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Project leader:	David Talbot, ADAS UK Ltd.
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Location of project:	Darby Nursery Stock, Norfolk Frank P Matthews, Tenbury, Worcestershire ADAS UK Ltd., Boxworth, Cambridge
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AUTHENTICATION

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.

David Talbot

Senior Horticulture Consultant

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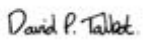
Signature  Date 31.03.2023

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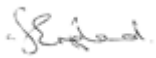
Signature  Date 31.03.2023

CONTENTS

Grower Summary

Headlines

- For budded tree production in the field, herbicide programmes of Sencorex Flow + Stomp Aqua + Venzar 500 SC + Sunfire after planting and Sencorex Flow + Stomp Aqua + Sunfire after heading back proved safe and effective.
- HDC 42, HDC H43, HDC H44, HDC H46 and HDC H47 proved safe and effective on field-grown trees post budding when tank mixed with Sencorex Flow + Stomp Aqua + Venzar 500 SC or Sencorex Flow + Stomp Aqua + Sunfire.
- Sencorex Flow at the maximum rate of 1.15 L/ha proved safe, applied alone and as a component of tank mixes as a post-planting and post heading back treatment to four tree species.
- Sencorex Flow has not previously been widely used within container production and shows strong potential as a dormant season treatment.
- Sencorex Flow proved effective against eight weed species tested as a pre- and post-emergence treatment.
- HDC H43 and HDC H46 showed potential for use in container production if suitable EAMUs can be obtained.

Background

The decreasing number of herbicides available to the Hardy Nursery Stock (HNS) sector is an ongoing challenge with restrictions on the rates, timings, and number of applications of many of the available herbicides all impacting upon chemical weed control options.

Field grown nursery stock. Sencorex Flow performed well in previous trials on field grown nursery stock and has proven its suitability to form the basis of a residual herbicide programme post-planting and post-heading-back on field grown trees as an effective, crop safe alternative to Flexidor. The trials carried out under this programme of work have already assessed the suitability of this herbicide at higher rates than previously used on field grown trees. The final year of trials on field grown trees assessed Sencorex Flow at the maximum rate permitted on the EAMU alone and as a component of tank mixes. Although Devrinol has recently been issued an Extension of Authorisation for Minor Use (EAMU) for use in ornamentals, its restrictions prevent its use in many field-grown production systems. This combined with the restriction of one application of Flexidor per crop has resulted in a pressing need to test replacement products for tree production.

Other herbicides selected for inclusion in the field tree trials are those for which appropriate EAMUs have recently been granted, e.g., Sunfire (flufenacet), alongside some newer products that are not yet authorised. In 2018, this project looked at the efficacy and crop safety of two-season herbicide programmes, including new products for field tree production. The aim of the current trials was to build on the knowledge gained from the previous trial, and to include new products alongside robust herbicides such as Sencorex Flow in other field-grown ornamentals.

Container grown nursery stock. Restrictions on the use of Butisan S (metazachlor) and Venzar 500 SC (under EAMU) have left gaps in the herbicides available to growers of container hardy nursery stock. Flexidor (isoxaben) has in recent years become the mainstay of weed control programmes in container hardy nursery stock production, but it does not offer control of annual meadow grass, groundsel, willowherb, moss or liverwort, and now only one application is permitted per year. Research in projects CP 86 *'Weed control in ornamentals, fruit and vegetable crops – maintaining capability to devise suitable weed control strategies'* (Atwood, 2015), HNS/PO 192 & 192a *'Herbicides screening for ornamental plant production (nursery stock, cut flowers and wallflowers)'* (Atwood 2015, 2016), and HNS 198 '*Improving weed control in hardy nursery stock'* (Atwood & Talbot 2016) have investigated promising new actives in screening trials, and reviewed cultural controls. As a result, Dual Gold (s-metolachlor) and Springbok were developed as container hardy nursery stock treatments (though with limitations). Since then, additional crop safety screening has been carried out within this project. Currently, relatively few new residual herbicides show potential for container hardy nursery stock testing, but two were selected for 2017-18 trials; Sunfire (flufenacet) and Defy (prosulfocarb), both promising for efficacy on key weeds and safety on indicative nursery stock species, additional crop safety screening has continued to demonstrate their potential. Two new herbicide actives (both coded products) were also selected for inclusion in 2018 and 2019 trials; HDC H44 and HDC H46. The withdrawal of Aramo (tepraloxydim), a selective contact herbicide for grass control, has had an impact across both field and container-grown hardy nursery stock. It was used as a post-emergence control of a range of annual grasses, in particular annual meadow grass. A safe and effective replacement, Centurion Max (clethodim) was selected as the most promising candidate and included in phytotoxicity screening on indicative nursery stock species. This was done alone and as a tank mix with Flexidor where it has proved its potential for use within the majority of species tested. Centurion Max has recently been granted an EAMU for use in ornamentals.

