

Eradication of grey willow (*Salix cinerea*) using herbicidal gel technology

Brian G. Ward¹, Ron F. Henzell¹ and Graeme H. Pritchard²

¹The Horticulture and Food Research Institute of New Zealand Limited, Ruakura Research Centre, Private Bag 3123, Hamilton, New Zealand

²Keith Turnbull Research Institute, Department of Natural Resources and Environment, PO Box 48, Frankston, Victoria, 3199, Australia

Summary Invasions of grey or pussy willow (*Salix cinerea*) in many parts of New Zealand and Australia are becoming a major threat to the biodiversity and ecological processes in these areas. Weed management strategies in the past have mainly depended on the foliar application of herbicides, pruning or the physical removal of the plants. In many circumstances these techniques are not completely effective, are not cost effective or can result in collateral damage to adjacent plant species. HortResearch has developed herbicidal gel technology for the selective eradication of invasive weeds.

One such technology is the cut stump application of the herbicidal gel Vigilant®, active ingredient 5% picloram, for controlling grey willow. In trials in both New Zealand and Australia, Vigilant has been 95–100% effective at killing this willow species without affecting adjacent plants. Similar efficacy of the product was achieved when applied to cut stumps pruned 80 mm to 1 metre above the ground.

As part of the trials, the pruned stems were allowed to fall on or embed in to the ground and after two years none of the stems had re-shooted. This indicates in many situations grey willow cuttings or stems do not readily re-shoot when in contact with the ground. This therefore improves the viability of control methods involving cut stem treatments of grey willow saplings and trees, as there is no need to remove or dispose of prunings at the site.

This paper summarises trials on Vigilant applied to the cut stumps of grey willow for killing the plant.

Keywords Willow, control, herbicide, gel, cut stump, picloram.

INTRODUCTION

Grey or pussy willow (*Salix cinerea* L.), in Australia the common names seem to be grey willow or pussy willow, has become a dominant weed in many reserves, wet areas or wetlands throughout New Zealand (Roy *et al.* 1998), Tasmania, Victoria, NSW and South Australia (Lazarides *et al.* 1997). This vigorous woody weed can be found smothering and preventing the establishment and growth of native flora, or obstructing waterways and contributing to soil erosion or flooding in drainage or water catchment areas.

In many cases infestations are so dense that they smother or prevent the establishment of native flora of high conservation value.

In New Zealand, the Department of Conservation has given a high priority to establishing effective weed control strategies and developing environmentally friendly and practical weed control methods for controlling invasive weeds species (Timmins 1997). The concept of targeting the removal of willow saplings growing amongst native species using herbicidal gel techniques was investigated and considered to be worth pursuing.

In the early 1990s HortResearch started research into herbicidal gels and evaluating their efficacy for controlling environmental weeds. The main advantage of gels is they sit on and adhere to the cut stumps allowing the herbicide to be taken up directly by the stump without any run-off or contamination of adjacent plant species. This technique provides a very targeted non-spray alternative for selectively eradicating weeds growing amongst desirable plants or in environmentally sensitive areas with little, if any, impact on the local ecology.

An initial trial of the technology on willow saplings investigated a wide range of herbicide active ingredients to establish which herbicides were the more effective for killing willow. This was followed by two further trials in 1996 and 2000, outlined below, to identify a herbicide, its application rate and the optimum height above ground to cut and treat grey willow saplings and trees.

Results from these and other trials including old man's beard, in Australia the common name is traveller's joy, (*Clematis vitalba* L.), (Ward and Henzell 2000) resulted in the commercial release of a 5% picloram gel, tradename Vigilant®, on the New Zealand market in June 2000. As a result of interest shown in Australia for this concept, an Australian trial, described below, was initiated to determine whether Vigilant gave comparable results on willows in Australia. The trial site chosen for the Australian trial was Yellingbo, Victoria as this locality has similar climatic conditions to the upper North Island of New Zealand where the New Zealand trials were carried out.

MATERIALS AND METHODS

1996 New Zealand trial The 1996 grey willow trial to determine the most effective herbicide and concentration was carried out on an easily accessible area of the Whangamarino wetland, Te Kauwhata owned by the Auckland/Waikato Fish and Game Council. The area is covered with large numbers of saplings and mature willow trees scattered amongst kanuka (*Leptospermum ericoides* Rich.). Throughout most of the year the ground is dry but occasionally during winter months the area can become flooded.

Saplings were selected and divided into two groups of ten plots consisting of ten trees (2–4 m high) per plot. Saplings were generally multi-stemmed and all main stems were treated. The number of stems treated per sapling varied between one and five depending on stem size and position. In most cases, treated stems were between 20 and 30 mm diameter and were cut at about waist height using a lopper, then the stumps were treated with herbicidal gel dispensed from a brushbottle.

