

**Project title** Hardy ornamentals: herbicide screening for herbaceous perennials and grasses

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**Previous report**

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*Achillea, Alstromeria, Bergenia, Coreopsis, Crocosmia, Geranium*, dimethachlor, dimethenamid-p, *Dryopteris goldinia*, Dual Gold, Flexidor 125, *Fragaria*, hardy nursery stock, *Helenium, Hemerocallis*, herbaceous perennial, herbicide, *Hosta, Iris*, isoxaben, *Leymus, Lobelia, Lupinus*, metazachlor, oxadiazon, *Penstemon, Peonia*, Ronstar 2G, s-metolachlor, *Schizostylis, Sedum*, Springbok, *Symphytum*, Teridox, weed control

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

## AUTHENTICATION FOR HNS 166

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

John Atwood

Senior Horticultural Consultant

ADAS UK Ltd

Signature ..... Date .....

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## **GROWER SUMMARY**

### **Headline**

A range of herbicide products have been assessed for crop safety when applied post-potting to container-grown herbaceous perennial nursery stock and the most successful have been identified.

### **Background and expected deliverables**

Good weed control continues to be important for hardy ornamental growers to ensure that plant quality is maintained and that accreditation standards are achieved. Herbicides remain the most cost-effective weed control method although herbaceous subjects are particularly vulnerable to herbicide damage.

With the loss of herbicides and changes in weed populations on nurseries it is important to continue to assess new products to help combat resistant weed species and extend the range of subjects screened for which herbicides can be used.

The recently completed HDC project HNS 139 (Atwood, 2009) identified herbicides, new to the UK, which appear to have potential for use on herbaceous perennial and grass crops. The focus of HNS 139 was mainly on shrub species, so further screening work is required specifically on herbaceous perennial and grass crops.

This project is evaluating several new herbicides for efficacy and safety for use on a wide range of container-grown herbaceous subjects as well as extending the range of crop species phytotoxicity information for currently used herbicides

### **Summary of the project and main conclusions**

Trial plants of 20 herbaceous perennial species (Table 1) were potted up in late May/early June 2008 and kept weed-free until commencement of the trial.

Table 1. Herbaceous perennial species used in the experiments

<i>Achillea</i> 'Salmon Beauty'	<i>Hosta albo marginata</i>
<i>Alstroemeria lutea</i>	<i>Iris germanica</i> 'Jane Philips'
<i>Bergenia</i> 'Baby Doll'	<i>Leymus arenaria</i>
<i>Coreopsis</i> 'Zagreb'	<i>Lobelia</i> 'Queen Victoria'
<i>Crocsmia</i> 'Kathleen'	<i>Lupinus</i> 'Galaxy mixed'
<i>Dryopteris goldinia</i>	<i>Penstemon</i> 'Sour Grapes'
<i>Fragaria</i> 'Pink Panda'	<i>Peonia</i> 'Prima Verde'
<i>Geranium nodosum</i>	<i>Schizostylis</i> 'Sunrise'
<i>Helenium</i> 'Bruno'	<i>Sedum</i> 'Autumn Joy'
<i>Hemerocallis</i> 'Stafford'	<i>Symphytum</i> 'Wisley Silver'

The following herbicide treatments were applied on 20 June 2008 (Table 2).

Table 2. Treatments used in summer herbaceous plant nursery experiments

Treatment	Product	Active ingredient	Product application rate	Approval status
1.	Untreated control			
2.	Ronstar 2G	oxadiazon (2 % w/w)	200 kg/ha	Label
3.	Teridox	dimethachlor (500 g/L)	3.0 L/ha	Not in UK
4.	Flexidor 125	isoxaben (125 g/L)	1.0 L/ha	Label
5.	Springbok	metazachlor (200 g/L) + dimethenamid-p (200 g/L)	2.5 L/ha	LTA*
6.	Dual Gold	s-metolachlor (960 g/L)	1.6 L/ha	Not in UK
7.	New code A	not disclosed	2.6 kg/ha	Not in UK

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

Dual Gold (s-metolachlor) and New Code A were completely safe to all of the 20 subjects tested. The other treatments were generally safe but there were a few incidences of damage. The *Penstemon* were damaged by both Flexidor 125 (isoxaben) and Ronstar 2G (oxadiazon), both causing scorch and flower abortion. The *Hemerocallis* were damaged initially by Ronstar 2G and Flexidor 125, although

the visible damage was low by the time of the second assessment. The *Bergenia* suffered veinal yellowing and scorch from Springbok (metazachlor + dimethenamid-p). Ronstar 2G also appeared to cause some scorch to *Crocasmia*.

