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PESTICIDES TOXIC TO STRIPED EARWIG, AN IMPORTANT INSECT PREDATOR[1]

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Abstract. **Pesticides were tested on the striped earwig,** Labidura riparia **(Pallas), an effective insect predator, to identify those safest for use in integrated pest control. Of the pesticides used on cabbage, potato, corn, and sorghum at Hastings, Florida, fungicides and herbicides showed little toxicity. Insecticides of low toxicity included** Bacillus thuringiensis **Berliner, chlordimeform, oxydemeton-methyl, and primicarb. Carbaryl, diazinon, methamidophos, mevinphos, and parathion were highly toxic. The experimental synthetic pyrethroid compounds, Ambush, Pounce, and Pydrin indicated low toxicity at crop dosages.**

Integrated pest management combines biological and chemical control for crop protection. Indiscriminate pesticide selection can eliminate natural control agents and increase dependence on chemicals. However, reports on the toxicity of pesticides to beneficial organisms are limited. The striped earwig has been noted as an important insect predator (2, 3, 6, and 7). It is common in the southern part of the U. S. and many of the warmer parts of the world. Nguyen (5) reported that the striped earwig was one of the most important predators attacking the cabbage looper, *Trichoplusia ni* (Hübner), a major pest of crucifers at Hastings, Florida. Workman (8) found that the chlorinated hydrocarbon insecticides were of low toxicity to the earwig, but most are now restricted from crop use. The organic phosphate insecticides showed high toxicity. Gross and Spink (4) reported that striped earwigs exhibited chlorinated hydrocarbon resistance and that populations increased after applications of heptachlor and mirex due to the reduction of 2 species of ants preying on earwig eggs.

Toxicity of pesticides generally used in the Hastings area to the striped earwig are reported herein.

Methods and Materials

Due to technical and space requirements for testing many pesticides, laboratory trials of 4 to 8 treatments were made at different times. Four oz (113 ml) of Bladen loamy fine sand, common to the area, were placed in wide-mouth, pint Mason jars and treated either by sprays with a DeVilbis atomizer at the rate of 100 gal/a (379 l/ha) or granular forms mixed into the top 6 in (15 cm) of soil/a. Each treatment was replicated 4-5 times including the untreated checks. Pesticides comprised most of those used for control of insects, weeds, and diseases plus some promising experimental ones. Dosage ranged from the recommended or effective rate to several times that amount. Earwigs for the tests were collected from pit fall traps in the field the day before testing. Four earwigs of similar size (mature) with ca. equal numbers of males and females were added to each jar one hour after treatment. Pellets of dry dog food were placed in the jars to prevent cannibalism. Mortality was corrected against deaths in the untreated checks (1) and recorded 1, 2, and 5 days later.

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Results and Discussion

Earwig mortality after 2 days exposure to pesticide treated soil was used to assess the relative toxicity between materials. Maneb, most herbicides, and the effective cabbage looper controls, *Bacillus thuringiensis*, chlordimeform, and methomyl exhibited low toxicity (Table 1). Of the widely-used aphicides, oxydemeton-methyl and primicarb, were not harmful while demeton was very toxic. The synthetic pyrethroid insecticides, Ambush, Pounce, and Pydrin, were of low toxicity at rates giving good looper control. They produced aggressiveness and hyperactivity of the earwigs within seconds often followed by knockdown in ca. 15 minutes. Some recovery occurred at lower ranges, but little at higher dosages. Recovery was slow and commenced 16-24 hours after exposure.

Table 1. Toxicity of pesticides to the striped earwig after 2 days: (percent mortality + pesticide + active ingredient per acre in lbs).

0 alachlor 10.0	0 dalapon 10.0	0 methomyl 1.0
0 aldicarb 10.0	0 DCPA 20.0	0 metribuzin 10.0
0 *Bacillus thuringiensis* 10.0	0 DNBP 8.0	0 nitrofen 10.0
0 bendiocarb 2.0	0 endosulfan 4.0	0 oxamyl 10.0
	0 EPTC 10.0	0 oxydemeton-methyl 8.0
0 CDEC 10.0	0 ethion 1.0	0 paraquat 4.0
0 chlorbromuron 10.0	0 linuron 10.0	0 pirimicarb 4.0
0 chlordimeform 2.0	0 maneb 10.0	0 trifluralin 10.0
0 2,4-D 10.0	0 metobromuron 10.0	
6 bendiocarb 4.0	6 Pydrin 0.1	25 Pydrin 0.2
6 carbofuran 1.0	7 chlordimeform 4.0	31 ethion 4.0
6 carbophenothion 4.0	13 benomyl 10.0	38 carbaryl 1.0
6 CDAA 10.0	13 bromophos ethyl 1.0	38 carbaryl 4.0
6 Ambush 0.1	19 methomyl 4.0	40 demeton 1.0
6 Pounce 0.1	25 propoxur 1.0	40 ronnel 0.5
50 Ambush 0.2	60 diazinon 0.5	75 demeton 2.0
50 Pounce 0.2	63 carbofuran 4.0	15 parathion 1.0
50 Pydrin 0.4	63 ronnel 1.0	81 acephate 2.0
53 acephate 0.5	69 mevinphos 1.0	94 dyfonate 1.0
56 methamidophos 1.0	69 propoxur 2.0	94 methamidophos 2.0
60 chlorpyrifos 0.5		

In light of the usual 6-8 seasonal treatments on cabbage and 4-6 on potato, corn, and sorghum crops, even the safer pesticides may be deleterious to earwigs and other beneficial organisms. A number of insecticides are highly toxic to crop pests and earwigs and are attractive to growers. Fortunately, most fields at Hastings are adjoined by untreated weedy and wooded areas where beneficial organisms can be maintained until control programs of least injury can be developed.

