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Container HNS: Use of contact herbicides in the nursery situation

HNS 70a

September 2000

Project Title:	Container HNS: Use of contact herbicides in the nursery situation
Project Number:	HNS 70a
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Keywords cont.	isoxaben, bentazone, propyzamide, ethofumesate,

terbuthylazine, terbutryne, hairy bittercress, groundsel, sow thistle, common chickweed, mouse ear chickweed, willowherb, pearlwort, annual meadow grass, *Sonchus oleraceus*, *Stellaria media*, *Cerastium holostoides*, *Cardamine hirsuta*, *Senecio vulgaris*, *Epilobium ciliatum*, *Sagina procumbens*, *Poa annua*, container nursery stock, weed control, herbicides, phytotoxicity.

CONTENTS

PRACTICAL SECTION FOR GROWERS

Commercial benefits of the project

This project has identified and evaluated a number of herbicides to control a range of common weeds of nursery stock, after weed emergence, over the winter period. The most effective herbicides have been determined for each of the weed species studied, to enable growers to tailor their winter herbicide programme according to their weed problems. As a result it should be possible to make substantial savings in hand-weeding costs in the spring.

Further information on crop safety is provided, adding to the information gained by previous HDC experiments.

Background and objectives

Herbicide programmes, until recently, have predominantly been used for application to container HNS over the growing season. However, development of weeds over the winter can become a serious problem especially in milder autumn periods. Late season weed build up can occur even where herbicides are applied during the growing season if the programme adopted does not fully control the range of weed species, or if weed pressure becomes too great or resistant strains occur. In these situations hand weeding is usually the only option.

The potential of a number of herbicides with contact action over the winter was identified in HNS 70 (Scott, Girard and Brough 1998), where efficacy of the chemicals was assessed first at HRI Efford, on individual weed species, in the absence of the nursery crop, and subsequently on a commercial nursery. While weed pressure was relatively low in the latter experiment for fully testing contact action, benefits from residual activity in limiting further weed build up were obtained. In addition, few phytotoxic symptoms were observed over ten HNS species included in the experiment with the majority of herbicides used.

The current research was carried out at Hillier Nurseries Ltd, Ampfield, under commercial conditions. The aim of the research was to confirm the promising contact results obtained in the earlier Efford work, to further test the safety of these herbicides over another range of HNS species during the winter period, and to improve spray contact with the weeds in the presence of the nursery crop.

Summary of results and conclusions

Trial plants of 10 nursery stock species (see below) were potted into 3 litre containers in July 1999 and kept weed-free with pot toppers until commencement of the trial:

Chamaecyparis lawsoniana 'Ellwoods' Gold'
Potentilla fruticosa 'Primrose Beauty'
Spiraea japonica 'Candlelight'
Spiraea 'Arguta'
Hypericum 'Hidcote'
Viburnum tinus 'Eve Price'
Chamaecyparis pisifera 'Boulevard'
Symphoricarpos X chenaultii 'Hancock'
Lonicera japonica 'Halliana'
Vinca minor 'Bowles' Variety'

A prepared seed mix of hairy bittercress, willowherb, groundsel, common chickweed, sow thistle, annual meadow grass, pearlwort and mouse ear chickweed was sown into each pot on 29 September 1999.

The following herbicide treatments were applied on 14 December 1999 and again on 13 March 2000 to half of the plots:

Treatment	Trade name	Active ingredient	Application rate /ha	Water volume litres/ha	Status Note
1.	Untreated				
2.	Flex	fomesafen (250 g/l)	0.9 litres	2500	[1]
3.	Butisan S +	metazachlor (500 g/l)	2.5 litres	1200	[1]
	Flexidor 125	isoxaben (125 g/l)	2.0 litres		[2]
4.	Butisan S +	metazachlor (500 g/l)	2.5 litres	2500	[1]
	Flexidor 125	isoxaben (125 g/l)	2.0 litres		[2]
5.	Basagran SG	bentazone (87% w/w)	1.65 kg	1200	[1]
6.	Basagran SG	bentazone (87% w/w)	1.65 kg	2500	[1]
7.	Diuron	diuron (500 g/l)	0.8 litres	1200	[1]
8.	Diuron	diuron (500 g/l))	0.8 litres	2500	[1]
9.	Kerb 50W	propyzamide (80% w/w)	1.7 kg	1200	[1]
10.	Kerb 50W	propyzamide (80% w/w)	1.7 kg	2500	[1]
11.	Nortron	ethofumesate (200 g/l)	5.0 litres	1200	[1]
12.	Nortron	ethofumesate(200 g/l)	5.0 litres	2500	[1]
13.	Opogard +	terbuthylazine (150 g/l) terbutryne (350 g/l)	2.8 litres	1200	[1]
	Flexidor 125	Isoxaben (125 g/l)	0.6 litres		[2]
14.	Opogard +	terbuthylazine (150 g/l) terbutryne (350 g/l)	2.8 litres	2500	[1]
	Flexidor 125	Isoxaben (125 g/l)	0.6 litres		[2]

Note - Approval status
[1] This product can be used off-label at grower's own risk under the Revised Long Term Arrangements for Extension of Use (2000). [2] This product has on-label approval for use.

The weed sowing was successful, producing good numbers of all weed species. Weed counts were taken on four occasions during the period. At the time of the first herbicide application, most weeds were at the two true leaf stage, by the time of the second herbicide application, most remaining weeds were at the four true leaf stage.

The best overall weed control was achieved by Butisan S + Flexidor 125 and Opogard + Flexidor 125. Flex, Basagran SG and Diuron did not give such broad-spectrum control but were useful for specific weeds such as groundsel and willowherb. The following table summarises the results:

	Hairy bittercress	Willowherb	Groundsel	Common chickweed	Sow thistle	Annual meadow grass	Pearlwort	Mouse ear chickweed
Flex	***	**	***		*			
Flexidor + Butisan	***	*	*	***	***	***	***	***
Basagran	***	**	**	**	***			**
Diuron	***	**		**			*	*
Kerb				**		***		**
Nortron						**	**	***
Opogard+ Flexidor	***	***		***	***	*	***	***

*** = good control (>90%), ** = moderate but useful control (50-90%), * = slight control (<50%)

Most of the herbicides were quite slow-acting, taking several months to achieve control, suggesting that much of the activity was through root uptake rather than direct scorch. Flex and Basagran SG, however, were much faster in activity giving a rapid knockdown of susceptible weed species.

In general the same pattern of weed control was seen whether a one (December) or two (December and March) spray programme was used. For most herbicides there was little difference in weed control from applying the herbicides in 1200 litres/ha or 2500 litres/ha. However for Diuron, and to a lesser extent with Kerb 50W there was an improvement in weed control where 2500 litres/ha rather than 1200 litres/ha was used.

All of the herbicides tested were relatively safe when used as a single application to the dormant crops in December. There were just a few incidences of damage. *Potentilla fruticosa* 'Primrose Beauty' was stunted by Opogard + Flexidor 125. Flex caused die-back on *Viburnum tinus* 'Eve Price', but was safe on other evergreens as well as the deciduous species. *Lonicera japonica* 'Halliana' was not fully dormant and

was scorched by Butisan S + Flexidor 125 and Nortron. Kerb 50W caused a growth reduction on *Vinca minor* 'Bowles' Variety' and *Symphoricarpos X chenaultii* 'Hancock'. Opogard + Flexidor 125 damaged both *Spiraea* species.

The spring application was made as the crops were starting to grow away and caused more damage. At this stage, Flex, Butisan S + Flexidor 125, Nortron and Opogard + Flexidor 125 caused unacceptable damage either from direct contact action or root uptake. Higher volume sprays tended to be more damaging. However, Basagran SG and Kerb 50W were safer causing virtually no damage from the spring treatment. Previous experiments (HNS 70) confirmed the relative safety of Basagran SG, Diuron (at the low rates used), Kerb 50W and Nortron as winter treatments. However this is the first year of results from the use of Flex and the Opogard + Flexidor 125 mix, so some caution should be exercised before using these products widely. Butisan S and Flexidor 125 can damage some species, and the HDC weed control handbook should be consulted for crop safety tables.

Action points for growers

- First choice for cleaning up a broad range of weeds in hardy nursery stock over the winter period should be Butisan S + Flexidor 125.
- Where groundsel is the main weed Basagran SG is an alternative or supplement.
- Where willowherb is the main weed Diuron is an alternative or supplement.
- Opogard + Flexidor 125 has the potential for outstanding control of a range of weed including willowherb, but should be used with caution, pending further work.
- Flex has potential for use as a quick knockdown of hairy bittercress, groundsel and small willowherb seedlings, but should be used with caution.
- Application in 1200 litres/ha gave similar results to 2500 l/ha except for Diuron and Kerb 50W, where the higher volume gave better control.
- Clean-up treatments should be applied when the crop is fully dormant. If application is delayed, Basagran SG is the safest option.

Anticipated practical and financial benefits from the study

- Improved overwinter weed control, leading to a reduction in hand-weeding.
- Further information on crop safety, avoiding crop losses due to inappropriate herbicide use.

SCIENCE SECTION

INTRODUCTION

Herbicide programmes, until recently, have predominantly been used for application to container HNS over the growing season. However, development of weeds over the winter can become a serious problem especially in milder autumn periods. Late season weed build up can occur even where herbicides are applied during the growing season if the programme adopted does not fully control the range of weed species, or if weed pressure becomes too great or resistant strains occur. In these situations hand weeding is usually the only option.

The potential of a number of herbicides with contact action over the winter was identified in HNS 70 (Scott, Girard and Brough 1998), in detailed research at HRI Efford, where the efficacy of the chemicals was assessed in 90 mm pots sown with individual weed species, in the absence of the nursery crop. The most promising of these herbicides were then further evaluated by ADAS in the second part of the experiment on a commercial nursery. While weed pressure was relatively low for fully testing contact action, benefits from residual activity in limiting further weed build up were obtained. In addition, few phytotoxic symptoms were observed over ten HNS species included in the experiment with the majority of herbicides used, (apart from *Buddleia*, included as a particularly herbicide-sensitive indicator species).

Consequently, given the importance of obtaining cost-effective weed control over the winter period, these further experiments were carried out on a commercial nursery in order to confirm the promising contact results obtained in the Efford work, to further test the safety of use of these herbicides over a range of HNS species over winter, and to improve spray contact with the weeds in the presence of the nursery crop. One of the promising herbicides (Skirmish) used in HNS 70 was no longer available, so was replaced by the nearest equivalent, a tank mix of Opogard and Flexidor 125.

