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OVIPOSITION AND LARVAL SURVIVAL OF *DIAPREPES ABBREVIATUS* (COLEOPTERA: CURCULIONIDAE) ON SELECT HOST PLANTS

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Abstract

In a preliminary survey in four commercial ornamental nurseries in south Florida (1998), *Diaprepes abbreviatus* (L.) (Coleoptera: Curculionidae) egg masses, feeding damage, or adults occurred on numerous field-grown ornamental plant species. Live oak (*Quercus virginiana* Mill.), silver buttonwood (*Conocarpus erectus* L. variety *sericeus* Fors. Ex DC), and black olive (*Bucida buseras* L.) had the highest percentage of plants with egg masses. Adult feeding damage was found on all examined plants of dahoon holly (*Ilex cassine* L.), cocoplum (*Chrysobalanus icaco* L.), black olive, live oak, *Bauhinia* sp., and *Cassia* sp. Oviposition of *D. abbreviatus* was evaluated in no-choice, two-choice, three-choice and multiple–choice caged tests. In no-choice tests, silver buttonwood had the highest mean number of egg masses. In two-choice tests, egg masses were laid on all plant species tested but there were significantly more egg masses on silver buttonwood than the alternate choice. The number of egg masses in the three-choice tests was low and there were no significant differences among the plant species tested. As in the no-choice and two-choice tests, significantly more egg masses were found on silver buttonwood in multiple-choice tests. Survival of larvae and their effect on plant growth was examined on several commonly grown plant species in southern Florida. Larval survival was highest on silver buttonwood and *Sorghum sudanense* Pers (sorghum-sudan) compared with other plant species. Root and/or total biomass was significantly reduced on green bean (*Phaseolus vulgaris*), silver buttonwood, Tahiti lime (*Citrus aurantifolia*), and sorghum-sudan.

Key Words: root weevil, oviposition, host preference, larval survival

Resumen

En un muestreo preliminar realizado en 1998 en cuatro viveros de plantas ornamentals localizados en el sur de Florida, se demostró que *Diaprepes abbreviatus* (L.) (Coleoptera: Curculionidae) estaba asociado oviposición, daño al follaje, o en base a la presencia de adultos en varias especies de plantas ornamentals. Las especies de plantas que presentaron el mayor porcentaje de oviposición fueron el roble, (*Quercus virginiana* Mill), el arbol plateado del botón (*Conocarpus erectus* L.,) variedad *sericeus* y la bucida *(Bucida buseras* L). Se observó consumo del follaje por adultos en todas las plantas muestreadas de las siguientes especies, acebo (*Ilex cassine* L.), icaco (*Chrysobalanus icaco* L.), bucida, roble, casco de vaca *Bauhinia* sp., y *Cassia* sp. Se evaluó la oviposicion de *Diaprepes* mediante experimentos en jaulas donde se ofrecieron una opción de planta, dos opciones de plantas, tres opciones de plantas, y varias opciones de plantas. En los experimentos con una sola opción de plantas, el arbol plateado del boton obtuvo el mayor número de huevos. En experimentos con dos opciones de plantas, se encontraron posturas en todas las plantas, pero mas en el arbol plateado del boton comparado con otras plantas. Cuando se ofrecieron 3 opciones de plantas el número de posturas por planta fue bajo, y no hubo diferencias entre las especies expuestas. En las pruebas de opciones multiples de plantas hospederas, el arbol plateado del botón tuvo mayor oviposición que las otras especies. La supervivencia de las larvas y su efecto en el crecimiento de examinado en varias plantas cultivadas en el Sur de la Florida. La supervivencia de las larvas fue mayor en raices del arbol plateado del botón, y sorgo sudanés comparado con la supervivencia en las raices de otras especies de plantas. *Diaprepes abbreviatus* redujo significatinamente el peso de las raíces y el peso total de frijol verde (*Phaseolus vulgaris*), arbol plateado del botón, lima acida (*Citrus aurantifolia*) y sorgo sudanés.

Translation provided by author.

The root weevil, *Diaprepes abbreviatus* (L.), native to the Caribbean Islands, is believed to have entered Florida from Puerto Rico on a shipment of ornamental plants (Woodruff 1985). It was first reported in an Apopka nursery in 1964 (Woodruff 1968) and has spread throughout many counties in Florida. *Diaprepes abbreviatus* is associated with at least 270 plant species including several important and economic crops grown in Florida such as citrus, ornamentals, and sugar cane (Simpson et al. 1996). In citrus groves the cost of control and losses incurred by *Diaprepes* root weevils exceed $1,200 per acre. This pest infests approximately 60,000 acres of citrus at an annual cost of about $72 million to the Florida citrus industry (Stanley 1996). *Diaprepes* is currently attacking many ornamental nursery plants, which has resulted in restrictions on the movement of plant material from areas infested with the weevil. Quarantine treatments can be expensive, labor intensive and time-consuming. Sometimes there are losses in sales and customers because there are no known treatments acceptable for quarantine and plants cannot be shipped to a particular location. Twenty-four Florida counties were known to be infested as of April 2001 (Michael C. Thomas, Florida Department of Agriculture and Consumer Services, pers. comm.).

