Black vine weevil: an increasing problem for California nurseries

Michael P. Parrella □ Clifford B. Keil

Adult black vine weevil is parthenogenic (there are no males) and cannot fly. Damage it causes is minor compared with that of larva (lower, right, with pupa) feeding on plant roots.

The black vine weevil is widespread throughout the continental United States but, until recently, has been a sporadic and minor pest of numerous container-grown ornamental plants and several field-grown berry crops. This insect has been a more serious pest in the Pacific Northwest, however, and has been increasing in pest status in other areas, such as Ohio, New York, and Michigan. The black vine weevil is also a problem for nursery growers in Australia, the Netherlands, Germany, Norway, and England.

During the past two years, a growing number of reports have come from California nurseries about control problems and damage done by the black vine weevil. We therefore conducted research on the distribution of this insect in a typical California nursery and investigated the inherent toxicity of selected insecticides to adult weevils.

Characteristics

The adult black vine weevil, *Otiorhynchus sulcatus* Fabricius, is a hard-shelled, roughened beetle, approximately ½ inch (9 mm) long and black or brownish black in color, usually with small patches of yellow or white scales on the forewings. As with all weevils, the front of the head projects into a long broad snout. Adults feed on plant foliage and lay approximately 500 eggs in the soil 20 to 30 days after emergence. The weevils are primarily nocturnal and adults often hide in dense debris at the base of the plant during the day. The adult black vine weevil is parthenogenetic: no males are known from this species. In addition, adults cannot fly, because the forewings are fused together.

Eggs hatch into legless, white grubs with dark head capsules; the grubs feed within the root zone of many plant species. This stage requires approximately one year of development before pupation. The whitish pupa is about the same size as the adult and also occurs in the soil within the root zone of plants. Adult emergence generally occurs as temperatures begin to rise in early spring.

Adult weevils commonly chew on foliage, causing a distinctive notching. The notching can be severe when adult populations are large, but this damage is usually inconsequential when compared with larval feeding. Young larvae consume small feeder roots; as larvae increase in size, they may strip or girdle larger roots, reducing the efficiency of the root system. This damage is most noticeable in the spring when plants normally produce considerable new growth. The plants sometimes die, particularly azaleas, which larvae tend to girdle at the soil line. In California, we have found azaleas, *Taxus*, camellias, euonymus, gardenia, and arborvitae commonly attacked.

Distribution within a nursery

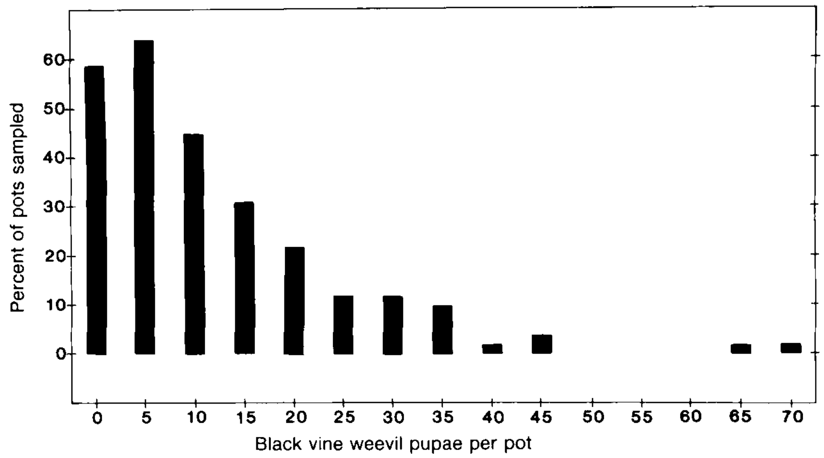
For our study, we chose a northern California nursery where black vine weevil activity had been reported. The study plant was *Taxus*, a preferred host of the black vine weevil. In addition, although many species of root weevils occur in California, only the black vine weevil feeds on *Taxus*. In fact, it is often referred to as the "taxus weevil." We

Distinctive notching on euonymus caused by adult weevil.

examined all *Taxus* plants in one area of the nursery (253 5-gallon plants in 3,000 square feet) for presence of larvae or pupae by sifting through the soil in the pots and around the roots. Weevil larvae and pupae were counted, placed in glass petri dishes (25 per dish) containing moist soil, and held in an environmental chamber until adult emergence.

