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HDC HNS 28a and 35a Chemical Weed Control in Outdoor Container Grown Nursery Stock 1991-1996.

HNS 35d Chemical Weed Control in Sand Beds 1992-93.

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Location of Project: Darby Nursery Stock Ltd, Methwold, Norfolk

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Date Project Commenced: May 1991

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Key Words: Container grown hardy nursery stock, weed control, overhead applied herbicides, sand bed herbicides, phytotoxicity.

This report combines the results of 5 years work. Inclusion of products in these trials does not necessarily mean that they have approval for use on hardy nursery stock. Manufacturers literature must be consulted.

Acknowledgment:

The help of Mr A Darby and his staff in providing the site and their assistance in setting up the trials is gratefully acknowledged.

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RELEVANCE TO GROWERS AND PRACTICAL APPLICATION

Application

Good weed control is a key component in the production of top quality container grown stock. The withdrawal of key herbicides and build up of weeds resistant to some herbicides has meant that this series of HDC trials has played a vital part in the development of new herbicide programmes. These programmes are already in use on many nurseries.

Summary and Conclusions

Sand Bed Treatments

Of the treatments applied to sand beds before standing out the crop the herbicide Ardent consistently gave the best weed control with no signs of crop damage from uptake. A tank mix application of Ronstar Liquid and Flexidor 125 also gave good results except for Liverwort control.

N.B.

a) There is no label for the use of Ardent on HONS therefore it is a GROWER RISK TREATMENT.

b) Neither Ardent nor Ronstar Liquid must be applied over the crop as extensive damage would be caused.

None of the herbicides or algaecides used in the trials had a significant effect on the prevention of rooting through.

Overhead Applied Herbicide Programmes

The following programmes all gave good weed control with little phytotoxicity *overall.

1. Ronstar 2G at potting then alternated with Flexidor 125 at 9 week intervals.

   N.B. Ronstar 2G and Flexidor 125 applications limited to two/crop/year.

2. Ronstar 2G at potting them alternated with Butisan S at 9 week intervals.

3. Flexidor 125 + Butisan S at potting them every 18 weeks. This treatment carries the greatest risk of damage.

4. Ronstar 2G at potting, after 9 weeks Flexidor 125, after further 9 weeks Butisan S, after further 9 weeks Flexidor 125, after further 9 weeks Butisan S.

   Rate of use Ronstar 2G 200 kg/ha; Flexidor 125 1 l/ha; Butisan S 2.5 l/ha.

*N.B. The trials used well grown liners potted into 3 litre containers before being stood out on the sand beds.

Ronstar 2G granules have been the cornerstone of HONS weed control programmes for many years. However, the trials have shown that using products such as Flexidor 125 and Butisan S in

programmes with Ronstar 2G gives improved weed control. Some weeds such as Chickweed are resistant or poorly controlled, e.g. Pearlwort, by Ronstar 2G.

The trials have also shown that it is possible to use Flexidor 125 and Butisan S without Ronstar 2G but with an increased risk of phytotoxicity. It is likely that most growers will continue to use Ronstar 2G, particularly as the first treatment after potting because of its convenience of use and general low level of phytotoxicity despite its high price.

The original formulation of isoxaben (Flexidor) and from 1994 the modified formulation, sold as Flexidor 125, performed well in the trials giving good control of the main container weeds except Liverwort. Control of Chickweed and Pearlwort has proved very complimentary to Ronstar 2G's weed spectrum. The results from HDC trials played a significant part in the development of a manufacturers label for the use of Flexidor 125 on outdoor container grown nursery stock. The manufacturers (Dow Elanco) label suggests a rate of use of 2 1/ha. However, the rate of original Flexidor formulation and Flexidor 125 was at a rate equivalent to 1 litre/ha of Flexidor 125. In the 94/95 trial the rates were compared and there was no obvious advantage in using 2 l/ha although there was little increase in phytotoxicity. A possible justification for using the higher rate would be if Groundsel was a problem weed. However, Butisan S normally gives better control of Groundsel then Flexidor 125.

Butisan S has given good levels of weed control and surprisingly little phytotoxicity in the trials since it is known that it can cause scorch on soft foliage in certain circumstances when used on field grown stock. Butisan S does not have a label for use on container stock so remains a GROWER RISK TREATMENT. Butisan S is probably best considered as an autumn or winter treatment when risk of damage is reduced. Tank mixing Butisan S with Flexidor 125 gives enhanced weed control but enhanced risk of damage. However, even at an 18 week application interval weed control was good and is the cheapest of the treatments. Growers should assess Butisan S and Flexidor 125 as a tank mix under their own conditions on a small scale before using widely.

When first used in the trial in 1993 lenacil (Venzar) gave good weed control, especially of Liverwort, with little damage. However, in subsequent trials in 1994 and 1995 there has been considerable damage and this product cannot be recommended for general use in container grown shrubs. It is felt that the reason for the damage in 1994 and 1995 was that weather conditions were much hotter in July/August than in 1993 and that the herbicide was taken up during periods of rapid growth and heavy overhead irrigation.

When used in late autumn/winter the risk from lenacil appeared to be much less so this might be a possibility if Liverwort is a particular problem but would require grower trialling on their range of plants.

N.B. Lenacil should not be used as a standing base treatment because of the risk of uptake.

Other products used in the trials shown to be active against Liverworts were Mogeton and Panacide M. Neither of these products have labels for use over container nursery stock so are GROWER RISK TREATMENTS. General experience has shown that Mogeton is much safer than Panacide M.

The herbicide Devrinol has a label for use on outdoor container stock as a winter applied treatment. However widespread use is unlikely because it does not control cruciferous weeds, e.g. Hairy Bitter-cress, and at 9 l/ha is a relatively expensive treatment.

Of the other products used in the trials as overhead applied treatments Granular Naptol and Enide 50W were withdrawn from the market during the trials period.

The trials examined application intervals from 6 weeks up to 18 weeks. In most situations an interval of 9 weeks proved to be satisfactory. However, under severe weed pressure it may be necessary to reduce to 6 week intervals on some nurseries. If Flexidor 125 + Butisan S is to be used as a tank mix treatment this should only be done at 18 week intervals.

Levels of phytotoxicity recorded over the five years of trials are shown on pages 4-6. Ronstar 2G caused the least damage followed by Flexidor 125 and Butisan S. Tank mixes of Flexidor 125 plus Butisan S caused more damage than the products used singly.

The risk of damage was affected by the stage of crop growth. For example products which appeared safe on certain crops in the first year of growth caused damage when applied at or just after bud burst in the spring of the following season. *Euonymus fortunei* 'Emerald and Gold' had shoot tips burnt out by both Flexidor 125 and Butisan S in 1994 and similar damage occurred on *Cotoneaster horizontalis* from Butisan S in spring 1995.

Buddleia cultivars were consistently damaged by both Flexidor 125 and Butisan S.

Herbicide Costs at 1996 Prices

Ronstar 2G £4.49/kg cost per application at 200 kg/ha	£898
Flexidor 125 £56.80/l cost per application at 1l/ha	£56.80
Butisan S £33.15/l cost per application at 2.5 l/ha	£82.87
Ardent £13/l cost per application at 2.5 l/ha	£32.50
Mogeton £36.87/kg cost per application at 10 kg/ha	£368.70

Phytotoxicity

Details of crop damage on the range of subjects used in the trials from 1991-96 are shown in the following table.

KEY:

✓ = No phytotoxicity
x = Slight damage
xx = Moderate damage
xxx = Severe damage or death
- = Not tested

PHYTOTOXICITY SCREENING IN HDC/ADAS CHEMICAL WEED CONTROL TRIALS ON OUTDOOR CONTAINER NURSERY STOCK AT DARBY NURSERY STOCK LTD 1991-1996

		Herbicides			
Subject	**oxadiazon as Ronstar 2G**	**isoxaben as Flexidor 125**	**metazachlor as Butisan S**	**isoxaben + metazachlor as Flexidor 125 & Butisan S**	**lenacil as Venzar**
Aucuba japonica 'Golden King'	✓	✓	✓	✓	-
Aucuba japonica 'Variegata'	✓	✓	✓	-	-
Berberis x ottawensis 'Purpurea'	✓	✓	✓	✓	-
Buddleia alternifolia	✓	xx	xx	xx	✓
Buddleia davidii 'Black Knight'	✓	xx	xxx	xxx	-
Buddleia davidii 'Pink Delight'	✓	x	✓	xx	-
Buddleia davidii 'Royal Red'	✓	x	✓	-	-
Caryopteris x clandonensis	✓	✓	✓	✓	-
Ceanothus 'A T Johnson'	✓	✓	✓	✓	xx
Ceanothus thyrsiflorus repens	✓	✓	✓	✓	xx
Chaenomeles x superba 'Crimson and Gold'	✓	✓	✓	✓	-
Chaenomeles x superba 'Nicoline'	✓	✓	✓	✓	xx
Charmaecyparis lawsoniana 'Ellwoodii'	✓	✓	✓	✓	✓
Charmaecyparis lawsoniana 'Stardust'	✓	✓	✓	✓	-
Charmaecyparis pisifera 'Boulevard'	✓	✓	✓	✓	✓
Cistus x purpureus	✓	✓	✓	✓	✓
Cistus 'Sunset'	✓	✓	✓	✓	xxx
Clematis tangutica 'Aureolin'	✓	✓	✓	✓	-
Cornus alba 'Elegantissima'	✓	✓	x	x	✓
Cotoneaster dammeri	✓	✓	✓	x	-
Cotoneaster horizontalis	✓	✓	xx	xx	✓
Cytisus x praecox	✓	✓	✓	✓	-
Cytisus x praecox 'Allgold'	✓	✓	✓	-	-
Cytisus x praecox 'Hollandia'	✓	✓	✓	✓	✓
Deutzia 'Mont Rose'	✓	✓	✓	✓	xxx
Elaeagnus pungens 'Maculata'	✓	✓	✓	✓	-
Escallonia 'Apple Blossom'	✓	✓	✓	✓	-
Escallonia 'Crimson Spire'	✓	✓	✓	✓	✓
Euonymus fortunei 'Emerald and Gold'	✓	xx	✓	xx	-
Euonymus japonica 'Ovatus Aureus'	✓	✓	✓	✓	✓
Forsythia 'Lynwood'	✓	✓	✓	✓	xx
Hebe x franciscana 'Variegata'	✓	✓	✓	✓	-
Hebe 'Margaret'	✓	✓	✓	✓	-
Hebe pinguifolia 'Pagei'	✓	✓	✓	✓	✓
Hedera canariensis 'Gloire de Marengo'	✓	x	✓	x	-
Hedera helix 'Goldheart'	✓	✓	✓	✓	✓

