Susceptibility of great bindweed (*Calystegia silvatica*) to herbicides

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Abstract A field trial was conducted in Palmerston North to compare autumn applications of several translocated herbicides for great bindweed (*Calystegia silvatica*) control in riparian zones. Regrowth in the following spring showed that a triclopyr/picloram/aminopyralid mixture, a 2,4-D/dicamba mixture and aminopyralid by itself were the three most effective treatments, though none gave complete control. Glyphosate provided partial control whereas metsulfuron and clopyralid provided poor control. These and two other herbicides were further assessed in a glasshouse trial in which they were applied to leaves either on the upper or lower half of plants to compare efficacy. The relative effectiveness of these herbicides on great bindweed was similar to that found in the field. Most herbicides had similar efficacy whether applied to upper or lower parts in autumn, except glyphosate, which was more effective applied to upper plant parts. Implications for control of great bindweed in riparian plantings are discussed.

Keywords great bindweed, *Calystegia silvatica*, triclopyr, picloram, dicamba, aminopyralid, glyphosate, riparian.

INTRODUCTION

In Taranaki and many other parts of New Zealand, riparian zones next to pasture land are being fenced off and planted in native shrubs and trees to help reduce detrimental effects of farming on waterways. Many of these riparian plantings are now being threatened by severe competition exerted by great bindweed (*Calystegia silvatica*), which has become dense at some sites, often totally covering planted species (Wilson-Davey et al. 2009).

As this deciduous, perennial weed has seldom caused much economic harm in the past, few studies have been conducted on its biology and control. However, much of its success is due to an aggressive rhizome system (Williams 2009). There had been uncertainty over whether it

produces much seed, but recent work by Gawn (2013) has found that, on average, each flower produces 1.5 seeds, with 71% viability. Seeds are relatively large (43.4 mg) and only germinate following scarification.

There has also been considerable confusion over the taxonomy of bindweeds, especially differences between *Calystegia sepium* (hedge bindweed), *Calystegia silvatica* and their sub-species (Ogden 1978). A review of the taxonomy of these two species followed by a brief field survey by Gawn (2013) showed that most of the bindweed plants in Manawatu and Hawke's Bay are *Calystegia silvatica* ssp. *disjuncta*.

The susceptibility of this weed to herbicides is not known due to a lack of trial work, and thus

extrapolation has often been necessary from work done overseas on *Convolvulus arvensis* (field bindweed) and *Ca. sepium* (Wilson-Davey et al. 2009). Work by Rahman & Sanders (1992) on great bindweed emerging from rhizomes within New Zealand asparagus crops showed few herbicides had much effect on it apart from imazapyr, which is not suitable for use among young native shrubs beside waterways. A 2,4-D/dicamba mixture has often been recommended for great bindweed control in waste places (O'Connor 1984).

The objective of this work was to determine the relative efficacy of several translocated herbicides on great bindweed when applied in autumn just prior to winter dormancy of the weed, and also to determine if these herbicides would work effectively if only applied to part of each plant as might be necessary when spraying near native plants.

MATERIALS AND METHODS

Field trial

A field trial was conducted in ungrazed areas near the Turitea Stream and adjacent to the Massey University No. 1 Dairy Farm on Poultry Farm Road, Palmerston North. Plots were set up around discrete colonies of established great bindweed plants, identified as *Calystegia silvatica* ssp. *disjuncta*. The plants were growing over a range of different self-planted tree, shrub, perennial grass and herbaceous weed species, such as willow (*Salix* spp.), elder (*Sambucus nigra*), poroporo (*Solanum aviculare*), Yorkshire fog (*Holcus lanatus*), hemlock (*Conium maculatum*) and wandering Jew (*Tradescantia fluminensis*). There were 28 plots in total and the great bindweed plants varied in size.

On 16 April 2012, six herbicide treatments (Table 1) were applied to the great bindweed plants and compared with untreated plants within a randomised complete block design (blocking based on plant size) with four replicates. Each herbicide was mixed with Done That (triarylmethane dyestuff, Farmers Industries Ltd) marker dye (but no surfactants) and was applied only to great bindweed foliage using a 15-litre Solo

backpack sprayer, thoroughly wetting leaves but trying to avoid run-off to plants beneath the great bindweed plants. A 10% portion of each great bindweed plant was left unsprayed to simulate avoiding spraying near wanted native plants. The maximum and minimum temperatures for the 2 weeks following spraying (taken from the nearby AgResearch Grasslands weather station) were 17.8°C and 5.3°C respectively.

