Chemical control of blue periwinkle (*Vinca major* L.) in Croajingolong National Park, Victoria

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Abstract

Blue periwinkle (*Vinca major*) is a serious environmental weed of protected areas in eastern Australia. A trial to evaluate the effectiveness of glyphosate, metsulfuron methyl, clopyralid and triclopyr for controlling this weed was undertaken east of Mallacoota Inlet within Croajingolong National Park, Victoria. The herbicides had their greatest effect six months after treatment. Brown-out at that time was 96% with glyphosate at 360 g 100 L^{-1}, 59% with triclopyr at 126 g 100 L^{-1}, 23% with clopyralid at 150 g 100 L^{-1} and negligible with metsulfuron methyl at 6 g 100 L^{-1}.

Introduction

Blue periwinkle (*Vinca major* L.) is a vigorous perennial prostrate creeper originating from the Mediterranean (Swarbrick and Skarratt 1994). It is a serious environmental weed in temperate regions of southern Australia and New Zealand. This plant is naturalized in State Forest and conservation reserves in Western Australia (Keighery 1991), South Australia (SA NPWS 1989), the Sydney region (Smith and Patterson 1978, Smith 1983), Tasmania (Young 1992), the ACT and Lord Howe Island (cited in Swarbrick and Skarratt 1994). It is considered to be a significant problem weed of protected areas (Williams and Timmins 1990) and urban environments (Elser 1988a) in parts of New Zealand. It frequently occurs in very large infestations in the semi-shade of trees. Seed set is low in New Zealand (Elser 1988a) with most spread being a vegetative marginal advance of the infestation. The procumbent stems of up to one metre long, can root at the tips (Elser 1988b) and nodes (SA NPWS 1989). The dumping of garden refuse is an important means of spread (Elser 1988c, Anon. 1991). Blue-purple flowers are produced primarily in spring.

In Victoria, blue periwinkle has been recorded invading seven of the 15 vegetation formations recognized by Carr *et al.* (1992) who classified it as a very serious threat to native vegetation. An interim survey of the most important environmental weeds within Victoria identified blue periwinkle as one of the top eight weeds of concern to public land managers (Williamson 1991).

In East Gippsland, major infestations of blue periwinkle occur along the lower Snowy River (Edwards and May 1990) and Tambo River. These infestations represent a serious threat to the conservation values of remnant riparian vegetation and downstream protected areas. Populations of blue periwinkle in Croajingolong National Park in far eastern Victoria are limited to relatively small infestations at Gipsy Point and Bakers Bight. At these locations the species is a high priority for management due to the threat which the weed poses to nature conservation values, the localized nature of both infestations and the high potential for eradication from the Park (Twyford and Humphrey 1993).

Despite the significance of blue periwinkle as a major threat to native vegetation in southern Australia, documented accounts of control measures are limited. SA NPWS (1989) recommend spot spraying of actively growing plants with triclopyr in water. Control using glyphosate is recommended in Tasmania (Harris 1991, Robin 1991). Recommendations for mechanical control of small infestations are also available (Anon. 1991, Robin 1991).

This trial evaluated four herbicides to determine which was the most effective herbicide in the management of this serious environmental weed.

Study area

The trial site was situated in a coastal locality within Croajingolong National Park, east of Mallacoota Inlet, Victoria (149° 45'E, 37° 31'S) (Figure 1) on a gentle, southerly-facing slope bounded by partially cleared private property to the north and low-lying swamp vegetation to the

