Biocontrol Science and Technology

ISSN: 0958-3157 (Print) 1360-0478 (Online) Journal homepage: http://www.tandfonline.com/loi/cbst20

Biological control increases the susceptibility of melaleuca quinquenervia to fire

Philip W. Tipping, Melissa R. Martin & Lyn A. Gettys

To cite this article: Philip W. Tipping, Melissa R. Martin & Lyn A. Gettys (2017) Biological control increases the susceptibility of melaleuca quinquenervia to fire, Biocontrol Science and Technology, 27:8, 1014-1017, DOI: 10.1080/09583157.2017.1366424

To link to this article: https://doi.org/10.1080/09583157.2017.1366424

BIOCONTROL SCIENCE AND TECHNOLOGY, 2017
VOL. 27, NO. 8, 1014–1017
https://doi.org/10.1080/09583157.2017.1366424

Taylor & Francis
Taylor & Francis Group

SHORT COMMUNICATION

Biological control increases the susceptibility of *melaleuca quinquenervia* to fire

Philip W. Tipping[a], Melissa R. Martin[a]* and Lyn A. Gettys[b]

[a]Invasive Plant Research Lab, USDA-ARS, Ft. Lauderdale, FL, USA; [b]Fort Lauderdale Research and Education Center, University of Florida, Ft. Lauderdale, FL, USA

ABSTRACT

A field experiment evaluating herbivory from biological control agents on *Melaleuca quinquenervia* saplings experienced a wildfire, which resulted in post-fire tree mortality of 64.6% and 28.1% in the unrestricted and restricted herbivory treatments, respectively. The fire did not negatively impact populations of the biological control agent *Oxyops vitiosa*.

ARTICLE HISTORY
Received 7 February 2017
Returned 20 June 2017
Accepted 7 August 2017

KEYWORDS
Biological control; wildfire; *Melaleuca quinquenervia*

Melaleuca quinquenervia (Cav.) S. T. Blake (Myrtaceae) is an invasive Australasian tree that has been the target of an integrated management programme in southern Florida since 1990 (Laroche, 1998). A biological control programme using insect natural enemies began in 1986 and has developed and established three species, *Oxyops vitiosa* Pascoe (Coleoptera: Curculionidae), *Boreioglycaspis melaleucae* Moore (Hemiptera: Psyllidae), and *Lophodiplosis trifida* Gagné (Diptera: Cecidomyiidae (Tipping, Martin, & Gettys, 2016). Herbivory by these agents have reduced the invasive nature of the species (Tipping et al. 2012). In addition to reduced seed production, plants are now clearly less vigorous, grow more slowly, and suffer increased mortality (Tipping, Martin, Pratt, Center, & Rayamajhi, 2008; Tipping et al., 2009).

Despite these successes the integrated programme continues to manage the plant at a landscape level, albeit with a lower priority than in the past. One tactic that has been used cautiously is prescribed fire because of the risk of accidentally promoting this fire adapted species by inducing the serotinous capsules on the branches to open and discharge large quantities of seeds (Myers, 1983). To avoid this risk, land managers usually target seedlings and pre-reproductive saplings (Pernas & Synder, 1999). In the course of conducting a longer term field evaluation study on the effect of biological control on *M. quinquenervia*, a wildfire burned through the experimental plots, thereby providing a unique opportunity to quantify the influence of herbivory on the susceptibility of *M. quinquenervia* saplings to fire. Thus, the objective of this opportunistic study was to determine if herbivory by biological control agents affected their response to fire. The null hypothesis was that *M. quinquenervia* saplings would respond similarly regardless of the degree of herbivory experienced.

CONTACT Philip W. Tipping philip.tipping@ars.usda.gov
*Current address: National Resources Conservation Service, Washington, DC, USA.

