



Essays for the control of *Clethra arborea* and *Pittosporum undulatum*

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Abstract

Clethra arborea Aiton (Clethraceae) is a tree endemic to Madeira island and naturalised in São Miguel island (Azores). *Pittosporum undulatum* Ventenat (Pittosporaceae) is a tree from Australia which invades all the Azorean islands. Several chemical formulations were tested against these invaders by cutting the trunk and applying herbicide, namely triclopyr, imazapyr and glyphosate, at several rates. For *P. undulatum* imazapyr was the most promising herbicide. For *C. arborea* good results were obtained at low rates, specially with triclopyr, which stimulated microbial growth and stump rotting. After two years, seedlings of several species were found around the treated stumps. Uprooting of saplings might complement a general control strategy.

Key words: Azores, *Clethra arborea*, *Pittosporum undulatum*, invaders, chemical control.

Title: Ensaios para o controlo de *Clethra arborea* e *Pittosporum undulatum*

Resumo

Clethra arborea Aiton (Clethraceae) é uma árvore endémica da Madeira, naturalizada em São Miguel (Açores). *Pittosporum undulatum* Ventenat (Pittosporaceae) é uma árvore originária da Austrália e que invade todas as ilhas dos Açores. Foram testados métodos de luta utilizando corte total ou parcial dos troncos e aplicação localizada de herbicida. Os herbicidas utilizados foram o triclopir, o imazapir e o glifosato, em várias concentrações. Para *P. undulatum* o herbicida mais promissor foi o imazapir. Para *C. arborea* obtiveram-se bons resultados mesmo para reduzidas concentrações de herbicida, especialmente com o triclopir misturado com gasóleo, o qual estimulou o desenvolvimento de microorganismos e o apodrecimento do cepo. Passados dois anos, plântulas de várias espécies colonizaram as zonas tratadas. A aplicação de reduzidas concentrações de imazapir também resultou, embora não estimulando o apodrecimento do cepo. O desenraizamento de plantas jovens poderá complementar as acções de controlo.

Palavras chave: Açores, invasoras, *Clethra arborea*, *Pittosporum undulatum*, luta química

Introduction

Pittosporum undulatum Ventenat (Pittosporaceae), from Australia and invasive elsewhere, is a dominant species in the Azores, where it was introduced in the last century as an hedge plant in orange-tree plantations. In other regions it was treated with concentrated glyphosate, and with Tordon and 2,4,5-T, which present undesirable side effects (Goodland & Healey, 1996). This tree invaded large areas in all the Archipelago, mainly from sea level up to 600 m, at *Myrica faya* - *Erica azorica* - *Picconia azorica* scrub, but also at *Eucalyptus sp.* and *Acacia sp.* mixed woods, and at abandoned vineyards.



Clethra arborea Aiton (Clethraceae), a tree endemic to Madeira island invades native vegetation in São Miguel island (Azores). It is a relatively recent introduction that was found for the first time as naturalised in 1960 (Franco, 1984). Le Grand (1982) already cited the invasion by *C. arborea*, of the native vegetation where the endemic bird *Pyrrhula murina* nests. Today, this tree invades several pockets of high altitude native vegetation in São Miguel, namely near Monte Escuro (Lagoa do Fogo Nature Reserve), Salto do Cavalo, Achada das Furnas, Tronqueira and Pico da Vara Nature Reserve, and at the area surrounding Achada forestry road. Only some tickets of high altitude native vegetation at the western part of the island (Sete Cidades) are free from the invader. Moreover, the seeds of *C. arborea* are used by *P. murina* during the winter (Ramos, 1994), which may cause some difficulties in the management decisions.

In previous essays, *C. arborea* was successfully controlled using three herbicides in relatively high rates, and microbial growth and rotting occurred in some of the treated stumps (Silva et al., in press). In this research, lower herbicide rates were used to stimulate microbial growth.

C. arborea and *P. undulatum* are associated with high conservation value vegetation, so that only very localised application methods were used, namely cutting the trunk and applying the herbicide directly on the stump. To avoid runoff, methods like foliar spray were not used. The use of herbicides with considerable side effects like Tordon (2,4-D at 39.6% and picloram at 10,2%) and 2,4,5-T (Goodland & Healey, 1996), was avoided. The herbicides used are among those authorised in Portugal for non-agricultural areas (Machado & Rocha, 1994).

