Project Title	Control of problem weeds in Hardy Nursery Stock
Project number:	HNS 139
Project leader:	John Atwood, ADAS UK Ltd
Report:	2nd annual report, September 2007
Previous report	September 2006
Key staff:	John Atwood, Project leader Sarah Cook, Screening experiments Jon Carpinini, Field experiments
Location of project:	ADAS Boxworth ADAS Terrington Nursery site not disclosed, Norfolk Goregate Ltd.,Dereham, Norfolk, NR19 2AW Frank P Matthews, Tenbury Wells, Worcs WR15 8TH
Project coordinator:	Alastair Hazel, Darby Nursery Stock Ltd. Methwold, Norfolk, IP26 4PW. Nick Dunn, Frank P Matthews Ltd. Tenbury Wells, Worcs, WR15 8TH
Date project commenced:	1 July 2005
Date completion due:	30 June 2009

Key words:

2,4-D amine, 212 H, 213H, A9950A, adjuvant, Agroxone, amitrol, Aramo, Artist, Atlantis WG, BAS 635H, ,*Berberis darwinii,* bindweed, *Buddleja davidii* 'Royal Red', Butisan S, *Calistegia sepia, Cardamine corymbosa, Cardamine flexuosa, Cardamine hirsuta,* carfentrazone-ethyl, Casoron G, *Cerastium fontanum,* Centium, Challenge, *Chamaecyparis lawsoniana* 'Elwoods Gold', chlorotoluron, Cleancrop Unival, clomazone, cockspur grass, creeping yellow cress, Crystal, cycloxydim, dicamba, dichlobenil, dichlorprop-p,dimethenamid-p Dual Gold, *Echinochloa crus-galli, Epilobium ciliatum, Equisetum arvense,* Falcon, fallow, false hedge bindweed, flazasulfuron, Flexidor 125, flexuous bittercress, florasulam, fluazifop p butyl, flufenacet, fluroxypyr, Fusilade Max, glufosinate ammonium, Glyfos, glyphosate, Goal, goat willow, Goltix WG, grey willow, groundsel, hairy bittercress, hardy nursery stock,Headland Link, Headland Fortune, Headland Guard 2000, Headland Tolerate, *Hebe* 'Margaret', herbicides, Herboxone, horsetail, I.T. Dicamba, Iodosulfuron-methyl-sodium, isoxaben, Kerb Flo, Laser, *Lavandula* 'Princess Blue', lenacil, *Lonicera* 'Halliana', *Malus domestica* 'Reverend W Wilks', *Malus domestica* 'Grenadier', marestail, MCPA, metamitron, metazachlor, metosulam, metribuzin, metsulfuron-methyl, common mouse-ear, New Zealand bittercress, nicosulfuron, ornamentals, oxadiazon, oxyfluorfen, pearlwort, pendimethalin, *Philadelphus* 'Manteau d'hermine', *Potentilla fruticosa* 'Summer Sorbet', propaquizafop, propyzamide, Prospect, *Prunus* 'Amanagowa', *Prunus insititia* 'Merryweather Damson' *Pyracantha* 'Red Column', *Pyrus communis* 'Concorde', Ronstar 2G, Ronstar Liquid, *Rorripa sylvestris, Rosmarinus* 'Miss Jessop', s – metolachlor, *Sagina procumbens, Salix caprea, Salix cinerea,* Samson, *Senecio vulgaris,* Shark, Skirmish, *Sorbus intermedia, Spiraea* 'Snowmound', Starane 2, Starane XL, Stomp 400 SC, Springbok, tepraloxydim, Terano, terbuthylazine, thifensulfuron-methyl, triclopyr, Venzar Flowable, *Veronica* 'Ulster Dwarf Blue', weed control, Weedazol-TL, willowherb

The results and conclusions in this report are based on a series of experiments conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

AUTHENTICATION FOR HNS 139

We declare that this work was done under my supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

John Atwood
Senior Horticultural Consultant
ADAS UK Ltd

Signature .... Date ....

Report authorised by:

Dr W E Parker
Horticulture Research & Consultancy Manager
ADAS UK Ltd

Signature .... Date ....

TABLE OF CONTENTS

Grower Summary

Headline

- A range of herbicide products have been assessed for their efficacy in controlling persistent and perennial weeds in hardy nursery stock and the most successful so far have been identified.

Background and expected deliverables

A number of weed species have proved difficult to control in either container-grown or field-grown nursery stock crops in recent years.

The problem weeds include non-indigenous, recent introductions such as New Zealand bittercress (*Cardamine corymbosa*) and flexuous bittercress (*Cardamine flexuosa)* in container-grown crops. Pearlwort (*Sagina procumbens*) is an increasing problem in container-grown nursery stock with growers reporting more difficulty in control with existing herbicides. Other annual weeds such as groundsel (*Senecio vulgaris*), common mouse-ear chickweed (*Cerastium fontanum*), willowherb (*Epilobium* spp.) and sallows (*Salix caprea, S. cinerea*) are still commonly found in container-grown stock because of resistance to commonly used herbicides or timing issues.

Although there has been a past programme of weed control research on container-grown nursery stock carried out for the HDC, some of the weeds in this study (e.g New Zealand and flexuous bittercress) have not been previously investigated in detail. A further range of herbicides has become available since the last screening studies were conducted. It is hoped that some of these new herbicides tested in this study can be developed to provide improved control of these weeds, which are currently difficult to control. In this project, the most promising herbicides are currently being tested for crop safety on a range of container-grown hardy nursery stock.

Cockspur grass (*Echinochloa crus-galli*) is another non-indigenous species causing problems in field-grown nursery stock in the southern counties. It can rapidly outshade field crops leading to loss of quality and difficulty in lifting. Once established it is difficult to remove by hoeing or mechanical cultivations. It is hoped to develop both residual herbicide treatments for summer applications and selective contact treatments for use in field grown tree crops.

Deep rooted perennial weeds such as creeping yellow cress (*Rorippa sylvestris*) and horsetail (*Equisetum arvense*) are long-standing problems in perennial nursery crops and can also cause problems in container standing beds and a wide range of other horticultural crops. Creeping yellow cress and horsetail are competitive with crops and the rhizomes can be spread with planting stock. The presence of such weeds on nurseries limits the availability of the land to be used for planting, forcing growers to seek alternative land or to limit rotations.

For these perennial weeds it is hoped to establish the best combination of treatments for control either in a pre-planting fallow or as 'directed' treatments within a tree crop. Some of the more promising treatments are being tested for crop safety within a crop of field grown tree rootstocks.

Summary of the project and main conclusions

Seedling weeds of container-grown nursery stock

A range of herbicides (Table 1) were tested on selected broad-leaved weeds (Table 2) grown in peat-based media at pre-emergence, 1-2 true leaf and 3-4 true leaf stages.

Table 1. Herbicides tested against seedling weeds of container-grown nursery stock

Treatment	Product	Active ingredient	Product application rate	Approval status
1.	Untreated control			
2.	Butisan S	metazachlor (500 g/L)	2.5 L/ha	LTA*
3.	Venzar Flowable	lenacil (440 g/L)	4.5 L/ha	LTA*
4.	Stomp 400 SC	pendimethalin (400 /L)	5.0 L/ha	LTA*
5.	Flexidor 125	isoxaben (125 g/L)	2.0 L/ha	Label
6.	Ronstar 2G	oxadiazon (2% w/w)	200.0 kg/ha	Label
7	Dual Gold	s – metolachlor 960 (g/L)	1.6 L/ha	Not in UK
8.	Skirmish	terbuthylazine + isoxaben (420 : 75 g/L)	1.0 L/ha	LTA*
9.	Terano	flufenacet + metosulam (60 : 2.5 % w/w)	0.75 kg/ha	Not in UK
10.	Goltix WG	metamitron (70 % w/w)	3.0 kg/ha	LTA*
11.	Flazasulfuron	flazasulfuron (25 % w/w)	0.2 L/ha	Not in UK
12.	212 H 50WP	Not disclosed	0.2 kg/ha	Not in UK
13.	213H 0.25% Granule	Not disclosed	64.0 kg/ha	Not in UK

*LTA = Long-Term Arrangements for Extension of Use.

Table 2. Broad leaved weed species tested

Weed Species	Common Name
Cardamine corymbosa	New Zealand bittercress
Cardamine flexuosa	flexuous bittercress
Cardamine hirsuta	hairy bittercress
Cerastium fontanum	common mouse-ear
Epilobium ciliatum	willowherb
Sagina procumbens	pearlwort
Salix caprea	goat willow
Salix cinerea	grey willow
Senecio vulgaris	groundsel

Two sets of experiments were conducted, one in summer 2006 and the other in autumn 2006. The autumn experiments excluded *Salix*. Results of the summer treatments were reported in the first annual report (2006). The results of the autumn treatments are provided in this report and the action points for growers are based on both sets of experiments.

New Zealand, **flexuous** and **hairy bittercress** were all controlled pre-emergence by most treatments including the industry standards Ronstar 2G and Flexidor 125. Stomp 400 SC, and Dual Gold were less effective and Goltix WG provided only very short-term control. Control at the post emergence stages for the New Zealand and flexuous bittercress was more difficult than with hairy bittercress with only Skirmish, Terano, 212H and Flazasulfuron providing control up to 3-4 leaves. By comparison, hairy bittercress proved easier to control post emergence with all the latter herbicides and Flexidor 125 and Ronstar 2G providing control up to 3-4 leaves. Venzar flowable controlled all bittercress species pre-emergence but only hairy bittercress post emergence (1-2 leaves), and with variable control of New Zealand bittercress.

Common mouse-ear chickweed was controlled pre-emergence by all treatments except Ronstar 2G and Goltix WG. Stomp 213H granules and Dual gold gave only partial control. Results were similar to the summer treatment except that the 213H granules were slightly less effective in the autumn. Venzar Flowable, Skirmish, Terano, Flazasulfuron and 212H 50WP also gave good control at all stages up to 3-4 true leaves and Flexidor 125 up to 1-2 true leaves. The other herbicides were relatively ineffective for post emergence control.

Willowherb was well controlled pre-emergence by all herbicides except Flexidor 125, Goltix WG and Stomp 400 SC. Venzar Flowable, Skirmish, and 212H WP also gave control up to 3-4 true leaves. Interestingly, Flazasulfuron gave excellent post-emergence control, slightly better than the pre-emergence control and similarly Stomp 400 SC, Flexidor 125 and Goltix WG had some early post-emergence activity in spite of poor pre-emergence control.

Pearlwort was completely controlled by all pre-emergence treatments, except Ronstar 2G and Goltix. At the 1-2 leaf stage, pearlwort was much more difficult to control, with only Skirmish, Terano, Flazasulfuron and 212H 50WP giving full control. Of these, only Skirmish and 212H 50WP worked quickly. Only Skirmish controlled seedlings with 3-4 true leavesf and control was slow, taking more than 21 days.

For **groundsel**, the most effective pre-emergence treatments were Butisan S, Venzar Flowable, Ronstar 2G, Terano, Goltix WG, Flazasulfuron and 212H 50WP, giving complete control at 21 days – similar results to the summer treatment. Dual Gold gave partial control. Stomp 400 SC, Flexidor 125, Skirmish and 213H granules were ineffective, although 213H granules had worked better in the summer. The most effective treatments at the 1-2 leaf stage were Venzar flowable, Ronstar 2G, Flazasulfuron and 212H 50WP. At the 3-4 leaf stage in the summer experiments, only Flazasulfuron gave rapid kill, while Venzar Flowable was effective but slower.

New Products

Of the **newer treatments** Terano, Skirmish, Flazasulfuron, 212H 50WP and 213H granules were all effective on most of the target weeds tested. However Skirmish, Flazasulfuron, and 212H 50WP are known to have a strong contact action so will only have potential for use during the dormant season on nursery stock. Dual Gold has potential for use as a summer spray treatment as an alternative or supplement to Flexidor 125. Compared with Flexidor 125 the control of willowherb was very good and control of groundsel was better, but there were some significant weaknesses in the control of bittercress and mouse ear. Unfortunately it has become clear that 213H granules will not be introduced into the UK market, so work on this product has ceased.

Terano and Dual Gold were taken for further testing for phytotoxicity as a summer/autumn treatment on container grown nursery stock together with two new herbicides recently made available for trials, Springbok (metazachlor +dimethenamid-p (200 : 200 g/L) applied at 2.5 L/ha and A9950A (not disclosed) applied at 2.6 kg/ha. The initial observations on a range of container grown nursery stock (Table 3) indicate that Springbok, Terano and Dual Gold might be safe enough for summer use. Terano, however, caused slight damage to *Hebe* 'Margaret'. For all of these products, crop safety needs to be further established, for both growing and dormant season uses on container grown nursery stock.

Table 3 Nursery stock species used for phytotoxicity testing

Berberis darwinii	*Potentilla fruticosa* 'Summer Sorbet'
Buddleja davidii 'Royal Red'	*Pyracantha* 'Red Column'
Hebe 'Margaret'	*Rosmarinus* 'Miss Jessop'
Lavandula 'Princess Blue'	*Spiraea* 'Snowmound'
Lonicera 'Halliana'	*Chamaecyparis lawsoniana* 'Elwoods Gold'
Philadelphus 'Manteau d'hermine'	*Veronica* 'Ulster Dwarf Blue'.

Cockspur grass experiment

A range of herbicides (Table 4) were tested on two strains of cockspur grass gown in soil media at pre-emergence, 3-4 true leaves, and the 6-10 true leaf stage:

Table 4. Herbicides used in cockspur grass control experiment

Treatment	Product	Active ingredient	Product application rate	Approval status (Field grown HNS)	Growth stages for treatment
1.	Untreated control				
2.	Butisan S	metazachlor (500 g/L)	2.5 L/ha	Label	Pre,3-4
3.	Venzar Flowable	lenacil (440 g/L)	4.5 L/ha	LTA*	Pre,3-4
4.	Stomp 400 SC	pendimethalin (400 g/L)	5.0 L/ha	LTA*	Pre,3-4
5.	Samson	nicosulfuron (40 g/L)	1.5 L/ha	LTA*	Pre,3-4, 6-10
6.	Kerb Flo	propyzamide (500 g/L)	4.2 L/ha	Label	Pre,3-4, 6-10
7.	Artist	flufenacet + metribuzin (24 : 17.5 % w/w)	2.5 kg/ha	LTA*	Pre,3-4
8	Crystal	pendimethalin + flufenacet (60 : 300 g/L)	4.0 L/ha	LTA*	Pre,3-4
9.	Atlantis WG	iodosulfuron-methyl-sodium +metsulfuron-methyl (0.6 : 3 % w/w)	0.4 kg/ha	LTA*	Pre,3-4,6-10
10.	Headland Tolerate	chlorotoluron (500 g/L)	7.0 L/ha	LTA*	Pre,3-4, 6-10
11.	Dual Gold	s – metolachlor (960 g/L)	1.6 L/ha	Not in UK	Pre,3-4, 6-10
12.	Laser + Actipron	cycloxydim (200 g/L) adjuvant oil	2.25 L/ha 0.8%	SOLA	3-4, 6-10
13.	Fusilade Max	fluazifop p butyl (125 g/L)	3.0 L/ha	SOLA	3-4, 6-10
14.	Aramo	tepraloxydim (50 g/L)	1.5 L/ha	LTA*	3-4,6-10
15.	Falcon	propaquizafop (100 g/L)	1.5 L/ha	LTA*	3-4,6-10

*LTA = Long-Term Arrangements for Extension of Use

For pre-emergence control of cockspur grass, Butisan S, Stomp 400 SC, Kerb Flo, Artist, Crystal and Dual gold were all very effective for both strains tested in pot-raised-seed experiments.

For post emergence control all the specific graminicides tested had good activity. All provided complete control of 3-4 true leaf plants at both timings. Laser was slightly more effective at controlling the 10 leaf plants in the summer compared with the other graminicides, but all provided complete control in the autumn.

In the field experiments Butisan S, Artist, Crystal and Dual Gold were tested as residual herbicides, and Laser as a selective contact herbicide, in a range of tree crops. A further herbicide was made available for trials, Springbok (metazachlor +dimethenamid-p (200 : 200 g/L)), and was included as a treatment. Tree species used for phytotoxicity testing were *Malus domestica* 'Reverend W Wilks', *Malus domestica* 'Grenadier', *Prunus* 'Amanagowa', *Prunus insititia* 'Merryweather Damson' (crop failed to establish), *Pyrus communis* 'Concorde', *Sorbus intermedia*.

The field experiment confirmed the results obtained in the pot experiments. Butisan S, Artist and Dual Gold were particularly effective giving complete residual control of a high population of cockspur grass. Crystal and Springbok were also effective but with a slightly lower level of control. An application of Laser + adjuvant oil gave complete post-emergence control of plants, some of which had 10 tillers and were 0.6 m high.

Artist had some contact action, and caused marginal scorch on all subjects. Other treatments appeared safe in this experiment (but Butisan S is known to sometimes cause damage to soft growth).

Field horsetail experiment

A range of herbicides and adjuvant combinations were tested on a natural infestation of *Equisetum arvense* in a fallow situation. Two years of experiments on two sites were carried out. The first year's results were reported in the first annual report (2006), and the effect of treatment on re-growth was evaluated in 2007. Treatments are listed in Table 5.

Field horsetail proved difficult to control, with only the Weedazol-TL and Agroxone (MCPA) treatments giving effective control in the season of treatment. Weedazol-TL was the only treatment to give a significant reduction in horsetail re-growth the following year. Although Agroxone gave a very good knockdown and control in the season of treatment, there was no significant effect in the following year. The addition of Agroxone to Weedazole-TL was counterproductive in terms of control. None of the other hormone herbicides tested in 2007 were effective when used alone, but when used in addition to Agroxone, immediate re-growth during the season was reduced.

Differences in adjuvant activity were not significant in 2006, but there were indications that Headland Fortune was the most effective and the use of this combination resulted in the least re-growth the following year.

Table 5. Herbicides treatments used in 2007 field horsetail control experiments

Treatment	Product	Active ingredient	Product application rate	Approval status (field-grown HNS)	Timing
1.	Untreated control				
2.	Weedazol-TL+ Headland Fortune	amitrol (225 g/L) + adjuvant	20.0 L/ha + 2.0 L/ha	LTA*	18/06/07
3.	Agroxone + Headland Fortune	MCPA (500 g/L) + adjuvant	6.0 L/ha + 2.0 L/ha	LTA*	18/06/07
4.	I.T. Dicamba + Headland Fortune	dicamba (480 g/L) + adjuvant	5.0 L/ha + 2.0 L/ha	LTA*	18/06/07
5.	Headland Link + Headland Fortune	dichlorprop-p (600 g/L) + adjuvant	2.4 L/ha + 2.0 L/ha	LTA*	18/06/07
6.	Agroxone + I.T. Dicamba + Headland Fortune	MCPA (500 g/L) + dicamba (480 g/L) + adjuvant	6.0 L/ha + 5.0 L/ha + 2.0 L/ha	LTA*	18/06/07
7.	Agroxone + I.T. Dicamba + Headland Link + Headland Fortune	MCPA (500 g/L) + dicamba (480 g/L) + dichlorprop-p (600 g/L) + adjuvant	7.0 L/ha + 5.0 L/ha + 2.4 L/ha + 2.0 L/ha	LTA*	18/06/07

*LTA = Long Term Arrangements for Extension of Use

Creeping yellow cress experiment

A range of herbicides and adjuvant combinations were tested on a natural infestation of creeping yellow cress in a fallow situation. Two years of experiments on two sites were carried out. The first year's results were reported in the first annual report (2006), and the effect of treatment on re-growth was evaluated in 2007. Treatments are listed in Table 6.

Table 6 Herbicides treatments used in 2007 creeping yellow cress control experiments

Treatment	Product	Active ingredient	Product rate	Approval status (field-grown HNS)	Timing
1.	Untreated control				
2.	Weedazole	amitrol (225 g/L)	20.0 L/ha	LTA*	2 May
3.	Cleancrop Unival	triclopyr (240 g/L)	6.0 L/ha	LTA*	2 May
4.	Herboxone	2,4 D (500 g/L)	3.3 L/ha	LTA*	2 May
5.	IT Dicamba	dicamba (480 g/L)	5 L/ha	LTA*	2 May
6.	Headland Link	dichlorprop-p (600 g/L)	2.4 L/ha	LTA*	2 May
7.	Herboxone + IT Dicamba + Unival	2,4 D (500 g/L) + dicamba (480 g/L) + triclopyr (240 g/L)	3.3 L/ha 5 L/ha 6.0 L/ha	LTA*	2 May
8.	Herboxone + I.T.Dicamba Headland Link	2,4 D (500 g/L) + dicamba (480 g/L) + dichlorprop-p (600 g/L)	3.3 L/ha 5 L/ha 2.4 L/ha	LTA*	2 May
9.	Cleancrop Unival + I.T.Dicamba + Headland Link	triclopyr (240 g/L) + dicamba (480 g/L) + dichlorprop-p (600 g/L)	6.0 L/ha 5 L/ha 2.4 L/ha	LTA*	2 May

*LTA = Long Term Arrangements for Extension of Use

Weedazol-TL, Glyfos, and Cleancrop Unival controlled creeping yellow cress during the 2006 treatment season. Cleancrop Unival was the only treatment to substantially reduce the re-growth in the following season although weedazole-TL also gave a good reduction. Similarly in 2007, Cleancrop Unival gave a rapid knockdown with no re-growth seen. Weedazole-TL was less effective in 2007, possibly due to a wetter season.

False hedge bindweed experiment

A range of herbicides and adjuvant combinations were tested on a natural infestation of false hedge bindweed in an abandoned *Malus* stoolbed. Two years of experiments on this site were carried out. The first year's results were reported in the first annual report (2006), and the effect of treatment on re-growth was evaluated in 2007. Treatments are listed in Table 7.

Table 7. Herbicides treatments used in 2007 false hedge bindweed control experiments

Treatment	Product	Active ingredient	Product rate	Approval status (Field grown HNS)	Timing
1.	Untreated control				
2.	Centium +	clomazone (360 g/L)+	0.33 L/ha	LTA*	19 July
	Roundup	glyphosate (360 g/L)	5 L/ha	Label	
3.	Centium	clomazone (360 g/L)	0.33 L/ha	Label	19 July
	Roundup	glyphosate (360 g/L)	5 L/ha	LTA*	13 Sept
4.	Herboxone +	2,4 D amine (500 g/L)+	3.3 L/ha	LTA*	19 July
	Roundup	glyphosate (360 g/L)	5 L/ha	Label	
5.	Herboxone	2,4 D amine (500 g/L)	3.3 L/ha	LTA*	19 July
	Roundup	glyphosate (360 g/L)	5 L/ha	Label	13 Sept
6.	IT.Dicamba+	dicamba (480 g/L) +	5 L/ha	LTA*	19 July
	Roundup	glyphosate (360 g/L)	5 L/ha	Label	
7.	IT Dicamba	dicamba (480 g/L)	5 L/ha	LTA*	19 July
	Roundup	glyphosate (360 g/L)	5 L/ha	Label	13 Sept
8.	Starane 2 +	fluroxypyr (200 g/L)+	2 L/ha	LTA*	19 July
	Roundup	glyphosate (360 g/L)		Label	
9.	Starane 2	fluroxypyr (200 g/L)	2 L/ha	LTA*	19 July
	Roundup	glyphosate (360 g/L)	5 L/ha	Label	13 Sept
10.	Herboxone +	2,4 D amine (500 g/L) +	6 L/ha +	LTA*	19 July
	IT Dicamba+	dicamba (480 g/L)+	5 L/ha +	LTA*	
	Starane 2 +	fluroxypyr (200 g/L)+	2 L/ha +	LTA*	
	Roundup	glyphosate (360 g/L)	5 L/ha	Label	
11.	Herboxone +	2,4 D amine (500 g/L) +	6 L/ha +	LTA*	19 July
	IT Dicamba+	dicamba (480 g/L)+	5 L/ha +	LTA*	
	Starane 2	fluroxypyr (200 g/L)	2 L/ha	LTA*	
	Roundup	glyphosate (360 g/L)	5 L/ha	Label	13 Sept

*LTA = Long term arrangement for the extension of use

False hedge bindweed also proved difficult to control. Whilst Herboxone (2,4-D), or I.T. Dicamba proved moderately effective during the treatment season, it was only the combination of I.T. Dicamba + Roundup that significantly reduced the re-growth the following year. The combination of July-applied hormone herbicides in a tank mix with Roundup have proved effective again in 2007, but it will be the re-growth in 2008 that will determine the most effective treatment.

