Forest Ecology and Management, 59 (1993) 289–294
Elsevier Science Publishers B.V., Amsterdam

Control of the epiphytic weeds *Tillandsia recurvata* and *Tillandsia aëranthos* with different herbicides

C.G. Bartoli, J. Beltrano, Laura V. Fernandez, D.O. Caldiz*
Instituto de Fisiologia Vegetal, Facultad de Ciencias Agrarias y Forestales, UNLP. CC 31, 1900 La Plata, Argentina
(Accepted 15 January 1993)

Abstract

The population of the epiphytic weeds *Tillandsia recurvata* and *Tillandsia aëranthos* on forestry and ornamental trees in different areas of Argentina has increased, causing deleterious effects on their hosts. As a result, an experiment was performed to control these epiphytes with different herbicides. During October 1988/June 1989, in the La Plata woods (34°55′S) the following treatments were applied to ten different host species which were actively growing: Atrazine 10 g l^{-1}; Dichlobenil 5 g l^{-1}; Simazine 5 g l^{-1} of formulated product and their combination. All the selected herbicides, alone or in combination, controlled the epiphytes without causing phytotoxicity to the host plant, owing to the different absorption systems of the epiphytes and the hosts. This is a new approach to control these epiphytic weeds and an important tool for preserving natural forests which are very susceptible to the invasion of epiphytes.

Introduction

The genus *Tillandsia* which belongs to the Bromeliaceae includes almost 400 species distributed from the south of the United States of America to the northern part of Patagonia in Argentina. In previous papers evidence was presented of the increase in the population of *Tillandsia recurvata* L. and *Tillandsia aëranthos* (Loisel) L. B. Smith in different areas of Argentina (Abedini et al., 1980; Claver et al., 1983; Caldiz et al., 1992). These epiphytes have a great multiplication capacity owing to the numerous plume seeds that allow them to fix onto the wrinkled surface of trunks and branches. They are adapted to live on the canopies of trees and bushes and minerals released by host plants during the rains are absorbed by *Tillandsia* spp. trichomes (Benzing and Davinson, 1979).

Abedini et al. (1980) suggested that under severe invasion the growth of host species may be reduced, comparable with an overly exploitive forest

*Corresponding author.

management, while Benzing (1978) demonstrated that epiphytes caused significant shade when present in great numbers in host trees. In agreement with this finding, Claver et al. (1983) defined *T. recurvata* and *T. aëranthos* as epiphytic weeds, that cause light competition and release some kind of growth inhibitor which is responsible for leaf abscission. Resulting from their position on the host, *Tillandsia* spp. individuals cannot be controlled by cutting or pulling, thus selective herbicides are a logical choice.

In previous works, Cárdenas (1971) and Caldiz and Beltrano (1989) demonstrated the effectiveness of Simazine to control *T. recurvata*, and *T. recurvata* and *T. aëranthos*, respectively, without causing phytotoxicity to the host plant. In the present paper further evidence is shown about the effects of some selective herbicides that are absorbed by *Tillandsia* spp. trichomes and not by the host foliage.

Materials and methods

This work was carried out during October 1988 to June 1989 in the La Plata woods (34°55′S, 57°56′W) upon ten different species: *Evonymus japonica* L.; *Maytenus ilicifolia* (Celastraceae); *Sebastiana brasiliensis* Spreng. (Euphorbiaceae); *Eugenia uniflora* L. (Myrtaceae); *Scutia buxifolia* Reissek (Rhamnaceae); *Crataegus monogyna* Jacq. (Rosaceae); *Citrus reticulata* Blanco, *Fagara rhoifolia* (Rutaceae); *Abies alba* Mill, *Cedrus deodara* (Roxb.) Loud and *Pinus sylvestris* L. (Pinaceae). All of them were well developed and actively growing at the time of herbicide application. Individuals of *Tillandsia* spp. were classified into three different classes following Caldiz and Beltrano (1989), and according to their development stage: (a) less than five leaves; (b) more than five leaves and (c) adults that have flowered. These different classes, on each branch, were identified and surveyed for 3 months before treatments. One hundred and fifty individuals per treatment were counted at the beginning of the survey. Three further assessments were made after the treatments had been applied.

A completely randomized design with three host-trees per species were used, and each host was considered a replication. On 9 February 1989, six treatments were applied to different branches of each host: (1) untreated control; (2) Dichlobenil 50 wettable powder (WP), 5 g l^{-1}; (3) Simazine 80 WP, 5 g l^{-1}; (4) Atrazine 80 emulsifiable concentrate (EC), 10 g l^{-1}; (5) Simazine+Dichlobenil and (6) Atrazine+Dichlobenil in the same doses of formulated product. Tween 80 (0.5%) was added to each solution and the foliage of the host and *Tillandsia* spp. were sprayed with a spraying machine to achieve complete wetting. The dose of Simazine was chosen according to previous work (Caldiz and Beltrano, 1989), while doses for the other herbicides were chosen by a dose response assay (D.O. Caldiz and J. Beltrano, unpublished results, 1989). All herbicides are safe for humans and wildlife when used at the recommended doses. Results were subjected to an analysis of variance and the significance was determined by Tukey's test ($P<0.05$).

