THE TOLERANCE OF DIRECT SEEDED NATIVE SPECIES TO HERBICIDES

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Abstract The tolerance of a range of Australian native plants to pre and post emergent herbicides was determined and herbicide strategies for revegetation proposed. Glyphosate was tolerated at 225 g a.i./ha by 34 of the 39 species tested. Chlorthal was the most selective broad spectrum, pre emergent herbicide tested. About half the species showed some tolerance of triasulfuron, imazethapyr and chlorsulfuron applied either as a pre or post emergence application. It is proposed that low rates of glyphosate could be used to economically regenerate degraded bush and reduce weed spread along roadsides.

INTRODUCTION

Herbicides are a potent and economic method of weed control in agriculture and forestry but their use for weed control in reclamation or direct seeded planting of native vegetation is minimal. Reasons for this include a lack of knowledge on the tolerance of native species to herbicides and an ideology based reluctance to use chemicals in these situations. The range of desired species in these situations is often large and the target species few which directly contrasts with agriculture and forestry situations. Land managers often request a single mixture of herbicides that will kill all the weeds and leave all the natives species. While such a mixture is unlikely to exist, there are a number of herbicides that are quite selective for specific weeds and these may be safe for use with some mixtures of native plants. Alternatively, mixtures of species that tolerate the herbicides required for weed control could be formulated. To achieve either of the above the tolerance of the native species to herbicides is required. This paper presents the results of a screening trial where the tolerance of 41 native species from 14 genera to 46 herbicides was evaluated and formulates strategies for weed control in native revegetation that are worthy of further investigation.

MATERIALS AND METHODS

Seeds of 41 Australian native plants were sown into potting mix in trays. Twenty one pre emergent herbicide treatments (Table 1) were applied, at normal and 4 times normal rates, immediately after planting and watered in with approximately 2mm of overhead irrigation. They were subsequently watered from below to reduce leaching of herbicide from the tray. Thirty nine post emergent herbicides (Table 3) were applied, at normal and 4 times normal rates, 8 weeks after planting as an overall spray.

Herbicides were applied in 267 L ha^{-1} water using a boom with fan jet nozzles mounted over a conveyor belt that transported the trays below the boom. The plants were initially grown in a white washed glasshouse then in a shade house.

The plants were scored for size, survival and symptoms approximately 60 and 100 days after spraying. Some species did not germinate or survive in sufficient numbers, especially in trays watered from below. These were excluded from analysis.

RESULTS

The growth and survival percentages were averaged and divided into three classes of response. These were; less than 50%, 50 to 75% and greater than 75% growth and survival. To ease presentation of results these scores were averaged over the two assessment times to produce the 3 classes of response in Tables 1 to 4. In this system good growth or recovery may partially compensate for poor survival and vice versa.

Results for pre emergent treatments are in Tables 1 and 2 and those for post emergent treatments are in Tables 3 and 4.

Acacias In the pre emergence treatments trial, *Acacias* had low survival levels, so only general assessments can be made and data is not included. The overall tolerance to pre emergent applications of group B herbicides was imazethapyr(Spinnaker®) > triasulfuron(Logran®) > sulfometuron(Oust®) > chlorsulfuron. The group C herbicides were generally very damaging apart from normal rates of simazine. Other herbicide groups were variable. Based on this data, products worthy of further testing would include imazethapyr (Spinnaker®), triasulfuron (Logran®), trifluralin and propyzamide (Kerb®).

For the post emergent treatments, establishment was better, presumably because they were watered from above rather than below. They generally tolerated group A herbicides with some showing sensitivity to tralkoxydim (Achieve®) and haloxyfop (Verdict®). They also showed surprising tolerance of the group B herbicides apart from chlorsulfuron (Glean®) and sulfometuron (Oust®). In the group C herbicides responses ranged from death of all species after cyanazine (Bladex®) to good tolerance of methabenzthiazuron (Tribunil®). The hormone herbicides of group I had variable tolerance. Group K herbicides were generally tolerated. Glyphosate was less damaging than the glufosinate (Basta®) or the group L herbicides.

Actinostrobus arenarius This had poor germination and survival overall. Post emergent group A herbicides, clopyralid (Lontrel®), diflufenican (Brodal®), Diflufenican+MCPA (Tigrex®), imazethapyr (Spinnaker®), Linuron and oxyfluorfen (Goal®) appeared to be tolerated.

Agonis Few pre emergent herbicides were well tolerated by this genus. Napropamide (Devrinol®) may be worthy of further work.

