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# COMPARATIVE TOXICITY OF SEVERAL PYRETHROIDS, PARATHION AND CHLORPYRIFOS TO ADULTS OF THE SPINY BOLLWORM, *EARIAS INSULANA* (BOISDUVAL) (LEPIDOPTERA: NOCTUIDAE), IN LABORATORY ASSAYS*

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ABSTRACT

Several formulations of six pyrethroids and three organophosphorus (OP) com- pounds were tested against adult spiny bollworms by a forced contact bioassay method. The most effective compounds were decamethrin, fenpropathrin, fen- valerate and two cypermethrin formulations, with LD50's of 0.37, 2.3,21, 21 and 33 ng/cm$^2$, respectively. Moderate activity was obtained with cypermethrin (Sherpaz), permethrin, cybolt and a second formulation of fenpropathrin (Vivitrin), giving LD50's of 90, 70, 54 and 170 ng/cm$^2$, respectively. The least active pyre- throid was fluvalinate, with LD50 of 1100 ng/cm$^2$. The OP insecticides ethyl parathion, methyl parathion and chloropyrifos were of moderate toxicity, with LD50's of 24, 85 and 290 ng/cm$^2$, respectively. There were no significant differences in mortality between males and females treated with three formulations of pyrethroids.

## INTRODUCTION

The spiny boll worm, *Earias insulana* (Boisduval), attacks plants of the Malvaceae in Israel and neighbouring countries (Avidov & Harpaz, 1969, Rivnay, 1962). Most of the damage is caused to cotton plants. Insecticides are applied against adults, eggs and neonate larvae as these are the only forms which are found on plant surfaces. Five commercial insecticides were previously screened in this laboratory against adult spiny bollworms (Klein *et al.,* 1980), but only methomyl and methidathion were found to have reasonable activity. Pyrethroids are applied to cotton in Israel against the tobacco whitefly, *Bemisia tabaci,* and against the Egyptian cotton leaf worm, *Spodoptera lit- toralis* (Shoham, 1981). Cotton fields which were treated against these two pests in 1981 were free of *Earias insulana* (Klein, unpublished data).

Ten formulations of six of the synthetic pyrethroids which are available in Israel and three commercial organophosphorus insecticides were screened in the present work for their toxicity to *E. insulana* adults. Three formulations of two pyrethroids were checked on males and females separately.

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## MATERIALS AND METHODS

Adults of the spiny bollworm were obtained from laboratory cultures (Klein *et al.*, 1981). Pupae were allowed to develop to adults individually in glass vials (1.0 cm diam., 7.0 cm height). In several cases they were sexed and tested separately. All efforts to use adult males caught at night in pheromone traps failed due to their activity in the traps which caused them to lose their scales. This condition greatly increased their susceptibility to insecticides. In addition, their age was unknown.

The following pyrethroids were screened: cypermethrin (as Cymbush, ICI; as Titan, SHELL as Sherpaz, RHONE-POULENC); (RS)-a-cyano-3-phenoxybenzyl-(S)-2-(4 difluoromethoxyphenyl)-3-methylbutyrate (Cybolt, CYANAMID), decamethrin (Decis, ROUSSEL UCLAF), fenpropathrin (as Smash, SUMITOMO, as Vivitrin, DOW), fenvalerate (Aqmatrin, SUMITOMO), fluvalinate (Maverick, ZOECON) and permethrin (Ambush, ICI). The organophosphorus insecticides screeened were: ethyl parathion and methyl parathion (PAZCHEM), and chlorpyrifos (Dursban, DOW). All insecticides were commercial products (emulsifiable concentrates). Appropriate dilutions were made in acetone. Controls were pure acetone.

Ten adults, either unsexed or of the same sex, were transferred to each vial for the force contact treatment (Klein *et al.*, 1980). Each concentration was tested on 10 adults (4-5 repetitions). Following a 1 hr exposure to the insecticide the insect was transferred to a 250-ml glass jar provided with a cotton swab presoaked in 10% sucrose solution as adult food. Mortality was recorded after 14 h; $LC_{50}$ and $LC_{90}$ and slope values of mortality curves were calculated by probit-log analysis.

## RESULTS AND DISCUSSION

The toxicity of the 13 insecticides to adults is summarized in Tables 1-2.

The $LD_{50}$s of the pyrethroids tested in the present work were in the range of $3.7 \times 10^{-7}$ (Decis) to $1.1 \times 10^{-3}$ mg/cm$^2$ (Maverick), the $LD_{90}$s were between $2.8 \times 10^{-6}$ for Decis and $2.0 \times 10^{-2}$ mg/cm$^2$ for Maverick. The latter was the only pyrethroid which was less toxic to 90% of the adults than azinphosmethyl (Guthion), which served as the standard insecticide against *E. insulana* in cotton until 1979 (Klein, unpublished data). All other formulations of the pyrethroids were 7 to 1300 times more toxic than azinphos-methyl (Table 1).