Adult weevils feed on plant foliage, often leaving a characteristic pattern of notches around leaf edges. Female weevils lay clusters of eggs between leaves and protect them by secreting a sticky substance that cements the leaf surfaces together (Fennah 1942; Woodruff 1968; Adair et al. 1998). The number of eggs per egg mass varies but on average is approximately 50 eggs. One female may lay as many as 5,000 to 29,000 eggs during her three to four month lifespan (Wolcott 1936; Beavers 1982). Neonates hatch from the eggs in 7 to 10 days, fall to the soil surface, and burrow into the soil seeking out plant roots on which to feed. The larvae remain in the soil 8 to 12 months where they complete development to the adult stage. Adult weevils live 4 to 5 months, but often half of this time is spent below the surface of the ground (Wolcott 1936). In Florida, there are overlapping generations with two peak adult emergence periods in the spring (May-June) and fall (August-September) (Beavers & Selhime 1976).

Adult weevils can cause moderate to severe defoliation of host plants; larval feeding can kill hosts. In some plants, larvae girdle the taproot, which reduces nutrient uptake, and ultimately kill the plant (Quintela et al. 1998). Additionally, larval root-feeding injury also provides an avenue for microbial infections such as *Phytophthora* and *Fusarium* (Knapp et al. 2000; Nigg et al. 2001a). Several larvae can cause serious decline of established citrus trees and it has been speculated by researchers that one larva is capable of killing a young citrus tree.

The objectives of this research were to evaluate host preferences for oviposition and to determine the presence of *D. abbreviatus* eggs, adults, or adult feeding damage in a preliminary survey of field-grown ornamentals, and to evaluate larval survival and root consumption of various plant species.

Materials and Methods

Field Survey

A preliminary survey for the presence of adult *D. abbreviatus*, feeding damage and egg masses was conducted over a 2-day period in four commercial, field-grown ornamental nurseries in Miami-Dade County, Florida. Three plant rows were randomly selected from each field and two people inspected all plants within the three rows for 5 minutes per plant. The presence or absence of adults, feeding damage, and egg masses on each plant were recorded. All sites contained a diversity of ornamental plants with moderate to high populations of *D. abbreviatus*.

No-Choice Oviposition Tests

Three tests were conducted to compare oviposition on four plant species when there was no choice in host plant. In each test, eight plants of the same species were placed in a screen cage (1.8 × 3.7 × 1.8 m). Each plant was planted in a 7.6 liter container with Pro-Mix 'BX' (peat-based growing medium) potting media and exhibited new leaves at the time of the experiment. In Test 1, the plants evaluated were *Conocarpus erectus* L. variety *sericeus* Fors. Ex DC (silver buttonwood), *Manihot esculenta* Krantz (cassava), *Carica papaya* L. (papaya), and *Xanthosoma* sp. (malanga). In Test 2, the plants evaluated were silver buttonwood, *Sorghum sudanense* Pers (sorghum-sudan), *Persea americana* Mill. (avocado), and *Chrysophillum oliviforme* L. (satinleaf tree). In Test 3 the plants evaluated were silver buttonwood, *Solanum tuberosum* (white potato), *Pennisetum purpureum* Schumach (elephant grass), and *Zea mays* L. (sweet corn). Fifty male and fifty female, adult *D. abbreviatus* were released in each cage. The number of adults used was selected to ensure some oviposition. Adult weevils were field collected from mixed plant species. The adult weevils were maintained in cages with *Conocarpus erectus* L. (green buttonwood) before use for approximately 24 hours. Each treatment was replicated four times. The number of egg masses per plant was recorded 7 days after the adults had been released into the cages, which was sufficient time for the weevils to lay eggs. The number of eggs per egg mass were not counted.

Two-Choice Oviposition Tests

Two tests were conducted in which adults were given a choice of silver buttonwood or another plant host (each planted in a 7.6 liter containers with ProMix potting media) on which to oviposit. In the first test the alternate plant was *Citrus aurantifolia* (Christm.) Tahiti lime, and in the second test the alternate plant was sorghum-sudan.