Post emergence, group A herbicides were well tolerated apart from fenoxaprop ethyl (Wildcat®). Metosulam (Eclipse®) was tolerated in the group B herbicides. The group C, F and G herbicides generally caused damage. Fluroxypyr (Starane®) and high rates of dicamba caused damage in the group I herbicides. Group K herbicides were well tolerated. Other groups had variable responses.

Allocasuarina heugeliana Few pre emergent were well tolerated and none were well tolerated at 4 times normal use rates. Diuron, napropamide (Devrinol®) and propyzamide (Kerb®) showed the best selectivity at normal use rates.

Post emergent applications of group A and the normal rates of group B and I herbicides were generally tolerated apart from fluroxypyr (Starane®). Group C herbicides were not generally tolerated. 2,2-DPA (Agripon®), metolachlor (Dual®), propyzamide (Kerb®), glyphosate and glufosinate (Basta®) were well tolerated.

Banksia *Banksia media* had a 100% germination and survival level and tolerated many pre emergent herbicides at the normal rate. The other two species had a lower levels and appeared to be far less tolerant of herbicides. All three species tolerated imazethapyr (Spinnaker®), triasulfuron (Logran®) and propyzamide (Kerb®).

Post emergent group A, some group B herbicides, oxyfluorfen (Goal®), clopyralid (Lontrel®), 2,4-DB, 2,2-DPA (Agripon®), metolachlor (Dual®) and glyphosate were generally well tolerated. The group C herbicides were generally damaging and other groups were rather variable.

Beaufortia sparsa This tolerated pre emergence triasulfuron (Logran®), and napropamide (Devrinol®) at normal rates. Post emergent applications of group A, J, K and M herbicides apart from fenoxaprop ethyl (Wildcat®) were well tolerated. Group B herbicides were variable. Group C and L herbicides were generally damaging. *B. shaueri* survival was low in the controls but odd plants survived in the above treatments indicating that it has similar tolerances.

Bossiaea linophylla This tolerated pre emergent group D herbicides, metolachlor (Dual®) and possibly imazethapyr (Spinnaker®).

Normal rates of post emergent group A, B, I and K herbicides and metolachlor (Dual®) were generally well tolerated. Group C and other herbicides were generally damaging apart from pyridate (Tough®) and the low rate of glyphosate.

Callistemon phoniceus This had a poor germination and survival level in the pre emergent experiment. Overall, they appeared reasonably tolerant of group B and D herbicides.

Group A, glyphosate and propyzamide (Kerb®), as well as normal rates of group B and I herbicides applied post emergence were generally well tolerated apart from sulfometuron (Oust®) and fenoxaprop ethyl (Wildcat®). Group C and L herbicides apart from bromoxynil (Buctril®) were generally damaging.

Calothamus quadrifidus This was tolerant of pre emergent imazethapyr (Spinnaker®) chlorthal (Dacthal®), trifluralin, metolachlor (Dual®) and napropamide (Devrinol®).

This species was very sensitive to most post emergent herbicides apart from clopyralid (Lontrel®), diclofop methyl (Hoegrass®), fluazifop (Fusilade®) and normal rates of sethoxydim (Sertin®) and 2,4-DB.

Dryandra formosa These showed tolerance to odd pre emergent herbicides in various groups including, imazethapyr (Spinnaker®), triasulfuron (Logran®), chlorthal (Dacthal®), oryzalin (Surflan®), napropamide (Devrinol®), oxyfluorfen (Goal®) and propyzamide (Kerb®).

They also tolerated post emergent diclofop methyl (Hoegrass®), fluazifop (Fusilade®) sethoxydim (Sertin®), metosulam (Eclipse®), triasulfuron (Logran®), 2,4-D, 2,4-DB and propyzamide (Kerb®). There were generally damaged by group C and L herbicides.

Hakea laurina This was sensitive to most pre emergent herbicides apart from napropamide (Devrinol®) and oxyfluorfen (Goal®).

Post emergent group A and K herbicides, flumetsulam (Broadstrike®), 2,4-DB, Clopyralid (Lontrel®) and glyphosate were well tolerated. Group C herbicides were generally damaging apart from normal rates of pyridate (Tough®).

Kunzea The *Kunzea* species were relatively tolerant of pre emergent applications of imazethapyr (Spinnaker®), group D herbicides, napropamide (Devrinol®) and oxyfluorfen (Goal®).