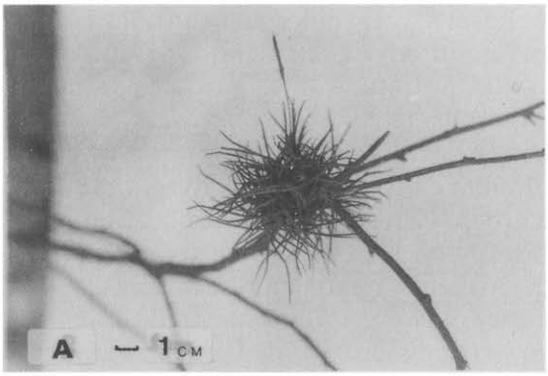
Results and discussion

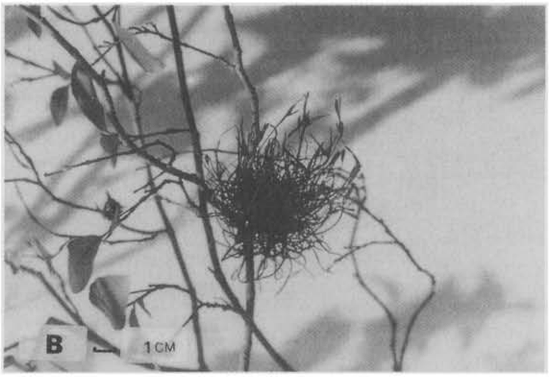
As the results in the three different classes of the epiphytes were similar, they were pooled in an unique group. Forty days after application, the *Tillandsia* spp. population significantly decreased with all treatments except Atrazine. Population levels in Atrazine treatments decreased gradually, reaching almost 100% control after 3 months following application. When Dichlobenil was applied alone or in combination with Atrazine a greater control was achieved. Moreover, the effect of Simazine forty days after treatments was enhanced when applied in combination with Dichlobenil. Meanwhile, the untreated control maintained population levels similar to those of the first survey. This situation was not modified during the following months (Table 1). Cárdenas (1971) mentioned only that *T. recurvata* was controlled by Simazine but he did not evaluate population level nor did he attempt to explain the mechanism of herbicide action.

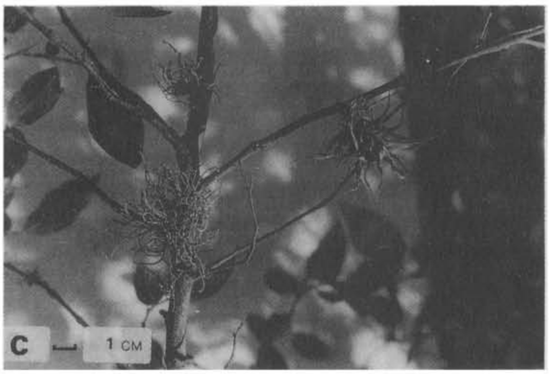
In a previous work, Caldiz and Beltrano (1989) suggested that the control of *T. aëranthos* and *T. recurvata* by Simazine was due to the particular absorption system of these species, based on trichomes situated on their leaves (Benzing and Davinson, 1979), which have similar absorbtion mechanisms to roots. The same considerations are valid for Atrazine, even though it is absorbed through the foliage more easily than is Simazine (Klingman, 1961).

Dichlobenil, mainly used as a pre-emergent herbicide (Martin, 1968), is also absorbed by roots, but more easily than Atrazine or Simazine (Weed Society of America, 1967). The same seems to be true with respect to absorption by *Tillandsia* trichomes, as can be concluded from the results presented here, because Dichlobenil treatments produced a sharp decrease in the *Tillandsia* population when applied alone or when combined with Atrazine or Simazine. When Atrazine was applied alone the *Tillandsia* population remained higher for a longer time (Table 1). These results confirmed Caldiz and Beltrano's (1989) proposal concerning the particular absorption system of these two *Tillandsia* spp. Moreover, the most important characteristic of the chosen herbicides is that they can be absorbed by *Tillandsia* trichomes without affecting the host species. However, Baigorria (1983) using a mixture of an antievaporative oil+Cupric complex (2% metallic Cu), found phytotoxic effects on terminal buds and leaves of the host plants. These effects were not observed with the herbicides chosen for this work (Fig. 1). Moreover, these and previous results (Caldiz and Beltrano, 1989) provide evidence that a better control can be achieved when ambient temperatures are above 20°C.

