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Diaprepes Root Weevil

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Diaprepes root weevil, *Diaprepes abbreviatus* (L.) (Coleoptera: Curculionidae), is a large, colorful weevil, 3/8 to 3/4 inch (10 to 19 mm) long, with numerous forms, or morphs, ranging from gray to yellow to orange and black (fig. 1). This weevil is native to the Caribbean region. It was accidentally introduced into central and south Florida in 1964 in an ornamental plant shipment from Puerto Rico (Woodruff 1968). Since then, it has spread throughout Florida, where it sometimes causes serious damage to citrus trees. In addition, it poses a threat to many ornamental plants and a number of other agronomic crops such as papayas and sweet potatoes. In 2000, Diaprepes became established in a mature citrus grove in the Rio Grande Valley of Texas (Skaria and French 2001) (fig. 2). Diaprepes has been intercepted a number of times in California since 1974 in shipments of plants, in truck trailers, and in the cargo holds of aircraft. The weevils found in these interceptions were destroyed. However, the risk of introduction and establishment of this weevil in California is high because of the high volume of host plants brought into California.

HOST PLANTS

Diaprepes root weevil feeds on more than 270 species of plants from 59 plant families (Simpson et al. 1996). Some of the more common hosts are citrus (all varieties), peanut, sorghum, guinea corn, corn, Surinam cherry, dragon tree, sweet potato, sugarcane, panicum grasses, coffee weed (sesbania), and Brazilian pepper. Because of its broad host range, the Diaprepes root weevil poses a great threat to citrus and ornamental plant industries in California.

Figure 1. Diaprepes root weevil adults vary in color and striations.

Figure 2. Current distribution of Diaprepes root weevil. Note population in South Texas.

Figure 3. Mating pair of Diaprepes root weevils.

Figure 4. Cluster of Diaprepes eggs deposited between leaves.

Figure 5. Diaprepes eggs are slightly over 0.04 inch (1 mm) long.

Figure 6. Late-instar Diaprepes larva inhabiting soil.

LIFE CYCLE

Adult Diaprepes root weevils are long-lived, with females surviving an average of 147 days and males an average of 135 days. During this time, a female lays an average of 5,000 eggs (Wolcott 1936). The majority of the oviposition activity occurs during dawn or dusk. After mating (fig. 3), the female deposits eggs in clusters of 30 to 260 eggs between two leaves (fig. 4) or inside the folded edge of a leaf. The female weevil secretes a gelatinous substance that glues the leaf edges together. The eggs within the cluster are usually arranged in a single layer. The eggs are white, oval shaped, and slightly over 0.04 inch (1 mm) in length (fig. 5). Newly laid eggs are uniformly white, but they darken slightly just before hatch. The eggs hatch in 7 to 10 days.

The newly emerged grublike larvae drop from leaves to the soil surface. The young larvae move about on the surface before burrowing into the soil to find roots on which to feed. The young larvae cannot burrow into dry soil. They initially feed on the smaller fibrous roots of a plant, moving to larger roots as they mature. The larvae complete 10 or 11 instars over a period of 8 to 15 months, attaining a length of about 1 inch (2.5 cm). Larval instars 3 through 9 (fig. 6) are the most aggressive feeders and may girdle the crown area of the root system, killing the plant. Larvae in the last two instars (10 and 11) feed very little as they enter a quiescent, prepupal period. The pupa remains in a pupal chamber in the soil for 15 to 30 days (fig. 7).

New adults emerge from the pupal chambers in the soil. Adults may walk on the soil surface or fly a short distance from where they emerge. Adult weevils will not emerge from soil that is dry and compacted. Irrigation or rainfall promotes adult emergence (McCoy et al. 2003a). Mating occurs mainly on the leaves of the host plant, with much of the mating activity occurring in the early morning or late at night. Female weevils may begin ovipositing within 7 to 14 days of emergence. The length of the life cycle of Diaprepes depends on temperature and soil moisture. It may be as short as 5 months or as long as 18 months.