K. ericafolia was generally less tolerant than *K. baxteri* to both pre and post emergent herbicides.

K. baxteri were generally tolerant to group A herbicides apart from high rates of fenoxaprop ethyl (Wildcat®). *K. ericafolia* on the other hand was severely damaged by sethoxydim (Sertin®) and only marginally tolerant of fluazifop (Fusilade®). Group B and C herbicides were generally damaging. Other groups had variable responses.

Eucalyptus Half of the species failed to establish in sufficient numbers for analysis in the pre emergent trial. The remaining six species were tolerant of chlorthal (Dacthal®) and five of the six species showed some tolerance to chlorsulfuron (Glean®), triasulfuron (Logran®), napropamide (Devrinol®) and trifluralin. Group C herbicides were very damaging.

The post emergent group A herbicides were generally well tolerated by the 14 species tested. Odd species were damaged by the high rate of diclofop methyl (Hoegrass®), sethoxydim (Sertin®) and fenoxaprop ethyl (Wildcat®). They generally tolerated normal rates of flumetsulam (Broadstrike®), metosulam (Eclipse®), triasulfuron (Logran®) and imazethapyr (Spinnaker®) from group B, normal rates of linuron and pyridate (Tough®) from group C, group I herbicides (apart form fluroxypyr (Starane®), group K herbicides, oxyfluorfen (Goal®), 2,2-DPA (Agripon®), glyphosate, glufosinate (Basta®). and diflufenican (Brodal®). Group L herbicides were generally damaging.

Melaleuca The *Melaleuca* species had similar tolerances to the eucalypts with napropamide (Devrinol®) being generally safest overall followed by chlorthal (Dacthal®), trifluralin and chlorsulfuron (Glean®). The group C herbicides were very damaging.

Post emergent applications of the group A herbicides were well tolerated by this genus apart from a few species that were sensitive to fenoxaprop ethyl (Wildcat®). Within the group B herbicides they tolerated normal rates flumetsulam (Broadstrike®), metosulam (Eclipse®) and triasulfuron (Logran®). Clopyralid (Lontrel®) was the only group I herbicide tolerated by all species. Normal rates of group K, 2,2-DPA (Agripon®), glyphosate and glufosinate (Basta®) were also well tolerated.

The group C and L herbicides were generally damaging.

DISCUSSION

When this trial was planned it was hoped that some herbicides would be generally tolerated at the genus level. In many cases there has been one or two species that have been severely damaged by herbicides that were generally tolerated by other species in the same genus. This makes generalisation of results to other species difficult and potentially dangerous. However, given that it is unlikely that all herbicides will be rigorously tested on all native species a few generalisations need to be made to reduce the risk of damage.

Pre emergence weed control Some species such as *Banksia media* tolerate a wide range of herbicides whilst others like *Agonis* and *Hakea* species tolerate very few. Reclamation of degraded vegetation using pre emergent herbicides is likely to lead to a species shift that may need to be remedied with other strategies such as supplemental planting.

Pre emergence napropamide (Devrinol®) was tolerated by 20 species and chlorthal (Dacthal®) by 17 of the 26 species tested. Chlorthal (Dacthal®) controls a wide range of weeds but tends to be weak on weeds from the Brassicaceae (radish, turnip and mustard) family. Napropamide (Devrinol®) has a narrower weed spectrum. Both herbicides are quite expensive. Trifluralin was the next most selective herbicide. This was tolerated by 12 species and has a narrow weed spectrum of annual grasses and wireweed. Triasulfuron (Logran®), imazethapyr (Spinnaker®) and Chlorsulfuron (Glean®) were tolerated by 10, 8 and 7 species and severely damaged 13, 7 and 9 species respectively. All three have a wide weed spectrum and are considerably cheaper than

chlorthal (Dacthal®). In some reclamation situations, price and survival may be more important than maximum growth.

Post emergence weed control Fluazifop (Fusilade®) is the preferred grass selective herbicide because it well tolerated at 4 times normal use rates by a wide range of native species has a wider weed spectrum than diclofop methyl (Hoegrass®) or tralkoxydim (Achieve®). Haloxyfop (Verdict®) was tolerated only slightly less than fluazifop (Fusilade®) but does have the advantage of having action on the weedy *Erodium* spp. which often occurs in degraded bush.

Normal rates of glyphosate applied post emergence were also well tolerated in this experiment. At 225 g a.i./ha 34 species showed good tolerance and at 900 g a.i./ha 25 species showed good tolerance.

