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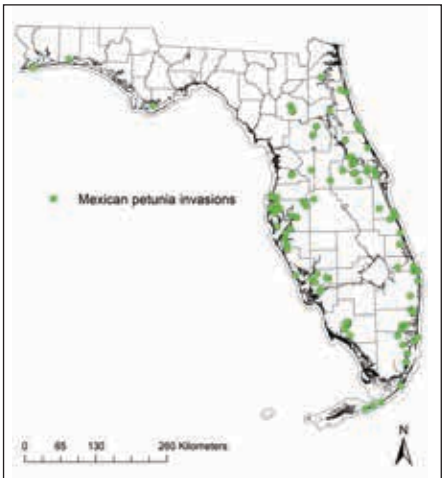
Mexican-petunia invasion at Lake Jesup Conservation Area (Sanford, FL).

Mexican-petunia (*Ruellia simplex*) Invasions:
Management Challenges and Research Opportunities

By Adrienne M. Smith, Carrie Reinhardt Adams, and Sandra B. Wilson

Mexican-petunia (*Ruellia simplex*), known for its prolific purple flowering in a range of conditions, is a commonly planted herbaceous perennial used in many landscape settings. Native to Mexico and South America, Mexican-petunia was presumably introduced as an ornamental (Bailey and Bailey 1976). It was first noticed as naturalized along the Florida through Louisiana coastlines in 1933 (Small 1933). Presently, this species is invading natural areas throughout the southeastern United States (EDDMapS 2013), including 29 counties in Florida (Wunderlin and Hansen 2012) (Figure 1). In Florida, Mexican-petunia was first listed in 1999 as a Florida Exotic Pest Plant Council (FLEPPC) Category II Invasive (classified as increasing in abundance but not displacing native plant communities). In 2001, it was promoted to a FLEPPC Category I Invasive as displacement of native plant communities by Mexican-petunia was recurrently observed (FLEPPC 2011). In addition to its FLEPPC ranking, the UF/IFAS Assessment does not recommend its use for North, Central, and South Florida due to its invasiveness and rapid spread in these regions (IFAS Invasive Plant Working Group 2013).

It has been shown that Mexican-petunia has a competitive advantage over the native Carolina wild-petunia (*Ruellia caroliniensis*) for resource utilization and efficiency (Wilson et al. 2004). In addition, Mexican-petunia seeds germinate readily under a range of temperature and light conditions (Wilson and Mecca 2003). In natural areas, Mexican-petunia propagules often travel through stormwater runoff deposited in floodplain forests. Upon germination and establishment in these floodplains, Mexican-petunia increases in abundance and ultimately dominates the aboveground cover, creating monotypic invasions (Figures 2a and 2b). Continued propagule introduction into floodplains contributes to the capacity for Mexican-petunia to alter ecosystem processes and successfully compete with native species for available resources (Gordon 1998; Mack et al. 2000). Control of existing propagule sources (i.e. seed from surrounding landscapes) is required to limit invasions.



Mexican petunia invasions: EDDMapS (2014)
County boundaries: University of Florida GeoPlan Center 1:3,600,000 (2011)

Figure 1. Documented invasions of Mexican petunia in Florida (EDDMapS 2014).

The same plant characteristics that are desirable for the ornamental market of plants often increase the probability for invasion (repeat blooming, low maintenance, wide adaptability, ease of propagation, stress tolerance, short juvenile period, consumer demand) (Wirth et al. 2004; Drew et al. 2010). Since Mexican-petunia is

an ornamental invasive that is still in commercial production, it presents unique challenges as future invasions and reinvasions are likely. A number of cultivars of Mexican-petunia are available commercially and most are fertile (Wilson and Mecca, 2003; Hupp et al. 2009). The University of Florida Ornamental Breeding Program (Gainesville, FL) has recently released two sterile cultivars as alternatives for growers and homeowners (Freyre et al. 2012; Freyre et al. 2013). A second approach to reducing propagule pressure of invasives is to suggest the use of native species that have similar ornamental value (Wilson et al. 2009).


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Figure 2a. Mexican-petunia invasion at Hogtown Creek (Gainesville, FL).

Initial control of Mexican-petunia is relatively straightforward. Experiments for developing control methods for Mexican-petunia tested four readily available herbicides and found that glyphosate effectively reduced Mexican-petunia cover (R. Stocker, personal communication; Wiese et al. 2013). Adams et al. (2013) further examined the effect and number of glyphosate applications on Mexican-petunia when sprays were initiated in the fall or spring. Sixty to seventy percent reductions in cover of Mexican-petunia resulted, regardless of the number of applications and application season, thus concluding that a single glyphosate application in the fall or spring is sufficient to control Mexican-petunia (Adams et al. 2013).