Adult weevils are capable of strong flight for a short duration and distance. Once the weevils land, they tend to stay on that

Figure 7. The pupal stage of Diaprepes can be found in the soil.

Figure 8. Citrus leaf feeding by Diaprepes adults.

Figure 9. Papaya leaf feeding.

Figure 10. Guava leaf feeding.

particular host plant unless they are disturbed or their food source is depleted. Their initial reaction to disturbance is to feign death and fall to the soil. Because of these behaviors, natural dispersal of the weevil is slow. However, human movement of plants, crops, and farm equipment greatly increases the rate at which the Diaprepes root weevil can disperse within an area.

ADULT DIAPREPES FEEDING

Adult Diaprepes weevils feed along the edges of leaves, creating semicircular notches (figs. 8–10). They prefer young, tender leaves over older leaves. On rare occasions, adults may feed on fruit. Fruit feeding is usually limited to papaya (fig. 11) and citrus (fig. 12). Damage caused by adult weevils is similar to damage caused by other citrus weevils such as Fuller rose beetle *(Asynonychus godmani)*, so it is important to locate and identify the weevil that is causing the damage. In addition to notching, Diaprepes adults leave frass scattered on the leaves (fig. 13). Adults are sometimes difficult to find because they feed during the early morning and late afternoon, hiding in the foliage during the day. However, they may be dislodged by shaking the foliage over a light-colored cloth. The trees on which the feeding damage is seen are the trees that should be sampled. In citrus groves with well-established populations, weevils may be found on every tree or sometimes aggregated on just a few trees.

Figure 11. Papaya fruit feeding by adults.

Figure 12. Citrus fruit feeding.

Figure 13. Frass (excrement) left behind by feeding adults.

Figure 14. Larval damage to cassava root.

Figure 15. Larval feeding on potato.

Figure 16. Loss of root hairs due to Diaprepes feeding (right), compared with normal roots (left).

Figure 17. Eventually, Diaprepes may girdle the crown of citrus.

LARVAL DIAPREPES FEEDING

Larvae of the Diaprepes root weevil cause extensive damage to their host plants by feeding on the roots, tubers, or other underground portions. In cassava and potatoes, the larvae feed directly on the tubers (figs. 14–15). In citrus, they begin by feeding on the smallest roots, and as the larvae grow, they move to the larger structural roots (fig. 16). Eventually they may girdle the large lateral roots or the crown area of the tree (fig. 17). In laboratory studies, citrus rootstocks commonly used in the United States showed no resistance or tolerance to feeding by Diaprepes root weevil larvae. Many citrus trees do not show symptoms of decline (e.g., leaf yellowing, wilting, defoliation, etc.) until extensive damage has been done to the root system (fig. 18). Damage is particularly serious in groves where trees are planted in poorly drained soils that

Figure 18. Citrus trees declining due to a heavy infestation of Diaprepes root weevil in Osceola County, Florida.

Figure 19. Inspect notched leaves, such as the citrus leaves shown here, for the presence of Diaprepes adults.

Figure 20. Characteristic notching on citrus leaves. Adults may hide in sheltered parts of the plant during the day.

Figure 21. A Tedders ground trap captures adults as they emerge from pupating in the soil.

are optimal for larval development (McCoy 1999). The feeding activity of the larvae may also make the plant more susceptible to root rot organisms such as *Phytophthora* spp. (Graham et al. 2002).