In each test, eight plants (four of each species) were placed in a screen cage (2 × 4 × 2 m). Each test was replicated four times. Plant species within a cage were placed in an alternating pattern. One hundred field-collected adult *D. abbreviatus* (50 female; 50 male) were released into each cage. Each plant was examined for number of egg masses as above.

Three-Choice Oviposition Tests

Three plant species were evaluated in a choice test for oviposition preference by *D. abbreviatus*. The plant species included *Citrus sinensis* L. sour orange, Tahiti lime, and silver buttonwood each grown in a 7.6 liter containers in a Pro-Mix 'BX' (peat-based growing medium) potting soil. The containers were placed on five raised beds in a screen house (12.2 × 18.3 m). Beds were 16.5 × 0.7 m with 1.3 m between beds. Twenty-four silver buttonwood were evenly spaced on each of the two outside beds with 0.61 m between plants. On the three inner beds, ten orange and ten lime trees were alternated with two buttonwood plants at the end of each bed totaling 24 plants per bed. Five hundred field-collected adult weevils from plant species not included in the test were released inside the screen house in the late afternoon on day 1. The male-female ratio was 1:1. The adult weevils were released along the centerline of the screen house perpendicular to the beds. The number of egg masses per plant was recorded on day 8.

Multiple-Choice Oviposition Test

Plants of seven species were each planted in a 7.6 liter container with Pro-Mix 'BX' (peat-based growing medium) potting soil. The plants included silver buttonwood, lime, elephant grass, sorgham-sudan, sweet corn, malanga, and white potato. Five replications of each plant were placed in a randomized complete block design in a screenhouse (12.2 m × 18.3 m). Five hundred adult *D. abbreviatus* were collected from the field from hosts other than those in the test and released inside the screen house. Ten days after the release, plant leaves were checked for egg masses.

Larval Survival and Root Consumption

Survival of larvae on different host plants and their effect on the plant was measured. Treatment containers were infested with 50 neonate *D. abbreviatus*. Neonates were collected from eggs produced by field-collected adults held in cages. For each plant species, a paired comparison of infested and not infested plants was conducted. Eight plant species were tested; *Phaseolus vulgaris* L. (green bean), silver buttonwood, lime, malanga, satinleaf, sorghum-sudan, cassava and *Ilex cassine* L. (dahoon holly). Each plant was planted in a 7.6 liter container with Pro-Mix 'BX' (peat-based growing medium) and maintained in a greenhouse. Replications for each plant species varied between 5 and 10. Green bean and sweet corn were evaluated 2 months after infestation. Silver buttonwood, Tahiti lime, malanga, satinleaf, and sorghum-sudan were evaluated 3 months after infestation. Larval survival was also evaluated on silver buttonwood, Tahiti lime and malanga 6 months after infestation. Plant height, fresh and dry weight of roots and total biomass, and the number and weight of surviving larvae were recorded. Comparisons were made between infested plants and not infested plants.

Data in all of the oviposition choice tests except the two-choice test and the larval survival tests were subjected to analysis of variance with the means compared by the Student-Newman-Keuls Range Test (SAS 1999-2001). Data from the two-choice oviposition test and all the larval feeding tests were subjected to a *t*-test (SAS 1999-2001).

Results and Discussion

Field Survey

Numerous field-grown ornamental plant species were examined for the presence of adults, feeding damage, or egg masses (Table 1). The results of this survey are preliminary but are consistent with previous surveys or plant host lists (Simpson et al. 1996; Knapp et al. 2000) that indicate that *Diaprepes* will feed and lay eggs on a wide host range of ornamental plants. The survey conducted by Simpson et al. (1996) is a compilation of specimen identification reports submitted to the Florida Department of Agriculture and Consumer Services, Division of Plant Industry, from 1964 through 1995 in addition to any host records listed in the scientific literature from 1898 to 1995. Knapp et al. (2000) also compiled a list of plant hosts from the scientific literature but there is no information about the type of association with the host plant (i.e., adult host, larval host, etc.). The current survey is a snapshot of adult weevil presence, host plant damage, and presence of egg masses in four commercial, field-grown ornamental nurseries in south Florida. The plant species in this survey with the highest percentage of plants with egg masses were live oak, *Quercus virginiana* (46.2%), silver buttonwood (41.2%), and black olive, *Bucida buseras* (33.3%). All of the dahoon holly, cocoplum, *Chrysobalanus icaco*, black olive, live oak, *Bauhinia* sp. and *Cassia* sp. plants evaluated had adult feeding damage. Plant species with the highest number of adults per plant include dahoon holly, black olive, and *Bauhinia* sp. All plant species in the survey with egg masses, adults or feeding damage, except *Jacaranda mimosiflia* (jacaranda), *Clusia rosea* (autograph tree), and

TABLE 1. PRELIMINARY SURVEY OF ADULTS, FEEDING DAMAGE, AND EGG MASSES OF *Diaprepes abbreviatus* ON CULTIVATED NURSERY PLANTS IN MIAMI-DADE COUNTY, FL, SEPTEMBER 3-4, 1998.