Triasulfuron (Logran®) and Imazethapyr (Spinnaker®) were also tolerated by a wide range of species and have a wide weed spectrum including many of the common bushland weeds. At normal use rates 27 species tolerated triasulfuron (Logran®) and none were severely damaged. 23 species tolerated Imazethapyr (Spinnaker®), but it killed 4 of the species tested. About half of the tolerant species were damaged at four times normal use rates of both herbicides.

2,2-DPA (Agripon®) is also worthy of mention because of its action on grasses and the bulbous weed species such as Watsonia that often invades disturbed bushland. It was tolerated by 36 of the species tested at the 3700 g a.i./ha rate.

For specific weeds in specific communities the Tables can be used to determine appropriate herbicides for field testing. For example, to control Wild Radish in *Agonis* communities, metosulam (Eclipse®) or 2,4-D amine may be chosen as appropriate post emergence products.

CONCLUSIONS

The aim of this work was to formulate some general weed control strategies for testing on native plants grown from seed or regenerating naturally from the seed bank. Chlorthal (Dacthal®) applied pre emergence was the most selective herbicide with a wide spectrum of weeds controlled. This would probably need a follow up treatment about 6-8 weeks later to control brassica weeds and late germinating grasses. Triasulfuron (Logran®) or imazethapyr (Spinnaker®) could be used to control small Brassica weeds, a range of other weeds and extend the length of pre emergent weed control. For larger Brassica weeds metosulam (Eclipse®) is probably a better choice and more selective. Fluazifop (Fusilade®) or haloxyfop (Verdict®) could be used to control emerged grasses. Unfortunately both chlorthal (Dacthal®) and imazethapyr (Spinnaker®) are quite expensive which is likely to reduce their use. In these cases chlorsulfuron (Glean®) or triasulfuron (Logran®) are worthy of consideration as the pre emergence treatment followed by metosulam (Eclipse®) for Brassica weed control. This would cost $10-$22/ha compared to over $300/ha for the chlorthal (Dacthal®) followed by imazethapyr (Spinnaker®). It would also be less selective in many cases.

For regenerating disturbed bush and degraded roadside vegetation the selectivity of glyphosate at normal rates demonstrated in this experiment is worthy of further investigation. At 225-450 g a.i./ha many of the common bushland weeds would be controlled or suppressed for less than $6 ha^{-1}. In addition many authorities already spray the road shoulder and drain with high rates of glyphosate and it would be a relatively simple task to add an extra nozzle to deliver a low rate of glyphosate to the vegetation beyond the drain. This may prevent or reduce weed establishment in the susceptible transition zone between the disturbed area and the undisturbed bush. Annual applications may help to reduce the rate of spread of some of our most serious roadside weeds such as the Bridal Creeper, Veldt grass, African Love Grass, Wild Oats and Phalaris.

I hope that this work will help others plan field trials for their particular set of species.

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Table 1. The tolerance of various native plant species to pre emergent herbicides.

