FLIGHT ACTIVITY AND SUSCEPTIBILITY TO INSECTICIDES OF VARIEGATED CUTWORM, *PERIDROMA SAUCIA* (HÜBNER) ATTACKING FIELD TOMOATOES IN SOUTHWESTERN ONTARIO

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Abstract *J. ent. Soc. Ont.* 139: 19–25

The variegated cutworm, *Peridroma saucia* (Hübner), is a polyphagous pest that sporadically damages processing field tomatoes in southwestern Ontario. Recent anecdotal reports have suggested that it has developed resistance to pyrethroid insecticides used to control them. The objectives of this study were to acquire information on variegated cutworm flight activity in southwestern Ontario tomato fields and to assess the toxicity of currently registered and novel insecticides to determine if it has developed resistance to them.

Pheromone trap data (2006) in Norfolk County suggested 2 peaks of adult flight in field tomatoes - July and August, while in Essex County there were 3 peaks - July, August and September. Direct contact toxicity bioassays were done using larvae from a laboratory culture established at the University of Guelph in late summer 2006 from larvae collected from tomato fields in both counties. Of the 4 insecticides registered for use, lambda-cyhalothrin was most toxic to 3rd-4th instar larvae > permethrin > chlorpyrifos > methomyl. Chlorantraniliprole was most toxic of the reduced risk insecticides tested. Spinosad and metaflumizone, which act primarily as stomach poisons, were less toxic by direct contact. Second instar larvae were most susceptible to permethrin > 3rd-4th > 5th instar. Comparison of results with 1977 published data showed that variegated cutworm had developed low level resistance to methomyl but not to chlorpyrifos or permethrin. Results of the study showed that pyrethroid insecticides will be effective so long as stage of larval development and climatic conditions are considered and insecticides are applied in a manner resulting in the most effective penetration of the plant canopy as possible.

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Introduction

The variegated cutworm (VCW), *Peridroma saucia* (Hübner) (Lepidoptera: Noctuidae) is a generalist feeder on vegetable crops, cereals, ornamentals, fruit and forage crops (Rings et al. 1976). Adults migrate into southwestern Ontario and are present throughout the growing season (McClanahan and Elliot 1976). Larvae sporadically damage crops in the early part of the growing season but usually are a greater problem in mid-summer, especially in fields of processing tomatoes (Harris et al. 1977). While the organochlorine insecticides provided effective VCW control (Harris et al. 1961), organophosphorus and carbamate insecticides were less so, with effectiveness being very dependant on stage of larval development and method of insecticide application (Harris and Svec 1968; Harris and Kinoshita 1977; Harris et al. 1977). Pyrethroid insecticides provided effective VCW control (Harris et al. 1977). Insecticides recommended for cutworm control in Ontario are carbaryl (Sevin XLR), methomyl (Lannate LV), acephate (Orthene 75SP), permethrin (Pounce EC) and lambda-cyhalothrin (Matador 120EC), with the pyrethroids being considered most effective. However, recently anecdotal reports of less than adequate control have suggested that VCW has developed resistance to pyrethroid insecticides.

The objectives of this study were to: 1) monitor VCW flight in tomato fields in southwestern Ontario; 2) assess the effectiveness of currently registered and reduced risk insecticides on different larval instars; and, 3) determine whether VCW has developed resistance to presently registered control products.

Methods and Materials

Flight Activity

In Summer 2006, 6 bucket-style pheromone traps (Muti-Pher®) (2 traps/field) baited with Trece® Pherocon Cap VGC – variegated cutworm pheromone lures (Distributions Solida Inc., Saint Ferreol Les Neiges, QC) were operated from late June to mid-September at 3 tomato farms in Norfolk County. All traps were placed in hedgerows surrounding the fields. Traps were checked weekly from 26 June to 14 September and numbers of adult males captured were recorded. Pheromone lures were replaced in mid-July to maintain effectiveness. A Hercon® Vaportape II (Gempler's® – Div. of Lab Safety Supply Inc., Madison, WI) insecticide (10% dichlorvos) strip was placed in each trap to kill adults and prevent escape.