Plant family	Plant species (common name)	No. plants examined	No. plants with egg masses	No. plants with feeding damage	No. plants with adults present
Agavaceae	*Cordyline terminalis* (ti plant)	3	0	2	0
	Dracaena marginata (Dracena)	2	0	0	0
Aquifoliaceae	*Ilex cassine* (dahoon holly)	8	2	8	7
Bignonaceae	*Tabebuia heterophylla* (pink trumpet tree)	5	0	0	0
	Tabebuia caraiba (silver trumpet tree)	2	0	1	0
	Jacaranda mimosifolia (jacaranda)	5	0	1	1
Boraginaceae	*Cordia sebestena* (geiger tree)	1	0	1	0
Burseracea	*Bursera simaruba* (gumbo limbo)	8	0	5	4
Chrysobalanaceae	*Chrysobalanus icaco* (cocoplum)	10	0	10	2
Combretaceae	*Conocarpus erectus* var. *sericeus* (silver buttonwood)	17	7	10	6
	Bucida buseras (black olive)	9	3	9	7
Cycadaceae	*Cycas revolute* (king sago)	5	0	0	0
Fagaceae	*Quercus virginiana* (live oak)	13	6	13	4
Guttiferae	*Calophyllum braziliense* (Brazilian beauty leaf)	25	3	11	1
	Clusia rosea (autograph tree)	11	0	10	1
Leguminosae	*Bauhinia* sp.	7	0	7	5
	Cassia sp.	31	1	31	12
Lythraceae	*Lagerstroemia* sp. (crape myrtle)	11	0	6	0
Meliaceae	*Swietenia mahogany* (mahogany)	6	1	4	1
Myrtaceae	*Eugenia* sp.	5	0	0	0
Musaceae	*Strelitzia nicolai* (bird-of-paradise)	5	0	0	0
Oleaceae	*Ligustrum* sp. (privet)	1	0	1	0
Palmae	*Cocos nucifera* (coconut palm)	9	2	1	0
	Phoenix roebelinii (pygmy date palm)	38	4	20	1
	Acoelorraphe wrightii (Everglade palm)	1	0	0	0
	Livistona chinensis (Chinese fan palm)	1	0	0	0
	Vetchia merrillii (Christmas palm)	18	0	0	1
Sapindaceae	*Litchi chinensis* (lychee)	2	0	2	0
Sapotaceae	*Chrysophyllum olivivorme* (satinleaf)	2	0	1	0

Cocos nucifera (coconut palm), have previously been reported as being associated with *D. abbreviatus* (Simpson et al. 1996; Knapp et al. 2000).

No-Choice Oviposition Tests

In two of the three tests conducted, silver buttonwood had the highest mean number of egg masses ranging from 1.75 to 4.12 egg masses per plant (Table 2). Only two plant species (malanga and satinleaf) had no egg masses.

In Test 1, significantly more egg masses were found on cassava and silver buttonwood leaves compared with papaya and malanga ($F = 6.10$; df = 3, 28; $P = 0.0025$) (Table 2). A similar result was seen in Test 2. More egg masses were found on silver buttonwood and sorghum-sudan compared with avocado (West Indies cultivar) and satinleaf ($F = 8.26$; df = 3, 28; $P = 0.0004$) (Table 2). In Test 3, the mean number of egg masses did not significantly differ among plant species ($F = 1.90$; df = 3, 28; $P = 0.1525$). However, there were approximately twice as many egg masses on silver buttonwood as on the alternate hosts (Table 2).

Two-Choice Oviposition Tests

Egg masses were found on all plant species tested, however, there were significantly more egg masses on silver buttonwood than the alternate choice, sorghum-sudan ($t = 3.39$; df = 29; $P = 0.002$) or lime ($t = -2.83$; df = 30; $P = 0.008$) (Table 3).

