Effects of Abamectin on Peachtree Borers in the Laboratory and in Peach Orchards (Lepidoptera: Sesiidae)[1,2]

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ABSTRACT Abamectin was effective in reducing egg hatch, larval survival, adult mating behavior and oviposition of the lesser peachtree borer, *Synanthedon pictipes* (Grote and Robinson) LPTB, and egg hatch and larval survival of the peachtree borer, *Synanthedon exitisoa* (Say) PTB, in the laboratory at rates of 10 and 20 ppm. Subsequently, tests in peach orchards with comparable rates of abamectin were effective in reducing PTB populations in Peach and Taylor counties, Georgia. Although abamectin was less effective than chlorpyrifos (standard recommendation) for PTB control, it warrants consideration as an alternative for control because it is a natural product derivative and probably poses little threat to the environment.

KEY WORDS Peachtree borers, abamectin, pheromone, trapping, chlorpyrifos, *Synanthedon pictipes*, *S. exitiosa*, control.

Abamectin, a streptomycete-derived macrocyclic lactone developed by the Merck Sharp and Dohme Research Laboratory was first introduced to agriculture in 1979 (Putter et al. 1981). Although it appears to be most effective when ingested by the target organism, contact activity has also been observed against most insect species. It is toxic to a broad spectrum of invertebrate pests including imported fire ants (Lofgren et al. 1982), yellow jackets (Parrish et al. 1984), boll weevils (Wright 1984) and alfalfa weevils (Pienskowski and Mehring 1983).

Studies with pink bollworm adults treated with abamectin revealed that mating and oviposition were completely prevented at certain dose levels although little mortality was reported. Also hatching of treated eggs was reduced (Bariola 1984). More recently, abamectin was reported to have abnormal effects on neural activity and on sensory systems resulting in restricted crawl, posture and flight activity of bollworm moths (Agee 1985). Since these reported data have shown beneficial results in all developmental stages of the Lepidopteran life cycle, lesser peachtree borer (LPTB), *Synanthedon pictipes* (Grote and Robinson), and peachtree borer (PTB), *Synanthedon exitiosa* (Say), appeared to be good candidates for laboratory testing.

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[2] This paper reports the results of research only. Mention of a pesticide does not constitute a recommendation for use by the USDA nor does it imply registration under FIFRA as amended. Also, mention of a commercial or proprietary product does not constitute an endorsement by the USDA.

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The purpose of this paper is to describe the effects of abamectin observed on several life stages of the peachtree borers in laboratory tests, and results from some of other tests in peach orchards for control efficacy.

Materials and Methods

Abamectin 0.15 EC (MK-936) was first tested on laboratory reared larvae of LPTB. Larvae were recovered from thinning apples (rearing media) and separated into two size categories. 25 mg (2nd instar) and 70 mg (5th instar); and then treated topically with prepared formulations of 10 and 20 ppm abamectin using an aerosol applicator. Spray was directed from 15 to 20 cm above each individually treated larvae for one second. Larvae were contained in open petri dishes on filter paper. After drying for three minutes, each larva was gently moved with flexible forceps onto artificial diet in a 30 ml plastic cup and capped (Antonio et al. 1975). Water was administered in a similar manner to comparable numbers of larvae of both size categories to provide an untreated check for all treatments. The insects' behavior and survival were monitored at 7 and 14 days post-treatment. Surviving larvae were observed through pupation and their subsequent eclosion was recorded. A total of 84 larvae (14/treatment) was used in the replicated test.

Concurrently, abamectin was tested on eggs from laboratory reared LPTB and field mated PTB females. Female PTB were obtained from pupae (cocoons) collected from infested commercial peach orchards and then stored at 28° C, 80% RH in environmentally controlled chambers in the laboratory. After emergence, females were taken to nearby PTB infested orchards for mating. Gravid females were returned to the laboratory for testing. Females were allowed to oviposit on filter paper in covered polystyrene petri dishes (100 × 15 mm). After one day adults were removed and their eggs were immediately treated with 10 and 20 ppm of abamectin as described above. Eggs of PTB were also treated by the same method. Thirty LPTB and 10 PTB gravid females were used to obtain eggs for testing.

Adults of laboratory reared LPTB were treated with 20 ppm of abamectin as described above. Treatments were: (A) treated gravid females; (B) treated males paired with untreated females after application; (C) treated females paired with untreated males after application; and (D) untreated gravid females. Behavioral responses of both sexes in all treatments and controls were observed and number of eggs laid and egg viability were recorded. Replications of individual females or pairs of both sexes ranged from 12 to 18.

Field testing of abamectin in peach orchards was initiated in 1985 in Peach County, Georgia. We determined that PTB were better suited than LPTB for control evaluations because: (1) The moth flight of PTB is short (6-8 wks) and occurs after harvest; (2) Spraying would be limited to lower scaffold limbs and the trunk since most oviposition occurs on these structures and young larvae move down to eventually enter the tree at the base to begin feeding on roots (Snapp 1943); (3) evaluations can be made by counting eclosed pupae (cocoons) after seasonal flight and by counting frass mounds indicating new larval entries at the base of the trees.