Methods

Pittosporum undulatum

Chemical treatments were applied to *P. undulatum* at two places in São Miguel island (Road to Tronqueira 450 m, near a *Cryptomeria japonica* stand, in a heavily invaded area; Ginetes 150 m, a *Myrica faya* stand near the coast) following Santos et al. (1986) and Cuddihy et al. (1991). Herbicides used were: triclopyr (Garlon, Rhône-Poulenc, 480 g ae/l be ester) at 2, 4, 8, 16 and 32% in diesel; imazapyr (Arsenal, Cyanamid Ibérica, 250 g ae/l ipa salt) at 2, 4, 8, 16 and 32% in water; and glyphosate (Roundup, Monsanto 360 g ae/l ipa salt) at 10 and 50% in water. Application followed: i) cut stump method - cutting the trunk near the crown with a chain-saw and applying herbicide with a 6 litres hand sprayer to the cut surface; ii) frill tests - making a frill around the base of the trunk with a chain-saw in order to sever the vascular tissue, and applying herbicide to the frill with a 6 litres hand sprayer; one control with water and another with diesel were also applied. Ten trees were used for each treatment in July. Observations included: resprout number and length, for cut stumps; and defoliation (0, 0%; 1, <10%; 2, <25%; 3, <50%; 4, <75%; 5, >75%) and plant vigour (0=dead, 1=low, 2=fair, 3=good; 4=excellent) for frill tests.

Clethra arborea

Treatments were applied to *C. arborea* stands at Achada Forestry Road (São Miguel, 700 m) in a heavily invaded *Juniperion brevifolii* stand surrounded by a *Cryptomeria japonica* wood. Herbicides used were: triclopyr at 0,125, 0,25, 0,5, 1, 2, 4 and 8 % in diesel (TD1-TD7) or in water (TA1-TA7); imazapyr at the same rates in water (IA1-IA7); and glyphosate at 8, 16, 32, 64 and 96 % in water (GA1-GA5). Two control operations (with water or diesel) were also

applied (A and D). Ten replicates per treatment and per each of the three basal diameter classes defined (<5 cm, <10 cm, and >10 cm) were used on August following the cut stump method. Observations included re-sprout number and length, and level of macroscopic microbial growth on treated stumps (1=null, to 5=completely rot).

Triclopyr is a systemic and selective herbicide used for woody species; glyphosate is a systemic non-selective herbicide used for annual and perennial weeds, but also for woody species; imazapyr is a systemic non-selective herbicide, used against annual and perennial weeds, vines, shrubs and trees. While glyphosate and imazapyr present a high soil adsorption and a relatively low toxicity for animal species, triclopyr presents a higher soil mobility and is very toxic for fish (Cuddihy et al., 1991; Ahrens, 1994; Nunes, 1995).

Results

Pittosporum undulatum

Results after one year show that imazapyr was the most promising herbicide used, since it might be efficacious at a concentration of 5 g ae/l with the cut stump method (Table 1). Regarding the frill tests, they might be used, with higher herbicide rates, specially if very tall trees are to be controlled, but their removal is not possible.

Table 1- The effect of three herbicides and two applications methods on *Pitosporum undulatum*, at Tronqueira and Ginetes (São Miguel, Azores). Average \pm standart deviation

Herbicide (g L ⁻¹)	Cut Stump				Frill Test			
	Tronqueira		Ginetes		Tronqueira		Ginetes	
	Resprout				Defoliation (0-5)	Vigour (0-4)	Defoliation (0-5)	Vigour (0-4)
	Number	Length (cm)	Number	Length (cm)				
Imazapyr in water	5.0	0	0	0	2,1 \pm 1,1	2,4 \pm 0,9	3,1 \pm 1,1	1,7 \pm 0,6
	10,0	0	0	0	3,4 \pm 1,2	1,6 \pm 0,8	4,7 \pm 0,5	1,6 \pm 0,5
	20,0	0	0	0	4,6 \pm 0,5	1,0 \pm 0,0	5,0 \pm 0,0	1,0 \pm 0,0
	40,0	0	0	0	4,7 \pm 0,6	1,1 \pm 0,1	5,0 \pm 0,0	1,2 \pm 0,6
	80,0	0	0	0	5,0 \pm 0,0	1,0 \pm 0,0	5,0 \pm 0,0	1,0 \pm 0,0
Triclopyr in diesel	0	0	2,1 \pm 5,3	2,1 \pm 4,0	1,0 \pm 0,0	3,6 \pm 0,5	1,0 \pm 0,0	4,0 \pm 0,0
	0	0	0,9 \pm 1,6	2,1 \pm 4,0	1,1 \pm 0,3	3,5 \pm 0,5	1,0 \pm 0,0	4,0 \pm 0,0
	0	0	7	0	1,0 \pm 0,0	3,5 \pm 0,5	1,0 \pm 0,0	4,0 \pm 0,0
	0	0	1,0 \pm 2,0	4,0 \pm 8,0	1,0 \pm 0,0	3,2 \pm 0,4	1,8 \pm 0,9	2,4 \pm 0,5
	0	0	0	0	1,3 \pm 0,5	2,8 \pm 0,4	1,8 \pm 0,9	2,7 \pm 0,5
Glyphosate in water	0	0	0	0	2,7 \pm 0,9	2,1 \pm 0,6	3,7 \pm 0,8	1,0 \pm 0,0
	0	0	0	0	4,9 \pm 0,3	1,0 \pm 0,0	5,0 \pm 0,0	1,0 \pm 0,0
Water	2,6 \pm 2,8	1,4 \pm 1,5	22 \pm 12,6	17,5 \pm 9,4	1,0 \pm 0,0	4,0 \pm 0,0	1,3 \pm 8,5	4,0 \pm 0,0
Diesel	0,5 \pm 1,6	1,5 \pm 4,7	17,5 \pm 10,9	11,7 \pm 7,5	1,1 \pm 0,3	3,4 \pm 0,5	1,0 \pm 0,0	4,0 \pm 0,0

