Suitability of Selected Ornamental Plants for Growth and Survival of Lissachatina fulica (Gastropoda: Achatinidae)

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Suitability of selected ornamental plants for growth and survival of *Lissachatina fulica* (Gastropoda: Achatinidae)

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Abstract

Lissachatina fulica (Bowdich, 1822) (Gastropoda: Achatinidae), also known as the giant African land snail, is a plant pest throughout much of the world, including southern Florida, where an established population of this snail was discovered in 2011. Apart from reports that it is polyphagous, food preferences and suitability are not well known. The suitability of 21 ornamental plants commonly grown in Miami, Florida, was tested using snail growth (snail shell height and snail mass) and survival. After hatching, 50 snails were reared for 70 d on each of 24 dietary treatments (21 natural diets and 3 control diets). French marigold (*Tagetes patula* [Asteraceae]) was the ornamental plant diet that produced the largest snails (24 mm in shell height), producing snails equivalent in size to 2 of the control diets: romaine lettuce (*Lactuca sativa* [Asteraceae]) and synthetic insect diet (gypsy moth). Plants allowing intermediate growth (> 10 mm) were cosmos (*Cosmos bipinnatus* [Asteraceae]), salvia (*Salvia splendens* [Lamiaceae]), petra croton (*Codiaeum variegatum* [Euphorbiaceae]), zinnia (*Zinnia elegans* [Asteraceae]), Texas sage (*Leucophyllum frutescens* [Scrophulariaceae]), beach sunflower (*Helianthus debilis* [Asteraceae]), lantana (*Lantana camara* [Verbenaceae]), kalanchoe (*Kalanchoe blossfeldiana* [Crassulaceae]), and butterfly weed (*Asclepias tuberosa* [Apocynaceae]). There was a strong positive correlation between survival and plant suitability, as judged by shell height (r = 0.89). However, some plants tested, such as purslane (*Portulaca oleracea* [Portulacaceae]), sunflower (*Helianthus annuus* [Asteraceae]), dusty miller (*Centaurea cineraria* [Asteraceae]), and oyster plant (*Tradescantia spathacea* [Commelinaceae]) only provided minimal growth (< 10 mm) but may be able to sustain snails until they can find better quality food. Overall, annual plants tended to be more suitable than perennial plants for snail growth and survival (P < 0.01). This information can be used to identify which ornamental plants support snail growth and survival, where snails can likely be found on infested properties, and which plants might be at greatest risk for feeding damage.

Key Words: giant African land snail; herbivory; snail diets; snail development

Resumen

Lissachatina fulica (Bowdich, 1822) (Gastropoda: Achatinidae), también conocido como el caracol gigante africano terrestre, es una plaga de las plantas para sostenebilidad por un gran parte del mundo, incluyendo el sur de la Florida, donde se descubrió una población establecida de este caracol en el 2011. Aparte de las informadas en que este caracol es polífaga, su preferencia y La capacidad de las alimentarias no son bien conocidas. El adecuado de 21 plantas ornamentales comúnmente cultivadas en Miami, Florida, fue probada para medir el crecimiento del caracol (altura de concha del caracol y masa del caracol) y su sobrevivencia. Después de la eclosión, se criaron 50 caracoles durante 70 dias sobre cada uno de los 24 tratamientos dietéticos (21 dietas naturales y 3 dietas de control). La caléndola frances (*Tagetes patula* [Asteraceae]) fue la planta ornamental que produjo los caracoles más grandes (24 mm de altura de concha), produciendo caracoles de tamaño equivalente a 2 de las dietas de control: lechuga romana (*Lactuca sativa* [Asteraceae]) y la dieta sintética de insecto (polilla gitana). Las plantas que permiten un crecimiento intermedio (> 10 mm) fueron: cosmos (*Cosmos bipinnatus* [Asteraceae]), salvia (*Salvia splendens* [Lamiaceae]), petra croton (*Codiaeum variegatum* [Euphorbiaceae]), zinnia (*Zinnia elegans* [Asteraceae]), cenizo *Leucophyllum frutescens* [Scrophulariaceae]), girasol de playa (*Helianthus debilis* [Asteraceae]), lantana (*Lantana camara* [Verbenaceae]), kalanchoe (*Kalanchoe blossfeldiana* [Crassulaceae]) y la maleza mariposa (*Asclepias tuberosa* [Apocynaceae]). Hubo una fuerte correlación positiva entre la sobrevivencia y la sostenebilidad de las plantas, según la altura de la concha (r = 0,89). Sin embargo, algunas plantas probadas, como el perejol (*Portulaca oleracea* [Portulacaceae]), el girasol (*Helianthus annuus* [Asteraceae]), centaurea (*Centaurea cineraria* [Asteraceae]) y la planta ostra (*Tradescantia spathacea* [Commelinaceae] sólo proporcionaron un crecimiento mínimo (<10 mm) pero puede ser capaz de sostener los caracoles hasta que puedan encontrar alimentos de mejor calidad. En general, las plantas anuales tienden a ser más adecuadas que las plantas perennes para el crecimiento y la sobrevivencia del caracol (P <0,01). Esta información puede usarse para identificar qué plantas ornamentales apoyan el crecimiento y la sobrevivencia del caracol, donde los caracoles pueden encontrarse probablemente en propiedades infestadas y qué plantas podrían estar en mayor riesgo de dañar.

