Black vine weevil management in nursery plants

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The best tactic may be to control adults before they start laying eggs

Black vine weevil larvae feeding on liquidambar roots have girdled the main stem just above the soil line.

The black vine weevil has recently been recognized as a serious pest in some California nurseries. Extensive losses have occurred in several northern California nurseries as a result of black vine weevil larvae feeding on roots of perennial plants, including azaleas, cyclamen, escallonia, euonymus, gardenia, juniper, liquidamber, rhododendron, photinia, and taxus.

The life history and feeding damage of the black vine weevil, *Otiorhynchus sulcatus,* were described in detail by Parrella and Keil (*California Agriculture,* March-April 1984). Briefly, the weevil has one generation each year. In northern California, the adults, all of them flightless females whose feeding damage is limited to foliage, are found from late March to September or later, depending on weather conditions. At 70°F, the adults require, on average, 600 day-degrees before they begin to lay eggs. Consequently, eggs are usually deposited in the soil around the roots of host plants beginning in late April. Hatch is temperature-dependent; at soil temperatures of 75°F, eggs hatch about 10 days after deposition. Larvae feed on the roots and, in high infestations, girdle the base of the stem. Black vine weevils overwinter as larvae, and pupation occurs in the spring.

Nursery infestations become widespread through the movement of infested plant material and the availability of favored host plants in concentrated areas. High beetle populations probably occur because the well-drained organic potting mix in nursery plantings is ideal for larval survival. Daily watering reduces soil temperatures so that the larvae can survive the summer heat in California's Central Valley. Infestations are often overlooked because of the adults' nocturnal behavior, and because damage by the adults may be mistaken for feeding by grasshoppers or other insects.

Inspection of potential hosts for black vine weevil stages before movement from one location to another may limit their spread, although eggs and small larvae are difficult to find in soil. The large number of host species and the economics of the nursery industry usually make it impossible to avoid infestation buildup by dispersing the host plants around the nursery grounds.

Regularly scheduled spring and summer host plant monitoring for the presence of adult weevils is the easiest and least costly method of detecting black vine weevil infestations. Since adults stay in the soil or under debris or pots during the day, ascending the plants to feed at night, the best time to sample host plants is one to two hours after dark. Weevil adults can be found with a bright light or can be collected by a sweepnet.

A regular sweeping program beginning in early spring allows detection of initial adult emergence, from which the date of first oviposition can be estimated through the tabulation of accumulated degree-days. This makes it possible to suppress the adults before their long preovipositional period is completed.

Although no economic threshold levels have been established, the presence of a significant number of black vine weevil adults will require the use of an adulticide such as acephate (Orthene). Application two or more hours after dark is most effective, because adult populations increase on the foliage until three or four hours after sunset.

Larval and pupal control

Although chemical control of black vine weevil adults is the best method of reducing an infestation, information on larval and pupal control has been needed for nurseries that have such infestations. Therefore, in 1983 and 1984, we initiated greenhouse and lathhouse tests using two species of insect parasitic nematodes, *Heterorhabditis heliothidis* and *Steinernema feltiae* (=*Neoaplectana carpocapsae*) and five chemical pesticides — bendiocarb (Ficam), carbofuran (Furadan), acephate (Orthene), isofenphos (Oftanol), and chlordane — against black vine weevil larvae and pupae.

Bendiocarb, carbofuran, and acephate are registered in California for use on nursery ornamentals. Isofenphos is not currently registered for this use in California but has been shown to be very effective against soil-inhabiting insects in tests in other states. Chlordane was included in this study only as a reference and is not registered for use on any agricultural or nursery crops. The insect-parasitic nematodes are exempt from federal and state registration processes. We reared both nematode species in our laboratory.

In some experiments, we obtained test plants from naturally infested 1-gallon pots in nearby commercial nurseries; in others, addition of black vine weevil eggs to pots containing susceptible host plants provided adequate infestations for our experiments.

We applied all treatments by drenching 300 ml of the chemical or nematode suspension onto the potted soil. Drenching appears to be the best application method for both. In all tests there were nine plants per treatment.