Clethra arborea

After two years, significant differences were found between the basal diameter classes for the number of resprouts (Fig. 1). Stumps with lower basal diameter tend to present more sprouts. Significant differences were also found between formulations for resprout number and length (Fig. 2). Fungal growth on treated stumps tend to be higher on larger stumps, and differed between formulations (Figs 3 and 4).

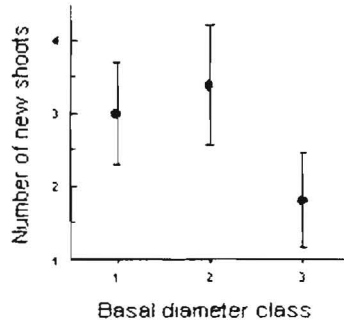


Figure 1. - Regrowth of *Clethra arborea* in accordance with the basal diameter of treated trees: 1) $BD < 5$ cm; 2) $5 \text{ cm} < BD < 10$ cm; 3) $BD > 10$ cm. (95% confidence interval)

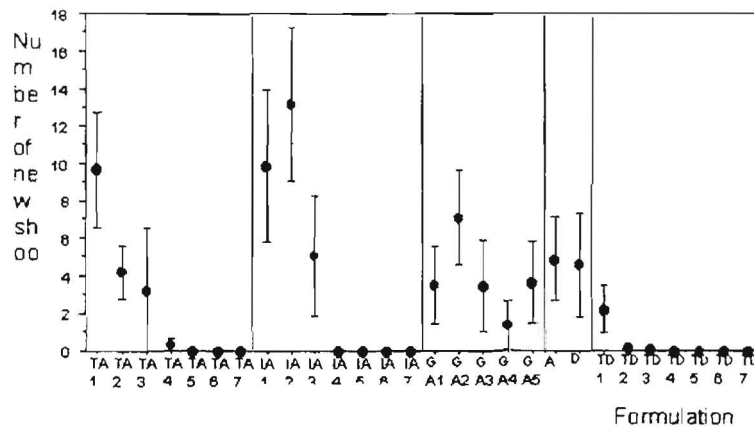


Figure 2 - Regrowth of *Clethra arborea* trees in accordance with the formulation. See Methods for formulation code. (95% confidence interval)

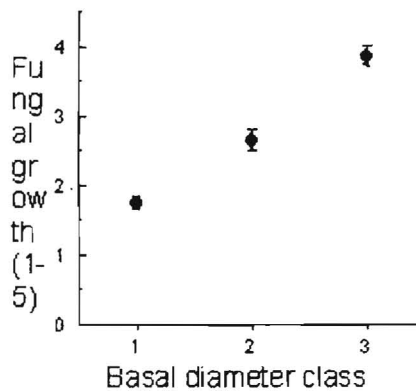


Figure 3 - Fungal growth on the stumps of *Clethra arborea*, in accordance with the basal diameter of treated trees: 1) $BD < 5$ cm; 2) $5 \text{ cm} < BD < 10$ cm; 3) $BD > 10$ cm. Microbial growth on the cut surface: a ordinal scale of 1= null to 5= rot. (95% confidence interval)



Glyphosate at 32 % or higher rates, partially prevented re-growth and stimulated microbial growth. Imazapyr at 1 % or higher rates prevented re-growth, but without microbial growth. Triclopyr at 0.5 % or higher rates prevented re-growth and stimulated microbial growth and wood decay. Diesel or water were not effective, although some microbial growth was present. Two years after the treatments, seedlings of several species were found around the treated stumps (Fig. 5).