A block of 'Redglobe' peach, ca 3 ha (839 trees), bordered by hay fields and pastures, was selected for treatment. A portion of a larger orchard ('Dixiland' cultivar) of comparable size served as the untreated control. This was not a replicated test. Both orchards were 7 years old and had received standard recommended PTB treatments (chlorpyrifos at 2.27 kg ai per ha) beginning at second leaf and continuing for 7 consecutive years, 1978 to 1984. The commercial peach grower stopped all PTB treatments in 1984 in both orchards before abamectin testing began in 1985. The test orchard received an application of abamectin in mid-September at the peak of moth flight activity. The check orchard received no PTB treatment.

Spray was delivered with a portable John Bean handgun sprayer at 300 psi. The spraying apparatus consisted of the spray pump and a 189 *l* tank mounted on a small rubber-tired metal trailer and pulled by a small Sears® garden tractor. Abamectin 0.15EC was mixed at the rate of 287 m*l*/tank (22.96 ppm). Treatments were made in 1985, 1986, and 1987. Efficacy evaluations were made in November and December after the seasonal moth flight each year by counting eclosed pupal cases (cocoons) at the base of the trees. Fifty percent of all treated and untreated check trees were examined during five seasons.

In 1987, a larger replicated test was initiated in Taylor County, Georgia, using 7-yr-old 'Redcap' scions on 'Lovell' rootstock (16 ha). Spraying for PTB had never been done in the orchard. Chlorpyrifos (3.6 ai/*l*) was included as the standard to compare with abamectin. Spraying procedures were the same as previously described. One PTB pheromone trap was monitored in the center of each of the 400 tree replicated plots (3 treatments × 4 reps = 12 plots). Chlorpyrifos treatments were applied on August 14, 1987 and on August 11, 1988. Abamectin was applied on September 15, 1987 and September 13, 1988. Trap counts were made weekly April - October and cocoon and new larval entries were counted once each yr. after moth flight (Nov. and Dec.) for 1987, 1988, and 1989. A total of 100 trees (25%) was sampled from each plot each year.

Results

Application of abamectin to LPTB larvae. Second instar larvae were affected more by 20 ppm treatments (43% mortality) than be 10 ppm treatments (14% mortality) after 14 days. None from the higher rate pupated and completed to adults. Fifth instar larvae, although apparently unaffected after 14 days, were indeed affected at the 20 ppm treatment because none pupated and completed to adults while 14% completed to adults from the 10 ppm treatment compared to 86% in the untreated (Table 1).

Application of abamectin to LPTB and PTB eggs. Viability of LPTB eggs, treated with 10 and 20 ppm of abamectin, did not differ significantly from the untreated eggs. PTB eggs treated with 10 ppm showed a significant reduction ($P = 0.05$) in egg hatch (Table 2).

Application of abamectin to LPTB adults. Treated males, paired with untreated females, were erratic and sluggish in flight, and only 4 of 16 (25%) of them responded and mated with 'calling' females. Oviposition of treated gravid females was significantly lower than untreated gravid females. When females were treated before being placed with males, calling and mating was apparently unaffected but few eggs were laid. When males were treated before they were paired with untreated females, fewer males responded to mating even though females were calling aggressively. However, number of eggs laid was reduced. Egg viability was significantly different ($P = <0.001$) for all treatment combinations except AC (Table 3).

Table 1. Effects of abamectin on larvae of LPTB, Byron, GA 1982.

Rate	Percent survival post-treatment		Percent completed
(PPM)	7 d	14 d	to adults
	Second instar larvae		
20	57	57	0
10	86	86	29
Ck	100	100	29
	Fifth instar larvae		
20	100	100	0
10	100	100	14
check	100	100	86

Table 2. Effects of abamectin on eggs of LPTB and PTB, Byron, GA, 1983.

	LPTB			PTB		
Rate (ppm)	No. eggs treated	No. eggs hatched	% survival*	No. eggs treated	No. eggs hatched	% survival*
20	1126	559	49.6 a	—	—	—
10	809	467	57.7 a	591	136	23.0 a
check	1293	945	73.0 a	603	424	70.1 b

* Means followed by the same letter in a column are not significantly different as determined by DNMRT (P = 0.05) (Duncan 1955).

Peach orchard treatments for PTB. Efficacy data was first collected in November 1985 in Peach County, following the first year's application of abamectin. Cocoon counts represented nearly all existing PTB's inasmuch as the effects of the 1985 treatments would not be known until the following year when surviving larvae successfully fed in the trees, pupated in the soil, and eclosed as adults. The 1985 cocoon counts were nearly the same in treated and non-treated orchards (Table 4). In 1986, following the second year's application of abamectin, cocoon counts were reduced from 0.41/tree to 0.07/tree while cocoon counts in the untreated orchard were 0.54/tree and 0.41/tree during the same time. From 1987 through 1989, cocoon counts remained somewhat lower in the treated orchard than in the untreated orchard, but by 1989, cocoon counts were up from the previous year and there was little difference in cocoon counts for both treated and untreated orchards (Table 4).