Because plants were examined in mid-April, almost all weevils were collected as pupae; less than 1 percent were still in the larval stage. Although we recorded a mean number of 31 weevils per plant, the variation was large, ranging from 0 to 70 per plant (see graph). This was not unexpected, because the insects' flightlessness would contribute to severe, but patchy, infestations.

Examination of other plants surrounding this infestation in *Taxus* revealed a very low level of weevils, which suggests slow movement out of this primary area of infestation. Probably the weevils would take many years to spread across the entire nursery. This finding has important ramifications for control: if the primary site of infestation can be identified (through unthrifty plants, notching of leaves, and the like), then treating just this area may adequately control the weevil.



Black vine weevil pupae in 253 5-gallon *Taxus* plants sampled varied widely, ranging from none to 70 per plant.

Insecticides

Insecticides registered for control of black vine weevil in California nurseries include acephate, bendiocarb, carbaryl, carbofuran, chlorpyrifos, diazinon, and oxydemeton-methyl. Most of these can be used as foliar sprays directed against adults or as soil drenches against the immature stages. Carbofuran is labeled under a "24c" special local needs registration for application through the overhead sprinkler system. This application method is likely to have activity against both adults and larvae.

Because of increasing reports concerning the failure of these insecticides to control larvae or adults, we evaluated the inherent toxicity to black vine weevil adults of four of the compounds, as well as one unregistered material, isofenphos. We obtained adult weevils for these tests from the *Taxus* plants described earlier. After adults had emerged, we placed them on strawberry plants in 5-gallon glass containers in the same environmental chamber, thus standardizing the age before testing: all were between 20 and 30 days old.

Technical insecticide dissolved in acetone was applied to the center of the ventral surface of all weevils (2 microliters acetone per weevil). No anesthetization of weevils was required. After application, weevils were placed in 25-dram ventilated plastic containers with a fresh cutting of *Taxus* foliage, which was replaced as needed.

Five doses per insecticide were tested (including the control), with four containers per dose. Carbofuran, isofenphos, and bendiocarb containers each had 10 weevils; acephate and chlorpyrifos containers each had five weevils. Mortality was recorded after 72 hours; all weevils that could not coordinate their movements when touched with a probe were considered dead. None of these moribund insects recovered.

Materials were evaluated by compar-

Black vine weevil larvae may strip or girdle larger roots, often killing plants such as azalea.

The black vine weevil is sometimes referred to as the "taxus weevil" because of its preference for this plant species. Differences in new spring growth were caused by larval feeding on plant roots.

ing their LD_{50} values (the dosage of insecticide required to kill 50 percent of the test weevils; the larger the LD_{50} value, the less toxic the material is to the black vine weevil). All materials killed adult weevils, with carbofuran and bendiocarb being the most toxic (LD_{50} values of 0.09 and 0.18 mg/ml, respectively). Chlorpyrifos and acephate achieved greater mortality than did isofenphos (LD_{50} values of 0.88, 1.01, and 1.93 mg/ml, respectively). The pattern of toxicity was the same when the data were extrapolated to compare the recommended field rates of all toxicants. Because adult weevils feed on foliage, all insecticides might have been more toxic if ingestion toxicity had also been considered.

This study provides comparative toxicity data for selected insecticides to adults. It cannot be presumed that toxicity will be the same to larvae. Larvae are often deep among the roots of plants and, despite a thorough drenching, it may be difficult to obtain coverage with the toxicant. In addition, different soil types used in various nurseries could significantly affect the activity of an insecticide applied to soil. In general, newly hatched larvae are more susceptible to insecticides than are older larvae. Therefore, insecticides applied soon after egg hatch will probably provide the greatest larval control. Researchers at UC Davis and at research laboratories in other countries are evaluating the control potential of parasitic nematodes and fungi against black vine weevil larvae. Parasitic nematodes have been used successfully in Australia, and results appear promising in California.