Herbicide Active ingredient (Product) {Group)}	Rate (mL or g/ha of product)	*Agonis flexuosa*	*Agonis hypericifolia*	*Agonis parviceps*	*Allocasuarina huegeliana*	*Banksia baxteri*	*Banksia coccinea*	*Banksia media*	*Beaufortia sparsa*	*Bossiaea linophylla*	*Calothamnus quadrifidus*	*Dryandra formosa*	*Hakea laurina*	*Kunzea baxteri*	*Kunzea ericifolia*	*Eucalyptus annulata*	*Eucalyptus gomphocephala*	*Eucalyptus macrandra*	*Eucalyptus occidentalis*	*Eucalyptus platypus*	*Eucalyptus talyuberlup*	*Melaleuca acuminata*	*Melaleuca cuticularis*	*Melaleuca hamulosa*	*Melaleuca scabra*	*Melaleuca thyoides*	*Melaleuca uncinata*
Chlorsulfuron 75%	10	X	?	X	?	X	ok	?	X	ok	?	X	?	X	X	?	?	ok	X	ok	ok	?	?	ok	X	ok	?
(Glean®) {B}	40	X	X	X	?	X	X	?	X	X	X	X	X	X	X	X	X	?	X	?	?	X	?	X	X	X	X
Imazethapyr 24%	500	X	?	X	?	ok	ok	ok	?	?	ok	ok	X	ok	ok	?	X	?	?	?	X	?	?	ok	ok	X	X
(Spinnaker®) {B}	2000	X	X	X	?	X	X	X	X	?	X	X	X	X	?	X	X	?	?	?	X	X	?	?	?	X	X
Sulfometuron	50	X	X	X	X	ok	X	?	X	X	X	?	X	X	X	?	X	X	X	X	X	X	ok	X	X	?	X
(Oust®) {B}	200	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Triasulfuron 75%	40	X	X	X	X	ok	ok	ok	ok	X	X	ok	X	?	X	?	?	ok	X	ok	ok	X	X	X	ok	X	ok
(Logran®) {B}	160	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Linuron 50%	2000	X	X	X	X	X	X	ok	X	X	X	X	X	X	X	X	X	X	X	X	ok	X	X	X	X	X	X
{C}	8000	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Atrazine 90%	1000	X	X	X	X	?	X	ok	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
{C}	4000	X	X	X	X	X	X	ok	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cyanazine 50%	2000	X	X	X	X	X	?	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
(Bladex®) {C}	8000	X	X	X	X	X	X	?	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Diuron 90%	500	X	X	X	ok	ok	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
{C}	2000	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Metribuzin 75%	250	X	X	X	X	ok	X	?	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
(Lexone®) {C}	1000	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Simazine 90%	1000	X	X	X	X	X	X	ok	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
{C}	4000	X	X	X	X	X	X	ok	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chlorthal 75%	5000	?	ok	X	?	ok	X	ok	X	ok	ok	ok	X	?	ok	ok	ok	ok	ok	ok	ok	?	ok	?	ok	ok	ok
(Dacthal®) {D}	20000	X	X	X	X	X	X	ok	X	ok	X	X	X	?	X	?	ok	ok	ok	ok	ok	?	?	?	ok	X	ok
Oryzalin 500 g/L	2000	X	X	X	X	X	X	?	X	ok	X	ok	X	ok	ok	?	X	?	ok	ok	ok	X	ok	X	ok	X	ok
(Surflan®) {D}	8000	X	X	X	X	X	X	?	X	ok	X	X	X	?	X	?	X	?	?	?	?	X	?	X	?	X	?
Trifluralin 40%	2000	ok	?	X	?	?	?	ok	?	ok	ok	X	?	ok	ok	?	ok	ok	?	ok	X	X	ok	?	ok	?	ok
{D}	8000	X	X	X	X	X	X	?	?	X	X	X	?	ok	X	X	X	X	X	X	X	X	X	X	X	X	ok
Oxyfluorfen 24%	250	X	?	X	?	?	ok	ok	X	X	X	ok	ok	ok	ok	X	X	ok	?	ok	ok	?	ok	X	X	X	X
(Goal®) {G}	1000	X	X	X	?	?	X	ok	X	X	X	X	ok	X	X	?	X	?	?	X	ok	X	X	X	X	X	X
Metolachlor 72%	1000	X	X	X	X	X	ok	ok	X	ok	ok	X	?	X	X	X	X	X	?	X	X	X	?	X	X	X	ok
(Dual®) {K}	4000	X	X	X	X	X	X	ok	X	?	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Napropamide 50%	2000	?	?	ok	ok	ok	X	ok	ok	X	ok	ok	ok	ok	ok	?	X	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
(Devrinol®) {K}	8000	?	?	ok	?	?	X	ok	X	X	X	ok	X	X	?	X	X	?	ok	ok	ok	X	X	X	X	X	?
Propachlor 48%	5000	X	?	?	X	X	X	ok	X	X	?	X	X	X	X	?	X	ok	X	X	ok	?	?	X	X	?	ok
(Ramrod®) {K}	20000	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Propyzamide 50%	1000	X	X	ok	ok	ok	ok	ok	X	X	X	ok	X	X	X	ok	X	ok	X	X	ok	X	ok	X	X	X	X
(Kerb®) {K}	4000	X	X	X	X	ok	X	ok	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chorthal + Linuron	5000	?	X	X	X	X	X	ok	X	X	ok	X	?	?	?	?	ok	ok	ok	ok	ok	X	X	X	X	X	X
(Shamrox®) {D,C}	20000	X	X	X	X	X	X	X	X	X	X	X	X	X	X	?	X	?	X	X	ok	X	X	X	X	X	X
Chlorthal+Propachlor	5000	?	?	X	X	X	ok	ok	?	ok	X	ok	X	X	ok	X	X	ok	ok	ok	ok	X	ok	X	?	X	X
(Prothal®) {D,K}	20000	X	X	X	X	X	X	ok	X	?	X	X	X	X	X	X	X	X	X	X	?	X	?	X	?	X	X

X = Don't use – less than 50% growth and/or survival.
? = Further research required – 50-75% growth and survival.
ok = adequate tolerance displayed in pots – greater than 75% growth and survival.