A separate phytotoxicity experiment was conducted on newly planted tree rootstocks. When applied as directed sprays to the soil surface avoiding the tree foliage during July 2007 in plantings of *Malus domestica* 'M9', *Prunus* 'Colt', Quince 'C', and *Sorbus aucuparia*, none of the herbicides Herboxone, Agroxone, I.T. Dicamba, Headland Link, Cleancrop Unival, 212H 50WP, Terano, or Flazasulfuron caused visible phytotoxicity.

Financial benefits

It is not possible to determine financial benefits from this project as yet, because all of the treatments tested require further development either on crop safety or longer-term effectiveness before recommendations can be developed.

Action points for growers

- When available, Dual Gold and A9950A show promise for general container-grown HNS weed control during the growing season.

- Dual Gold could be a useful supplement to Flexidor 125 to improve control of groundsel, grasses and willowherb.

- Tree growers with cockspur grass problems should consider using Butisan S, Artist or Crystal as summer-applied residual herbicides.

- Butisan S or Artist are best applied as directed sprays avoiding the growing point of the trees.

- When available, Dual Gold will provide very good control of cockspur grass with potential for safe use when applied overall.

- Existing infestations of cockspur grass can be controlled with Laser. This product is selective in many broad-leaved tree crops.

- Weedazol-TL remains the best control measure for field horsetail. Headland Fortune was the most effective adjuvant tested.

- The addition of MCPB to Weedazole-TL reduced the long-term control of field horsetail.

- MCPA gave the most rapid initial knockdown of field horsetail, but did not eradicate it.

- Cleancrop Unival (triclopyr) was the most effective control for creeping yellow cress.

- Dicamba + glyphosate combinations appeared to offer the best control of false hedge bindweed.

Before using any of the products listed in this report, growers should always check the approval status of each (see Tables) and consult with a BASIS qualified advisor.

Science Section

Introduction

A number of weed species have proved difficult to control in either container-grown or field-grown nursery stock crops in recent years. The problem weeds include non-indigenous, recent introductions such as New Zealand bittercress (*Cardamine corymbosa*) and flexuous bittercress (*Cardamine flexuosa)* in container-grown crops. Pearlwort (*Sagina procumbens*) is an increasing problem in container-grown nursery stock with growers reporting more difficulty in control with existing herbicides. Other annual weeds such as groundsel (*Senecio vulgaris*), common mouse-ear (*Cerastium fontanum*), willowherb (*Epilobium* spp.) and sallows (*Salix caprea, S. cinerea*) are still commonly found in container-grown stock because of resistance to commonly used herbicides or herbicide application timing difficulties.

Although there has been a past programme of weed control research on container grown nursery stock carried out for the HDC, certain of the weeds in this study have not been investigated previously in detail. It had been intended to include New Zealand bittercress in HNS 111 but it was not possible to obtain seed at the time. Seed is now available. A study in Belgium (Eelden & Bulcke, 1998) showed that flexuous bittercress was less susceptible to isoxaben than hairy bittercress when applied post emergence, but the response to other herbicides was not studied and no further work has been carried out. The sallows (*S. caprea*, *S. cinerea*) have not previously been studied as a nursery stock weed. Pearlwort, common mouse-ear, willowherb and groundsel were studied in HNS 35f, HNS 70 or HNS 111. Although some useful control measures came out of these studies, timing restrictions, phytotoxicity to certain crops, and possible resistance in pearlwort, mean that a further range of treatments would be beneficial. Further herbicides have become available since these studies were carried out, requiring testing, alongside existing herbicides to check whether resistance has developed.

Cockspur grass (*Echinochloa crus-galli*) is another non-indigenous species causing problems in field-grown nursery stock in the southern counties. It can rapidly outshade field crops leading to loss of quality and difficulty in lifting. Once established it is difficult to remove by hoeing or mechanical cultivations. Cockspur grass has been much studied in tropical crops (Kahn & Kahn, 2003) and some control measures could be adapted for use in nursery stock. Populations are known to differ in susceptibility to herbicides and the mechanism has been studied (Hoagland & Hirase, 2003) but little is known about the resistance status of populations recently introduced to southern counties of the UK.

Deep rooted perennial weeds such as creeping yellow cress (*Rorippa sylvestris*) and horsetail (*Equisetum arvense*) are long-standing problems in perennial nursery crops and can also cause problems in container standing beds and a wide range of other horticultural crops.

Creeping yellow cress and horsetail are competitive with crops, and the rhizomes can be spread with planting stock. The presence of such weeds on nurseries limits the availability of land for planting, forcing growers to seek alternative land or to limit rotation length.

Of the two deep-rooted perennial weeds *E. arvense* and *R. sylvestris*, the former has been studied more extensively with traditional treatments MCPA (Merbach, 1993; Marshall, 1984), amitrole (Vezina, 1990; Coupland & Peabody, 1981, Marshall, 1984), dichlobenil (Marshall, 1984) and glyphosate (Hallgren, 1996) all reported as giving partial control. More recent work has included fluroxypyr, glufosinate-ammonium and chlorsulfuron (Nilsson & Hallgren, 1991). Chlorsulfuron was particularly effective, but is no longer available in the UK. Other sulfonyl urea herbicides have potential, when used in a fallow situation the year before planting. There has been little work carried out on *R. sylvestris*, although there is anecdotal evidence of control from certain sulfonyl urea herbicides such as thifensulfuron-methyl on other *Rorripa* species (DuPont, pers. com).

Materials and Methods

A. Weed seedling container experiments

Herbicide screening

In 2006, 12 herbicides were tested for efficacy in controlling each of the nine target weeds (Table 1) at three growth stages: pre-emergence, 1-2 true leaves and 3-4 true leaves. The first screening experiments were carried out in June-July 2006, for the majority of the weed species and the results were reported in the 1st annual report, September 2006. The experiments on *Cardamine flexuosa* and *Sagina procumbens* were delayed due to non-availability of the seed but were included in the later, second screening experiment. The second screening experiments were done in September-October 2006 to see if cooler autumn conditions affect the results. Results from this screening are included in this report.

Weed seeds

Willow seed was purchased from: Wildlife & Countryside Services, Llanfair Talhaiarn, Abergele, North Wales, LL22 8TG, UK. Other weed seeds were purchased from Herbiseed, The Nurseries, Billingbear Park, Wokingham, RG11 5RY, except for *Sagina procumbens* (field collected).

Table 1. Weed species used in herbicide screening experiments

Scientific name	Common name
Cardamine corymbosa	New Zealand bittercress
Cardamine flexuosa	flexuous bittercress
Cardamine hirsuta	hairy bittercress
Cerastium fontanum	common mouse-ear
Epilobium ciliatum	willowherb
Sagina procumbens	pearlwort
Salix caprea	goat willow
Salix cinerea	grey willow
Senecio vulgaris	groundsel

Test plant production

Seed was mixed with fine silver sand and 1 gram of the mixture (except for *Sagina procumbens*, 0.5 g) was sown into 9 cm pots containing growing media (Premium Horticulture Ltd., seed and modular compost). The seed rate was calculated to give 25 seedlings per pot assuming 75% germination. Pots were placed in carrying trays and irrigated from above. Pre-emergence treatments were applied the day after sowing and irrigation. Seedlings were allowed to develop to the appropriate growth stage before the post emergence treatments were applied. Pots were set out in trays in the experimental layout and grown on for assessment.

Table 2. Sowing and application timings

Species	Growth stage	Sown	Treated
Cerastium fontanum	Pre-em	5/9/06	6/9/06
	1st pair true leaves	5/9/06	20/9/06
	3-4 leaves	5/9/06	4/10/06
Cardamine corymbosa	Pre-em	5/9/06	6/9/06
	1st pair true leaves	5/9/06	4/10/06
	3-4 leaves	5/9/06	24/10/06
Cardamine flexuosa	Pre-em	5/9/06	6/9/06
	1st pair true leaves	5/9/06	4/10/06
	3-4 leaves	5/9/06	24/10/06
Cardamine hirsuta	Pre-em	5/9/06	6/9/06
	1st pair true leaves	5/9/06	20/9/06
	3-4 leaves	5/9/06	4/10/06
Senecio vulgaris	Pre-em	5/9/06	6/9/06
	1st pair true leaves	5/9/06	20/9/06
	3-4 leaves	5/9/06	4/10/06
Epilobium ciliatum	Pre-em	5/9/06	6/9/06
	1st pair true leaves	5/9/06	4/10/06
	3-4 leaves	5/9/06	24/10/06
Sagina procumbens	Pre-em	5/9/06	6/9/06
	1st pair true leaves	5/9/06	4/10/06
	3-4 leaves	5/9/06	24/10/06

Experimental design

Experiments were laid out in a randomised, split-plot design with two treatment factors (i) chemical treatment (main plots) and (ii) weed species (sub-plots), with three replicate blocks. Separate experiments were conducted for each of the three growth stages for herbicide application. Treatments are listed in Table 3.

Table 3. Herbicides tested against seedling weeds of container-grown nursery stock

Treatment	Product	Active ingredient	Product application rate	Approval status
1.	Untreated control			
2.	Butisan S	metazachlor (500 g/L)	2.5 L/ha	LTA*
3.	Venzar Flowable	lenacil (440 g/L)	4.5 L/ha	LTA
4.	Stomp 400 SC	pendimethalin (400 /L)	5.0 L/ha	LTA
5.	Flexidor 125	isoxaben (125 g/L)	2.0 L/ha	Label
6.	Ronstar 2G	oxadiazon (2% w/w)	200.0 kg/ha	Label
7	Dual Gold	s – metolachlor 960 (g/L)	1.6 L/ha	Not in UK
8.	Skirmish	terbuthylazine + isoxaben (420 : 75 g/L)	1.0 L/ha	LTA
9.	Terano	flufenacet + metosulam (60 : 2.5 % w/w)	0.75 kg/ha	Not in UK
10.	Goltix WG	metamitron (70 % w/w)	3.0 kg/ha	LTA
11.	Flazasulfuron	flazasulfuron (25 % w/w)	0.2 L/ha	Not in UK
12.	212 H 50WP	Not disclosed	0.2 kg/ha	Not in UK
13.	213H 0.25% Granule	Not disclosed	64.0 kg/ha	Not in UK

*LTA = Long-Term Arrangements for Extension of Use.

All treatments were applied in 1000 L/ha water using a Mardrive pot sprayer except treatments 6 and 13, which were applied as granules with a shaker bottle.

Assessments

For the pre-emergence treatments assessments were made 20, 29 and 41 days after treatment. For the post-emergence treatments assessments were made 13-21 and 48-59 days after treatment using a scoring system with values of 1 to 9, as follows: 9 = healthy and 1 = dead.

Container plant nursery experiments

In 2007, an experiment was set up to investigate the efficacy and phytotoxicity of ten herbicide treatment programmes on a range of container-grown ornamental species in a commercial nursery situation.

Ten shrubs, one conifer and one herbaceous species were used (Table 4). All plants except the *Chamaecyparis* were supplied from Darby Nursery Stock Ltd. Plants were supplied as 9 cm liner pots potted into 3 litre pots on 23 May. The *Chamaecyparis* were supplied in 3 litre pots and were incorporated into the experimental plots on 4 September.

Table 4. Plant species used in container plant nursery experiments

Figure 1. Example plant species

Plant species

Chamaecyparis lawsoniana 'Elwoods Gold'
Berberis darwinii
Buddleja davidii 'Royal Red'
Hebe 'Margaret'
Lavandula 'Princess Blue'
Lonicera 'Halliana'
Philadelphus 'Manteau d'hermine'
Potentilla fruticosa 'Summer Sorbet'
Pyracantha 'Red Column'
Rosmarinus 'Miss Jessop'
Spiraea 'Snowmound'
Veronica 'Ulster Dwarf Blue'.

Potting Mix:
70% Medium grade peat
30% Pine bark
5.0 kg/m^3 Osmocote Exact Standard 12-14 month
1.8 kg/m^3 Magnesian limestone
0.5 kg/m^3 12:12:12 Compound fertiliser

Experimental design

The experiment was a split plot design (Appendix 1, Fig 42). There were 10 treatments (including one control) replicated three times (30 main plots for herbicide treatments, 12 HNS species sub-plots x 3 plants). The pots were placed on sub-irrigated "Efford" style sandbeds outdoors after potting. Overhead irrigation was used to settle the plants in.

Herbicide treatments

The herbicide treatments used are given in Table 5 (active ingredient and manufacturer details are given in Table 6). Treatments were applied on 29 May 2007 and 4 September 2007; a winter treatment is scheduled for mid-November 2007.

Table 5. Treatments used in container plant nursery experiments

	Post Potting (May)	Potting + 12 Weeks (Sep)	Potting + 24 Weeks (Nov)
1	Untreated control	Untreated control	Untreated control
2	Ronstar 2G 200 kg/ha	Flexidor 125 1 L/ha	Flexidor 125 1 L/ha + Butisan S 2.5 L/ha
3	Ronstar 2G 200 kg/ha	Butisan S 2.5 L/ha	Flexidor 125 1 L/ha + Butisan S 2.5 L/ha
4	Ronstar 2G 200 kg/ha	Springbok 2.5 L/ha	Flexidor 125 1 L/ha + Butisan S 2.5 L/ha
5	Ronstar 2G 200 kg/ha	Dual Gold 1.6 L/ha	Flexidor 125 1 L/ha + Butisan S 2.5 L/ha
6	Ronstar 2G 200 kg/ha	Terano 0.75 kg/ha	Flexidor 125 1 L/ha + Butisan S 2.5 L/ha
7	Ronstar 2G 200 kg/ha	A9950A 2.6 kg/ha	Flexidor 125 1 L/ha + Butisan S 2.5 L/ha
8	Ronstar 2G 200 kg/ha	Flexidor 125 1 L/ha`	212H 0.2 kg/ha
9	Ronstar 2G 200 kg/ha	Flexidor 125 1 L/ha	Flazasulfuron 0.2 L/ha
10	Ronstar 2G 200 kg/ha	Flexidor 125 1 L/ha	Skirmish 1 L/ha + Butisan S 2.5 L/ha

Table 6. Herbicide products and active ingredients used in container plant nursery experiments

Product name	Active ingredients	a.i. content	Main supplier
212H	not disclosed		Interfarm UK Ltd
A9950A	not disclosed		Syngenta Crop Protection UK Ltd
Butisan S	metazachlor	500 g/L	BASF Plc
Dual Gold	s-metolachlor	960 g/L	Syngenta Crop Protection UK Ltd
Flazasulfuron	flazasulfuron	25% w/w	Belchim/ISK
Flexidor 125	isoxaben	125 g/L	Landseer
Ronstar 2G	oxadiazon	2% w/w	Certis
Skirmish 495 SC	terbuthylazine + isoxaben	420 : 75 g/L	Syngenta Crop Protection UK Ltd
Springbok	metazachlor + dimethenamid-p	200 : 200 g/L	BASF Plc
Terano	flufenacet + metosulam	60 : 2.5 % w/w	Bayer CropScience Ltd

All treatments were applied in 1000 L/ha water at 2 bar pressure using a CO_2-pressurised Oxford Precision Sprayer with a 1 m boom and F03-110 spray nozzles, except Ronstar 2G granules which were applied with a "pepper pot" sprinkler ensuring even coverage.

Assessments

An assessment of weed cover by weed species was made on 20 August 2007 prior to application of the early September treatments. Further weed assessments are scheduled for October/November 2007 and March 2008. Observations on phytotoxic symptoms were made on 24 September. Plant quality will be scored in March 2008 at the end of the experiment.

*B. Cockspur grass (*Echinochloa crus-galli*) experiment*

Herbicide screening

In 2006, 14 herbicides were tested for efficacy in controlling two seed populations of *Echinochloa crus-galli* at up to three growth stages: pre-emergence, 3-4 leaves and 6-10 leaves. The first screening experiments were done in June-July 2006 and the results were reported in the 1st annual report, September 2006.

The second screening experiments were done in September-October 2006 to see if cooler autumn conditions affect the results. Results from this screening are included in this report.

Weed seeds

Strain 1 of *E. crus-galli* was purchased from Herbiseed, The Nurseries, Billingbear Park, Wokingham, RG11 5RY, and strain 2 was collected from A. E. Roberts Ltd., Gravel Hill, Shirrell Heath, Southampton, Hants, SO32 2JQ.

Germination test

Before testing, collected samples were cleaned in an air column separator to remove most empty seeds and debris. A minimum airflow was used and checks were made to minimise loss of seeds. A standard germination test was carried out on all species to check the viability of the seed samples.

Test plant production

Fifty seeds of *E. crus-galli* were sown into 9 cm pots containing an 80:20 mix of sterilised screened loam and lime free grit (3-6 mm) (J Arthur Bowers top soil, Gem horticultural grit), placed in carrying trays and irrigated from above. Pre-emergence treatments were applied the day after sowing and irrigation (Table 7).

Seedlings were allowed to develop to the appropriate growth stage before the post emergence treatments were applied. Pots were set out in trays in the experimental layout and grown on for assessment.

Table 7. Sowing and application timings for *E. crus-galli* experiment

Growth stage	Sown	Treated
Pre-emergence	5/9/06	6/9/06
6 leaves	7/9/06	4/10/06
10 leaves	11/9/06	24/10/06

Table 8. Herbicide treatments used in *E. crus-galli* screening experiments

Treatment	Product	Active ingredient	Product application rate	Approval status (Field grown HNS)	Growth stages for treatment
1.	Untreated control				
2.	Butisan S	metazachlor (500 g/L)	2.5 L/ha	Label	Pre,3-4
3.	Venzar Flowable	lenacil (440 g/L)	4.5 L/ha	LTA*	Pre,3-4
4.	Stomp 400 SC	pendimethalin (400 g/L)	5.0 L/ha	LTA	Pre,3-4
5.	Samson	nicosulfuron (40 g/L)	1.5 L/ha	LTA	Pre,3-4,10
6.	Kerb Flo	propyzamide (500 g/L)	4.2 L/ha	Label	Pre,3-4,10
7.	Artist	flufenacet + metribuzin (24 : 17.5 % w/w)	2.5 kg/ha	LTA	Pre,3-4
8	Crystal	pendimethalin + flufenacet (60 : 300 g/L)	4.0 L/ha	LTA	Pre,3-4
9.	Atlantis WG	iodosulfuron-methyl-sodium +metsulfuron-methyl (0.6 : 3 % w/w)	0.4 kg/ha	LTA	Pre,3-4,10
10.	Headland Tolerate	chlorotoluron (500 g/L)	7.0 L/ha	LTA	Pre,3-4,10
11.	Dual Gold	s – metolachlor (960 g/L)	1.6 L/ha	Not approved in UK	Pre,3-4,10
12.	Laser + Actipron	cycloxydim (200 g/L) + adjuvant oil	2.25 L/ha 0.8%	SOLA	3-4,10
13.	Fusilade Max	fluazifop p butyl (125 g/L)	3.0 L/ha	SOLA	3-4,10
14.	Aramo	tepraloxydim (50 g/L)	1.5 L/ha	LTA	3-4,10
15.	Falcon	propaquizafop (100 g/L)	1.5 L/ha	LTA	3-4,10

*LTA = Long Term Arrangements for Extension of Use

All treatments were applied in 1000 L/ha water using a Mardrive pot sprayer.

Experimental design

Experiments were laid out in a randomized split plot design with two treatment factors: (i) chemical treatment (main plots) and (ii) seed source (sub-plots); with three replicate blocks. Separate experiments were conducted for each of the three growth stages for treatment.

Assessments

For the pre-emergence treatments assessments were made 21, 29 and 41 days after treatment. For the post-emergence treatments assessments were made 13, 20 and 41 days (6 leaf plants) or 21 and 79 days (10 leaf plants) after treatment. All assessments used a scoring system with values from 1 to 9 as follows: 9 = healthy and 1 = dead.

Field nursery experiments

For the 2007 field experiment on *E. crus-galli* control a plot of land with a known history of infestation was selected on a nursery site in Hampshire (A E Roberts Ltd). Plots were marked out on 8 March 2007. The previous crop (2006) on the experimental site was winter wheat. The soil type was fine sandy loam.

Crop during experiment

Maiden nursery trees planted 4 April 2007 were used, all supplied by A E Roberts Ltd. The species used were *Malus domestica* 'Reverend W Wilks', *Malus domestica* 'Grenadier', *Prunus* 'Amanagowa', *Prunus insititia* 'Merryweather Damson', *Pyrus communis* 'Concorde' and *Sorbus intermedia.*

Site maintenance

Prior to the start of the experiment a small number of annual weeds had germinated following cultivation. These weeds were sprayed off with a directed application of Harvest (5 L/ha) on 11 May 2007. Heavy rain followed this initial application, so a further application was made on 24 May 2007.

Experimental design

Experiments were laid out in a randomized split plot design with three treatment factors: (i) chemical treatment (main plots), (ii) + or – application over the tree foliage in addition to soil application (sub-plots), (iii) tree species (sub-sub-plots); with three replicate blocks (Appendix 2). A full treatment list is given in Table 9.

Table 9. Herbicides treatments used in *E. crus-galli* field experiments

Treatment	Product	Active ingredient	Product rate	Approval status (Field grown HNS)	Timing
1.	Untreated control				
2.	Butisan S	metazachlor (500 g/L)	2.5 L/ha	LTA	11 May
3.	Springbok	metazachlor + dimethenamid-p (200 : 200 g/L)	2.5 L/ha	LTA	11 May
4.	Crystal	pendimethalin + flufenacet (60 : 300 g/L)	4.0 L/ha	LTA	11 May
5.	Dual Gold	s – metolachlor (960 g/L)	1.6 L/ha	Experimental	11 May
6.	Artist	flufenacet + metribuzin (24 : 17.5 % w/w)	2.5 kg/ha	LTA	11 May
7.	Laser + Nufarm Cropoil	cycloxydim (200 g/L) + adjuvant oil	2.25 L/ha 0.8%	LTA	11 July

LTA = Long Term Arrangements for Extension of Use

All treatments were applied in 500 L/ha water using a Cooper-Pegler CP-15 Knapsack Sprayer with a single (green) fan jet spray nozzle.

Treatments 2-6 were applied to the soil surface on 11 May 2007. The trees at this stage were at bud break. A further application of treatments 2-6 was made on 11 June 2007 directly to the tree foliage but only to the sub-plots destined for over-foliage application. This application was made at the same concentration as the 11 May 2007 application but was applied to the foliage only with minimal run-off to the soil. The trees were in early leaf at this stage. Treatment 7 was applied to the weed growth and lower part of the trees on 11 July 2007.

Assessments

The number of seedlings of *E. crus-galli* was recorded on 6 July 2007. Percentage ground cover of *E. crus-galli* was assessed on 31 August 2007. Phytotoxicity following the over-foliage treatments was recorded on 6 July 2007.

*C. Field horsetail (*Equisetum arvense*) experiment*

First year efficacy experiment (2006)

For the first year (2006 treated) experiment, a plot of land with a uniform natural infestation of *E. arvense* was selected at ADAS Terrington. Plots were marked out and the initial pre-treatment infestation recorded in September 2005 and in June 2006.The previous crop (2005) was winter wheat. Oilseed rape was sown on the site in autumn 2005 and removed by application of Gramoxone 100 (paraquat) prior to the experiment during which the site was fallow. Soil type was silty clay loam.

Site maintenance

Prior to the start of the experiment contact herbicides were applied to remove existing weeds (Table 10).

Table 10. Site maintenance herbicide applications

Herbicide	Application rate	Water volume	Date of application
Gramoxone 100	2.0 L/ha	200 L/ha	18/11/05
Roundup	4.0 L/ha	200 L/ha	18/01/06

All plots were hand-weeded on 10 May 2006 to remove large seedling weeds and perennials other than *E. arvense*.

Experimental design

The experiment was laid out in a randomised block design with twenty treatments (Table 11) replicated three times. Plot size was 2 m x 5 m with 0.3 m pathways between plots, 1 m pathways between blocks and 2.5 m pathways around the experimental area.

