

Invasive Plants in Natural Areas: *Solanum* spp. in Florida¹

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Introduction

The Florida Invasive Species Council's (FISC, formerly FLEPPC) 2019 List of Invasive Plant Species includes two Category I and two Category II *Solanum* species (Solanaceae) (FLEPPC 2007). Category I *Solanum* species identified by the Council are *S. tampicense* Dunal (wetland nightshade, aquatic soda apple) and *S. viarum* Dunal (tropical soda apple). Category II *Solanum* species identified by the Council are *S. diphyllum* L. (twoleaf nightshade) and *S. torvum* Sw. (turkeyberry). *Solanum jamaicense* Mill. (Jamaican nightshade) was previously included as a Category II species in the 2009 FLEPPC list but was removed in 2011 because of a lack of occurrence data in natural areas.

Category I invasive exotics are defined by FISC as those plants that alter native plant communities by displacing native species, changing community structure or ecological functions, or hybridizing with natives. FISC defines Category II invasive exotics as those that have increased in abundance or frequency, but have not yet altered Florida plant communities to the extent shown by Category I species.

As members of the same genus, the *Solanum* species identified by FISC as invasive share certain morphological features. These similarities can lead to misidentification.

This publication provides a guide to differentiate the invasive *Solanum* species, along with information about the ecology and management of each species. We have also included information on Jamaican nightshade and another relatively common species, *Solanum capsicoides* All. (red soda apple), both of which can easily be confused with the invasive *Solanum* species.

Identification and Florida Distribution

The four *Solanum* spp. on the FLEPPC's 2019 list and the two other species mentioned above can be identified using morphological characteristics and also by the habitat in which they are found. For example, wetland nightshade (*S. tampicense*) is found in wetlands, whereas the other five species are typically found in more upland and often disturbed, habitats. Tropical soda apple is found both in open areas with full sun (often in pastures) but also in wooded hammocks. In contrast, Jamaican nightshade is found almost exclusively in or nearby wooded areas.

The following table provides some of the key characteristics that can be used to differentiate the species, as well as information on the habitats in which the species are found and the counties where herbaria specimens have been collected.

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Table 1. Identifying characteristics of FISC Category I and Category II *Solanum* spp. and *S. capsicoides*.

Scientific name Common name(s)	Habitat	Distribution in Florida*	Key characteristics
<i>S. viarum</i> Dunal tropical soda apple sodom apple  Photo: John J. Mullahey	Common in pastures, and ruderal/disturbed sites. Troublesome in pastures, ditch banks, citrus groves, sugarcane fields, wet areas of rangelands; and becoming more frequent in pinelands and hammocks (Mullahey 2003).		Broad-based, straight, prickles found on stems and leaves (ONLY); leaves with smooth, clear petiole, but surface covered with fine, soft, hairs that exude sticky fluid, making the leaves "clammy" to touch; mature berry 2-3 cm (0.8-1.2 in) wide and light yellow, immature fruit to 3cm and similar to colors of watermelon.
<i>S. diphyllum</i> L. twoleaf nightshade twinleaf nightshade  Photo: Kenneth A. Langeland	Disturbed uplands (e.g., roadsides, agricultural fields, and/or thickets), floodplain forests (floodplain with substrate of sand, silt, clay or organic soil; seasonally flooded; temperate; oaks, palmetto, cane, mixed hardwood), maritime hammocks.		Lack of prickles on otherwise smooth branches and stems (dark maroon brown to white); on more established plants, the presence of well defined leaf pairs with one leaf of pair notably larger than the other; leaf edges smooth, entire, elliptic; major leaves widest at the center; major leaves to 4.7-6.8 cm (1.8-2.6 in) x 2.2 cm (0.89 in), minor leaves ovate to obovate and range up to 2.5 cm x 1.4 cm (0.98 in x .55 in); flowers white (immature) to whitish-lavender (mature); fruit a globose berry, to 1.2 cm in diameter and bright orange and fleshy when ripe.
<i>S. jamaicense</i> Mill. Jamaican nightshade  Photo: William A. Overholt	Most common in ruderal/disturbed areas (roadsides, agricultural fields, thickets, pastures and/or ecotone of neighboring hammocks). Several sources note plant as "noxious weed" and troublesome in Central Florida near cypress swamps, lake edges, berms, pastures, ditch banks, and wooded areas.		Angularly lobed, sessile (or nearly sessile) leaves (attached directly at the base, without a stalk). Apart from 2-3 prickles at base of leaf stems, along lower midribs leaves are free of prickles and densely pubescent (soft trichomes, hairs); stems are flexuous (zig-zag form), pubescent, and contain short, recurved prickles that are very narrow at the base. Fruit is globose berry that, at maturity, is red and glossy, to 0.8 cm (0.3 in) across, with seeds to 2 mm (0.08 in) across.
<i>S. tampicense</i> Dunal wetland nightshade aquatic soda apple  Photo: Allison M. Fox	Riparian zones and wetlands, in relatively undisturbed wetlands, such as cypress swamps and river margins; grows in full shade to full sunlight; age-dependent tolerance to regional flooding (mature plants can tolerate several weeks of submersion).		Clambering, vine-like growth habit over the tops of surrounding vegetation; deeply sinuate (wavy margin) leaves; clusters of up to 11 pea-sized berries that are bright red at maturity; pubescence of stellate (star-shaped) hairs ONLY; straight prickles on veins on upper surfaces of leaves and curved prickles underneath and on stem.