At present, trials suggest that consistently good results can be obtained through foliar applications of insecticides against adults. A foliar spray with long residual properties, applied at night, will kill weevils both through direct contact and ingestion. In addition, applications when adult activity is first observed may provide appreciable adult mortality before egg laying occurs because of the relatively long, 20- to 30-day, prereproductive period. Finally, once the primary infestation area is identified, treating only that location may be sufficient to reduce the problem; treating the entire nursery probably is not necessary, unless the weevils have been established for a long time and are widespread.

Michael P. Parrella is Assistant Professor of Entomology, and Clifford B. Keil is Postdoctoral Research Scientist, Department of Entomology, University of California, Riverside. *This research was partially supported by California Association of Nurserymen and University of California Academic Senate, Riverside.*

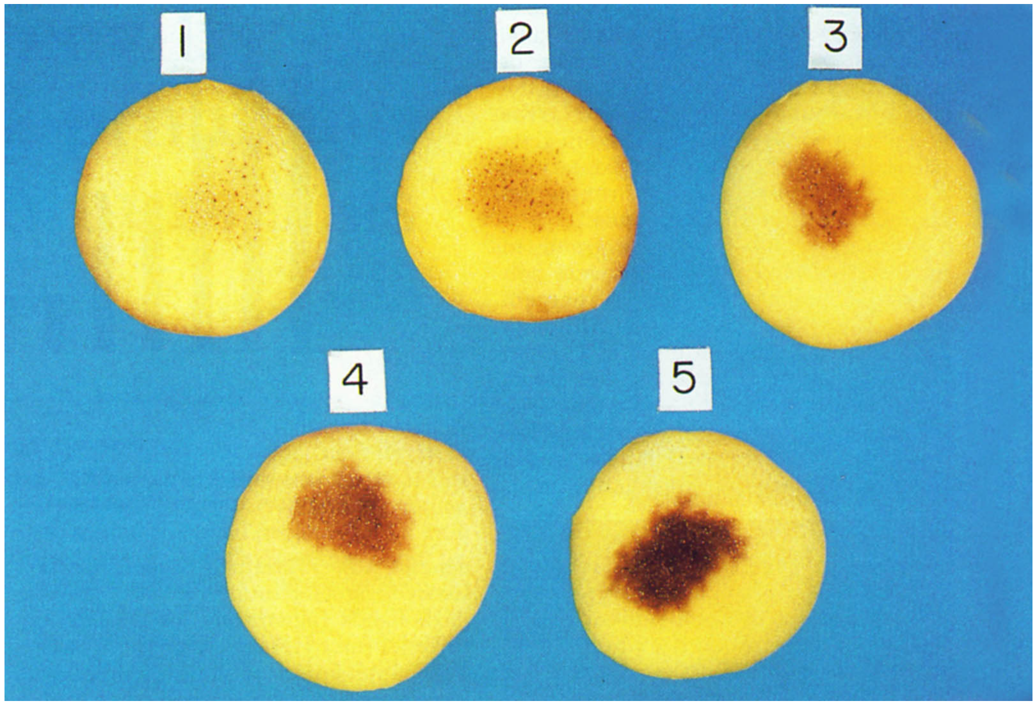


Fig. 1: Phenolic compounds and activity of polyphenol oxidase (PPO) enzyme cause undesirable browning in peaches. Catechol added to peach slices (above) tests level of

Evaluating the browning potential of peaches

Adel A. Kader □ Alexander Chordas

Fresh fruit tissues turn brown when bruised, cut, or otherwise damaged during harvesting and postharvest handling. This browning detracts from the appearance of fruits marketed fresh or used for processing. The extent of the discoloration depends not only on the severity of bruising, but also on the inherent browning potential of the fruits. Browning potential depends upon the total amount of phenolic compounds and level of activity of the polyphenol oxidase (PPO) enzyme, which catalyzes enzymic browning in fresh fruits. Normally, phenolic compounds are separated from PPO enzyme in the intact tissue. Once the fruit tissue is damaged, PPO gets access to the phenolic compounds, and reactions leading to browning occur. These reactions involve the oxidation of phenolic compounds to form quinones, which are tightly unstable and polymerize quickly to form brown-colored products.

In a study of peach bruising and browning initiated in 1978, we found large differences in browning potential, total phenolics content, and PPO activity among cultivars and within a given cultivar in relation to environmental conditions and cultural practices. These results indicate that it is possible to