Dual Gold in particular could be a useful herbicide for herbaceous growers. Although there are gaps in the weed control spectrum – notably bittercress – results from HNS 139 showed that it does give good control of willowherb and grasses and some control of groundsel so could be a useful supplement to Flexidor 125 which offers poor control of these weeds.

Springbok appeared relatively safe in this experiment but the active ingredient metazachlor has been associated with damage to container grown herbaceous plants in the past when used as Butisan S. Springbok product does contain less metazachlor than Butisan S so might be safer but further work is needed to confirm safety.

Teridox is relatively unknown as a herbicide for ornamentals. Initial crop safety results suggest that it may be a useful and relatively safe product.

Both Flexidor 125 and Ronstar 2G are used on herbaceous crops although a number of species are susceptible to damage. The results reported here indicate a further range of species (*Alstroemeria*, *Dryopteris*, *Frageria*, *Leymus*, *Paeonia* and *Symphytum*) that can be safely treated. The successful result with *Dryopteris* is interesting as growers have tended to avoid treating ferns with herbicides.

Where species have been previously tested these results are generally in line with previous findings and entries in the '*Weed Control for Nursery Stock Growers Handbook*'. However Ronstar 2G, which has previously been listed as safe to *Crocasmia* and *Penstemon*, did affect plants in this experiment. *Hosta* and *Schizostylus* were previously listed as moderately susceptible and *Sedum* fully susceptible to Ronstar 2G although no damage was recorded in this experiment. These subjects should be treated with caution until the results are confirmed.

Since the start of the experiment development work on New Code A has stopped and the product will not now be developed for the UK or European market.



## Financial benefits

It is difficult to establish the full financial benefit from the project at this stage because two of the key new herbicides identified are not yet available on the UK market and Springbok requires a SOLA for use on ornamentals. However the benefits from extending the range of crops to which Ronstar 2G and Flexidor 125 can be applied can be estimated to save around £2,500/ha in hand-weeding costs for those crops less the cost of herbicide at £54/ha for Flexidor 125 or £1,000/ha for Ronstar 2G.

## Action points for growers

- When available in the UK, Dual Gold and Teridox show promise for use in container-grown herbaceous perennial nursery stock during the growing season.
- Dual Gold could be a useful supplement to Flexidor 125 to improve control of groundsel, grasses and willowherb.
- Springbok appeared safe to a range of herbaceous perennials except *Bergenia*.
- Springbok is currently available in the UK and can be used under LTA on ornamentals until June 2009 but would require SOLA for use after that date.
- Further crop safety information is available to extend the use of Ronstar 2G and Flexidor 125 to *Alstroemeria*, *Dryopteris*, *Fragaria*, *Leymus*, *Paeonia* and *Symphytum*.

## **SCIENCE SECTION**

### **Introduction**

Good weed control continues to be important for hardy ornamentals growers to ensure that plant quality is maintained and that accreditation standards are achieved. Herbicides remain the most cost-effective weed control method although herbaceous subjects are particularly vulnerable to herbicide damage. The most recent herbaceous weed control project carried out for the HDC was HNS 35e (Atwood 1995). Information from this project forms the basis for current recommendations in Great Britain.

In recent years a number of weed species have proved difficult to control and are increasing in distribution and importance. In addition some familiar herbicides are being lost due to the EC review process for pesticide approval (revision/replacement of Council Directive 91/414/EEC). It is therefore important to continue to assess new products to help combat resistant weed species and extend the range of subjects screened for which herbicides can be used.

The recently completed HDC project HNS 139 (Atwood, 2009) identified herbicides, new to the UK, which appear to have potential for use on herbaceous perennial and grass crops. The focus of HNS 139 was mainly on shrub species, so further screening work is required specifically on herbaceous perennial and grass crops.

This project aims to evaluate several new herbicides for efficacy and safety for use on a wide range of container-grown herbaceous subjects as well as extending the range of crop species phytotoxicity information for currently used herbicides.

### **Materials and methods**

In 2008, an experiment was set up to investigate the phytotoxicity of six herbicide treatments on a range of container-grown herbaceous species in a commercial nursery situation. A summer experiment was set up to test the treatments applied immediately after potting.

Twenty herbaceous species were used (Table 3). All plants were supplied from Pickmere Nurseries. Plants were supplied as either plugs potted into 9 cm pots or as liners potted into 1 or 2 litre pots. Plant species, pot size and potting date are shown in Table 3.

