



Open field host selection and behavior by tamarisk beetles (*Diorhabda* spp.) (Coleoptera: Chrysomelidae) in biological control of exotic saltcedars (*Tamarix* spp.) and risks to non-target athel (*T. aphylla*) and native *Frankenia* spp. [☆]

Patrick J. Moran ^{a,*}, C. Jack DeLoach ^b, Tom L. Dudley ^c, Joaquin Sanabria ^d

^a United States Department of Agriculture, Agricultural Research Service, Beneficial Insects Research Unit, 2413 E Highway 83, Weslaco, TX 78596, USA

^b USDA-ARS, Grassland, Soil and Water Research Laboratory, Temple, TX 76502, USA

^c Marine Science Institute, University of California, Santa Barbara, CA 93106, USA

^d Texas Agrilife Research and Extension, 720 E. Blackland Rd., Temple, TX 76502, USA

ARTICLE INFO

Article history:

Received 15 September 2008

Accepted 16 April 2009

Available online 24 April 2009

Keywords:

Biological control of weeds

Saltcedar

Athel

Tamarix

Frankenia

Host range

Nontarget effects

Texas

Nevada

Diorhabda elongata

Diorhabda sublineata

Diorhabda carinulata

Opsius stactogalus

ABSTRACT

Biological control of invasive saltcedars (*Tamarix* spp.) in the western U.S. by exotic tamarisk leaf beetles, *Diorhabda* spp., first released in 2001 after 15 years of development, has been successful. In Texas, beetles from Crete, Greece were first released in 2004 and are providing control. However, adults alight, feed and oviposit on athel (*Tamarix aphylla*), an evergreen tree used for shade and as a windbreak in the south-western U.S. and México, and occasionally feed on native *Frankenia* spp. plants. The ability of tamarisk beetles to establish on these potential field hosts was investigated in the field. In no-choice tests in bagged branches, beetle species from Crete and Sfax, Tunisia produced 30–45% as many egg masses and 40–60% as many larvae on athel as on saltcedar. In uncaged choice tests in south Texas, adult, egg mass and larval densities were 10-fold higher on saltcedar than on adjacent athel trees after 2 weeks, and damage by the beetles was 2- to 10-fold greater on saltcedar. At a site near Big Spring, in west-central Texas, adults, egg masses and 1st and 2nd instar larvae were 2- to 8-fold more abundant on saltcedar than on athel planted within a mature saltcedar stand being defoliated by Crete beetles, and beetles were 200-fold or less abundant or not found at all on *Frankenia*. At a site near Lovelock, Nevada, damage by beetles of a species collected from Fukang, China was 12–78% higher on saltcedar than on athel planted among mature saltcedar trees undergoing defoliation. The results demonstrate that 50–90% reduced oviposition on athel and beetle dispersal patterns within resident saltcedar limit the ability of *Diorhabda* spp. to establish populations and have impact on athel in the field.

Published by Elsevier Inc.

1. Introduction

1.1. Origin and impacts of saltcedar

Exotic saltcedars (*Tamarix* spp., Tamaricaceae: Tamaricales, known as *cedros salados* in México) from Eurasia and Africa (Baum, 1978; Crins, 1989), introduced to North America for erosion control and as ornamentals in the 1800s, have come to dominate many arid riparian habitats in western North America (Robinson, 1965; Baum, 1967; Friedman et al., 2005; Birken and Cooper, 2006), causing great ecological and economic damage (DeLoach et al., 2000, in press; Zavaleta, 2000) to water and wildlife resources (van Hylck-

ama, 1980; Gay and Hartman, 1982; Weeks et al., 1987; DeLoach and Tracy, 1997; DiTomaso, 1998; Lovich and de Gouvenain, 1998; Kennedy and Hobbie, 2004; Shafroth et al., 2005). Saltcedar trees support reduced levels of faunal diversity compared to native vegetation (Boer and Schmidly, 1977; Engle-Wilson and Ohmart, 1978; Kerpez and Smith, 1987; Knutson et al., 2003). The two most widespread species, ranging from the northern Great Plains of the U.S. to northern México, are *Tamarix ramosissima* Ledebour and *Tamarix chinensis* Loureiro, which often form hybrids with each other and two other species, *Tamarix canariensis* Willdenow and *Tamarix gallica* L. (Gaskin and Schaal, 2003), which also occur in pure form along the Gulf coast of Texas and México (Crins, 1989; Gaskin and Schaal, 2003). A fifth species, *Tamarix parviflora* de Candolle, is most invasive in Pacific coastal drainages (Baum, 1967; Dudley et al., 2006). Saltcedar can be controlled by chemical herbicides (Sisneros, 1990; Duncan and McDaniel, 1998; Hart, 2006), mechanical removal, and burning (DiTomaso, 1998), but these methods are costly and can cause collateral damage to native plants and wildlife.