Three-Choice Oviposition Tests

The numbers of egg masses per plant were low. There were no significant differences among the three host plants, silver buttonwood, Tahiti lime and sour orange, although the highest mean number of egg masses occurred on silver buttonwood ($F = 1.06$; df = 2, 117; $P = 0.3510$) (Table 4). There were significantly more adults per plant on silver buttonwood compared with sour orange ($F = 4.83$; df = 2, 117; $P = 0.0096$) 8 days after the

TABLE 2. MEAN NUMBER OF EGG MASSES FROM 50 FEMALE *DIAPREPES ABBREVIATUS* IN A NO-CHOICE TEST.

	Host plant	Mean egg masses per plant (±SE)[1]
Test 1	*Manihot esculenta* (cassava)	4.75 ± 1.21 a
	Conocarpus erectus (silver buttonwood)	2.87 ± 1.25 ab
	Carica papaya (papaya)	0.50 ± 0.38 bc
	Xanthosoma sp. (malanga)	0.00 ± 0.00 c
Test 2	*Conocarpus erectus* (silver buttonwood)	1.75 ± 0.36 a
	Sorghum sudanense (sorghum-sudan)	1.25 ± 0.45 a
	Persea americana (avocado)	0.13 ± 0.12 b
	Chrysophyllum oliviforme (satinleaf)	0.00 ± 0.00 b
Test 3	*Conocarpus erectus* (silver buttonwood)	4.12 ± 1.24 a
	Solanum tuberosum (white potato)	2.25 ± 0.31 a
	Pennisetum purpureum (elephant grass)	2.25 ± 0.70 a
	Zea mays (sweetcorn)	1.75 ± 0.41 a

[1]Means within a column for each test followed by different letters are significantly different ($P < 0.05$).

adults were released into the screen house (Table 4). The number of female adults on silver buttonwood was significantly greater than on the other two plant species ($F = 6.79$; df = 2, 117; $P = 0.0016$), while the number of male adults was not ($F = 2.15$; df = 2, 117; $P = 0.1209$).

Multiple-Choice Oviposition Tests

Significantly more egg masses were found on the foliage of silver buttonwood compared with all other plants in the test ($F = 26.31$; df = 6, 326; $P = 0.0001$) (Table 5). No eggs were found on the foliage of malanga.

Overall, silver buttonwood appeared to be the preferred host for oviposition in all the choice tests. Although differences were not always significant, the highest mean numbers of egg masses per plant were on silver buttonwood in all tests but one. In the latter test, the second highest mean number of egg masses was found on silver buttonwood. Silver buttonwood is very common in nursery production, and in the landscape in southern Florida. The preference for silver buttonwood, however, did not preclude oviposition on other hosts. No choice tests were conducted without silver buttonwood but should be considered in future studies to help better understand host selection by adult weevils. In southern Florida ornamental nurseries, mixed species of plants are commonly planted within a row. Thus, female *D. abbreviatus* may lay eggs on the foliage of several species, despite the presence of a more preferred host, such as silver buttonwood.

There were other factors inherent in the choice bioassays that may have influenced the outcome. First, the egg-laying potential of the weevils was unknown because they were field collected. All weevils used in a given test were all collected at the same time, however, the choice tests were not conducted concurrently. Therefore, there could be differences in oviposition due to female age, condition, etc. Additionally, plant phenology could also influence the level of oviposition. Although plant phenology was not controlled for, all plants exhibited foliage that appeared suitable for oviposition. Lastly, all adult weevils collected from the field were caged and provided green buttonwood as a food source. Although the time the weevils here held before use was relatively short (24 h), feeding on green buttonwood prior to the test may have increased their preference for oviposition on silver buttonwood. Also, no tests were conducted without silver buttonwood. More tests are necessary to evaluate these influences as well as when no preferred hosts are available for oviposition.

TABLE 3. MEAN NUMBER OF EGG MASSES OF 50 FEMALE *DIAPREPES ABBREVIATUS* IN A TWO-CHOICE TEST.

	Host plant	Mean egg masses per plant (±SE)[1]
Test 1	*Conocarpus erectus* (silver buttonwood)	7.00 ± 1.22 a
	Sorghum sudanense (sorghum-sudan)	2.38 ± 0.65 b
Test 2	*Conocarpus erectus* (silver buttonwood)	0.88 ± 0.27 a
	Citrus aurantifolia (lime)	0.19 ± 0.03 b

[1]Means within a column for each test followed by different letters are significantly different ($P < 0.05$).

TABLE 4. THE MEAN NUMBER OF *DIAPREPES ABBREVIATUS* ADULTS AND EGG MASSES ON THREE PLANT SPECIES 8 DAYS AFTER RELEASE OF 500 ADULTS (1:1 MALE:FEMALE) INTO THE SCREEN HOUSE.