Scientific name Common name(s)	Habitat	Distribution in Florida*	Key characteristics
<i>S. torvum</i> Sw. turkeyberry susumber gully-bean Thai eggplant devil's fig  Photo: Forest and Kim Starr	Disturbed uplands (roadsides, agricultural fields, pastures, and/or thickets) and swamps; noted by some sources to currently have become a nuisance species in some areas where the plant has been documented to form impenetrable thickets in pastures, preventing animals from grazing (www.lucidcentral.org). In its native range (Mexico to Peru and Venezuela, and in Bermuda and the West Indies), the plant grows in woodland clearings, dry brushy plains, wet thickets, and on rocky hillsides (Langeland and Craddock-Burks 1998).		One of the largest of the prickly <i>Solanum</i> spp., reaching heights close to 5 m (16 ft); fruits are numerous, erect (fruits of other prickly <i>Solanum</i> spp. typically droop or hang towards the ground), a subglobose berry that is yellow and grape-sized at maturity (to 0.6 in); prickles stout, wide at base, and slightly curved (occasionally straight); flowers are vivid white, to 2.5 cm (1 in), and are many per group in branched clusters with glandular hair on axes; leaves are large, to 25 cm (10 in) long, with blades oval to elliptic and tips notably pointed; leaves are distinctly petioled and have a dense covering of stellate (star-shaped) hairs on the undersurface.
<i>S. capsicoides</i> soda apple red soda apple cockroach berry  Photo: William A. Overholt	Moist, disturbed sites. Often seen co-occurring in pastures with tropical soda apple.		Short-lived shrubs up to 1 m tall with prickles on most parts, up to 12 mm long. Leaves entire, alternate, broadly ovate, up to 11 cm long and 10 cm wide, margins with 5-7 lobes divided 1/2 or less to midrib, petioles ca. 5 cm long. Leaves appear shiny when compared to those of tropical soda apple. Flowers in clusters of 2-4 on short peduncles 3-4 mm long. Fruits are bright red when mature and 2-3.5 cm in diameter. Seeds are numerous, flattened, bordered by a distinct narrow wing ca. 1.5 mm wide, 4-5 mm in diameter.

Native Distribution

The four *Solanum* spp. on the FISC 2019 list, along with Jamaican nightshade, are native to Mexico, Central America, South America, and/or the Caribbean.

