Herbicide tolerance of three ornamental ground cover species: *Polygonum capitatum*, *Sedum mexicanum* and *Soleirolia soleirolii*

Chin Lui Foo, Kerry C. Harrington and Marion B. MacKay
Institute of Natural Resources, Massey University, Palmerston North 4442, New Zealand
Corresponding author: K.Harrington@massey.ac.nz

Summary As part of a study on ground cover use for weed deterrence, herbicide tolerance trials were performed on three ornamental ground cover species: *Soleirolia soleirolii* (baby's tears), *Polygonum capitatum* (pink-head knotweed) and *Sedum mexicanum* 'Acapulco Gold'. Plants of each species were established in planter bags, and each trial involved application of about 18 herbicide treatments to each species. Scoring of plant damage allowed herbicides to be identified that will control weeds selectively in these plant species as well as herbicides capable of controlling these species should they outgrow their intended boundaries. The selection of herbicides available for the management of each of these species makes them ideal for mass planting in amenity horticulture and urban areas.

Keywords Herbicide selectivity, *Soleirolia soleirolii*, *Polygonum capitatum*, *Sedum mexicanum*, amenity horticulture, urban weeds.

INTRODUCTION

Use of ground covers, defined as low-growing plants that spread horizontally with a profusion of dense foliage (van der Spuy 1976), is an often under-appreciated strategy in weed management. A mature ground cover population not only outcompetes weed seedlings, they also do not require mowing, unlike turf. Should opportunistic weeds establish within ground cover plants, fallback to selective herbicide control is often possible.

This paper investigates selective herbicide options for three ground cover plant species. *Polygonum capitatum* Buch-Ham. ex D.Don (pink knot-weed) is a trailing perennial herbaceous ground cover plant. It has attractive leaves with a reddish centre and older leaves sometimes turn crimson or bronze. The numerous pink ball-shaped flower heads set seed easily but it is frost-tender (Fish 1970, MacKenzie 1997).

Sedum mexicanum Britton 'Acapulco Gold' is a succulent plant with yellow leaves that are russet-tinged in cooler seasons and spreads rapidly (Snodgrass and Snodgrass 2006). It has strong regenerative abilities, including from nodal fragments and also roots at stem nodes.

Soleirolia soleirolii Gaudich syn. *Helxine soleirolii* (Req.) Urtic. (baby's tears) is a small, tightly prostrate plant with tiny bean-shaped leaves. An ideal plant under trees where it is shaded and frost-protected, it roots from stem nodes as it creeps along the soil surface (Thomas 1977).

The objectives of this work were, firstly, to find which herbicides can be used to selectively remove weeds that establish within the ground covers, and secondly, to identify herbicides that will control the ground cover species should they begin growing where they are not wanted.

MATERIALS AND METHODS

Plants of each species were established in polythene planter bags each containing a bark-based potting mix and slow-release fertiliser, with the *S. soleirolii* and *S. mexicanum* in 600 mL bags and *P. capitatum* in 1.5 L bags. These were kept in an unheated shadehouse that received daily overhead irrigation until they were well established.

Herbicides were applied individually using a hand-held atomiser that sprayed a measured quantity of herbicide from a test-tube to simulate spot spraying, and this equated to application rates of 3000 L ha^{-1}. The treatments used in each of the three experiments are listed in Tables 1–3. Herbicide treatments were compared against an untreated control in each experiment, and all treatments were replicated five times using a randomised complete block design in which initial plant vigour was blocked. The *P. capitatum* plants were sprayed on 18 March 2009, *S. mexicanum* on 24 March 2009 and *S. soleirolii* on 31 March 2009. The average temperature for the 2 weeks after spraying was 15.2°C for *P. capitatum*, 14.8°C for *S. mexicanum* and 13.2°C for *S. soleirolii*.

After spraying the plants were scored at regular intervals for the severity of damage caused by the treatments applied to them. The scoring system used ranged from a score of 1 for very healthy plants through to 10 for dead plants. Results were subjected to an analysis of variance using the GLM procedure in SAS 9.1, and least significant differences were calculated at $P = 0.05$ when significant differences between means were detected.

RESULTS AND DISCUSSION

Polygonum capitatum The most damaging of the herbicides for *P. capitatum* was dicamba, and this would be a very suitable chemical for controlling the species should it become troublesome (Table 1). When looking at herbicides that would be useful for controlling weeds selectively within this ground cover species, haloxyfop was successfully tolerated and thus will be useful for grass weed control. Likewise, the tribenuron treatment was tolerated quite well and this gives good general control of a wide range of broad-leaved species. A tribenuron/haloxyfop mixture has been useful for weed control in our field plots since this trial. The three residual herbicides tested, simazine, pendimethalin and oxadiazon, were all tolerated quite well and could be used to help get this ground cover species established. However, there was some initial damage from the oxadiazon.