Table 3. Plant species used in herbaceous plant nursery experiments 2008

<b>Plant species</b>	<b>Pot size</b>	<b>Potting date</b>
<i>Achillea</i> 'Salmon Beauty'	9cm	06-Jun
<i>Alstromeria lutea</i>	2L	06-Jun
<i>Bergenia</i> 'Baby Doll'	1L	26-May
<i>Coreopsis</i> 'Zagreb'	9cm	10-Jun
<i>Crocsmia</i> 'Kathleen'	9cm	10-Jun
<i>Dryopteris goldinia</i>	2L	30-May
<i>Fragaria</i> 'Pink Panda'	9cm	10-Jun
<i>Geranium nodosum</i>	2L	06-Jun
<i>Helenium</i> 'Bruno'	9cm	10-Jun
<i>Hemerocallis</i> 'Stafford'	2L	06-Jun
<i>Hosta albo marginata</i>	2L	09-Jun
<i>Iris germanica</i> 'Jane Philips'	2L	06-Jun
<i>Leymus arenaria</i>	1L	26-May
<i>Lobelia</i> 'Queen Victoria'	1L	26-May
<i>Lupinus</i> 'Galaxy mixed'	2L	06-Jun
<i>Penstemon</i> 'Sour Grapes'	2L	06-Jun
<i>Peonia</i> 'Prima Verde'	3L	20-May
<i>Schizostylis</i> 'Sunrise'	2L	06-Jun
<i>Sedum</i> 'Autumn Joy'	1L	26-May
<i>Symphytum</i> 'Wisley Silver'	9cm	10-Jun

Potting Mix:

80% Medium grade peat

20% Medium grade pine bark

5.0 kg/m<sup>3</sup> Osmocote Exact Standard 8-9 month

1.8 kg/m<sup>3</sup> Magnesian limestone

0.5 kg/m<sup>3</sup> 12:12:12 Compound fertiliser

### **Experimental design**

The experiment was a split plot design (Appendix 1). There were seven treatments (including one control) replicated three times (21 main plots for herbicide treatments, 20 HNS species sub-plots x 5 plants). The pots were placed on woven plastic ground cover container beds with overhead irrigation. Overhead irrigation was used to settle the plants in.

### **Herbicide treatments**

The herbicide treatments used are given in Table 4. Treatments were applied on 20 June 2008 as a single application. All treatments were applied in 1,000 L/ha water at 2 bar pressure using a CO<sub>2</sub>-pressurised Oxford Precision Sprayer with a 1 m boom and F03-110 spray nozzles, except treatment 2, Ronstar 2G granules which were applied with a pepper pot shaker.

*Table 4.* Treatments used in summer herbaceous plant nursery experiments

<b>Treatment</b>	<b>Product</b>	<b>Active ingredient</b>	<b>Product application rate</b>	<b>Approval status</b>
1.	Untreated control			
2.	Ronstar 2G	oxadiazon (2 % w/w)	200 kg/ha	Label
3.	Teridox	dimethachlor (500 g/L)	3.0 L/ha	Not in UK
4.	Flexidor 125	isoxaben (125 g/L)	1.0 L/ha	Label
5.	Springbok	metazachlor (200 g/L) + dimethenamid-p (200 g/L)	2.5 L/ha	LTA*
6.	Dual Gold	s – metolachlor (960 g/L)	1.6 L/ha	Not in UK
7.	New code A	not disclosed	2.6 kg/ha	Not in UK

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

No other pesticides were applied to the experimental area during the experiment.

## Assessments

Observations on phytotoxicity symptoms were made on 8 July 2008 and 28 August 2008. Where significant damage was noted the symptoms were assessed using a scoring system (Table 5).

Table 5. Phytotoxicity scoring system used to assess herbicide damage to plant subjects

Score	% Phytotoxicity
0	Complete kill – 80% damage
1	60 – 80% damage
2	40 – 60% damage
3	20 – 40% damage (unacceptable damage but could recover)
4	5 – 20% damage (considered unlikely to cause a significant reduction in quality at marketing)
5	No damage (as untreated controls)

## Statistical analysis

All data were subjected to analysis of variance (ANOVA). Where significant F tests were obtained, means were separated using the least significant difference (L.S.D.) test.

## Results and Discussion

The results indicated that most of the 20 species tested were unaffected by any of the treatments. There were a few cases of phytotoxicity however (Table 6). The *Penstemon* were damaged by both Flexidor 125 and Ronstar 2G, both causing scorch and flower abortion (Fig. 1). The *Hemerocallis* were damaged at the first assessment date by Ronstar 2G and Flexidor 125, however these plants had largely recovered by the second assessment date.. The *Bergenia* suffered veinal yellowing and scorch from Springbok (Fig. 2). Ronstar 2G also appeared to cause some scorch to *Crocsmia* (Fig. 3). This result was unexpected as previously Ronstar 2G had been regarded as safe to this subject. Further work will conform whether this was an isolated effect of treatment.