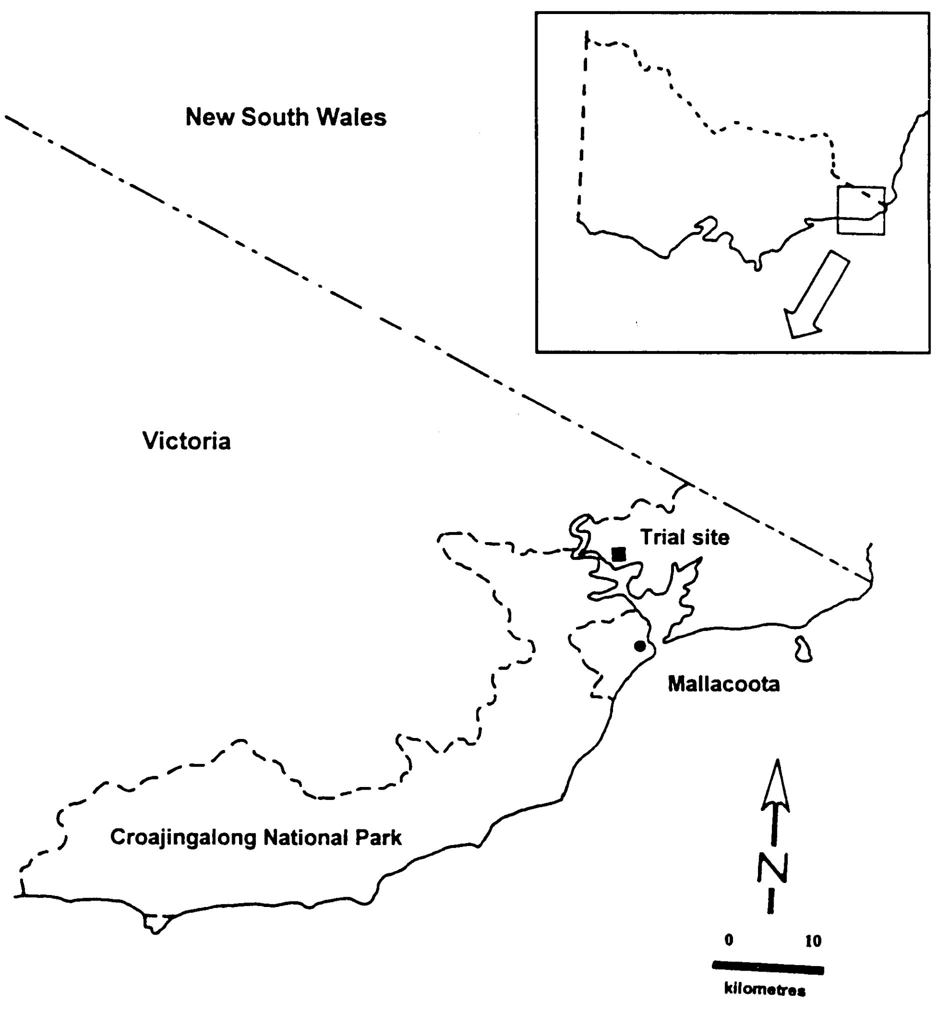

Figure 1. Location of trial site.

south. The extent of blue periwinkle in the area is generally limited by these physical features. Deep black tertiary sands with high organic matter underlie the site. Exact soil depth was not determined but steel pegs penetrated to a depth of about 30 cm without hitting rock.

Vegetation comprised tall coastal scrub dominated by black wattle (*Acacia mearnsii*, 10–15 m high) with giant honey-myrtle (*Melaleuca armillaris*, 3–5 m high) in the mid-storey. Jasmin morinda (*Morinda jasminoides*) and wombat berry (*Eustrephus latifolius*) occur as climbers in both tree species. Scattered individuals of cherry ballart (*Exocarpus cuppressiformis*, 3–5 m high) are also present. Shrubs are an uncommon component of the vegetation due to the vigorous growth of blue periwinkle. Shrub species present include scattered giant honey-myrtle and, where more open, shiny cassinia (*Cassinia longifolia*). Isolated individuals of mock-olive (*Notolaea venosa*) and blackberry (*Rubus fruiticosus* agg.) were also present.

The ground flora was almost completely dominated by blue periwinkle particularly on the mid-slope. In some places, particularly closest to private property, introduced pasture grasses were present as co-dominants. The most common associated species included arum lily (*Zantedeschia aethiopica*), austral bracken (*Pteridium esculentum*) and spiny-headed mat-rush (*Lomandra longifolia*).