The approach taken in this study for controlling these epiphytic weeds is


A
1 CM


B
1CM


C
1 CM

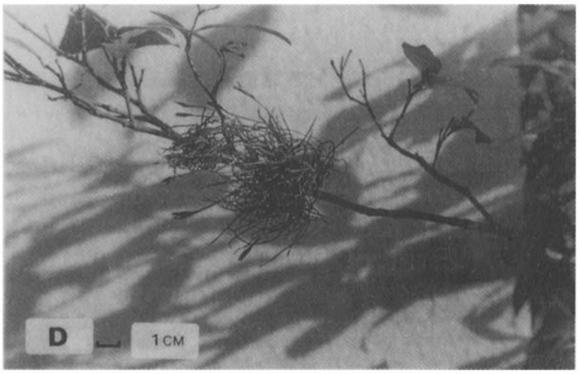


Fig. 1. Aspects of *Tillandsia recurvata* on *Sebastiana brasiliensis* after treatments. (A) Untreated control; (B) Simazine; (C) Atrazine; (D) Dichlobenil. Similar effects were observed for both epiphytes on different hosts with all treatments, including the combinations Simazine + Dichlobenil and Atrazine + Dichlobenil.

Table 1
Population level of *Tillandsia* spp. (Number of individuals) before and after treatments

Treatment	20 Oct.	20 Nov.	20 Dec.	9 Feb. TREATMENT	20 Mar.	20 Apr.	20 May
Control	150^{a}	145^{a}	139^{a}		147^{a}	143^{a}	140^{a}
Atrz. + Dich.	150^{a}	136^{a}	139^{a}		1^{d}	1^{d}	1^{c}
Simaz. + Dich.	150^{a}	138^{a}	138^{a}		16^{bc}	16^{c}	16^{b}
Atrazine	150^{a}	151^{a}	148^{a}		135^{a}	48^{b}	2^{c}
Simazine	150^{a}	150^{a}	144^{a}		25^{b}	2^{d}	5^{c}
Dichlobenil	150^{a}	141^{a}	139^{a}		4^{cd}	1^{d}	1^{c}

Averages followed by the same letter are not significantly different at $P < 0.05$.

entirely new. It takes into account the method of absorption by the epiphytes and will be a useful tool in the preservation of susceptible natural forests.

Acknowledgements

To Ing. Agr. P. A. Balatti for improving the English and for valuable suggestions; to A. Galinski for taking the photographs and to Ciba Geigy Argentina for kindly providing the Simazine and Atrazine.

References

Abedini, W.I., Caldiz, D.O. and Andia, I., 1980. Una maleza de especies forestales. Communication presented at IV Congreso Forestal Argentino, 27–31 October, Goya, Corrientes, Argentina (unpublished).

Baigorria, G., 1983. Notas preliminares sobre el control del clavel del aire. Acintacnia, Argentina, 2: 27–28.
Benzing, D.H., 1978. Germination and early establishment of *Tillandsia circinnata* Schlecht (Bromeliaceae) on some of its host and other supports in Southern Florida. Selbyana, 5: 95–106.
Benzing, D.H. and Davinson, E.A., 1979. Oligotrophic *Tillandsia circinnata* Schlecht (Bromeliaceae): an assesment of its patterns of mineral allocation and reproduction. Am. J. Bot., 66: 386–397.
Caldiz, D.O. and Beltrano, J., 1989. Control of the epiphytic weeds *Tillandsia recurvata* and *T. aëranthos* with simazine. For. Ecol. Manage., 28: 153–159.
Caldiz, D.O., Beltrano, J., Fernandez, Laura V. and Andia, I., 1992. Survey of *Tillandsia recurvata* L. Preference, abundance and its significance for natural forests. For. Ecol. Manage., 57: 161–168.
Cardenas, C.H., 1971. Observaciones sobre la tiña (*Tillandsia recurvata* L.) y su control mediante herbicidas. Rev. Fac. Agron., Univ. Cent. Venez., 6: 43–72.
Claver, F.K., Alaniz, J.R. and Caldiz, D.O., 1983. *Tillandsia* spp.: Epiphytic weeds of trees and bushes. For. Ecol. Manage., 6: 367–372.
Klingman, G.C., 1961. Weed Control as a Science. J. Wiley & Sons, New York, 168 pp.
Martin, H., 1968. Pesticide Manual. British Crop Protection Council, London, 464 pp.
Weed Society of America, 1967. Herbicide Handbook of the Weed Society of America, 1st Edition. W.F. Humphrey Press Inc., Geneva, NY, 293 pp.