# Determining best control methods for the National Environmental Alert List species, *Retama raetam* (Forssk.) Webb (white weeping broom) in Western Australia

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## Summary

**Field experiments were conducted in Perth, Western Australia between 2006 and 2007 to assess the efficacy of various methods in controlling the National Environmental Alert List species *Retama raetam* (Forssk.) Webb (white weeping broom). Native to the Mediterranean region, this species is naturalized in Western Australia in relatively low numbers and mainly restricted to disturbed sites on the western edge of the Swan Coastal Plain. Hand removal and herbicide treatment are known effective methods of controlling seedlings, however a preferred method of treating mature plants has not yet been developed. This study tested a range of physical and chemical treatments, with results indicating that two treatments were highly effective on mature plants. Both the cut and paint method with 50% glyphosate and basal bark with triclopyr at 1.25 L 60 $L^{-1}$ resulted in 100% mortality 12 months after application. Basal bark with tricoplyr and picloram (1.25 L 60 $L^{-1}$) was less effective than triclopyr on its own, achieving only 70% mortality. Less effective again was the felling method, resulting in mortality in 50% of plants, the remaining 50% vigorously resprouting within five months. Foliar spraying with triclopyr (17 mL 10 $L^{-1}$) and stem-injection with 50% glyphosate were less effective again, resulting in 40% and 50% mortality respectively 12 months after treatment.**

## Introduction

*Retama raetam* is a woody leguminous shrub in the Fabaceae family originating from dry desert areas of the Mediterranean region (USDA 2002). It was first introduced to South Australia as an ornamental as early as 1841 (Weeds CRC 2003) and for some time has been prized as a garden plant for its prolific bloom of white flowers. Naturalized populations are recorded in south-western Western Australia and South Australia, and specimens have been collected north of Brisbane and King Island off the northwest of Tasmania (AVH 2010). In Western Australia, *R. raetam* is naturalized from Bunbury, 180 km south of Perth, north to Two Rocks, with the majority of populations in this western corridor of the Swan Coastal Plain within a 30 km radius of the city of Perth. These sites are typically disturbed, with sandy, coastal, alkaline soils. Naturalized populations are interspersed with roadside amenity plantings and plants in private gardens. It is currently still sold in commercial nurseries.

*Retama raetam* is a member of the Cytiseae tribe, which includes the other major Australian broom weeds *Cytisus scoparius* (L.) Link (Scotch or English broom), *Genista linifolia* (L.) (flax-leaf broom) and *G. monspessulana* (L.) L.A.S.Johnson (Montpellier broom). In south-western Western Australia both *G. monspessulana* and *G. linifolia* are naturalized in areas of higher rainfall and higher fertility soils, while *R. raetam* appears climatically suited to much of southern Australia, particularly to lower rainfall areas with alkaline soils (Emms *et al*. 2006). To date the focus of concern on brooms in Australia has been *Cytisus* and *Genista*, however *R. raetam* has been identified nationally as of equal or greater threat (Weeds CRC 2008), earning nomination as one of the ten most invasive garden plants in southern Western Australia (Groves *et al*. 2005). *R. raetam* appears on the 'National Alert List for Environmental Weeds', which includes species currently found in low numbers and/or restricted in distribution that pose significant threats to biodiversity (Department of Environment and Heritage 2004).

Various studies highlight traits that make *R. raetam* a successful environmental weed and support its placement on the National List (Emms *et al*. 2006). Most brooms have high growth rates, form dense monospecific stands and resprout vigorously when cut or damaged. They produce large numbers of dormant seed resulting in a large persistent soil seed bank (Emms *et al*. 2006). The seed may germinate on mass after physical removal of adult plants, herbicide treatment or fire. As such, they are notoriously difficult to manage in natural areas (Weeds CRC 2008). *R. raetam* also has a range of adaptations to dry, arid environments, including entering dormancy under drought stress, reduced leaf area (Weeds CRC 2003) and metabolic suppression (Merquiol *et al*. 2002, Pneuli *et al*. 2002).

As part of a 2006–2008 Natural Heritage Trust-funded environmental weed project, a strategic plan was recently developed (Department of Environment and Conservation, Swan Catchment Council 2007) with the aim of eradicating *R. raetam* in the Swan Natural Resource Management Region. There was however little published information specifically on control methods for this species (Weeds CRC 2003). Work on other brooms suggested hand removal or foliar spray with glyphosate or triclopyr could be effective on seedlings, while basal bark or cut and paint applications could be reasonably effective on mature adult plants (Muyt 2001, Parsons and Cuthbertson 2001, California Invasive Plants Council 2006, Weeds CRC 2008, Oneto *et al*. 2009). In addition, DeLaine and Stokes (2006) suggested glyphosate or triclopyr herbicides may be useful in controlling *R. raetam*, however no rates of application or indication of the efficacy of treatments were given. The aim of this trial was to develop effective and appropriate control techniques that could be used in a variety of situations to eradicate *R. raetam* across its range on the Swan Coastal Plain.