Experts do not agree on the native range of *S. capsicoides*. Some consider the plant to be a native in Florida (Wunderlin and Hansen 2008) while others believe it is native to the Caribbean (D'Arcy 1974) or to eastern Brazil (Wagner et al. 1999). Regardless of the origin of *S. capsicoides*, it is not considered to be invasive in Florida. Native and exotic ranges for the six species are indicated in Table 2.

Control Measures

Prior to taking action to control a suspected invasive plant, verify that the plant is an invasive and not a native species. Species verification can be obtained from a local UF/IFAS Extension office (<http://sfyl.ifas.ufl.edu/find-your-local-office/>).

Chemical

***Solanum tampicense*.** Herbicides that have shown the most promise in controlling this species include glyphosate, 2,4-D, and triclopyr. Aminopyralid should also be effective in seasonally dry wetland areas. However, aminopyralid is not

labeled for use when target plants are in water. Seeds buried in the soil have been found to maintain their viability for as long as five years. As such, follow-up site scouting of treated areas and additional treatments of newly germinated plants may be necessary (Langeland and Stocker 2001).

***Solanum viarum*.** Based on research conducted by Ferrell and Mullahey (2006), heavy infestations of tropical soda apple are best controlled by herbicides, such as aminopyralid (Milestone or GrazonNext HL). Field research has shown that aminopyralid provides both pre- and post-emergence control of tropical soda apple for several months following the initial application.

The following application rates for each herbicide are label rates for rangeland/pasture/open space with dense infestations: 1) Milestone, 5–7 oz./acre in at least 20 gallons of water per acre; 2) GrazonNext HL, 1.5–2.1 pints/acre in at least 20 gallons of water per acre. Best results are obtained with the use of a non-ionic surfactant (0.25% v/v) in the spray mix. Spot treatment recommendations include triclopyr (Remedy) or aminopyralid (GrazonNext HL) at 0.5%–1.0% v/v, or Milestone at 0.5 to 0.8 oz. per 2.5 gal. (15–20 ml per 2.5 gal). Consider adding a spray indicator to the herbicide solution to help identify plants that have been treated. It is also recommended that applications are made

before early flowering if possible. For more information, see EDIS Publication SSAGR77, *Tropical Soda Apple: Biology, Ecology and Management of a Noxious Weed in Florida*, <https://edis.ifas.ufl.edu/UW097>.

For triclopyr, an integrated approach with mowing is required to obtain best control. Old infestations and/or newly germinating patches must be mowed regularly (through April) to control budding and flowering. Following this, a broadcast treatment of 1 quart triclopyr in 40 gallons of water/acre is recommended 50–60 days after the April mowing (late May–June). Follow up with spot treatments (1–1.5 gallons of Remedy Ultra in 100 gallons of total spray mixture) of remaining plants or newly germinated plants.

Solanum jamaicense/Solanum diphylum. No research has been conducted on chemical control methods for either of these plants. Control methods developed for tropical soda apple (*Solanum viarum*) may be tried (see above) on these plants. Aminopyralid is very likely to be effective due to its high level of efficacy on other *Solanum* species.

Solanum torvum. Control of turkeyberry has been achieved chemically on the Hawaiian Islands, where the plant has been found to be susceptible to glyphosate (Swarbrick 1997).

Biological

Solanum viarum. In early 2003, the South American tropical soda apple leaf beetle, *Gratiana boliviana* (Coleoptera: Chrysomelidae) was released in Florida for biological control of tropical soda apple. Since then, more than 250,000 beetles have been released in over 40 counties in Florida. In addition, this beetle has been released in Georgia, Alabama, South Carolina, and Texas. The beetles are well established in Florida and cause considerable damage to tropical soda apple populations. In many cases, the beetles provide sufficient control and no additional control tactics are not required. However, damage due to tropical soda apple by the beetle was much more extensive in areas below 29° N latitude (Diaz et al. 2013). For more detailed information on the TSA beetle, see EDIS publication ENY-865 Classical Biological Control of Tropical Soda Apple with *Gratiana boliviana* (<https://edis.ifas.ufl.edu/publication/in974>).