Table 11. Treatments used in 2006 field horsetail experiment

Treatment	Product	Active ingredient	Product application rate	Approval status (Field grown HNS)	Timing
1 & 2	Untreated control				
3.	Casoron G granules	dichlobenil (6.75% w/w)	125.0 kg/ha	Label	13/03/06
4.	Weedazol-TL+ Headland Fortune	amitrol (225 g/L) + adjuvant	20.0 L/ha + 2.0 L/ha	LTA*	19/06/06
5.	Weedazol-TL + Headland Guard 2000	amitrol (225 g/L) + adjuvant	20.0 L/ha + 0.4 L/ha	LTA	19/06/06
6.	Weedazol-TL + Headland Rhino	amitrol (225 g/L) + adjuvant	20.0 L/ha + 0.6 L/ha	LTA	19/06/06
7.	Weedazol-TL + Headland Intake	amitrol (225 g/L) + adjuvant	20.0 L/ha + 2.0 L/ha	LTA	19/06/06
8	Weedazol-TL + Headland Fortune	amitrol (225 g/L) + adjuvant	20.0 L/ha 2.0 L/ha	LTA	8/09/06
9.	Weedazol-T + Agroxone + Headland Fortune	amitrol (225 g/L) + MCPA (500 g/L) + adjuvant	20.0 L/ha + 6.0 L/ha + 2.0 L/ha	LTA	19/06/06
10.	Glypfos + Headland Rhino	glyphosate (360 g/L) + adjuvant	5.0 L/ha + 0.6 L/ha	Label	19/06/06
11.	Glyfos + Headland Fortune	glyphosate (360 g/L) + adjuvant	5.0 L/ha + 2.0 L/ha	Label	19/06/06
12.	Glyfos + Headland Rhino	glyphosate (360 g/L) + adjuvant	5.0 L/ha + 0.6 L/ha	Label	8/09/06
13.	Glyfos + Agroxone + Headland Fortune	glyphosate (360 g/L) + MCPA (500 g/L) + adjuvant	5.0 L/ha + 6.0 L/ha + 2.0 L/ha	Label	19/06/06
14.	Glyfos + Shark	glyphosate (360 g/L) + carfentrazone-ethyl (60 g/L)	5.0 L/ha + 0.33 L/ha	Label	19/06/06
15.	BAS 635H + Headland Fortune	not disclosed + adjuvant	70.0 g/ha + 2.0 L/ha	Experimental	19/06/06
16.	Harvest + Headland Fortune	glufosinate ammonium (150 g/L) + adjuvant	5.0 L/ha + 2.0 L/ha	LTA	19/06/06

Table 11 (continued

Treatment	Product	Active ingredient	Product application rate	Approval status (Field grown HNS)	Timing
17.	Agroxone + Headland Fortune	MCPA (500 g/L) + adjuvant	6.0 L/ha + 2.0 L/ha	LTA	19/06/06
18.	Cleancrop Unival + Headland Fortune	triclopyr (240 g/L) + adjuvant	6.0 L/ha + 2.0 L/ha	LTA	19/06/06
19.	Starane 2 + Headland Fortune	fluroxypyr (200g/L) + adjuvant	2.0 L/ha + 2.0 L/ha	LTA	19/06/06
20.	212H 50WP + Challenge + Headland Fortune	not disclosed + glufosinate ammonium (150 g/L) + adjuvant	0.84 kg/ha + 5.0 L/ha + 2.0 L/ha	Experimental	19/06/06

*LTA = Long Term Arrangements for Extension of Use

All treatments were applied in 400 L/ha water at 2 bar pressure using a CO_2-pressurised Oxford Precision Sprayer with a 2 m boom and F03-110 spray nozzles.

Assessments

E. arvense frond counts were made using a 0.06 m^2 quadrat, with 10 quadrats assessed per plot within the central 1 m x 4 m area of the plot. Results were expressed as fronds/m^2. Assessments were made 6 October 2005 (pre treatment), 18 June 2006 (pre treatments 4-20), 17 July 2006, 22 August 2006 (all reported in the 2006 annual report), 4 October 2006 and 26 June 2007.

Second year efficacy experiment (2007)

For the second year (2007 treated) experiment a plot of land with a uniform natural infestation of *E. arvense* was selected at ADAS Terrington. Plots were marked out and the initial pre-treatment infestation recorded in June 2007. The previous crop (2006) was winter wheat., but the site was fallow during the experiment. Soil type was silty clay loam.

Site maintenance

Prior to the start of the experiment the site was ploughed and cultivated in early spring. Very little annual weed developed so it was not necessary to apply additional contact herbicides.

Experimental design

The experiment was laid out in a randomised complete block design with seven treatments (Table 12) replicated three times. Plot size was 2 m x 5 m with 0.3 m pathways between plots, 1 m pathways between blocks and 2.5 m pathways around the experimental area (Appendix 3).

Table 12. Treatments used in 2007 field horsetail experiment

Treatment	Product	Active ingredient	Product application rate	Approval status (Field grown HNS)	Timing
1.	Untreated control				
2.	Weedazol TL+ Headland Fortune	amitrol (225 g/L) + adjuvant	20.0 L/ha + 2.0 L/ha	LTA*	18/06/07
3.	Agroxone + Headland Fortune	MCPA (500 g/L) + adjuvant	6.0 L/ha + 2.0 L/ha	LTA	18/06/07
4.	I.T. Dicamba + Headland Fortune	dicamba (480 g/L) + adjuvant	5.0 L/ha + 2.0 L/ha	LTA	18/06/07
5.	Headland Link + Headland Fortune	dichlorprop-p (600 g/L) + adjuvant	2.4 L/ha + 2.0 L/ha	LTA	18/06/07
6.	Agroxone + I.T. Dicamba + Headland Fortune	MCPA (500 g/L) + dicamba (480 g/L) + adjuvant	8.0 L/ha + 5.0 L/ha + 2.0 L/ha	LTA	18/06/07
7.	Agroxone + I.T. Dicamba + Headland Link + Headland Fortune	MCPA (500 g/L) + dicamba (480 g/L) + dichlorprop-p (600 g/L) + adjuvant	9.0 L/ha + 5.0 L/ha + 2.4 L/ha + 2.0 L/ha	LTA	18/06/07

*LTA = Long Term Arrangements for Extension of Use

All treatments were applied in 400 L/ha water at 2 bar pressure using a CO_2-pressurised Oxford Precision Sprayer with a 2 m boom and F03-110 spray nozzles.

<u>Assessments</u>

E. arvense frond counts were made using a 0.06 m^2 quadrat, with 5 (10 June assessment) or 10 (all other assessments) quadrats per plot assessed within the central 1 m x 4 m area of the plot. Results were expressed as fronds/m^2.

Assessments were made on 12 June 2007 (pre treatment), 23 July 2007 and 28 August 2007. Further assessments are planned for October 2007 and June 2008.

Phytotoxicity field experiment (2007)

In order to test for possible phytotoxicity resulting from the herbicides tested for control of *E. arvense, Rorrippa sylvestris* or *Calystegia sepia,* a further experiment was done using the same site (ADAS Terrington) as the 2007 efficacy experiment. A range of 10 herbicide or herbicide combinations was applied as a directed spray alongside rows of field -planted tree rootstocks. Plots marked out on 22 March 2007 and one year old rootstocks were planted on the same day. The tree subjects used were *Malus domestica* 'M9', *Prunus* 'Colt', Quince 'C' and *Sorbus aucuparia.* All rootstocks were supplied by Frank P Matthews Ltd, Tenbury Wells, Worcs.

<u>Site maintenance</u>

In order to keep the plants free from annual weeds during the experiment, a standard residual herbicide treatment was applied to the entire experimental area on 30 March 2007, 1 week after planting (Table 13).

Table 13. Maintenance herbicide applications

Herbicide	Application rate	Water volume	Date of application
Stomp 400SC (pendimethalin 400g/L) + Ronstar Liquid (oxadiazon 250 g/L)	3.3 L/ha 4.0 L/ha	200 L/ha	30 March 2007

<u>Experimental design</u>

The experiment was laid out in a randomised split plot design with two treatment factors (i) chemical treatment, (ii) crop species (*Malus* 'M9', *Punus* 'Colt', *Sorbus aucuparia*, or Quince C), with 10 treatments (Table 14) replicated three times. The rootstocks were planted at 1.0 m x 0.3 m with a 0.3 m guard pathway between blocks I and II and between blocks II and III and between plots (Appendix 3). Plots were 2.0 m wide and 3.0 m long with two parallel rootstock rows running 1 m apart down the centre of the plot. Each rootstock row contained 2 species with 5 plants of each. Each plot contained a total of 20 plants, 5 each of 4 species.

Treatments were applied with a hooded knapsack sprayer as two 35 cm bands as close as practical to each side of the row. Therefore each plot received 4 x 35 cm x 3 m band treatments (Appendix 3).

Aphids were noted on the *Malus* and *Prunus* plants in June. These were treated with Aphox (pirimicarb), 280 g/ha on 13 June 2007.

Table 14. Treatments used in field horsetail herbicide phytotoxicity experiment

Treatment	Product	Active ingredient	Product rate	Approval status (Field grown HNS)
1.	Untreated control			
2.	Herboxone	2,4 D (500 g/L)	3.3 L/ha	LTA*
3.	Agroxone	MCPA (500 g/L)	6 L/ha	LTA
4.	I.T. Dicamba	dicamba (480 g/L)	5 L/ha	LTA
5.	Headland Link	dichlorprop-p (600 g/L)	2.4 L/ha	LTA
6.	Cleancrop Unival	triclopyr (240 g/L)	6 L/ha	LTA
7.	Agroxone + I.T.Dicamba + Headland Link	MCPA (500 g/L)+ dicamba (480 g/L)+ dichlorprop-p (600 g/L)	6 L/ha + 5 L/ha + 2.4 L/ha	LTA
8.	212H 50WP	flumioxazin	0.84 kg/ha	Experimental
9.	Terano	flufenacet + metosulam (60 : 2.5 % w/w)	0.75 kg/ha	Experimental
10.	Flazasulfuron	flazasulfuron (25 % w/w)	0.2 L/ha	Experimental

*LTA = Long Term Arrangements for Extension of Use

All treatments were applied in 400 L/ha water at 2 bar pressure using a CO_2-pressurised Oxford Precision Sprayer with a single hooded F02-110 spray nozzle. Spray treatments were applied to the soil surface on 9 July 2007 using a hooded sprayer to avoid spraying the trees as far as possible. The trees at this stage were at early leaf emergence.

Assessments

The plants were examined for signs of phytotoxicity during June and July 2007.

D. **Rorippa sylvestris** (creeping yellow cress) experiment

First year efficacy experiment (2006)

For the first year experiment on *R. sylvestris* a naturally-infested plot of land was selected on a long-established nursery site in Norfolk. Plots were marked out and the initial pre-treatment infestation recorded 26 May 2006. The previous crop on the experimental site (2005) was iris; the experimental area was fallow during the experiment. The soil type was medium sandy clay loam.

Maintenance

Prior to the start of the experiment the larger seedling weeds and perennials were removed by hand, and no herbicides other than the treatments were applied.

Experimental design

The experiment was laid out in a randomised complete block design with 10 treatments (Table 15) replicated three times. Plot size was 1.5 m x 2 m.

Table 15. Herbicide treatments used in creeping yellow cress efficacy experiment

Treatment	Product	Active ingredient	Product rate	Approval status (Field grown HNS)	Timing
1.	Untreated control				
2.	Weedazol-TL	amitrol (225 g/L)	20.0 L/ha	LTA*	15 June
3.	Glyfos	glyphosate (360 g/L)	5.0 L/ha	LTA	15 June
4.	Glyfos + Shark	glyphosate (360 g/L) + carfentrazone-ethyl (60 g/L)	5.0 L/ha + 1.0 L/ha	LTA	15 June
5.	BAS 635H+ Activator 90	Not disclosed adjuvant	70.0 g/ha+ 1.0 L/ha	Experimental	15 June
6.	Cleancrop Unival	triclopyr (240 g/L)	6.0 L/ha	LTA	15 June
7.	Starane XL	fluroxypyr (100 g/L)+ florasulam (2.5 g/L)	1.8 L/ha	LTA	15 June
8	Starane 2	fluroxypyr (200 g/L)	2.0 L/ha	LTA	15 June
9.	Prospect	thifensulfuron-methyl (75% w/w)	40.0 g/ha	LTA	15 June
10.	Terano	metosulam + flufenacet (60 : 2.5 % w/w)	0.75 kg/ha	Not approved in UK	15 June

*LTA = Long Term Arrangements for Extension of Use

All treatments were applied in 400 L/ha water at 2 bar pressure using a CO_2-pressurised Oxford Precision Sprayer with a 1.5 m boom and F03-110 spray nozzles.

Assessments

Percentage ground cover of *R. sylvestris* was assessed, recording only within the central 1 m x 1.5 m of the plot. Assessments were made on 26 May 2006 (pre treatment), 10 July 2006, 15 August 2006 (all reported in the 2006 annual report), 22 September 2006 and 2 July 2007.

Second year efficacy experiment (2007)

For the second year experiment on *R. sylvestris* a naturally-infested plot of land was selected on non-cropped land on a fruit farm site in Norfolk. Plots were marked out and the initial pre-treatment infestation recorded 26 May 2006. There was no previous crop. Soil type was medium sandy loam.

Table 16. Herbicide treatments used in creeping yellow cress efficacy experiment

Treatment	Product	Active ingredient	Product rate	Approval status (Field grown HNS)	Timing
1.	Untreated control				
2.	Weedazole	amitrol (225 g/L)	20.0 L/ha	LTA*	2 May
3.	Cleancrop Unival	triclopyr (240 g/L)	6.0 L/ha	LTA	2 May
4.	Herboxone	2,4 D (500 g/L)	3.3 L/ha	LTA	2 May
5.	IT Dicamba	dicamba (480 g/L)	5 L/ha	LTA	2 May
6.	Headland Link	dichlorprop-p (600 g/L)	2.4 L/ha	LTA	2 May
7.	Herboxone + IT Dicamba + Unival	2,4 D (500 g/L) + dicamba (480 g/L) + triclopyr (240 g/L)	3.3 L/ha 5 L/ha 6.0 L/ha	LTA	2 May
8.	Herboxone + I.T.Dicamba Headland Link	2,4 D (500 g/L) + dicamba (480 g/L) + dichlorprop-p (600 g/L)	3.3 L/ha 5 L/ha 2.4 L/ha	LTA	2 May
9.	Cleancrop Unival + I.T.Dicamba + Headland Link	triclopyr (240 g/L) + dicamba (480 g/L) + dichlorprop-p (600 g/L)	6.0 L/ha 5 L/ha 2.4 L/ha	LTA	2 May

*LTA = Long Term Arrangements for Extension of Use

Maintenance

At this site the predominant weed cover was *R. sylvestris* so there was no need to remove other weeds and no herbicides other than the treatments were applied.

Experimental design

The experiment was laid out in a randomized block design with nine treatments (Table 16) replicated three times. Plot size was 1.5 m x 2 m (Appendix 4). All treatments were applied in 400 L/ha water at 2 bar pressure using a CO_2-pressurised Oxford Precision Sprayer with a 1.5 m boom and F03-110 spray nozzles.

Assessments

Percentage ground cover of *R. sylvestris* was assessed, recording only within the central 1 m x 1.5 m of the plot. Assessments were made on 5 June 2007, 3 July 2007 and 30 August 2007.

E.* Calistegia sepium *(false hedge bindweed) experiment

First year efficacy experiment (2006)

For the first year experiment on *C. sepium,* a naturally-infested plot of land with a natural was selected at the Frank P Matthews stoolbed site in Worcestershire. Plots were marked out and the initial pre-treatment infestation recorded on 24 May 2006. The experimental area was an abandoned *Malus* stoolbed. The soil type was fine sandy clay loam.

Maintenance

Prior to the start of the experiment, in early Spring 2006, a routine application of Flexidor 125 2 L/ha + Butisan S 2.5 L/ha was made to the entire site. This was effective in controlling annual weeds, allowing the false hedge bindweed to grow without competition.

Experimental design

The experiment was laid out in a randomized block design with 12 treatments (Table 17) replicated three times. Plot size was 1.5 m x 2 m. All treatments were applied in 400 L/ha water at 2-bar pressure using a CO_2-pressurised Oxford Precision Sprayer with a 1.5 m boom and F03-110 spray nozzles.

Table 17. Herbicide treatments used in 2006 false hedge bindweed efficacy experiment

Treatment	Product	Active ingredient	Product rate	Approval status (Field grown HNS)	Timing
1.	Untreated control				
2.	Roundup	glyphosate (360 g/L)	5.0 L/ha	Label	12 June
3.	Roundup	glyphosate (360 g/L)	5.0 L/ha	Label	Mid Sept
4.	Samson	nicosulfuron (40 g/L)	1.5 L/ha	LTA*	12 June
5.	Ronstar Liquid	oxadiazon (250 g/L)	8.0 L/ha	Label	12 June
6.	Goal	oxyfluorfen (2 g/L)	4.0 L/ha	Not approved in UK	12 June
7.	212H 50WP	Not disclosed	0.84 kg/ha	Experimental	12 June
8	Starane XL	fluroxypyr(100 g/L)+ florasulam (2.5 g/L)	1.8 L/ha	LTA	12 June
9.	Herboxone	2,4-D amine (500 g/L)	3.3 L/ha	LTA	12 June
10.	I.T. Dicamba	dicamba (480 g/L)	5.0 L/ha	LTA	12 June
11.	I.T. Dicamba + Roundup	dicamba (480 g/L) + glyphosate (360 g/L)	5.0 L/ha + 5.0 L/ha	LTA	12 June
12.	BAS 635H + BAS 152000	Not disclosed + adjuvant	70.0 g/ha + 2.4 L/ha	Experimental	12 June

*LTA = Long Term Arrangements for the Extension of Use

Assessments

Percentage ground cover of *C. sepium* was assessed, recording only within the central 1 m x 1.5 m of the plot. Assessments were made on 24 May 2006 (pre treatment), 4 July 2006, 1 August 2006, 29 August 2006 (all reported in the 2006 annual report) and 6 June 2007.

Second year efficacy experiment (2007)

For the second year experiment on *C. sepium* a plot of land with a natural infestation of *C. sepium* was selected at the Frank P Matthews stoolbed site in Worcestershire. Plots with 100% cover were marked out on 6 June 2007. The experimental area was an abandoned *Malus* stoolbed. The soil type was fine sandy clay loam.

Maintenance

Because of the high level of infestation with false hedge bindweed, there was no need to apply pre-treatment herbicides to control annual weeds in 2007.

Experimental design

The experiment was laid out in a randomized block design with 11 treatments (Table 18) replicated three times. Plot size was 1.5 m x 2 m (Appendix 5). All treatments were applied in 400 L/ha water at 2-bar pressure using a CO_2-pressurised Oxford Precision Sprayer with a 1.5m boom and F03-110 spray nozzles.

Assessments

Percentage ground cover of *C. sepium* was assessed, recording only within the central 1 m x 1.5 m of the plot. An assessment was made on 21 August 2007.

Table 18. Herbicide treatments used in 2007 false hedge bindweed efficacy experiment

Treatment	Product	Active ingredient	Product rate	Approval status (Field grown HNS)	Timing
1.	Untreated control				
2.	Centium + Roundup	clomazone (360 g/L)+ glyphosate (360 g/L)	0.33 L/ha 5 L/ha	LTA* Label	19 July
3.	Centium Roundup	clomazone (360 g/L) glyphosate (360 g/L)	0.33 L/ha 5 L/ha	Label LTA	19 July 13 Sept
4.	Herboxone + Roundup	2,4 D amine (500 g/L)+ glyphosate (360 g/L)	3.3 L/ha 5 L/ha	LTA Label	19 July
5.	Herboxone Roundup	2,4 D amine (500 g/L) glyphosate (360 g/L)	3.3 L/ha 5 L/ha	LTA Label	19 July 13 Sept
6.	IT.Dicamba+ Roundup	dicamba (480 g/L) + glyphosate (360 g/L)	5 L/ha 5 L/ha	LTA Label	19 July
7.	IT Dicamba Roundup	dicamba (480 g/L) glyphosate (360 g/L)	5 L/ha 5 L/ha	LTA Label	19 July 13 Sept
8.	Starane 2 + Roundup	fluroxypyr (200 g/L)+ glyphosate (360 g/L)	2 L/ha	LTA Label	19 July
9.	Starane 2 Roundup	fluroxypyr (200 g/L) glyphosate (360 g/L)	2 L/ha 5 L/ha	LTA Label	19 July 13 Sept
10.	Herboxone + IT Dicamba+ Starane 2 + Roundup	2,4 D amine (500 g/L) + dicamba (480 g/L)+ fluroxypyr (200 g/L)+ glyphosate (360 g/L)	6 L/ha + 5 L/ha + 2 L/ha + 5 L/ha	LTA LTA LTA Label	19 July
11.	Herboxone + IT Dicamba+ Starane 2 Roundup	2,4 D amine (500 g/L) + dicamba (480 g/L)+ fluroxypyr (200 g/L) glyphosate (360 g/L)	6 L/ha + 5 L/ha + 2 L/ha 5 L/ha	LTA LTA LTA Label	19 July 13 Sept

*LTA = Long term arrangement for the extension of use

Results and Discussion

A. Weed seedling container experiments

Herbicide screening

Cardamine corymbosa (New Zealand bittercress)

Butisan S, Venzar Flowable, Flexidor 125, Ronstar 2G, Skirmish, Flazasulfuron, 212H 50WP and 213H granules all provided complete pre-emergence control by 30 days after treatment. Stomp 400 SC, and Terano were slower acting but gave control by 41 days. Goltix WG and Dual Gold were less effective in these autumn experiments compared with the summer (Fig. 2).

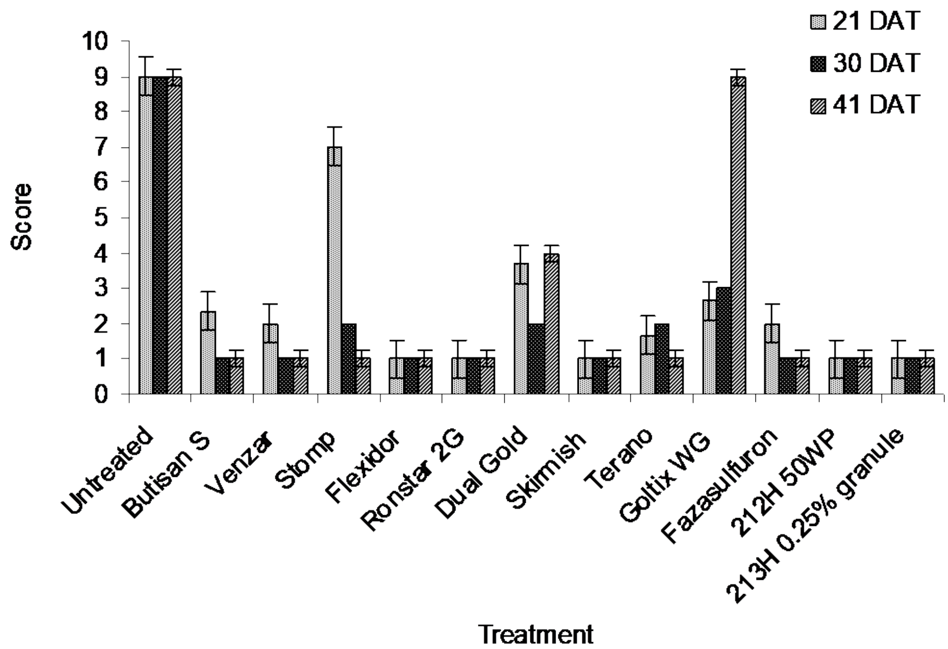


Figure 2. New Zealand bittercress: Pre-emergence control score at 20, 30 and 41 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at *P* = 0.05. Score 9 = healthy, 1 = dead)

As with the summer treatments only Skirmish, Terano, Flazasulfuron and 212H 50WP provided post emergence control at the 1-2 true leaf stage. Venzar Flowable and Stomp 400 SC failed to give the stunting that had been seen in the summer treatment (Fig 3).