The health of the great bindweed plants in each plot was visually scored each week until the plants had died back for winter. Scores were assigned from 0 (for plants in which all foliage had died) to 10 (where foliage was very healthy). When plants began regrowing again in the following spring, the number of shoots per m² emerging within each plot was recorded. All data were subjected to analyses of variance using SAS and least significant differences were calculated where treatment means were significantly different.

Glasshouse trial

Rhizomes of great bindweed plants were collected from the Massey University orchard on 17 February 2012 and segments averaging 35 cm in length were planted 3 cm deep within planter bags each containing 1.5 litres of potting mix. These were kept in a glasshouse with automated irrigation at the Massey University Plant Growth Unit, Palmerston North, and rhizomes or roots were prevented from growing out of the bottom of the bags by placing each bag on an inverted plastic dish. The foliage was trained up strings suspended from overhead wires so that all foliage was kept to just one string and trimmed when they reached a height of 2 m.

On 21 April 2012, all eight herbicide treatments (Table 1) were applied to the upper half of plants and these were compared with the same treatments applied to the lower half of plants. These treatments plus two untreated controls were replicated four times and organised within a randomised complete block design, with initial health and vigour of plants used for blocking. Only 1.0 ml of each herbicide treatment was applied per plant using a small paint brush, with 0.1% organosilicone surfactant (Boost Penetrant)

Table 1 Details of herbicides used in both trials (2,4-D and fluroxypyr were used only in the glasshouse trial).

Active ingredient	Trade name	Formulation	g ai/100 litres
2,4-D	Pasture Kleen	ethyhexyl ester	780
2,4-D/dicamba	Banvine	amine salt	240/120
aminopyralid	Tordon Max	tri-isopropylamine salt	18
clopyralid	Versatill	amine salt	90
fluroxypyr	Starane 200	methylheptyl ester	100
glyphosate	Roundup 360 Pro	isopropylamine salt	540
metsulfuron	Answer	methyl ester	15
triclopyr/picloram/ aminopyralid	Tordon Brushkiller XT	amine salt/butoxyethyl ester/ amine salt	90/30/2.4

added to help retain herbicide on treated foliage. All leaves and stems in the treated half of the plant were covered in herbicide by this method. The maximum and minimum temperatures for the 2 weeks following treatment were 21.7°C and 12.9°C respectively.

The plants were scored weekly following treatment for state of health as described for the field trial until they had died back for winter. The shoot material was then cut back and the pots were placed in an unheated shadehouse for the remainder of the trial. Once regrowth began in spring, shoots regrowing from each pot were counted. All shoot material was removed on two occasions (6 December 2012 and 8 January 2013), dried at 75°C and weighed. Roots and rhizomes were also removed from pots on 9 January, dried and weighed. Data were analysed as for the field trial.

RESULTS

Field trial

The triclopyr-based mixture caused the most rapid chlorosis of great bindweed foliage. By 4 weeks after treatment (WAT), all treatments had adversely affected the plants noticeably, with the triclopyr-based mixture and glyphosate causing most damage (Table 2). All great bindweed plants started to die back for winter dormancy following the 4 week assessment, making it difficult to separate treatment effects from natural senescence. Very little damage could be found 6 WAT from herbicide treatments on other plants within each plot.

In the following spring, great bindweed plants regrew for all treatments, although there was least regrowth from plots that had been treated with the triclopyr-based mixture, 2,4-D/dicamba or aminopyralid. In the absence of follow-up treatment, the great bindweed re-established eventually from all herbicide treatments so that by early December, many plants had recovered to similar densities to those present prior to spraying 8 months earlier.

Table 2 Health scores (0 = dead; 10 = healthy) of great bindweed foliage 2 and 4 weeks after treatment (WAT), and the density of great bindweed shoots that emerged in plots after winter dormancy.

Treatment	Health score		Shoots m ² 22 WAT
	2 WAT	4 WAT	
2,4-D/dicamba	4.3	2.5	0.6
aminopyralid	4.3	3.0	1.0
clopyralid	4.5	2.3	3.8
glyphosate	3.5	1.5	2.7
metsulfuron	5.5	3.8	5.3
triclopyr/picloram/ aminopyralid	2.5	2.0	0.3
untreated	7.0	5.3	3.5
LSD (P=0.05)	1.4	2.1	3.4

Glasshouse trial

As with the field trial, the triclopyr-based mixture produced a rapid response in the glasshouse trial, but this time so did metsulfuron and 2,4-D (Table 3). With plants dying back for winter

soon after the 4-week assessment, it was not until the spring regrowth that the true effect of the treatments on plants could be seen.