Table 2. The tolerance of various native plant species to post emergent herbicides.

Herbicide Active ingredient (Product) {Group)}	Rate (mL or g/ha of product)	*Acacia acuminata*	*Acacia cyclops*	*Acacia pulchella*	*Acacia saligna*	*Agonis flexuosa*	*Agonis hypericifolia*	*Agonis parviceps*	*Allocasuarina huegeliana*	*Banksia baxteri*	*Banksia coccinea*	*Banksia media*	*Beaufortia sparsa*	*Bossiaea linophylla*	*Callistemon phoniceus*	*Calothamnus quadrifidus*	*Dryandra formosa*	*Hakea laurina*	*Kunzea baxteri*	*Kunzea ericifolia*	*Eucalyptus amulata*	*Eucalyptus decipiens*	*Eucalyptus forrestiana*	*Eucalyptus gomphocephala*	*Eucalyptus lehmannii*	*Eucalyptus loxophleba*	*Eucalyptus macrandra*	*Eucalyptus marginata*	*Eucalyptus megacornuta*	*Eucalyptus occidentalis*	*Eucalyptus platypus*	*Eucalyptus staeri*	*Eucalyptus talyuberlup*	*Eucalyptus tetragona*	*Melaleuca acuminata*	*Melaleuca cuticularis*	*Melaleuca hamulosa*	*Melaleuca scabra*	*Melaleuca thyoides*	*Melaleuca uncinata*
Diclofop 37% {A}	4000	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	X	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
Fenoxaprop 10% {A}	2000	ok	ok	ok	ok	X	X	X	ok	ok	ok	ok	X	?	X	X	X	?	X	X	ok	X	X	ok	X	ok	ok	ok	ok	ok	X	?	ok	ok	ok	ok	X	X	?	X
Fluazifop 21.2% {A}	1000	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	?	ok	?	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	?	?	ok	ok
Haloxyfop 13% {A}	400	ok	ok	X	ok	ok	ok	ok	ok	ok	ok	ok	ok	X	ok	?	?	ok	?	?	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
Sethoxydim 18.6% {A}	2000	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	X	ok	ok	?	X	ok	ok	X	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
(Tralkoxydim 40% {A}	2000	ok	X	X	X	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	?	?	ok	ok	ok	ok	ok	?	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
Chlorsulfuron 75%	20	?	X	X	X	X	?	?	ok	ok	ok	ok	X	?	?	X	?	?	X	X	ok	ok	ok	ok	?	?	ok	?	ok	ok	ok	X	ok	X	ok	X	?	?	?
(Glean®) {B}	80	?	X	X	X	X	X	X	?	ok	ok	ok	X	?	X	X	X	?	X	X	X	X	ok	X	X	X	X	?	X	?	X	?	X	X	X	?	X	X	X	X
Flumetsulam 80%	25	ok	ok	ok	ok	ok	?	ok	ok	ok	ok	ok	?	ok	ok	?	ok	ok	?	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	?	ok	?	ok	ok	?	ok	ok	ok	ok
(Broadstrike®) {B}	100	ok	ok	ok	ok	ok	X	?	ok	ok	ok	ok	?	ok	ok	?	?	ok	X	?	ok	ok	ok	ok	ok	ok	ok	ok	?	?	?	ok	?	?	?	ok	ok	?	?	ok	?
Imazethapyr 24%	500	ok	ok	ok	ok	?	?	?	?	ok	ok	ok	?	ok	ok	X	ok	?	X	?	ok	ok	ok	ok	ok	ok	ok	ok	?	ok	ok	ok	?	ok	ok	?	?	X	X	ok	?
(Spinnaker®) {B}	2000	ok	ok	?	ok	X	X	X	?	ok	ok	ok	?	X	ok	X	?	X	X	X	?	?	ok	ok	?	ok	ok	?	X	?	ok	?	ok	?	?	?	X	X	?	?
Metosulam 71%	5	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	?	ok	?	?	?	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