Palabras Clave: caracol de tierra africano gigante; herbivoria; dietas de caracol; desarrollo de caracoles

Invasive plant pests, whether direct crop pests or plant disease vectors, are a major concern in agriculture. For example, it is estimated that $120 billion nationwide are lost annually to invasive pest species (Pimentel et al. 2005). Gastropods are typically generalists, but *Lissachatina fulica* (Bowdich 1822) (Gastropoda: Stylommatophora: Achatinidae), also known as the giant African land snail, is a generalist herbi-

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vore with documented consumption of over 158 plant species and 152 plant genera, including both food and ornamental plants (Lange 1950; Sturgeon 1971; Rao & Singh 2002; Raut & Barker 2002). The ability of *L. fulica* to accept so many food sources has helped make it adaptable to environments in many areas of the world, where it has established and become a pest (Raut & Barker 2002).

In Jun 1966, *L. fulica* was introduced to Miami when a boy brought 3 back with him after vacationing in Hawaii and released them outside his home. The snails were not identified until Sep 1969 and finally eradicated in 1975 (Sturgeon 1971; Poucher 1975). More recently another *L. fulica* infestation is believed to have originated from snails smuggled into Miami-Dade County for use in religious rituals. This population was detected in Sep 2011 and has yet to be eradicated, as it is much larger than the *L. fulica* population discovered decades earlier.

To combat the recent infestation in southern Florida (Miami area), government officials are applying molluscicide treatments. However, the most effective molluscicides are harmful to pets, and some homeowners in the area are resistant to their use. As an alternative, or in addition to using chemical treatments, efforts are underway to design traps to catch *L. fulica*. For these trap designs, it may be useful to know what *L. fulica* prefers to eat so those plants or their volatiles can be used as baits or bait components. Knowing the preferred food plants would also help to know where to search for *L. fulica*, making it easier to find and remove them from infested areas. This information could also be used to avoid creating preferred habitats for the establishment of these snails. Homeowners could avoid preferred plants when selecting ornamental plants for planting in residential settings.

Although we know that *L. fulica* feeds on a large number of plants, there is very little known about the relative food preferences and suitability. Of the plants mentioned in Lange (1950), Sturgeon (1971), Raut & Ghose (1983), Rao & Singh (2002), Raut & Barker (2002), and Sridhar et al. (2012) only 10 (Table 1) reportedly grow well in Miami (Haynes et al. undated). Rao & Singh (2002) found only 4 out of 20 plants that they tested to be susceptible and preferred. Plants likely to be found in Miami landscaping should therefore be tested for suitability, as these are more applicable to the Florida population of *L. fulica*.