Plant species (common name)	Mean egg masses per plant[1] (±SE)	Mean adults per plant[1] (±SE)	Mean males per plant[1] (±SE)	Mean females per plant[1] (±SE)
Conocarpus erectus (silver buttonwood)	0.30 ± 0.12 a	1.53 ± 0.34 a	0.67 ± 0.20 a	0.90 ± 0.19 a
Citrus aurantifolia (Tahiti lime)	0.10 ± 0.05 a	0.60 ± 0.30 ab	0.33 ± 0.19 a	0.27 ± 0.13 b
Citrus sinensis (sour orange)	0.13 ± 0.13 a	0.17 ± 0.08 b	0.13 ± 0.06 a	0.03 ± 0.03 b

[1]Means within a column followed by different letters are significantly different ($P < 0.05$).

Larval Survival and Root Consumption

Survival of larvae and their effect on plant growth was examined on several commonly grown plant species in southern Florida. Both fresh and dry root weight (fresh: $t = 3.68$; df = 18; $P = 0.001$; dry: $t = 3.85$; df = 18; $P = 0.001$) and plant biomass (fresh: $t = 4.71$; df = 18; $P = 0.0002$; dry: $t = 3.58$; df = 18; $P = 0.002$) were significantly reduced on green bean as a result of larval feeding 2 months after infestation (Table 6). However, the measured traits of sweet corn were not altered (Table 6). Almost no larvae survived on the sweet corn but an average of 2.6 larvae survived per green bean plant (Table 7).

Larvae survived on silver buttonwood, lime, and sorghum-sudan 3 months after infestation (Table 7). Larvae did not survive on malanga or satinleaf (Table 7), and therefore, there was no effect on plant height, root weight and biomass of malanga or satinleaf (Table 6). The highest mean number of larvae survived on silver buttonwood. The fresh root weight and fresh biomass weight were significantly reduced in silver buttonwood plants infested with larvae with a 13.1 percent reduction in the dry biomass (root: $t = 3.30$; df = 20; $P = 0.003$; biomass: $t = 3.04$; df = 20; $P = 0.006$) (Table 6). On Tahiti lime, an average of 1.8 larvae per plant survived (Table 7), and both the fresh and dry root weight and biomass weight were significantly reduced (fresh root: $t = 3.33$; df = 42; $P = 0.001$; fresh biomass: $t = 8.02$; df = 42; $P = 0.0001$; dry root: $t = 3.07$; df = 42; $P = 0.004$; dry biomass: $t = 6.60$; df = 41; $P = 0.0001$) (Table 6). The net reduction of dry biomass was 42.9%. At the time of evaluation, the lime plants were dead or dying. An average of 5.5 larvae per plant survived on sorghum-sudan (Table 7). Both fresh and dry root weights (fresh: $t = 3.09$; df = 18; $P = 0.0063$; dry: $t = 3.83$; df = 18; $P = 0.003$) and fresh and dry biomass weights (fresh: $t = 2.71$; df = 18; $P = 0.014$; dry: $t = 2.71$; df = 10; $P = 0.02$) were significantly reduced as a result of larval feeding (Table 6). The overall reduction in biomass of the sorghum-sudan was 41.9%.

Larval survival was low on silver buttonwood, Tahiti lime and malanga 6 months after infestation and there were no significant differences among host plants ($F = 2.41$; df = 3, 28; $P = 0.08$). Nevertheless, silver buttonwood supported the highest mean number of larvae and these larvae had the highest weights (Table 7).

Regardless of the host plant infested, the number of larvae per plant that survived was low relative to the number of neonates initially used to inoculate (50). Neonates are highly mobile (Wolcott 1936), and some of them may actually leave the containers at the time of infestation. Neonates have been shown to move over the tops of containers as well as through holes in the bottoms of containers (Mannion, unpublished data). It is very difficult to prevent this movement. Mean weights of larvae varied with the infestation time and the host plant species. The highest mean larval weight 3 months after infestation was that of larvae feeding on silver buttonwood. Average

TABLE 5. MEAN NUMBERS OF EGG MASSES OF *DIAPREPES ABBREVIATUS* IN A MULTIPLE-HOST CHOICE TEST.

Plant species (common name)	Mean no. egg masses per plant (±SE)[1]
Conocarpus erectus (silver buttonwood)	1.66 ± 0.27 a
Zea mays (sweetcorn)	0.33 ± 0.06 b
Solanum tuberosum (white potato)	0.23 ± 0.07 b
Sorghum sudanense (sorghum-sudan)	0.18 ± 0.06 b
Pennisetum purpureum (elephant grass)	0.04 ± 0.03 b
Citrus aurantifolia (lime)	0.04 ± 0.03 b
Xanthosoma sp. (malanga)	0.00 ± 0.00 b

[1]Means within a column followed by different letters are significantly different ($P < 0.05$).