There was some tolerance of the lower rate of glyphosate, but double this rate killed the plants, so this is probably not safe enough to use as a selective treatment. The rate of clopyralid used was higher than necessary for weed control, and the recovery from this rate suggests this chemical may be useful if used at lower rates to avoid initial damage. There was some slight damage from both diflufenican and bentazone initially, which the *P. capitatum* recovered from, so it is possible these treatments might be useful in some circumstances.

Table 1. Scores of *Polygonum capitatum* plant health at 7 and 11 weeks after spraying with 18 herbicide treatments (1 = healthy, 10 = dead).

Herbicide	Rate (kg ha^{-1})	Score	
		7 w	11 w
Bentazone	1.4	3.6	1.6
Bentazone	2.9	3.4	1.6
Clopyralid	0.3	4.6	1.8
Dicamba	0.42	9.2	9.8
Dicamba	0.84	9.6	10.0
Diflufenican	0.1	4.8	1.4
Diflufenican	0.2	4.4	2.0
Glyphosate	1.1	3.2	5.6
Glyphosate	2.2	4.4	9.6
Haloxyfop	0.9	3.2	1.6
Oxadiazon	0.74	3.4	1.8
Oxadiazon	1.5	4.0	1.0
Pendimethalin	2.0	2.2	1.8
Pendimethalin	4.1	3.2	2.2
Simazine	1.5	3.0	1.2
Simazine	3.0	2.4	1.8
Tribenuron	0.12	4.0	1.4
Tribenuron	0.24	2.8	1.4
Untreated		2.8	2.0
LSD (P = 0.05)		1.6	1.4

Sedum mexicanum As *Sedum* species are known to become weedy in some environments, treatments that would control this succulent species were of interest. Although the triclopyr/picloram treatments look effective in Table 2, eventually the *S. mexicanum* did recover from this herbicide mixture, despite a very high rate being used. Rather surprisingly, the higher rate of the contact herbicide mixture of paraquat/diquat gave better long-term control than the triclopyr/picloram mixture. Diflufenican, which took some time to show its full effect, gave the best control when assessed 20 weeks after treatment, resulting in 100% kill.

Treatments such as glyphosate, amitrole and metsulfuron, which would often be considered for controlling such species, were generally ineffective at killing *S. mexicanum*, raising the possibility that they would be useful for selectively controlling weeds within a *S. mexicanum* ground cover. The glyphosate and metsulfuron treatments did knock the vigour of the plants for some time after application, which is not ideal when trying to keep ground covers dense and vigorous. For the broad-spectrum herbicides, glufosinate and amitrole showed the most potential for selective use in *S. mexicanum* ground covers. Haloxyfop appears to be safe for controlling grasses, while the clopyralid treatment also looks promising for broad-leaved weed control. The mecoprop/ioxynil/bromoxynil mixture could also be useful, though it did cause some damage in the first few weeks after application. Simazine appears to be safe as a residual herbicide treatment, but oxadiazon caused some initial damage to *S. mexicanum*.

Soleirolia soleirolii This species has been found growing invasively in the nurseries where it is produced, and has also been reported to invade grass turf adjacent to gardens where it grows, so herbicides capable of controlling it are necessary if it is to be used as a ground cover. As had been reported anecdotally, turf herbicide mixtures based on a mixture of MCPA, mecoprop and dicamba had little effect on the *S. soleirolii* plants, and likewise a mecoprop, ioxynil and bromoxynil mixture gave no useful control of this species (Table 3). Other herbicides suitable for use in turf that gave no control included bentazone, MCPA and 2,4-D ester, while clopyralid, triclopyr and diflufenican only temporarily checked the growth of *S. soleirolii*.

Table 2. Scores of *Sedum mexicanum* plant health at 7 and 15 weeks after spraying with 19 herbicide treatments (1 = healthy, 10 = dead).

Herbicide	Rate (kg ha^{-1})	Score 7 w	Score 15 w
Amitrole	1.2	2.4	2.4
Bentazone	1.4	2.0	3.0
Clopyralid	0.90	2.0	2.8
Dicamba	0.42	4.6	2.4
Diflufenican	0.10	6.2	9.6
Diflufenican	0.21	5.4	9.4
Glufosinate	1.2	2.2	1.0
Glyphosate	2.2	1.8	4.8
Haloxyfop	0.90	1.8	1.8
MCPA	1.1	6.8	2.8
MCPA/ mecoprop/ dicamba	0.42/1.7/0.21	6.2	2.6
Mecoprop/ ioxynil/ bromoxynil	1.03/0.22/0.22	1.6	1.6
Metsulfuron	0.090	1.4	3.2
Oxadiazon	0.76	5.2	3.8
Paraquat/diquat	0.6/0.52	4.6	4.8
Paraquat/diquat	1.2/1.0	9.6	8.4
Simazine	1.5	1.4	2.0
Tribenuron	0.090	1.8	2.4
Triclopyr/ picloram	1.8/0.6	8.0	7.0
Untreated		1.2	1.6
LSD (P = 0.05)		1.9	2.6

Table 3. Scores of *Soleirolia soleirolii* plant health at 7 and 15 weeks after spraying with 23 herbicide treatments (1 = healthy, 10 = dead).