(Eclipse®) {B}	20	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	?	ok	ok	?	ok	?	?	?	ok	ok	X	ok	ok	?	ok	?	ok	ok	ok	ok	?	ok	?	X	ok	?	?	ok	?
Metsulfuron 60%	5	ok	ok	ok	ok	ok	?	X	ok	?	?	?	ok	?	ok	X	?	?	?	?	ok	ok	ok	ok	ok	?	ok	?	ok	ok	ok	X	ok	X	X	ok	X	?	?	?
(Ally®) {B}	20	ok	ok	ok	ok	X	X	X	?	?	X	?	X	?	X	X	X	X	X	X	X	X	?	X	X	X	X	?	X	?	X	X	X	X	X	?	X	X	X	X
Sulfometuron	50	?	X	ok	ok	X	X	X	ok	ok	ok	ok	ok	?	?	?	ok	ok	?	X	X	ok	?	?	?	?	X	?	?	?	?	?	?	X	X	ok	X	X	?	?
(Oust®) {B}	200	?	X	X	X	X	X	X	X	X	?	?	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	?	X	X	X	X
Triasulfuron 75%	40	ok	ok	ok	ok	?	?	?	ok	?	ok	ok	ok	ok	ok	?	ok	?	ok	?	ok	ok	ok	ok	?	ok	ok	?	ok	ok	ok	?	ok	?	ok	ok	ok	ok	?	ok
(Logran®) {B}	160	ok	ok	ok	ok	X	?	?	X	?	ok	ok	X	?	?	X	ok	?	?	X	ok	ok	ok	?	?	ok	ok	?	X	?	X	?	ok	X	?	ok	X	?	?	?
Atrazine 90% {C}	4000	X	ok	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	?	X	X	X	X	X	X	X	X
Bromoxynil 20% {C}	4000	?	ok	?	ok	X	ok	ok	?	ok	X	X	X	?	ok	X	X	X	X	X	X	X	X	ok	X	X	X	X	X	X	X	ok	?	X	X	X	ok	X	X	X	X
Cyanazine 50% {C}	8000	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	?	X	X	X	?	X	X	X	X	X	X	X	X
Diuron 90% {C}	2000	X	ok	X	ok	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	?	X	X	X	X	X	X	X	X	X	X	X	X
Linuron 50% {C}	4000	ok	X	X	X	X	X	X	X	ok	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	ok	ok	X	X	?	X	X	X	X	X	X	X
Methabenzthiazuron	1000	ok	ok	ok	ok	X	X	ok	ok	ok	X	ok	X	?	?	X	X	?	?	X	ok	ok	ok	ok	ok	X	ok	?	ok	ok	ok	?	ok	?	X	ok	?	X	?	X
70% Tribunil® {C}	4000	ok	ok	ok	ok	X	?	?	X	X	X	ok	X	X	X	X	X	X	X	X	ok	X	X	X	ok	X	X	X	?	ok	ok	?	?	ok	X	X	ok	X	X	X	X
Metribuzin 75% {C}	1000	ok	?	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	?	X	X	X	X	X	X	X	X
Pyridate 45% {C}	8000	ok	X	?	?	X	?	ok	X	X	X	X	X	ok	X	?	X	?	X	?	ok	ok	ok	ok	ok	X	X	ok	ok	ok	ok	?	X	ok	X	ok	X	ok	X	ok
Simazine 50%	2000	X	ok	X	X	X	X	ok	X	X	ok	ok	X	X	X	X	ok	X	X	X	X	X	X	ok	ok	X	X	?	X	?	X	?	X	X	X	ok	X	X	X	X
{C}	8000	X	X	X	X	X	X	X	X	?	X	ok	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	?	X	X	X	?	X	X	X	X	X	X	X	X
Terbutryn 50% {C}	2000	ok	ok	X	?	X	X	X	X	ok	X	ok	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	?	X	X	X	ok	X	X	X	X
Diflufenican 50%	200	ok	X	X	ok	X	X	X	ok	ok	ok	ok	X	?	X	X	?	?	X	X	ok	ok	ok	ok	ok	X	ok	?	ok	ok	ok	?	ok	X	?	ok	ok	X	X	X
(Brodal®) {F}	800	X	X	X	?	X	X	X	X	?	X	ok	X	X	X	X	X	X	X	X	X	?	X	ok	X	X	X	X	ok	ok	X	?	ok	X	X	ok	ok	?	ok	X
Oxyfluorfen 24%	250	ok	?	X	ok	ok	X	ok	?	ok	ok	ok	ok	X	?	X	?	?	ok	?	ok	ok	ok	ok	ok	?	ok	ok	ok	ok	?	ok	?	X	ok	ok	?	X	ok	ok
(Goal®) {G}	1000	X	X	X	?	?	X	X	X	ok	ok	ok	ok	X	X	X	?	?	?	?	ok	ok	ok	ok	ok	ok	ok	?	X	ok	ok	?	?	X	?	ok	?	X	X	X