HDC H46 is a potential new active for the UK; it is approved in other countries and is used in hardy nursery stock production, and therefore was included in the 2018 and 2019 container screening tests, 2019 field trials and 2022 container pot screen. The UK formulation is likely to be different to the formulation used in hardy nursery stock production in other countries. It gives pre-emergence residual control of a range of annual grasses and broad-leaf weeds including the following weed species: Hairy Bittercress, Common Chickweed, Mouse Eared Chickweed, Groundsel, Annual Meadow Grass, Clovers and Italian Ryegrass.

Sencorex Flow (metribuzin) showed potential in trials carried out in Ireland (personal communication, Flanagan, D., 2018) as a winter treatment applied to container grown hardy nursery stock. Given the lack of herbicide options Sencorex Flow was included in the 2019-year two herbicide screen and the 2022 container pot screen.

The Long Term Arrangements for Extensions of Use (LTAEU) have now ceased so only herbicides with either on label uses or EAMUs for use in ornamentals can legally be used.

The industry has become increasing reliant on Flexidor in recent years, however the current label only permits one application per crop, so growers need to consider the alternative residual options assessed in this project.

Summary

Three herbicide trials were carried out on 1) field grown budded trees and 2) container-grown nursery stock and 3) crop safety of a range of herbicides on twenty container-grown HNS subjects. The herbicides included in these trials are listed in **Table 1**.

Table 1. Herbicides, approval status and rates used in HNS trials carried out in 2019 - 2022.

Product	Active	Approval status	2019 Field tree trial year two (L/ha)	HNS Container trial 2019 year two (L/ha)	2022 Container pot screen (L/ha)
Centurion Max	120 g/L clethodim	LTAEU			2.0
Devrinol	450 g/l napropamide	EAMU		7.0	
Dual Gold		EAMU			0.78
Flexidor	500 g/L isoxaben	Label			0.5

HDC H42	Confidential	Not authorised	1.5		
HDC H43	Confidential	Not authorised	2.0		1.0
HDC H44*	Confidential	Not authorised	1.75		
HDC H46	Confidential	Not authorised	0.1	0.1	0.1
HDC H47	Confidential	Not authorised	3.75		
Sencorex Flow	600 g/L metribuzin	EAMU	1.0 and 1.15	0.5 and 1.0	0.5 and 1.15
Springbok	200 g/L metazachlor + 200 g/L dimethenamid-p	EAMU		1.66	
Stomp Aqua	455 g/L pendimethalin	EAMU	2.9		
Sunfire	500 g/L flufenacet	EAMU	0.48		0.48
Venzar 500 SC	500 g/L lenacil	LTAEU, now EAMU			0.4

*HDC H44 has been evaluated on wide range of horticultural crops in the SCEPTRE plus project. The active is authorised for use in potatoes and has a number of EAMUs and label extensions for other crops.

1. Field Tree Trial (2019). Year 2

The 2019 field tree trial was set up on newly planted rootstocks at Frank P Matthews, Worcestershire in 2019 (see 2018 annual report for results from year one). The aim of the work carried out in year two (2020) of this study was to test the crop safety and efficacy of a number of residual herbicides as alternatives to Flexidor, post heading back (rootstocks cut back to just above the bud that was budded the previous season) as growers need alternative residual options.

The trial was set up so that each plot contained four tree species (e.g., *Malus, Prunus, Quince* and *Sorbus)* and three replicate blocks. The trial consisted of eight herbicide treatments that were applied as residual pre-emergence treatments post heading back of rootstocks (**Table 2**). Phytotoxicity and weed assessments were carried out at 4, 6 and 12 weeks after treatment (WAT). Phytotoxicity was scored on a scale of 0-9; plants scoring 0 were considered dead, and 9 considered healthy, with plants scoring 7 or more considered to be of commercially acceptable quality. Weed cover was assessed as an overall percentage of the plot.