		Herbicides			
Subject	**oxadiazon as Ronstar 2G**	**isoxaben as Flexidor 125**	**metazachlor as Butisan S**	**isoxaben + metazachlor as Flexidor 125 & Butisan S**	**lenacil as Venzar**
Hydrangea macrophylla 'Blue Wave'	✓	✓	□	✓	-
Hydrangea macrophylla 'Europe'	✓	✓	✓	✓	-
Hydrangea macrophylla 'White Wave'	✓	✓	✓	-	-
Hypericum 'Hidcote'	✓	✓	✓	✓	-
Hypericum x moseranum 'Tricolor'	✓	✓	✓	✓	-
Juniperus chinensis 'Kuriwao Gold'	✓	✓	✓	✓	✓
Juniperus x media 'Old Gold'	✓	✓	✓	✓	✓
Juniperus squamata 'Blue Carpet'	✓	✓	✓	-	-
Juniperus squamata 'Blue Star'	✓	✓	✓	✓	-
Kerria japonica 'Pleniflora'	✓	✓	✓	✓	-
Lavandula angustifolia 'Dwarf White'	✓	✓	✓	✓	✓
Lavandula angustifolia 'Vera'	✓	✓	✓	✓	✓
Lavatera olbia 'Rosea'	✓	✓	✓	✓	xx
Lavatera thuringiaca 'Barnsley'	✓	✓	✓	□	-
Lonicera nitida 'Baggesen's Gold'	✓	✓	✓	x	-
Lonicera periclymenum 'Serotina'	✓	✓	✓	✓	-
Pachysandra terminalis 'Variegata'	✓	✓	✓	-	-
Philadelphus 'Manteau d'Hermine'	✓	✓	✓	✓	xx
Potentilla 'Goldfinger'	✓	✓	x	x	-
Potentilla 'Tilford Cream'	✓	✓	✓	✓	xx
Prunus laurocerasus 'Otto Luyken'	✓	✓	✓	✓	-
Pyracantha 'Orange Glow'	✓	✓	✓	✓	xx
Rhododendron 'Bengal'	✓	✓	□	-	-
Rhododendron 'Carmen'	✓	✓	□	-	-
Rhododendron 'Evening Red'	✓	✓	✓	-	-
Rosa 'Baby Masquerade'	✓	✓	✓	✓	-
Santolina chamaecyparissus	✓	✓	✓	✓	xxx
Spiraea x bulmada 'Goldflame'	✓	✓	✓	x	-
Symphoricarpos x doorenbosii 'Magic Berry'	✓	✓	✓	✓	✓
Syringa x josiflexa 'Bellicent'	✓	✓	✓	✓	✓

		Herbicides			
Subject	**oxadiazon as Ronstar 2G**	**isoxaben as Flexidor 125**	**metazachlor as Butisan S**	**isoxaben + metazachlor as Flexidor 125 & Butisan S**	**lenacil as Venzar**
Thuja occidentalis 'Rheingold'	✓	✓	✓	✓	✓
Thuja orientalis 'Aurea Nana'	✓	✓	✓	✓	✓
Viburnum opulus 'Sterile'	✓	✓	✓	✓	xx
Viburnum tinus	✓	✓	✓	✓	-
Vinca major	✓	✓	✓	✓	xxx
Vinca minor	✓	✓	✓	□	xx

Weed Susceptibility

The susceptibility of weeds to some of the herbicides is shown in the following table.

SUSCEPTIBILITY OF WEEDS TO SOME HERBICIDES

S = susceptible
s = moderately susceptible
R = resistant
r = moderately resistant
- = not known

	Enide 50W diphenamid	Ronstar 2G oxadiazon	Devrinol napropamide	Flexidor 125 isoxaben	Butisan S metazachlor	Venzar lenacil
Annual Meadow-grass	S	S	S	R	S	S
Black-bindweed	-	S	S	-	s	S
Black Nightshade	R	s	R	-	-	R
Cleavers	-	S	S	r	s	R
Common Chickweed	S	R	S	S	S	S
Charlock	-	S	R	S	r	S
Fat-hen	s	S	S	S	s	S
Common Fumitory	R	S	S	S	R	S
Groundsel	S	S	S	S	S	s
Common Hemp-nettle	-	-	S	S	r	r
Henbit Dead-nettle	-	-	S	-	S	s
Hairy Bitter-cress	S	S	r	S	S	S
Knotgrass	s	S	s	S	R	S
Mayweed spp.	s	S	S	S	S	s
Pale Persicaria	-	-	S	-	-	-
Redshank	s	S	s	S	s	S
Shepherd's purse	S	S	r	S	S	S
Scarlet Pimpernel	-	-	R	S	-	S
Small Nettle	S	S	S	S	s	s
Smooth sow-thistle	-	S	S	-	-	S
Speedwell spp.	S	S	S	S	S	r
Willowherb spp.	S	S	s	s	s	R
Wood-sorrel (oxalis)	-	r	-	-	-	-
Common Poppy	-	-	S	S	S	-
Corn Spurrey	S	-	S	S	-	-
Creeping Yellow-cress	-	-	-	s	-	-
Parsley-piert	-	-	R	S	S	-
Dandelion	-	R	-	-	-	-
Pearlwort spp.	S	R	S	S	s	-
Sheep's Sorrel	S	-	S	-	-	-
Willow spp.	-	-	-	-	-	-
Field Pansy	-	-	s	S	r	R
Field Penny-cress	S	R	R	S	R	S
Liverworts	R	s	-	r	s	S
Mosses	R	r	-	r	-	-
Algae	-	-	-	-	-	-

EXPERIMENTAL SECTION

INTRODUCTION

Good weed control is a vital component in the production of top quality container grown nursery stock. Hand weeding is a very expensive option compared to chemical control and can be inefficient in that very often weeds and weed seed and spores are left to provide a source of future contamination.

When this series of trials started in 1991 there were very few herbicides available for use on outdoor container nursery stock because of the withdrawal of products such as Tenoran 50WP, Ronstar TX and Surflan. In addition weeds which were resistant to Ronstar 2G, e.g. chickweed and pearlwort, were beginning to build up on many nurseries. Therefore it was vital to find a range of treatments which gave improved, cost effective weed control and which caused as little crop damage as possible.

The trials have looked at weed control in the sand base by applying herbicides prior to standing out the crop and at weed control by applying herbicides over the crop at intervals through the production cycle.

Trial treatments were modified and species range extended through the period of the trials based on previous results and because of continuing problems of herbicide availability.

MATERIALS AND METHODS

Trials procedure, unless stated otherwise, was common across the five years of trials.

Production System

3 litre containers were grown on outdoor drained sandbeds with overhead irrigation at Darby Nursery Stock Ltd, Methwold, Norfolk.

Growing Medium

The nurseries standard peat/bark compost with controlled release fertiliser was used for the trials.

Start Material

Well graded liners were potted into 3 litre pots in May of each year and stood out on sand beds.

Design

The trials were set out in blocks with treatments randomised within blocks.

Records

Treatments were assessed for degree of weed control and crop phytotoxicity.

Results were analysed using Standard Analysis of Variance where appropriate.

Treatments

Treatments, species and start date are detailed as follows.

<u>Year 1: 1991/92 HNS 28a Chemical Weed Control in Outdoor Container Grown Hardy Ornamental Nursery Stock</u>

Treatments

1. Untreated control
2. Ronstar 2G granules every 12 weeks
3. Ronstar 2G after potting then alternating with Enide 50 W every 6 weeks
4. Ronstar 2G after potting then alternating with Flexidor every 6 weeks
5. Ronstar 2G after potting then alternating with Butisan S every 6 weeks
6. Ronstar 2G after potting then alternating with Granular Naptol every 6 weeks

Treatment Dates

Treatment	22/5/91	5/7/91	13/8/91	11/10/91	22/11/91
1	-	-	-	-	-
2	R	-	R	-	R
3	R	E	R	E	R
4	R	F	R	F	R
5	R	B	R	B	R
6	R	GN	R	GN	R

Rates of Use:

Ronstar 2G	200 kg/ha (Granules)
Enide 50W	9 kg/ha
Flexidor (Old formulation)	250 ml/ha
Butisan S	2.5 l/ha
Granular Naptol	112 kg/ha (Granules)

Spray treatments were applied in 2,500 litres of water/ha. None of the spray treatments were washed off.

There were 2 replicates of each treatment.

Species Treated

Aucuba japonica 'Variegata'
Buddleia davidii 'Royal Red'
Chamaecyparis lawsoniana 'Stardust'
Cornus alba 'Elegantissima'
Cytisus x praecox 'Allgold'
Escallonia 'Apple Blossom'
Forsythia 'Lynwood'
Hedera helix 'Goldheart'
Hebe x franciscana 'Variegata'
Hydrangea macrophylla 'White Wave'
Hypericum 'Hidcote'
Juniperus squamata 'Blue Carpet'
Lonicera periclymenum 'Serotina'
Pachysandra terminalis 'Variegata'
Philadelphus 'Manteau d'Hermine'
Potentilla 'Goldfinger'
Prunus laurocerasus 'Otto Luyken'
Rhododendron 'Bengal'
Rhododendron 'Carmen'
Rhododendron 'Evening Red'
Spiraea x bumalda 'Gold Flame'
Vinca minor

Year 2: 1992 HNS 35d Chemical Weed Control in Sand Beds

Treatments

1. Untreated control
2. Paramoss 150 mls in 4.5 l/10m²
3. Flexidor (Old formulation) 250 mls/ha
4. Butisan S 2.5 l/ha
5. Ardent 2.5 l/ha
6. Ronstar Liquid 4 l/ha

The treatments were applied to the sand beds on 15/5/92. The 3 litre containers were treated with Ronstar 2G granules before standing out on the beds to give some weed control in the containers. With the exception of Paramoss all products were applied at a rate of 2,500 l water/ha. There were 4 replicates of each treatment. Two replicates on each of two sand beds.

Species stood out on Sand Beds

Juniper squamata 'Blue Star'	*Hedera canariensis* 'Gloire de Marengo'
Vinca minor	*Forsythia* 'Lynwood'
Hebe x fransiscana 'Variegata'	*Escallonia* 'Apple Blossom'
Aucuba japonica 'Golden King'	*Cytisus x praecox*
Spiraea x bumalda 'Gold Flame'	*Philadelphus* 'Manteau d'Hermine'
Potentilla 'Goldfinger'	*Prunus laurocerasus* 'Otto Luyken'
Chamaecyparis lawsoniana 'Stardust'	*Hydrangea macrophylla* 'BlueWare'
Cornus alba 'Elegantissima'	*Hypericum* 'Hidcote'
Buddleia davidii 'Black Knight'	*Cotoneaster dammeri*
Loniera periclymenum 'Serotina'	*Rose* 'Baby Masquerade'

Year 2: 1992/93 HNS 35a Chemical Weed Control in Outdoor Container Grown Nursery Stock

Treatments

1. Untreated control
2. Ronstar 2G alternated with Flexidor every 6 weeks
3. Ronstar 2G alternated with Butisan S every 6 weeks
4. Ronstar 2G alternated with Ardent every 6 weeks.
5. Ronstar 2G, after 6 weeks Flexidor + Butisan S, after further 12 weeks Flexidor + Butisan S, after further 12 weeks Butisan S.
6. Ronstar 2G, after 6 weeks Flexidor + Enide 50W, after further 12 weeks Flexidor + Enide 50W after further 12 weeks Butisan S.

Treatment dates

	15/5/92	26/6/92	7/8/92	18/8/92	30/10/92	10/12/92	21/1/93
Treatment							
1	-	-	-	-	-	-	-
2	R	F	R	F	R	-	F
3	R	B	R	B	R	B	R
4	R	A	R	A	R	A	R
5	R	F+B	-	F+B	-	B	-
6	R	F+E	-	F+E	-	B	-

Rates of Use

Ronstar 2G	200 kg/ha
Flexidor (old formulation)	250 ml/ha
Butisan S	2.5 l/ha
Ardent	2.5 l/ha
Enide 50W	9 kg/ha

Sprays applied in 2,500 litres water/ha with no washing off.

Two sand beds were used for the trial with two replicates of each treatment on each bed giving four replicates in total.