The brushbottle is a plastic bottle with a lid like a brush so when the bottle is squeezed, the gel is forced through a hole in the brush and onto the cut stump. A 3–5 mm layer of gel was applied over the entire pruned surface of the cut stump. If needed, the brush can be used to spread the gel.

The gel was applied within 30 seconds of cutting. Eight of the trees had stems greater than 30 mm diameter and these were cut with a saw. Gel treatments contained one of five different herbicides (Table 1) and were applied on 22 February 1996. The treatments were applied in fine weather around 20°C. The fine weather continued for most of the following week. The efficacy of treatments was assessed and any off-target effects noted at 9 and 21 months after application.

2000 New Zealand trial In 2000, a further trial was carried out to determine the height above ground the stems should be cut and treated, and whether pruned stems need to be kept off the ground to avoid re-rooting.

Grey willow in a tidal swamp on the edge of Lake Taupo was selected for the trial. The trees were 2–4 metres tall and all were multi-stemmed. There were four to 36 stems per tree and stem sizes ranged between 10 and 100 mm diameter. The trees were divided into six plots each containing four trees or saplings and individually labelled. Each plot consisted of saplings or trees of similar size.

In two of the plots the stems were cut at 300 mm above the ground and the pruned stems were left to fall on the ground. A 3–5 mm layer of Vigilant was then applied to the cut surface of the stumps in one

of the plots and on the other, the cut stumps were left untreated.

In the remaining two plots, the stems were cut at 0.5–1 m above ground and the pruned stems were wedged amongst the cut stumps below the zone of gel application so the stems were not in contact with the herbicide or ground. Again Vigilant was applied to the cut surface of stumps in one plot and the cut stumps in the remaining plot were left untreated. The trees were cut and treated in overcast conditions at about 18°C on 18 May 2000 and assessed on 2 May 2002.

Australian trial This trial was carried out on a small cluster of willow at Yellingbo State Nature Reserve, Victoria. The trees were 4–5 metres high and were growing in a low-lying area between cleared land and remnant eucalypt forest.

Saplings and trees were selected and divided into six plots of ten per plot. Plots were grouped into three pairs of two plots and the herbicide treatment was randomly assigned to one plot in each pair. Each plot contained a mix of single stem plants and plants with up to four stems, branching at or just above ground level. Stem diameters were 20 to 105 mm with a similar size range in each plot.

Stems in all plots were cut 80–200 mm above ground level with a pruning saw. A 3–5 mm layer of Vigilant gel was spread over the entire cut stump of willow in the treated plots using a brushbottle while cut stumps in the control plots received no further treatment.

At application, on 2 April 2001, the willow foliage was yellowish from the onset of senescence. The treatments were applied under fine sunny conditions at around 22°C, which prevailed for the following few days. Assessment was on 26 April 2002, over 12 months after treatment.

RESULTS

1996 New Zealand trial At the final assessment 21 months after treatment the picloram gels gave the best level of control (Table 1) and total kill was achieved with the 5% gel. At this time the root systems of the plants had rotted and if the stumps had not already fallen over, the root systems were so weak that they could easily be pulled out or broken at ground level.

The triclopyr, sodium chlorate and metsulfuron methyl gels also gave excellent control killing more than 70% of the grey willow saplings treated. By contrast the glyphosate gel was less effective and not significantly different from the cut control.

No off-target effects were noticed around any treated saplings with any herbicide treatment and

there was no re-rooting of pruned stems lying on or embedded in the ground.

2000 New Zealand trial At the final assessment, 24 months after treatment, more than 94% of stumps cut and treated with Vigilant were dead compared with less than 23% of stumps that were cut and left untreated.

There was little difference in the efficacy of Vigilant applied to stumps at 300 mm or 0.5–1 metre above ground. No pruned stem allowed to fall on the ground or held above ground had re-rooted.

Australian trial At 12 months after treatment Vigilant had totally killed all saplings and trees treated and no off-target effects were apparent around treated saplings. In contrast every untreated stump had new shoots growing. There was no re-rooting of the pruned stems that were left lying on the ground.

DISCUSSION

Compared with foliar spray applications, cut stump treatments using herbicidal gels are much more labour intensive. Therefore, for herbicidal gels to become widely accepted close to a total kill needs to be achieved every time the technology is used.

In the 1996 New Zealand trial the picloram-based gels had the best efficacy with the 5% concentration killing all saplings treated. The triclopyr and sodium chlorate gels killed around 80 percent of saplings treated, which is effective, but these were used at twice the concentration of the picloram gel. The 5% picloram gel was therefore the most attractive herbicide for wide scale use.