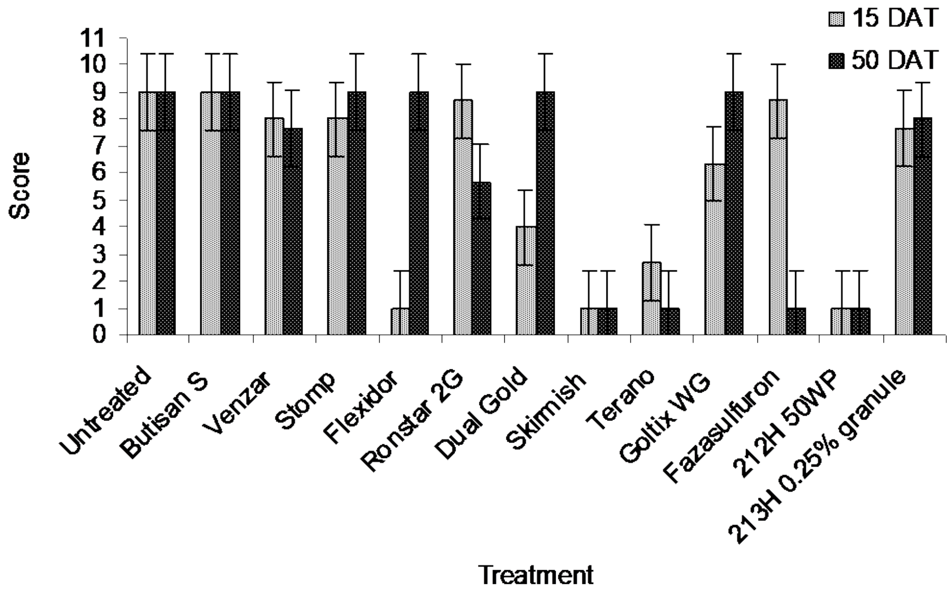


Figure 3. New Zealand bittercress: 1-2 true leaf control score at 15 and 50 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at *P* = 0.05. Score 9 = healthy, 1 = dead)

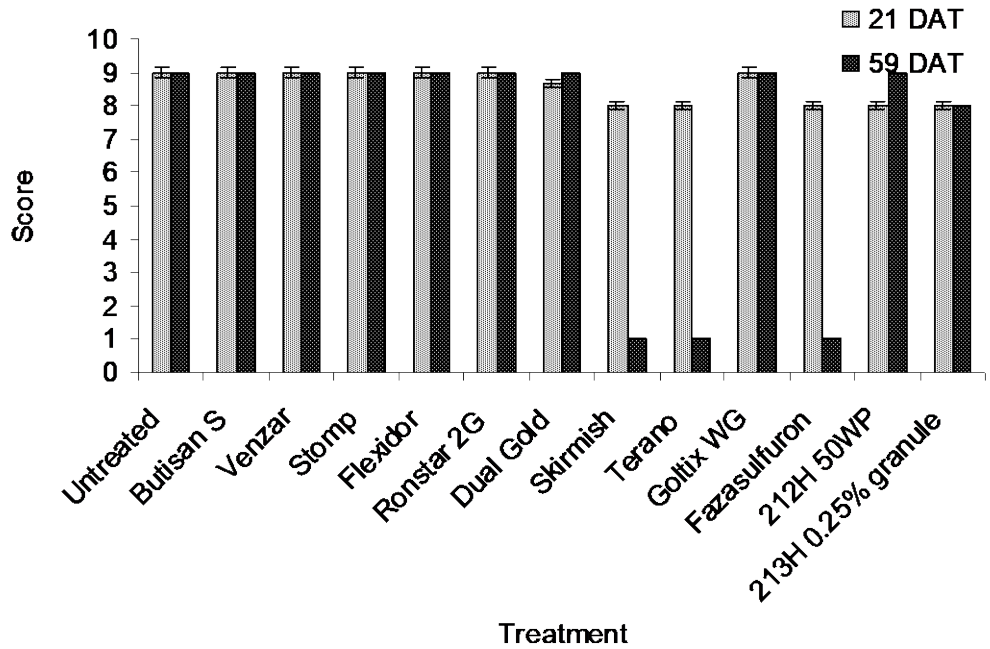


Figure 4. New Zealand bittercress: 3-4 true leaf control score at 21 and 59 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at *P* = 0.05. Score 9 = healthy, 1 = dead)

Skirmish, Terano, and Flazasulfuron provided post emergence control at the 3-4 true leaf stage but somewhat delayed (Fig 4). Venzar Flowable, Goltix WG and 212H 50WP failed to give the post emergence control that had been seen from summer treatment.

Cardamine flexuosa (flexuous bittercress)

All treatments except Dual Gold and Goltix WG gave effective pre-emergence control. Stomp and to a lesser extent Venzar flowable and Butisan S were slower acting allowing some seedlings to emerge before they died. Dual Gold only gave partial control (Fig. 5).

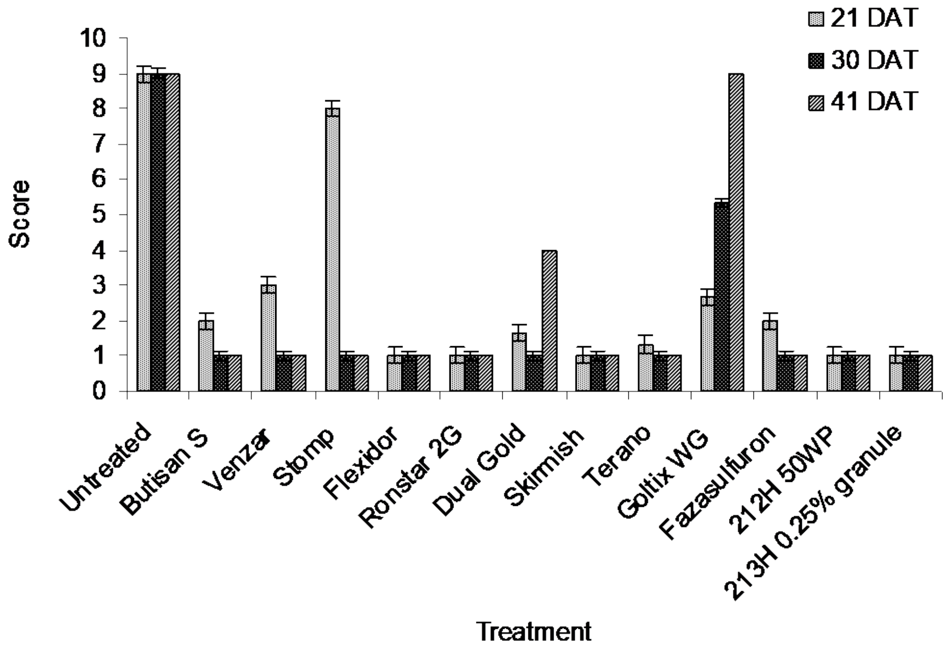


Figure 5. Flexuous bittercress: pre-emergence control score at 21, 30 and 41 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at $P = 0.05$. Score 9 = healthy, 1 = dead)

Only Skirmish, Terano, Flazasulfuron and 212H 50WP gave full post emergence control at the 1-2 leaf stage. Ronstar 2G and Flexidor 125 were partially effective with around 50% control (Fig. 6).

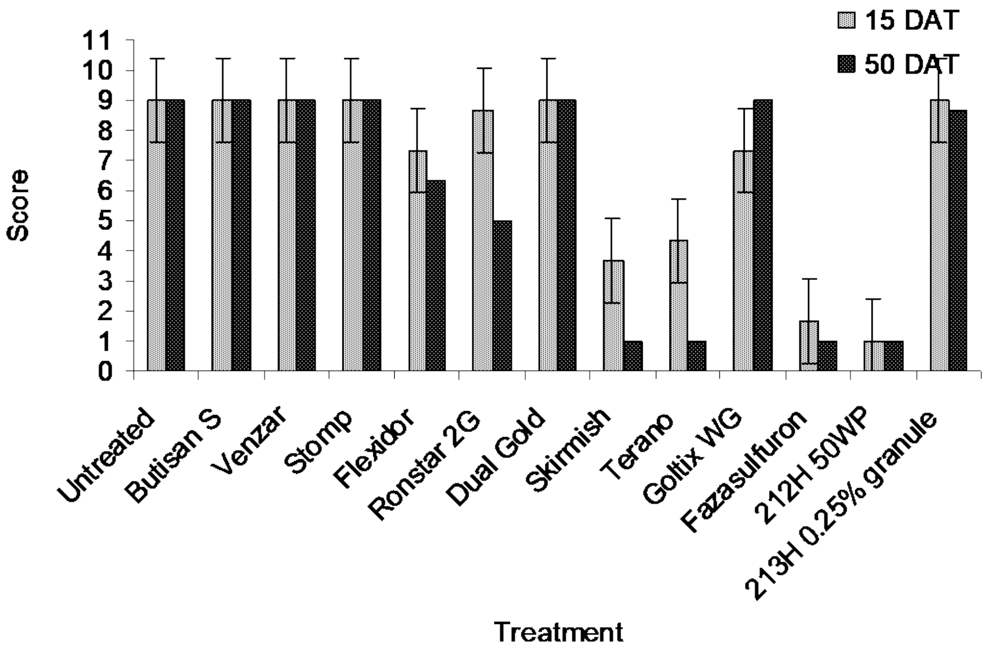


Figure 6. Flexuous bittercress: 1-2 true leaf control score at 15 and 50 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at *P* = 0.05. Score 9 = healthy, 1 = dead)

Skirmish, Terano and Flasasulfuron were also effective at controlling the 3-4 leaf seedlings but 212H 50WP failed to control the larger seedlings (Fig. 7).

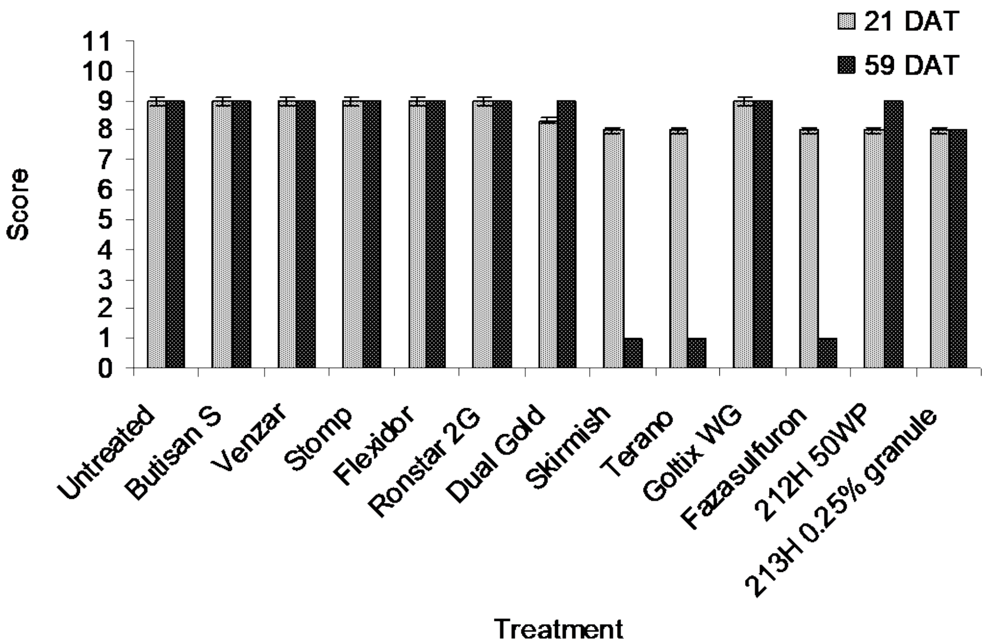


Figure 7. Flexuous bittercress: 3-4 true leaf control score at 21 and 59 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at *P* = 0.05. Score 9 = healthy, 1 = dead)

Cardamine hirsuta (hairy bittercress)

Venzar Flowable, Flexidor 125, Ronstar 2G, Skirmish, Terano, Goltix WG, Flazasulfuron and 213H granules all provided good pre-emergence control. Stomp 400SC was effective, but slower acting allowing some seedlings to emerge before they died. Butisan S, Goltix WG and Dual Gold only gave partial control. Results were similar to the summer treatment except that Goltix was much less effective in the autumn (Fig 8).

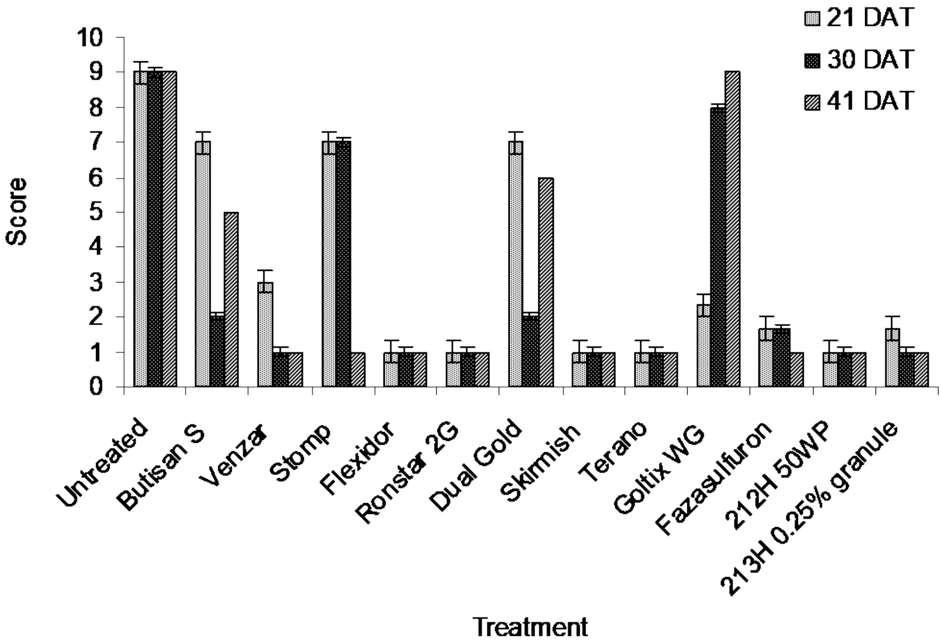


Figure 8. Hairy bittercress: pre-emergence control score at 21, 30 and 41 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at *P* = 0.05. Score 9 = healthy, 1 = dead)

Venzar Flowable, Flexidor 125, Ronstar 2G, Skirmish, Terano, Goltix WG, Flazasulfuron, and 212H 50WP all provided complete early post emergence control at the 1-2 true leaf stage. Butisan S, Goltix WG, Stomp 400 SC, 213H granules and Dual Gold were ineffective at this stage (Fig 9). Goltix WG, Stomp 400SC and 213H had given better results in the summer.

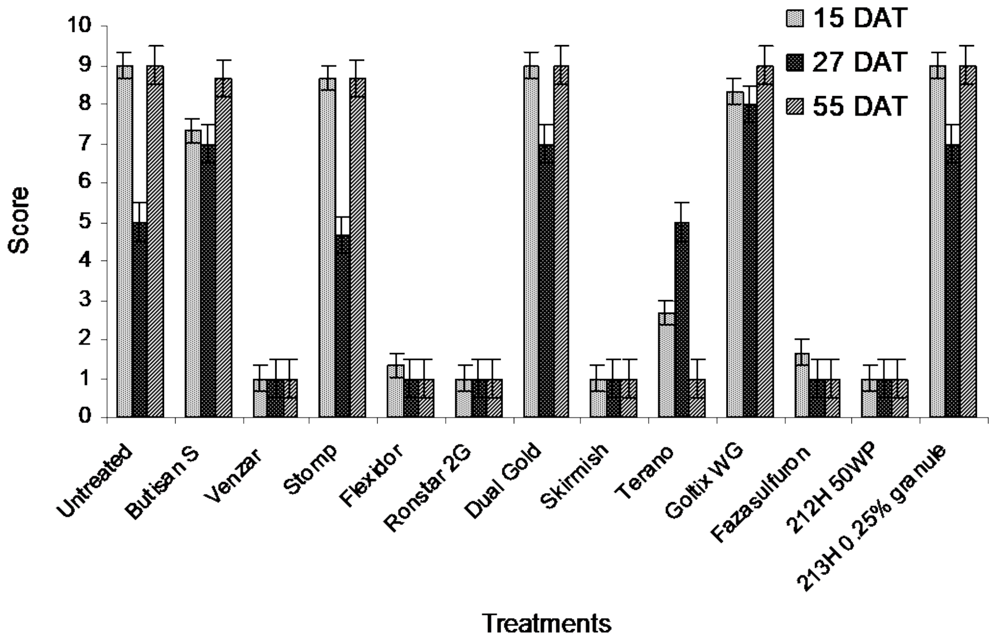


Figure 9. Hairy bittercress: 1-2 true leaf control score at 15, 27 and 55 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at *P* = 0.05. Score 9 = healthy, 1 = dead)

Seedlings at the 3-4 true leaf stage proved more difficult to control with only Flexidor 125, Ronstar 2G, Terano, Flasasulfuron and 212H 50WP giving control (Fig 10). Surprisingly Skirmish did not give control although it did give control of the 1-2 true leaf seedlings and both stages of *C. corymbosa* and *C. flexuosa*.

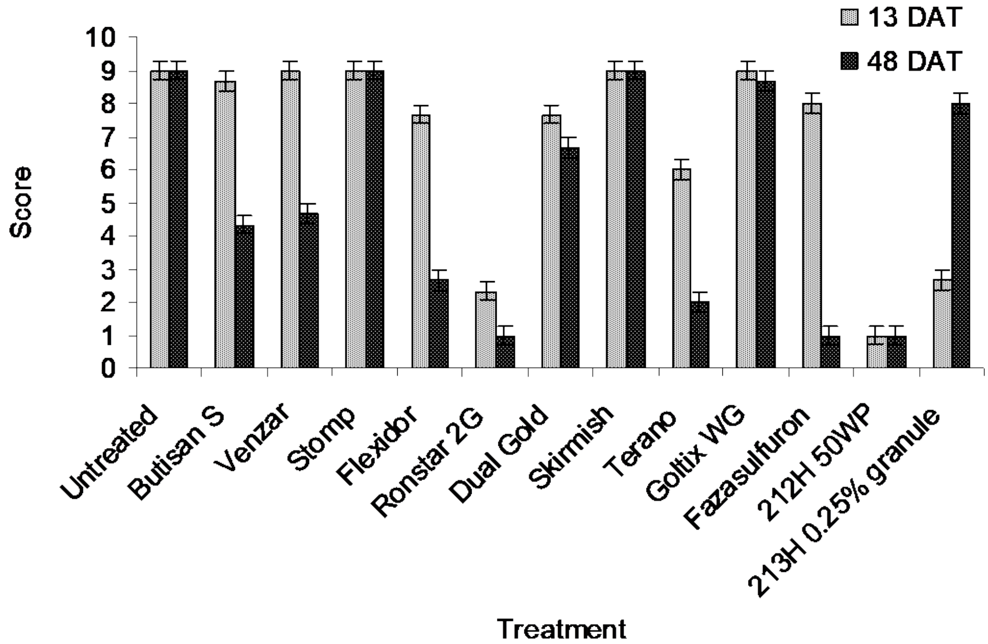


Figure 10. Hairy bittercress: 3-4 true leaf control score at 13 and 48 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at *P* = 0.05. Score 9 = healthy, 1 = dead)

Cerastium fontanum (common mouse-ear)

Butisan S, Venzar Flowable, Stomp 400 SC, Flexidor 125, Skirmish, Terano, Flazasulfuron, and 212H 50WP all provided complete pre emergence control although Stomp 400SC was slow acting (Fig 11). Ronstar 2G, Dual Gold and Goltix WG were ineffective. 213H granules gave partial control. Results were similar to the summer 2006 tests except that 213H was slightly less effective in the autumn.

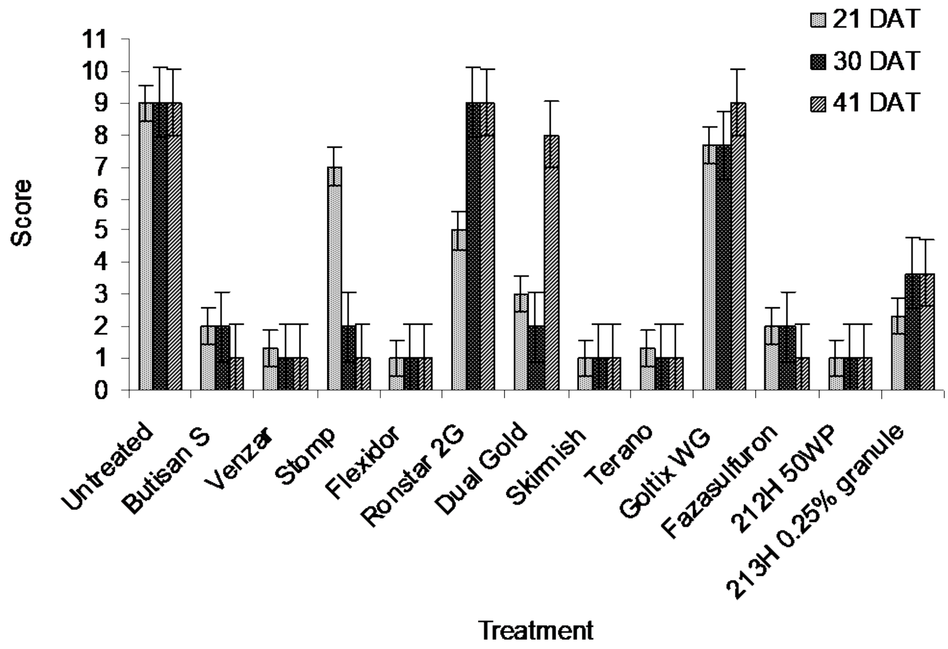


Figure 11. Common mouse-ear: pre-emergence control score at 21, 30 and 41 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at P = 0.05. Score 9 = healthy, 1 = dead)

Only Venzar Flowable, Flexidor 125, Skirmish, Terano, Flazasulfuron and 212H 50WP gave control at the 1-2 true leaf stage. The other herbicides were much less effective (Fig 12).

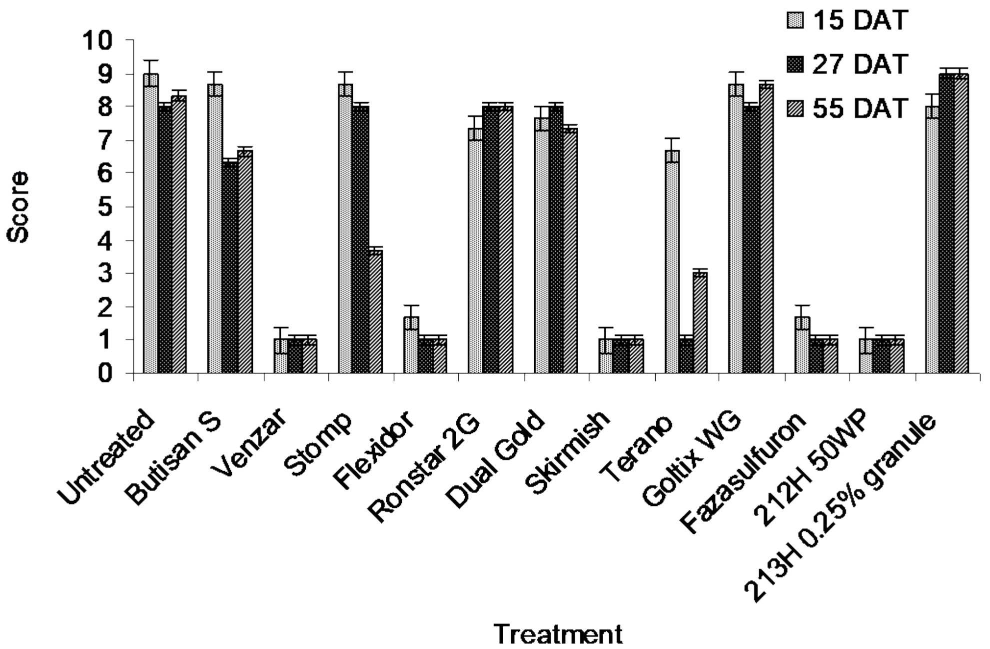


Figure 12. Common mouse-ear: 1-2 true leaf control score at 14, 27 and 55 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at *P* = 0.05. Score 9 = healthy, 1 = dead)

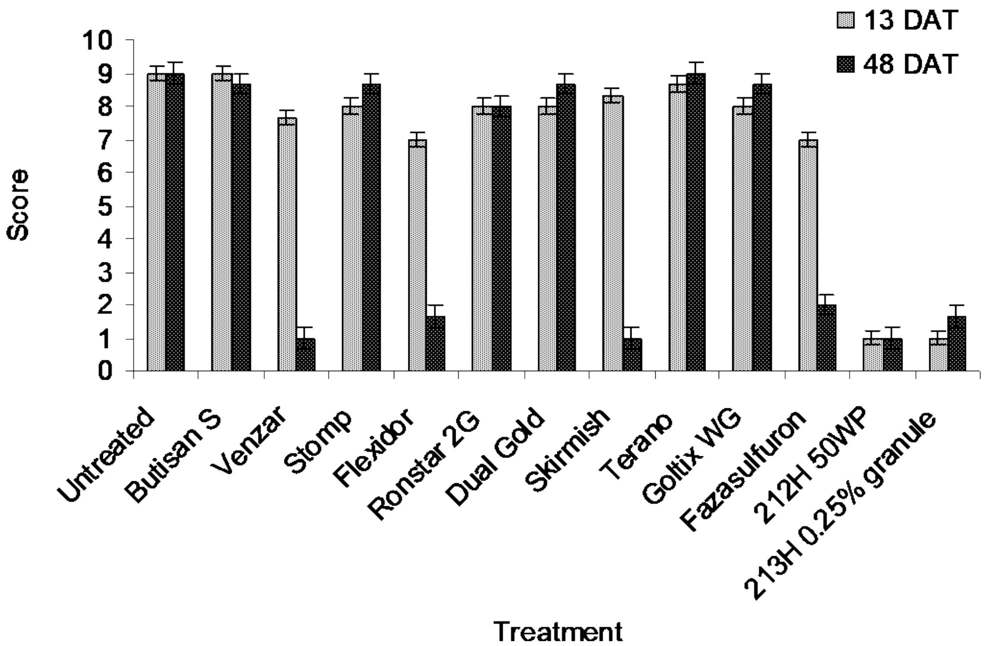


Figure 13. Common mouse-ear: 3-4 true leaf control score at 13 and 48 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at *P* = 0.05. Score 9 = healthy, 1 = dead)

Only Venzar Flowable, Skirmish, and 212H 50WP gave complete control at the 3-4 true leaf stage. Flexidor 125, Flazasulfuron and 213H granules gave a useful degree of control and Butisan S, Stomp 400 SC, Ronstar 2G, Goltix WG and Dual Gold were relatively ineffective at this growth stage (Fig 13).