Species Treated

Juniper squamata 'Blue Star'
Vinca minor
Hebe x fransiscana 'Variegata'
Aucuba japonica 'Golden King'
Spiraea x bumalda 'Gold Flame'
Potentilla 'Goldfinger'
Chamaecyparis lawsoniana 'Stardust'
Cornus alba 'Elegantissima'
Buddleia davidii 'Black Knight'
Loniera periclymenum 'Serotina'
Hedera canariensis 'Gloire de Marengo'
Forsythia 'Lynwood'
Escallonia 'Apple Blossom'
Cytisus x praecox
Philadelphus 'Manteau d'Hermine'
Prunus laurocerasus 'Otto Luyken'
Hydrangea macrophylla 'BlueWare'
Hypericum 'Hidcote'
Cotoneaster dammeri
Rose 'Baby Masquerade'

Year 3 1993 HNS 35d Chemical Weed Control in Sand Beds

Treatments

1. Untreated control
2. Ardent 2.5 l/ha
3. Ardent plus Howes Olympic Algaecide (22.5 l/ha)
4. Howes Olympic Algaecide
5. Mogeton (7 kg/ha)
6. Ronstar liquid 4 l/ha plus Flexidor 250 ml/ha

All products were applied high volume at a rate of 2,500 water/ha.

The treatments were applied to the sand beds on 17 May 1993. Heavy rain fell within 1 hour of application. The containers were treated with Ronstar 2G granules before standing out.

Two sand beds were used for the trial with two replicates of each treatment on each bed giving 4 replicates in total.

Species used in the trial

Elaeagnus punges 'Maculata'
Thuja occidentalis 'Rheingold'
Hebe 'Margaret'
Lavandula angustifolia 'Dwarf White'
Euonymus fortunei 'Emerald and Gold'
Kerria japonica 'Pleniflora'
Ceanothus thyrsiflorus repens
Berberis x ottawensis 'Purpurea'
Hydrangea macrophylla 'Europa'
Clematis tangutica 'Aureolin'
Chaenomeles x superba 'Crimson and Gold'
Lavatera thuringiaca 'Barnsley'
Buddleia davidii 'Pink Delight'
Caryopteris x clandonensis
Hypericum x moserianum 'Tricolor'
Chamaecyparis pisifera 'Boulevard'
Santolina chamaecyparissus
Viburnum tinus
Lonicera nitida 'Baggesson's Gold'
Juniperus squamata 'Old Gold'

Supplementary Observation on Liverwort Control

Because by the end of the trial a carpet of liverwort had become established on one of the beds it was decided to look at the following eradicant treatments.

Flexidor 250 ml/ha plus Venzar 2.8 kg/ha
Venzar 2.8 kg/ha
Flexidor 500 mls/ha plus Venzar 2.8 kg/ha
Flexidor 500 mls/ha
Mogeton 14 kg/ha
Panacide M 2% solution

The treatments were applied on 11/11/93.

Year 3 1993/94 HNS 35a Chemical Weed Control in Outdoor Container Grown Nursery Stock

Treatments

1. Untreated control
2. Ronstar 2G alternated with Flexidor at 9 week intervals
3. Ronstar 2G alternated with Butisan S at 9 week intervals
4. Flexidor + Enide 50W, after 18 weeks Flexidor + Venzar, after further 18 weeks Flexidor + Devrinol
5. Flexidor + Butisan S every 18 weeks
6. Ronstar 2G initially, after 9 weeks Flexidor + Venzar, after further 18 weeks Flexidor + Butisan S.

Liners of 20 cultivars were potted in mid May 1993 into 3 litre containers and stood out on overhead irrigated sandbeds.

Treatment Dates

Treatment	21/5/93	30/7/93	1/10/93	3/12/93	1/3/94
1	-	-	-	-	-
2	R	F	R	F	R
3	R	B	R	B	R
4	F + E	-	F + V	-	F + D
5	F + B	-	F + B	-	F + B
6	R	F + V	-	F + B	-

Rates of Use

Ronstar 2G	200 kg/ha
Flexidor (old formulation)	250 ml/ha
Butisan S	2.5 l/ha
Enide 50W	9 kg/ha
Venzar	2.8 kg/ha
Devrinol	7 l/ha

Sprays applied in 2,500 litres water/ha with no washing off.

Two sand beds were used in the trial with two replicates of each treatment on each bed giving 4 replicates in total.

Species Treated

Elaeagnus pungens 'Maculata'
Thuja occidentalis 'Rheingold'
Hebe 'Margaret'
Lavandula angustifolia 'Dwarf White'
Euonymus fortunei 'Emerald and Gold'
Kerria japonica 'Pleniflora'
Ceanothus thyrsiflorus repens
Berberis x ottawensis 'Purpurea'
Hydrangea macrophylla 'Europa'
Clematis tangutica 'Aureolin'
Chaenomeles x superba 'Crimson and Gold'
Lavatera thuringiaca 'Barnsley'
Buddleia davidii 'Pink Delight'
Caryopteris x clandonensis
Hypericum x moserianum 'Tricolor'
Chamaecyparis pisifera 'Boulevard'
Santolina chamaecyparissus
Viburnum tinus
Lonicera nitida 'Baggesson's Gold'
Juniperus squamata 'Old Gold'

Year 4 1994/95 HNS35a Chemical Weed Control in Outdoor Container Grown Nursery Stock and on Sandbeds

Treatments

Both overhead and sand bed treatments were applied in a single trial.

i) Sanbed Treatments

A	Untreated Control
B	Ardent 2.5 L/ha
C	Ronstar Liquid 4 L/ha + Flexidor 125 2L/ha
D	Flexidor 125 2 L/ha + Venzar 2.8 kg/ha
E	Diuron (Unicrop Flowable) 800 ml/ha
F	Flexidor 125 2 L/ha + Butisan S 2.5 L/ha

All products were applied high volume ata rate of 2,500 L water/ha. The treatments were applied to the sandbeds on 18 May 1994.

ii) Overhead Treatments

1. Untreated

2. Ronstar 2G, after 9 weeks Venzar, after further 9 weeks Devrinol, after further 9 weeks Butisan S, after further 9 weeks Devrinol.

3. Flexidor 125 1 L/ha + Butisan S every 18 weeks.

4. Ronstar 2G, after 9 weeks Flexidor 125 l L/ha, after further 9 weeks Butisan S, after further 9 weeks Flexidor 125 l L/ha, after further 9 weeks Butisan S.

5. Ronstar 2G, after 9 weeks Flexidor 125 2 L/ha in 1,000 litres water, after further 9 weeks Butisan S, after further 9 weeks Flexidor 125 at 2 L/ha in 1,000 litres water, after further 9 weeks Butisan S.

6. Venzar, after 9 weeks Flexidor 125 1 L/ha + Venzar, after further 9 weeks Devrinol, after further 9 weeks Flexidor 125 lL/ha + Venzar, after further 9 weeks Devrinol.

Rates of use:	Ronstar 2G	200 kg/ha
	Venzar	2.8 kg/ha
	Butisan S	2.5 L/ha
	Devrinol	7 L/ha
	Flexidor 125	As above

None of the herbicides were washed off foliage.

Water volume:

With the exception of Flexidor 125 in treatment 5, all water volumes at 2,500 litres/ha. Treatments 4 and 5 compared previous rates of Flexidor 125 used in trials with the new label rates of Flexidor 125 of 2 L/ha in 1,000 litres water.

Treatment Dates

	2/6/94	**8/8/94**	**7/10/94**	**14/12/94**	**21/2/95**
Treatment					
1	-	-	-	-	-
2	R	V	D	B	D
3	F + B		F + B		F + B
4	R	F	B	F	B
5	R	F	B	F	B
6	V	F + V	D	F + V	D

Trial Layout

Four sandbeds were used for the trial. Each bed was split into 3 plots giving a total of 12 plots which allowed two replicates for the sandbed treatments. Each of the 12 plots was subdivided into six sub plots for the overhead treatments.

Species Used in Trial

Well grown liners of 20 subjects were potted on the 19 and 20 May 1994 into 3 litre pots.

Subjects used in the trial:

1. *Thuja orientalis* 'Aurea Nana'
2. *Cotoneaster horizontalis*
3. *Chamaecyparis lawsoniana* 'Ellwoodii'
4. *Cytisus* 'Hollandia'
5. *Euonymus japonicus* 'Ovatus Aureus'
6. *Symphoricarpos* 'Magic Berry'
7. *Deutzia* 'Mont Rose'
8. *Lavatera olbia* 'Rosea'
9. *Ceanothus* 'A T Johnson'
10. *Chaenomeles superba* 'Nicoline'
11. *Hedera helix* 'Gold Heart'
12. *Syringa x josiflexa* 'Bellicent'
13. *Escallonia* 'Crimson Spire'
14. *Cistus* 'Sunset'
15. *Viburnum opulus* 'Sterile'
16. *Philadelphus* 'Manteau d'Hermine'
17. *Cornus alba* 'Elegantissima'
18. *Potentilla fruticosa* 'Tilford Cream'
19. *Hebe pinguifolia* 'Pagei'
20. *Juniperus chinensis* 'Kuriwao Gold'

Year 5 1995/96 HNS 35a Chemical Weed Control in Outdoor Container Grown Nursery Stock

Treatments

This trial was designed specifically to look at the effects of using different rates and timings of lenacil in terms of crop damage and efficacy.

1. Untreated control

2. Ronstar 2G, after 9 weeks Stefes Lenacil 2.8 kg + Flexidor 125, after further 9 weeks Stefes Lenacil 2.8 kg + Flexidor 125, after further 9 weeks Butisan S.

3. As 2 except Stefes Lenacil at 1.4 kg/ha.

4. Stefes Lenacil 2.8 kg/ha, after 9 weeks Flexidor 125 + Stefes Lenacil 2.8 kg/ha, after further 9 weeks Butisan S, after further 9 weeks Flexidor 125 + Stefes Lenacil 2.8 kg/ha.

5. As 4 except Stefes Lenacil at 1.4 kg/ha.

6. Ronstar 2G, after 9 weeks Flexidor 125 + Butisan S, after further 9 weeks Stefes Lenacil 2.8 kg/ha, after further 9 weeks Flexidor 125 + Stefes Lenacil 2.8 kg/ha.

7. As 6 except Stefes Lenacil at 1.4 kg/ha.

8. Stefes Lenacil 2.8 kg/ha, after 9 weeks Flexidor 125 + Butisan S, after further 9 weeks Stefes Lenacil 2.8 kg/ha, after further 9 weeks Flexidor 125 + Butisan S.

9. As 8 except Steves Lenacil at 1.4 kg/ha.

10. Ronstar 2G, after 9 weeks Venzar Flowable 4.5 l/ha + Flexidor 125, after further 9 weeks Fenzar Flowable 4.5 l/ha + Flexidor 125, after further 9 weeks Butisan S.

11. As 10 except Venzar Flowable at 2.25 l/ha.

12. Untreated control

Treatment Dates

	26/5/95	**31/7/95**	**29/9/95**	**5/12/95**
1	-	-	-	-
2	R	SL+F	SL+F	B
3	R	SL½+F	SL½+F	B
4	SL	SL+F	B	SL+F
5	SL½	SL½+F	B	SL½+F
6	R	F+B	SL	SL+F
7	R	F+B	SL½	SL½+F
8	SL	F+B	SL	F+B
9	SL½	F+B	SL½	F+B
10	R	V+F	V+F	B
11	R	V½+F	V½+F	B
12	-	-	-	-

Rates of Use

Ronstar 2G 200 kg/ha
Flexidor 125 1 l/ha
Butisan S 2.5 l/ha
Stefes Lenacil and Venzar flowable as above
Sprays applied in 2,500 litres water/ha

Species used in trial

Vinca minor
Santolina chamaecyparissus
Ceanothus thyrsiflorus repens
Lavandula spica 'Vera'
Vinca major
Buddleia alternifolia
Cistus x purpureus
Pyracantha 'Orange Glow'
Forsythia 'Lynwood'
Deutzia 'Mont Rose'

RESULTS

Year 1: 1991/92 HNS 28a Chemical Weed Control in Outdoor Container Grown HONS

Weed Control

The main weeds present were Pearlwort, Groundsel and Hairy Bitter-cress. Chickweed, Sowthistle, Willowherb and Moss were also present but at much lower levels. The trial was hand weeded to remove Groundsel and a count was made on the numbers of Groundsel.