Identification of preferred food plants can be challenging, and often varies with plant species, age, and region (Raut & Barker 2002). Furthermore, if a plant is preferred but unavailable, another can become relatively susceptible. Although plant preference is affected by food availability, usually there is a good correlation between food plant preference and suitability (Mulkern 1967; Mody et al. 2015). Thus, suitability, the quality of the plant to allow the herbivore to grow, is not affected by food availability can be used as an index of preference. To discover which plants will have the most impact on the South Florida *L. fulica* infestation, laboratory no-choice studies were used to identify plants suitable to sustain growth of young *L. fulica*.

Materials and Methods

Plant suitability was tested by comparing the survival and growth rates of juvenile *L. fulica* while rearing them on each of 21 test plants (Table 2). Plants selected included some from the 10 plants already identified in earlier studies as preferred food plants growing in this area (Table 1). Other plants were selected, mostly from a list of 350 plants described as low-maintenance plants for Miami landscaping (Haynes et al. undated). In addition, romaine lettuce (*Lactuca sativa* [Asteraceae]), wheat germ-based synthetic insect diet (gypsy moth diet, BioServ, Frenchtown, New Jersey), and soil alone were included as controls. Juvenile snails were chosen for testing their development on different food plants because if plants are not able to support growth and survival of juveniles, the snail population will not persist.

Snails used in this experiment were reared in the laboratory and were F1 generation snails produced by snails that were field collected from the wild population in Miami-Dade County, Florida. Snails (1–2 d after hatch, 3.5–6.3 mm shell height) were reared at a density of 10 per 4 L cage for 70 d. There were 5 cages (n = 50 snails) of each dietary treatment (21 natural diets and 3 control diets) (Table 2) (21 + 3 treatments = 24 × 5 = 120 cages × 10 = 1200 snails). Cages were plastic boxes measuring 25 cm L × 16 cm W × 10 cm H, and were maintained in The Florida Biological Control Laboratory (FBCL) quarantine in Gainesville, Florida, with a photoperiod of 16:8 h L:D. Temperature and humidity ranged from 21 to 25 °C and 28 to 66%, respectively. The calcium needed for shell growth was provided to all treatments as lawn lime (Pulverized Garden Lime, Soil Doctor, Haines City, Florida) suspended in agar (300 g 54% lime, 25 g agar, and 1 L boiling water). Cages were cleaned as needed and 500 mL of potting soil (Metro Mix 930, Sun Gro Horticulture, Agawam, Massachusetts) was provided in each cage. Snails were fed ad libitum on each diet treatment, except for the treatment that consisted of soil and calcium only. Pot-grown foliage was harvested immediately before each use. All snails were measured for shell height (measured parallel to the axis of coiling from the tip of the spire to the most distant point of the aperture edge) and snail mass every 10 d using a Fisher Scientific (Pittsburgh, Pennsylvania) 15-077-958 caliper and a Mettler Toledo (Columbus, Ohio) ML1502e balance, respectively. The experiment continued until 70 d after hatch when shell height, snail mass, and percent survival per cage were determined.

Growth and survival across treatments were analyzed using R statistical computing software (R Core Team 2014) with the lawstat

Table 1. Known preferred or susceptible food plants of *Lissachatina fulica* that occur in the snail-infested area of Florida.

Food plant	Order: Family	Common name	Reference
Aloe indica	Asparagales: Xanthorrhoeaceae	Aloe	Raut & Barker (2002)
Annona squamosa	Magnoliales: Annonaceae	Sugar apple	Rao & Singh (2002)
Cosmos spp. *	Asterales: Asteraceae	Cosmos	Raut & Barker (2002)
Helianthus annuus *	Asterales: Asteraceae	Sunflower	Raut & Barker (2002)
Ipomoea pes-caprae	Solanales: Convolvulaceae	Railroad vine	Raut & Barker (2002); Lange (1950)
Kalanchoe blossfeldiana *	Saxifragales: Crassulaceae	Kalanchoe	Raut & Barker (2002)
Mangifera indica	Sapindales: Anacardiaceae	Mango	Rao & Singh (2002)
Portulaca oleracea *	Caryophyllales: Portulacaceae	Purslane	Lange (1950)
Swietenia mahagoni	Sapindales: Meliaceae	Mahogany	Raut & Barker (2002)
Tagetes patula	Asterales: Asteraceae	French Marigold	Sridhar et al. (2012); Raut & Ghose (1983)
Zinnia elegans *	Asterales: Asteraceae	Zinnia	Raut & Barker (2002)