Epilobium ciliatum (willowherb)

The most effective treatments were Butisan S, Venzar Flowable, Ronstar 2G, Dual Gold, Flazasulfuron, Skirmish, Terano, 212H and 213H granules. Flexidor 125 and Goltix were ineffective and Stomp 400 SC provided only partial control (Fig 14). Goltix was much less effective in this experiment compared with summer 2006, but other results were similar.

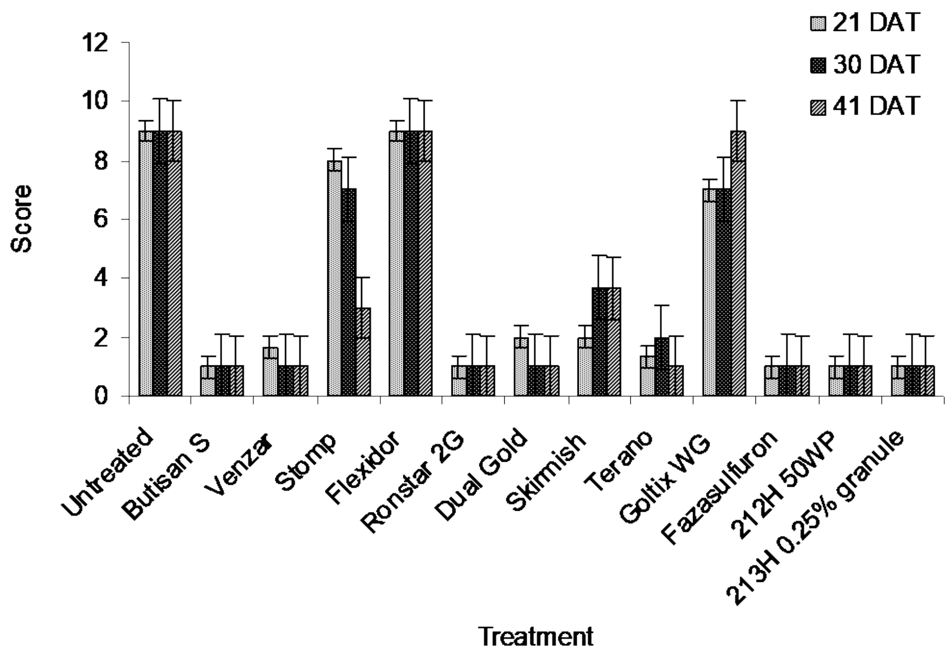


Figure 14. Willowherb: pre-emergence control score at 21, 30 and 41 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at *P* = 0.05. Score 9 = healthy, 1 = dead)

The only fully effective treatments for control at the 1-2 leaf stage were Ronstar 2G, Skirmish, Terano (but slow acting) and 212H 50WP (Fig 15). Stomp 400SC, Flazasulfuron and 213H granules were slow acting and only partially effective. Venzar Flowable was more effective as a summer treatment.

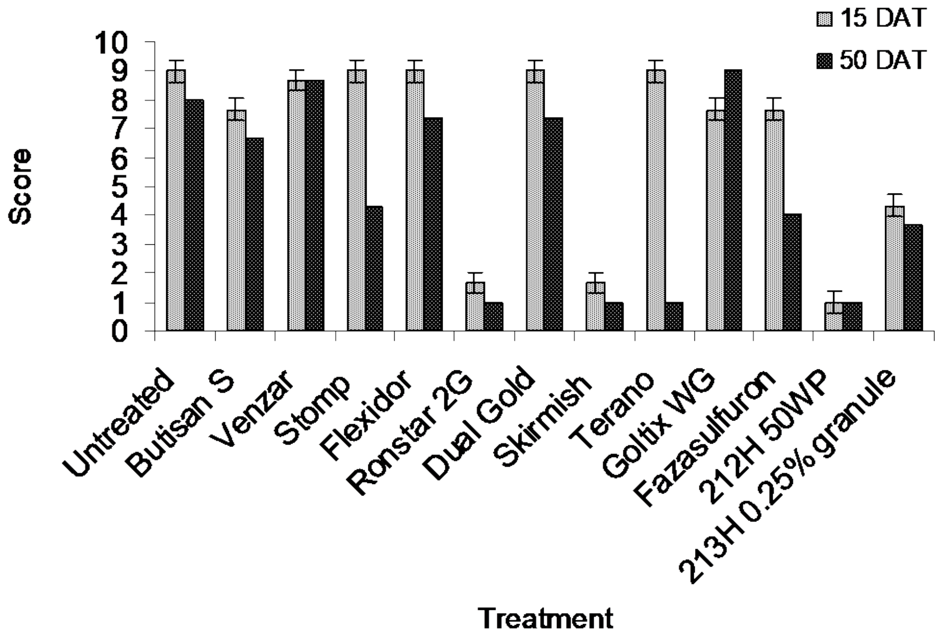


Figure 15. Willowherb: 1-2 true leaf control score at 15 and 50 days after treatment (DAT) (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at *P* = 0.05. Score 9 = healthy, 1 = dead)

The only treatments providing control at both 1-2 and 3-4 true leaf stage were Skirmish and 212H 50WP (Fig 16). Surprisingly Venzar flowable and 213H granules proved more effective at the 3-4 true leaf stage than at the 1-2 leaf stage. Venzar flowable had been effective at all stages when applied in summer 2006.

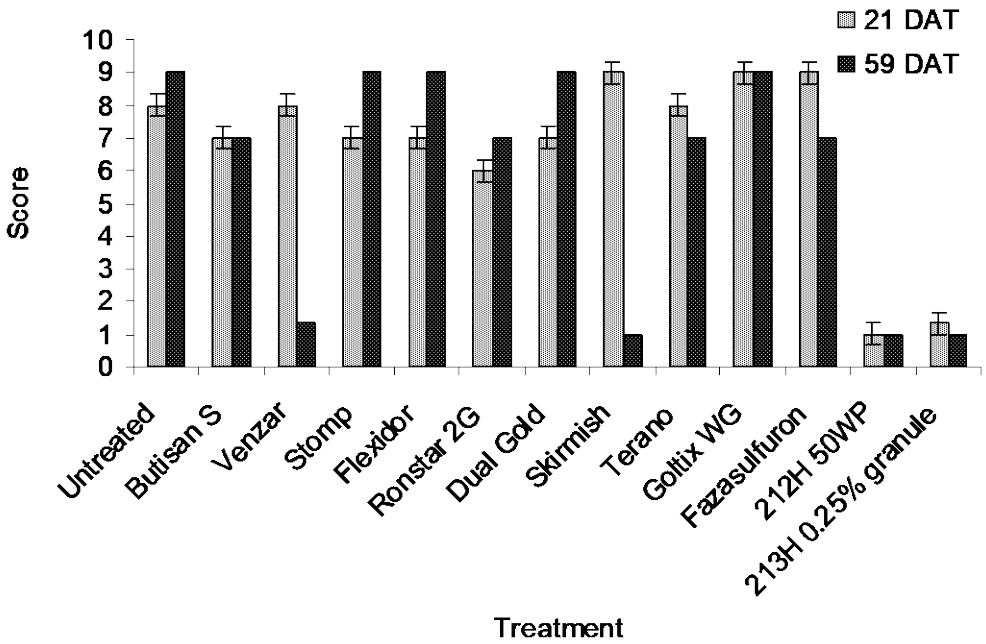


Figure 16. Willowherb: 3-4 true leaf control score at 21 and 59 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at *P* = 0.05. Score 9 = healthy, 1 = dead)

Sagina procumbens (pearlwort)

All treatments except Ronstar 2G and Goltix WG controlled pearlwort completely (Fig 17).

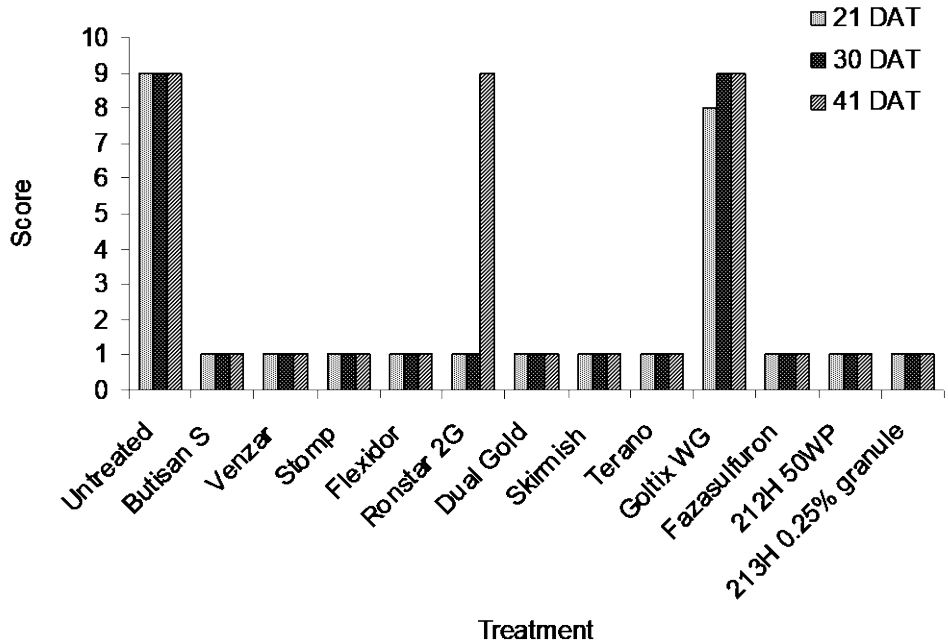


Figure 17. Pearlwort: pre-emergence % control at 21, 30 and 41 days after treatment (DAT) (Score 9 = healthy, 1 = dead)

At the 1-2 leaf stage, pearlwort was much more difficult to control with only Skirmish, Terano, Flazasulfuron and 212H 50WP giving full control (Fig 18). Of these, only Skirmish and 212H 50WP worked quickly.

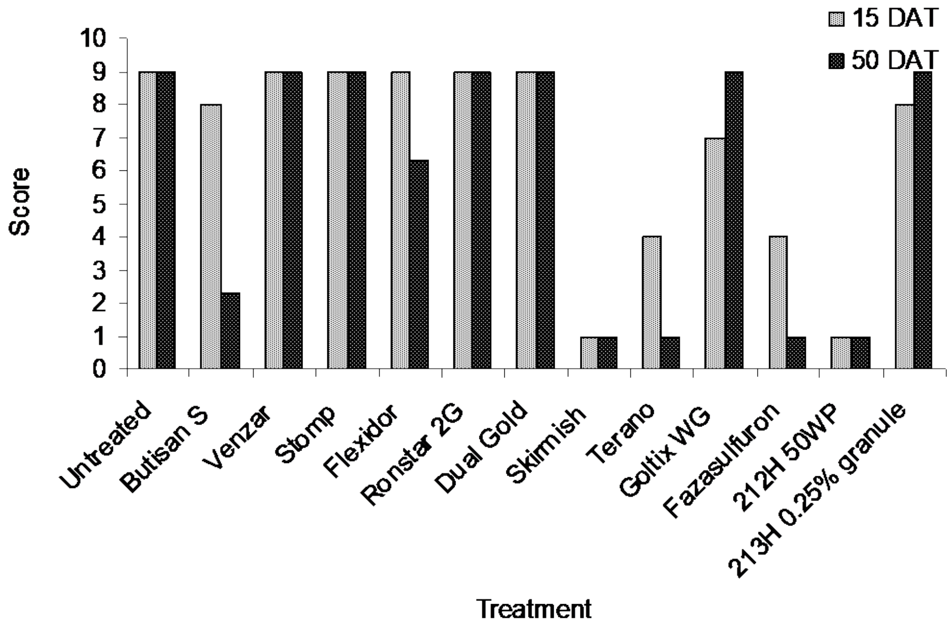


Figure 18. Pearlwort: 1-2 true leaf control score at 15 and 50 days after treatment (DAT). (Score 9 = healthy, 1 = dead)

At the 3-4 true leaf stage control was more difficult with only Skirmish giving control (Fig 19). Even with Skirmish, control was not achieved within 21 days.

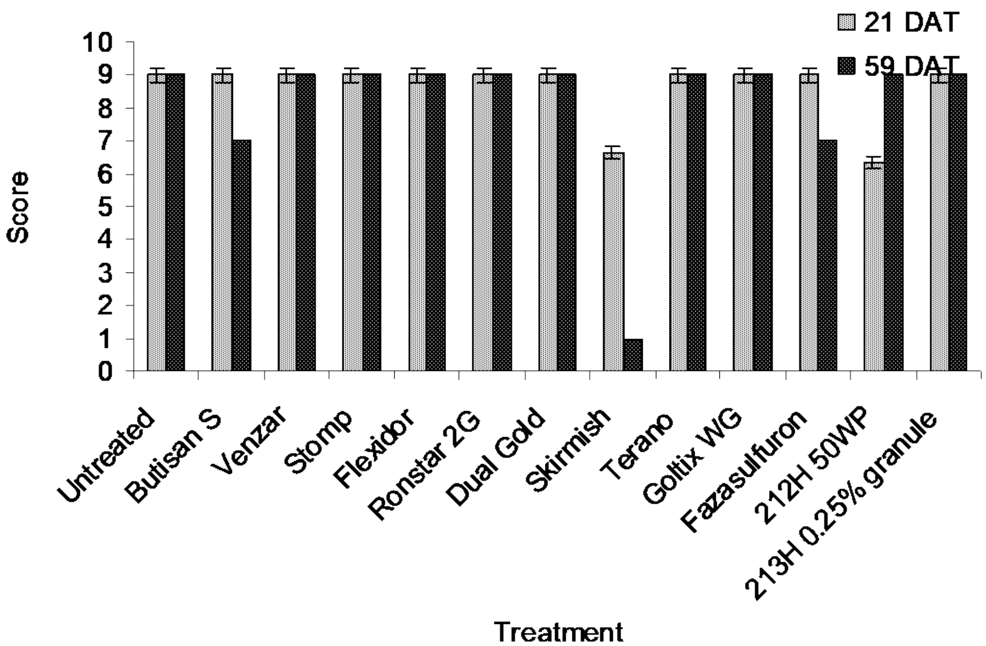


Figure 19. Pearlwort: 3-4 true leaf control score at 21 and 59 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at P = 0.05. Score 9 = healthy, 1 = dead)

<u>*Senecio vulgaris* (groundsel)</u>

The most effective treatments were Butisan S, Venzar Flowable, Ronstar 2G, Terano, Goltix WG, Flazasulfuron and 212H 50WP, giving complete control at 21 days – similar results to the summer treatment. Dual Gold gave partial control. Stomp 400 SC, Flexidor 125, Skirmish and 213H granules were ineffective (Fig 20).

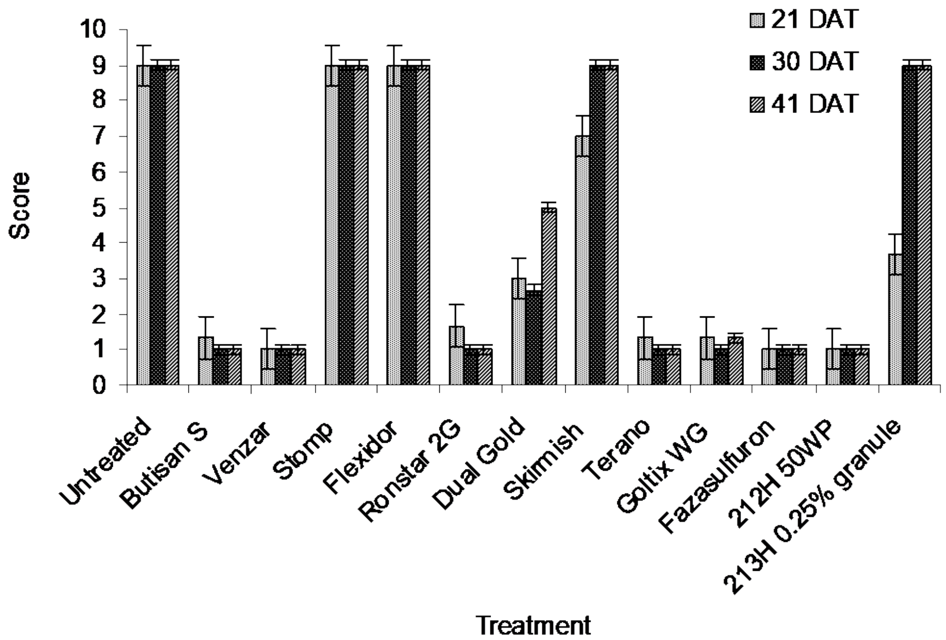


Figure 20. Groundsel: pre-emergence control score at 21, 30 and 41 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at $P = 0.05$. Score 9 = healthy, 1 = dead)

The most effective treatments at the 1-2 leaf stage were Venzar flowable, Ronstar 2G, Flazasulfuron and 212H 50WP (Fig 21). Some treatments (e.g. Stomp 400SC and Flexidor 125) worked slightly better as an early post emergence treatment than as a pre-emergence. However these treatments still did not give full control. There was some natural death of the groundsel throughout all treatments, including the control, during the course of the experiment.

In the 3-4 true leaf stage experiment, many of the groundsel seedlings died before the second recording date. The most effective treatments were Dual Gold, Skirmish, Terano, Flasasulfuron and 212H 50WP (Fig 22).

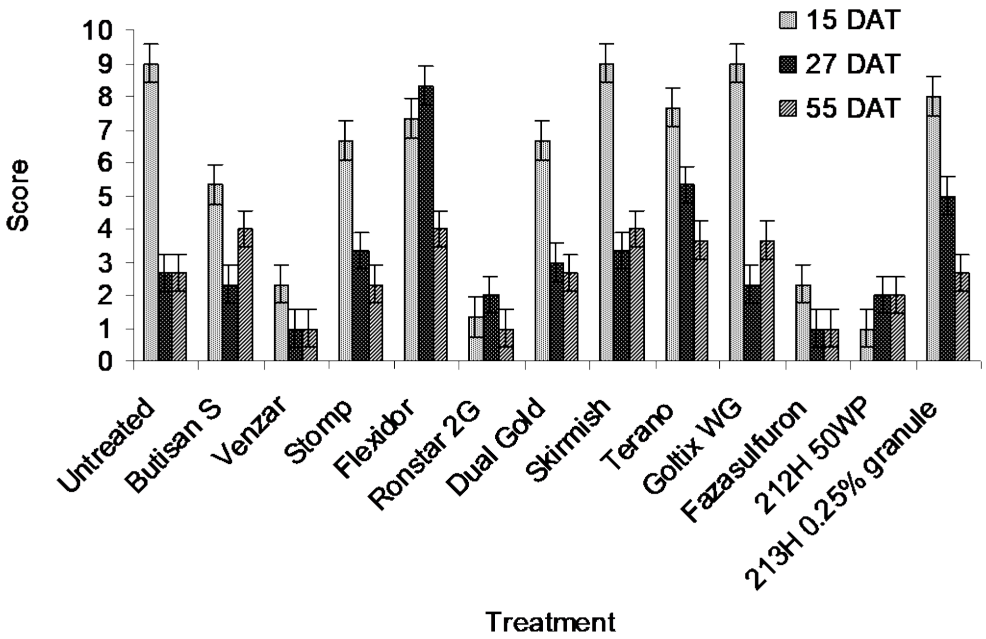


Figure 21. Groundsel: 1-2 true leaf control score at 15, 27 and 55 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at P = 0.05. Score 9 = healthy, 1 = dead)

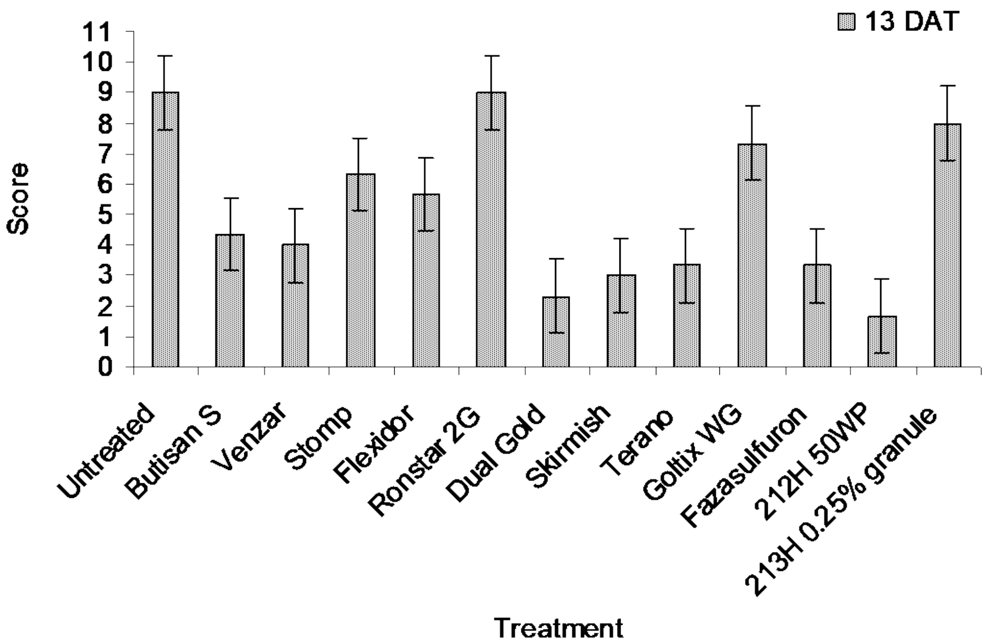


Figure 22. Groundsel: 3-4 true leaf control score at 13 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at P = 0.05. Score 9 = healthy, 1 = dead)

Container plant nursery experiments

Apart from the untreated control, all other treatment programmes started with Ronstar 2G, with the different experimental treatments being applied 4 September 2007. At the time of preparation of this report there were very low levels of weed present in the plots, insufficient to determine differences between the treatments.

Twenty days (24 September 2007) after the second application of herbicides slight phytotoxicity was noted in *Hebe* 'Margaret' in plots treated with Terano – brown leaf spotting near the shoot tips (Fig. 23), and in plots treated with Dual Gold – slight bleaching of the shoot tips (Fig. 24). None of the other treatments appeared to have caused any phytotoxicity.

Figure 23. Hebe treated with Terano showing spotting

Figure 24. Hebe treated with Dual Gold showing bleaching

B: Echinochloa crus-galli (cockspur grass) experiment

Herbicide Screening

For pre-emergence control, the most effective treatments were Butisan S, Stomp 400 SC, Kerb Flo, Artist, Crystal, Chlorotoluron and Dual Gold, controlling both strains. Venzar Flowable and Samson were partially effective and Atlantis WG was ineffective (Figs 25 and 26). Although strain 2 appeared to be more tolerant of some herbicides in the summer treatment experiment, in these autumn experiments the strains were similar in performance.