MATERIALS AND METHODS

Production system

The research was carried out at the Hillier Nurseries container production unit, Ampfield, Hants.

Experimental plants were potted up from 9cm liners into 3 litre containers in a peat-based growing media with controlled release fertiliser in July 1999 and stood out on a drained mypex bed outdoors with overhead irrigation. 'Spin Out' treated pot toppers were placed over the compost to keep it weed free until commencement of the experiment.

The experiment was set out on 21 September 1999 and the pot toppers removed. The prepared seed mix was sown into each pot on 29 September 1999.

Herbicide treatments were applied on 14 December 1999 and again on 13 March 2000 (second application to sub-plots).

Plant species and stage of growth when treated

First treatment: 14 December 1999

Chamaecyparis lawsoniana 'Ellwoods' Gold'	Dormant.
Potentilla fruticosa 'Primrose Beauty'	No leaf, dormant.
Spiraea japonica 'Candlelight'	No leaf, dormant.
Spiraea 'Arguta'	No leaf, dormant.
Hypericum 'Hidcote'	Full leaf, slight shoot growth.
Viburnum tinus 'Eve Price'	Tight flower bud, full leaf, no shoot growth.
Chamaecyparis pisifera 'Boulevard'	Rather soft foliage, dormant.
Symphoricarpos X chenaultii 'Hancock'	Full leaf, turning senescent.
Lonicera japonica 'Halliana'	Old leaf fallen, buds breaking with 2cm new growth.
Vinca minor 'Bowles' Variety'	Full leaf, dormant.

Second treatment: 13 March 2000

Chamaecyparis lawsoniana 'Ellwoods' Gold'	Just breaking dormancy.
Potentilla fruticosa 'Primrose Beauty'	Young leaf at base of plant.
Spiraea japonica 'Candlelight'	Young leaf all over.
Spiraea 'Arguta'	Just breaking dormancy.
Hypericum 'Hidcote'	2 cm young growth on 50% of shoot tips.
Viburnum tinus 'Eve Price'	New growth just starting. Flower buds present.
Chamaecyparis pisifera 'Boulevard'	Young shoot growth starting.
Symphoricarpos X chenaultii 'Hancock'	Few young leaves, mainly dormant.
Lonicera japonica 'Halliana'	Young shoot growth starting.
Vinca minor 'Bowles' Variety'	3 cm new growth starting, flowering.

Seed sowing

Weed seed was bought from Herbiseed, (The Nurseries, Billingbear Park, Wokingham, RG11 5RY). Seed counts and germination percentage was available from Herbiseed, and a further germination check was made prior to sowing.

Using the germination % and seed weight data, a seed mix was prepared to give the potential of 10 seedlings of each weed species per pot (total of (2520 pots). The quantity of weed seed was as follows:

Species	**Weight (g.)**
*Senecio vulgaris**	7.0
Epilobium roseum	2.5
Cardamine hirsuta	8.3
Sagina procumbens	2.5
Cerastium holostoides	2.5
Poa annua	7.1
Stellaria media	15.6
Sonchus oleraceus	9.3

*triazine-resistant strain

The seed was thoroughly mixed with 25.2 litres silver sand and 10 ml of the mixture was dispensed to each pot in the trial using a measuring scoop.

Herbicide treatments

Treatment	Trade name	Active ingredient	Application rate /ha	Water volume litres/ha	Status Note
1.	Untreated				
2.	Flex	fomesafen (250 g/l)	0.9 litres	2500	[1]
3.	Butisan S +	metazachlor (500 g/l)	2.5 litres	1200	[1]
	Flexidor 125	isoxaben (125 g/l)	2.0 litres		[2]
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7.	Diuron	diuron (500 g/l)	0.8 litres	1200	[1]
8.	Diuron	diuron (500 g/l))	0.8 litres	2500	[1]
9.	Kerb 50W	propyzamide (80% w/w)	1.7 kg	1200	[1]
10.	Kerb 50W	propyzamide (80% w/w)	1.7 kg	2500	[1]
11.	Nortron	ethofumesate (200 g/l)	5.0 litres	1200	[1]
12.	Nortron	ethofumesate(200 g/l)	5.0 litres	2500	[1]
13.	Opogard	terbuthylazine (150 g/l)	2.8 litres	1200	[1]
	+	terbutryne (350 g/l)			
	Flexidor 125	isoxaben (125 g/l)	0.6 litres		[2]
14.	Opogard	terbuthylazine (150 g/l)	2.8 litres	2500	[1]
	+	terbutryne (350 g/l)			
	Flexidor 125	isoxaben (125 g/l)	0.6 litres		[2]

Note - Approval status

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[2] This product has on-label approval for use.

Herbicide treatments were applied using a gas-pressurised, precision plot sprayer at the appropriate water volume. Applications were made to entire plots on 14 December 1999, and as a repeat treatment to half plots on 13 March 2000.

Experimental layout

The experiment was a three replicate, two treatment factor, split-plot design. The main treatment factor was herbicide and water volume, with each plot then split into single or double treatment sub-plots. Each main plot consisted of six plants each of 10 species with an area of 1.66m x 3.0m. For the second spray treatment the plots were divided into two sub-plots, untreated or treated, each with three plants of 10 species.

The results were analysed using Analysis of Variance (ANOVA) and the data are presented in the appendix tables.

Assessments

Weed assessments were made as follows:

First assessment (pre 1st spray)	30 November - 2 December 1999
Second assessment (post 1st spray)	21-24 January 2000
Third assessment (pre 2nd spray)	6-7 March 2000
Fourth assessment (post 2nd spray)	10-14 April 2000

Weeds were recorded as numbers of each species per pot by size category, cotyledon, 2 true leaf, 4 true leaf, more than 4 true leaf. Where the species was unidentifiable it was recorded separately.

Crop phytotoxicity assessments were made as follows:

After spraying notes were taken of visual symptoms. Detailed scoring was undertaken on 10 April 2000. Plants were put into scoring categories 1-5. Examples of each category were photographed (see Appendix 2) and the height was measured.

RESULTS AND DISCUSSION

Total weed numbers

The experimental pots were seeded on 29 September 1999. Very little germination occurred during October, but from early November groundsel started to germinate followed by the other species. By the end of November there were sufficient weeds of all species for the herbicide treatments to be applied.

The change in total weed numbers (per 100 pots) from November to April can be seen in the following chart, (Figure 1). Spray applications were made between the first and second record and between the third and fourth record. For clarity, results from the two water volumes for each herbicide treatment have been combined. The full table of results with statistical analysis is in Appendix 1 (Table 10).

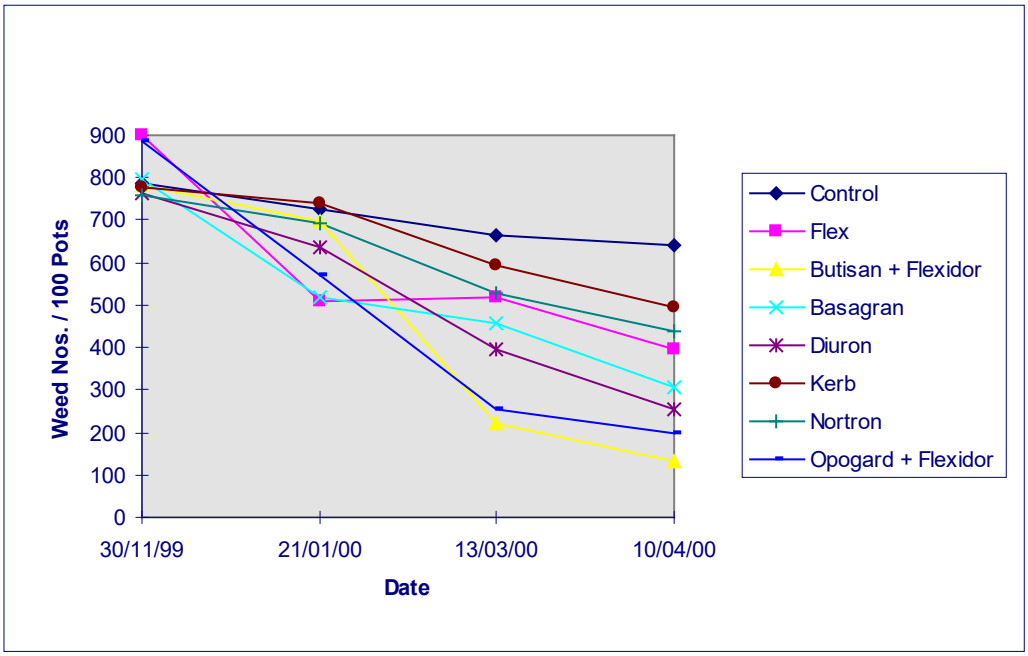


Figure 1. Total weed numbers, November 1999 - April 2000

Although there were small differences between treatments in the initial weed populations these were not significant. The untreated control showed a small decline overall in weed numbers over the winter, however individual weed size increased.

Flex, Opogard + Flexidor 125 and Basagran caused the sharpest initial decline in weed numbers from the initial spraying. All treatments with the exception of Flex, continued to reduce weed numbers between January and March with the sharpest decline caused

by Butisan S + Flexidor 125, Opogard + Flexidor 125 and Diuron. Following the second spray treatment in March, Flex and Diuron caused the sharpest reduction in weed numbers. By the final record in April the lowest numbers of weed were in the Butisan S + Flexidor 125, Opogard + Flexidor 125 and Diuron plots. All treatments had significantly ($P < 0.05$) less weed than the control at this stage (Appendix 1, Table 10). Although none of the herbicides eradicated all of the weed species, some were particularly effective against certain weeds as shown below.