*Plants also were tested in the present study.

Table 2. Diet treatments fed to juvenile *Lissachatina fulica* to assess suitability.

Diet treatment	Order: Family	Common name	Category
Antirrhinum majus	Lamiales: Plantaginaceae	Snapdragon	Annual
Centaurea cineraria	Asterales: Asteraceae	Dusty Miller	Annual
Cosmos bipinnatus	Asterales: Asteraceae	Cosmos	Annual
Helianthus annuus	Asterales: Asteraceae	Sunflower	Annual
Helianthus debilis	Asterales: Asteraceae	Beach sunflower	Annual
Leucophyllum frutescens	Lamiales: Scrophulariaceae	Texas sage	Annual
Portulaca oleracea	Caryophyllales: Portulacaceae	Purslane	Annual
Salvia splendens	Lamiales: Lamiaceae	Salvia	Annual
Solenostemon scutellarioides	Lamiales: Lamiaceae	Coleus	Annual
Tagetes patula	Asterales: Asteraceae	French Marigold	Annual
Zinnia elegans	Asterales: Asteraceae	Zinnia	Annual
Aloe ciliaris	Asparagales: Xanthorrhoeaceae	Aloe	Perennial
Asclepias tuberosa	Gentianales: Apocynaceae	Butterfly weed	Perennial
Bougainvillea glabra	Caryophyllales: Nyctaginaceae	Bougainvillea	Perennial
Callicarpa americana	Lamiales: Lamiaceae	Beautyberry	Perennial
Codiaeum variegatum	Malpighiales: Euphorbiaceae	Petra croton	Perennial
Kalanchoe blossfeldiana	Saxifragales: Crassulaceae	Kalanchoe	Perennial
Lantana camara	Lamiales: Verbenaceae	Lantana	Perennial
Persea americana, cv Choquette	Laurales: Lauraceae	Avocado	Perennial
Philodendron bipinnatifidum	Alismatales: Araceae	Philodendron	Perennial
Tradescantia spathacea	Commelinales: Commelinaceae	Oyster Plant	Perennial
Soil		Soil	Control
Synthetic diet		Synthetic insect diet	Control
Lactuca sativa	Asterales: Asteraceae	Romaine lettuce	Control

package (version 2.4.1.tar.gz) and dunn.test package. Because heteroscedasticity was detected with the Levene's test, the nonparametric Mann-Whitney rank sum test (U) was used to compare the overall means of snail shell height, snail mass, and survival 70 d after hatch between annual and perennial treatments. For the same reason, the Kruskal-Wallis (H) and Dunn (post-hoc) tests were used to test snail shell height, snail mass, and survival, among 11 annual plants and 2 controls (lettuce, synthetic diet), and among 9 perennial plant treatments with the same controls. The soil control and aloe (*Aloe ciliaris* [Xanthorrhoeaceae]) treatments were not included in the snail shell height and snail mass statistical analyses because fewer than 3 snails survived to 70 d post treatment. For treatments where snail shell height was < 10 mm after 70 d, mean shell height data from each cage at 2 and 70 d after hatching were analyzed using a paired Student's t-test (t) to determine whether snails grew or just maintained their initial shell height at hatching. The relationship between snail shell height and snail mass was tested using all shell heights and snail masses, using shell heights and snail masses from only annuals and controls, and then from perennials and controls. These tests and the relationship between mean shell height and percent survival for each cage were analyzed with Pearson's correlation coefficient.