Herbicide	Rate (kg ha^{-1})	Score 7 w	Score 15 w
Aminopyralid	0.06	10.0	10.0
Amitrole	1.2	4.4	3.6
Bentazone	1.4	2.0	1.2
Clopyralid	0.30	2.0	6.8
2,4-D ethylhexyl ester	1.0	2.2	1.4
Dicamba	0.20	2.2	2.0
Diflufenican	0.10	5.0	2.2
Diuron	1.6	1.4	1.4
Glufosinate	1.0	2.2	2.2
Glyphosate	0.36	2.4	2.4
Haloxyfop	0.30	2.0	1.8
MCPA	1.1	2.6	2.2
MCPA/ mecoprop/ dicamba	0.42/1.7/0.21	3.6	1.8
Mecoprop/ ioxynil/ bromoxynil	1.03/0.22/0.22	1.6	2.4
Metsulfuron	0.090	3.4	5.8
Oxadiazon	1.5	7.8	5.0
Oxyfluorfen	0.60	8.0	5.4
Paraquat/diquat	0.2/0.12	1.6	1.8
Pendimethalin	1.3	3.6	3.4
Simazine	1.5	2.6	1.4
Tribenuron	0.090	3.4	2.2
Triclopyr	0.42	6.0	4.4
Triclopyr/ picloram	0.6/0.2	10.0	10.0
Untreated		1.4	1.4
LSD (P = 0.05)		1.8	1.8

The most suitable herbicide for controlling *S. soleirolii* selectively in grass turf is a mixture of triclopyr and picloram, which gave total control. Likewise aminopyralid gave total control although this is not registered for use in turf within New Zealand.

Other herbicides used to control weeds within nurseries that were ineffective included amitrole, glyphosate, glufosinate and a paraquat/diquat mixture (Table 3). However, some of these were applied at low rates to try finding suitable herbicides for selectively controlling weeds within *S. soleirolii* ground covers.

Although this raises the possibility that *S. soleirolii* may be too difficult to contain and thus should not be used as a ground cover species, it does mean that a wide range of herbicide options appear to exist should weeds need to be selectively removed from this species. If preference is given to herbicides that do not check its growth, this reduces the options, as the elevated scores at 7 weeks after application measured for herbicides such as amitrole, diflufenican and triclopyr probably make them unacceptable.

The herbicides of most interest initially are the broad-spectrum herbicides such as glyphosate, glufosinate and paraquat. If these can effectively control weeds without damaging the *S. soleirolii* ground cover, there is no need to use more expensive products that control a narrower range of weeds, such as haloxyfop, which only controls grasses. Subsequent unpublished work we have done with these herbicides suggests glufosinate and paraquat can be damaging initially under some conditions, but the *S. soleirolii* recovers

rapidly. Glyphosate appears to cause no damage. If residual herbicides are required, oxadiazon and oxyfluorfen look to be too damaging, and in fact these two herbicides could be useful for keeping the species in check. Diuron and simazine appear to be the most suitable chemicals for selective residual weed control.

CONCLUDING DISCUSSION

Although there may be concern over widespread use of ground cover species that could be invasive, it should be remembered that the species do not necessarily thrive in a wide range of habitats. We have found that *P. capitatum* is very susceptible to frosts, and generally *S. soleirolii* only thrives under very moist, shaded environments. We believe the herbicide information obtained by our research will allow the species to be controlled should they escape from where they are planted.

This paper has concentrated on use of herbicides to control weeds selectively within the ground covers. However, once the ground covers are established, it is expected that minimal use of herbicide would be required and that these ground covers would stop further weeds from establishing by keeping the soil shaded. By using selective herbicides rather than relying on more labour-intensive and thus expensive hand-weeding, these ground covers could be planted more extensively in urban areas than they are at present.

ACKNOWLEDGMENTS

This project was partially funded by Massey University, the Dan Watkins Scholarship and the Sir Victor Davies Foundation. The assistance rendered by the staff of Plant Growth Unit, Massey University, is gratefully acknowledged.

REFERENCES

Fish, M. (1970). ‘Ground cover plants’, 4th edition. (David and Charles, Newton Abbot, Devon).

MacKenzie, D.S. (1997). ‘Perennial ground covers’. (Timber Press, Portland, USA).

Snodgrass, E.C. and Snodgrass, L.C. (2006). ‘Garden roof plants: a resource and planting guide’. (Timber Press, Portland, USA).

Thomas, G.S. (1977). ‘Plants for ground cover’. (revised). (Aldine Press, London).

van der Spuy, U. (1976). ‘Gardening with ground covers: ground covers of the world for gardens in the southern hemisphere and other temperate regions’. (A.H. & A.W. Reed, Wellington).