TABLE 6. THE EFFECT OF LARVAL FEEDING OF *DIAPREPES ABBREVIATUS* 2 MONTHS AFTER INFESTATION OF PLANTS INFESTED WITH 50 NEONATES.

Plant species (common name)	Treatment	n	Plant height (cm) (SE)	Fresh root weight (g)[1] (SE)	Dry root weight (g)[1] (SE)	Fresh biomass weight (g)[1] (SE)	Dry biomass weight (g)[1] (SE)	Percent dry biomass reduction
Phaseolus vulgaris (green bean)	Infested	10	n/a	0.233 b (0.14)	0.08 b (0.05)	11.30 b (1.80)	5.03 b (0.34)	55.1
	Not infested	10	n/a	2.49 a (0.60)	1.53 a (0.37)	45.90 a (7.12)	11.20 a (1.70)	
Zea mays (sweet corn)	Infested	10	15.27 a (0.41)	6.93 a (0.90)	5.51 a (0.54)	60.77 a (7.57)	36.56 a (2.67)	0.00
	Not infested	10	14.78 a (0.69)	5.82 a (0.67)	5.10 a (0.59)	50.79 a (4.93)	34.57 a (3.16)	
Conocarpus erectus (silver buttonwood)	Infested	6	115.2 a (3.19)	82.85 b (19.90)	25.32 b (4.21)	362.32 b (27.25)	110.13 a (6.81)	13.1
	Not infested	5	117.8 a (11.27)	141.36 a (4.96)	33.70 a (1.60)	453.96 a (8.27)	126.72 a (4.54)	
Citrus aurantifolia (Tahiti lime)	Infested	8	57.3 a (3.80)	25.74 b (8.26)	12.53 a (1.91)	82.07 b (9.14)	57.91 b (6.32)	42.9
	Not infested	8	59.8 a (3.71)	121.79 a (31.79)	29.14 a (7.55)	281.71 a (39.03)	101.39 a (12.28)	
Xanthosoma sp. (malanga)	Infested	8	62.88 a (5.38)	234.8 a (21.25)	30.38 a (4.05)	416.65 a (55.78)	44.51 a (6.65)	0.0
	Not infested	8	73.13 a (2.95)	202.5 a (20.27)	20.64 a (2.42)	387.29 a (42.37)	32.48 a (3.71)	
Chrysophyllum oliviforme (satinleaf)	Infested	5	120.6 a (7.20)	203.82 a (40.95)	114.14 a (22.82)	369.02 a (63.54)	207.00 a (35.19)	3.1
	Not infested	5	115.8 a (6.80)	253.90 a (52.64)	116.48 a (23.20)	427.68 a (59.49)	213.52 a (29.82)	
Sorghum sudanense (sorghum-sudan)	Infested	10	232.8 a (4.50)	34.76 b (5.38)	18.48 b (1.14)	355.99 b (28.59)	122.44 b (7.27)	41.9
	Not infested	10	236.4 a (5.80)	60.71 a (6.44)	25.00 a (2.32)	472.10 a (31.97)	210.69 a (16.92)	

[1]Means within a column for each plant species followed by different letters are significantly different ($P < 0.05$).

TABLE 7. LARVAL SURVIVAL AND LARVAL WEIGHTS OF *DIAPREPES ABBREVIATUS* ON DIFFERENT HOST PLANTS EACH INFESTED WITH 50 NEONATES.

Plant species	2 Months after infestation		3 Months after infestation		6 Months after infestation	
	Mean larvae (SE)	Mean larval weight (g) (SE)	Mean larvae[1] (SE)	Mean larval weight (g)[1] (SE)	Mean larvae[1] (SE)	Mean larval weight (g)[1] (SE)
Phaseolus vulgaris (green bean)	2.6 (0.37)	0.20 (0.05)	—	—	—	—
Zea mays (sweet corn)	0.2 (0.20)	0.02 (0.02)	—	—	—	—
Conocarpus erectus (silver buttonwood)	—	—	7.5 (0.71) a	0.13 (0.01) a	1.217 (0.65) a	0.130 (0.05) a
Citrus aurantifolia (lime)	—	—	1.8 (0.61) b	0.09 (0.02) a	0.13 (0.13) a	0.03 (0.03) a
Xanthosoma sp. (malanga)	—	—	0.0 c	0.0 b	0.13 (0.13) a	0.02 (0.17) a
Chrysophyllum oliviforme (satinleaf)	—	—	0.0 c	0.0 b	—	—
Sorghum sudanense (sorghum-sudan)	—	—	5.5 (1.16) a	0.07 (0.01) a	—	—

[1]Means within a column followed by different letters are significantly different ($P < 0.05$).

weights of larvae feeding on the other hosts 3 months after infestation were relatively low.