Results

Rearing snails under different dietary treatments affected snail growth and survival. Overall, annual plants produced snails with greater shell height ($U = 57050$; $P < 0.01$), mass ($U = 58039$; $P < 0.01$), and higher survival ($U = 1740$; $P < 0.01$) than perennial plants. Individually, annual plant and control treatments differed in snail shell height ($H = 347.96$; df = 12; $P < 0.01$) and snail mass ($H = 346.22$; df = 12; $P < 0.01$) (Fig. 1-A). Snails fed *Tagetes patula* (Asteraceae), *L. sativa*, or synthetic diet had mean shell heights > 20 mm and snail masses > 2 g, and were the largest snails among the 22 diet treatments tested that allowed survival (Fig. 1). *Cosmos bipinnatus* (Asteraceae), *Salvia splendens* (Lamiaceae), *Zinnia elegans* (Asteraceae), *Leucophyllum frutescens* (Scrophulariaceae), and *Helianthus debilis* (Asteraceae) were somewhat less suitable annuals for snail growth, resulting in snails with mean shell heights of 10 to 20 mm and snail masses of 0.3 to 2 g. Growth was minimal (mean shell heights < 10 mm and snail masses < 0.3 g), but significant in snails fed *Helianthus annuus* (Asteraceae) ($t = 4.28$; df = 4; $P = 0.01$), *Portulaca oleracea* (Portulacaceae) ($t = 6.17$; df = 3; $P < 0.01$), *Centaurea cineraria* (Asteraceae) ($t = 7.15$; df = 4; $P < 0.01$), *Solenostemon scutellarioides* (Lamiaceae) ($t = 9.63$; df = 4; $P < 0.01$), and *Antirrhinum majus* (Plantaginaceae) ($t = 11.34$; df = 3; $P < 0.01$).

Perennial plant and control treatments significantly differed in snail shell height ($H = 245.42$; df = 10; $P < 0.01$) and snail mass ($H = 247.61$; df = 10; $P < 0.01$) (Fig. 1-B). *Codiaeum variegatum* (Euphorbiaceae) resulted in the largest snail shell height (15 mm) of the perennial plants, but not larger than the controls *L. sativa* and the synthetic diet. The perennial treatments with snail shell heights from 10 to 15 mm were *Lantana camara* (Verbenaceae), *Kalanchoe blossfeldiana* (Crassulaceae), and *Asclepias tuberosa* (Apocyanaceae). Growth was minimal (mean shell heights < 10 mm), but significantly different from the initial shell height at hatching in snails fed *Tradescantia spathacea* (Commelinaceae) ($t = 7.15$; df = 4; $P < 0.01$), *Philodendron bipinnatifidum* (Araceae) ($t = 7.00$; df = 3; $P < 0.01$), *Persea americana* (Lauraceae) ($t = 3.09$; df = 4; $P = 0.04$), *Callicarpa americana* (Lamiaceae) ($t = 6.62$; df = 3; $P < 0.01$), and *Bougainvillea glabra* (Nyctaginaceae) ($t = 35$; df = 1; $P = 0.02$). Overall, there was a very strong positive correlation between snail shell height and snail mass ($r = 0.87$). This also is true when comparing shell height and snail mass among annuals and controls ($r = 0.90$) and among perennials and controls ($r = 0.89$). Due to these correlations, we expect results from shell height and from snail mass to show the same pattern and, therefore, only height was used in the remainder of the analyses.