Numbers of Groundsel removed from the 2 replicates.

Treatment	No. Groundsel in Sand Bed	No. Groundsel in Pots
1	170	61
2	54	58
3	10	39
4	6	37
5	6	2
6	9	5

Ronstar 2G alone (Treatment 2) gave only partial control of Groundsel in the sand bed and none in the pots. Alternating Ronstar 2G with Enide (Treatment 3) gave a slight improvement. Ronstar 2G alternated with Flexidor (Treatment 4) gave good control in the sand base but only moderate control in the pots. The best control of Groundsel was given by Ronstar 2G alternated with Butisan S.

Granular Naptol performed well in the trial but this product was withdrawn by the manufacturer at the end of 1991.

An assessment of % weed cover in the sand bed was made on 15/11/91.

	% Weed Cover	
Treatment	Replicate A	Replicate B
1	20	10
2	10	5
3	5	< 2
4	< 1	< 1
5	2	< 1
6	< 1	< 1

A final inspection of the trial was made on 12/2/92. The overall picture had not changed except that Pearlwort was beginning to grow in treatments 5 and 6. Flexidor gave outstanding control of Pearlwort throughout the trial.

Phytotoxicity

There was very little obvious crop damage in the trial. Enide 50W caused a transient yellowing of shoot tips on Forsythia, Philadelphus and Vinca on the first application.

Height measurements on the more upright subjects were made on 12/2/92.

Average Height (cm)

	Treatments					
Subject	**1**	**2**	**3**	**4**	**5**	**6**
Cytisus	58.8	57.5	57.8	61.0	57.3	55.8
Philadelphus	59.8	57.8	56.3	56.0	53.0	55.0
Buddleia	88.0	81.8	82.5	76.0	83.3	84.0
Hedera	47.0	51.3	50.8	44.3	52.0	53.3
Forsythia	78.0	83.5	80.5	87.3	76.5	81.8
Cornus	64.5	55.3	52.5	55.8	47.0	62.5
Escallonia	67.3	60.5	59.8	56.3	54.0	60.4
Chamaecyparis	47.5	49.5	48.8	49.5	46.8	50.3

____ = Significantly less than control at P = 0.05

Flexidor (Treatment 4) had reduced the height of Buddleia and Butisan S (Treatment 5) had reduced the height of Cornus.

Conclusions

1. Using other herbicides in an alternating programme with Ronstar 2G granules gave much improved weed control particularly of Pearlwort and Groundsel.

2. Flexidor gave outstanding control of Pearlwort right up to final assessment on 12/2/91. Butisan S and Granular Naptol gave good early season control of Pearlwort but control was breaking down by final assessment date.

3. The dominant weed in the trial was Groundsel. Ronstar 2G alone did not give sufficient control of this weed. All the alternating herbicides improved the control of Groundsel in the standing base but only Butisan S and Granular Naptol gave good control in the pots.

4. Granular Naptol gave good overall weed control but unfortunately has now been withdrawn from sale.

5. There was little obvious visual phytotoxicity from any of the treatments. However, the growth of Buddleia was restricted by Flexidor and Cornus by Butisan S.

RESULTS

Year 2: 1992 HNS 35d Chemical Weed Control in Sand Beds

An initial assessment was made on 16 July 1992.

% WEED CONTROL COVER ON SAND BEDS (16/7/92)

Bed A

Treatment	Rep I	Rep II	Weeds Present
1	30	5	LW, CW, PW, G
2	10	<5	LW, CW, G
3	<5	<2	LW, M, BC
4	<2	<2	LW, M
5	<2	<1	LW, M
6	<2	<5	PW, LW

LW = Liverwort; PW = Pearlwort; CW = Chickweed; BC = Bitter-cress; M = Moss; G = Groundsel

Bed B

Treatment	Rep III	Rep IV	Weeds Present
1	5	2	LW, PW
2	<2	<1	LW, PW
3	<2	<1	LW
4	<1	0	LW
5	0	0	
6	<2	<3	LW

There was no phytotoxicity from any of the treatments and no difference in growth compared with the control treatments.

A further and final assessment was made on 7 October 1992.

% WEED COVER ON SAND BEDS (7/10/92)

Bed A

Treatment	Rep I	Rep II	Weeds Present
1	70	60	LW, CW, BC, PW, G
2	65	50	LW, CW, PW, CW, G
3	50	40	LW, BC, PW, G
4	50	50	LW, G, CW, PW
5	40	20	LW, G, BC
6	70	60	LW, PW, BC

Bed B

Treatment	Rep III	Rep IV	Weeds Present
1	50	50	LW, PW, CW, BC, G
2	40	50	LW, G, PW, BC
3	30	30	LW, BC, PW, G
4	30	20	LW, CW, BC, G, PW
5	20	20	LW, BC, G, PW
6	40	50	LW, G, PW, BC

Although present in Treatment 5 the Liverwort and Bitter-cress were still small and lacking in vigour. There was no phytotoxicity apparent on any of the container plants and no differences in growth compared with control treatments.

Conclusions

1. None of the sand bed applied treatments caused any phytotoxicity or reduced growth in this trial.

2. Nine weeks after application all treated plots had less weed than control plots with Treatments 5 (Ardent) and 4 (Butisan S) giving the best control. At this stage Liverwort was the main weed present.

3. Nineteen weeks after application weed control had broken down in Treatments 2 (Paramos) and 6 (Ronstar Liquid). Treatments 3 (Flexidor) and 4 (Butisan S) were still giving some control and Treatment 5 (Ardent) was giving the best control. By this stage a much wider spectrum of weeds was present in the trial.

4. With the exceptional of *Cotoneaster dammeri* all the cultivars used in the trial rooted through into the sand in the control plots. The only treatment that had some effect on rooting through was Treatment 5 (Ardent). It prevented or reduced rooting through in Vinca, Hebe, Prunus, Hydrangea and Rose.

RESULTS

Year 2: 1992/93 HNS 35a Chemical Weed Control in Outdoor Container Grown Nursery Stock

Weed Control

The effectiveness of the treatments was measured by assessing the percentage of weed cover in the sand bed and on the pot surface. Assessments were made on 7/10/92 and 2/3/93.

WEED ASSESSMENT 7 OCTOBER 1992

Bed A **% Weed Cover**

	Rep I		Rep II		Weeds Present
	Bed	Pot Surface	Bed	Pot Surface	
1	60	60	40	30	PW, BC, LW, G, AMG, ST, WH
2	<5	<5	<2	<2	PW, G
3	<2	<2	<10	<2	PW, BC
4	1	1	1	1	PW, G
5	2	2	2	2	PW, G
6	1	1	<5	<5	PW, G, LW

PW = Pearlwort, BC = Bitter-cress, LW = Liverwort, G = Groundsel, AMG = Annual Meadow Grass, ST = Sowthistle, WH = Willowherb, CW = Chickweed, M = Mayweed

Bed B **% Weed Cover**

	Rep III		Rep IV		Weeds Present
	Bed	Pot Surface	Bed	Pot Surface	
1	5	5	10	10	LW, PW, G, BC
2	1	1	<5	<5	PW, G, AMG
3	1	1	5	1	BC, PW, LW, CW
4	2	2	1	1	LW, G
5	1	1	2	2	PW, G, M
6	2	2	5	2	PW, G, M

WEED ASSESSMENT 2 MARCH 1993

Bed A **% Weed Cover**

	Rep I		Rep II		Weeds Present
	Bed	Pot Surface	Bed	Pot Surface	
1	50	50	30	40	BC, PW, LW, G, AMG
2	<2	<1	2	2	LW, PW
3	<1	0	2	<1	PW
4	0	2	1	1	G, LW
5	2	0	<1	0	PW, G
6	1	1	3	3	PW

Bed B **% Weed Cover**

	Rep III		Rep IV		Weeds Present
	Bed	Pot Surface	Bed	Pot Surface	
1	15	10	10	15	BC, G, PW, LW
2	3	1	1	1	PW, G, LW
3	1	0	<1	0	PW, LW
4	0	1	0	<1	LW, G
5	0	0	<1	<1	PW
6	2	4	<1	<1	LW, G, BC, PW

Phytotoxicity

An initial assessment of phytotoxicity was made on 16 July 1992.

Treatment 1: No phytotoxicity.

Treatment 2: Slight scorch on *Potentilla* and *Cornus*.

Treatment 3: Scorch on *Spiraea* and *Potentilla*.

Treatment 4: Severe foliage yellowing and reddening on all cultivars except *Juniper, Chamaecyparis*, *Forsythia* and *Hypericum.*

Treatment 5: Scorch on *Spiraea*, *Cornus* and *Lonicera*. Damage to terminal buds and stunting on *Buddleia*.

Treatment 6: Scorch on *Spiraea*, *Philadelphus*, *Buddleia* and *Cornus*.

A further assessment of phytotoxicity was made on 7 October 1992.

Phytotoxicity 7 October 1992

Treatment 1: No phytotoxicity.

Treatment 2: Browning of shoot tips and reduced growth on *Buddleia*. Slight scorch and shoot tips of *Hydrangea*.

Treatment 3: As treatment 2 above.

Treatment 4: Severe foliage yellowing and reddening on all cultivars except *Juniper*, *Aucuba, Chamaecyparis, Spiraea, Hedera and Cytisus*.

Treatment 5: Severe scorch and stunting on *Buddleia.*

Treatment 6: Scorch and stunting on *Buddleia*.

GROWTH ASSESSMENT

Growth was assessed on 2 March 1993 either by measuring the height or on prostrate subjects, the spread.

Mean Ht or Spread cms

	Treatment					
Cultivar	**1**	**2**	**3**	**4**	**5**	**6**
Juniper	39.6	38.0	39.3	41.9	38.3	40.3
Vinca	36.9	32.0	36.1	24.4	33.9	36.6
Hebe	24.6	23.8	24.0	21.9	23.3	24.8
Aucuba	14.0	13.5	15.8	13.5	15.5	14.6
Spiraea	21.8	19.3	19.4	18.1	17.5	21.8
Potentilla	33.0	31.1	29.0	26.3	28.5	30.5
Chamaecyparis	55.1	55.0	53.1	53.1	53.1	57.1
Cornus	47.3	48.0	51.6	27.0	46.9	47.0
Buddleia	44.5	29.3	23.1	33.0	23.8	34.4
Lonicera	91.8	89.9	98.3	59.8	94.5	96.3
Hedera	99.6	87.9	93.5	96.6	86.3	91.5
Forsythia	62.3	61.4	61.5	50.4	57.5	59.9
Escallonia	58.1	55.8	54.5	60.4	55.1	60.9
Cytisus	49.4	49.8	46.6	48.0	46.1	47.5
Philadelphus	35.9	31.3	32.9	17.3	33.4	32.6
Prunus	28.0	26.0	27.0	24.3	25.8	27.0
Hydrangea	26.5	24.1	23.8	16.3	24.3	26.4
Hypericum	43.9	46.8	41.6	42.9	43.4	45.9
Cotoneaster	35.4	37.3	33.8	28.6	28.5	32.9
Rose	14.5	13.9	13.3	11.3	14.0	13.9

___ = Growth significantly less than control at P = 0.05

CONCLUSIONS

1. All the herbicide treatments gave very good levels of weed control.

2. The herbicide Ardent (Treatment 4) caused far too much phytotoxicity over too wide a range of cultivars to be considered a possibility for use as an overhead spray on container nursery stock.