Methods

Four treatments and a control were arranged in randomized blocks with three (clopyralid, control) and four (glyphosate, metsulfuron methyl, triclopyr) replications of 4 × 4 m plots (Table 1). All herbicides were mixed in clean fresh tap water. As none of the chemicals used have label recommendations for control of blue periwinkle, herbicide concentrations were selected based on experience with control of weeds of a similar climbing vine habit elsewhere in the region.

All treatments were applied on 25 February 1992 when the temperature was 22°C, relative humidity 40%, no cloud cover and there was a light south-easterly wind of 0–5 knots. Herbicides were foliar applied using a 15 L knapsack at a volume of 3.5 L per plot (or 2188 L ha^{-1}). Surfactant was added to metsulfuron methyl at the rate of 1:140. Adjuvants were not included with any of the other herbicides. Prostrate stems between plots were severed prior to spraying to eliminate the potential for translocation of herbicides into adjoining plots.

Percentage cover of blue periwinkle was visually assessed in each plot prior to herbicide application (Table 1) and at 1, 2, 4, 6, 12 and 18 months after treatment (MAT). Herbicide effects were recorded as percentage brown-out for blue periwinkle and noted for non-target species at 1, 2, 4, 6, 12 and 18 MAT. Recolonization by native and exotic species was recorded.

The data were heteroscedastic and not amenable to transformation, thus we could not use parametric analysis, such as ANOVA, which would have allowed comparison of effectiveness over time. The non-parametric Kruskall-Wallis test was used for all herbicides at 6 MAT, when all treatments had greatest brown-out. The null hypothesis was that the observations of brown-out for each herbicide were taken from populations which had the same statistics of location (Sokal and Rohlf 1981), i.e. that the degree of brown-out was the same for each herbicide. Following a significant result the mean ranks of brown-out for each herbicide were compared using the z statistic (Piggott 1986).

Results

Effects of chemical treatments on blue periwinkle

All treatments reached their greatest brown-out at 6 MAT (Figure 2). At that time glyphosate (360 g 100 L^{-1}) was more effective than any other treatment (H adjusted for ties = 15.21, $P = 0.004$: $z = 2.8$, $P = 0.005$). Leaf yellowing and initial brown-out were evident at 1 and 2 MAT (mean brown-out of 11 and 45% respectively) and tended towards substantial (79% at 4 MAT) and then almost complete brown-out (96%) at 6 MAT. Extensive brown-out at 12 and 18 MAT were still apparent (83 and 70% respectively) although the overall cover of live blue periwinkle had begun to increase due to invasion of plants from adjacent plots and untreated areas. The general effectiveness afforded from glyphosate application was evident from the extremely low rate of regrowth from stems and roots within the glyphosate treated plots. Regeneration from seed was evident in the form of a small number of seedlings.

The average rank of brown-out produced by triclopyr, clopyralid and metsulfuron methyl were not significantly different at 6 MAT (for pairwise comparisons respectively $z = 0.49$ and 1.85, $P = 0.15$ and 0.06). Physiological effects of triclopyr (126 g 100 L^{-1}) were clearly apparent at 1 MAT with the majority of blue periwinkle plants being severely wilted. Tissue yellowing was evident at this stage and became more prevalent at later assessments leading to a moderate level of brown-out at 2 and 4 MAT of 18% and 30% respectively. By 6 MAT most blue periwinkle plants were herbicide affected and leaf brown-out had reached a mean of 59%, the highest for the trial duration. However, treatment results using triclopyr were particularly inconsistent at 6 MAT with brown-out levels ranging from 5 to 90%. Monitoring at 12 and 18 MAT indicated that blue periwinkle was recovering from herbicide effects (mean brown-out of 44% and 36% respectively) through reshooting combined with some regeneration from seed.