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GROWTH CHARACTERISTICS OF CELERY '2-14' IN CENTRAL FLORIDA[1]

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Abstract. **Individually tagged petioles of celery '2-14' were examined weekly from 29 September 1976 through 6 January 1977 in each of two 0.17 ha fields at Zellwood, Florida. No significant differences between plots treated with fungicides or fungicides plus insecticides were observed with respect to petiole production rate (ca. 2/week), petiole longevity (ca. 5-6 weeks) or marketable weights (ca. 0.5 kg/plant). Vegetable leafminer (***Liriomyza sativae* **Blanchard; Diptera: Agromyzidae) maggot and adult populations were significantly lower in insecticide protected plots than in those treated only with fungicides. Numbers of mines on marketable plants (0.2-0.3/plant, average) did not differ significantly between fields after stripping and trimming. Studies on insecticide treated celery '2-14' plants grown in bins of muck soil at Sanford (February-May 1977) confirmed that approximately 50% of the petioles produced by plants, 17 out of 34, were actually marketed.**

Since 1975, an interdisciplinary team of University of Florida researchers has been systematically assembling data on a variety of horticultural, pathological and entomological problems associated with Florida celery production. The ultimate goal of this team effort is development of a feasible pest management program for celery such that crop maintenance decisions can be evaluated objectively while yield is optimized. One outcome of this joint research is an accumulation of data necessary for a plant growth model, a prerequisite for most management decisions. In addition, we have gathered data for certain variables, such as insect pests, that interact with the celery plant and affect yield in some manner. Although considerable work still is needed to translate these plant and insect data into a mathematical format, the work described below represents some of our progress on the preliminary stages of developing interacting models for celery and selected insect pests. Since vegetable leafminer, *Liriomyza sativae* Blanchard (Diptera: Agromyzidae), is of prime concern to celery producers, data pertinent to their population dynamics were taken in conjunction with plant growth studies.

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Materials and Methods

Growth of individual celery '2-14' transplants was observed in muck soil during both fall 1976 and spring 1977 crops. In the fall study two 0.17 ha fields were transplanted on 23 September 1976 at Zellwood, Florida in 3-row, flat beds using 17.8 cm row spacing with 0.9 m between beds. Both fields were treated weekly with selected fungicides: chlorothalonil at 2.3 liters/ha; copper hydroxide at 2.2 kg/ha; benomyl at 0.28 kg/ha to 0.56 kg/ha and mancozeb at 0.56 kg/ha to 1.68 kg/ha. One field was not treated with insecticides while the other was treated 1-2x per week with selected combinations of oxamyl (1.1 liter/ha), *Bacillus thuringiensis* (1.03 kg/ha), dimethoate (1.1 liter/ha), parathion (0.5 liter/ha), or toxaphene (1.1 kg/ha to 2.3 kg/ha).

Each field was subdivided into a 4 x 5 array of 20 study sites, each 7.6 m (long) x 3.7 m. One plant in a center row of each site was selected for the growth study. Individual petioles were labeled with flexible plastic strips as soon as they grew ca. 1 cm long. Petioles were numbered consecutively on each transplant, beginning with the outermost, oldest one. Dates of initiation and death or destruction were recorded for each petiole on each plant. At harvest, fates of individual petioles (i.e. senescent, stripped or marketable) were determined along with fresh weights of marketable celery plants.

Numbers of leaf mines, both empty and active (i.e. containing maggots and/or their parasites), were counted weekly on each labeled petiole of all 40 plants in both blocks from 29 September 1976 until harvest on 6 January 1977. Maggot counts and leafminer parasite activity also were monitored weekly from samples of 20 "trifoliates" (i.e. the terminal 3 leaflets of 20 mature petioles, each on a different plant) taken from each plot. After counting the maggots and mines on fresh leaflets, samples were retained in labeled paper, pint cartons for 3 weeks. Leafminers and their parasites reared from these samples were identified and counted. Mine counts on individual petioles and petiole fates were tabulated through harvest.

Numbers of adult leafminers were also monitored weekly in each plot by using: 1) sweep net samples (10 sweeps taken over the length of the plot using a 37.5 cm diameter sweep net with a canvas bag); 2) sticky traps (one 7.6 cm x 12.7 cm yellow railroad board card, thinly covered with Tack-Trap®; and 3) D-Vac® samples (10 dips of the vacuum hose over the length of the plot) with samples taken weekly from alternate plots beginning 19 November 1977 and ending on 6 January 1977.

In the spring study at Sanford, Florida, an outdoor soil bin, ca. 3.6 m x 3.6 m x 46 cm deep, was filled with muck soil from Zellwood. Fifteen celery '2-14' plants were transplanted on 24 February; individual petioles on each plant were labeled as described previously. New growth was