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LD50S BY TOPICAL APPLICATION AND COMPARATIVE INITIAL AND RESIDUAL TOXICITY OF PYRETHROID, ORGANOCHLORINE AND ORGANOPHOSPHORUS INSECTICIDES IN FIELD TESTS AGAINST THE BOLL WEEVIL

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Abstract

LD50s of methyl parathion and fenpropathrin ranged from 0.0027 to 0.0089 µg/weevil, indicating susceptibility. The LD50 of methidathion was 0.037 µg/weevil, indicating susceptibility. On 0 d one spray each of cyfluthrin, *lambda* cyhalothrin, bifenthrin and zeta cypermethrin to cotton plants showed 5% to 30% mortality of boll weevils. Seven d later the mortalities were within this same range. On 0 d one spray each of malathion, endosulfan and azinphosmethyl showed 90% to 100% mortalities. Azinphosmethyl, malathion and endosulfan caused 70%, 30% and 12% mortality after seven d, respectively. Mortalities for cyfluthrin, zeta cypermethrin and *lambda* cyhalothrin peaked at 95%, 70% and 72% on 3, 2 and 3 d, respectively. This suggests a repellency by pyrethroids on 0 and 1 d. Field tests with season long sprays of bifenthrin and endosulfan alone, a mixture and alternate applications of the insecticides showed variation in efficacy, determined by damaged squares, against the boll weevil in 1993 and 1994. In 1993 endosulfan, the mixture and alternate applications of bifenthrin and endosulfan were significantly more effective than the untreated. In 1994, none of the treatments were significantly more effective than the untreated. Damage levels were the greatest in 1994.

Introduction

Insecticides of the organophosphorus class i.e. methyl parathion and malathion, are more widely used against the boll weevil, *Anthonomus grandis [*Boheman] in the Americas than insecticides of any other class. Azinphosmethyl has been widely used in the United States of America, but in two y will no longer be registered for use on cotton in the Lower Rio Grande Valley (LRGV). Its efficacy against the boll weevil declined in the early 1990s (Wolfenbarger 2002). The organochlorine insecticide, i.e. endosulfan, is registered for use against the boll weevil in the United States, but its cost has prevented its widespread use. Pyrethroid insecticides can control the boll weevil in the Americas at maximum use rates applied at frequent intervals which increases costs.

A laboratory strain of adult weevils held in field cages on foliage treated with cyfluthrin, cypermethrin, fenvalerate and permethrin, showed significantly lower mortalities after 1 h than mortalities shown for organophosphorus insecticides (Hopkins et al. 1984). Perhaps chemical residues of the pyrethroids penetrate the leaves and do not contact the weevil. Perhaps the weevils are repelled by a pyrethroid 1 h after application.

Butifos was shown to be an effective synergist with malathion when topically applied against the boll weevil in northeastern Mexico (Teran-Vargas and Wolfenbarger 2001). Both butifos and piperonyl butoxide are considered to be synergists with insecticides.

In 1992 a petri-dish bioassay was conducted to compare initial and residual toxicity and /or repellency of a laboratory strain of the boll weevil to endosulfan, three pyrethroids and two organophosphorus insecticides in the LRGV. In 1993 and 1994 field tests were conducted with bifenthrin and endosulfan alone and in mixture and as alternate applications. In 1992-1993 comparative toxicity to a laboratory strain topically applied with fenpropathrin, a pyrethroid, two organophosphorus insecticides, including methyl parathion and two synergists was determined. Two field collected strains were combined and topically treated as one with methyl parathion.

Materials and Methods

Boll weevils used in leaf bioassays and topical applications were from a laboratory strain from Gast Laboratory, Starkville MS. This strain was considered to be susceptible to all insecticides. In 1992 field strains were collected from cotton near Rio Bravo, Tamaulipas, Mexico and Weslaco, LRGV, TX, USA, and combined for treatment.

Emulsifiable concentrate formulations of azinphosmethyl (Guthion) as 240, bifenthrin (Capture) as 240, *lambda* cyhalothrin (Karate) as 120, cyfluthrin (Baythroid) as 192, endosulfan (Thiodan) as 360, malathion as 480, methyl parathion as 480 and zeta cypermethrin (Forte) as 192 g/L were applied once in 38.5 L./ha, in aqueous sprays by hand. Sprays were applied to three replicates of one row of 20 m/replicate of cotton at 0.28, 0.09, 0.0.38, 0.045, 0.56, 1.12 and 0.056 kg (AI)/.ha, respectively. Immediately following the spray application and on 1, 2, 3 and 7 d five true leaves from the first node of the terminal were randomly selected from the three plots and placed in five 9 cm diameter petri dishes The leaves were placed on one side of the dish and cut to occupy about 67% of the dish. This was done to insure that there was an area where no insecticide was present. Ten weevils were placed in each dish and each dish was a replicate; 50 weevils/insecticide were bioassayed on each d. Dead + moribund weevils were counted 48 h after indicated d post-treatment.

Analysis of variance was determined for mortalities of each of the five replicates of the insecticides on the indicated d (SAS 1987). Means of damage levels were separated by least significant differences (LSD) at 5% level of probability. Mortalities from untreated check (50 weevils/d of bioassay) were determined to correct for natural mortalities.

Field tests were established in a randomized complete block design with four replications in 1993 (Wolfenbarger et al. 1994) and 1994 (Loera-Gallardo et al. 2005). The same emulsifiable concentrate formulations of bifenthrin and endosulfan were applied with a high clearance tractor at the same rate and volume used for the initial and residual tests previously described. Alternate applications were initiated with bifenthrin. In each replicate, on 15 and 10 sample d in 1993 and 1994, respectively, 25 one third grown or larger squares were examined for oviposition punctures or feeding scars by the adult boll weevil. Squares were randomly selected from the middle 10 rows on each sample d. Damaged squares from all treatments of every sample d each y were combined and used to determine mean percent.