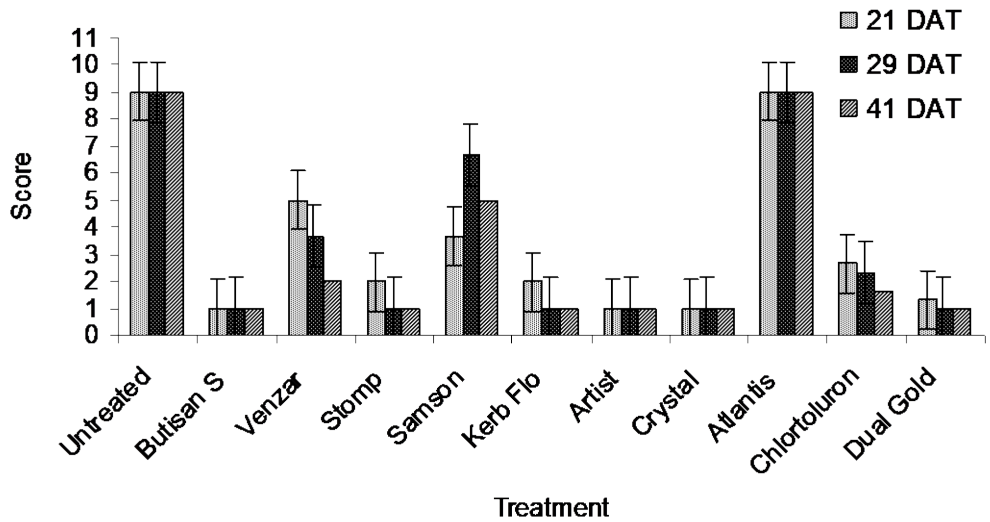


Figure 25. Cockspur grass: pre-emergence control score, strain 1 at 21, 29 and 41 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at $P = 0.05$. Score 9 = healthy, 1 = dead)

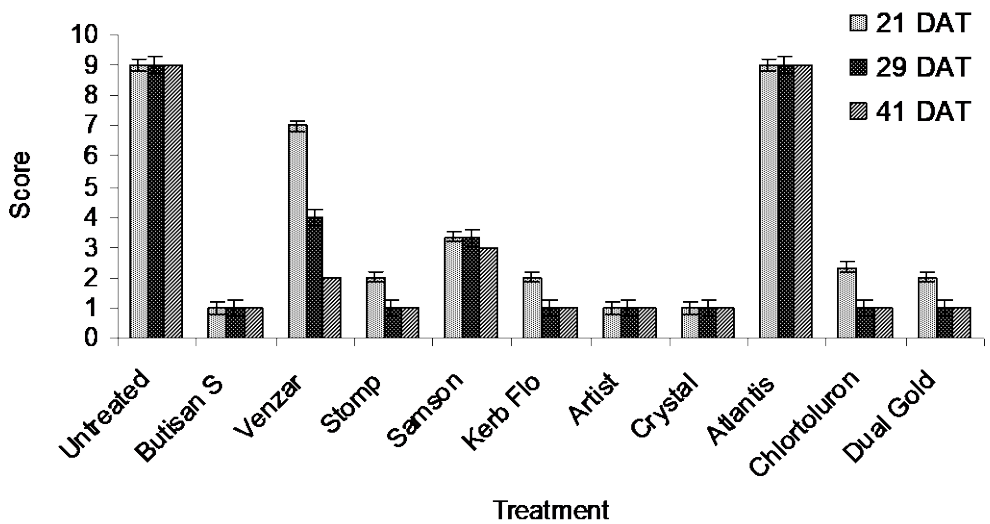


Figure 26. Cockspur grass: pre-emergence control score, strain 2 at 21, 29 and 41 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at $P = 0.05$. Score 9 = healthy, 1 = dead)

At the 3-4 leaf stage the specific grass herbicides Laser, Fusilade Max, Aramo and Falcon all gave complete control of plants of both strains at the 3-4 leaf stage. As noted in the summer, Laser and Fusilade Max were faster acting than Aramo or Falcon. Artist gave good control of strain 1 with strain 2 resistant post-emergence. Apart from the specific graminicides, Samson was the only other herbicide to give post emergence control. Butisan S stunted the plants, but not as much as when used in the summer treatment. (Figs 27 and 28). Venzar Flowable, Stomp 400SC, Kerb Flo, Crystal, Chlorotoluron, Dual Gold and Atlantis WG were relatively ineffective.

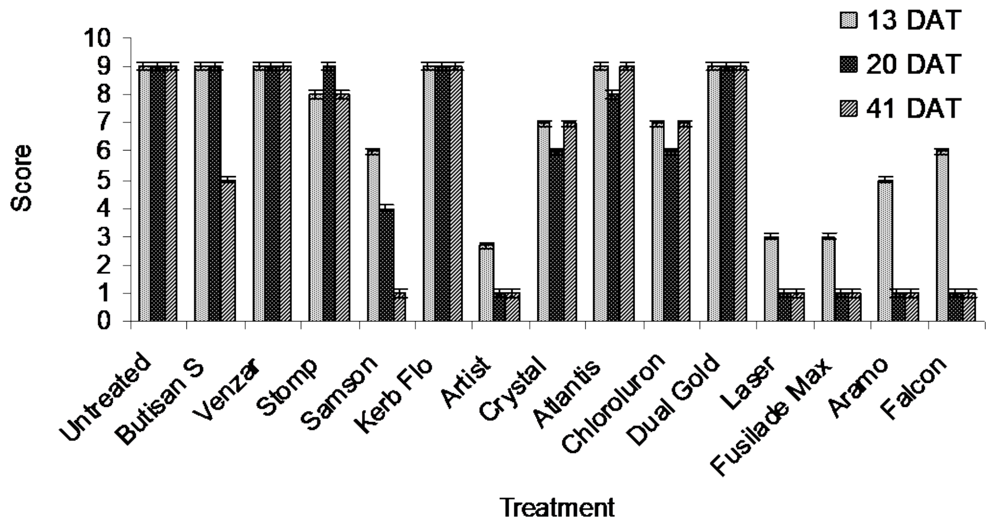


Figure 27. Cockspur grass: 3-4 leaf control score, strain 1 at 13, 20 and 41 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at P = 0.05. Score 9 = healthy, 1 = dead)

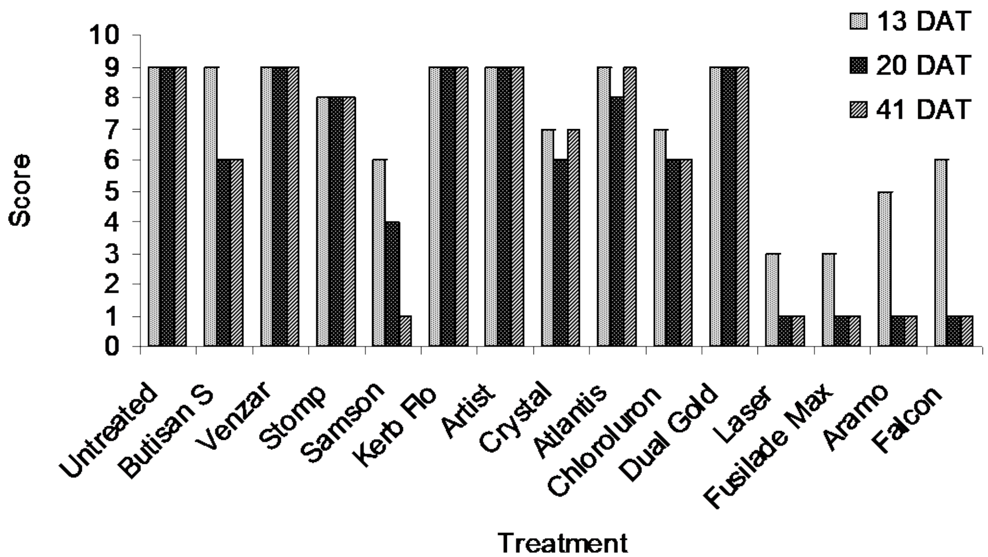


Figure 28. Cockspur grass: 3-4 leaf control score, strain 2 at 13, 20 and 41 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at P = 0.05. Score 9 = healthy, 1 = dead)

Laser, Fusilade Max, Aramo and Falcon gave control of 10 leaf plants of both strains (Figs 29 and 30). None of the other herbicides controlled these larger plants.

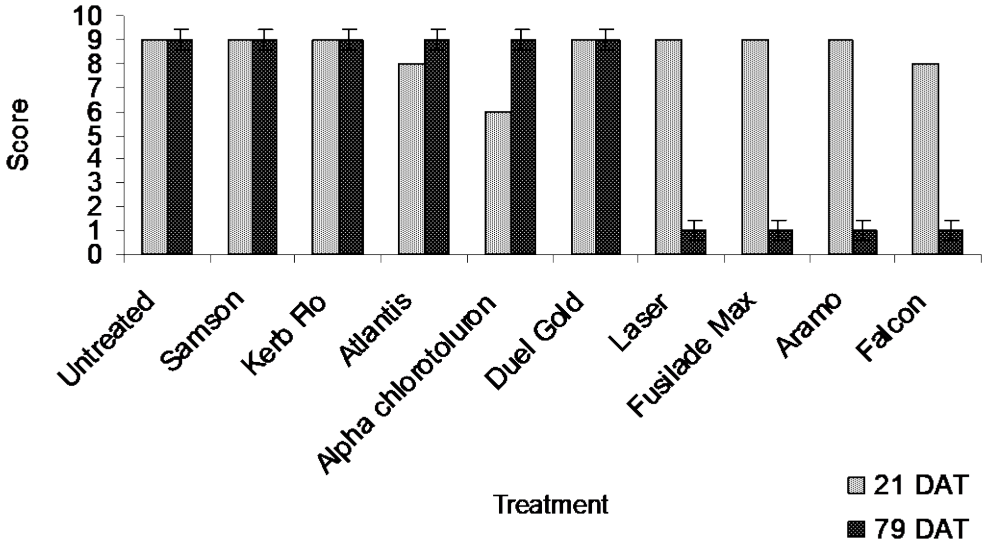


Figure 29. Cockspur grass: 6-10 leaf control score, strain 1 at 21 and 79 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at P = 0.05. Score 9 = healthy, 1 = dead)

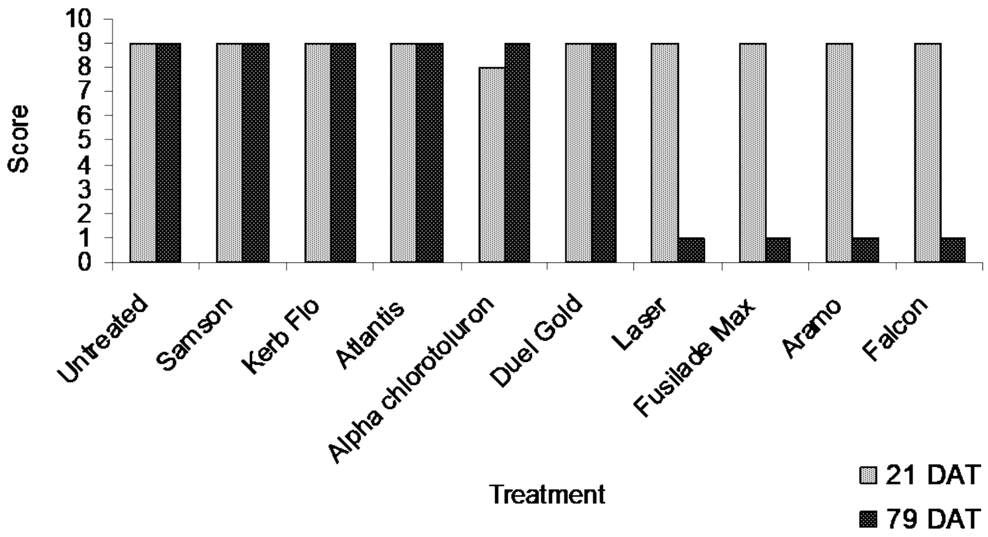


Figure 30. Cockspur grass: 6-10 leaf control score, strain 2 at 21 and 79 days after treatment (DAT). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at P = 0.05. Score 9 = healthy, 1 = dead)

Field nursery experiments

In the field experiment a very high population of *E. crus-galli* developed (Fig 31), germinating during June 2007. The May-applied herbicide treatments (2-6) were all very effective, significantly reducing the seedling population to a low level (Table 18). Butisan S, Dual Gold and Artist (Fig 33) were particularly effective. No further seedlings germinated after 6 July and the percentage cover recorded on 31 August was the result of growth from existing seedlings. An application of Laser (treatment 7) in July completely controlled all *E. crus-galli* in those plots, even though plants had 10 tillers and were 60 cm in height (Fig 33). Overall the most effective pre-emergence treatments were Butisan S and Dual Gold, and Laser was fully effective as a post emergence treatment.

Table 18. Seedling numbers and % cover of *Echinocloa crus-galli* – 6 July 2007 and 31 August 2007

Treatment	Product / Rate	Seedling No. / m^2 6/07/07	Seedling No. / m^2 log transform 6/07/07	% Cover *Echinocloa* 31/08/07
1.	Untreated control	15.9	1.006	80.0
2.	Butisan S 2.5 L/ha	0.2	0.086	0.2
3.	Springbok 2.5 L/ha	1.7	0.403	21.7
4.	Crystal 4.0 L/ha	2.7	0.435	29.3
5.	Dual Gold1.6 L/ha	0.1	0.057	1.0
6.	Artist 2.5 kg/ha	0.1	0.044	26.7
7.	Laser 2.25 L/ha+ Nufarm Cropoil 0.8%	7.6	0.816	0.0
	P (ANOVA)		0.011	0.007
	df		12	12
	SED		0.2502	17.53

The trees were examined for signs of phytotoxicity on 6 July 2007, 50 days after treatment. Phytotoxicity was seen only where the trees had been sprayed over the foliage with Artist. None of the soil applied herbicide treatments caused any damage. Foliar applied Artist caused marginal leaf scorch to *Malus domestica* 'Reverend W Wilks' and 'Grenadier', *Prunus* 'Amanagowa' *Pyrus communis* 'Concorde' and *Sorbus intermedia*. The *Prunus insititia* 'Merryweather Damson' failed to establish.

Figure 31. *E. crus-galli* untreated

Figure 32. Artist treatment

Figure 33. Laser + oil treatment

C.* Equisetum arvense *(field horsetail) experiment

Following treatment in 2006, records were taken of the frond re-growth in 2007. The only treatments to significantly reduce the re-growth (by around 50%) were June-applied Weedazole TL with either Headland Fortune or Guard 2000 adjuvant. Although treatments including Agroxone had controlled virtually all *E. arvense* top growth in 2006, re-growth from these treatments was strong in 2007. While the addition of Agroxone to Weedazole TL improved initial “knockdown” , this was detrimental to longer-term control.

A further range of hormone herbicides was tested in 2007, all with Headland Fortune adjuvant. The infestation on the 2007 plots was lower and more variable than in 2006. Probably as a result of the wetter summer, the amount of re-growth from the treatments was greater than in 2006. I.T. Dicamba and Headland Link (dichlorprop-p) had no significant effect when applied with Headland Fortune, but the combination of one or both products with Agroxone significantly reduced the re-growth by 28 August 2007.

Table 19. Field horsetail: fronds/m^2 in 2007 following June (March* or Sept**) 2006 treatment

Treatment	Product	Fronds / m^2 26/6/07
1.	Untreated control	326
2.	Untreated control	349
3.	Casoron G granules125.0 kg/ha (*March 2006)	397
4.	Weedazol-TL 20.0 L/ha + Headland Fortune 2.0 L/ha	164
5.	Weedazol-TL 20.0 L/ha + Headland Guard 2000 0.4 L/ha	232
6.	Weedazol-TL 20.0 L/ha + Headland Rhino 0.6 L/ha	173
7.	Weedazol-TL 20.0 L/ha + Headland Intake 2.0 L/ha	215
8	Weedazol-TL 20.0 L/ha + Headland Fortune 2.0 L/ha (**Sept 2006)	226
9.	Weedazol-TL 20.0 L/ha + Agroxone 6.0 L/ha + Headland Fortune 2.0 L/ha	233
10.	Glypfos 5.0 L/ha + Headland Rhino 0.6 L/ha	272
11.	Glyfos 5.0 L/ha + Headland Fortune 2.0 L/ha	236
12.	Glyfos 5.0 L/ha + Headland Rhino 0.6 L/ha (**Sept 2006)	238
13.	Glyfos 5.0 L/ha + Agroxone 6.0 L/ha + Headland Fortune 2.0 L/ha	324
14.	Glyfos 5.0 L/ha + Shark 0.33 L/ha	360
15.	BAS 635H 70.0 g/ha + Headland Fortune 2.0 L/ha	309
16.	Harvest 5.0 L/ha + Headland Fortune 2.0 L/ha	288
17.	Agroxone 6.0 L/ha + Headland Fortune 2.0 L/ha	311
18.	Cleancrop Unival 6.0 L/ha + Headland Fortune 2.0 L/ha	290
19.	Starane 2 2.0 L/ha + Headland Fortune 2.0 L/ha	318
20.	212H 50WP 0.84 kg/ha + Harvest 5.0 L/ha + Headland Fortune 2.0 L/ha	313
	P (ANOVA)	0.108
	df	38
	SED	68.9

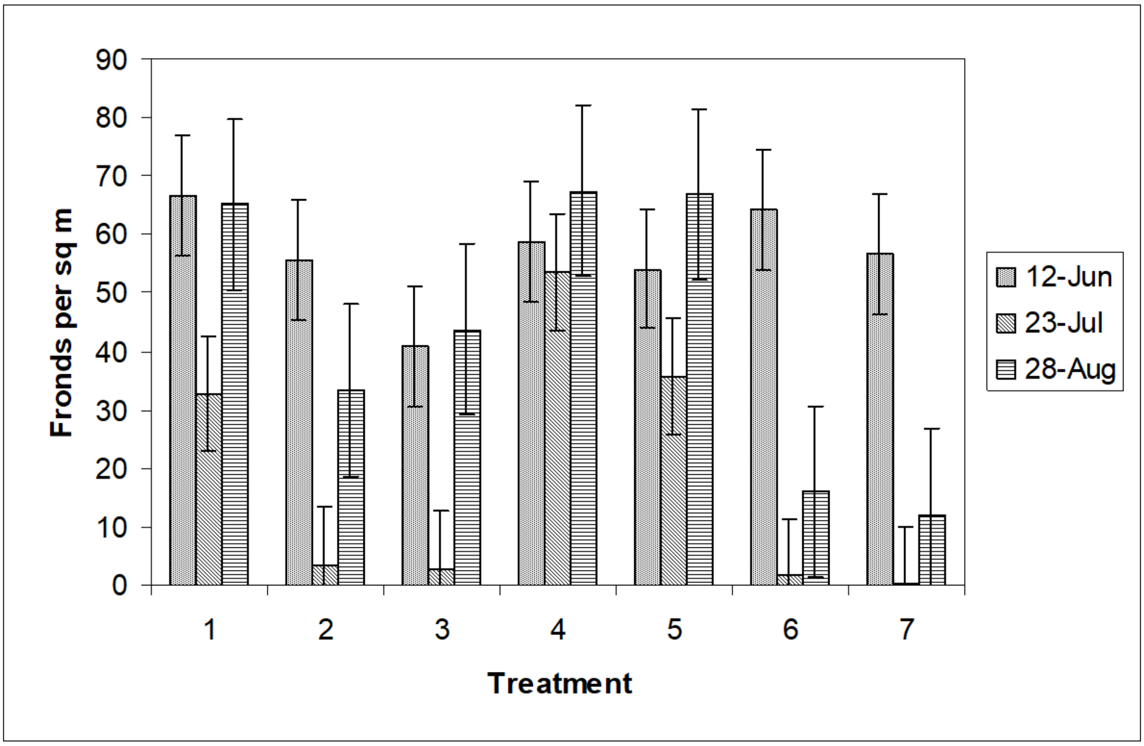


Figure 34. Field horsetail: frond counts (fronds/m^2) (treatment numbers are detailed in Table 20). (For each assessment date comparing treatments, differences falling within the error bar (SED) range are not significant at P = 0.05)

Table 20. Treatment key for field horsetail experiment

Treatment	Product
1.	Untreated control
2.	Weedazol-TL 20.0 L/ha + Headland Fortune 2.0 L/ha
3.	Agroxone 6.0 L/ha + Headland Fortune 2.0 L/ha
4.	I.T. Dicamba 5.0 L/ha + Headland Fortune 2.0 L/ha
5.	Headland Link 2.4 L/ha + Headland Fortune 2.0 L/ha
6.	Agroxone 6.0 L/ha + I.T. Dicamba 5.0 L/ha + Headland Fortune 2.0 L/ha
7.	Agroxone 6.0 L/ha + I.T. Dicamba 5.0 L/ha + Headland Link 2.4 L/ha + Headland Fortune 2.0 L/ha

D.* Rorrippa sylvestris *(creeping yellow cress) experiment

In 2006 the Weedazol-TL, Glyfos and Cleancrop Unival treatments both gave the most immediate control of creeping yellow cress. By 2007 however only the Cleancrop Unival treatment treatment was giving virtually full control (Table 21). Weedazole-TL was the next best treatment.

Table 21. Percentage cover of *R. sylvestris* in 2007 following June 2006 treatment

Treatment	Product / Rate		% Cover 2/07/07
1.	Untreated control		98.3
2.	Weedazol-TL 20.0 L/ha		18.3
3.	Glyfos 5.0 L/ha		40.0
4.	Glyfos 5.0 L/ha + Shark 1.0 L/ha		30.0
5.	BAS 635H 70.0 g/ha + Activator 90 1.0 L/ha		95.0
6.	Cleancrop Unival 6.0 L/ha		7.3
7.	Starane XL 1.8 L/ha		86.7
8.	Starane 2 2.0 L/ha		95.0
9.	Prospect 40.0 g/ha		100.0
10.	Terano 0.75 kg/ha		78.3
		P(ANOVA)	<0.001
		df	18
		SED	9.36

The Weedazole-TL treatment was less effective in 2007 than in 2006 with re-growth occurring by the end of August (Figs 36, 38). Cleancrop Unival (Fig 37) was again the most effective treatment, with a rapid knockdown and no re-growth at the end of August. At this stage there was no advantage in mixing other herbicides with Cleancrop Unival. Of the other hormone herbicides, IT Dicamba was the most effective and the three way mix of Herboxone, I.T. Dicamba and Headland Link was as effective as Cleancrop Unival.


Figure 35. Cress untreated


Figure 36. Weedazole-TL


Figure 37. Cleancrop Unival

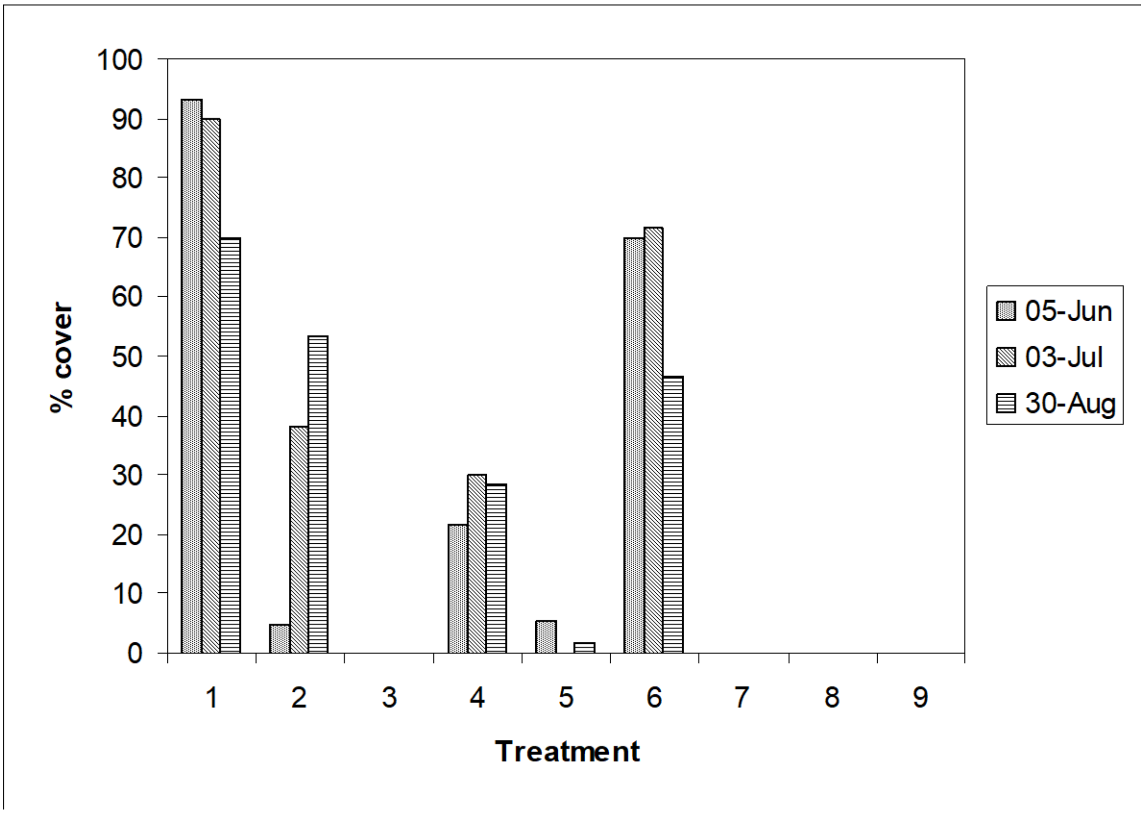


Figure 38. Percentage cover (in summer 2007) of *R. sylvestris* following May 2007 treatment (Statistical analysis is shown in Appendix 4)

Table 22. Treatment key for data in Figure 38.