Hairy bittercress (*Cardamine hirsuta)*

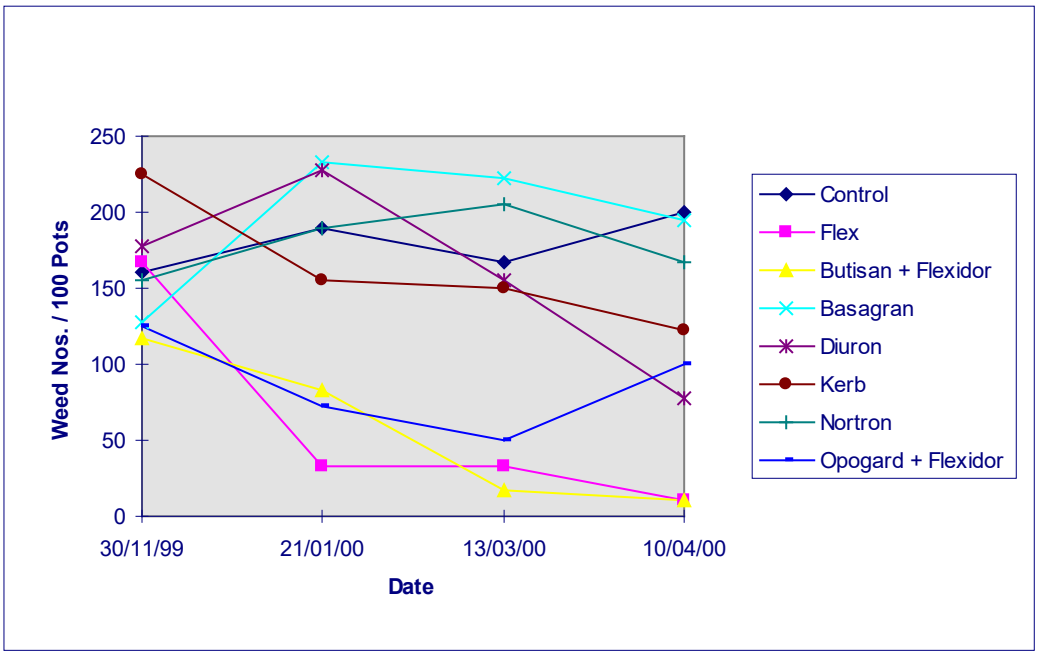


Figure 2. Numbers of hairy bittercress, November 1999 - April 2000
Host crop: *Vinca*

There was some variation in initial levels of hairy bittercress, however these differences were not significant. Weed size in November ranged from cotyledon to > 4 true leaves. Following the first spray treatment, Flex gave a particularly effective knock down. At the second record, Flex, Butisan S + Flexidor 125 and Opogard + Flexidor 125 treatments had significantly fewer weeds than the control ($P < 0.05$)(Appendix 1, Table 2). Most remaining weed at this time was >4 true leaf. Weed numbers then stabilised, but were further reduced in the Diuron, Butisan S + Flexidor 125 and Opogard + Flexidor 125 treatments. By April most weeds were 4 true leaf or >4 true leaf, the lowest weed numbers were in the Flex, Diuron and Butisan S + Flexidor 125 plots, significantly less than the control ($P < 0.05$).

Willowherb (*Epilobium ciliatum)*

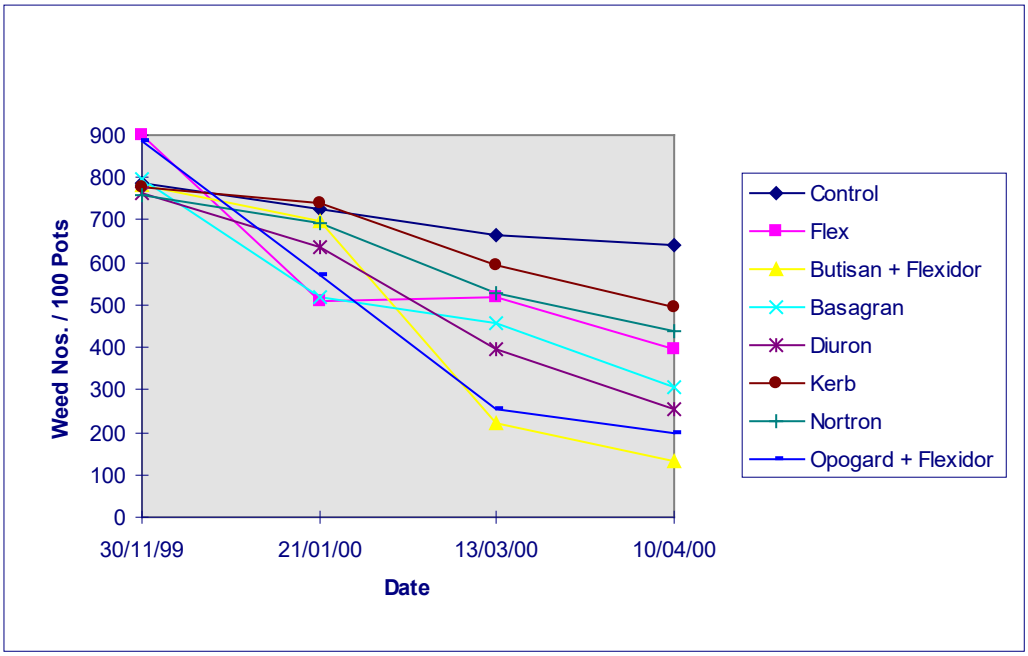


Figure 3, Numbers of willowherb, November 1999 - April 2000
Host crop: *Chamycyparis lawsoniana* 'Ellwoodii'

The population of willowherb in the control plots increased steadily from November to March, then declining slightly. In November most weeds were at the cotyledon stage, some at 2 - 4 true leaf. The first spray treatments of Flex, Basagran SG and Diuron caused the sharpest reduction in willowherb numbers. However by March, Butisan S + Flexidor 125, and Opogard + Flexidor 125 had also reduced numbers significantly, although these treatments were slower acting. In March the majority of the willowherb in the control plots were large, 4 or >4 true leaf, whereas in the herbicide plots there were a range of sizes. At the final record in April, following the second spray treatment, the lowest weed numbers were in the Butisan S + Flexidor 125, Opogard + Flexidor 125 and Basagran SG plots. All treatments except Nortron significantly reduced the weed numbers compared with the control ($P < 0.05$)(Appendix 1, Table 3). However Nortron and Basagran SG were particularly effective at reducing weed numbers at the second treatment.

Groundsel (*Senecio vulgaris*)

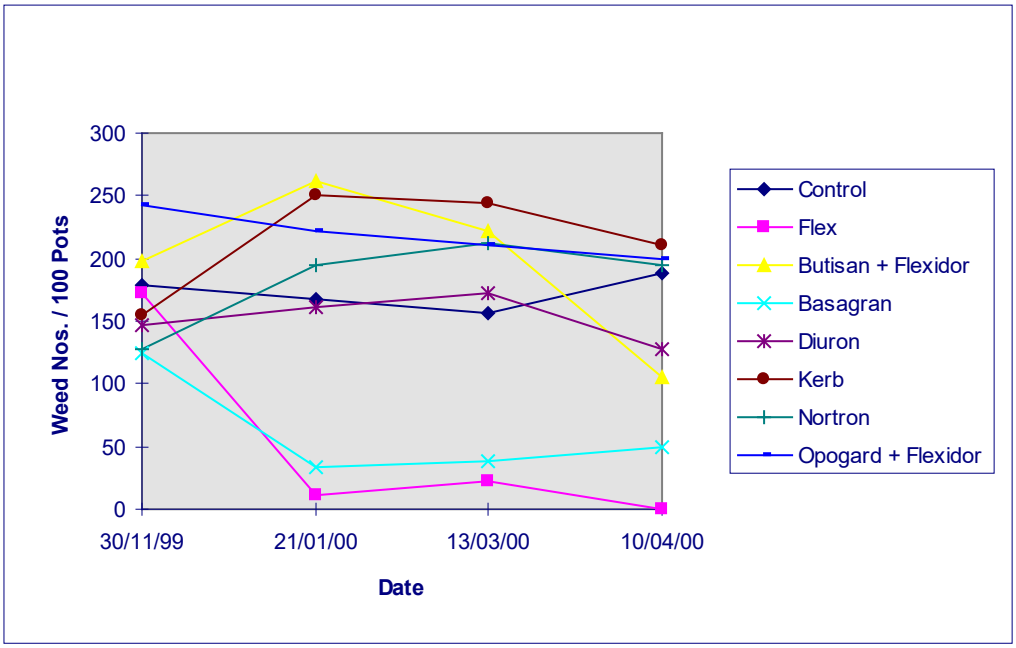


Figure 4. Numbers of groundsel, November 1999 - April 2000
Host crop: *Spiraea* 'Arguta'

The control population of groundsel declined slightly over the winter period but then increased between March and April. Most were at 2 true leaf in November. Flex and Basagran SG were the only two herbicides to give control. The Butisan S + Flexidor 125 treatment gave no control initially, but following a second treatment weed numbers were reduced but not significantly different from the control. By the final record Flex had given 100% control. In March and April most of the groundsel was at the 4 or >4 true leaf stage.

Common chickweed (*Stellaria media*)

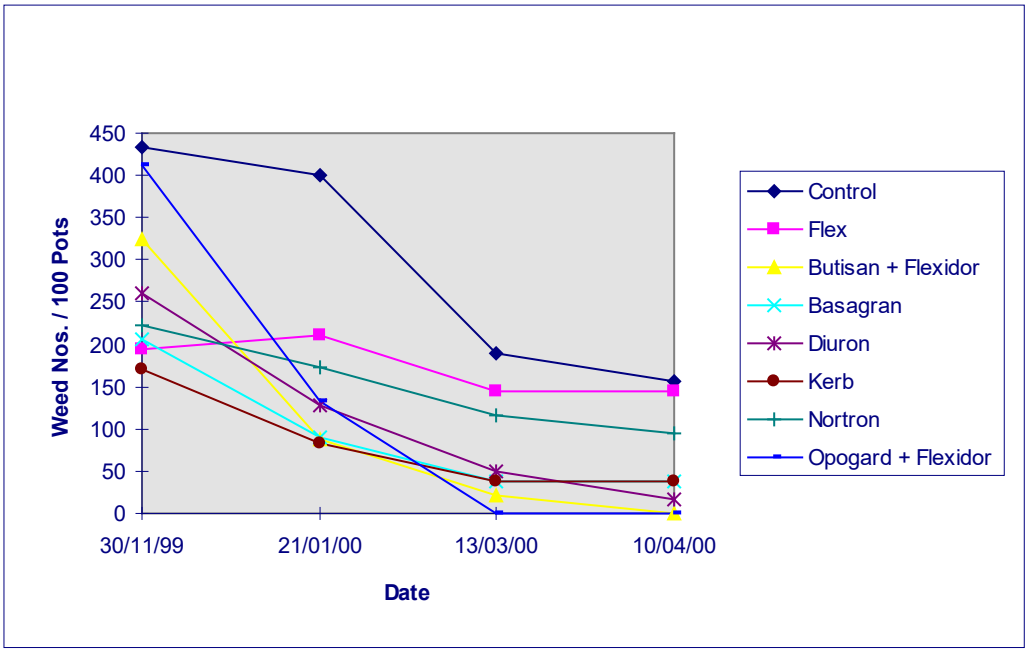


Figure 5. Numbers of common chickweed, November 1999 - April 2000
Host crop: *Hypericum*

The control population declined sharply from January to March with a 50% reduction in population by April. In November most of the weeds were at the 2 true leaf stage, by the end of the trial the majority were mature >4 true leaf plants.