At the first harvest of shoot material on 6 December 2012 (32 WAT), the 2,4-D/dicamba, aminopyralid and the triclopyr-based mixture, had only small regrowth (Table 3). The second harvest on 8 January 2013 (37 WAT) showed similar results. The metsulfuron and 2,4-D treatments, which gave rapid knockdown initially, had regrowth similar to untreated plants.

When underground material was dug up on 9 January 2013 and healthy rhizome tissue was separated from necrotic tissue and fibrous roots, it was found that all treatments still had some healthy rhizome present (Table 3). However, the triclopyr-

based mixture and 2,4-D/dicamba treatments had the least rhizome material, whereas aminopyralid-treated pots still had a lot of rhizome. There was generally little difference in results between applications to lower or upper parts of the plant (Table 3), except glyphosate where applications to upper parts were more effective.

DISCUSSION

Results from both experiments show that the 2,4-D/dicamba mix currently recommended for control of great bindweed (O'Connor 1984) is still the best herbicide for controlling it. However, the triclopyr/picloram/aminopyralid mixture gave similar levels of control and the aminopyralid by itself also appeared promising.

Table 3 Health score (0 = dead; 10 = healthy) at 4 WAT, shoot regrowth in spring (32 and 37 WAT), and dry weight (DW) of healthy rhizome at 37 WAT for great bindweed foliage to which herbicides has been applied either to the upper (U) or lower (L) parts of the plant.

Treatment	Score 4 WAT	Shoot no./pot 32 WAT	Shoot DW (g/pot) 32 WAT	Shoot DW (g/pot) 37 WAT	Rhizome DW (g/pot) 37 WAT
2,4-D (U)	1.8	5.5	0.73	0.54	5.09
2,4-D (L)	1.0	6.8	0.93	0.54	4.25
2,4-D/dicamba (U)	1.8	0.3	0.03	0.03	1.49
2,4-D/dicamba (L)	3.5	0.0	0.00	0.05	3.25
aminopyralid (U)	3.0	0.3	0.00	0.06	9.67
aminopyralid (L)	3.8	0.5	0.03	0.15	6.48
clopyralid (U)	5.3	2.8	0.43	0.60	15.21
clopyralid (L)	4.8	3.8	0.35	0.78	9.33
fluroxypyr (U)	2.3	5.5	0.58	0.94	8.83
fluroxypyr (L)	2.3	3.3	0.33	0.77	7.43
glyphosate (U)	2.8	1.3	0.03	0.40	8.34
glyphosate (L)	4.0	8.0	0.45	1.27	12.95
metsulfuron (U)	1.8	5.3	0.73	0.64	4.64
metsulfuron (L)	1.0	3.3	0.58	0.43	2.71
triclopyr/picloram/ aminopyralid (U)	1.0	1.5	0.20	0.24	2.30
triclopyr/picloram/ aminopyralid (L)	1.0	0.8	0.00	0.01	0.18
untreated control A	4.0	5.0	0.63	0.74	10.69
untreated control B	5.0	4.0	0.53	1.04	10.80
LSD (P=0.05)	1.4	2.0	0.32	0.39	4.52

Only one application rate was used for each herbicide, based on recommended rates for similar species. Some of the other herbicides may have also performed well if higher rates were applied. Also, if a surfactant was used in the field trial, or the entire plant had been treated in the glasshouse experiment, improved efficacy could have resulted. Complete control was achieved in some replicates, but the main objective of this work was to rank the herbicides for efficacy.

As great bindweed is deciduous, it is assumed that materials from most leaves are translocated down to the rhizome system in late autumn. In spring and summer, leaves in upper parts of the stem send most sugars towards the shoot tip as part of the sink source relationship (Willeke et al. 2012). Thus it was expected that herbicide applied to these leaves in late autumn would move to the rhizomes as effectively as herbicide applied to lower leaves, which was confirmed with the present work. This would be an advantage where great bindweed plants are growing around and over newly planted native species in riparian zones, as herbicides such as 2,4-D/dicamba and aminopyralid would presumably need to be kept off most broad-leaved native species (Harrington & Gregory 2009).

Results from the field trial suggest that it would not be wise to wait until the following autumn to respray the regrowth as plants could recover fully by then. However, respraying as soon as shoots appear may not be effective as sugar flow would be mainly upwards from rhizomes to new shoots initially (Willeke et al. 2012). It may be better to wait until translocation of sugars back down to the rhizomes has begun again so herbicides might be moved into the rhizomes, although only basal leaves would be expected to send herbicides to the rhizomes at this stage.

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