2,4-D Amine 50%	1000	ok	ok	ok	ok	ok	ok	ok	?	ok	X	ok	?	ok	ok	X	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	?	X	ok	ok
{I}	4000	ok	X	X	ok	ok	ok	ok	X	ok	X	ok	?	ok	X	X	ok	?	ok	?	?	ok	ok	?	X	?	ok	ok	ok	ok	?	ok	X	X	X	X	X	X	X	X
2,4-DB 50% {I}	8000	ok	?	ok	ok	ok	ok	X	X	ok	ok	ok	ok	?	ok	?	ok	ok	ok	X	ok	ok	ok	ok	ok	ok	ok	?	ok	ok	?	ok	ok	X	X	?	X	X	X	X
Chlopyralid	250	X	X	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	?	ok	ok	?	ok	ok	ok	ok	ok	?	ok	ok	ok	ok	?	ok	ok	ok	ok	ok	ok	ok	ok	ok
(Lontrel®) {I}	1000	X	X	?	?	ok	ok	ok	ok	ok	ok	ok	ok	X	ok	ok	?	ok	ok	X	ok	ok	X	ok	ok	ok	ok	?	ok	ok	ok	?	ok	ok	ok	ok	ok	ok	ok	ok
Dicamba 20% {I}	2000	X	ok	X	ok	?	X	X	ok	X	X	?	X	X	X	X	?	?	?	X	X	X	ok	ok	X	ok	X	?	X	?	?	?	ok	X	X	X	X	X	X	X
Fluroxypyr 20% {I}	4000	?	?	?	?	X	X	X	X	X	X	X	ok	?	?	X	X	?	X	X	?	X	X	?	?	?	?	?	X	X	?	?	X	X	X	X	X	X	X	X
MCPA 50%	1000	ok	?	X	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	?	X	ok	ok	ok	?	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	X	ok	?	X	X	ok	X	ok
{I}	4000	?	?	X	?	ok	ok	ok	X	?	X	?	?	X	X	X	X	X	X	X	ok	ok	ok	ok	ok	?	ok	ok	ok	ok	ok	ok	ok	X	X	X	X	X	X	X
2,2-DPA 74%	5000	ok	ok	?	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	?	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	?	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
(Agripon®) {J}	2000	X	X	X	?	?	?	ok	ok	ok	ok	X	ok	X	ok	X	?	X	X	?	ok	ok	ok	ok	ok	?	ok	ok	ok	ok	ok	?	ok	X	ok	ok	ok	X	ok	X
Metolachlor 72% {K}	4000	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	X	?	ok	ok	?	ok	ok	ok	ok	ok	ok	ok	ok	?	ok	ok	ok	ok	X	ok	ok	X	ok	ok
Propyzamide 50%	1000	X	ok	ok	ok	ok	ok	ok	ok	ok	X	ok	ok	ok	ok	?	ok	ok	ok	?	ok	ok	ok	ok	ok	ok	ok	ok	?	?	ok	ok	ok	ok	?	ok	ok	ok	ok	ok
(Kerb®) {K}	4000	X	?	?	?	ok	ok	ok	ok	ok	X	ok	ok	ok	ok	?	ok	ok	ok	?	ok	ok	?	ok	ok	ok	ok	?	?	ok	ok	ok	X	ok	ok	ok	ok	X	ok	ok
Diquat 20% {L}	4000	?	?	?	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Paraquat 20% {L}	4000	X	ok	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Glyphosate 45%	500	ok	ok	ok	ok	ok	ok	?	ok	ok	ok	ok	ok	ok	ok	X	?	ok	ok	?	ok	ok	ok	ok	ok	ok	ok	ok	ok	?	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
{M}	2000	ok	?	?	?	ok	ok	?	ok	ok	ok	ok	ok	X	ok	X	?	ok	?	?	ok	ok	ok	ok	X	?	ok	ok	ok	ok	?	ok	ok	ok	ok	ok	?	ok	ok	ok
Glufosinate 20%	1000	ok	?	?	ok	?	?	ok	ok	?	ok	ok	ok	?	ok	?	ok	?	X	?	ok	ok	ok	ok	?	ok	ok	ok	?	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
(Basta®) {N}	4000	X	X	?	X	?	X	ok	ok	?	X	?	X	X	?	X	?	X	X	X	ok	X	?	X	X	X	?	?	?	ok	ok	?	X	?	ok	ok	ok	X	ok	X

X = Don't use – less than 50% growth and/or survival.
? = Further research required – 50-75% growth and survival.
ok = adequate tolerance displayed in pots – greater than 75% growth and survival.