Opogard + Flexidor 125 and Butisan S + Flexidor 125 were particularly effective in reducing the initial population and maintaining control through to April. Kerb 50W, Basagran SG and Diuron were also effective though slower-acting. At the final record Opogard + Flexidor 125 and Butisan S + Flexidor 125 gave complete control. Only Nortron and Flex failed to give significant control compared with the untreated ($P < 0.05$)(Appendix 1, Table 5)

Sow Thistle (*Sonchus oleraceus*)

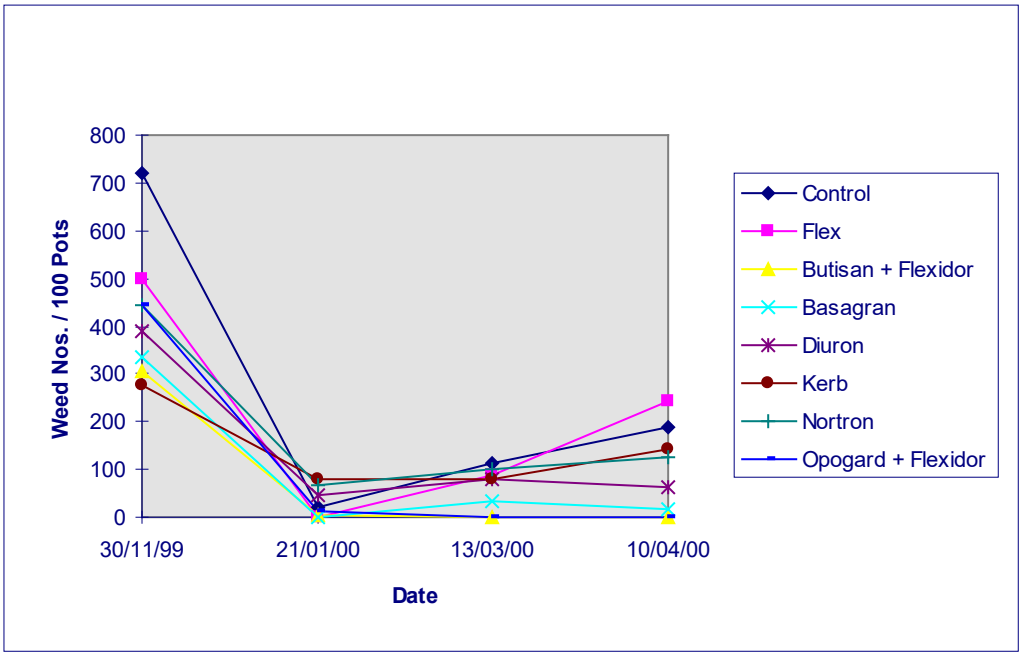


Figure 6. Numbers of sow thistle, November 1999 - April 2000
Host crop: *Potentilla*

All populations of sow thistle declined sharply between November and January regardless of treatment. In November the majority of weeds were at the 2 true leaf stage. The control population then increased through to April with cotyledon stage weeds noted in March and April as well as more mature plants. Butisan S + Flexidor 125, Opogard + Flexidor and Basagran SG maintained good control through to April. These treatments and Diuron had significantly fewer weeds than the control in April ($P < 0.05$)(Appendix 1, Table 6).

Annual meadow grass

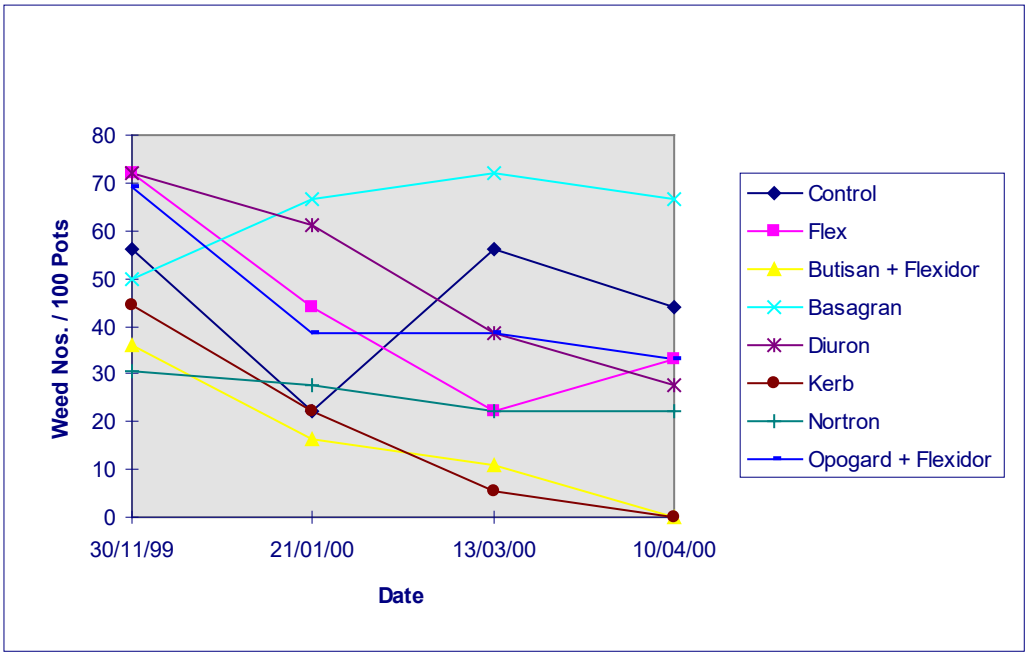


Figure 7. Numbers of annual meadow grass, November 1999 - April 2000
Host crop: *Chamaecyparis lawsoniana* 'Ellwoods' Gold'

Germination of grass was poor compared with the other weeds, consequently there was more variability throughout the trial. In November the weed was at the 1 to 2 true leaf stage. The control population declined sharply between November and January so it was difficult to see any result of the initial treatment. However both Kerb 50W and Butisan S + Flexidor 125 maintained complete control through to April, by which time there were larger plants present in the other treatment plots. No other results were significant.

Pearlwort (*Sagina procumbens)*

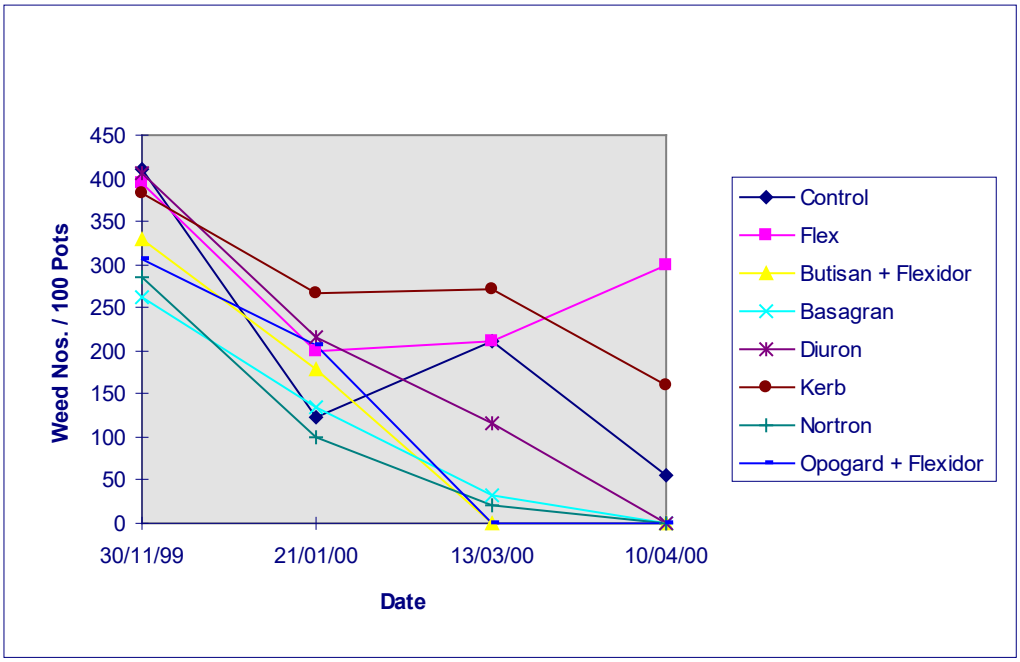


Figure 8. Numbers of pearlwort, November 1999 - April 2000
Host crop: *Symphoricarpos*

The initial population was made up of cotyledon and 2 true leaf plants. The control population declined sharply between November and January, making it difficult to draw any conclusions about the effectiveness of the initial treatments. By March any remaining weeds were at the 2 or 4 true leaf stage. Nortron, Opogard + Flexidor 125, Butisan S + Flexidor 125 and Basagran SG all maintained good control from January and by April had given complete control.