References

D'Arcy, W.G. 1974. "Solanum and its close relatives in Florida." *Annals Missouri Botanical Garden* 61: 819–867.

Diaz, Rodrigo, William A. Overholt, Ken Hibbard, and Julio Medal. 2013. *Tropical soda apple leaf beetle, Gratiana boliviana Spaeth (Insecta: Coleoptera: Chrysomelidae: Cassidinae)*. EENY-543. Gainesville: University of Florida Institute of Food and Agricultural Sciences. <https://edis.ifas.ufl.edu/publication/in974>

Sellers, Brent, Jay Ferrell, J. Jeff Mullahey and Pat Hogue. 2006 and 2009. *Tropical Soda Apple: Biology, Ecology and Management of a Noxious Weed in Florida*. SS-AGR-77. Gainesville: University of Florida Institute of Food and Agricultural Sciences. <https://edis.ifas.ufl.edu/UW097>

FLEPPC. 2017. "Florida Pest Plant Council Invasive Species List, 2017." Available at <http://bugwoodcloud.org/CDN/fleppc/plantlists/2017/2017FLEPPCLIST-TRIFOLD-FINALAPPROVEDBYKEN-SUBMITTEDTOALTA.pdf>

Hickman, J. C. (Eds.). 1993. *The Jepson Manual*. Berkeley, CA: University of California Press.

Langeland, K. A., and K. Craddock-Burks. (Eds.). 1998. *Identification and Biology of Non-Native Plants in Florida's Natural Areas*. Gainesville, FL: University of Florida.

Langeland, K. A. and R. K. Stocker. 2001. *Control of Non-native Plants in Natural Areas of Florida*. SP242. Gainesville: University of Florida Institute of Food and Agricultural Sciences. <https://edis.ifas.ufl.edu/WG209>

Mullahey, J. J. 2003. "Tropical Soda Apple: A Short Summary on the Biology and Description of *S. viarum*." <http://tsa.ifas.ufl.edu>

Swarbrick, J.T. 1997. *Weeds of the Pacific Islands*. Noumea, New Caledonia: South Pacific Commission.

USDA/ARS. 2006. "Germplasm Resources Information Network (GRIN)." <http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?101505>

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. *Manual of the Flowering Plants of Hawai'i*. 2 vols. Bishop Museum Special Publication 83. Honolulu, HI: University of Hawai'i and Bishop Museum Press.

Wunderlin, R. P. and B. F. Hanson. 2008. "Atlas of Florida vascular plants." *Institute for Systematic Botany, University of South Florida*. <http://www.plantatlas.usf.edu/>

Table 2. Native ranges of each of the five invasive *Solanum* spp. and current locations of establishment. (Information from Langeland and Craddock-Burks 1998; USDA/ARS 2008).

Species	Native Distribution	Exotic Range
<i>S. tampicense</i> Dunal	West Indies, Caribbean, Mexico, Belize, Central America	North America: US (FL, OK, SC)
<i>S. viarum</i> Dunal	Argentina, central Brazil	North America: US (AR, AZ, FL, GA, PR, SC, TN, TX), Mexico; Africa , naturalized in certain tropical regions; and Asia , naturalized in various temperate and tropical regions
<i>S. diphyllum</i> L.	Mexico, Central America	North America: US (FL, TX)
<i>S. torvum</i> Sw.	West Indies, Antilles, Bermuda, Mexico, Peru, Venezuela	North America: US (AL, FL, HI)
<i>S. jamaicense</i> Mill.	West Indies, Central American, and northern South America	North America: US (FL)
<i>S. capsicoides</i> All.	Lack of consensus among experts with eastern Brazil, the Caribbean, and the neotropics (including Florida) suggested as areas of nativity	North America: US(AL, FL, HI, LA, MS, NC, SC, TX); widely distributed in Asia, Australia, and Pacific Islands