Clopyralid (150 g 100 L^{-1}) failed to show any large effect upon blue periwinkle until 6 MAT when maximum brown-out (23%) was reached. Similar to triclopyr treatments, plots where clopyralid was applied responded inconsistently with brown-out at 6 MAT ranging between 5 and 60%. By 12 MAT, all plots showed significant recovery including reshooting from previously damaged stems. At 18 MAT, brown-out was still evident in one plot although the strong vegetative recovery observed at 12 MAT had continued.

The only effect observed from metsulfuron methyl (6 g 100 L^{-1}) throughout the trial was an extremely small amount of yellowing and an even smaller amount of brown-out (<1% to 3%) observed across the assessment period. This small amount of brown-out was not significantly more than found in the control plots ($z = 2.24$, $P = 0.04$).

Effects on non-target species

Glyphosate resulted in mortality of most ground and understorey species sprayed.

Table 1. Herbicides and rates evaluated, blue periwinkle cover pre-treatment and treatment replication.

Herbicide	Trade name	Concentration (g 100 L^{-1})	Rate (kg ha^{-1})	Mean blue periwinkle cover prior to treatment (%)	No. of replicates (4 × 4 m plots)
Metsulfuron methyl	Brushoff®, Dupont Australia (see note)	6	0.13	80	4
Glyphosate	Roundup®, Monsanto Australia	360	7.88	88	4
Triclopyr	Garlon 600®, DowElanco	126	2.76	75	4
Clopyralid	Lontrel®, DowElanco	150	3.28	77	3
Control (no herbicide)	–	–	–	80	3

Note. Nufarm surfactant was added to metsulfuron methyl at the rate of 1:140.

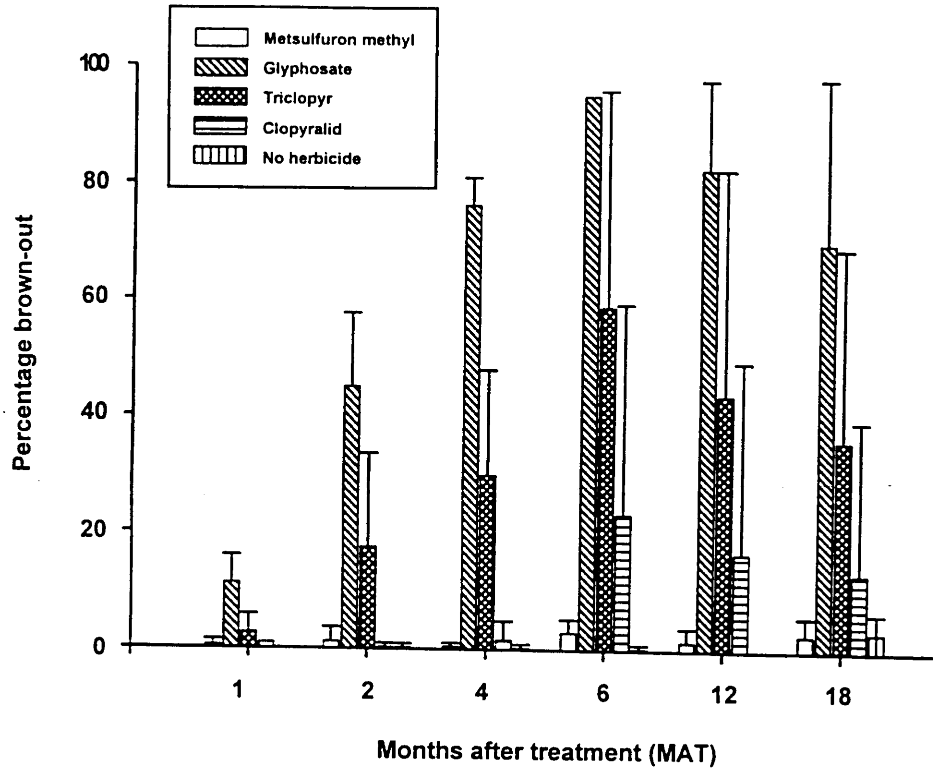

Figure 2. Percentage brown-out of blue periwinkle 1–18 months after treatment (MAT). Mean + 95 % confidence interval.

