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Field Tests of Fenvalerate for Control of Black Vine Weevil

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The black vine weevil, *Otiorhynchus sulcatus* (F.), is the major pest of ornamental nurseries in the northeastern United States (C. Staines, Maryland Department of Agriculture, personal communication). The highly polyphagous adults (Fig. 1) feed on more than 100 plant species in 46 families (Masaki et al. 1984). Adults are nocturnal, so they are rarely seen. However, adult feeding results in characteristic notches on leaves (Fig. 1) that can be used to diagnose weevil presence in a planting before damage occurs. Although feeding by adults may cause aesthetic damage to broadleaved evergreens it has very little impact on plant vigor. On the other hand, the larvae (Fig. 1 inset) feed on roots and frequently cause mortality in greenhouse and nursery plantings. Since effective soil-applied insecticides are not available, control efforts are aimed at killing adults before they lay eggs.

Adults begin emerging from the soil in late May, and new adults continue to emerge throughout June, July and early August. Newly emerged females require approximately 30 days for their ovaries to mature before they begin laying eggs (Smith 1932). Eggs are laid on or in the soil (Montgomery & Nielsen 1979), and females prefer to oviposit near *Taxus* spp. (Hanula 1988). Newly hatched larvae move through the soil and begin feeding on small roots. They continue to feed on roots throughout late summer and fall until soil temperatures become cold (>5.5 C; Smith 1932) and activity ceases. Larvae overwinter in the soil and become active again in the spring as soil temperatures rise. During this time they move near the surface and feed on any portion of the plant that is below ground, often resulting in girdling of the stem just beneath the soil line. Fully developed weevil larvae transform into pupae in the soil and emerge as adults several weeks later.

Larvae develop more quickly in container grown plants maintained under plastic during the winter. Observations of weevils developing on container grown azalea, *Rhododendron kiusianum* 'Hinocrimson' Makino, showed that adults emerged approximately 2-3 weeks earlier than weevils on field grown *Taxus cuspidata* Sieb. & Zucc. However, *R. kiusianum* was an inferior food (Hanula 1988), so, consequently, development may be faster on more favorable hosts such as taxus.

Adult black vine weevils are unable to fly, so they are dependent on man for long distance transport. Therefore, limiting the movement of infested plants helps slow the spread of weevils within nurseries.

Acephate (Orthene) is the most widely used insecticide for control of black vine weevil adults in Connecticut. Other registered insecticides such as bendiocarb (Ficam or Turcam), oxamyl (Vydate), or azinphosmethyl (Guthion) have not been widely accepted because of cost or high mammalian toxicity. Although acephate is effective, several applications are required because of its short residual activity and the prolonged adult emergence of the weevils. Therefore, alternatives are needed. Nielsen and Montgomery (1977) reported that the insecticide fenvalerate (Pydrin or Asana) provided control of adults for 4-8 weeks on taxus foliage. In addition, Nielsen et al. (1978) suggested that control could be achieved with a single, well timed application of fenvalerate, and that pitfall traps were the most effective means of monitoring adult activity for timing spray applications.

This study was conducted to determine the effectiveness of single and multiple applications of fenvalerate under field conditions. In addition, I tested a number of insecticides as potential controls of late-instar larvae on the roots of balled and burlapped plants.

MATERIALS AND METHODS

A randomized complete block design with five treatments (10 replicates/treatment) was used to test the efficacy of fenvalerate. In April 1986, 200 Japanese yews, *T. cuspidata* 'Densa' (45 cm diam. canopy), heavily infested with larvae, were transplanted into a field of five rows of 10 plots in Windsor, Connecticut. Each plot contained four plants. Plants were placed 0.6 m apart within plots, and the plots were spaced 1.5 and 2.1 m apart within and between rows, respectively. Each four plant plot was surrounded by a barrier constructed from aluminum lawn edging (15 cm wide) coated with Floun (a slippery material that stops insects from climbing) to prevent adult weevils from moving between plots. The barrier was imbedded in the soil so that