The parathions were equally effective as the cypermethrin Sherpaz, the permethrin Ambush and Cybolt (Table 2). Chlorpyrifos has a $LD_{50}$ and $LD_{90}$ lower than the two parathions (Table 2). According to the results presented in Tables 1-2 and those obtained in a previous work (Klein *et al.*, 1980) it is possible to divide the insecticides into several groups relative to the toxicity of azinophos methyl taken as 1 (Klein *et al.*, 1980): (i) The most active, consisting of the decamethrin (Decis) and the fenpropathrin (Smash) (toxicity factors at the $LD_{90}$s of 1300 and 850 respectively). (ii) The fenvalerate Aqmatrin and the cypermethrins Cymbush and Titan (Toxicity factors of 76 for Aqmatrine, 94 for Cymbush, and 53 for Titan). (iii) The cypermethrin (Sherpaz), the

**TABLE 1: TOXICITY OF SEVERAL PYRETHROIDS TO ADULTS OF *EARIAS INSULANA* IN LABORATORY ASSAYS**

| Insecticide (commercial name) | | $LD_{50}$ | | $LD_{90}$ | | |
|---|---|---|---|---|---|---|
| | | ng/cm² (95% fiducial limits) | Toxicity factor* | ng/cm² (95% fiducial limits) | Toxicity factor* | Slope ± S.E. |
| Decamethrin (Decis) | | 0.37 (0.29-0.49) | 3492 | 2.8 (1.7-5.7) | 1300 | 1.46 ± 0.2 |
| Fenpropathrin (Smash) | | 2.3 (1.9-2.9) | 563 | 4.3 (3.4-6.9) | 850 | 4.88 ± 0.8 |
| Fenvalerate (Aqmatrin) | m** | 21 (10-35) | 62 | 57 (35-500) | 79 | 3.07 ± 0.8 |
| | f** | 16 (6-33) | 81 | 67 (33-190) | 67 | 2.0 ± 0.9 |
| Cypermethrin (Cymbush) | m | 18 (9-40) | 72 | 48 (26-100) | 94 | 3.06 ± 0.3 |
| | f | 21 (11-55) | 62 | 72 (35-200) | 63 | 2.37 ± 0.6 |
| Cypermethrin (Titan) | m | 26 (21-33) | 50 | 85 (59-180) | 53 | 2.4 ± 0.4 |
| | f | 33 (28-43) | 39 | 98 (69-190) | 46 | 2.77 ± 0.4 |
| Cypermethrin (Sherpaz) | | 90 (79-130) | 14 | 190 (130-490) | 24 | 3.8 ± 0.6 |
| Permethrin (Ambush) | | 71 (38-77) | 18 | 240 (97-2000) | 19 | 2.4 ± 0.7 |
| (Cybolt) | | 54 (13-130) | 24 | 340 (140-8100) | 13 | 1.6 ± 0.3 |
| Fenpropathrin (Vivitrin) | | 170 (120-270) | 8 | 650 (380-2300) | 7 | 2.23 ± 0.4 |
| Fluvalinate (Maverick) | | 1100 (830-1800) | 1.1 | 10000 (9100-7100) | 0.2 | 1.03 ± 0.1 |

*Toxicity factor of azinphos-methyl is 1 ($LD_{50}$ = 1300 ng/cm², $LD_{90}$ = 4500 ng/cm²).

** m = males, f = females.

TABLE 2: TOXICITY OF THREE COMMERCIAL ORGANOPHOSPHORUS INSECTICIDES TO ADULTS OF *EARIAS INSULANA* IN LABORATORY ESSAYS

| Insecticide | $LD_{50}$ ng/cm$^2$ (95% fiducial limits) | $LD_{50}$ Toxicity factor* | $LD_{90}$ ng/cm$^2$ (95% fiducial limits) | $LD_{90}$ Toxicity factor* | Slope±S.E. |
|---|---|---|---|---|---|
| Methyl parathion | 85 (4.1-870) | 15 | 160 (85-4300) | 28 | 4.86±2.2 |
| Ethyl parathion | 24 (5.5-520) | 54 | 280 (130-2600) | 16 | 1.20±0.5 |
| Chlorpyrifos | 290 (130-690) | 4.5 | 1400 (600-40000) | 3.2 | 1.91±0.5 |

*Toxicity factor of azinphos-methyl is 1 ($LD_{50}$ = 1300 ng/cm$^2$; $LD_{90}$ = 4500 ng/cm$^2$).

permethrin (Ambush), the (RS)-a-cyano-3-phenoxybenzyl-(S)-2-(4) difluoromethoxy-phenyl)-3-methylbutyrate (Cybolt), and the fenpropathrin (Vivitrin) (toxicity factors of: 24, 19, 13 and 7, respectively). Methyl parathion and ethyl parathion showed toxicity factors of 28 and 16. Methidathion and monocrotophos showed toxicity factors in the same range (15.5 and 6.6 respectively, according to Klein *et al.*, 1980). (iv) The less effective group, fluvalinate (Maverick) and chlorpyrifos, with toxicity factors of 0.2 and 3.2, respectively.

No significant differences were observed between the $LD_{50}$s and $LD_{90}$s of males and of females with respect to the three formulations of the two pyrethroids tested. Pyrethroids as well as some of the organophosphorus insecticides are routinely sprayed from the air on cotton, especially against *Bemisia tabaci* and *Spodoptera littoralis*. Most of these insecticides proved in our work to be very effective against adults of *Earias insulana*. This is probably the reason why no special insecticide applications were needed for this pest. Caution in using pyrethroids on cotton was also recommended in Israel because of the ability of certain insect species to develop resistance to this group of insecticides (Davis *et al.*, 1975, Chadwick *et al.*, 1977; Twine and Reynolds, 1980), and due to their high toxicity to natural enemies, thereby causing an upsurge of certain species of spider mites (Plaut and Mansour, 1981, Riedl and Hoying, 1980; Zwick and Fields, 1978).

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