Throughout the trial an overall increase in the cover of native species was observed in glyphosate plots with the reduction in the vigorous growth and cover of blue periwinkle. Native ground flora such as New Zealand spinach (*Tetragonia tetragonioides*) increased in cover between pre- and post-control assessments through natural seed regeneration. There was less regeneration of giant honey-myrtle through seed than of New Zealand spinach.

Triclopyr caused mortality of all non-target broad-leaved ground flora with the exception of arum lily which displayed leaf yellowing at 1 and 2 MAT but recovered from any herbicide effect from 4 MAT and thereafter. The death of one giant honey-myrtle shrub (over 1.5 m high and not foliarly sprayed) may have been caused by herbicide uptake through basal bark tissue.

Clopyralid had very little if any effect on non-target ground flora and no effect on understorey shrubs. Leaf yellowing in individual specimens of arum lily was evident, but brown-out and mortality of this species was not recorded. Arum lily invaded one plot in the absence of any appreciable reduction in blue periwinkle and increased in cover from 5% prior to treatment to 35% at 18 MAT.

Metsulfuron methyl had a selective effect on non-target ground flora. Arum lily suffered wilting at 2 MAT and brown-out by 6 MAT in some plots due to the application of herbicide, as did austral bracken and giant honey-myrtle. Other ground flora such as grasses were not affected. Arum lily seedlings appeared at 18 MAT. The death of a giant honey-myrtle shrub may have been attributable to root uptake of herbicide as no other apparent cause for mortality was evident. At 6 and 18 MAT, snowflakes (*Leucojum aestivum* L.) were recorded (cover <5%) in one plot for the first time.

Discussion

Glyphosate applied at the rate of 360 g 100 L^{-1} during February provided the most effective control of blue periwinkle in this trial. Maximum foliage death was achieved at 6 MAT. Although further trials are required to ascertain the most effective time for re-application of glyphosate, the results of this trial suggest that follow-up spot spraying of stem and root regrowth and seedling regeneration would be best undertaken between 6 and 12 MAT.

An important prerequisite for maximizing the impact of glyphosate is delivering it at a time when the target weed is actively growing and photosynthesizing (J. Whitehead personal communication). Targeting glyphosate application to periods when maximum sap flow to the roots is occurring is important for control of perennial plants. Given the high mortality rate of blue periwinkle observed in this trial through application of glyphosate in February, it is recommended that future control programs targeting this species be undertaken when seasonal conditions are contributing to the production of vigorous plant growth.

Application of triclopyr (126 g 100 L^{-1}) was moderately effective but inconsistent between trial plots. Clopyralid (15 g 100 L^{-1}) and metsulfuron methyl (6 g 100 L^{-1}) were ineffective.

Although glyphosate application resulted in initial high mortality of native understorey species, this outcome was of little long-term consequence as regeneration of native species from seed was strong once the dense and vigorous cover of blue periwinkle was reduced. Follow up spot spraying of weed regrowth at between 6 and 12 MAT as recommended from these trials should be directed to avoid native understorey species and be undertaken when blue periwinkle is most actively growing.

The success of glyphosate in operational control programs for blue periwinkle has been subsequently demonstrated at an area adjoining the Bakers Bight trial site where a mortality rate of greater than 95% was achieved. Interestingly, high populations of the exotic garden species, snowflakes and daffodils (*Narcissus* sp. L.), have appeared after blue periwinkle control indicating the importance and necessity for follow-up control of secondary weed species which emerge after the substantial removal of the primary weed infestation.

Indications from this trial were that arum lily, another serious environmental weed in temperate Australia (Keighery 1991, Carr *et al.* 1992), may increase and expand it's range once the competition from blue periwinkle was reduced. Given the highly invasive nature of arum lily, control of this species warrants a high priority. Observations from this trial and elsewhere (e.g. Parsons and Cuthbertson 1992) have indicated the effectiveness of sulphonyl urea compounds such as chlorsulfuron in controlling this species.

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