In the Taylor County, Georgia test, the 1987, cocoon counts were not different as expected (Table 5). New larval entries, however, were significantly less (P = 0.02) in the abamectin and chlorpyrifos treatments than the check. Pheromone trap

Table 3. Effects of abamectin (20 ppm) on oviposition and viability of eggs of LPTB applied to adults before or after mating, Byron, GA 1984.

Treatment*	Number females	Egg laid per female†	Egg viability Live	Egg viability Dead	% Hatch
A. + G females	12	16.6 b	189	175	52
B. + males & - females	4	48.1 bc	98	148	40
C. + females & - males	16	2.8 a	80	58	58
D. - G females	18	53.6 c	1,291	238	84

Treatment comparisons for egg viability‡

AB = < 0.001	AC = 0.266NS	AD = < 0.001
BC - < 0.001	BD = < 0.001	CD = < 0.001

* Treatments B and C treated before mating; + = treated, - = not treated, G = gravid.

† Values followed by the same letter in a column are not significantly different as determined by Fisher's protected LSD (P = 0.05); values are antilogs of means of data transformed to log 10.

‡ Comparisons AB, AD, BC, BD, and CD were significantly different (P = < 0.001) as determined by chi-square test using Yate's correction for continuity.

Table 4. Comparison of an abamectin treated peach orchard with an untreated orchard for peachtree borer control Peach County, GA, 1985-1989.

Treated*	Year evaluated	Mean no. cocoons per tree: abamectin	Mean no. cocoons per tree: untreated
1985	1985	0.41	0.54
1986	1986	0.07	0.41
1987	1987	0.12	0.19
—	1988	0.08	0.18
—	1989	0.27	0.30

* Treated once each of 3 yrs on September 10, 1985; September 10, 1986; September 15, 1987.

captures of males were not significantly different. The same pattern was observed in 1988 except that new larval entries were significantly different (P = 0.001) between abamectin (x = 170.5b) and chlorpyrifos (x = 6.75c) and between the insecticide treatments and the untreated check (x = 483.25 a). It was not until 1989 that differences were observed with cocoon counts. New larval entries were significantly less in chlorpyrifos treatments. Trap captures of males were not significantly different (Table 5).

Table 5. Comparison of abamectin and chlorpyrifos treated peach trees for control of the peachtree borer, Taylor county, GA, 1987-89.*

		Mean Number†		
Year	Treatment	cocoons	new larval entries	pheromone trapping
1987	abamectin	22.75 a	26.50 b	101.75 a
	chlorpyrifos	47.50 a	6.00 b	88.00 a
	Untreated	27.50 a	60.00 a	88.25 a
		Trt.P = NS	Trt.P = 0.02	Trt.P = NS
1988	abamectin	82.25 a	170.50 b	44.00 a
	chlorpyifos	60.00 a	6.75 c	29.00 a
	Untreated	104.00 a	483.25 a	49.00 a
		Trt.P = NS	Trt.P = < 0.001	Trt.P = NS
1989‡	abamectin	74.50 ab	255.00 a	27.00 a
	chlorpyrifos	26.50 b	67.50 b	13.50 a
	Untreated	93.25 a	307.25 a	28.25 a
		Trt.P = 0.06	Trt.P = 0.02	Trt.P = NS

* Treatments=abamectin @ 16.7 g ai/ha and chlorpyrifos @ 2.27 kg ai/ha.

† Data analyzed is total/experimental unit; Duncan's multiple range test for variable.

‡ No insecticide treatments were administered in 1989.

Discussion

In the Peach County, GA test where a comparison of abamectin and untreated peach orchards were evaluated for PTB control, cocoon counts remained lower in the treated orchard two years after treatments stopped. However, the final year of evaluation (1989), showed that cocoon counts were about the same for both treated and untreated controls. It appeared that continued yearly treatments would have sustained the PTB population at a lower level lower than in untreated. However, the untreated orchard also showed a decreasing population for four consecutive years before an increase was evident in 1989 (final yr of evaluation). We can only speculate that low rainfall during 1987 and 1988 may have affected PTB populations and their ability to survive during drought stressed years (Table 4).

Unlike the Peach County test, the Taylor County test showed that the PTB population was apparently stressed only during 1987, and recovery was evident in 1988. This phenomenon is indicated by cocoon counts and new larval entries (Table 5).

The third method of evaluation in the Taylor County test (pheromone trapping) revealed that there were no differences among treatments for any of the three years. However, it is noteworthy that the overall PTB adult population was consistently less after each year of trapping. It appears that combined treatments during the test period may have suppressed the PTB population in this relatively large (16 ha) peach orchard. Although abamectin exerted some control of the PTB population, it was not as good as chlorpyrifos, the standard recommended treatment.

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