The experimental plots were located in a 19 ha section of the Belle Meade Tract (ca. 6700 ha) within the Picayune State Forest (29,000 ha) near Naples, Florida, USA. Within this tract are cypress strands, wet prairies, and pine flatwood communities in lowland sloughs and subtropical hardwood hammocks in more upland ridges (Martin, Tipping, & Sickman, 2009). This area consists of nearly level, poorly drained, low fertility soils, which are loamy, siliceous, hyperthermic Arenic Glassoqualfs (USDA, 1998). This area is inundated each year typically from June through January to a mean maximum depth of 60 cm and dry during the rest of the year (Tipping et al., 2012). Average annual rainfall in this region is 1.36 m (SERC, 2007). *M. quinquenervia* has invaded this area over the years and replaced many of the native communities with large monotypic stands of various aged trees, a process expedited by several large canopy fires, including one in 1998 that resulted in a large recruitment of seedlings that formed the cohort of plants used in this study.

Twenty-six plots each measuring 9 m^2 were established in 2002 at locations at least 20 m apart throughout a mosaic of even-aged, dense stands of *M. quinquenervia* saplings and assessed annually. Half of the plots were subjected to one of two herbivory treatments: (1) an insecticide control where the background herbivory by *O. vitiosa* and *B. melaleucae* was restricted by foliar applications of acephate (OS – dimethyl acetylphosphor-amidothiote), and (2) a biological control treatment where the trees were sprayed with water. The insecticide control treatment was effected by applying acephate at a concentration of 0.367% ai (v/v) to all plant foliage until wet every 4–6 w from 2003 through 2008 using a hand pressurised back pack sprayer. Annual assessments were typically done each February in the central 1 m^2 quadrat of each plot by capturing the following data: number and height of live trees, number of seed capsule clusters, herbivory damage rating, and the number of dead trees. The leaf damage rating was based on feeding damage by the biological control agent *O. vitiosa* after Tipping et al. (2008). Saplings were considered dead if they had no leaves and stems broke off at the soil surface with minimal finger pressure.

In early May of 2007, about 10 weeks after the 2007 annual assessment ('pre-fire') of the *M. quinquenervia* populations in the plots, the Great Balsa fire burned approximately 8000 ha in southwest Florida including all the experimental plots. The fire was unplanned; so no direct measurements were taken of fire intensity but all the saplings in all the plots appeared to have burned completely to the point where no leaves or branches remained and the former sapling was reduced to a blackened stub. Experimental treatments resumed on 20 June 2007 following appearance of re-growth after the fire. The next annual assessment ('post-fire') was conducted on 6 February 2008 and was the last sample date for this study.

Data on plant parameters were first analysed using analysis of covariance for repeated measures (SAS Institute, 2003). Initial measurements of plant variables from 2006 served as the covariate. Treatment means of variables between and within fire intervals were separated using *t*-tests.

The wildfire increased sapling mortality in both herbivory treatments but to a greater degree in the unrestricted herbivory treatment where percent mortality was more than twice as great as in the restricted herbivory treatment (Table 1). Although pre-fire sapling mortality was increasing and height was decreasing in the unrestricted herbivory treatment, fire had no effect on plant height in either treatment (Table 1). The number of

Table 1. Means (±SE) for plant variables of *Melaleuca quinquenervia* pre- and post-fire at permanent sites in Picayune State Forest 2007–2008.

Variable[a]	Herbivory	*N*	Pre-Fire[b]	Post-Fire	*t*[c]
# Live stems	Restricted	13	70.8 ± 8.1 b	41.8 ± 4.9 b	3.0**
	Unrestricted	13	29.1 ± 3.1 a	7.7 ± 1.6 a	5.9**
Mortality (%)	Restricted	13	5.8 ± 1.0 a	28.1 ±3.8 a	5.6**
	Unrestricted	13	16.8 ± 3.6 b	64.6 ± 5.7 b	7.0**
Height (cm)	Restricted	13	128.2 ± 6.9 b	128.1 ± 7.4 b	0.6
	Unrestricted	13	49.7 ± 3.2 a	36.8 ± 11.8 a	1.2
Capsule clusters	Restricted	13	1.2 ± 0.8 a	0.5 ± 0.5 a	0.6
	Unrestricted	13	0.0 ± 0.0 a	0.0 ± 0.0 a	–
Damage rating	Restricted	13	1.6 ± 0.1 a	2.1 ± 0.1 a	3.0**
	Unrestricted	13	4.6 ± 0.3 b	3.1 ± 0.2 b	3.4**