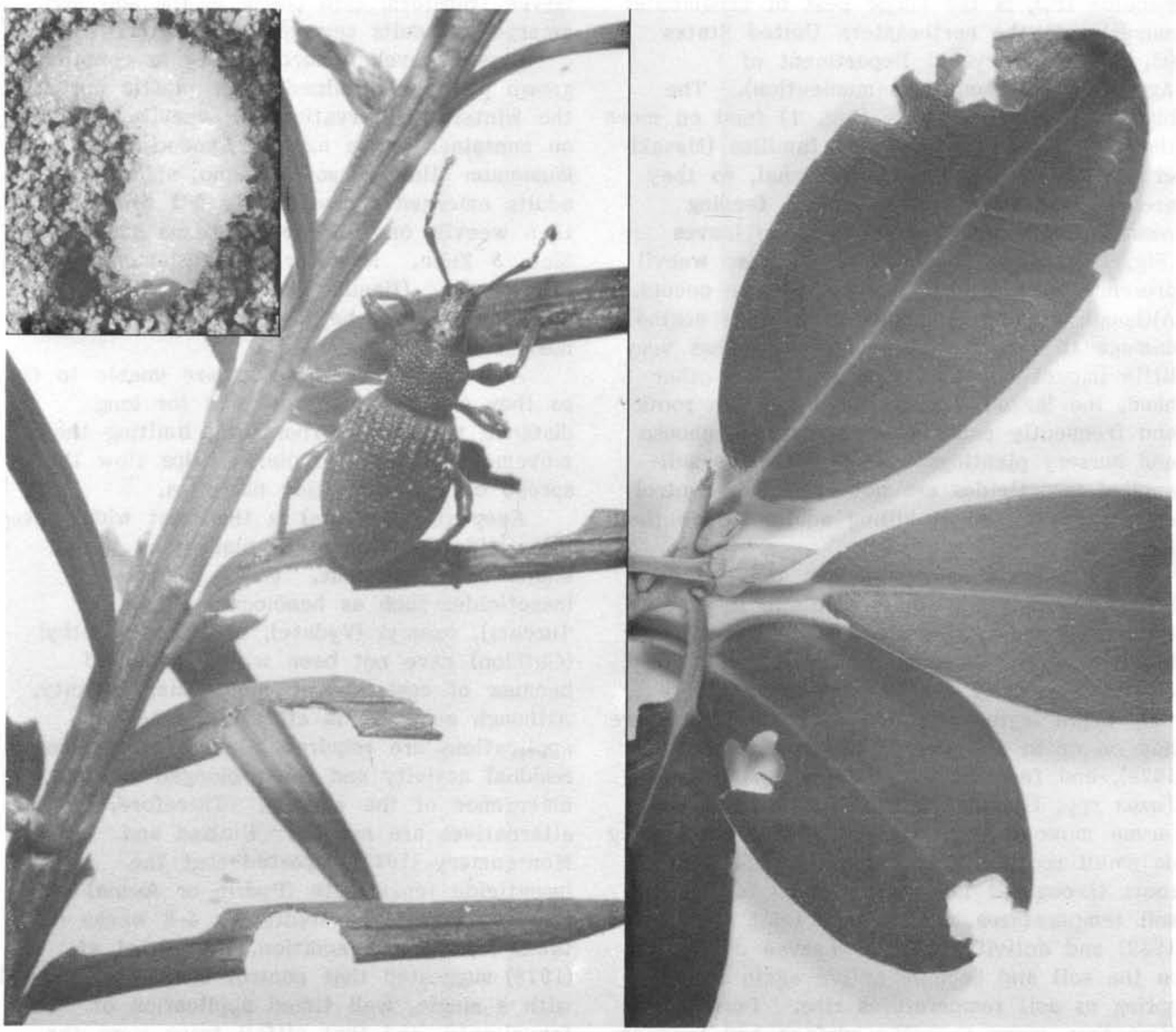

Figure 1—Adult of black vine weevil feeding on foliage of *T. cuspidata* (left) and larva (inset); (right) characteristic feeding damage on *R. catawbiense*.

10 cm remained above ground. The field was irrigated with 2-3 cm water/week by overhead sprinklers. All plots, except the controls, received an application of fenvalerate at a rate of 72 g AI/400 liters (0.15 lb AI/100 gal) applied until runoff with a Solo backpack sprayer (30 psi) on June 13, 2 weeks after the first adults were caught in pitfall traps in a nearby field. The treatments consisted of one to four applications of fenvalerate applied at 2 week intervals beginning with June 13. Treatment efficacy was evaluated in May 1987 by sifting the soil beneath the canopy of each plant to a depth of 40 cm and examining it for larvae.

A second study was conducted to test four insecticides for control of larvae in balled and burlaped plants in the spring. Ninety *T. cuspidata* 'Capitata' (ca. 1 m height) were dug from a weevil-infested field, and the rootballs were wrapped in burlap and tied according to standard nursery practice. The plants were dug May 6, 1986 and treated the next day by submerging the rootballs in insecticide solution for 60 sec. Controls were treated with water. The rootballs of three plants, not included in the study, were treated with water and examined immediately to insure that the solutions penetrated throughout. The following insecticides were tested at two rates each: fenvalerate (48 & 96 g AI/400 liter), oxamyl (Vydate; 119 & 239 g AI/400 liter), carbofuran (Furadan; 60 & 120 g AI/400 liter) and chlorpyrifos (Dursban; 478 & 861 g AI/400 liter). Larval mortality was evaluated 5 days after treatment by removing the soil from the roots and examining for larvae. Larvae were considered alive if they moved when prodded with a pencil point. Plants which contained five or more larvae were included in the analysis.