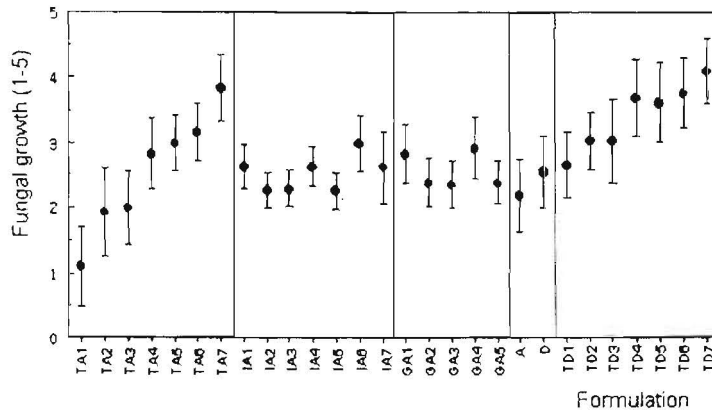


Figure 4 - Fungal growth on the stumps of *Clethra arborea* trees, in accordance with the formulation. See Methods for formulation code. Microbial growth on the cut surface - a ordinal scale of 1 to 5. (95% confidence interval)

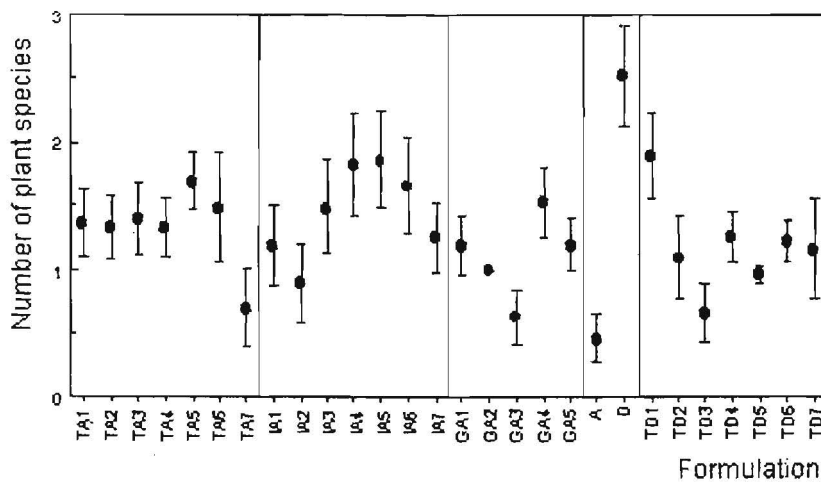


Figure 5 - Number of plant species growing near *Clethra arborea* herbicide treated stumps in accordance with the formulation, and after two years. See Methods for formulation code. (95% confidence interval)

Discussion

Regarding *P. undulatum*, the present results are promising, and further tests should be performed with application of lower rates of imazapyr. The real problem with this tree would be, not to find a way to kill individual plants, but the need to control the large areas presently invaded. Furthermore, control of this plant would be very difficult to implement due to several reasons: i) in the very steep ravines where it is commonly found, the problem would be, not only to control it, but also to avoid a probable increase in erosion and land slide



occurrence, during and after control; ii) in communities where it is found in a dense and complex mixture with other species with conservation value, measures would have to be taken to minimise the disturbance associated with control activities; iii) in many cases control of *P. undulatum* would imply the subsequent reforestation with native species, for what high numbers of saplings of those species would have to be produced. In these context, only priority sites for conservation or other uses might be managed for *P. undulatum* in the near future.

Regarding *C. arborea*, research is underway to isolate, identify and evaluate the potential of the native fungi, which grow on the treated stumps, as stump decay agents. A similar technique is already used in the Netherlands with a formulation named Biochon, using *Chondrostereum purpureum*, to control *Prunus serotina* and other woody species (de Jong et al., 1990). Since *C. arborea* invaded native vegetation but is now used as a food source by the endemic bird *P. murina*, the control of *C. arborea* will have to be integrated with the management plan for the entire community. Furthermore, *C. arborea* is commonly associated with other invaders (*Hedychium gardnerianum*, *Leycesteria formosa*, *Gunnera tinctoria*) so that it will be necessary to apply management strategies for the joint or sequential control of several alien plants.

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