A strong positive correlation existed between survival and food plant suitability, as judged by snail shell height ($r = 0.89$). As with shell height, survival varied among the different annual plant and control

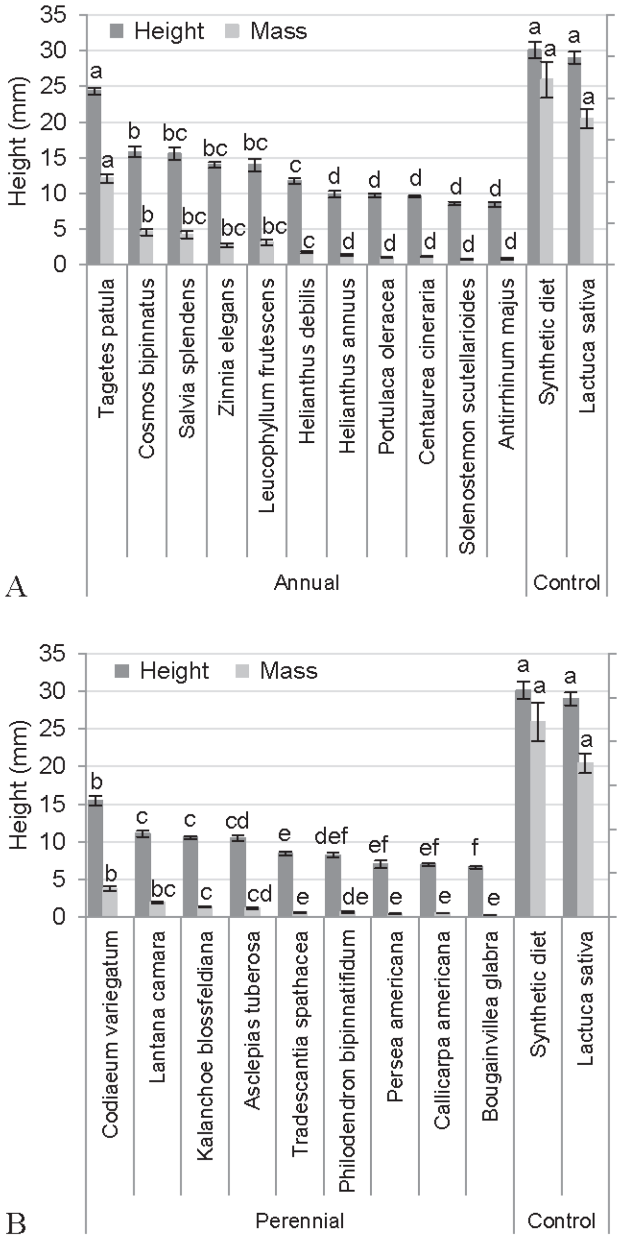

Fig. 1. Mean shell height and snail mass of newly hatched *Lissachatina fulica* after 70 d of feeding on a single diet treatment. (A) Annual plants. (B) Perennial plants. Means topped by the same lowercase letters are not significantly different ($P > 0.05$; Kruskal-Wallis rank sum test and Dunn's test). Error bars indicate standard error.