3. *Buddleia* 'Black Knight' was damaged by all the herbicide treatments.

4. Treatment 2 (Ronstar 2G alternated with Flexidor) was safe on all the cultivars used in the trial except *Buddleia* and *Hedera* where it reduced height without obvious damage.

5. Treatment 3 (Ronstar 2G alternated with Butisan S) was safe on all cultivars except *Buddleia* and *Potentilla* 'Goldfinger'.

6. Flexidor + Butisan S (Treatment 5) reduced growth on *Spiraea* 'Gold Flame', *Potentilla* 'Goldfinger' and on *Hedera* in addition to *Buddleia*.

7. The Flexidor + Enide 50W programme (Treatment 6) gave good weed control with no obvious effects on growth of the cultivars except *Buddleia*.

RESULTS

Year 3: 1993 HNS 35d Chemical Weed Control in Sand Beds

Weed Control

Assessments of % weed cover were made on 30/7/93 and 1/10/93/ Bed A had a much higher level of Liverwort than Bed B. The dominant weed in Bed B was Pearlwort.

% WEED COVER ON SAND BEDS 30/7/93

Bed A

Rep I

Treatment	% Liverwort	% Other Weeds	Weeds Present
1	50	<5	LW, PW, Tr CW
2	2		LW
3	4		LW
4	55	<1	LW, Tr PW
5	25	<1	LW, Tr PW, Tr G
6	10		LW

Rep II

Treatment	% Liverwort	% Other Weeds	Weeds Present
1	30	<5	LW, PW, Tr BC
2	3	<1	LW, Tr G
3	2	<1	LW, Tr G
4	25	<1	LW, Tr PW, Tr AMG
5	40	<1	LW, Tr G
6	20		LW

LW = Liverwort, PW = Pearlwort, CW = Chickweed, G = Groundsel, AMG = Annual Meadow Grass, BC = Bitter-cress, Tr = Trace of.

Bed B

Rep III

Treatment	% Liverwort	% Other Weeds	Weeds Present
1	10	4	LW, PW
2	<1		Tr LW
3	<1		Tr LW
4	<1	5	Tr LW, PW
5	<1		Tr LW, Tr PW
6	<1		Tr LW

Rep IV

Treatment	% Liverwort	% Other Weeds	Weeds Present
1	2	15	LW, PW
2	<1		Tr LW
3	<1		Tr LW
4	<1		Tr LW
5	<1	1	Tr LW, PW
6	<1	<1	Tr LW, Tr G, Tr PW

There was no phytotoxicity from any of the treatments and no differences in growth compared with the control treatments.

% WEED ON SAND BEDS 1/10/93

Bed A

Rep I

Treatment	% Weed Cover	Weeds Present
1	90	LW, PW, Tr G
2	12	LW, Tr G
3	15	LW, Tr G
4	85	LW, Tr PW
5	85	LW, Tr G, Tr PW
6	60	LW, Tr G, Tr PW

Rep II

Treatment	% Weed Cover	Weeds Present
1	70	LW, BC, PW, Tr G
2	10	LW, Tr G
3	12	LW, Tr G
4	70	LW, BC, Tr PW
5	95	LW, PW
6	60	LW, Tr G, Tr PW

By October Liverwort had developed substantially in Bed A and only Treatments 2 and 3, both of which contain the herbicide Ardent, were still giving reasonable control.

Rep III

Treatment	% Weed Cover	Weeds Present
1	80	LW, PW, G
2	5	LW, Tr G
3	5	LW, Tr G
4	35	LW, PW
5	10	LW, PW
6	5	LW

Treatment	Rep IV % Weed Cover	Weeds Present
1	40	LW, PW, Tr G
2	1	Tr LW
3	<1	Tr LW
4	5	LW, PW
5	4	PW, Tr LW
6	2	PW, Tr G

Weed cover was substantial in Treatment 1 the unsprayed control. As with Bed A Treatments 2 and 3 containing Ardent were giving the best weed control.

There was no phytotoxicity from any of the treatments.

ROOTING THROUGH

Rooting through was assessed on 11 November 1993. There was even less effect on rooting through than in 1992. Treatments containing Ardent reduced rooting through very slightly on a few of the cultivars, but this advantage was minor compared to the effects on weed control.

CONCLUSION

1. As in the 1992 trial the Herbicide Ardent again proved to give the most effective control of both weeds and Liverwort. Butisan S and Ronstar Liquid plus Flexidor gave good weed control of Hairy Bitter-cress but not Pearlwort.

   NB: Ardent must not be used over the crop.

2. The algaecides used in the trial, Mogeton and Howes Olympic, did not give control of Liverwort. It is possible that the heavy rainfall shortly after application could have affected these treatments.

3. There was no obvious phytotoxicity from any of the treatments and little effect on rooting through.

Supplementary Observation on Liverwort Control

The supplementary treatments applied to severe Liverwort in Bed A on 11/11/93 were first assessed on 29/11/93. At this stage only Mogeton and Panacide M had produced a scorching of the Liverwort. However, when assessed in the following spring 9/3/94 it was apparent that treatments containing Venzar had also scorched out the Liverwort. At this stage the Liverwort treated with Mogeton was still badly affected but the Panacide M treated Liverwort was beginning to regrow.

RESULTS

Year 3: 1993/94 HNS 35a Chemical Weed Control in Outdoor Container Grown Nursery Stock

Weed Control

Assessments of % weed cover in the sand bed standing base and pots were made on 30/7/93, 1/10/93 and 9/3/94.

WEED ASSESSMENT 30/7/93

Bed A

Rep I

Treatment	% Weeds in Standing Base	Weeds Present in Base	% Weeds in Pots	Weeds Present in Pots
1	50	LW, PW	<1	Tr BC, Tr S, Tr G
2	30	LW, PW	<1	Tr BC, Tr PW, Tr G
3	27	LW, PW	<1	Tr G, Tr BC
4	35	LW	0	
5	25	LW	0	
6	50	LW	0	

Rep II

Treatment	% Weeds in Standing Base	Weeds Present in Base	% Weeds in Pots	Weeds Present in Pots
1	22	LW, PW	0	
2	32	LW, PW	0	
3	21	LW, PW	0	
4	6	LW, Tr PW, Tr G	0	
5	35	LW	0	
6	76	LW, Tr PW	2	LW, Tr G

Bed B

Treatment	% Weeds in Standing Base	Rep III Weeds Present in Base	% Weeds in Pots	Weeds Present in Pots
1	25	LW, PW	2	BC, Tr LW, Tr R, Tr S
2	31	LW, Tr PW, Tr CW	0	
3	25	LW, PW	0	
4	15	LW	<1	Tr LW
5	<1	Tr LW	0	
6	12	LW, PW	0	

Treatment	% Weeds in Standing Base	Rep IV Weeds Present in Base	% Weeds in Pots	Weeds Present in Pots
1	11	LW, PW	1	S, Tr AMG, Tr BC
2	5	LW, PW	<1	Tr PW, Tr S, Tr G
3	17	LW, PW	0	
4	2	LW	0	
5	<1	Tr LW	0	
6	11	LW, PW, Tr CW	0	

PW = Pearlwort, LW = Liverwort, CW = Chickweed, S = Sorrel, AMG = Annual Meadow Grass, G = Groundsel, BC = Bitter-cress, Tr = Trace of.

None of the initial herbicide treatments had given consistent control of Liverwort in the sand bed. At this stage little weed had developed in the pots.

% Weed Cover 1/10/93

Bed A

Treatment	% Weeds in Standing Base	Rep I Weeds Present in Base	% Weeds in Pots	Weeds Present in Pots
1	85	LW, PW, Tr G, Tr BC	20	BC, G
2	50	LW, PW	5	Tr PW, Tr G, Tr BC, Tr LW
3	30	LW, PW, Tr G	2	Tr BC, Tr G
4	55	LW, Tr G	4	Tr BC, Tr LW
5	55	LW, Tr G	0	
6	5	LW	0	

Treatment	% Weeds in Standing Base	Rep II Weeds Present in Base	% Weeds in Pots	Weeds Present in Pots
1	40	LW, PW, Tr G, Tr BC	20	BC, Tr G, Tr LW
2	40	LW, PW	<2	Tr PW, Tr LW
3	10	LW, PW, Tr G	0	
4	25	LW, Tr G	2	Tr LW, Tr G, Tr AMG
5	70	LW, Tr G	0	
6	<2	LW	0	

Bed B

Treatment	% Weeds in Standing Base	Rep III Weeds Present in Base	% Weeds in Pots	Weeds Present in Pots
1	40	LW, BC, PW	40	BC, S
2	60	LW, Tr PW	<2	Tr LW
3	25	LW, PW, Tr CW	0	
4	25	LW, Tr G, Tr PW	4	BC, Tr LW
5	10	LW	<1	Tr BC
6	<1	Tr PW	0	

Treatment	% Weeds in Standing Base	Rep IV Weeds Present in Base	% Weeds in Pots	Weeds Present in Pots
1	40	LW, BC, PW, S	20	BC, G, S
2	15	LW, PW	2	BC, Tr G
3	30	LW, PW	<1	Tr PW
4	10	LW, Tr G	2	Tr LW
5	10	LW, BC, Tr G, Tr BW	4	BC, G
6	3	PW	0	

The surprising feature of these results was that there had been a substantial reduction in the amount of Liverwort present in Treatment 6 plots compared with the 30 July assessment. It appeared that the Flexidor plus Venzar applied on 30 July had scorched out the Liverwort.

Weeds had built up significantly in the pots in the unsprayed controls.

% Weed Cover 9/3/94

Bed A

Treatment	% Weeds in Standing Base	Rep I Weeds Present in Base	% Weeds in Pots	Weeds Present in Pots
1	100	LW, BC, G, PW, S	80	BC, G, LW, PW, S, M, AMG
2	95	LW, PW, Tr G	50	LW, PW, M, G, Tr AMG
3	45	LW, PW, Tr G	5	G, PW, Tr LW
4	5	LW*, G	10	M, BC, G, Tr LW
5	70	LW, Tr G, Tr PW, Tr BC	3	G, Tr LW, Tr BC
6	30	LW**, Tr PW	1	Tr G, Tr BC

Treatment	% Weeds in Standing Base	Rep II Weeds Present in Base	% Weeds in Pots	Weeds Present in Pots
1	80	LW, PW, BC, G, S, AMG	70	LW, G, AMG, BC, S, R
2	85	LW, PW, Tr G	40	LW, G, M
3	30	LW, PW, Tr G	3	Tr LW
4	5	LW*, Tr G, Tr PW	10	G, BC, M, Tr LW, Tr AMG
5	80	LW, Tr G	0	
6	15	LW**, PW, Tr G	3	LW, Tr G

Bed B

Treatment	% Weeds in Standing Base	Rep III Weeds Present in Base	% Weeds in Pots	Weeds Present in Pots
1	80	LW, PW, BC, S, Tr G	75	BC, S, G, LW, AMG, R
2	60	LW, PW	40	LW, Tr G
3	60	LW, PW, Tr CW	4	LW, Tr CW
4	5	LW*, G, PW	8	G, BC, M, Tr LW
5	20	LW, Tr G	<1	Tr BC, Tr G
6	5	LW**, Tr G	1	G

Treatment	% Weeds in Standing Base	Rep IV Weeds Present in Base	% Weeds in Pots	Weeds Present in Pots
1	70	LW, PW, S, BC, Tr G	60	G, BC, LW, S, Tr PW
2	20	LW, PW	15	LW, G, Tr BC
3	60	LW, PW	8	LW, PW
4	5	LW*, G, Tr PW	8	G, M
5	20	LW, G, BC, PW	8	G, BC
6	20	LW**, PW	3	S, Tr G, Tr LW

LW = Liverwort, PW = Pearlwort, BC = Bitter-cress, S = Sorrel, G = Groundsel, AMG = Annual Meadow Grass, M = Moss, R = Rush, CW = Chickweed, Tr = Trace of, LW* = Liverwort had been present but scorched out, LW** = Liverwort beginning to regrow.