In this trial, the saplings were cut and treated at about waist height to gauge the level of translocation of the herbicides by measuring stump die-back from the point of application. By 21 months after treatment, all stumps had died on the 5% picloram treated saplings and the root systems of the saplings had generally rotted. This indicated that picloram readily translocated through the plant. By comparison, saplings treated with the other herbicides had fewer stumps dying back and roots rotting, which is likely to be a reflection of the lower translocation properties of these herbicides. Adjacent plant species were also assessed throughout the trial to determine if there was any possible cross contamination of the herbicides, but no off-target effects were noticed.

Following this and various other trials on weed species such as Japanese honeysuckle (*Lonicera japonica* Thunb.), old mans beard, gorse (*Ulex europaeus* L.), cotoneaster (*Cotoneaster simonsii* Baker), Darwin's barberry (*Berberis darwinii* Hook.), and woolly nightshade (*Solanum mauritianum* Scop.), a

Table 1. Efficacy of herbicidal gels applied to cut stumps on grey willow saplings at 21 months after treatment in 1996 New Zealand trial.

Treatment	Active ingredient (%)	Dead saplings (%)
Picloram (potassium salt)	10	95
"	5	100
"	1	80
Triclopyr (amine salt)	10	85
Sodium chlorate	10	79
Metsulfuron methyl	1	75
Glyphosate	10	50
"	5	45
Glyphosate + Metsulfuron methyl	10 + 0.25	35
Cut only – control	–	37
LSD (P<0.05)		34.5

Table 2. Efficacy of Vigilant applied to cut stumps on grey willow trees at 24 months after treatment in the 2000 New Zealand trial.

Treatment (active ingredient)	Height above ground cut and treated (m)	Dead saplings (%)
Vigilant (5% picloram)	0.3	94.8
Cut only – control	0.3	22.4
Vigilant (5% picloram)	0.5–1	96.3
Cut only – control	0.5–1	6.8

Table 3. Efficacy of herbicidal gel applied to cut stumps on grey willow saplings at 12 months after treatment in Australian trial.

Treatment (active ingredient)	Active ingredient (%)	Dead saplings (%)
Vigilant (picloram)	5	100
Cut only – control	–	0

5% picloram gel, tradename Vigilant was registered with the New Zealand Pesticide Board. This was the lowest concentration of picloram that consistently killed greater than 95% of plants treated across all these species.

In the 2000 New Zealand trial, Vigilant proved to be just as effective at killing willow when applied to

cut stumps at any height between 0.3 and one metre above ground level.

The Australian trial was to determine the efficacy of Vigilant on willow under Australian climatic and soil conditions. In this trial the stems were cut at 80–200 mm above ground. Treating closer to the ground should increase the potential for the herbicide to translocate into the root system. Applying the gel at 80 mm above ground was high enough above ground to avoid contact of the herbicide with adjacent plant species or soil.

In the trial, the herbicidal gel was applied on a sunny day around 22°C. Applying the gel under these conditions is ideal as the gel is normally taken up into the stump within 4 hours of application.

In the Australian trial, all stumps treated with Vigilant were dead at 12 months after treatment and no off-target effects were observed. This result is similar to the New Zealand trials and indicates Vigilant is effective under both New Zealand and Australian conditions.

Also none of the pruned stems from either the New Zealand trials or the Australian trial that had been lying on or embedded in the ground had re-shooted. This indicates cuttings or stems of grey willow do not readily re-shoot when in contact with the ground so the pruned wood does not need to be held off the ground or disposed of separately.

This makes cut stump treatments using Vigilant an effective technique for controlling grey willow saplings and trees under both New Zealand and Australia soil and weather conditions.

ACKNOWLEDGMENTS

We wish to thank the New Zealand Department of Conservation for assistance with the New Zealand trials, and the Auckland/Waikato Fish and Game Council and Parks Victoria for providing trial sites for willow trials.

REFERENCES

- Lazarides, M., Cowley, K., and Hohnen, P. (1997). 'CSIRO handbook of Australian weeds'. (CSIRO Publishing, Collingwood, Australia).
- Roy, B., Popay, I., Champion, P., James, T. and Rahman, A. (1998) 'An illustrated guide to common weeds of New Zealand' (New Zealand Plant Protection Society, Lincoln University, New Zealand).
- Timmins, S.M. (1997) 'Environmental Weeds Research Plan 1997–2006' (Department of Conservation, Wellington, New Zealand).
- Ward, B.G. and Henzell, R.F. (2000) Herbicide gels for controlling old mans beard (*Clematis vitalba*) in ecologically sensitive areas. Proceedings of the New Zealand Plant Protection Conference 53, 284–288