotton bollworm in mid-south cotton, 1995 PIRATE EUP trials.

	Which product was superior?			Total # of
	PIRATE	Comp. Trt.	Equal	comparisons
PIRATE + low rate OP				
vs. pyrethroid TM	6	3	7	16
vs. OP or Carb. SA	1	0	1	2
TOTAL	**7**	**3**	**8**	**18**
(as %)	39%	17%	44%	100%
PIRATE + high rate OP				
vs. pyrethroid TM	4	0	2	6
vs. OP or Carb. SA	0	0	2	2
vs. OP and Carb. TM	0	0	3	3
TOTAL	**4**	**0**	**7**	**11**
(as %)	36%	0%	64%	100%

Low rate OP = Curacron 8E or Bolstar 6E <0.51 lb (AI)/acre; high rate OP = Curacron 8E or Bolstar 6E >0.5 lb (AI)/acre; TM = tank mixture; SA = stand alone; OP and Carb. = organophosphate and carbamate insecticides, respectively; OP or Carb. SA = Curacron 8E, Bolstar 6E, or Larvin >0.5 lb (AI)/acre, or Lannate > 0.25 lb (AI)/acre.

Table 6. Performance of PIRATE (0.2-0.25 lb [AI]/acre) tank mixed with pyrethroid insecticides compared with commercial standards for control of tobacco budworm and cotton bollworm in mid-south cotton, 1995 PIRATE EUP trials.

	Which product was superior?			Total # of
	PIRATE	Comp. Trt.	Equal	comparisons
PIRATE + Pyrethroid				
vs. Pyrethroid TM	14	5	25	44
vs. OP or Carb. SA	1	1	4	6
vs. OP and Carb. TM	0	0	1	1
TOTAL	**15**	**6**	**30**	**51**
(as %)	29%	12%	59%	100%

TM = tank mixture; SA = stand alone; OP and Carb. = organophosphate and carbamate insecticides, respectively; OP or Carb. SA = Curacron 8E, Bolstar 6E, or Larvin >0.5 lb (AI)/acre, or Lannate > 0.25 lb (AI)/acre.

Table 7. Performance of PIRATE (0.2-0.25 lb [AI]/acre) tank mixed with Ovasyn 1.5E (0.15-0.25 lb [AI]/acre) compared with pyrethroid tank mixtures for control of tobacco budworm and cotton bollworm in mid-south cotton, 1995 PIRATE EUP trials.

	Which product was superior?			Total # of
	PIRATE	Comp. Trt.	Equal	comparisons
PIRATE (0.2) + Ovasyn				
vs. Pyrethroid TM	0	1	2	3
PIRATE (0.25) + Ovasyn				
vs. Pyrethroid TM	0	1	3	4
TOTAL	**0**	**2**	**5**	**7**
(as %)	0%	29%	71%	100%

TM = tank mixture.

Table 8. Comparison of PIRATE (0.3-0.35 lb [AI]/acre) with PIRATE (0.2-0.25 lb [AI]/acre) tank mixtures for control of tobacco budworm and cotton bollworm in mid-south cotton, 1995 PIRATE EUP trials.

	Which product was superior?			
Rate(lb [AI]/acre)	PIRATE Stand Alone	PIRATE Tank Mixture	Equal	Total # of comparisons
PIRATE (0.3) SA vs. PIRATE (0.2) TM	0	2	7	9
PIRATE (0.35) SA vs. PIRATE (0.25) TM	3	2	11	16
TOTAL	**3**	**4**	**18**	**25**
(as %)	12%	16%	72%	100%

TM = tank mixture and SA = stand alone.

Table 9. Efficacy of PIRATE for control of tobacco budworm (TBW) and cotton bollworm (CB) in 1995 PIRATE EUP trials on mid-south cotton

	Median percent control of TBW/CB					
	Tank-mixed with PIRATE 0.2-0.25 lb (AI)/acre		Applied as stand alone		Applied as tank mixture	
Pyrethroid	84	(55)	75	(10)	71	(90)
Organophosphate low rate	85	(20)	---		---	
Organophosphate high rate	92	(10)	81	(10)	72	(11)
Carbamate low rate	77	(15)	---		---	
Carbamate high rate	91	(4)	78	(8)	89	(5)
Ovasyn	93	(9)	---		---	
PIRATE (0.3-0.35 lb AI/acre)	---		78	(42)	--	

Number in parentheses ( ) indicates sample size. Organophosphate low rate = Curacron 8E or Bolstar 6E <0.51 lb (AI)/acre and high = Curacron 8E or Bolstar 6E >0.5 lb (AI)/acre; carbamate low rate = Larvin <0.51 lb (AI)/acre and Lannate <0.26 lb (AI)/acre and high rate = Larvin >0.5 lb (AI)/acre and Lannate >0.25 lb (AI)/acre; Ovasyn rate = 0.125-0.25 lb (AI)/acre.

Table 10. Survival of tobacco budworm (TBW) and cotton bollworm (CB) in 1995 PIRATE EUP trials on mid-south cotton.

	Median percent TBW/CB larvae surviving after treatment		
	Tank-mixed with PIRATE 0.2-0.25 lb (AI)/acre	Applied as stand alone	Applied as tank mixture
Pyrethroid	4.0	7.0	6.0
Organophosphate low rate	4.0	---	---
Organophosphate high rate	2.0	10.0	6.0
Carbamate low rate	6.0	---	---
Carbamate high rate	4.0	6.0	6.0
Ovasyn	2.0	---	---
PIRATE (0.3-0.35 lb AI/acre)	---	7.4	---

Organophosphate low rate = Curacron 8E or Bolstar 6E <0.51 lb (AI)/acre and high = Curacron 8E or Bolstar 6E >0.5 lb (AI)/acre; carbamate low rate = Larvin <0.51 lb (AI)/acre and Lannate <0.26 lb (AI)/acre and high rate = Larvin >0.5 lb (AI)/acre and Lannate >0.25 lb (AI)/acre; Ovasyn rate = 0.125-0.25 lb (AI)/acre.