Liverwort which had been greatly reduced by Flexidor plus Venzar applied in July 1993 was beginning to regrow. Flexidor plus Venzar applied in Treatment 4 on 1 October had also scorched out the Liverwort. Despite severe weed pressure from the surrounding heavily infested control plots weed control was still reasonable in Treatments 3, 4, 5 and 6, but had begun to breakdown in Treatment 2 because of the establishment of Liverwort and Groundsel in the pots.

Phytotoxicity

Initial observations from the first herbicide applications showed little obvious phytotoxicity except for slight tip scorch from Flexidor plus Enide 50W (Treatment 4) and Flexidor plus Butisan S (Treatment 5) on Buddleia.

Flexidor plus Venzar (Treatment 6) applied 30/7/93 appeared to cause a scorch on Santolina in Reps I & II but not III & IV.

Growth Assessment

Growth assessments were made either by measuring the height or spread of the cultivars.

Cultivar	Average Height of Spread cm 9/3/94 Treatment					
	1	**2**	**3**	**4**	**5**	**6**
Chamaecyparis	20.5	19.9	20.1	20.4	22.5	20.3
*Lonicera**	-	-	-	-	-	-
Viburnum	21.5	18.1	18.3	19.5	21.0	20.8
Santolina	17.1	17.1	17.5	17.5	18.0	17.0
Chamaecyparis	20.5	20.9	22.3	21.4	23.1	22.5
Hypericum	24.8	29.8	26.3	29.0	33.1	29.0
Caryopteris	35.5	37.1	35.8	33.0	35.6	37.5
Buddleia	57.9	65.5	62.1	58.1	55.1	58.5
Lavatera	66.5	71.5	65.8	67.0	63.8	63.8
Chaenomeles	50.6	47.0	44.3	52.4	47.0	51.9
Clematis	84.5	77.8	87.5	78.4	81.3	82.9
Hydrangea	22.0	18.3	22.4	20.1	20.1	21.1
Berberis	29.0	36.8	28.8	24.8	26.5	31.7
Ceanothus	32.8	34.5	37.1	32.6	35.9	37.1
Kerria	28.4	37.1	32.9	33.9	34.0	28.9
Euonymus	16.1	17.5	17.3	16.8	13.9	15.9
Lavender	10.8	12.0	12.1	11.8	12.6	12.6
Hebe	20.2	22.3	22.1	22.6	24.3	22.9
Thuja	18.6	15.0	17.0	16.6	18.5	17.9
Elaeagnus	16.8	18.6	18.9	21.1	18.1	21.0

*** NB:** *Lonicera* 'Baggesen's Gold' was not measured because of severe frost damage.

None of the treatments gave significantly poorer growth than the untreated control plots at P = 0.05.

A final visual assessment was made on 8/4/94. At this time it was very obvious that the 1 March application of Flexidor + Devrinol (Treatment 4) and Flexidor + Butisan S (Treatment 5) had burnt out the shoot tips on *Euonymus fortunei* 'Emerald and Gold' causing stunting compared to other treatments which were growing normally. Treatment 5 had bleached the foliage of *Lonicera* 'Baggesen's Gold' and scorched the shoot tips on *Buddleia davidii* 'Pink Delight'.

CONCLUSIONS

1. There was more weed present on the trial beds, particularly Liverwort, than in the two previous trials on the nursery in 1991/92 and 1992/93. This exposed the treatments to greater weed pressure.

2. The herbicide Venzar seemed to have a very useful scorching effect on Liverwort and would seem to have potential as a container herbicide. However, subsequent trials in 1994/95 and 1995/96 showed substantial amounts of damage.

3. Treatment 2, Ronstar 2G alternated with Flexidor at 9 week intervals, gave poorer weed control than previous years. Control of Liverwort was poor and was beginning to build up significantly in the pots by 9/3/94.

4. Treatments 3, 5 and 6 had given the best overall weed control in the pots.

5. Treatment 5, Flexidor plus Butisan S at 18 week intervals, is an extremely cost effective treatment.

6. Although Treatment 4 had given good control of Liverwort in the standing base there was an indication that weeds, particularly Groundsel and Bitter-cress, were beginning to build up in the pots.

7. The shoot tip damage to *Buddleia* from Treatment 5 was not unexpected as previous trials have shown *Buddleia* to be sensitive to both Flexidor and Butisan S. However, the severe shoot tip damage on *Euonymus* was unexpected. A possible explanation is that the buds were just beginning to break and were therefore at a very sensitive stage when the herbicides were applied. Although this damage appears to be transient with normal growth coming from below the shoot tips any damage in the spring could have serious consequences for the saleability of stock. In designing weed control programmes it would therefore be sensible to plan to avoid Flexidor and Butisan S during the spring growth flush on saleable susceptible subjects.

RESULTS

Year 4: 1994/95 HNS 35a Chemical Weed Control in Outdoor Container Grown Nursery Stock

WEED CONTROL

There was much less weed, particularly Liverwort, present in beds I and II than in beds III and IV. A weed assessment made on beds III and IV on the 7 October 1994 gave the following results.

Sandbed Trt.	Overhead Trt.	% Weed cover in pots	Weeds Present in pots	% Weed cover in beds	Weeds Present in beds
	1	12	LW,PW,G,STH,WH	30	LW, PW
	2	1	PW, S	4	PW
A	3	<1	G	5	PW
	4	4	LW, PW	25	PW, LW, G
	5	10	LW, PW, S	30	LW, PW, G
	6	<1	G	5	PW, G
	1	10	BC,G,AMG,S,PW	2	PW, G
	2	2	PW, G	1	PW, G
B	3	<1	G	<1	G, PW
	4	1	LW, PW	<1	PW, LW
	5	2	G, LW	1	PW, G
	6	<1	G	<1	G
	1	10	BC, LW, G	55	LW, G
	2	1	PW	<1	PW, LW
	3	1	LW, BC	20	LW, PW
C	4	4	LW	35	LW
	5	5	LW, PW, BC, G	40	LW, G
	6	0		<1	PW, G
	1	7	PW, LW, BC, G	6	G, PW
	2	<1	PW	5	PW
D	3	<1	G, BC	<1	G, BC
	4	1	LW, PW, BC, G	1	PW
	5	3	G, LW, PW	3	PW, G
	6	<1	G	4	PW
	1	3	LW, BC,AMG,PW,S	5	LW, PW, S, BC
	2	1	PW, BC	<1	PW
E	3	1	BC, G	5	BC, PW, LW
	4	1	LW, G	1	LW, PW
	5	1	G, PW, LW	1	LW, PW
	6	0		<1	PW, G
	1	7	LW,AMG,BC,PW,WH,STH	25	LW
	2	<1	PW	<1	LW, PW
	3	1	BC, LW, PW	4	LW, PW
F	4	4	LW, PW	25	LW
	5	2	LW, PW	20	LW, G
	6	0		<1	PW

A second weed assessment was made on the 16 March 1995

Sandbed Trt.	Overhead Trt.	% Weed cover in pots	Weeds Present in pots	% Weed cover in beds	Weeds Present in beds
	1	15	LW, G, WH, PW	25	PW. LW
	2	1	G, BC, S, PW	2	PW
A	3	0		3	PW
	4	4	PW, LW	20	PW. LW. G
	5	4	LW, S, PW	15	PW. LW
	6	0		3	PW
	1	50	BC, G, S, LW	1	PW
	2	2	G, PW, WH	<1	PW
	3	0		<1	PW
B	4	<1	G	0	
	5	1	G, LW, PW	1	PW
	6	0		0	
	1	75	BC,G,LW,PW,AMG,S	50	LW, G
	2	2	PW	<1	PW
C	3	0		10	LW, PW, G
	4	4	G, LW, PW, BC	30	LW
	5	3	LW	30	LW, G
	6	0		<1	PW
	1	15	G,BC,WH,PW,LW	6	PW, G, BC
	2	<1	G	3	PW
D	3	0		<1	G
	4	2	G, LW, BC	1	PW, G
	5	2	LW, G, BC, PW	3	PW, G
	6	0		2	PW
	1	40	BC, S, G, PW, WH	4	PW, BC, S, LW
	2	2	PW, G, BC	<1	PW
E	3	1	BC, G	1	PW, BC
	4	<1	G, PW	0	
	5	1	LW, PW, G	<1	PW
	6	0		<1	PW
	1	20	BC, LW, PW, G	25	LW, G
	2	1	BC, PW	1	PW, LW
F	3	1	BC, G	2	LW, PW
	4	2	LW, G, PW	15	LW, G
	5	3	LW, PW	7	LW
	6	0		1	PW

Weed Key:

AMG	=	Annual Meadow Grass	LW	=	Liverwort
BC	=	Bittercress	PW	=	Pearlwort
G	=	Groundsel	S	=	Sorrel
STH	=	Sowthistle	WH	=	Willowherb

In the absence of overhead treatments the best weed control in the sand beds was given by Treatment B (Ardent). Treatments D and E also gave reasonable weed control. However, Treatment D (Flexidor 125 and Venzar) caused damage because of uptake of the Venzar. Trials experience with Treatment E (Diuron) is very limited as a sand bed treatment. It is known that Diuron can be damaging when used as an overhead treatment. Treatment C (Ronstar Liquid + Flexidor 125) and Treatment F (Flexidor 125 + Butisan) gave poorer weed control because of their failure to control Liverwort.

All the overhead applied herbicides programmes gave good weed control in the pots compared to the untreated controls. Treatments 2 and 6 gave the best combined weed control in pots and bed but caused excessive damage because of Venzar uptake.

Treatment 3 (Flexidor + Butisan S) gave good weed control in the pots and reasonable weed control in the beds.

Treatment 4 and 5 gave slightly poorer control in the pots than other treatments and significantly poorer weed control in the beds because of Liverwort.

Phytotoxicity

An initial assessment was made on 24 June, three weeks after the first overhead herbicide application. At that stage the only damage noted was some shoot tip yellowing on *Cytisus* from Treatment 3 (Flexidor 125 + Butisan S).

A second assessment on 19 August showed significant damage from treatments containing Venzar. The worst damage was in treatments D6 where Venzar had been used as part of the sand bed treatment and there had been two subsequent overhead sprays. The most seriously affected subject was *Cistus* where there had been leaf scorch and some plant death. Apart from the *Cistus* the main effect of the Venzar was to cause veinal yellowing on a range of subjects including *Chaenomeles, Ceanothus, Lavatera, Philadelphus, Potentilla* and *Viburnum* and a more general leaf yellowing on *Deutzia*.

When a third assessment was made on 7 October, the effects of the Venzar treatment were still apparent. In addition, it was noted that the new growth on *Philadelphus* in Treatment C5 was paler than normal. This treatment had the higher rate of Flexidor 125 both on a sand bed treatment and as an overhead spray.

A fourth assessment on 16 March 1995 showed some shoot tip yellowing on *Cytisus* but this did not clearly relate to a treatment effect.