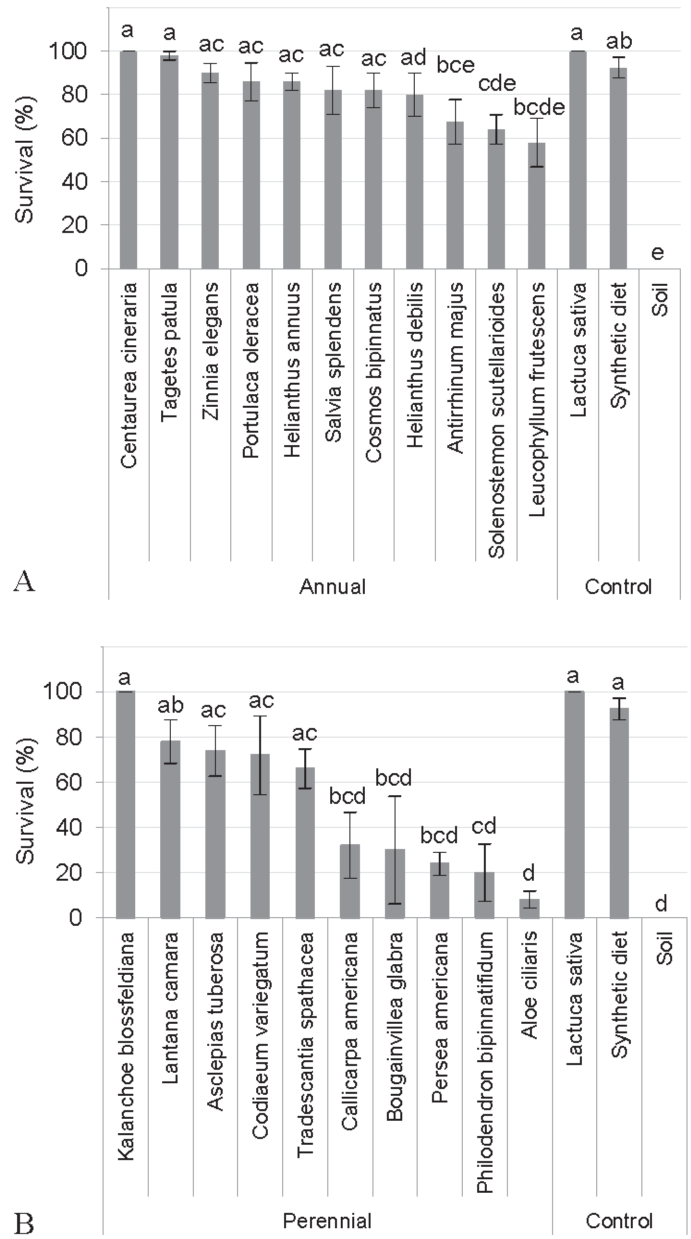

Fig. 2. Mean percent survival of newly hatched *Lissachatina fulica* after 70 d of feeding on a single diet treatment. (A) Annual plants. (B) Perennial plants. Means topped by the same lowercase letters are not significantly different ($P > 0.05$; Kruskal-Wallis rank sum test and Dunn's test). Error bars indicate standard error.

treatments ($H = 39.61$; df = 13; $P < 0.01$) and the perennial plant and control treatments ($H = 45.47$; df = 12; $P < 0.01$) (Fig. 2). The 10 most suitable annual plant and control diet treatments for snail survival (> 80%) (in order from greater to lesser snail survival) were *L. sativa*, *C. cineraria*, *T. patula*, synthetic diet, *Z. elegans*, *P. oleracea*, *H. annuus*, *S. splendens*, and *C. bipinnatus*. No snails survived from the soil control treatment, and snails fed *A. majus*, *S. scutellarioides*, and *L. frutescens* had the lowest survival (< 70%) of the annual plants tested. Of the perennial plant and control diet treatments, *L. sativa*, *K. blossfeldiana*, and synthetic diet were the most suitable for snail survival (> 80%). Other than the controls, the lowest survival rates (< 25%) occurred in snails fed with *P. americana*, *P. bipinnatifidum*, and *A. ciliaris*.

Discussion

Food plant preference and suitability often are found to be positively correlated. Food preference involves active herbivore selection processes and is thought to be principally affected by geographic region, availability of alternate plants, plant age, plant morphology, and plant chemistry (Raut & Barker 2002; An et al. 2007). Food plant suitability reflects herbivore responses, principally physiological in nature, after a food plant has been selected. Suitability is thought to be most influenced by the quality of the plant (nutrition and chemical and physical defenses), which can vary by plant and leaf age (An et al. 2007).

With multiple factors influencing food plant preference and suitability, a few studies have found preference and suitability to be independent or negatively correlated (An et al. 2007). Even so, many studies have found that the plants most preferred by insects (e.g., grasshoppers) also were the most suitable for survival, growth, and reproduction (Mulkern 1967). Similarly, apple cultivars that were less preferred by the weevil *Anthonomus pomorum* L. (Coleoptera: Curculionidae) were associated with *A. pomorum* that had lower mass and later emergence times than *A. pomorum* found on more preferred cultivars (Mody et al. 2015). Consistent with this, in a study of mollusc diet preference using synthetic insect diets, Capinera (2012) reported that preference generally corresponded to mollusc performance on those diets.