Mouse Ear Chickweed (Cerastium holostoides)

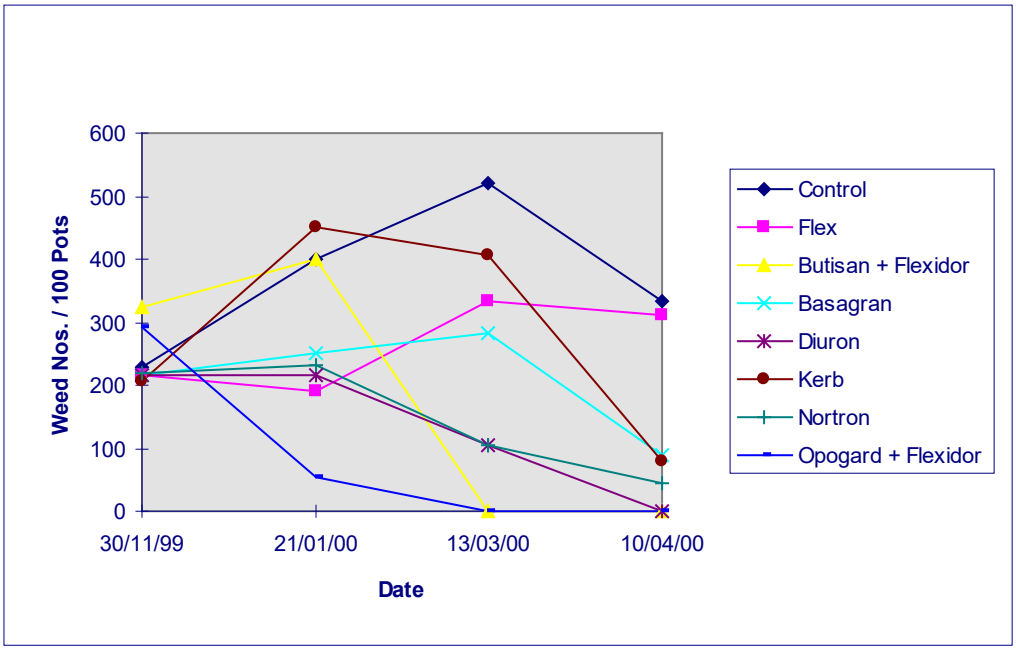


Figure 9. Numbers of mouse ear chickweed, November 1999 - April 2000
Host crop: *Spiraea* 'Arguta'

In November seedlings were at the 2 true leaf stage. The control population increased steadily from November to March, then declined in numbers slightly in April but with more weeds at the >4 true leaf stage. Opogard + Flexidor 125 was the only treatment to substantially reduce the population immediately following the first herbicide application. By January more seedlings had emerged and there were also 4 true leaf plants present in the plots. Diuron, Nortron and Butisan S + Flexidor 125 reduced the population giving complete control by April but were slower acting than Opogard + Flexidor 125.

Final weed control - all plots

The full combined results at the final record are shown below in Figures 10 and 11 so that the effect of single or two spray programme and water volume can be seen. The tabulated data and statistical analyses are given in Appendix 1, Table 11.

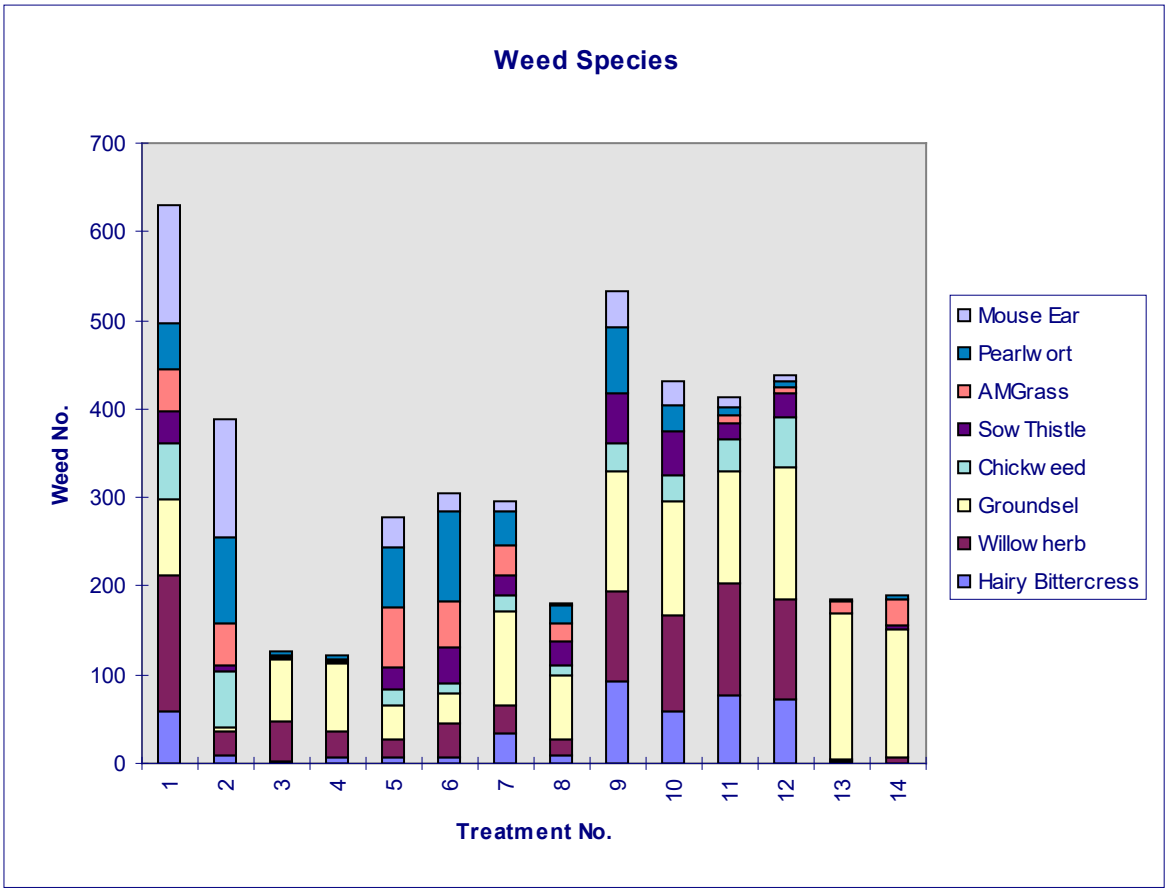
For the two spray programmes (Figure 10) the best overall reduction in weed numbers was achieved by Butisan S + Flexidor 125, Opogard + Flexidor 125 and Diuron, all of these were significantly different from the control ($P < 0.05$).

The same pattern was repeated for the single spray treatments (Figure 11) with the best overall reduction in weed numbers achieved by Butisan S + Flexidor 125, Opogard + Flexidor 125 and Diuron. Diuron was significantly less effective as a single spray compared with the two spray programme.

The main weeds present in the Butisan S + Flexidor 125 treated plots were groundsel and willowherb. For the Opogard + Flexidor 125 treated plots, the main weeds were groundsel and annual meadow grass.

For most herbicides there was little difference in weed control from applying the herbicides in 1200 litres/ha or 2500 litres/ha. However for Diuron, and to a lesser extent with Kerb 50W there was an improvement in weed control where 2500 litres/ha rather than 1200 litres/ha was used, but this was not quite significant at $P < 0.05$.

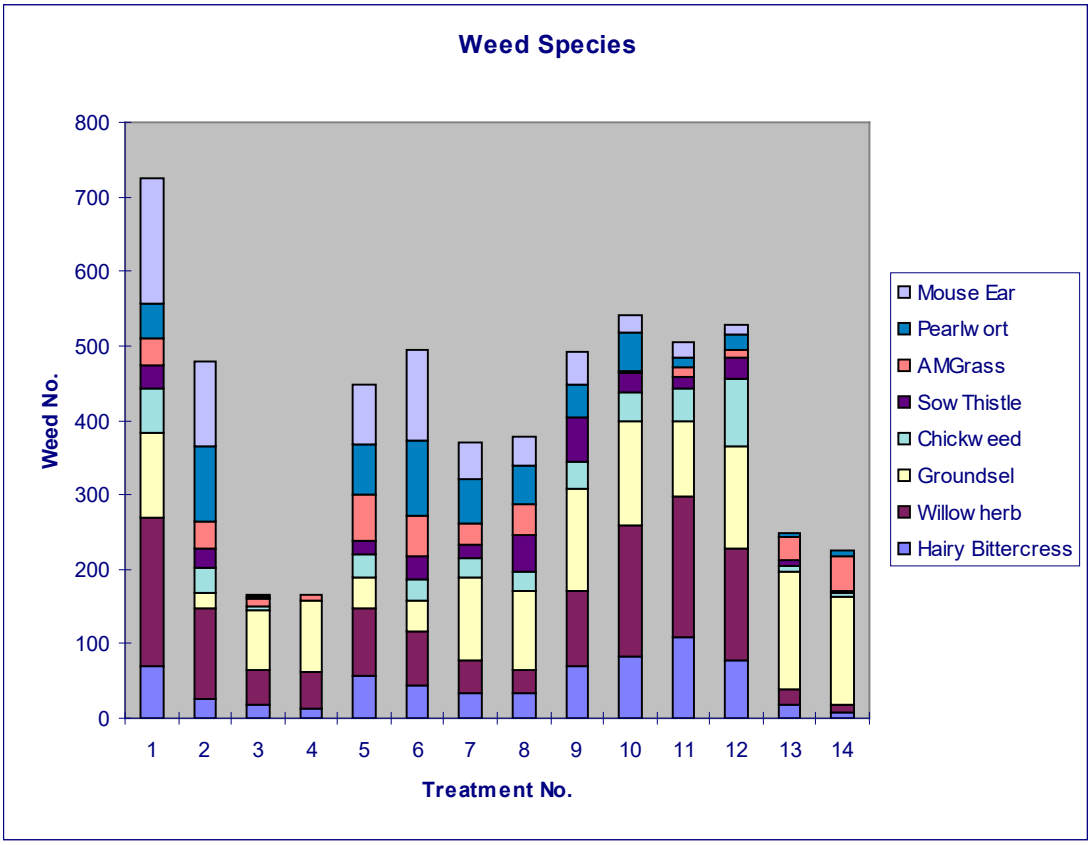
Figure 10: Weed population 10 April 2000 (weeds per 100 pots) by species, two spray programme.



Treatment codes:

Treatment	Trade name	Application rate /ha	Water volume litres/ha
1.	Untreated		
2.	Flex	0.9 litres	2500
3.	Butisan S + Flexidor 125	2.5 litres 2.0 litres	1200
4.	Butisan S + Flexidor 125	2.5 litres 2.0 litres	2500
5.	Basagran SG	1.65 kg	1200
6.	Basagran SG	1.65 kg	2500
7.	Diuron	0.8 litres	1200
8.	Diuron	0.8 litres	2500
9.	Kerb 50W	1.7 kg	1200
10.	Kerb 50W	1.7 kg	2500
11.	Nortron	5.0 litres	1200
12.	Nortron	5.0 litres	2500
13.	Opogard + Flexidor 125	2.8 litres 0.6 litres	1200
14.	Opogard + Flexidor 125	2.8 litres 0.6 litres	2500

Figure 11: Weed population 10 April 2000 (weeds per 100 pots) by species, single spray treatment.