MONITORING FOR DIAPREPES ROOT WEEVIL IN CALIFORNIA

Monitoring for the presence of the Diaprepes root weevil adults requires inspection of the edges of new, tender leaves and shoots on host plants. Plants that have semicircular notches on the edges of new leaves should be inspected closely for the presence of adult weevils (figs. 19–20). Fuller rose beetle causes a similar type of damage, although the notches are smaller and frass is less often seen on leaves. Adult Diaprepes can be collected by placing an open umbrella or light-colored cloth (beating apron) beneath the foliage and shaking the foliage vigorously. If you find a weevil that you believe might be Diaprepes, place it in a small jar filled with rubbing alcohol and take it to your local county agricultural commissioner's office. State or county officials will have the specimen identified and respond to a positive sample by surveying the plants in the surrounding area to determine the extent of the infestation. Once the extent of the infestation is known, the appropriate regulatory actions (quarantine and eradication) will be taken to remove the infestation and minimize the spread of Diaprepes from the site. These measures will include insecticides and host plant destruction.

Sample for the larvae and pupae by digging and examining soil near the location of adult foliar feeding. Eggs can be found in folded and stuck-together leaves.

Once Diaprepes root weevil becomes established in an area, good sanitation practices will help reduce its rate of spread. Life stages of the weevil may be found in soil, plants, leaves, grass, sod, and stump wood. Removal of all soil and plant material from equipment, picking sacks, bins, personal items, and so on prior to their exit from a known infested area helps reduce the movement of this insect. Maintaining weevil-free citrus and ornamental nurseries is vital to preventing the spread of Diaprepes root weevil from area to area. Established adult populations can also be collected in a modified Tedders trap (Duncan et al. 2001) (fig. 21). The adults climb up the black trunk-like vanes of the Tedders trap and are caught in the inverted cup. Inspect the opening in the wire mesh screen on the inverted cup before use to make sure the hole is large enough to allow the weevils to enter.

LONG-TERM MANAGEMENT OF DIAPREPES IN FLORIDA

Diaprepes root weevil is now well established in Florida. The following integrated pest management (IPM) practices have been developed to help reduce the damage it causes to citrus (McCoy and Duncan 2000). If the pest were to become established in California, similar tactics would be employed.

Chemical Control

In Florida, growers and nursery owners use pesticide drenches for larvae and foliar sprays for adults and eggs (McCoy et al. 2003b). However, insecticides have limited effectiveness because the larvae are well-protected in the soil and adults have a wide host range that is difficult to treat on an area-wide basis.

Cultural Practices

Because the primary damage caused by Diaprepes root weevil is to the roots, fertilization and irrigation that promote the growth of the roots should be practiced. Avoid overirrigation and provide proper soil drainage. Additionally, in situations where *Phytophthora* is of concern, resistant rootstocks should be used, if available, to lessen the impact of the interaction of Diaprepes root weevil and *Phytophthora* spp. on plant health.

Biological Control

Egg Control

A number of species of small parasitic wasps that attack the egg stage of the Diaprepes root weevil were collected from the Caribbean and released in Florida from 1998 to 2001 (Hall et al. 2001). Two of the parasites, *Aprostocetus vaquitarum* (fig. 22) and *Quadrastichus haitiensis*, have become established. The levels of parasitism in southern Florida range from 70 to 80 percent. However, in central Florida, parasitism is only 5 percent. This variability may be due to differences in winter temperature or differences in application of various pesticides.

Figure 22. A parasitic wasp *(Aprostocetus vaquitarum)* that attacks Diaprepes eggs.

Larval Control

Entomopathogenic nematodes, both native and commercially available, have been found to cause significant mortality to Diaprepes root weevil larvae in sandy soils in Florida and the Caribbean (McCoy et al. 2000) (fig. 23). The nematodes are ineffective in heavier, clay loam soils with a small particle size. This lack of effectiveness may be due to the inability of the nematodes to move through the smaller pore spaces found in the heavier soils.

Figure 23. Diaprepes larva killed by nematodes.

Adult Control

In field trials, the entomopathogenic fungus *Beauveria bassiana* applied as a soil drench killed larvae and newly emerging adult root weevils (fig. 24), but the fungus had limited persistence in the soil and required application rates that were cost-prohibitive. Studies are underway to induce outbreaks of this fungus in adults.

Figure 24. Adult Diaprepes killed by fungi.

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