Effective control and management of invasive plants is critical to restoration of degraded urban lands, yet in some cases, relying on natural recolonization of native species after initial control is not sufficient (Kettenring and Adams 2011). Planting natives for revegetation has been shown to facilitate restoration of the native plant community and simultaneously limit reinvasion (Blumenthal et al. 2003). This has been well-demonstrated for prairie vegetation (Blumenthal et al. 2003) and has shown promise in wetlands, but research is lacking (Kettenring and Adams 2011). Planting native species for control of invasive species may be particularly important in landscapes where reinvasion is likely; for example, if the invasive plant is ornamental and still in commercial production. As noted by Adams et al. (2013), the next step in management is to determine possible mechanisms that prevent native species establishment. Current research is underway for 1) determining revegetation methodology, and 2) determining abiotic factors that may promote Mexican-petunia dominance.

While active revegetation is commonly needed to fully restore the native plant community following invasive species control, specific strategies for revegetation are limited. Determining which natives are appropriate for revegetation is one of the first steps. Appropriate criteria are presented in Table 1. We applied these criteria to identify candidate native species for active revegetation of managed Mexican-petunia floodplain sites. Using a broad survey of vendors with seed availability, the candidate list was narrowed to the following 4 species: bushy bluestem (*Andropogon glomeratus*), soft rush (*Juncus effusus*), redtop panicgrass (*Panicum longifolium*), and pinebarren goldenrod (*Solidago fistulosa*). Germination studies were conducted under varying light and temperature regimes to compare the rate of germination of these natives compared to Mexican-petunia. Natives had a slower germination rate than Mexican-petunia (data not presented). For an effective revegetation strategy, this suggests the potential need for sowing natives at higher densities to compensate for the slower germination, thus allowing them to better establish and suppress Mexican-petunia. Current research is in progress to test this theory, both in greenhouse competition studies and field studies (conducted at the Lake Jesup Conservation Area).

Another barrier to Mexican-petunia control and native species establishment may be related to plant-soil interactions. Monotypic invasions are commonly characterized by having little to no other species (native or invasive/exotic) present in the aboveground cover (Eliason and Allen 1997; Brewer 2008; Spyreas et al. 2010). Despite our observations of bare ground that should represent microsites for other species to establish, there are no co-occurring species within Mexican-petunia invasions. The lack of additional species in the cover is particularly unexpected, especially given the native species detected in the seedbank beneath Mexican-petunia invasions. In fact,

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Figure 2b. Mexican-petunia invasion at Paynes Prairie Preserve State Park (Gainesville, FL).

seedbank studies conducted on Mexican-petunia invasions at Paynes Prairie Preserve State Park (Gainesville, FL) (Mazzota et al. 2012) and the Lake Jesup Conservation Area (Sanford, FL) (Smith et al., unpublished data) show that the majority of species present in the seedbank are natives. It may be that degraded soils suppress native species establishment and promote invasive species (Brown et al. 2008). Our research also shows differences in soil characteristics between invaded and uninvaded areas. This may suggest that altered soil nutrients related to stormwater runoff promote Mexican-petunia dominance and limit establishment of these native species. Other research has demonstrated that degraded soils promote invasion, but this link has yet to be established for Mexican-petunia. Current research is underway to determine how native soil changes over time in the presence of Mexican-petunia.

To see the list of references, please refer to the full article on the FLEPPC website under Publications or contact the corresponding author.

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Table 1. Criteria for species selection and justification for revegetation of formerly invaded Mexican-petunia floodplains.

Criteria	Justification	Reference
Select species presence in local ecosystem	To ensure greatest chance of site-level adaptation	Garbisch 1986; Fischenich 2001
Characteristic of vegetation present at the reference ecosystem	To ensure greatest chance of abiotic and biotic characteristics	White and Walker 1997
Common, dominant, or early successional	To ensure characteristic primary succession of site	Corr 2003; McClain et al. 2011
The ability to withstand a wide range of water depths	To ensure survivability under seasonal flooding and drought conditions	Sheley et al. 2006
Low maintenance species	To ensure minimal human intervention	Stark 1972
High survival and growth rates in degraded systems	To ensure high survivability in disturbed areas	"framework species method" for tree species, Goosem and Tucker 1995
Species that are competitive under current site conditions	To ensure species competitiveness in current conditions	Fischenich 2001
Species that are competitive in disturbed environments	To ensure greatest chance of competiveness in altered habitats, including competition with invasive or exotic species	McClain et al. 2011
Species that are readily available	To ensure practicality and availability for future use in restoration programs	Kettenring et al. 2013