Numerous plant hosts are suitable as a food source and for oviposition by adult *D. abbreviatus* as well as supporting larvae. In our study, silver buttonwood, a common landscape plant in south Florida, was generally preferred. More larvae survived and more egg masses were found on this host plant. However, it is important to note that in the absence of silver buttonwood, other plant species still provide suitable sites for oviposition and larval survival. Schroeder et al. (1979) found 9 species of ornamental plants and one native plant species other than citrus and sugarcane to be suitable for larval development. Simpson et al. (1996) identified nine plant species that support oviposition and larval development. More than 40 plant species were associated with larval feeding. The host plants identified as having some association with *D. abbreviatus* are diverse belonging to 59 plant families. Eggs may be present without feeding adults and larvae may be present without evidence of oviposition. The survival of larvae and subsequent damage from root feeding for most plant host is not known. Dispersion of this pest is likely by the movement of plant material infested with any of the life stages of *D. abbreviatus*. Currently, this pest is considered a regulatory risk and any plant associated with any life stage of *D. abbreviatus* is considered a regulatory host. Growers in known infested counties are required to follow strict guidelines of treatments, which are time-consuming, expensive, and disruptive to natural enemies, before shipping plant material to non-infested areas.

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REFERENCES

ADAIR, R. C., H. N. NIGG, S. E. SIMPSON, AND L. LEFEVRE. 1998. Ovipositional preferences of *Diaprepes abbreviatus* (Coleoptera: Curculionidae). Florida Entomol. 81: 225-234.

BEAVERS, J. B. 1982. Biology of *Diaprepes abbreviatus* (Coleoptera: Curculionidae) reared on an artificial diet. Florida Entomol. 65: 263-269.

BEAVERS, J. B., AND A. G. SELHIME. 1976. Population dynamics of *Diaprepes abbreviatus* in an isolated citrus grove in central Florida. J. Econ. Entomol. 69: 9-10.

FENNAH, R. G. 1942. The citrus pest's investigation in the Windward and Leeward Islands, British West Indies 1937-1942. Agr. Advisory Dept., Imp. Coll. Tropical Agr. Trinidad, British West Indies. Pp. 1-67.

KNAPP, J. L., S. E. SIMPSON, J. E. PENA, AND H. N. NIGG. 2000. *Diaprepes* root weevil host list. Fla. Coop. Ext. Serv. ENY-641 (http://edis.ifas.ufl.edu).

NIGG, H. N, S. E. SIMPSON, N. E. EL-GHOLL, AND F. G. GMITTER, JR. 2001a. Response of citrus rootstock seedlings to *Diaprepes abbreviatus* L. (Coleoptera: Curculionidae) larval feeding. Proc. Fla. State Hort. Soc. 114: 57-64.

QUINTELA, E. D., J. FAN, AND C. W. MCCOY. 1998. Development of *Diaprepes abbreviatus* (Coleoptera: Curculionidae) on artificial and citrus root substrates. J. Econ. Entomol. 91: 1173-1179.

SAS INSTITUTE. 1999-2001. SAS Proprietary Software. Release 8.02. Cary, NC.

SCHROEDER, W. J., R. A. HAMLEN, AND J. B. BEAVERS. 1979. Survival of *Diaprepes abbreviatus* larvae on selected native and ornamental Florida plants. Florida Entomol. 62: 309-312

SIMPSON, S. E., H. NIGG, N. COILE, AND R. ADAIR. 1996. *Diaprepes abbreviatus* (Coleoptera: Curculionidae): Host plant associations. Environ. Entomol. 25: 333-349.

STANLEY, D. 1996. Suppressing a serious citrus pest. Agric. Res. 44: 22.

WOLCOTT, G. N. 1936. The life history of *Diaprepes abbreviatus* at Rio Piedras, Puerto Rico. J. Agr. Univ. Puerto Rico 20: 883-914.

WOODRUFF, R. E. 1968. The present status of a West Indian weevil (*Diaprepes abbreviatus* (L.)) in Florida (Coleoptera: Curculionidae). Florida Department of Agriculture Division of Plant Industry Entomology 77, Gainesville, FL.

WOODRUFF, R. E. 1985. Citrus weevils in Florida and the West Indies: Preliminary report on systematics, biology, and distribution (Coleoptera: Curculionidae). Florida Entomol. 68: 370-379.