RESULTS

A single application of fenvalerate, 2 weeks after adult weevils began emerging from the soil, was effective in reducing subsequent populations of the black vine weevil on taxus (Fig. 2). Control of summer adults before they laid eggs resulted in an average of less than one larva/plant compared to a mean of 5.2 larvae/plant in untreated plots. In addition, one application was as effective as two to four applications even though residues were subjected to repeated overhead irrigation throughout the summer. No phytotoxicity was observed on taxus.

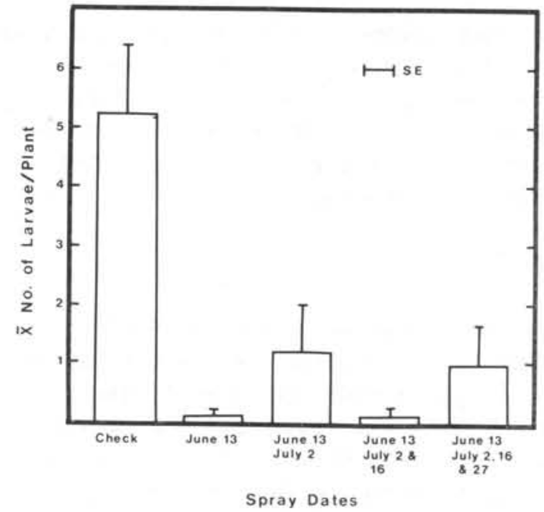

FIGURE 2—Mean numbers of black vine weevil larvae recovered from roots of *T. cuspidata* plants given none to four foliar applications of fenvalerate to control adults.

TABLE 1—MORTALITY OF *O. SULCATUS* LARVAE FROM *T. CUSPIDATA* 5 DAYS AFTER THE ROOTBALL WAS SUBMERGED IN INSECTICIDE FOR 60 SEC.

Insecticide	Rate (g AI/ 400 l.)	N	% Mortality (S.E.)
Check	0	8	25.5 (5.98)
Chlorpyrifos	478	9	42.8 (7.34)
(Dursban 4E)	861	7	48.7 (6.85)
Oxamyl	119	8	19.3 (5.36)
(Vydate L)	239	7	41.7 (11.07)
Carbofuran	60	7	27.2 (7.74)
(Furadan 4F)	120	7	32.4 (4.13)
Fenvalerate	48	9	38.8 (6.70)
(Pydrin 2.4 EC)	96	6	35.5 (4.42)

Means are not significantly different by analysis of variance ($P < 0.05$).

Larvae were difficult to control. None of the four insecticides used in the present study were effective in reducing the number of mature larvae at the rates applied (Table 1). The highest mortality (48.7%) was achieved with clorpyrifos but this was not significantly higher than the controls (25.2%).

DISCUSSION

Fenvalerate was an effective residual insecticide for the control of adult black vine weevil. Its use should supplement other insecticides currently registered for control of this insect in Connecticut. Current control efforts require three to four applications of insecticide throughout July and August, and the insecticides currently available require higher rates of application to be effective. Therefore, the use of fenvalerate should reduce the amount of insecticide entering the environment and the overall cost of control, since only one application is required. However, complete reliance on a single insecticide may result in the development of resistance in the treated population. Nielsen et al. (1975) demonstrated black vine weevil resistance to dieldrin in a population in Ohio. Consequently, alternating the use of fenvalerate with a second insecticide should extend the periods of effective use for both materials.

Some larvae were found on the roots of plants that had been sprayed four times with fenvalerate during the summer, even though care was taken in this study to ensure complete coverage of the foliage during each application. Based on these results, it appears that elimination of this insect from a field is unlikely. Therefore, once a field is infested it will probably require insecticidal treatment until the plants are removed. Proper timing and thorough coverage will maximize the effectiveness of the insecticide used.

The relatively ineffective control of mature larvae noted after plant roots were submerged in insecticide demonstrates that control of this stage is less effective than controlling adults. For example, fenvalerate was effective against adults but provided poor control of larvae. In the field, larvae may be distributed to depths of 40 cm or more, requiring large quantities of insecticide to adequately treat the soil to that depth. In addition, deep penetration of the insecticide into the soil requires either adequate rainfall or irrigation, which may be limited or unavailable. Therefore, the most effective management practice is to control adult weevils before they lay eggs.

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