Figure 1. Distortion, scorch and flower abortion on *Penstemon* caused by Flexidor 125



Figure 2. Veinal yellowing and leaf necrosis on *Bergenia* caused by Springbok



*Figure 3. Comparison of untreated plant (right) with scorch caused by Ronstar 2G (left) on Crocosmia*

Table 6. Plant quality scores, assessed 8 July and 28 August 2008

Treatment	<i>Bergenia</i>		<i>Crocsmia</i>		<i>Hemerocallis</i>		<i>Penstemon</i>	
	08-Jul	28-Aug	08-Jul	28-Aug	08-Jul	28-Aug	08-Jul	28-Aug
1 Untreated	5.0	5.0	5.0	4.7	5.0	5.0	5.0	5.0
2 Ronstar 2G	5.0	5.0	5.0	3.7	2.4	4.7	2.0	5.0
3 Teridox	5.0	5.0	5.0	4.7	5.0	4.3	5.0	5.0
4 Flexidor 125	5.0	5.0	5.0	5.0	2.7	4.7	2.0	3.3
5 Springbok	5.0	3.7	5.0	4.7	5.0	5.0	5.0	5.0
6 Dual Gold	5.0	4.7	5.0	4.3	5.0	4.7	5.0	5.0
7 New code A	5.0	5.0	5.0	4.7	5.0	4.3	5.0	5.0
<i>P</i> (ANOVA)	*	0.035	*	ns	<0.001	ns	*	0.029
df		12		12	11	12		12
S.E.D		0.39		0.53	0.24	0.44		0.47
L.S.D.		0.84		ns	0.54	ns		1.03

\* There was no variability so these results were not analysed. ns = not significant



## Conclusions

- Dual Gold and New Code A were completely safe to all of the 20 subjects tested. Springbok was safe to use on all but *Bergenia*. Flexidor 125 was safe to use on all but *Hemerocallis* and *Penstemon*. Ronstar 2G was safe to use on all but *Penstemon* and *Crocasmia*. Springbok was safe to all but *Bergenia*.
- Dual Gold in particular could be a useful herbicide for herbaceous growers. Although there are gaps in the weed control spectrum – notably bittercress – results from HNS 139 showed that it does give good control of willowherb and grasses and some control of groundsel (Atwood, 2009) so could be a useful supplement to Flexidor 125 which gives poor control of these weeds.
- Springbok appeared relatively safe in this experiment, except on *Bergenia*, but the active ingredient (metazachlor) has been associated with damage to container-grown herbaceous plants in the past when used as Butisan S. The Springbok product does contain less metazachlor than Butisan S so might be safer but further work is needed to confirm this.
- Teridox is relatively unknown as a herbicide for ornamentals. Initial crop safety results indicate that it may be a useful product on some subjects.
- Flexidor 125 is widely used on herbaceous crops particularly for good control of bittercress. A number of species are highly susceptible to damage from Flexidor 125 however. The results reported here indicate a further range of species that can be safely treated.
- Ronstar 2G is widely used on herbaceous crops particularly after potting. Some species suffer temporary foliage damage from Ronstar 2G however. The results reported here indicate a further range of species that can be safely treated.
- Where species have been previously tested (Atwood, 1995) these results generally are in line with previous findings and entries in the '*Weed Control for Nursery Stock Growers Handbook*'. However, Ronstar 2G which has previously been listed as safe to *Crocasmia* and *Penstemon* did affect plants in this experiment. *Hosta* and *Schizostylus* were previously listed as moderately susceptible and *Sedum* fully susceptible to Ronstar 2G although no damage was recorded in this experiment. These subjects should be treated with caution until the results are confirmed.

- Since the start of the experiment development work on New Code A has stopped and the product will not now be developed for the UK or European market.

### **Technology transfer**

An article for HDC news has been published and a talk based on these results was presented to growers at the HDC herbaceous perennial technical discussion group on 10 February 2009.

### **References**

Atwood, J., (1995) HDC report HNS 93e 'Chemical weed control in outdoor container-grown herbaceous perennial nursery stock

Atwood, J., (2009) HDC report HNS 139 'Control of problem weeds in hardy nursery stock'

## Appendix 1: experimental layout at Pickmere Nurseries

I	II	III	<i>Treatment</i>	<i>Rate</i>
4 7	7 14	5 21	1	Untreated
5 6	1 13	6 20	2.	Ronstar 2G 200.0 kg/ha
6 5	5 12	1 19	3	Teridox 3.0 L/ha
3 4	6 11	7 18	4	Flexidor 125 1.0 L/ha
2 3	4 10	3 17	5	Springbok 2.5 L/ha
1 2	7 9	2 16	6	Dual Gold 1.4 L/ha
7 1	3 8	4 15	7	New Code A 2.6 kg/ha