[☆] Mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.

* Corresponding author. Fax: +1 956 969 4888.

E-mail address: Patrick.Moran@ars.usda.gov (P.J. Moran).

1.2. *Athel* and *Frankenia* spp. plants related to saltcedar

Athel (*Tamarix aphylla* (L.) Karsten) (known as *pinabête* in México) is an exotic evergreen species of *Tamarix* that has been planted for shade and as a windbreak in urban and rural areas throughout the southwestern U.S. and northern Mexico (Baum, 1978; Crins, 1989; De Leon González and Vasquez Aldape, 1991), but its usage has decreased in recent years (DeLoach et al., 2008). Athel is invasive in Australia (Griffin et al., 1989), at Lake Mead and other sites along the lower Colorado River (Walker et al., 2006), along the Salton Sea in California (CA) (C.J.D., personal observation), and at sites in the Rio Grande Basin in Texas (TX) and Mexico (P.J.M. and C.J.D., unpublished data). Hybrids with *T. ramosissima* and *T. chinensis* have been discovered on Lake Mead in Nevada (NV), Blythe, CA, and along the Gila River east of Yuma, Arizona (AZ) (Gaskin and Shafroth, 2005). Nonetheless, athel is currently a nontarget plant in saltcedar biological control.

The genus *Frankenia* (family Frankeniaceae, Order Tamaricales) includes six native North American species, including *F. salina* (Molina) I.M. Johnston (alkali seaheath) in coastal and inland saline wet areas from central California to Baja California, western Sonora, Mexico and to Chile, and five uncommon, small desert shrubs: *F. palmeri* Watson in Baja California, western Sonora and southernmost California; *F. jamesii* Torrey ex. Gray from Colorado to western Texas; *F. johnstonii* Correll in southern Texas and north-eastern Mexico; and *F. gypsophila* I.M. Johnston and *F. margaritae* F. González Medrano in northern Mexico (Whalen 1987; Lewis et al., 2003a; Gaskin et al., 2004). Alkali heath provides food and habitat for wildlife; the wildlife values of the other *Frankenia* are unknown. These *Frankenia* do not occur in the same habitats as *Tamarix* but may occupy nearby habitats. Control methods targeting saltcedar must avoid or minimize impacts to these natives (Lewis et al., 2003a; DeLoach et al., in press).

1.3. Biological control of saltcedar

The potential for, research on, and results of the biological control program for saltcedar in North America have been extensively reviewed by DeLoach (1990, 2004), DeLoach and Tracy (1997), DiTomaso (1998), DeLoach et al. (2000, 2004, in press), Dudley et al. (2000), and Carruthers et al. (2008). The northern tamarisk beetle *Diorhabda carinulata* (Desbrochers) (Coleoptera: Chrysomelidae) (Tracy and Robbins, 2009), collected from Fukang, China and Chilik, Kazakhstan, was released at 10 sites in 6 western U.S. states (NV, UT, CO, WY, TX, and CA) beginning in May 2001, and have defoliated over 50,000 ha of saltcedar in Nevada and Utah (Geraci, 2006; DeLoach et al., 2007, in press), but enter diapause too early in southern latitudes (below 38°N), and do not overwinter or establish (Lewis et al., 2003b; Bean et al., 2007). Three species, collected from Uzbekistan (the larger tamarisk beetle, *Diorhabda carinata* (Faldermann)), Greece (Crete and Posidi) (the Mediterranean tamarisk beetle, *Diorhabda elongata* (Brullé)), and Tunisia (the subtropical tamarisk beetle, *Diorhabda sublineata* (Lucas)), are compatible with summer daylengths in Texas and other areas south of 38°N latitude (Milbrath et al., 2007; Tracy and Robbins, 2009). Mediterranean tamarisk beetles released in Texas in 2004–2005 have defoliated 6 ha of saltcedar along 9 km of riparian habitat and established satellite colonies over a 21-km area near Big Spring, in west-central TX (DeLoach et al., 2008, in press; Hudgeons et al., 2007a). Beetles of this species have also defoliated about 2.8 km of dense to scattered stands along the Pecos River, TX (Knutson and Muegge, 2008) and 500 acres along Cache Creek, near Rumsey, in north-central CA (Carruthers et al., 2008). Recent modeling results suggest that *D. sublineata* and *D. carinata* are most likely to establish under the daylength and climatic conditions prevalent in the Lower

Rio Grande Basin of Texas and northern México (Tracy and Robbins, 2009).