Four pheromone traps (2 traps/field) were operated from early July to late September at 2 commercial fresh-market tomato fields in Essex County. Traps were checked regularly from 11 June to 19 September and numbers of adult males captured were recorded. Two traps (1 at each location) did not operate correctly because of malfunctioning electrical generators, therefore trap catch data were generated from only 2 traps in Essex County.

Insecticide Effectiveness

Insect Culture

The laboratory colony was started in summer 2006 from late instar VCW larvae collected from tomato fields in Norfolk and Essex Counties. Larvae were reared in screened plastic containers (34 x 25 x 13 cm) filled with 5 cm sterilized sandy loam. Chinese cabbage, *Brassica rapa* L. (Brassicacaeae), was provided as food. Larvae were fed 3 times a week and dry, rotten or moldy food materials were removed. Pupae were collected and placed in adult cages made of 11 L ice cream buckets with a screened opening (15 x 10 cm) in the side. Red Gatorade® and deionized water were used as food and moisture sources. A piece of red tissue paper (20 x 20 cm) was crumpled and placed in the container for use as an oviposition site. Pieces of tissue paper with egg masses attached were placed on 9 cm diameter filter paper in 10 cm diameter Petri dishes with a commercial VCW artificial diet (Southland Products Inc., Lake Villages, AK) cube (0.5 cm^3) Rearing cages were kept in growth chambers set at 23 ± 2°C, 60-70% RH and 16:8 L:D.

Insecticide Assays

Direct contact toxicities of technical grade (> 95% purity) permethrin (FMC Corp., Philadelphia. PA), chlorpyrifos (Dow AgroSciences Canada, Inc., Calgary, AB), methomyl (E.I. DuPont Canada Co., Mississauga, ON), lambda-cyhalothrin (Syngenta Crop Protection Canada, Inc., Guelph, ON), chlorantraniliprole (E.I. DuPont Canada Co., Mississauga, ON), , spinosad (Dow AgroSciences Canada, Inc., Calgary, AB) and metaflumizone (BASF Canada, Inc., Mississauga, ON) to VCW larvae were determined using a Potter spray tower (PST) (Potter 1959) following the procedure described by Harris et al. (1977). Primary screening tests were done with 4 concentrations of the insecticide dissolved in 19:1 acetone:olive oil. Controls treated with the solvent mixture alone were included with each insecticide. Two groups of 10, 3rd-4th instar larvae were tested at each insecticide concentration. Each bioassay was repeated 3 times resulting in 60 treated larvae per concentration. Larvae were transferred with a fine paint brush to a clean 10 cm diameter glass Petri dish lined with 9 cm diameter filter paper. Five ml of the desired concentration of each insecticide was then applied to each dish via the PST. Immediately after treatment the larvae were placed in waxed paper Dixie® cups (10/cup) filled with 1 cm sifted sandy loam and two commercial VCW artificial diet cubes (0.5 cm^3) were provided as food. Cups were covered with a 10 cm diameter glass Petri dish and were placed in a holding room at 25 ± 1°C and 16:8 L:D. Mortality counts were made after 48 h. Larvae were considered dead if unable to crawl. Second and 5th instar larvae also were tested to determine the susceptibility of the different larval stages to pyrethroids. Corrections for natural mortality (< 10%) were made using Abbott's formula (Abbott 1925).

Results

Flight Activity

In 2006, there were 2 peaks of adult activity in Norfolk County in July and August. Populations dropped to low levels in mid-August remaining that way until the study was terminated in mid-September (Fig. 1). There were 3 smaller peaks of adult activity in July, August and September in Essex County (Fig. 1).