Analysis of variance was determined (Wolfenbarger et al. 1994 and Loera-Gallardo et al. 2005) for season long mean damaged squares by the boll weevil in 1993 and 1994, respectively. Differences in means of treatments were determined by LSD at 5% level probability (SAS 1987).

Topical applications of one microliter of each the four insecticides and two synergists were applied to the dorsum of the thorax of adults (Anonymous 1968, Wolfenbarger et al.1986 and Loera-Gallardo et al. 1996). Five or six doses of each insecticide were applied to 20 weevils/dose on each d of application during the two y of treating. Four d of treating were conducted, each d was a replicate. Doses for fenpropathrin, methidathion and methyl parathion ranged from 0.1 to 0.0001 µg/weevil; while those for abamectin and both synergists ranged from 10 to 0.1 µg/weevil. LD50s and 95% confidence interval (CI), as µg/weevil, and slopes ± standard error (SE) were determined by probit analysis (SAS 1988). Natural mortalities were determined from 200 weevils each yr. LD50s that indicated equality showed overlapping 95% CIs.

Results and Discussion

Methyl parathion and fenpropathrin were the most and equally toxic to the boll weevils of those tested against individuals of the laboratory strain Methyl parathion was equally toxic to both field collected and laboratory insects (Table 1). LD50 of methidathion against the laboratory strain was about ten fold less toxic than methyl parathion against the same strain of this insect. Abamectin, butifos and piperonyl butoxide showed LD50s from 1 to 5 µg/weevil. Natural mortalities of the laboratory strain were 7%; natural mortalities of the field collected population were 2%.

The toxicity patterns by the boll weevil following the single application of bifenthrin, cyfluthrin, *lambda* cyhalothrin and zeta cypermethrin were completely different than patterns shown for malathion, azinphosmethyl and endosulfan (Table 2). Toxicity of cyfluthrin, zeta cypermethrin and *lambda* cyhalothrin peaked on 3, 2 and 3 d at 95%, 70% and 72%, respectively. Results suggest a repellency to the pyrethroids. Even bifenthrin, the least toxic pyrethroid, showed peak mortalities of about 50% on 1 and 3 d. The four pyrethroids showed a low of 5% for bifenthrin to a high of 12% for cyfluthrin after 7 d.

Malathion, azinphosmethyl and endosulfan showed residual toxicities on 0 and 1 d of 90% to 100% and 66% to 100%, respectively. On two and three d mortalities of azinphosmethyl and endosulfan ranged from 18% to 58% and 30% to 65%, respectively. After 7 d mortalities of azinphosmethyl, malathion and endosulfan were 70%, 30% and 15%, respectively. Residual mortalities of the non-pyrethroids after 7 d were all greater than those shown for the pyrethroids. Natural mortalities of the laboratory strain were 12% 8%, 17%, 9% and 11% on 0, 1, 2, 3 and 7 d, respectively. These were used to correct for treatment mortalities on each d of bioassay.

Damaged squares by boll weevil were almost 100% greater in 1994 than in 1993 (Table 3). In 1993 endosulfan, the mixture and alternate applications showed significantly fewer percentage damaged squares than the untreated and bifenthrin. In 1994 none of the treatments were efficacious because season long damage was greater or equal to the untreated.

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Table 1. Toxicity of a pyrethroid and organophosphorus insecticides against a susceptible strain of boll weevils. 1992-1993.

Insecticide	Number weevils tested	Slope ± SE	LD50s (μg/weevil)	95% C.I (low-high)
Methidathion	452	1.2 ± 0.22	0.037	0.016-0.071
Fenpropathrin	619	0.84 ± 0.24	0.0046	0.00023-0.015
Methyl parathion (laboratory)	159	1.9 ± 0.77	0.0027	∞-∞
Methyl parathion (field)	388	0.9 ± 0.26	0.0089	0.0014-0.028
Abamectin	208	2.05 ± 0.88	1.04	0.48-1997.0
Piperonyl butoxide	449	0.69 ± 0.11	4.31	1.88-9.23
Butifos	984	0.51 ± 0.16	1.07	0.033-5.12

Table 2. Initial and residual mortalities of boll weevils from treated and untreated cotton leaves to three classes of insecticides. Weslaco, TX. 1992.

		Mortality (%) after 48 h on indicated d of residue [1]				
Insecticide	kg.(AI)/ha	0	1	2	3	7
Zeta cypermethrin	0.050	17b	35ab	43ab	72ab	10c
Endosulfan	0.56	95a	66ab	45ab	51b	15b
Cyfluthrin	0.045	28b	44ab	75a	95a	12b
Bifenthrin	0.09	30b	53ab	33ab	50b	5c
Lambda cyhalothrin	0.038	5b	20b	70a	13c	8c
Malathion	1.12	100a	90a	18c	65ab	30ab
Azinphosmethyl	0.28	90a	100a	58a	30b	70a

[1] Vertical means followed by the same letter on the scale were considered to be non significant by LSD at 5% level of probability

Table 3. Efficacy of insecticides against boll weevil in field tests. Weslaco, TX. 1993-1994.

		Percent damaged squares [1]	
Treatment	Kg (AI)/ha	1993	1994
Bifenthrin	0.09	15a	21b
Endosulfan	0.56	4b	25b
Alternate applications		5b	27b
Mixture		6b	30a
Untreated		13a	24b

[1] Vertical means followed by the same letter each y were considered to be non-significant by LSD at 5% level probability