1.4. Host specificity testing of saltcedar beetles

Weed biological control agents often show oviposition and feeding preferences within the target host genus (Olckers, 2000; Medal et al., 2002; Sheldon and Creed, 2003). Extensive laboratory and outdoor cage testing demonstrated that the northern tamarisk beetle *D. carinulata* (known formerly as *D. elongata deserticola*) is completely restricted in host range to *Tamarix* (with only slight reproduction also on *Frankenia*); adults did not feed or oviposit, and all larvae died in the first instar, on all other plant species tested (Lewis et al. 2003a; DeLoach et al. 2003). The host specificities of *D. elongata*, *D. sublineata*, and *D. carinata* (known formerly as the Crete, Tunisia and Uzbek ecotypes, respectively, of *D. elongata*) were similar to that of *D. carinulata* in cage tests (Milbrath and DeLoach, 2006a,b). Across all four species, oviposition in multiple-choice tests in large (3 × 3 × 2 m) field cages (% eggs laid on each test plant) was 21–27% on *T. ramosissima* saltcedars, 20–30% on *T. parviflora*, 10–20% on *T. canariensis*/*T. gallica*, 9–11% on athel and 0–0.70% on *Frankenia*. Larval survival in outdoor sleeve bags at Temple was 48–82% on saltcedars, 43–100% on *T. parviflora*, 53–62% on *T. canariensis*/*T. gallica*, 34–75% on athel, and 2.2–17% on *Frankenia* (mean of three species). The reproductive index was 1.5- to 4.2-fold lower on athel than on saltcedar and at least 100-fold lower on *Frankenia* (Table 1). Similar outdoor cage tests also showed that *D. elongata* (Crete) beetles selected athel proportionately less as the degree of choice increased in large field cages, from 52.7% to 18.7% of eggs on athel in no choice vs. multiple-choice tests, and selection of athel was 84.2% lower than saltcedar in large (17 m³) cages but only 34.0% lower in small (1 m³) cages (Milbrath and DeLoach, 2006a,b). These results imply that further reductions in selection of athel should occur in open-field releases. The choice tests (Lewis et al., 2003a; Milbrath and DeLoach, 2006a,b) also showed that the most highly selective life stage is the ovipositing female. Adults (males and females) searching for a plant on which to alight and feed are less selective. The relatively high no-choice survival of beetle larvae (up to 100% of saltcedar in lab vials and bagged branches) on athel and *Frankenia* is not likely to be of consequence in nature because the females lay few eggs on these plants, resulting in low reproductive indices relative to saltcedar (Table 1). This difference should lessen the degree of impact on athel in the field. However, athel has not been evaluated as a host in the context of open-field releases of tamarisk beetles. Laboratory and field-cage based host preference results do not always accurately predict open field host range, due to the limitations of

Table 1

Reproductive index of *Diorhabda* beetle species/ecotypes on saltcedar, athel, and *Frankenia* spp.^a

Test plant	Beetle species			
	<i>Diorhabda elongata</i> (Crete, Greece)	<i>Diorhabda sublineata</i> (Tunisia)	<i>Diorhabda carinata</i> (Uzbekistan)	<i>Diorhabda carinulata</i> (Fukang, China)
Saltcedars				
<i>T. ramosissima</i> / <i>T. chinensis</i>	20.5	12.6	12.4	19.9
<i>T. canariensis</i> / <i>T. gallica</i>	11.9	8.1	5.6	13.8
<i>T. parviflora</i>	20.1	19.1	9.1	9.1
Athel (<i>T. aphylla</i>)	8.2	3.0	8.2	5.4
<i>Frankenia</i> spp.	0.07	0.00	0.103	0.006

^a Reproductive index calculated as percent larval survival in no-choice tests × percent oviposition in multiple-choice tests in cages. (DeLoach et al., in press; data from Milbrath and DeLoach, 2006b).

Download English Version:

<https://daneshyari.com/en/article/4504585>

Download Persian Version:

<https://daneshyari.com/article/4504585>

[Daneshyari.com](https://daneshyari.com)