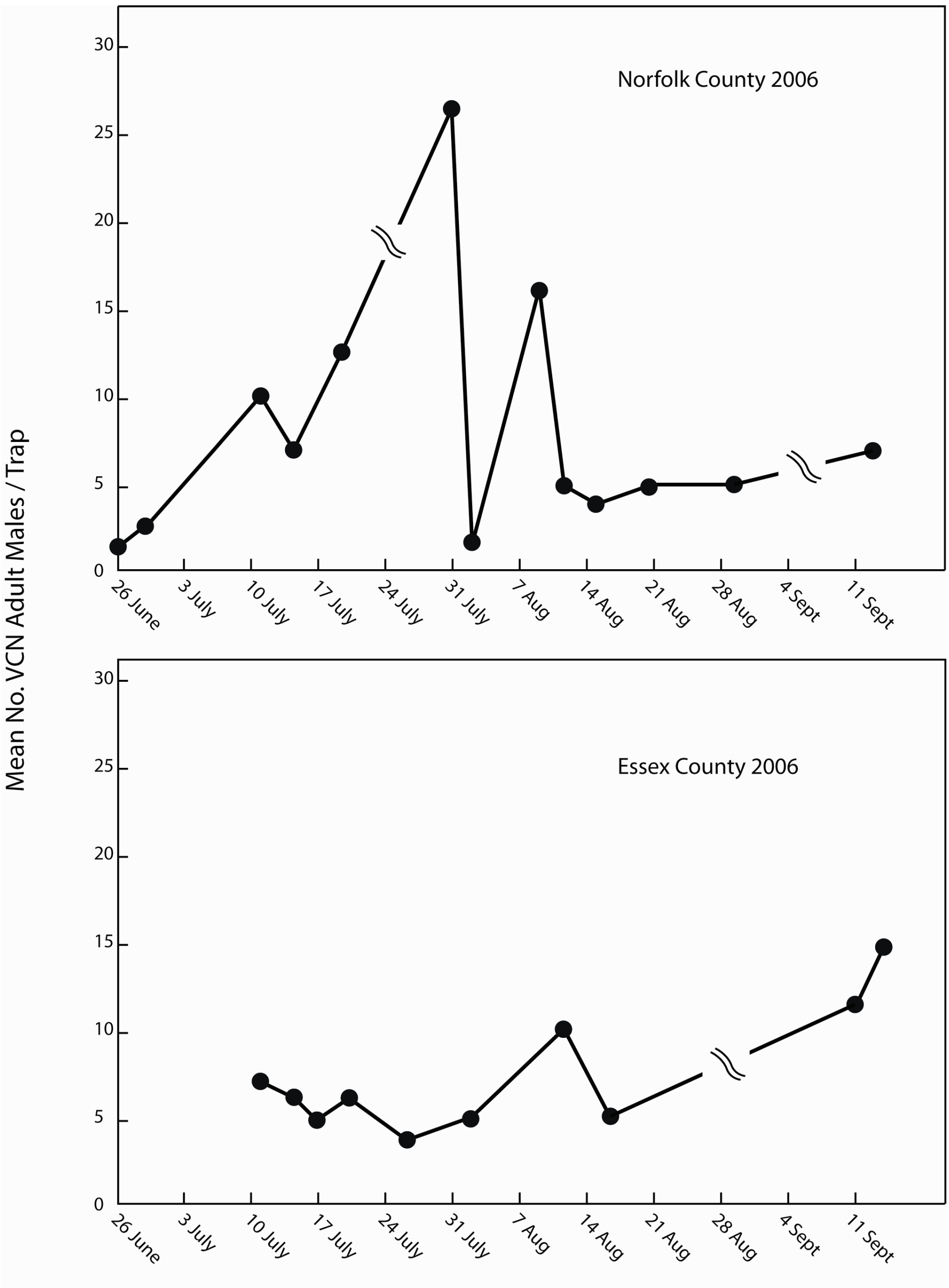

FIGURE 1. Mean numbers of adult male variegated cutworm (VCW) captured in pheromone traps in tomato fields in Norfolk and Essex Counties during Summer, 2006.

Insecticide Assays

Of the 4 insecticides commonly used for cutworm control, lambda-cyhalothrin was most toxic to 3rd-4th instar VCW > permethrin > chlorpyrifos > methomyl. Chlorantraniliprole was the most toxic of all the insecticides tested; spinosad and metaflumizone were the least toxic (Table 1). In tests on the direct contact toxicity of permethrin to different larval stages, at 0.001% solution, it was most toxic to 2nd instar (25% average corrected for mortality) > 3rd-4th (17%) > 5th (0%) larvae.