Treatment	Product
1.	Untreated control
2.	Weedazol-TL 20.0 L/ha
3.	Cleancrop Unival 6.0 L/ha
4.	Herboxone 3.3 L/ha
5.	I.T. Dicamba 5.0 L/ha
6.	Headland Link 2.4 L/ha
7.	Herboxone 3.3 L/ha + I.T. Dicamba 5.0 L/ha + Cleancrop Unival 6.0 L/ha
8.	Herboxone 3.3 L/ha + I.T. Dicamba 5.0 L/ha + Headland Link 2.4 L/ha
9.	Cleancrop Unival 6.0 L/ha + I.T. Dicamba 5.0 L/ha + Headland Link 2.4 L/ha

E.* Calistegia sepium *(false hedge bindweed) experiment

In 2006 the most effective treatments for initial control were the hormone containing products Herboxone (2,4-D) and I.T. Dicamba. I.T. Dicamba either alone or with Roundup was the most effective treatment, having less re-growth than other treatments. None of the treatments completely prevented re-growth in 2007. The most effective treatment was the combination of I.T. Dicamba with Roundup applied in June 2006 (Table 23). The only other treatment to give a significant re-growth reduction was Roundup, applied September 2006.

Table 23. Percentage cover of *C. sepium* in 2007 following June (or September*) 2006 treatment

Treatment	Product / Rate	% Cover 6 June 2007
1.	Untreated control	93.3
2.	Roundup 5.0 L/ha	66.7
3.	Roundup 5.0 L/ha*	43.3
4.	Sampson1.5 L/ha	93.3
5.	Ronstar Liquid 8.0 L/ha	76.7
6.	Goal 4.0 L/ha	83.3
7.	212H 50WP 0.84 kg/ha	93.3
8	Starane XL 1.8 L/ha	96.7
9.	Herboxone 3.3 L/ha	53.3
10.	I.T. Dicamba 5.0 L/ha	53.3
11.	I.T. Dicamba 5.0 L/ha + Roundup 5.0 L/ha	26.7
12.	BAS 635H 70.0 g/ha + BAS 152000 2.4 L/ha	80.0
	P(ANOVA)	0.009
	df	22
	SED	18.3

In 2007 a later (July) application was tried. The bindweed had developed fully by this stage (Fig 40). The trial plots were flooded on 20 July 2007, one day after treatment application but this does not appear to have affected the results. Again the most effective treatments for immediate knockdown were those including I.T. Dicamba (Figs 39, 41). Whilst the Herboxone treatment had controlled all existing bindweed foliage there were signs of re-growth at the time of recording. At this stage there appeared to be no advantage to using the three way combination of hormone herbicides, treatments 10 and 11. On 18 September percentage cover values were very similar, the effect of the 13 September herbicide application not being visible yet.

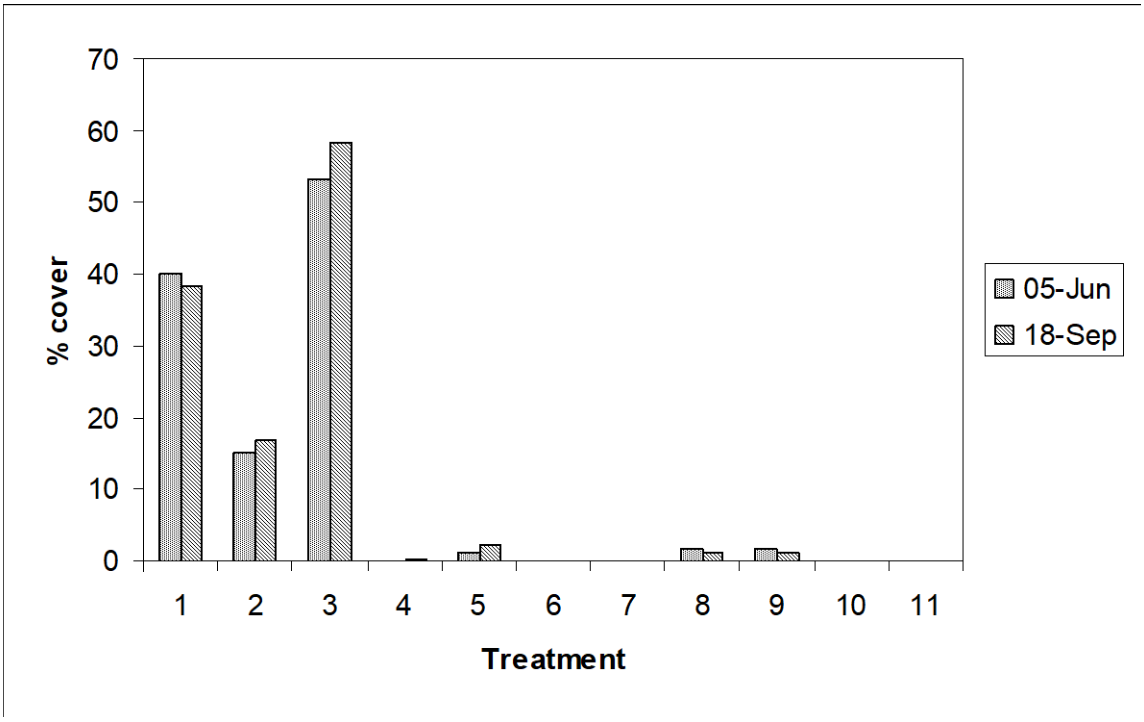


Figure 39. Percentage cover (in summer 2007) of *C. sepium* following 2007 treatment (see Table 24). (Statistical analysis is shown in Appendix 4)

Table 24. Treatment key for data in Figure 39.

Treatment	Product / Rate	Timing
1.	Untreated control	
2.	Centium 0.33 L/ha + Roundup 5 L/ha	19 July
3.	Centium 0.33 L/ha	19 July
	Roundup 5 L/ha	13 Sept
4.	Herboxone 3.3 L/ha + Roundup 5 L/ha	19 July
5.	Herboxone 3.3 L/ha	19 July
	Roundup 5 L/ha	13 Sept
6.	IT.Dicamba 5 L/ha + Roundup 5 L/ha	19 July
7.	IT Dicamba 5 L/ha	19 July
	Roundup 5 L/ha	13 Sept
8.	Starane 2 2 L/ha + Roundup 5 L/ha	19 July
9.	Starane 2 2 L/ha	19 July
	Roundup 5 L/ha	13 Sept
10.	Herboxone 6 L/ha + IT Dicamba 5 L/ha + Starane 2 2 L/ha + Roundup 5 /ha	19 July
11.	Herboxone 6 L/ha + IT Dicamba 5 L/ha + Starane 2 2 L/ha	19 July
	Roundup 5 L/ha	13 Sept

Figure 40. Bindweed IT Dicamba + Roundup

Figure 41. Bindweed untreated

Phytotoxicity field experiment (2007)

None of the herbicides Herboxone, Agroxone, I.T. Dicamba, Headland Link, Cleancrop Unival, 212H 50WP, Terano, or Flazasulfuron caused visible phytotoxicity when applied as directed sprays in *Malus domestica* 'M9', *Prunus* 'Colt', Quince 'C', *Sorbus aucuparia*.

Conclusions

New Zealand, flexuous and hairy bittercress were all controlled by most pre-emergence treatments including the industry standards Ronstar 2G and Flexidor 125. Stomp 400 SC, and Dual Gold were less effective. Goltix WG provided only very short term control. Butisan S did not give complete control of hairy bittercress but gave better control of New Zealand and flexuous bittercress. Control at the post emergence stages for the New Zealand and flexuous bittercress was more difficult with only Skirmish, Terano, 212H 50WP and Flazasulfuron providing control up to 3-4 true leaves. By comparison, hairy bittercress proved easier to control post emergence with all the latter herbicides, and Flexidor 125 and Ronstar 2G provided control up to 3-4 true leaves. Venzar flowable controlled all bittercress species pre-emergence but only hairy bittercress post emergence (1-2 true leaves), and with variable control of New Zealand bittercress.

All pre-emergence treatments except Ronstar 2G and Goltix WG controlled common mouse-ear. Stomp 213H granules and Dual gold gave only partial control. Results were similar to the summer treatment except that 213H was slightly less effective in the autumn. Venzar Flowable, Skirmish, Terano, Flazasulfuron and 212H also gave good control at all stages up to 3-4 true leaves and Flexidor 125 up to 1-2 true leaves. The other herbicides were relatively ineffective for post emergence control.

Willowherb was well controlled pre-emergence by all herbicides except Flexidor 125, Goltix WG and Stomp 400 SC. Venzar Flowable, Skirmish, and 212H 50WP also gave control up to 3-4 true leaves. Interestingly, Flazasulfuron gave excellent post-emergence control slightly better than the pre-emergence control and similarly Stomp 400 SC, Flexidor 125 and Goltix WG also had some early post-emergence activity in spite of poor pre-emergence control.

All pre-emergence treatments except Ronstar 2G and Goltix controlled pearlwort completely. At the 1-2 true leaf stage, pearlwort was much more difficult to control with only Skirmish, Terano, Flazasulfuron and 212H 50WP giving full control. Of these, only Skirmish and 212H 50WP worked quickly. Only Skirmish controlled the 3-4 true leaf seedlings and control was slow, taking more than 21 days.

For groundsel, the most effective pre-emergence treatments were Butisan S, Venzar Flowable, Ronstar 2G, Terano, Goltix WG, Flazasulfuron and 212H 50WP, giving complete control at 21 days – similar results to the summer treatments. Dual Gold gave partial control. Stomp 400 SC, Flexidor 125, Skirmish and 213H granules were ineffective, although 213H granules had worked better in the summer. The most effective treatments at the 1-2 true leaf stage were Venzar flowable, Ronstar 2G, Flazasulfuron and 212H 50WP. At the 3-4 true leaf stage the summer experiments showed only Flazasulfuron gave rapid kill, Venzar Flowable was effective but slower.

Of the newer treatments Terano, Skirmish, Flazasulfuron, 212H 50WP and 213H granules were all effective on most of the target weeds tested. However Skirmish, Flazasulfuron, and 212H 50WP are known to have a strong contact action so will only have potential for use during the dormant season on nursery stock. Dual Gold has potential for use as a summer spray treatment, as an alternative or supplement to Flexidor 125. Compared with Flexidor 125 the control of willowherb is very good and groundsel is better, but there are some significant weaknesses in the control of bittercress and mouse ear. The initial observations on a range of container-grown stock indicate that Terano and Dual Gold might be safe enough for summer use. Terano however caused slight damage to *Hebe*. For all of these products, crop safety needs to be further established, for both growing and dormant season uses on container grown nursery stock. Unfortunately it has become clear that 213H granules will not be introduced into the UK market, so further work on this product has ceased.

For pre-emergence control of Cockspur grass, Butisan S, Stomp 400 SC, Kerb Flo, Artist, Crystal and Dual Gold were all very effective for both strains tested in both the summer and autumn pot experiments. For post emergence control all the specific graminicides tested had useful activity even up to the 10 true leaf stage. Laser was faster acting in the autumn treatment and provided the better control of 10 true leaf plants in the summer. These results were confirmed in the field experiments where Butisan S, Artist and Dual Gold all proved to be very effective in providing residual control. Butisan S and Artist have known contact activity and some damage was noted where Artist was applied over the tree foliage. Dual Gold and Crystal have relatively little contact activity and so should prove safer for use over actively growing foliage. Of the two, Dual Gold provided better control, but Crystal is already available in the UK. Laser was tested as a selective contact herbicide and proved very effective, controlling 60 cm high Cockspur grass, without damaging the crop.

Field horsetail proved difficult to control, with only the Weedazol-TL and Agroxone (MCPA) treatments giving effective control in the season of treatment. Weedazol-TL was the only treatment to give a significant reduction in horsetail re-growth the following year. Although Agroxone gave a very good initial knockdown there was no significant effect in the following year and the addition of Agroxone to Weedazole-TL was counterproductive in terms of control. None of the other hormone herbicides tested in 2007 were effective when used alone, but when used in addition to Agroxone, re-growth during the season was reduced.

Differences in adjuvant activity were not significant in 2006, but there were indications that Headland Fortune was the most effective and the use of this combination resulted in the least re-growth the following year.

Weedazol-TL, Glyfos, and Cleancrop Unival controlled creeping yellow cress during the 2006 treatment season. Cleancrop Unival was the only treatment to substantially reduce the re-growth in the following season although weedazole-TL also gave a good reduction. Similarly in 2007, Cleancrop Unival gave a rapid knockdown with no re-growth seen. Weedazole-TL was less effective in 2007, possibly due to a wetter season.

False hedge bindweed also proved difficult to control. Whilst Herboxone (2,4-D), or Dicamba proving quite effective during the treatment season it was only the combination of Dicamba + Roundup that significantly reduced the re-growth the following year. The combination of July applied hormone herbicides in a tank mix with Roundup have proved effective again in 2007, but it will be the re-growth in 2008 that will determine the most effective treatment.

None of the herbicides Herboxone, Agroxone, I.T. Dicamba, Headland Link, Cleancrop Unival, 212H 50WP, Terano, or Flazasulfuron caused visible phytotoxicity when applied as directed sprays in *Malus domestica* 'M9', *Prunus* 'Colt', Quince 'C', or *Sorbus aucuparia*.

Technology transfer

Two HDC news articles were published during the year. One reported on results of the container seedling weed experiments and the other reported on the cockspur grass experiments.

References

Coupland, D. and Peabody, D.V. (1981). Effect of four foliage herbicides on field horsetail *Equisetum arvense*. Weed Science 29 (1):113-119.

Eelden, H. and Bulcke, R. (1998). Identification of bittercress species (*Cardamine* L.) in ornamental nurseries and their response to isoxaben. Abstracts "Ornamentals: developing the future", conference at St. Catherine's College Oxford, 29 June - 1 July 1998. Association of Applied Biologists.

Hallgren, R. (1996). Control of common horse tail (*Equisetum arvense*) in fallow. Agriculture – pests, diseases and weeds. Swedish Crop Protection Conference Uppsala 37:325-329.

Hoagland, R.E., Hirase, K. (2003). Isolation and study of arylacylamidase activity from propanil-resistant barnyardgrass [*Echinochloa crus-galli* (L.) Beauv.]. Proceedings of the Southern Weed Science Society. 43:347.

Kahn, M.A and Kahn, B.M. (2003). Efficacy of different herbicides on the yield and yield components of Maize. Asian Journal of Plant Science 2 (3):300-304.

Marshall, G. (1984). A review of the control of *Equisetum arvense* L. (field horsetail). Aspects of Applied Biology 8:3-42.

Merbach, I. (1993). Control of *Equisetum arvense* L. (field horsetail) on waste land with splitted and reduced doses of MCPA. Zeitschrift fuer Pflanzenkrankheiten und Pflanzenschutz 100 (3):317-342.

Nilsson, H. and Hallgren, R. (1991). Control of *Equisetum arvense* with herbicides. A greenhouse experiment. Agriculture – pests, diseases and weeds. Swedish Crop Protection Conference Uppsala 32:297-303.

Vezina, L. (1990). Efficacy of herbicide programmes used in barley and maize on *Equisetum arvense* L populations in Quebec Canada. Weed Research 30 (1):71-79.

Appendices

Appendix 1: seedling container weed experiment

Herbicide screening

Table 25. Mean control scores for *Cardamine corymbosa*

Growth stage	Pre-em	Pre-em	Pre-em	1-2 leaves	1-2 leaves	3-4 leaves	3-4 leaves
Assessment time	21 DAT	30 DAT	41 DAT	15 DAT	50 DAT	21 DAT	59 DAT
Untreated	9.0	9	9	9.0	9.0	9.0	9
Butisan S	2.3	1	1	9.0	9.0	9.0	9
Venzar	2.0	1	1	8.0	7.7	9.0	9
Stomp	7.0	2	1	8.0	9.0	9.0	9
Flexidor	1.0	1	1	1.0	9.0	9.0	9
Ronstar 2G	1.0	1	1	8.7	5.7	9.0	9
Dual Gold	3.7	2	4	4.0	9.0	8.7	9
Skirmish	1.0	1	1	1.0	1.0	8.0	1
Terano	1.7	2	1	2.7	1.0	8.0	1
Goltix WG	2.7	3	9	6.3	9.0	9.0	9
Fazasulfuron	2.0	1	1	8.7	1.0	8.0	1
212H 50WP	1.0	1	1	1.0	1.0	8.0	9
213H 0.25% granule	1.0	1	1	7.7	8.0	8.0	8
SED	0.54	*	0.23	1.39	1.390	0.13	*
P(ANOVA)	<0.001		<0.001	<0.001	<0.001	<0.001	
df	24		24	24	24	24	

*Not suitable for analysis

Table 26. Mean control scores for *Cardamine flexuosa*

Growth stage	Pre-em	Pre-em	Pre-em	1-2 leaves	1-2 leaves	3-4 leaves	3-4 leaves
Assessment time	21 DAT	30 DAT	41 DAT	15 DAT	50 DAT	21 DAT	59 DAT
Untreated	9.0	9	9	9.0	9.0	9.0	9
Butisan S	2.0	1	1	9.0	9.0	9.0	9
Venzar	3.0	1	1	9.0	9.0	9.0	9
Stomp	8.0	1	1	9.0	9.0	9.0	9
Flexidor	1.0	1	1	7.3	6.3	9.0	9
Ronstar 2G	1.0	1	1	8.7	5.0	9.0	9
Dual Gold	1.7	1	4	9.0	9.0	8.3	9
Skirmish	1.0	1	1	3.7	1.0	8.0	1
Terano	1.3	1	1	4.3	1.0	8.0	1
Goltix WG	2.7	5.3	9	7.3	9.0	9.0	9
Fazasulfuron	2.0	1	1	1.7	1.0	8.0	1
212H 50WP	1.0	1	1	1.0	1.0	8.0	9
213H 0.25% granule	1.0	1	1	9.0	8.7	8.0	8
SED	0.23	0.1307	*	1.38	*	0.13	*
P(ANOVA)	<0.001	<0.001		<0.001		<0.001	
df	24	24		24		24	

*Not suitable for analysis

Table 27. Mean control scores for *Cardamine hirsuta*

Growth stage	Pre-em	Pre-em	Pre-em	1-2 leaves	1-2 leaves	1-2 leaves	3-4 leaves	3-4 leaves
Assessment time	21 DAT	30 DAT	41 DAT	15 DAT	27 DAT	55 DAT	13 DAT	48 DAT
Untreated	9.0	9	9	9.0	5.0	9.0	9.0	9.0
Butisan S	7.0	2	5	7.3	7.0	8.7	8.7	4.3
Venzar	3.0	1	1	1.0	1.0	1.0	9.0	4.7
Stomp	7.0	7	1	8.7	4.7	8.7	9.0	9.0
Flexidor	1.0	1	1	1.3	1.0	1.0	7.7	2.7
Ronstar 2G	1.0	1	1	1.0	1.0	1.0	2.3	1.0
Dual Gold	7.0	2	6	9.0	7.0	9.0	7.7	6.7
Skirmish	1.0	1	1	1.0	1.0	1.0	9.0	9.0
Terano	1.0	1	1	2.7	5.0	1.0	6.0	2.0
Goltix WG	2.3	8	9	8.3	8.0	9.0	9.0	8.7
Fazasulfuron	1.7	1.7	1	1.7	1.0	1.0	8.0	1.0
212H 50WP	1.0	1	1	1.0	1.0	1.0	1.0	1.0
213H 0.25% granule	1.7	1	1	9.0	7.0	9.0	2.7	8.0
SED	0.32	0.13	*	0.33	0.48	0.48	0.3	0.3
P(ANOVA)	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
df	24	24		24	24	24	24	24

*Not suitable for analysis

Table 28. Mean control scores for *Cerastium fontanum*

Growth stage	Pre-em	Pre-em	Pre-em	1-2 leaves	1-2 leaves	1-2 leaves	3-4 leaves	3-4 leaves
Assessment time	21 DAT	30 DAT	41 DAT	15 DAT	27 DAT	55 DAT	13 DAT	48 DAT
Untreated	9.0	9	9	9.0	8.0	8.3	9.0	9.0
Butisan S	2.0	2	1	8.7	6.3	6.7	9.0	8.7
Venzar	1.3	1	1	1.0	1.0	1.0	7.7	1.0
Stomp	7.0	2	1	8.7	8.0	3.7	8.0	8.7
Flexidor	1.0	1	1	1.7	1.0	1.0	7.0	1.7
Ronstar 2G	5.0	9	9	7.3	8.0	8.0	8.0	8.0
Dual Gold	3.0	2	8	7.7	8.0	7.3	8.0	8.7
Skirmish	1.0	1	1	1.0	1.0	1.0	8.3	1.0
Terano	1.3	1	1	6.7	1.0	3.0	8.7	9.0
Goltix WG	7.7	7.7	9	8.7	8.0	8.7	8.0	8.7
Fazasulfuron	2.0	2	1	1.7	1.0	1.0	7.0	2.0
212H 50WP	1.0	1	1	1.0	1.0	1.0	1.0	1.0
213H 0.25% granule	2.3	3.7	3.7	8.0	9.0	9.0	1.0	1.7
SED	0.577	1.089	1.046	0.37	0.1307	0.1307	0.2327	0.3
P(ANOVA)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
df	24	24	24	24	24	24	24	24

Table 29. Mean control scores for *Epilobium ciliatum*

Growth stage	Pre-em	Pre-em	Pre-em	1-2 leaves	1-2 leaves	3-4 leaves	3-4 leaves
Assessment time	21 DAT	30 DAT	41 DAT	15 DAT	50 DAT	21 DAT	59 DAT
Untreated	9.0	9	9	9.0	8.0	8.0	9
Butisan S	1.0	1	1	7.7	6.7	7.0	7
Venzar	1.7	1	1	8.7	8.7	8.0	1.3
Stomp	8.0	7	3	9.0	4.3	7.0	9
Flexidor	9.0	9	9	9.0	7.3	7.0	9
Ronstar 2G	1.0	1	1	1.7	1.0	6.0	7
Dual Gold	2.0	1	1	9.0	7.3	7.0	9
Skirmish	2.0	3.7	3.7	1.7	1.0	9.0	1
Terano	1.3	2	1	9.0	1.0	8.0	7
Goltix WG	7.0	7	9	7.7	9.0	9.0	9
Fazasulfuron	1.0	1	1	7.7	4.0	9.0	7
212H 50WP	1.0	1	1	1.0	1.0	1.0	1
213H 0.25% granule	1.0	1	1	4.3	3.7	1.3	1
SED	0.36	1.102	1.046	0.36	*	0.33	0.1307
P(ANOVA)	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001
df	24	24	24	24		24	24

*Not suitable for analysis

Table 30. Mean control scores for *Sagina procumbens*

Growth stage	Pre-em	Pre-em	Pre-em	1-2 leaves	1-2 leaves	3-4 leaves	3-4 leaves
Assessment time	21 DAT	30 DAT	41 DAT	15 DAT	50 DAT	21 DAT	59 DAT
Untreated	9.0	9	9	9.0	9	9.0	9
Butisan S	1.0	1	1	8.0	2.3	9.0	7
Venzar	1.0	1	1	9.0	9	9.0	9
Stomp	1.0	1	1	9.0	9	9.0	9
Flexidor	1.0	1	1	9.0	6.3	9.0	9
Ronstar 2G	1.0	1	9	9.0	9	9.0	9
Dual Gold	1.0	1	1	9.0	9	9.0	9
Skirmish	1.0	1	1	1.0	1	6.7	1
Terano	1.0	1	1	4.0	1	9.0	9
Goltix WG	8.0	9	9	7.0	9	9.0	9
Fazasulfuron	1.0	1	1	4.0	1	9.0	7
212H 50WP	1.0	1	1	1.0	1	6.3	9
213H 0.25% granule	1.0	1	1	8.0	9	9.0	9
SED	*	*	*	*	*	0.19	*
P(ANOVA)						<0.001	
df						24	

*Not suitable for analysis

Table 31. Mean control scores for *Senecio vulgaris*

Growth stage	Pre-em	Pre-em	Pre-em	1-2 leaves	1-2 leaves	1-2 leaves	3-4 leaves
Assessment time	21 DAT	30 DAT	41 DAT	15 DAT	27 DAT	55 DAT	13 DAT
Untreated	9.0	9	9	9.0	2.7	2.7	9.0
Butisan S	1.3	1	1	5.3	2.3	4.0	4.3
Venzar	1.0	1	1	2.3	1.0	1.0	4.0
Stomp	9.0	9	9	6.7	3.3	2.3	6.3
Flexidor	9.0	9	9	7.3	8.3	4.0	5.7
Ronstar 2G	1.7	1	1	1.3	2.0	1.0	9.0
Dual Gold	3.0	2.7	5	6.7	3.0	2.7	2.3
Skirmish	7.0	9	9	9.0	3.3	4.0	3.0
Terano	1.3	1	1	7.7	5.3	3.7	3.3
Goltix WG	1.3	1	1.3	9.0	2.3	3.7	7.3
Fazasulfuron	1.0	1	1	2.3	1.0	1.0	3.3
212H 50WP	1.0	1	1	1.0	2.0	2.0	1.7
213H 0.25% granule	3.7	9	9	8.0	5.0	2.7	8.0
SED	0.58	0.1307	0.1307	0.59	0.574	0.574	1.202
P(ANOVA)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
df	24	24	24	24	24	24	24

Figure 42. Experimental layout

N >

XBM5508: Control of Problem Weeds. Herbicides Phytotoxicity in Container Plants. 2007. Darby's Nursery, Methwold.