The growth and survival of *L. fulica* found in this study generally is consistent with other studies. For example, *C. bipinnatus*, *Z. elegans*, and *K. blossfeldiana* were plants previously reported to be damaged by *L. fulica* (Raut & Barker 2002) and these plants also supported high survival rates and relatively high growth rates in the present study. In general, annual plants were more suitable for growth and survival than were perennials. It is likely that a perennial would be less suitable because perennials are generally vulnerable to herbivores for longer periods of time, and therefore have evolved stronger defense mechanisms, whereas annuals generally allocate more energy toward 'escape in time' (rapid growth and reproduction) or 'escape in space' (production of numerous propagules that are widely dispersed), rather than active defense against herbivores (Rhoades & Cates 1976; Brinker & Frank 1998; Tuljapurkar & Wiener 2000) and reproductive delay ('age gracefully'). The plants selected in this study differed in ways besides annual and perennial, but these characteristics were not analyzed.

Tagetes patula has been documented in other studies to be a preferred food plant by gastropods. For example, the brown slug, *Mariella dussumieri* Gray (Gastropoda: Ariophantidae), has been reported to eat most parts of this plant (Onkara Naik et al. 2014). *Zachrysia provisoria* Pfeiffer (Gastropoda: Pleurodontidae [Camaenidae]), *Bradybaena similaris* Férussac (Gastropoda: Bradybaenidae), *Deroceras laeve* Müller (Gastropoda: Agriolimacidae) and *Deroceras reticulatum* Müller (Gastropoda: Agriolimacidae) are other molluscs reported to readily consume *T. patula* (White-McLean 2012). *Lissachatina fulica* previously has been observed to cause significant damage to *T. patula*, especially to young plants (Sridhar et al. 2012). *Tagetes patula* reportedly was eaten by *L. fulica* at the same rate as lettuce (Raut & Ghose 1983). In the same study, the snails ate more *T. patula* when tested against gourd (*Cucurbita maxima* [Cucurbitaceae]), cabbage (*Brassica oleracea* [Brassicaceae]), castor (*Ricinus communis* [Euphorbiaceae]), papaya (*Carica papaya* [Caricaceae]), tomato (*Lycopersicum esculentum* [Solanaceae]), okra (*Hibiscus esculentus* [Malvaceae]), and cotton (*Gossypium herbaceum* [Malvaceae]). *Tagetes patula* is so attractive to *L. fulica* that it has been recommended as a trap crop (Raut & Ghose 1983). In contrast, many insects are not attracted to *T. patula*, and *T. patula* has been used successfully as an intercrop or companion plant to deter several insect pests, including the silverleaf whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) and the fruit borer *Leucinodes orbonalis* Guenée (Lepidoptera: Crambidae) (Sujayanand et al. 2015). Physiologically, molluscs and insects are quite distinct, and so deterrents to insects are not necessarily deterrents to snails. For example, chlorinated hydrocarbon and organophosphate insecticides, though effective on most arthropods, do not work well against gastropods (Henderson & Triebskorn 2002).

Growth and survival were correlated in this study, but are not entirely predictable. As reported by Capinera & Rodrigues (2015), a diet of either *P. oleracea* or *S. scutellarioides* each resulted in marginal growth (mass) for the slug *Leidyula floridana* (Leidy) (Gastropoda: Veronicellidae) and in this study, similarly resulted in marginal growth (snail shell height and snail mass) in *L. fulica*. *Helianthus annuus*, a plant reported as damaged by *L. fulica* (Raut & Barker 2002), was found in this study to be suitable only for minimal growth, but suitable for survival. Plants such as *P. oleracea*, *H. annuus*, *C. cineraria*, and *T. spathacea* are not ideal for growth, but capable of sustaining a snail until it can find better quality food (Yadav & Singh 2003; Capinera & Rodrigues 2015).

These studies document that *L. fulica* can survive and grow on a large number of ornamental plants grown in Florida. As is the case with most polyphagous herbivores, the plants were not equally suitable for survival and growth of this snail. On average, annual plants supported a higher rate of growth than perennial plants.

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