TABLE 1. Direct contact toxicity of 7 technical grade insecticides to 3rd-4th instar variegated cutworm larvae from a southwestern Ontario strain established from field populations collected in 2006.

Insecticide	Avg. corr. % mortality at % insecticide solution indicated				
	0.0001	0.001	0.01	0.1	1.0
Lambda-cyhalothrin	-	97	100	100	100
Permethrin	-	17	100	100	100
Chlorpyrifos	-	2	23	100	100
Methomyl	-	0	28	79	100
Chlorantraniliprole	15	100	-	-	-
Spinosad	-	2	14	78	100
Metaflumizone	-	0	3	66	84

TABLE 2. Comparison of the direct contact toxicity of technical grade methomyl, chlorpyrifos and permethrin to 3rd-4th instar variegated cutworm under identifical bioassay conditions, 1977 and 2007.

Insecticide	Year	Avg. corr. % mortality at % insecticide solution indicated			
		0.001	0.01	0.1	1.0
Methomyl	1977*	0	70	100	100
	2007	0	28	79	100
Chlorpyrifos	1977*	0	72	100	100
	2007	2	23	100	100
Permethrin	1977*	5	100	100	100
	2007	7	100	100	100

*Harris et al. 1977. Proc. Ent. Soc. Ont. 108: 63-68.

Discussion

In 2006, the July adult peaks noted in Norfolk County likely represented migratory adults, while that in August comprised the 1st generation arising from those adults (Fig. 1). McClanahan and Elliott (1976) reported that VCW had 3 peaks in Essex County in July, August and September suggesting that it had 2 generations in that area. Although adult collections were low at the Essex County sites in 2006, results were similar (Fig. 1). It appears that the warmer climatic conditions in Essex as compared to Norfolk County allow 2nd generation VCW to complete development.

The 2 pyrethroid insecticides, lambda-cyhalothrin and permethrin were the most toxic of the insecticides commonly used for cutworm control. Of the 3 reduced risk insecticides tested, chlorantraniliprole was at least as toxic as lambda-cyhalothrin (Table 1) suggesting that it might have a role in VCW IPM programs. Spinosad and metaflumizone were less toxic by direct contact, however it is known that both insecticides act primarily as stomach poisons. Results obtained with methomyl, chlorpyrifos and permethrin were compared with some obtained under identical bioassay conditions by Harris et al. (1977) (Table 2). VCW appears to have developed a relatively low level of resistance to methomyl, possibly due to exposure of the migrant population to use of that chemical on numerous host crops in North America. Results obtained with chlorpyrifos in the 2 years showed no indication of significant resistance development to that chemical.

While it has been suggested that unsatisfactory VCW control with permethrin on tomatoes could be due to resistance, results obtained with the 2006 Ontario strain were identical to those reported 30 years earlier (Harris et al., 1977). An explanation for less than acceptable control with permethrin can be found in past research which has shown that several factors influence the effectiveness of insecticides applied for VCW control including stage of larval development, climatic conditions and application method. Stage of larval development is very important. Similar to the results of this study, Harris et al. (1977) showed that, while 1st instar VCW were very susceptible, 3rd and 5th instar larvae were 2.9x and 3.7x more tolerant to permethrin, respectively. Harris and Kinoshita (1977) demonstrated that, like DDT, pyrethroid toxicity can be negatively correlated with temperature – permethrin was 7.4x more toxic to 3rd instar VCW at 15° as compared to 32°C. Finally application method has a major role. For example, VCW spends the larval stage on, or very close to, the soil surface hidden under dense foliage. While soil surface applications with permethrin were effective, foliar applications were more so (Harris and Svec 1968; Harris et al. 1977).

Results of this study show that the pyrethroid insecticides remain highly toxic to the Ontario VCW populations found in southern Ontario and that there is no evidence of resistance to permethrin. Lack of insecticide effectiveness in the field is undoubtedly due to limited mobility of the cutworms once they become established under the plant canopy. To achieve adequate control, insecticides should be applied when early instar larvae are present, under moderate to cool climatic conditions in a manner resulting in the most effective penetration of the plant canopy as possible.

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