[a] % Mortality = (dead stems/(dead stems + live stems)) × 100
[b] Variable means between herbivory treatment couplets within a fire category (pre- or post-fire) column followed by different letters are different at $t = 0.05$.
[c] *t* score using two sample *t*-test between pre- and post-fire means within variables and herbivory treatment rows.
*,** $t = 0.05$, $t = 0.01$, respectively.

capsule clusters was unaffected by herbivory or fire. The damage rating from insect attack was greater in the unrestricted herbivory treatment pre-fire and post-fire, indicating that the wildfire did not eliminate the population of *O. vitiosa*. Briese (1996) found that although prescribed burning initially eliminated the biological control agent *Chrysolina quadrigemina* (Suffrian) (Coleoptera: Chrysomelidae) from bitou bush (*Chrysanthemoides monilifera* (L.)) plots, they returned in the next season.

There was a clear synergistic effect between herbivory from biological control agents and fire on mortality of *M. quinquenervia* saplings in this study. Land managers opting for prescribed burning are therefore likely to see increased effectiveness with this tactic against *M. quinquenervia* because of landscape level reductions in plant vigour from attack by biological control agents.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

Briese, D. T. (1996). Biological control of weeds and fire management in protected natural area: Are they compatible strategies? *Biological Conservation*, *77*, 135–141.

Laroche, F. B. (1998). Managing melaleuca (*Melaleuca quinquenervia*) in the Everglades. *Weed Technology*, *12*, 726–762.

Martin, M. R., Tipping, P. W., & Sickman, J. O. (2009). Invasion by an exotic tree alters above and belowground ecosystem components. *Biological Invasions*, *11*, 1883–1894.

Myers, R. L. (1983). Site susceptibility to invasion by the exotic tree *Melaleuca quinquenervia* in southern Florida. *Journal of Applied Ecology*, *20*, 645–658.

Pernas, A. J., & Synder, W. A. (1999). Status of melaleuca control at Big Cypress Nation Preserve. In D. T. Jones & B. W. Gamble (Eds.), Proc. 1998 Joint Symp. Florida Exotic Pest Plant Council and the Florida Native Plant Soc. S. FL water Mange. dist., (pp. 133–137). West Palm Beach, FL.

SAS Institute. (2003). *SAS/STAT user's guide*. Cary, NC: Author.

SERC, SRCC. (2007). Naples, Florida (086078) Period of Record Monthly Climate Summary.

Tipping, P. W., Martin, M. R., & Gettys, L. A. (2016). A gall-forming biological control agent suppresses vegetative growth of an invasive tree. *Biocontrol Science and Technology*, *26*, 1586–1589.

Tipping, P. W., Martin, M. R., Nimmo, K. R., Pierce, R. M., Smart, M. D., White, E., … Center, T. D. (2009). Invasion of a west Everglades wetland by *Melaleuca quinquenervia* countered by classical biological control. *Biological Control*, *48*, 73–78.

Tipping, P. W., Martin, M. R., Pierce, R., Center, T. D., Pratt, P. D., & Rayamajhi, M. B. (2012). Post-biological control invasion trajectory for *Melaleuca quinquenervia* in a seasonally inundated wetland. *Biological Control*, *60*, 163–168.

Tipping, P. W., Martin, M. R., Pratt, P. D., Center, T. D., & Rayamajhi, M. D. (2008). Suppression of growth and reproduction of an exotic invasive tree by two introduced insects. *Biological Control*, *44*, 235–241.

United States Department of Agriculture. (1998). *Soil Survey of Collier County Area*, Florida. United States Department of Agriculture. Natural Resource Conservation Service.