Treatment codes:

Treatment	Trade name	Application rate /ha	Water volume litres/ha
1.	Untreated		
2.	Flex	0.9 litres	2500
3.	Butisan S + Flexidor 125	2.5 litres 2.0 litres	1200
4.	Butisan S + Flexidor 125	2.5 litres 2.0 litres	2500
5.	Basagran SG	1.65 kg	1200
6.	Basagran SG	1.65 kg	2500
7.	Diuron	0.8 litres	1200
8.	Diuron	0.8 litres	2500
9.	Kerb 50W	1.7 kg	1200
10.	Kerb 50W	1.7 kg	2500
11.	Nortron	5.0 litres	1200
12.	Nortron	5.0 litres	2500
13.	Opogard + Flexidor 125	2.8 litres 0.6 litres	1200
14.	Opogard + Flexidor 125	2.8 litres 0.6 litres	2500

Crop phytotoxicity observations

Following the initial spray treatment in December 2000, the crops were observed for signs of damage. No significant effects were noted at this stage. The main recording and scoring was undertaken on 10 April 2000 following the second spray treatment to half of the plots in March. Full details of the scoring system used are given in Appendix 2. A summary of the quality scoring results is shown below:

Table 1 : Crop quality scores (1-5 scale, 1 = worst, 5 = best).

Treatment	Volume	No of sprays	Chamaecyparis E	Chamaecyparis B	Hypericum	Lonicera	Potentilla	Spiraea A	Spiraea C	Symphoricarpus	Viburnum	Vinca
Control			3.8	3.9	4.1	4.7	4.1	4.3	4.6	4.1	4.1	4.3
Flex	1200	1	4.5	2.9	4.2	4.1	3.9	4.4	4.2	4.0	3.9	4.7
	1200	2	4.2	2.9	4.0	3.8	3.3	3.8	1.9	2.8	3.9	3.3
Butisan S + Flexidor 125	1200	1	3.8	4.2	4.5	4.3	3.4	5.0	4.5	4.4	3.9	4.4
	1200	2	4.1	4.1	4.1	3.1	4.1	4.0	2.9	2.8	3.4	4.4
	2500	1	4.1	4.1	4.1	4.3	3.8	4.1	5.0	3.7	4.0	4.2
	2500	2	4.0	3.9	3.7	3.9	3.9	4.5	2.9	3.4	3.2	4.1
Basagran	1200	1	4.1	4.3	4.7	4.5	3.5	4.3	4.7	4.1	4.3	4.4
	1200	2	3.7	4.0	4.4	3.7	3.0	4.3	4.4	4.6	4.1	4.5
	2500	1	4.4	4.2	4.4	4.7	3.9	4.9	5.0	5.0	3.8	4.8
	2500	2	4.1	4.3	4.4	4.2	3.1	4.5	4.9	4.9	3.9	4.8
Diuron 80WP	1200	1	4.1	3.9	4.1	4.7	3.7	4.3	4.8	4.4	4.4	4.4
	1200	2	4.1	4.4	4.1	4.7	4.1	4.4	4.8	4.3	3.5	4.8
	2500	1	4.4	3.4	3.9	4.5	3.5	4.3	5.0	4.7	4.1	4.4
	2500	2	3.9	3.7	4.8	3.7	3.9	4.4	5.0	4.4	3.7	4.7
Kerb 50W	1200	1	4.1	4.5	4.5	4.5	4.1	4.7	4.9	4.2	4.2	3.7
	1200	2	3.8	4.2	4.7	4.4	4.4	4.7	4.8	4.0	3.8	3.9
	2500	1	3.7	4.3	4.3	4.4	4.1	5.0	5.0	4.2	3.7	3.7
	2500	2	4.2	4.4	4.4	4.1	4.4	4.8	4.9	4.0	4.2	3.7
Nortron	1200	1	3.9	3.1	4.1	4.2	4.1	4.3	5.0	4.4	3.7	4.4
	1200	2	3.7	4.1	4.2	3.7	3.7	3.8	3.0	3.7	3.9	4.1
	2500	1	3.5	3.3	4.2	4.3	3.5	5.0	4.8	4.7	4.3	4.5
	2500	2	3.2	4.1	3.9	3.8	3.8	4.2	2.9	3.7	4.1	3.9
Opogard + Flexidor 125	1200	1	3.8	3.3	4.0	4.3	4.0	4.7	4.2	4.7	4.0	4.3
	1200	2	3.8	3.4	3.9	3.2	3.1	4.1	1.8	4.4	3.4	4.7
	2500	1	4.2	3.5	4.2	4.4	4.2	4.7	4.7	5.0	4.1	4.9
	2500	2	4.1	3.6	4.3	4.4	2.8	3.5	2.0	4.7	3.8	4.5
	d.f		54	54	54	54	54	54	54	54	54	54
	s.e.d		0.33	0.47	0.32	0.32	0.34	0.29	0.32	0.28	0.35	0.32

In addition the following phytotoxicity symptoms were noted:

Flex

Chamaecyparis lawsoniana 'Ellwoods' Gold'	Scorch, 2nd spray only.
Potentilla fruticosa 'Primrose Beauty'	Scorch, 2nd spray only.
Spiraea japonica 'Candlelight'	No young foliage, shoot tips brown 2nd spray only, no damage from 1st spray.
Hypericum 'Hidcote'	Black spotting especially 2nd spray.
Viburnum tinus 'Eve Price'	Die-back, both sprays.
Chamaecyparis pisifera 'Boulevard'	Variable, inconclusive.
Lonicera japonica 'Halliana'	Black spotting especially 2nd spray.
Vinca minor 'Bowles' Variety'	Black spotting especially 2nd spray.

Butisan S + Flexidor 125

Potentilla fruticosa 'Primrose Beauty'	Slight reduction in height, both sprays.
Spiraea japonica 'Candlelight'	Stem tips desiccated, no new leaf, 2nd spray only.
Spiraea 'Arguta'	Slight flower bud death, 2nd spray only.
Hypericum 'Hidcote'	Red older foliage, 2nd spray only.
Viburnum tinus 'Eve Price'	Slight reduction, 2nd spray only.
Chamaecyparis pisifera 'Boulevard'	Browning of foliage.
Symphoricarpos X chenaultii 'Hancock'	Emerging growth scorched on 2nd spray, then fewer leaves, tip scorch spotting.
Lonicera japonica 'Halliana'	Black spotting and desiccation, 2nd spray some also from 1st spray.
Vinca minor 'Bowles' Variety'	Slight tip scorch 2nd spray.

Basagran SG

Chamaecyparis lawsoniana 'Ellwoods' Gold'	Higher volume 2nd spray only, very slight die-back, no damage from 1st spray.
Potentilla fruticosa 'Primrose Beauty'	Higher volume 2nd spray only, less foliage.

Diuron 80WP

Hypericum 'Hidcote'	Reddening of old leaf, 2nd spray only.
Viburnum tinus 'Eve Price'	Reduction in growth, 2nd spray only.
Chamaecyparis pisifera 'Boulevard'	Scorched tips higher volume only.
Lonicera japonica 'Halliana'	Leaf scorch 2nd spray, higher volume only.
Vinca minor 'Bowles' Variety'	Yellowing older foliage, 2nd spray higher volume only.

Kerb 50W

Symphoricarpos X chenaultii 'Hancock'	Later reduction in growth.
Vinca minor 'Bowles' Variety'	Reduction in growth.

Nortron

Spiraea japonica 'Candlelight'	Scorch, 2nd spray only.
Spiraea 'Arguta'	Scorched young foliage, 2nd spray only.
Hypericum 'Hidcote'	Reddening older leaves 2nd spray only.
Symphoricarpos X chenaultii 'Hancock'	Browning, smaller, 2nd spray high volume more so, later poor leaf growth yellowed, distorted, leaf drop.
Lonicera japonica 'Halliana'	Tip burning both sprays.
Vinca minor 'Bowles' Variety'	Smaller, 2nd spray high volume only.

Opogard + Flexidor 125

Potentilla fruticosa 'Primrose Beauty'	Severe growth reduction and foliage spotting, 2nd spray high volume especially.
Spiraea japonica 'Candlelight'	Severe leaf loss and die-back, 2nd spray mainly but some also on 1st.
Spiraea 'Arguta'	Stunted, scorch, 2nd spray, high volume especially.
Viburnum tinus 'Eve Price'	Foliage paler on 2nd spray only.
Lonicera japonica 'Halliana'	Severe tip scorch 2nd spray only.

The most damage was caused by the 13 March spray. This was not unexpected, since, following a mild winter, many of the plants had broken dormancy and some, for example *Spiraea japonica* 'Candlelight' were well into early growth. Flex, Butisan S + Flexidor 125, Nortron and Opogard + Flexidor 125 all damaged the majority of crop species at this stage of growth. By comparison, Basagran SG and Kerb 50W were relatively safe at this stage.

Most of the December spray treatments, however, were safe with just a few incidents of damage. *Potentilla fruticosa* 'Primrose Beauty' was stunted by Opogard + Flexidor 125. Flex caused die-back on *Viburnum tinus* 'Eve Price', but was safe on other evergreens as well as the deciduous species. *Lonicera japonica* 'Halliana' was not fully dormant and was scorched by Butisan S + Flexidor 125 and Nortron. Kerb 50W caused a growth reduction on *Vinca minor* 'Bowles' Variety' and *Symphoricarpos X chenaultii* 'Hancock'. Opogard + Flexidor 125 damaged both *Spiraea* species.

CONCLUSIONS

The seeding of pots proved particularly successful in this experiment and, together with the indigenous weed seed carried by some of the crops, provided a severe test for the herbicide treatments.

The best overall weed control was achieved by Butisan S + Flexidor 125 and Opogard + Flexidor 125. Both achieved excellent control of hairy bittercress, common chickweed, sow thistle, pearlwort and mouse ear chickweed. Butisan S + Flexidor 125 however did not give complete control of groundsel and to a lesser extent, willowherb, and Opogard + Flexidor 125 was weak on groundsel and annual meadow grass.

Both of these herbicide mixtures have good residual action as well as contact action. This was a clear advantage under the conditions of this experiment as some weed continued to germinate through the winter period.

Other herbicides with more contact than residual activity proved effective for knockdown of specific weed species rather than giving long term broad spectrum control. In particular Basagran SG was effective against willowherb, groundsel, and pearlwort. This confirms the previous results from HNS 70 (Scott, Girard and Brough, 1998) on willowherb and pearlwort.

Flex is primarily a contact herbicide used for the first time on nursery stock in this experiment. It appears to have a limited weed spectrum when used in the winter, but was particularly effective on groundsel, bittercress and smaller willowherb seedlings. Kerb 50W, Nortron and Diuron, did not control the broad range of weeds, but Kerb 50W was effective on annual meadow grass and Diuron was effective on willowherb.