A final assessment was made in mid April when all 20 subjects were in active growth. At this stage it was apparent that new growth on *Cotoneaster horizontalis* had been checked by sprays of Butisan S and Butisan S + Flexidor 125 applied on 21/2/95. It was also apparent that growth of *Deutzia* 'Mont Rose' still showed some effects of Venzar damage with growth being slightly delayed and foliage paler than other treatments. New growth on other subjects which had been damaged by Venzar in the summer of 1994 was normal, i.e. there was no veinal yellowing on the new leaves.

VIGOUR ASSESSMENT

A vigour assessment was made on 16 March 1995 scoring the plants on a scale of 0-5.

0	=	Dead
5	=	Vigorous, good leaf colour, top grade

With the exception of *Cistus* in Treatment D6, the herbicides had had little effect on the overall vigour of growth.

Results for *Euonymus* were variable because of some shoot dieback perhaps as a result of weather damage and disease.

The *Cistus* and *Hebe* had some shoot tip damage from frost.

The vigour assessments are as follows:-

Vigour Assessments made on 16/3/95

Sand Bed Trt. A

0 = Dead
5 = Vigorous, good leaf colour, top grade

Overhead Treatments

Subject	1	2	3	4	5	6
1. *Thuja*	5	5	5	5	5	5
2. *Cot.*	5	4.5	5	5	5	4.5
3. *Cham*	5	5	5	5	5	5
4. *Cytis*	5	4.5	4.5	4.5	3.5	5
5. *Euon.*	4	3.5	3.5	4	4	3.5
6. *Symph.*	5	5	5	4.5	4.5	5
7. *Deutz.*	5	5	5	5	5	5
8. *Lava.*	4.5	4.5	4	5	5	5
9. *Cean.*	4.5	4.5	4	4	4	3.5
10. *Chaeno.*	4.5	5	4	4.5	4.5	4
11. *Hedera*	5	5	5	5	5	5
12. *Syring.*	5	5	5	5	5	5
13. *Escal.*	5	5	5	5	5	5
14. *Cistus*	5	4.5	5	4.5	4.5	4
15. *Vibu.*	4.5	5	5	4.5	4.5	5
16. *Phila.*	5	4.5	5	4.5	4.5	5
17. *Cornus*	4.5	5	5	5	5	5
18. *Poten.*	5	5	5	5	5	5
19. *Hebe*	4.5	5	4.5	5	5	4.5
20. *Junip.*	5	5	5	5	5	5

Sand Bed Trt. B

Overhead Treatments

Subject	1	2	3	4	5	6
1. *Thuja*	5	5	5	5	5	4.5
2. *Cot.*	5	5	5	5	4.5	4.5
3. *Cham*	5	5	5	5	5	5
4. *Cytis*	5	4	4.5	3.5	4	4.5
5. *Euon.*	4.5	3.5	4	4	4.5	3.5
6. *Symph.*	5	5	5	5	4.5	4.5
7. *Deutz.*	5	5	5	5	5	5
8. *Lava.*	5	4.5	5	4.5	5	4.5
9. *Cean.*	4.5	5	4.5	5	5	4.5
10. *Chaeno.*	3	4	4	4.5	4	4.5
11. *Hedera*	5	4.5	5	4.5	4.5	5
12. *Syring.*	5	5	5	5	5	4
13. *Escal.*	5	5	5	5	5	5
14. *Cistus*	5	4.5	4.5	4.5	4.5	3.5
15. *Vibu.*	4	4.5	4	5	4	4.5
16. *Phila.*	3.5	4.5	5	4.5	5	5
17. *Cornus*	5	5	4.5	5	5	5
18. *Poten.*	4.5	5	5	5	4.5	4.5
19. *Hebe*	4.5	5	5	5	4.5	5
20. *Junip.*	4.5	5	5	5	4..5	5

Sand Bed Trt. C

Overhead Treatments

Subject	1	2	3	4	5	6
1. *Thuja*	5	5	5	5	5	5
2. *Cot.*	5	5	5	5	5	5
3. *Cham*	5	5	5	5	5	5
4. *Cytis*	4	4	3.5	4	3.5	4.5
5. *Euon.*	4	3.5	3.5	4	4.5	4
6. *Symph.*	5	5	5	5	5	5
7. *Deutz.*	5	5	5	5	5	5
8. *Lava.*	4.5	5	4.5	5	4.5	5
9. *Cean.*	5	4.5	5	5	5	4
10. *Chaeno.*	5	4.5	3.5	5	4	4
11. *Hedera*	5	4.5	4.5	5	5	5
12. *Syring.*	4.5	4.5	5	4.5	5	4
13. *Escal.*	5	5	5	5	5	5
14. *Cistus*	4.5	4.5	4.5	4.5	4.5	4
15. *Vibu.*	4.5	4.5	4	5	4	4.5
16. *Phila.*	5	5	5	5	5	4.5
17. *Cornus*	5	5	5	5	5	5
18. *Poten.*	4.5	5	5	5	5	5
19. *Hebe*	4	4.5	3.5	4.5	4	3.5
20. *Junip.*	4.5	5	5	4.5	5	4.5

Sand Bed Trt. D

Overhead Treatments

Subject	1	2	3	4	5	6
1. *Thuja*	5	5	5	5	5	5
2. *Cot.*	5	4.5	5	5	5	5
3. *Cham*	5	4.5	5	5	5	5
4. *Cytis*	4	5	4	3.5	4.5	4.5
5. *Euon.*	4	4	4	4	5	4.5
6. *Symph.*	5	5	4.5	5	5	4.5
7. *Deutz.*	5	5	5	5	5	5
8. *Lava.*	5	5	5	5	4.5	5
9. *Cean.*	5	4	5	4.5	5	3.5
10. *Chaeno.*	3.5	4.5	4	4	4.5	4
11. *Hedera*	5	5	4.5	5	5	5
12. *Syring.*	5	5	5	5	5	5
13. *Escal.*	5	5	5	5	5	5
14. *Cistus*	4	4.5	4	4	4	0
15. *Vibu.*	4.5	4.5	4.5	4	5	5
16. *Phila.*	4.5	5	5	5	5	5
17. *Cornus*	5	5	5	5	5	4.5
18. *Poten.*	4	5	5	5	5	4.5
19. *Hebe*	4	4.5	4.5	3.5	4	4.5
20. *Junip.*	4.5	5	5	5	5	5

Sand Bed Trt. E

Overhead Treatments

Subject	1	2	3	4	5	6
1. *Thuja*	5	5	5	5	5	5
2. *Cot.*	5	5	5	5	4.5	5
3. *Cham*	5	5	5	5	4.5	5
4. *Cytis*	4	4	4.5	4	3.5	4
5. *Euon.*	4	4	4	4	4	4.5
6. *Symph.*	4.5	5	5	5	4.5	5
7. *Deutz.*	5	5	5	5	5	5
8. *Lava.*	4.5	5	5	5	5	4.5
9. *Cean.*	4.5	4	5	4.5	5	3
10. *Chaeno.*	5	5	4.5	4.5	4.5	4.5
11. *Hedera*	5	4.5	4.5	4.5	4.5	4.5
12. *Syring.*	5	5	5	4	5	5
13. *Escal.*	5	5	5	5	5	4.5
14. *Cistus*	4.5	4	4	5	5	3
15. *Vibu.*	4.5	5	4.5	4.5	4.5	4.5
16. *Phila.*	5	5	5	4.5	5	4.5
17. *Cornus*	5	5	5	5	5	4.5
18. *Poten.*	5	4.5	5	5	5	4.5
19. *Hebe*	3.5	5	4	4.5	3.5	5
20. *Junip.*	4.5	5	5	5	5	4.5

Sand Bed Trt. F

Overhead Treatments

Subject	1	2	3	4	5	6
1. *Thuja*	5	5	5	4.5	5	5
2. *Cot.*	5	5	5	4.5	4.5	5
3. *Cham*	5	5	5	5	5	5
4. *Cytis*	4.5	5	4.5	5	5	5
5. *Euon.*	4.5	3.5	3.5	4.5	4	4
6. *Symph.*	4.5	5	5	5	5	4
7. *Deutz.*	5	4.5	5	4.5	5	5
8. *Lava.*	5	5	3.5	4.5	5	3.5
9. *Cean.*	5	5	4.5	5	5	3.5
10. *Chaeno.*	4	4.5	5	5	4.5	4
11. *Hedera*	5	5	4	5	5	5
12. *Syring.*	4.5	4.5	5	5	5	5
13. *Escal.*	5	5	5	4.5	5	5
14. *Cistus*	4.5	4.5	4.5	5	4.5	3.5
15. *Vibu.*	4.5	4.5	4	4.5	5	5
16. *Phila.*	5	5	4.5	5	4	5
17. *Cornus*	5	4.5	4.5	5	5	4.5
18. *Poten.*	5	5	5	5	5	4.5
19. *Hebe*	4	4.5	4	5	5	5
20. *Junip.*	5	5	5	5	5	4.5

CONCLUSIONS

1. The 1994/95 trial has again demonstrated that good weed control can be achieved by the use of a combination of herbicide treatments.

2. The main container weeds have been well controlled but there are still problems with Liverwort. In the trials to date, only Venzar and Mogeton have given good control.

3. Venzar caused considerable damage in the 1994/95 trial but none in 1993/94. This is believed to be due to uptake during a period of rapid growth and high temperatures in July 1994. A further supplementary trial is to be undertaken in 1995/96 to look at timing and rate of use of Venzar (Lenacil).

4. Although expensive Ronstar 2G is likely to remain as a key herbicide in many nursery weed control programmes. It is convenient to use, especially for the first application after potting.

5. The cheapest herbicide programme is Flexidor 125 + Butisan S every 18 weeks. Comparative herbicide costs for the treatments are:-

Treatment 2	£1,500/ha
Treatment 3	£ 400/ha
Treatment 4	£1,100/ha
Treatment 5	£1,200/ha
Treatment 6	£ 800/ha

However, Flexidor 125 + Butisan S has caused damage on a number of subjects over the series of trials and growers should undertake their own trials in their nursery situations before using on a wide scale.

6. Some subjects, eg *Euonymus* (1993/94 trial) and *Cotoneaster* (1994/95 trial) have proved susceptible to damage from early spring application of Flexidor or Butisan S. The damage has been to scorch out just breaking shoot tips. These herbicides should ideally be applied whilst growth is still dormant to avoid possible damage to saleable stock.

7. The herbicide Ardent has consistently given the best weed control in sand beds.

   NB: Ardent must not be used over the crop.

8. In comparing Treatments 4 and 5, there was no obvious advantage from using the higher rate of Flexidor 125 although there was little increase in phytotoxicity.

RESULTS

Year 5: 1995/96 HNS 35a Chemical Weed Control in Outdoor Container Grown Hardy Ornamental Nursery Stock

Weed Control

There was less weed than in previous years and all the herbicide treatments gave good weed control. A detailed assessment was made on 20/11/95.

% Weed Cover Replicate A

Treatment	% Weed in Sand Beds	spps.	% Weed in Pots	spps.
1	10	LW, M, WH	4	WH, G, R, LW
2	<1	Tr M	0	
3	<1	Tr LW	0	
4	<1	Tr M	0	
5	3	LW, M, WH	5	WH
6	5	LW*	<1	Tr G
7	5	LW*	<1	Tr G
8	<1	Tr M	0	
9	<1	Tr M	0	
10	0		<1	Tr G
11	2	LW, M	<1	Tr WH
12	8	LW, M	5	WH, LW, ST, BC

*Liverwort scorched by herbicide application 29/9/95.