## Methods

The project was undertaken on a local government reserve in the western coastal suburb of City Beach (115°45′50″E, 31°56′2″S), Perth, Western Australia. The relatively small 0.52 ha site contained a population of over 150 mature *R. raetam* individuals and large numbers (300+) of seedlings. The reserve is enclosed by housing development and is heavily disturbed, with only a sparse cover of native coastal vegetation.

The trial was set out in a randomized block design with ten replicate blocks. Each block consisted of a control plus six treatments. Treatments were carried out on single individuals in each block. Plants within each block were each marked with the replicate number and treatment type. Plants were at least 1.0 m in height to represent individuals that would be difficult to remove manually. The number of stems at ground level and height (metres) of each individual was recorded immediately before treatment. After treatment, growth of any coppice was allocated to classes of height from the stump using the intervals of 0–50 cm, 50–100 cm, 100–200 cm, >200 cm at 0, 3, 5, 9 and 12 months.

Treatments were applied at the beginning of December 2006. Herbicides were applied at label rates for woody species with methods of application for treatments based on those in Brown and Brooks (2002), as follows.

### *Control*

No treatment was applied to control plants.

*Felling and cut and paint treatments*
Working in a team of two, all stems of an individual plant were cut horizontally using a chainsaw at no higher than 15 cm above ground level. For the cut and paint treatment, stems were cut in the same way as the felling method however cut surfaces were painted within 30 seconds with 50% glyphosate (Roundup® 360 g $L^{-1}$) using a small hand-held spray bottle.

*Basal bark treatment using triclopyr and triclopyr + picloram*
Two basal bark treatments were applied. One treatment used triclopyr (Garlon® 600 g $L^{-1}$) + diesel at 1.25 L 60 $L^{-1}$; the second basal bark treatment used triclopyr + picloram (Access® triclopyr 240 g $L^{-1}$ + picloram 120 g $L^{-1}$) + diesel at 1 L 60 $L^{-1}$. Bark of all stems of each plant was sprayed to a height of 60 cm above ground level. Stems were sprayed to the point of run-off.

*Stem injection*
Holes were drilled in all stems of all plants, at approximately 5 cm intervals around the circumference of each stem, as deep as required to meet the sapwood, and were then filled immediately using a squirt bottle with 50% glyphosate (Roundup® 360 g $L^{-1}$).

*Foliar spraying*
Foliar spraying of plants with triclopyr (Garlon 600 g $L^{-1}$) at 17 mL 10 $L^{-1}$ water was carried out using a hand-held sprayer. All foliage was wetted to the point of run-off. The surfactant Pulse® was used at the label rate (20 mL 10 $L^{-1}$).

Plants were scored at 0, 3, 5, 9 and 12 months after treatment, allowing sufficient time for effects and recovery or resprouting to be recorded. Methods to measure herbicide efficacy were based on Australian guidelines and recognized impact scales (Australian Weeds Committee 1991) and those specifically designed for woody weeds (Australian Pesticides and Veterinary Medicines Authority 1997). Treatments were assessed for phytotoxicity using a linear efficacy rating scale of 1 (alive), 2, 3, 4, and 5 (dead), similar to that used by Panetta and Anderson (2001).

## Results

Before treatments, the mean height of plants was 2.27 ± 0.08 m with a range of 1.0–3.0 m. The mean number of stems at ground level was of 3.3 ± 0.24 with a range of 1–10. Eleven plants out of the 70 were single stemmed.

*Control*
The mean phytotoxicity rating of control plants remained relatively unchanged throughout the trial (Figure 1). All treatments were compared to the control using a two-sample t-test, assuming either equal or unequal variances as appropriate.

*Felling*
The felling treatment resulted in 50% mortality by the end of the trial. One plant showed coppicing at three months and by five months 50% of plants were vigorously coppicing. The remaining 50% of plants did not go on to coppice.

*Cut and paint*
The phytotoxicity rating of plants treated with the cut and paint method was significantly different from the control plants. It was one of two treatments which resulted in 100% mortality by the end of the trial. After three months no individuals had resprouted and by 12 months there was complete mortality in 100% of treated plants.

*Basal barking using triclopyr and triclopyr + picloram*
All plants showed significant phytotoxic effects after basal bark treatment using triclopyr and triclopyr + picloram. The basal bark with triclopyr also resulted in 100% mortality of plants after 12 months, while basal bark with triclopyr + picloram resulted in 70% mortality at 12 months.

*Stem injection*
Fifty per cent of the glyphosate stem-injected plants were killed 12 months after treatment. The remaining plants showed varying degrees of phytotoxic effects without causing mortality.

*Foliar spraying*
Less effective again was the foliar application of triclopyr. This resulted in only 40% mortality of plants at 12 months.

## Discussion

These results indicate that either cutting and painting with glyphosate or basal bark with triclopyr provide effective control of *R. raetam*. Both treatments achieved 100% mortality by the end of the 12 month trial.