For most herbicides there was little difference in weed control from applying the herbicides in 1200 litres/ha or 2500 litres/ha. However for Diuron, and to a lesser extent with Kerb 50W there was an improvement in weed control where 2500 litres/ha rather than 1200 litres/ha was used.

All of the herbicides tested were relatively safe when used as a single application to the dormant crops in December. There were just a few incidences of damage. *Potentilla fruticosa* 'Primrose Beauty' was stunted by Opogard + Flexidor 125. Flex caused die-back on *Viburnum tinus* 'Eve Price', but was safe on other evergreens as well as the deciduous species. *Lonicera japonica* 'Halliana' was not fully dormant and

was scorched by Butisan S + Flexidor 125 and Nortron. Kerb 50W caused a growth reduction on *Vinca minor* 'Bowles' Variety' and *Symphoricarpos X chenaultii* 'Hancock'. Opogard + Flexidor 125 damaged both *Spiraea* species.

The spring application was made as the crops were starting to grow away. At this stage, Flex, Butisan S + Flexidor 125, Nortron and Opogard + Flexidor 125 caused unacceptable damage either from direct contact action or root uptake. However Basagran SG and Diuron were much safer at this stage causing virtually no damage.

The safest time to eradicate overwintered weed was December when the crops were relatively dormant. Butisan S + Flexidor 125 provided good activity against a range of weeds and was relatively safe at that time.

For control of certain specific weeds other herbicides provided better, or faster, control than Butisan S + Flexidor and could be considered as alternatives, providing crop safety was determined. In particular, Opogard + Flexidor 125 and Diuron were more effective in controlling willowherb, and Basagran SG was a relatively safer spring treatment for willowherb. Groundsel proved difficult to control, but Flex and Basagran SG were effective as a knockdown treatment and appeared to have a persistent effect. Flex also gave the quickest knockdown of hairy bittercress and might be worth investigating for control of the New Zealand bittercress *Cardamine flexuosa* which is resistant to Flexidor 125.

Summary of control

	Hairy bittercress	Willowherb	Groundsel	Common chickweed	Sow thistle	Annual meadow grass	Pearlwort	Mouse ear chickweed
Flex	***	**	***		*			
Flexidor + Butisan	***	*	*	***	***	***	***	***
Basagran	***	**	**	**	***			**
Diuron	***	**		**			*	*
Kerb				**		***		**
Nortron						**	**	***
Opogard+ Flexidor	***	***		***	***	*	***	***

*** = good control (>90%), ** = moderate but useful control (50-90%), * = slight control (<50%)

TECHNOLOGY TRANSFER

Planned activities

Article in Project News - February 2001
Update information in HDC Weed Control Handbook 2001
Weed control workshops Winter 2000/1
Informing grower members of the HDC of the results of this research during ADAS consultancy visits.

REFERENCE

Scott, M., Girard, K. and Brough, W. (1998). The use of contact herbicides on container grown nursery stock overwinter. Horticultural Development Council Report for project HNS 70.

APPENDICES

APPENDIX 1

Weed assessments and statistical analysis

Table 2: Hairy bittercress, weed numbers per 100 pots, in *Vinca*

Recording date:	31/11/99	21/01/00	06/03/00	10/04/00	10/04/00
Treatment				2 Sprays	1 Spray
Untreated	161	189	167	200	56
Flex, 0.9 l/ha, 2500 l/ha	167	33	33	11	89
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 1200 l/ha	122	44	22	11	89
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 2500 l/ha	111	122	11	11	33
Basagran SG, 1.65 kg/ha, 1200 l/ha	78	122	100	89	89
Basagran SG, 1.65 kg/ha, 2500 l/ha	178	344	344	300	78
Diuron , 0.8 l/ha, 1200 l/ha	161	244	178	89	89
Diuron, 0.8 l/ha, 2500 l/ha	194	211	133	67	200
Kerb 50W, 1.7 kg/ha, 1200 l/ha	311	200	189	133	144
Kerb 50W, 1.7 kg/ha, 2500 l/ha	139	111	111	111	256
Nortron, 5.0 l/ha, 1200 l/ha	161	178	167	156	189
Nortron, 5.0 l/ha, 2500 l/ha	150	200	244	178	200
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha, 1200 l/ha	161	78	44	178	200
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha, 2500 l/ha	89	67	56	22	156
d.f	26	26	26	54	54
s.e.d	78.1	53.4	89.3	82.8	82.8

Table 3: Willowherb, weed numbers per 100 pots, in *Chamaecyparis* 'Ellwoods' Gold'

Recording date:	31/11/99	21/01/00	06/03/00	10/04/00	10/04/00
Treatment				2 Sprays	1 Spray
Untreated	272	344	378	367	256
Flex, 0.9 l/ha, 2500 l/ha	217	89	44	78	100
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 1200 l/ha	161	100	33	0	0
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 2500 l/ha	189	167	78	22	100
Basagran SG, 1.65 kg/ha, 1200 l/ha	206	111	189	67	178
Basagran SG, 1.65 kg/ha, 2500 l/ha	300	189	189	33	233
Diuron , 0.8 l/ha, 1200 l/ha	278	189	111	167	122
Diuron, 0.8 l/ha, 2500 l/ha	211	167	89	22	89
Kerb 50W, 1.7 kg/ha, 1200 l/ha	161	144	122	111	244
Kerb 50W, 1.7 kg/ha, 2500 l/ha	194	122	156	167	100
Nortron, 5.0 l/ha, 1200 l/ha	256	256	344	233	267
Nortron, 5.0 l/ha, 2500 l/ha	244	200	289	222	289
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha, 1200 l/ha	217	144	67	11	56
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha, 2500 l/ha	244	300	122	11	44
d.f	26	26	26	39	39
s.e.d	108.7	106.3	97.8	100.5	100.5

Table 4: Groundsel, weed numbers per 100 pots, in *Spiraea* 'Arguta'

Recording date:	31/11/99	21/01/00	06/03/00	10/04/00	10/04/00
Treatment				2 Sprays	1 Spray
Untreated	178	167	156	189	122
Flex, 0.9 l/ha, 2500 l/ha	172	11	22	0	22
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 1200 l/ha	156	278	211	89	111
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 2500 l/ha	239	244	233	122	178
Basagran SG, 1.65 kg/ha, 1200 l/ha	139	44	44	56	111
Basagran SG, 1.65 kg/ha, 2500 l/ha	111	22	33	44	56
Diuron , 0.8 l/ha, 1200 l/ha	122	156	167	156	144
Diuron, 0.8 l/ha, 2500 l/ha	172	167	178	100	200
Kerb 50W, 1.7 kg/ha, 1200 l/ha	194	278	311	289	222
Kerb 50W, 1.7 kg/ha, 2500 l/ha	117	222	178	133	189
Nortron, 5.0 l/ha, 1200 l/ha	117	156	167	133	133
Nortron, 5.0 l/ha, 2500 l/ha	139	233	256	256	89
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha, 1200 l/ha	228	244	233	222	433
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha, 2500 l/ha	256	200	189	178	222
d.f	26	26	26	49	49
s.e.d	58	77.6	86.8	115.5	115.5

Table 5: Common chickweed, weed numbers per 100 pots, in *Hypericum*

Recording date:	31/11/99	21/01/00	06/03/00	10/04/00	10/04/00
Treatment				2 Sprays	1 Spray
Untreated	433	400	189	156	67
Flex, 0.9 l/ha, 2500 l/ha	194	211	144	144	89
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 1200 l/ha	367	144	11	0	33
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 2500 l/ha	283	33	33	0	0
Basagran SG, 1.65 kg/ha, 1200 l/ha	244	111	44	44	22
Basagran SG, 1.65 kg/ha, 2500 l/ha	167	67	33	33	33
Diuron , 0.8 l/ha, 1200 l/ha	317	211	67	33	56
Diuron, 0.8 l/ha, 2500 l/ha	206	44	33	0	67
Kerb 50W, 1.7 kg/ha, 1200 l/ha	172	89	33	33	22
Kerb 50W, 1.7 kg/ha, 2500 l/ha	167	78	44	44	44
Nortron, 5.0 l/ha, 1200 l/ha	178	133	100	78	33
Nortron, 5.0 l/ha, 2500 l/ha	267	211	133	111	278
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha, 1200 l/ha	511	222	0	0	0
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha, 2500 l/ha	311	44	0	0	0
d.f	26	26	26	54	54
s.e.d	155.6	123.7	84.2	25.4	25.4

Table 6: Sow thistle, weed numbers per 100 pots, in *Potentilla*

Recording date:	31/11/99	21/01/00	06/03/00	10/04/00	10/04/00
Treatment				2 Sprays	1 Spray
Untreated	722	22	111	189	200
Flex, 0.9 l/ha, 2500 l/ha	500	0	89	244	78
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 1200 l/ha	500	11	0	0	0
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 2500 l/ha	111	0	0	0	0
Basagran SG, 1.65 kg/ha, 1200 l/ha	278	0	56	33	67
Basagran SG, 1.65 kg/ha, 2500 l/ha	389	0	11	0	22
Diuron , 0.8 l/ha, 1200 l/ha	333	33	67	78	89
Diuron, 0.8 l/ha, 2500 l/ha	444	56	89	44	78
Kerb 50W, 1.7 kg/ha, 1200 l/ha	278	67	111	178	167
Kerb 50W, 1.7 kg/ha, 2500 l/ha	278	89	44	111	144
Nortron, 5.0 l/ha, 1200 l/ha	444	89	100	44	111
Nortron, 5.0 l/ha, 2500 l/ha	444	44	100	211	167
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha 1200 l/ha	500	11	0	0	0
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha, 2500 l/ha	389	11	0	0	44
d.f	26	26	26	51	51
s.e.d	34	40.7	59.9	43.4	43.4

Table 7: Annual meadow grass, weed numbers per 100 pots, *Chamaecyparis* 'Ellwoods' Gold'