% Weed Cover Replicate B

Treatment	% Weed in Sand Beds	spps.	% Weed in Pots	spps.
1	3	LW, G	12	ST, WH, S, BC, LW
2	0		<1	Tr G
3	<1	Tr M	1	G
4	<1	Tr G, Tr M	0	
5	<1	Tr M	0	
6	1	LW*	1	G, Tr LW
7	1	LW*	2	G, Tr LW
8	<1	Tr G	0	
9	<1	Tr G	0	
10	<1	Tr M	2	G, M. ST
11	0		1	Tr G, Tr M
12	20	LW, Tr G	8	LW, BC, WH

*Liverwort scorched by herbicide application 29/9/95

KEY: BC = Hairy Bitter-cress
G - Groundsel
LW = Liverwort
M = Moss
R = Rush
S = Sorrel
ST - Sowthistle
WH = Willowherb

Phytotoxicity

First sprays were applied on 26/5/95. An initial inspection was made on 12/6/95 and at this stage no obvious damage was apparent.

Second sprays were applied on 31/7/96 and lenacil applied as either Stefes Lenacil or Venzar Flowable caused extensive damage at this stage at both the normal and to a lesser extent at half rates.

A detailed assessment was made on 7/9/95.

Treatments 1-12	Unsprayed Control Plots - No damage.
Treatment 2	Severe scorch and plant deaths on *Santolina*. Severe yellowing on *Vinca major*. Veinal yellowing on *Ceanothus, Pyracantha, Forsythia*. Yellowing on *Deutzia*, Scorch and stunting on *Buddleia*.
Treatment 3	Slight scorch on *Santolina*. Severe veinal yellowing on *Vinca major*. Veinal yellowing on *Ceanothus, Pyracantha, Forsythia*. Yellowing on *Deutzia*. Scorch and stunting on *Buddleia*.
Treatment 4	Severe scorch and plant death on *Santolina*. Severe veinal yellowing on *Vinca major*. Veinal yellowing on *Vinca minor*, *Coanothus, Pyracantha, Forsythia*. Yellowing on *Deutzia*. Scorch and stunting on *Buddleia*.
Treatment 5	Slight scorch on *Santolina*. Severe veinal yellowing on *Vinca major*. Veinal yellowing *Ceanothus, Pyracantha, Forsythia*. Yellowing on *Deutzia*. Scorch on *Buddleia*.
Treatment 6	Scorch and stunting on *Buddleia*.
Treatment 7	As Treatment 6.
Treatment 8	Slight scorch on *Santolina*. Severe veinal yellowing *Vinca major*. Severe veinal yellowing on *Ceanothus, Pyracantha, Forsythia*. Yellowing on *Deutzia*. Scorch on *Buddleia*.
Treatment 9	Severe veinal yellowing on *Vinca major*. Veinal yellowing on *Ceanothus, Pyracantha, Forsythia*. Yellowing on *Deutzia*. Scorch on *Buddleia*.
Treatment 10	Scorch and death on *Santolina*. Severe veinal yellowing on *Vinca major*. Veinal yellowing on *Ceanothus, Pyracantha, Forsythia*. Yellowing on *Deutzia*. Slight scorch on *Buddleia*.
Treatment 11	Scorch on *Santolina*.

Severe veinal yellowing *Vinca major*.
Veinal yellowing *Ceanothus and Pyracantha*.
Slight veinal yellowing *Forsythia.*
Yellowing on *Deutzia*. Scorch on *Buddleia*.

The third round of sprays was applied on 29/9/95. When assessed on 20/11/95 no additional damage was noted except that there was very slight veinal yellowing on *Vinca major* in Treatments 6 and 7.

The final herbicide application was made on 5/12/95 and this did not cause any extra damage.

New growth in spring did not show veinal yellowing although damage on *Vinca major* was still very apparent in the old leaves.

Ceanothus and *Cistus* were badly damaged by winter frosts.

Height measurements were made on the upright subjects (except *Ceanothus*) on 12/4/96.

Average Height cm

Treatment	***Santolina***	***Lavender***	***Buddleia***	***Cistus***	***Pyracantha***	***Forsythia***	***Deutzia***
1	27.5	28.5	65.5	60.5	117.5	60.3	68.3
2	20.8	32.0	49.0	57.3	124.8	67.8	56.5
3	25.3	32.5	58.3	62.3	128.8	61.3	49.3
4	19.5	30.8	42.3	56.3	125.0	59.0	53.0
5	23.8	32.0	55.8	57.5	130.8	60.8	59.3
6	26.8	26.8	45.5	61.0	117.5	66.5	58.8
7	24.0	29.0	38.8	47.8	140.8	58.0	70.0
8	22.0	28.8	47.0	55.8	125.5	55.8	53.5
9	25.0	25.3	35.8	56.0	123.0	66.3	64.0
10	22.8	31.3	54.5	61.3	138.3	61.5	54.8
11	24.8	29.3	61.3	60.3	136.8	61.3	64.3
12	26.8	28.0	57.8	66.0	140.3	65.8	59.0

___ = Significantly less than untreated controls at P = 0.05

Conclusions

1. The 1995/96 trial has confirmed the results from the 1994/95 trial that under certain circumstances lenacil, as Venzar, Venzar Flowable or Stefes Lenacil, can cause serious damage.

2. Damage is most severe when applied in hot weather during periods of rapid growth.

3. *Santolina* is particularly sensitive and may be killed. *Vinca major* suffers severe veinal yellowing.

4. Other subjects such as *Pyracantha, Forsythia* and *Ceanothus* show veinal yellowing without overall growth being affected.

5. Lenacil can give improved weed control particularly if Liverwort is a problem.

6. Use of lenacil appears much safer when used in autumn/winter. However, growers would still need to undertake their own trials.

DISCUSSION AND OVERALL CONCLUSIONS

Over the five years of the trials programme results have demonstrated that it is possible to achieve a good level of weed control using a range of herbicides with commercially acceptable levels of crop damage.

Ronstar 2G granules have been the cornerstone of HONS weed control programmes for many years. However, the trials have shown that using products such as Flexidor 125 and Butisan S in programmes with Ronstar 2G gives improved weed control. Some weeds such as Chickweed are resistant or poorly controlled, e.g. Pearlwort, by Ronstar 2G.

The trials have also shown that it is possible to use Flexidor 125 and Butisan S without Ronstar 2G but with an increased risk of phytotoxicity. It is likely that most growers will continue to use Ronstar 2G particularly as the first treatment after potting because of its convenience of use and general low level of phytotoxicity despite its high price.

The original formulation of isoxaben (Flexidor) and from 1994 the modified formulation, sold as Flexidor 125, performed well in the trials giving good control of the main container weeds except Liverwort. Control of Chickweed and Pearlwort has proved very complimentary to Ronstar 2G's weed spectrum. The results from HDC trials played a significant part in the development of a manufacturers label for the use of Flexidor 125 on outdoor container grown nursery stock. The manufacturers (Dow Elanco) label suggests a rate of use of 2 l/ha. However the rate of use throughout most of the trials period for both the original Flexidor formulation and Flexidor 125 was at a rate equivalent to 1 litre/ha of Flexidor 125. In the 1994/95 trial the rates were compared and there was no obvious advantage in using 2 l/ha although there was little increase in phytotoxicity. A possible justification for using the higher rate would be if Groundsel was a problem weed. However, Butisan S normally gives better control of Groundsel than Flexidor 125.

Butisan S has given good levels of weed control and surprisingly little phytotoxicity in the trials since it is known that it can cause scorch on soft foliage in certain circumstances when used on field grown stock. Butisan S does not have a label for use on container stock so remains a GROWER RISK TREATMENT. Butisan S is probably best considered as an autumn or winter treatment when risk of damage is reduced. Tank mixing Butisan S with Flexidor 125 gives enhanced weed control but enhanced risk of damage. However, even at an 18 week application interval weed control was good and is the cheapest of the treatments. Growers should assess Butisan S and Flexidor 125 as a tank mix under their own conditions on a small scale before using widely.

When first used in the trial in 1993 lenacil (Venzar) gave good weed control, especially of Liverwort, with little damage. However, in subsequent trials in 1994 and 1995 there has been considerable damage and this product cannot be recommended for general use in container grown shrubs. It is felt that the reason for the damage in 1994 and 1995 was that weather conditions were much hotter in July/August than in 1993 and that the herbicide was taken up during periods of rapid growth and heavy overhead irrigation.

When used in late autumn/winter the risk from Lenacil appeared to be much less so this might be a possibility if Liverwort is a particular problem but would require grower trialling on their range of plants.

NB: Lenacil should not be used as a standing base treatment because of the risk of uptake.

Other products used in the trials shown to be active against Liverwort were Mogeton and Panacide M. Neither of these products have labels for use over container nursery stock so are GROWER RISK TREATMENTS. General experience has shown that Mogeton is much safer than Panacide M.

The herbicide Devrinol has a label for use on outdoor container stock as a winter applied treatment. However, widespread use is unlikely because it does not control cruciferous weeds, e.g. Hairy Bitter-cress and at 9 l/ha is a relatively expensive treatment.

Of the other products used in the trials as overhead applied treatments Granular Naptol and Enide 50W were withdrawn during the trials and the herbicide Ardent was far too damaging to be considered for grower use over plants.

However, in the assessments made on products for use on sand beds prior to standing out the crop Ardent gave the best results followed by Ronstar Liquid plus Flexidor 125 as a tank mix.

NB: Neither ARDENT NOR RONSTAR LIQUID MUST BE USED OVER THE CROP Ronstar Liquid has a manufacturers label as a standing base treatment ARDENT IS A GROWER RISK TREATMENT.

None of the products used in the trials on sand beds had a significant effect on the prevention of rooting through into the sand.

The trials examined application intervals from 6 weeks up to 18 weeks. In most situations an interval of 9 weeks proved to be satisfactory. However, under severe weed pressure it may be necessary to reduce to 6 week intervals on some nurseries. If Flexidor 125 and Butisan S is to be used as a tank mix treatment this should only be done at 18 week intervals.

Levels of phytotoxicity recorded over the five years of trials are shown on pages 4-6. Ronstar 2G caused the least damage followed by Flexidor 125 and Butisan S. Tank mixes of Flexidor 125 plus Butisan S caused more damage than the products used singly.

The risk of damage was affected by the stage of crop growth. For example products which appeared safe on certain crops in the first year of growth caused damage when applied at or just after bud burst in the spring of the following season. *Euonymus fortunei* 'Emerald and Gold' had shoot tips burnt out by both Flexidor 125 and Butisan S in 1994 and similar damage occurred on *Cotoneaster horizontalis* from Butisan S in spring 1995. *Buddleia* cultivars were consistently damaged by both Flexidor 125 and Butisan S.

In summary the following programmes all gave good weed control with little phytotoxicity overall.

1. Ronstar 2G at potting then alternated with Flexidor 125 at 9 week intervals.

NB: Ronstar 2G and Flexidor 125 applications limited to two/crop/year.

2. Ronstar 2G at potting then alternated with Butisan S at 9 week intervals.

3. Flexidor 125 + Butisan S at potting then every 18 weeks. This treatment carries the greatest risk of damage.

4. Ronstar 2G at potting, after 9 weeks Flexidor 125, after further 9 weeks Butisan S, after further 9 weeks Flexidor 125, after further 9 weeks Butisan S.

Rate of use Ronstar 2G 200 kg/ha Flexidor 125 1 l/ha
Butisan S 2.5 l/ha

Chemical costs at 1996 prices are:

Ronstar 2G £4.49/kg Cost per application £898/ha
Flexidor 125 £56.90/l Cost per application £56.80/ha
Butisan S £33.15/l Cost per application £82.87/ha

From these figures it can be seen that repeated used of Ronstar 2G is very expensive.

None of the above herbicides gave good control of Liverwort in the trials. Mogeton at a rate of 10 kg/ha should control Liverwort as an eradicant treatment but at £36.87/kg this is also an expensive treatment.