In greenhouse tests of older larvae (sixth stage) and pupae, the nematode *H. heliothidis* provided up to 90 percent mortality in test 1 and 85 percent in test 2 (table 1). The other nematode species, *S. feltiae,* was less effective, causing mor-

TABLE 1. Mortality of late-stage black vine weevil larvae and pupae in pots with liquidamber treated with chemicals and parasitic nematodes, greenhouse tests, March 1983

Treatment	Mean % mortality*
Test 1	
H. heliothidis, 15,000/pot	90 a
H. heliothidis, 30,000/pot	89 a
H. feltiae, 30,000/pot	78 ab
S. feltiae, 15,000/pot	71 b
Untreated control	13 c
Test 2	
H. heliothidis, 30,000/pot	85 a
bendiocarb, 1 lb ai/100 gal	84 a
chlordane,† 0.5% ai	76 ab
S. feltiae, 30,000/pot	76 ab
S. feltiae, 15,000/pot	75 ab
bendiocarb, 2 lb ai/100 gal	65 b
H. heliothidis, 15,000/pot	64 b
acephate, 1.5 lb ai/100 gal	24 c
acephate, 0.75 lb ai/100 gal	11 cd
Untreated control	—

* Means followed by the same letter are not significantly different according to Duncan's multiple range test, P=0.05.
† Chlordane is not registered for use on ornamentals and cannot legally be used for black vine weevil control.

TABLE 2. Number of early stage larvae recovered from artificially infested potted euonymus plants treated in the lathhouse with nematodes and chemical pesticides, November 1983

Treatment	Mean number larvae/pot*
Untreated control	6.4 a
H. heliothidis, 15,000/pot	3.7 b
H. heliothidis, 30,000/pot	2.5 b
S. feltiae, 15,000/pot	3.7 b
S. feltiae, 30,000/pot	2.1 bcd
carbofuran, 3 oz 4F/100 gal	1.9 bcd
carbofuran, 1.5 oz 4F/100 gal	0.2 cd
isofenphos, † ½ lb ai/100 gal	0.2 cd
isofenphos, † 1 lb ai/100 gal	0 d
isofenphos, † 2 lb ai/100 gal	0 d
bendiocarb, 1 lb ai/100 gal	0 d
bendiocarb, 2 lb ai/100 gal	0 d

* Means followed by the same letter are not significantly different according to Duncan's multiple range test, P=0.05.
† Isofenphos is not registered for use in California and cannot legally be used for black vine weevil control.

The adult black vine weevil (above) and its pupae (left). The white pupa is normal; the others have been infected with a parasitic nematode, which makes them appear reddish in color.

tality of 71 to 78 percent in tests 1 and 2. The best chemical treatment was bendiocarb, with 84 percent mortality. Better control resulted from the lower concentration than the higher concentration of bendiocarb; the reason for this difference is not known. Acephate was not effective against older larvae or pupae. Tests against older larvae and pupae in nursery situations gave similar results.

In lathhouse tests of younger weevil larvae (third stage), the chemicals bendiocarb and isofenphos were most effective (table 2). In general, the nematode species were not as effective. Although the reason is not known, it may be the inability of the infective nematode to locate the larvae. This finding corresponds with data obtained by Laurie Miller (personal communication) in Australia, where the nematodes were more effective against older larvae and pupae than against younger larvae.

Although bendiocarb controlled young larvae, it caused significant leaf drop and root damage on euonymus and escallonia.

Conclusion

The levels of control obtained in our experiments indicate that the nematode *H. heliothidis* may be the best material for suppressing older black vine weevil larvae and pupae. Unfortunately, *Heterorhabditis* spp. require special handling and storage. The infective nematode does not survive well under currently available storage conditions. *Steinernema feltiae* is easier to handle and store and is available from several commercial producers.

From the results of these experiments, we believe that 30,000 *S. feltiae* per pot would be necessary to achieve approximately 80 percent black vine weevil larval control. One million nematodes are sufficient to treat 33 1-gallon pots. The current cost per treated pot ranges from 5 to 60 cents. Further research may show that other strains of *S. feltiae* and *H. heliothidis* are more effective in controlling this pest.

Properly timed chemical treatments of young black vine weevil larvae can provide effective control. However, the best tactic is to monitor for the adults and use an appropriate adulticide in the spring before oviposition begins.

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