Recording date:	31/11/99	21/01/00	06/03/00	10/04/00	10/04/00
Treatment				2 Sprays	1 Spray
Untreated	56	22	56	44	56
Flex, 0.9 l/ha, 2500 l/ha	72	44	22	33	78
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 1200 l/ha	44	22	22	0	0
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 2500 l/ha	28	11	0	0	0
Basagran SG, 1.65 kg/ha, 1200 l/ha	28	33	33	33	67
Basagran SG, 1.65 kg/ha, 2500 l/ha	72	100	111	100	56
Diuron , 0.8 l/ha, 1200 l/ha	100	78	33	22	78
Diuron, 0.8 l/ha, 2500 l/ha	44	44	44	33	0
Kerb 50W, 1.7 kg/ha, 1200 l/ha	33	22	0	0	0
Kerb 50W, 1.7 kg/ha, 2500 l/ha	56	22	11	0	0
Nortron, 5.0 l/ha, 1200 l/ha	39	22	33	44	11
Nortron, 5.0 l/ha, 2500 l/ha	22	33	11	0	11
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha, 1200 l/ha	44	44	33	33	33
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha, 2500 l/ha	94	33	44	33	56
d.f	26	26	26	49	49
s.e.d	37.2	39.2	37	28.2	28.2

Table 8: Pearlwort, weed numbers per 100 pots, in *Symphoricarpos*

Recording date:	31/11/99	21/01/00	06/03/00	10/04/00	10/04/00
Treatment				2 Sprays	1 Spray
Untreated	411	122	211	56	44
Flex, 0.9 l/ha, 2500 l/ha	394	200	211	300	267
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 1200 l/ha	394	144	0	0	0
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 2500 l/ha	267	211	0	0	0
Basagran SG, 1.65 kg/ha, 1200 l/ha	378	178	33	0	89
Basagran SG, 1.65 kg/ha, 2500 l/ha	144	89	33	0	56
Diuron , 0.8 l/ha, 1200 l/ha	356	100	89	0	111
Diuron, 0.8 l/ha, 2500 l/ha	456	333	144	0	111
Kerb 50W, 1.7 kg/ha, 1200 l/ha	333	278	333	233	100
Kerb 50W, 1.7 kg/ha, 2500 l/ha	433	256	211	89	144
Nortron, 5.0 l/ha, 1200 l/ha	339	67	33	0	0
Nortron, 5.0 l/ha, 2500 l/ha	233	133	11	0	0
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha, 1200 l/ha	294	122	0	0	0
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha, 2500 l/ha	317	289	0	0	0
d.f	26	26	26	49	49
s.e.d	147.7	106.7	86.9	70	70

Table 9: Mouse ear chickweed, weed numbers per 100 pots, in *Spiraea* 'Arguta'

Recording date:	31/11/99	21/01/00	06/03/00	10/04/00	10/04/00
Treatment				2 Sprays	1 Spray
Untreated	228	400	522	333	411
Flex, 0.9 l/ha, 2500 l/ha	217	189	333	311	189
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 1200 l/ha	361	500	0	0	0
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 2500 l/ha	289	300	0	0	0
Basagran SG, 1.65 kg/ha, 1200 l/ha	244	322	289	89	200
Basagran SG, 1.65 kg/ha, 2500 l/ha	189	178	278	89	444
Diuron , 0.8 l/ha, 1200 l/ha	211	289	144	0	78
Diuron, 0.8 l/ha, 2500 l/ha	222	144	67	0	100
Kerb 50W, 1.7 kg/ha, 1200 l/ha	278	589	522	100	22
Kerb 50W, 1.7 kg/ha, 2500 l/ha	133	311	289	56	33
Nortron, 5.0 l/ha, 1200 l/ha	183	344	122	78	22
Nortron, 5.0 l/ha, 2500 l/ha	256	122	89	11	0
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha, 1200 l/ha	250	33	0	0	0
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha, 2500 l/ha	333	78	0	0	0
d.f	26	26	26	50	50
s.e.d	115.5	172.9	172.4	80.9	80.9

Table 10: All weeds, numbers per 100 pots, all crops

Recording date:	31/11/99	21/01/00	06/03/00	10/04/00	10/04/00
Treatment				2 Sprays	1 Spray
Untreated	786	727	667	641	737
Flex, 0.9 l/ha, 2500 l/ha	899	509	519	396	490
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 1200 l/ha	787	711	231	136	171
Butisan S, 2.5 l/ha + Flexidor 125, 2.0 l/ha, 2500 l/ha	777	686	211	124	166
Basagran SG, 1.65 kg/ha, 1200 l/ha	861	585	494	320	466
Basagran SG, 1.65 kg/ha, 2500 l/ha	731	451	419	294	523
Diuron , 0.8 l/ha, 1200 l/ha	763	662	420	316	396
Diuron, 0.8 l/ha, 2500 l/ha	763	612	371	193	386
Kerb 50W, 1.7 kg/ha, 1200 l/ha	769	748	614	548	508
Kerb 50W, 1.7 kg/ha, 2500 l/ha	783	728	578	444	554
Nortron, 5.0 l/ha, 1200 l/ha	812	770	575	425	528
Nortron, 5.0 l/ha, 2500 l/ha	707	615	478	456	557
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha, 1200 l/ha	842	535	253	191	252
Opogard, 2.8 l/ha + Flexidor 125, 0.6 l/ha, 2500 l/ha	933	608	253	206	232
d.f	26	26	26	49	49
s.e.d	115.5	172.9	172.4	76	76

Table 11 : Weeds by species per 100 pots, all crops, 10/4/00

Treatment	Water Volume	Double/Single	Hairy Bittercress	Willowherb	Groundsel	Chickweed	SowThistle	AMGrass	Pearlwort	Mouse Ear	Total
Control		D	58	154	86	63	36	48	51	133	641
Flex	2500	D	9	28	3	63	7	48	97	134	396
Butisan + Flexidor	1200	D	3	44	70	3	0	3	3	1	136
Butisan + Flexidor	2500	D	6	30	77	1	1	3	3	0	124
Basagran	1200	D	6	21	38	18	26	68	67	33	320
Basagran	2500	D	6	39	33	12	42	51	102	20	294
Diuron	1200	D	34	31	106	18	23	34	39	11	316
Diuron	2500	D	10	16	73	12	27	21	19	2	193
Kerb	1200	D	92	102	136	32	56	0	74	42	548
Kerb	2500	D	59	108	129	29	49	0	31	26	444
Nortron	1200	D	77	127	126	36	17	11	8	11	424
Nortron	2500	D	73	113	149	56	26	7	8	6	456
Opogard + Flexidor	1200	D	3	2	164	0	1	14	2	0	191
Opogard + Flexidor	2500	D	0	6	146	0	3	30	4	0	206
Control		S	69	201	112	61	32	34	48	167	736
Flex	2500	S	27	121	19	34	27	36	101	114	490
Butisan + Flexidor	1200	S	18	48	79	4	2	9	4	2	171
Butisan + Flexidor	2500	S	13	49	96	0	0	7	0	0	166
Basagran	1200	S	56	91	42	32	18	61	67	81	466
Basagran	2500	S	44	73	41	28	32	54	102	121	523
Diuron	1200	S	33	44	111	27	19	28	59	50	396
Diuron	2500	S	33	32	106	27	49	40	51	41	386
Kerb	1200	S	71	100	137	36	60	0	44	43	508
Kerb	2500	S	83	176	139	40	26	1	52	23	544
Nortron	1200	S	108	189	103	42	16	14	13	21	528
Nortron	2500	S	78	150	138	90	27	12	21	11	557
Opogard + Flexidor	1200	S	17	22	158	7	9	31	4	0	252
Opogard + Flexidor	2500	S	7	11	144	6	3	47	6	1	232
	d.f.		53	54	53	35	42	53	49	53	49
	s.e.d		16.4	32.5	24.1	17.8	8.3	14	16.2	21.2	76

APPENDIX 2

Crop scoring records

Plants were put into scoring categories 1-5. Examples of each score category were photographed and heights were measured. However, height was not always the best measure of quality, and other factors detailed below were taken into account.

Table 12: Height (cm) of graded plants.

Plant	Height in cm				
	Score 1	2	3	4	Score 5
Vinca minor 'Bowles' Variety'	7	8	11	11	11
Chamaecyparis lawsoniana 'Ellwoods' Gold'	23	28	39	42	55
Chamaecyparis pisifera 'Boulevard'	16	12	17	18	18
Spiraea japonica 'Candlelight'	16	23	18	19	20
Lonicera japonica 'Halliana'	30	70	80	150	140
Potentilla fruticosa 'Primrose Beauty'	27	26	27	29	30
Viburnum tinus 'Eve Price'	28	26	31	32	37
Symphoricarpos X chenaultii 'Hancock'	26	27	24	24	29
Spiraea 'Arguta'	50	70	70	80	100
Hypericum 'Hidcote'	29	30	35	30	40

Table 13: Other phytotoxicity factors used to score:

	Score 1	2	3	4	Score 5
Vinca minor 'Bowles' Variety'	Marked and stunted	Some leaf marking	paler and shorter		Lush green, long dangling shoots
Chamaecyparis lawsoniana 'Ellwoods' Gold'	Height differences only				
Chamaecyparis pisifera 'Boulevard'	Size differences . Die-back in lower grades				
Spiraea japonica 'Candlelight'	Severe leaf loss, die-back	Die-back	Slow bud emergence		Lush gold
Lonicera japonica 'Halliana'	Severe die-back and spotting	Leaf markings (purple edges)	Stunted		Tall, lush
Potentilla fruticosa 'Primrose Beauty'	Sparse leaf emergence				Lush growth
Viburnum tinus 'Eve Price'	Stunted and pale				Vigorous + dark green
Symphoricarpos X chenaultii 'Hancock'	Very little leaf emergence				Large plants good leaf emergence
Spiraea 'Arguta'	Thin growth	some dead leaves	3-5 = increase in bulkiness		
Hypericum 'Hidcote'	Red leaves and leaf drop				Lush, green, bushy

Scoring took place against this standard considering shape, size, colour and overall quality and saleability. Specific herbicide damage may not always be reflected in the score and notes have been made where visible damage symptoms have been observed.

Photographs illustrating quality scores

***Vinca minor* 'Bowles' Variety'**

***Chamaecyparis lawsoniana* 'Ellwoods' Gold'**

Chamaecyparis pisifera **'Boulevard'**

Spiraea japonica **'Candlelight'**

Lonicera japonica **'Halliana'**

Potentilla fruticosa **'Primrose Beauty'**

***Viburnum tinus* 'Eve Price'**

Symphoricarpos X chenaultii 'Hancock'

***Spiraea* 'Arguta'**

***Hypericum* 'Hidcote'**