Interestingly basal bark with triclopyr and picloram achieved only 70% mortality. One possible explanation is that the triclopyr only treatment (Garlon) has 600 g $L^{-1}$ triclopyr while the triclopyr and picloram treatment (Access) has only 240 g $L^{-1}$ triclopyr, indicating that the higher rate of triclopyr is required for effective control.

Plant response to felling was the most variable and achieved only 50%

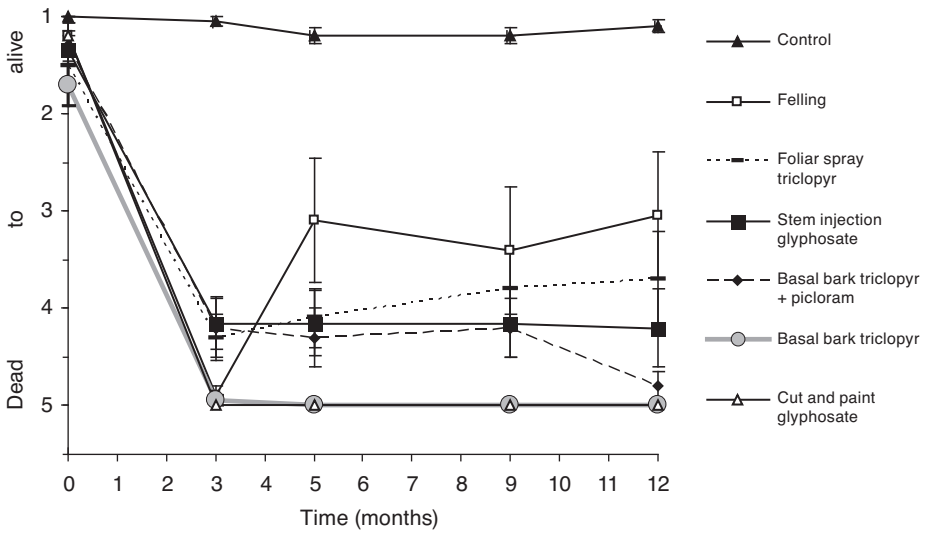


**Figure 1. Mean phytotoxicity rating[A] of plants over 12 months for each treatment and control ([A] phytotoxicity rating scale: 1 = alive, 5 = dead).**

**Table 1. Mean phytotoxicity rating of plants for each treatment and control and per cent mortality of plants after 12 months.**

| Treatment | Mean phytotoxicity[A] rating at 12 months | P value | Per cent mortality at 12 months |
|---|---|---|---|
| Control | 1.1 | | 0 |
| Felling | 3.0 | 0.026 | 50 |
| Foliar spray triclopyr | 3.7 | 0.0016 | 40 |
| Stem injection glyphosate | 4.2 | 0.0022 | 50 |
| Basal bark triclopyr + picloram | 4.8 | 0.0028 | 70 |
| Basal bark triclopyr | 5.0 | 0.00012 | 100 |
| Cut and paint 50% glyphosate | 5.0 | 0.0033 | 100 |

[A] Phytotoxicity rating scale: 1 = alive, 5 = dead.

mortality with half of the plants vigorously resprouting within five months of treatment. Stem injection also only achieved 50% mortality. In addition this treatment was difficult to carry out because of the multitude of stems, many with small diameters which allowed only limited amounts of herbicide to be injected. Foliar spraying with tricolpyr caused mortality of only 40% of individuals and, although stressing the remainder, was largely ineffective on mature plants. Other studies have found foliar spraying of other brooms was effective only on small plants (California Invasive Plant Council 2006) or recently burnt infestations (Allan *et al*. 2006). Foliar spraying is therefore only likely to be a viable option in limited situations where there is mass seedling germination, actively growing unstressed or resprouting adult plants, and where impacts on co-occurring native flora can be avoided.

Either of the two most effective treatments, cutting and painting with glyphosate or basal bark with triclopyr, is appropriate for use in natural areas. However it is important to note that if cutting and painting, removing brooms like *R. raetam* can leave gaps in vegetation cover resulting in opening up of light, space and nutrients, thus creating conditions suitable for mass seedling recruitment. Alternatively basal barking plants and leaving standing biomass can result in increased fuel loads. In addition, triclopyr has moderate persistence in the soil and is strongly absorbed to soil particles depending on soil type and environmental conditions (Pesticide Information Project 1993), and so requires careful application in natural areas. On the other hand, glyphosate with the cut and paint method provides an effective, relatively safe non-soil residual alternative.

What ever the treatment applied, long term follow-up work controlling germinating seedlings will be required until the soil seed bank is depleted. Fire stimulates germination of soil-stored seed and is often seen as an effective tool for managing populations of other invasive broom species (Weeds CRC 2008). In combination with effective herbicide treatment of adult plants, fire could be a useful tool in managing *R. raetam* populations, particularly the persistent soil seed bank. Control of germinating seedlings following fire will prevent recruitment and limit expansion of populations.

The continued problem of the species being commercially available and garden plantings with the potential to infest natural areas remains. However this trial demonstrates that it is possible to effectively control naturalized populations of *R. raetam*.

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