Spiraea	Pyracanth	Veronica	Berb.da	Veronica	Spiraea	Hebe	Buds	Rosmarin	Potentilla	Rosmarin	Hebe
Berb.da	Cham	Cham	Potentilla	Cham	Philadelph	Cham	Berb.da	Pyracanth	Philadelph	Cham	Pyracanth
Lavender	Lonicera	Pyracanth	Philadelph	Lavender	Pyracanth	Rosmarin	Lavender	Lavender	Hebe	Philadelph	Berb.da
Veronica	Hebe	Buds	Rosmarin	Hebe	Berb.da	Lonicera	Philadelph	Buds	Lonicera	Lavender	Buds
Buds	Philadelph	Hebe	Lonicera	Lonicera	Rosmarin	Spiraea	Potentilla	Berb.da	Spiraea	Potentilla	Veronica
Rosmarin	Potentilla	Spiraea	Lavender	Potentilla	Buds	Veronica	Pyracanth	Veronica	Cham	Lonicera	Spiraea
Plot 1	**T2**	**Plot 6**	**T6**	**Plot 11**	**T7**	**Plot 16**	**T9**	**Plot 21**	**T4**	**Plot 26**	**T9**
Berb.da	Potentilla	Pyracanth	Veronica	Lavender	Buds	Lavender	Spiraea	Lonicera	Spiraea	Buds	Hebe
Lonicera	Rosmarin	Buds	Lavender	Berb.da	Cham	Buds	Lonicera	Cham	Lavender	Lonicera	Lavender
Lavender	Philadelph	Philadelph	Rosmarin	Philadelph	Pyracanth	Rosmarin	Berb.da	Berb.da	Buds	Berb.da	Philadelph
Cham	Veronica	Berb.da	Cham	Spiraea	Lonicera	Philadelph	Potentilla	Philadelph	Veronica	Veronica	Pyracanth
Hebe	Buds	Hebe	Spiraea	Potentilla	Rosmarin	Cham	Hebe	Hebe	Rosmarin	Rosmarin	Cham
Spiraea	Pyracanth	Lonicera	Potentilla	Veronica	Hebe	Veronica	Pyracanth	Pyracanth	Potentilla	Potentilla	Spiraea
Plot 2	**T9**	**Plot 7**	**T7**	**Plot 12**	**T3**	**Plot 17**	**T2**	**Plot 22**	**T1**	**Plot 27**	**T5**
Hebe	Lonicera	Rosmarin	Potentilla	Rosmarin	Lavender	Rosmarin	Spiraea	Philadelph	Spiraea	Hebe	Lonicera
Potentilla	Berb.da	Hebe	Cham	Pyracanth	Spiraea	Veronica	Lonicera	Buds	Lavender	Potentilla	Spiraea
Lavender	Pyracanth	Buds	Veronica	Veronica	Philadelph	Lavender	Potentilla	Berb.da	Potentilla	Veronica	Buds
Philadelph	Veronica	Lonicera	Philadelph	Cham	Berb.da	Pyracanth	Berb.da	Hebe	Veronica	Berb.da	Pyracanth
Spiraea	Rosmarin	Lavender	Spiraea	Hebe	Potentilla	Buds	Cham	Rosmarin	Lonicera	Philadelph	Lavender
Buds	Cham	Berb.da	Pyracanth	Buds	Lonicera	Hebe	Philadelph	Cham	Pyracanth	Cham	Rosmarin
Plot 3	**T10**	**Plot 8**	**T4**	**Plot 13**	**T4**	**Plot 18**	**T8**	**Plot 23**	**T8**	**Plot 28**	**T3**
Lavender	Pyracanth	Lonicera	Philadelph	Veronica	Spiraea	Potentilla	Philadelph	Rosmarin	Potentilla	Berb.da	Spiraea
Buds	Spiraea	Pyracanth	Veronica	Lonicera	Pyracanth	Veronica	Buds	Philadelph	Berb.da	Veronica	Lonicera
Hebe	Potentilla	Buds	Lavender	Lavender	Philadelph	Pyracanth	Spiraea	Hebe	Lonicera	Philadelph	Buds
Cham	Philadelph	Cham	Berb.da	Cham	Rosmarin	Hebe	Lonicera	Spiraea	Buds	Cham	Hebe
Berb.da	Lonicera	Hebe	Potentilla	Potentilla	Berb.da	Berb.da	Rosmarin	Lavender	Cham	Potentilla	Pyracanth
Rosmarin	Veronica	Spiraea	Rosmarin	Hebe	Buds	Lavender	Cham	Veronica	Pyracanth	Lavender	Rosmarin
Plot 4	**T3**	**Plot 9**	**T1**	**Plot 14**	**T10**	**Plot 19**	**T1**	**Plot 24**	**T7**	**Plot 29**	**T2**
Spiraea	Lonicera	Berb.da	Hebe	Lavender	Rosmarin	Philadelph	Berb.da	Lonicera	Spiraea	Philadelph	Potentilla
Veronica	Pyracanth	Lavender	Philadelph	Potentilla	Berb.da	Spiraea	Rosmarin	Cham	Philadelph	Hebe	Rosmarin
Hebe	Rosmarin	Rosmarin	Spiraea	Philadelph	Pyracanth	Pyracanth	Veronica	Buds	Lavender	Buds	Cham
Philadelph	Lavender	Potentilla	Lonicera	Veronica	Spiraea	Lonicera	Lavender	Potentilla	Berb.da	Pyracanth	Lonicera
Cham	Potentilla	Veronica	Pyracanth	Hebe	Lonicera	Buds	Cham	Hebe	Rosmarin	Veronica	Lavender
Buds	Berb.da	Buds	Cham	Buds	Cham	Potentilla	Hebe	Veronica	Pyracanth	Berb.da	Spiraea
Plot 5	**T8**	**Plot 10**	**T5**	**Plot 15**	**T5**	**Plot 20**	**T6**	**Plot 25**	**T10**	**Plot 30**	**T6**
Block 1				**Block 2**				**Block 3**			

Plot dimension and plant layout

<1.5m >

O	O	O	O	O	O
O	O	O	O	O	O
O	O	O	O	O	O
O	O	O	O	O	O
O	O	O	O	O	O
O	O	O	O	O	O

<1.5m>

Appendix 2: Cockspur grass experiment

Herbicide Screening

Table 32. Mean control scores for *Echinochloa crus-galli* Strain 1

Growth stage	Pre-em	Pre-em	Pre-em	3-4 leaves	3-4 leaves	3-4 leaves	6-10 leaves	6-10 leaves
Assessment time	21 DAT	29 DAT	41 DAT	13 DAT	20 DAT	41 DAT	21 DAT	79 DAT
Untreated	9.0	9	9	9.0	9.0	9	9.0	9
Butisan S	1.0	1	1	9.0	9.0	5		
Venzar	5.0	3.7	2	9.0	9.0	9		
Stomp	2.0	1	1	8.0	9.0	8		
Samson	3.7	6.7	5	6.0	4.0	1	9.0	9
Kerb Flo	2.0	1	1	9.0	9.0	9	9.0	9
Artist	1.0	1	1	2.7	1.0	1		
Crystal	1.0	1	1	7.0	6.0	7		
Atlantis	9.0	9	9	9.0	8.0	9	8.0	9
Chlortoluron	2.7	2.3	1.7	7.0	6.0	7	6.0	9
Dual Gold	1.3	1	1	9.0	9.0	9	9.0	9
Laser				3.0	1.0	1	9.0	1
Fusilade Max				3.0	1.0	1	9.0	1
Aramo				5.0	1.0	1	9.0	1
Falcon				6.0	1.0	1	8.0	1
SED	1.1	1.132	1.065	0.1	0.1	0.1217	*	0.447
P(ANOVA)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001
df	24	24	24	28	28	28		18

*Not suitable for analysis

Table 33. Mean control scores *Echinochloa crus-galli* Strain 2

Growth stage	Pre-em	Pre-em	Pre-em	6 leaves	6 leaves	6 leaves	6-10 leaves	6-10 leaves
Assessment time	21 DAT	29 DAT	41 DAT	13 DAT	20 DAT	41 DAT	21 DAT	79 DAT
Untreated	9.0	9.0	9	9.0	9	9	9.0	9
Butisan S	1.0	1.0	1	9.0	6	6		
Venzar	7.0	4.0	2	9.0	9	9		
Stomp	2.0	1.0	1	8.0	8	8		
Samson	3.3	3.3	3	6.0	4	1	9.0	9
Kerb Flo	2.0	1.0	1	9.0	9	9	9.0	9
Artist	1.0	1.0	1	9.0	9	9		
Crystal	1.0	1.0	1	7.0	6	7		
Atlantis	9.0	9.0	9	9.0	8	9	9.0	9
Chlortoluron	2.3	1.0	1	7.0	6	6	8.0	9
Dual Gold	2.0	1.0	1	9.0	9	9	9.0	9
Laser				3.0	1	1	9.0	1
Fusilade Max				3.0	1	1	9.0	1
Aramo				5.0	1	1	9.0	1
Falcon				6.0	1	1	9.0	1
SED	0.2	0.3	*	*	*	*	*	*
P(ANOVA)	<0.001	<0.001						
df	24	24						

*Not suitable for analysis

Figure 43. Field nursery experiment layout for control of *E. crus-galli* 2007

HOUSE

Key to tree species

MR - *Malus domestica* 'Reverend W Wilks'
MG - *Malus domestica* 'Grenadier'
PA - *Prunus* 'Amanagowa'
PD - *Prunus* insititia 'Merryweather Damson'
PC - *Pyrus communis* 'Concorde'
SI - *Sorbus intermedia*

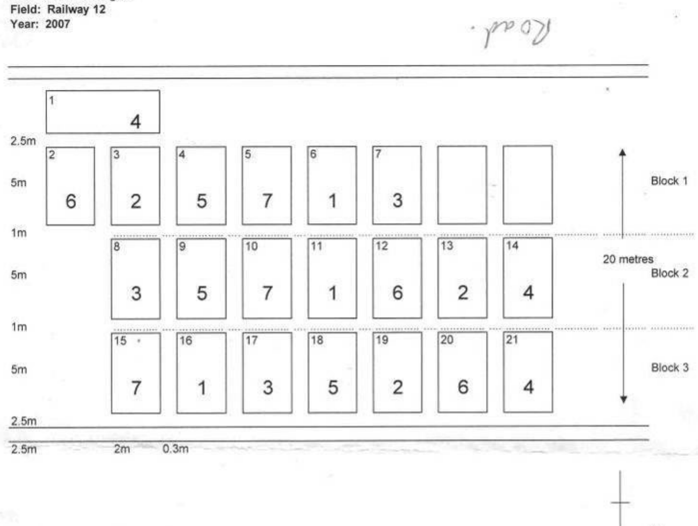
	Block III		Block II		Block I
	<1.5m>	<1.5m>	<1.5m>	<1.5m>	<1.5m>
< 6M >	**Plot 15** **T3** MR MR MR MR MG MG MG MG		**Plot 8** **T2** PC PC PC PC SI SI SI SI		**Plot 1** **T4** PA PA PA PA PD PD PD PD
	Plot 16 **T7** MR MR MR MR MG MG MG MG		**Plot 9** **T4** PC PC PC PC SI SI SI SI		**Plot 2** **T1** PA PA PA PA PD PD PD PD
	Plot 17 **T1** MR MR MR MR MG MG MG MG		**Plot 10** **T7** PC PC PC PC SI SI SI SI		**Plot 3** **T7** PA PA PA PA PD PD PD PD
	Plot 18 **T4** MR MR MR MR MG MG MG MG		**Plot 11** **T3** PC PC PC PC SI SI SI SI		**Plot 4** **T6** PA PA PA PA PD PD PD PD
	Plot 19 **T6** MR MR MR MR MG MG MG MG		**Plot 12** **T5** PC PC PC PC SI SI SI SI		**Plot 5** **T2** PA PA PA PA PD PD PD PD
	Plot 20 **T5** MR MR MR MR MG MG MG MG		**Plot 13** **T1** PC PC PC PC SI SI SI SI		**Plot 6** **T5** PA PA PA PA PD PD PD PD
	Plot 21 **T2** MR MR MR MR MG MG MG MG		**Plot 14** **T6** PC PC PC PC SI SI SI SI		**Plot 7** **T3** PA PA PA PA PD PD PD PD
	Foliar | Soil		Foliar | Soil		Foliar | Soil

Appendix 3: field horsetail 2007 experiment

Table 34. Summary of *E. arvense* mean frond numbers per m^2 2007

	Mean number of fronds per m^2		
Treatment	12-Jun	23-Jul	28-Aug
1	66.7	32.8	65.1
2	55.5	3.5	33.3
3	40.8	2.9	43.7
4	58.7	53.6	67.5
5	54.1	35.7	66.9
6	64.3	1.6	16
7	56.8	0.3	12
P(ANOVA)	0.318	<0.001	0.007
df	12	12	12
SED	10.29	9.82	14.67

Nursery Stock: Control of problem weeds (Equisetum arvense)
Expt code: XBM5508
Site: ADAS Terrington
Field: Railway 12
Year: 2007



Treatments:

Product	Rate		Timing
1. Untreated control			
2. Weedazol-TL	20	l/ha	mid June
+ Fortune	2	l/ha	
3. Agroxone	6	l/ha	mid June
+ Fortune	2	l/ha	
4. I.T. Dicamba	5	l/ha	mid June
+ Fortune	2	l/ha	
5. Headland Link	2.4	l/ha	mid June
+ Fortune	2	l/ha	
6. Agroxone	6	l/ha	mid June
+ I.T. Dicamba	5	l/ha	
+ Fortune	2	l/ha	
7. Agroxone	6	l/ha	mid June
+ I.T. Dicamba	5	l/ha	
+ Headland Link	2.4	l/ha	
+ Fortune	2	l/ha	

Figure 44. Field horsetail (*Equisetum arvense*) experimental Layout 2007

Field nursery phytotoxicity experiment

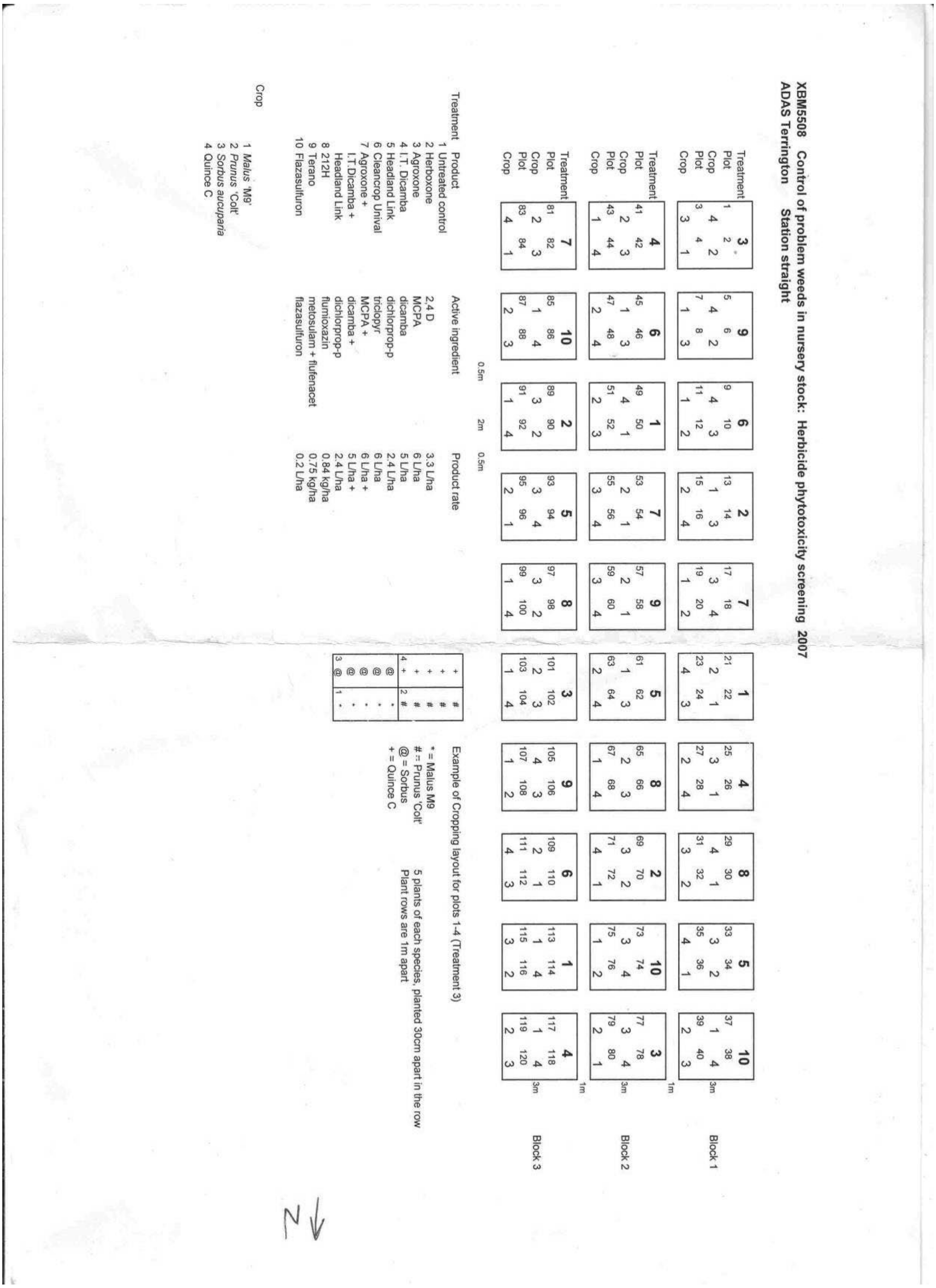


Figure 45. Experimental layout 2007

Appendix 4: creeping yellow cress 2007 experiment

Table 35. Mean of % cover 2007 *Rorippa sylvestris* 2007 treated

	Mean % cover		
Treatment	05-Jun	03-Jul	30-Aug
1	93.3	90	70
2	4.8	38.3	53.3
3	0	0	0
4	21.7	30	28.3
5	5.3	0	1.7
6	70	71.7	46.7
7	0	0	0
8	0	0	0
9	0	0	0
P(ANOVA)	<0.001	<0.001	<0.001
df	15	16	16
SED	7.38	8.46	7.8

Nursey Stock Control of Problem Weeds: *Rorrippa sylvestris.* Field Expts 2007. Goregate Hall, Dereham, Norfolk.

Block	1	1	1	1	1	1	1	1	1
Treatment	2	8	1	3	5	7	9	4	6
Plot number	1	2	3	4	5	6	7	8	9
	2	2	2	2	2	2	2	2	2
	9	1	6	4	5	8	7	2	3
	10	11	12	13	14	15	16	17	18
	3	3	3	3	3	3	3	3	3
	2	5	6	3	7	8	4	9	1
	19	20	21	22	23	24	25	26	27

Treatment	Product	Product Rate	Timing
1	Untreated		
2	Weedazole	20 l/ha	Mid May
3	Unival	6 l/ha	Mid May
4	Herboxone	3.3 l/ha	Mid May
5	IT Dicamba	5 l/ha	Mid May
6	Headland Link	2.4 l/ha	Mid May
7	Herboxone + IT Dicamba + Unival	3.3 l/ha 5 l/ha 6 l/ha	Mid May
8	Herboxone + IT Dicamba + Headland Link	3.3 l/ha 5 l/ha 2.4 l/ha	Mid May
9	Unival + IT Dicamba + Headland Link	6 l/ha 5 l/ha 2.4 l/ha	Mid May

Plot Dimensions

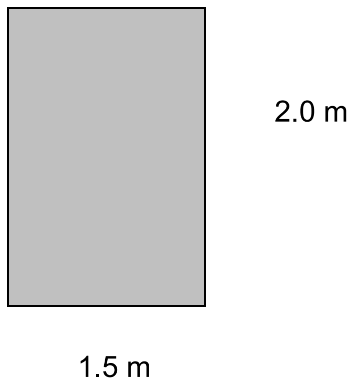


Figure 46. Layout for creeping yellow cress (*Rorrippa sylvestris*) experiment

*Appendix 5: false hedge bindweed (*Calistegia sepium*) experiment*

Table 36. Percentage cover (in summer 2007) of *C. sepium* following 2007 treatment

Treatment	Product	Product rate	Timing	% Cover 21/08/07	% Cover 18/09/07
1.	Untreated control			40	38.3
2.	Centium + Roundup	0.33 L/ha 5 L/ha	19 July	15	16.7
3.	Centium	0.33 L/ha	19 July	53.3	58.3
	Roundup	5 L/ha	13 Sept		
4.	Herboxone + Roundup	3.3 L/ha 5 L/ha	19 July	0	0.3
5.	Herboxone	3.3 L/ha	19 July	1	2.3
	Roundup	5 L/ha	13 Sept		
6.	IT.Dicamba+ Roundup	5 L/ha 5 L/ha	19 July	0	0
7.	IT Dicamba	5 L/ha	19 July	0	0
	Roundup	5 L/ha	13 Sept		
8.	Starane 2 + Roundup	2 L/ha	19 July	1.7	1
9.	Starane 2	2 L/ha	19 July	1.7	1
	Roundup	5 L/ha	13 Sept		
10.	Herboxone + IT Dicamba+ Starane 2 + Roundup	6 L/ha + 5 L/ha + 2 L/ha + 5 L/ha	19 July	0	0
11.	Herboxone + IT Dicamba+ Starane 2	6 L/ha + 5 L/ha + 2 L/ha	19 July	0	0
	Roundup	5 L/ha	13 Sept		
			P (ANOVA)	<0.001	<0.001
			df	20	20
			SED	8.4	9.43

False Hedge Bindweed Experiment 2007 Frank P Matthews Ltd Tenbury Wells Worcs.														
				III										
				4										
				33										
O Telegraph pole														
Block	II	II	II	II	II	II	II	II	II	II	II			
Treatment	5	4	11	6	1	3	8	7	9	10	2			
Plot No	22	21	20	19	18	17	16	15	14	13	12			
													Continues >	
Block		I	I	I	I	I	I	I	I		I	I	I	
Treatment		5	11	9	2	7	4	1	8		6	3	10	
Plot No		11	10	9	8	7	6	5	4		3	2	1	

												HEDGE
<Previous page												
III	III	III		III	III	III	III	III	III	III		
6	10	7		1	8	9	5	2	11	3		
32	31	30		29	28	27	26	25	24	23		

Figure 47. Layout for false hedge bindweed experiment