Sencorex was tested at the maximum rate (1.15 L/ha) on the test species and was applied post heading back on 20/03/20. This was a higher rate of Sencorex Flow than previously used in tank mixes and it proved to be crop safe at this higher rate; experimental treatment 3 resulted in initial damage on *Prunus, Quince, Sorbus* that was considered commercially unacceptable at 4 WAT. Experimental treatment 8 resulted in initial damage on *Prunus* that was considered commercially unacceptable at 4 WAT. However, all species grew away from the initial damage and were considered comparable with untreated control by 12 WAT in terms of crop safety.

Table 2. Treatment list and percentage weed cover, 4, 6 and 12 WAT (assessed 24/04/20, 07/05/20 and 20/06/20).

Trt. No.	Post heading back	Rate (L/ha)	Weed cover (%) 4 weeks	Weed cover (%) 6 weeks	Weed cover (%) 12 weeks
1	Untreated (10,16,25)	Untreated	81.8	88.3	98.3
2	Sencorex Flow + Sunfire + Stomp Aqua + HDC H47	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 3.75 L/ha	0.5	2.0	4.2
3	Sencorex Flow + Sunfire + Stomp Aqua + HDC H44	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 1.75 L/ha	0.0	0.2	1.0
4	Sencorex Flow + Sunfire + Stomp Aqua	1.15 L/ha + 0.48 L/ha + 2.9 L/ha	0.3	0.7	1.0
5	Sencorex Flow + Sunfire + Stomp Aqua + HDC H43	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 2.0	0.7	0.8	1.7
6	Sencorex Flow + Sunfire + Stomp Aqua + HDC H46	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 0.1 L/ha	0.5	0.5	0.7
7	HDC H46	0.1 L/ha	0.8	2.0	10.0
8	Sencorex Flow + Sunfire + Stomp Aqua + HDC H42	1.15 L/ha + 0.48 L/ha + 2.9 L/ha +1.5 L/ha	0.2	0.3	1.0
9	Sencorex Flow	1.0 L/ha	0.8	1.3	6.7
10	Sencorex Flow	1.15 L/ha	0.7	0.8	1.8

The trials showed that both HDC 46 and Sencorex Flow have gaps in their weed control spectrums when applied alone, therefore they should be used with complimentary tank mix partners.

None of the treatments applied resulted in lasting phytotoxic damage on any of the four species by 12 WAT. All the post-heading back treatments were crop safe and effective and resulted in significantly improved weed control compared to untreated control

2. Hardy nursery stock container trial (2019). Year 2

The 2019 hardy nursery stock trial (2019), year two was carried out as Darby Nursery Stock, Norfolk, using 20 container grown hardy nursery stock subjects (**Table 3**). It was a continuation of the trial reported in the previous annual report; the trial assessed four herbicide products as late winter treatments for crop safety assessed at the timings

detailed in **Appendix 2**.

Sencorex Flow had mostly been used in field grown crops prior to this work which demonstrated the product's potential for use as an alternative residual herbicide in container production of hardy nursery stock when applied as a dormant season treatment. Where the higher rate treatment of 1 L/ha appeared to be too damaging (*Pachysandra* and *Vinca),* the lower rate of 0.5 L/ha appeared to be relatively crop safe with only slight damage recorded at the 12 weeks after treatment assessment that was deemed to be commercially acceptable. Sencorex Flow is not suitable for use on *Hebe* x *franciscana* however it has potential on the other 19 species within this trial.

Devrinol tank mixed with Springbok showed potential as tank mix partners where Springbok has not previously been applied to a crop. This tank mix appeared to be relatively safe when applied as a dormant season treatment. Where Springbok has already been applied Devrinol proved to be a safe stand-alone treatment on the species tested.

If authorised for use in ornamentals, the coded product HDC H46 has potential as a residual herbicide in programmes with Flexidor and as a tank mix with Devrinol. HDC H46 should provide residual control of most of the main weeds of container nurseries. Additional work to continue to build information relating to the crop safety of this herbicide within container hardy nursery stock production would be useful, particularly if the active gained an authorisation / EAMU for use in ornamental production.

All the herbicide treatments within the trial contributed significantly to weed control. Where crop safety has not been proven either conduct your own in house trials or use alternative cultural methods of weed control such as mulches or pot toppers.

Table 3. Average phytotoxicity scores for hardy nursery species, twelve weeks after early March treatment application (assessed 29/05/20). *(NS = no significant differences)*

Species	UTC	Sencorex Flow 1.0 L	HDC H46	HDC H46 + Devrinol	Devrinol	Sencorex Flow 0.5 L	Devrinol + Springbok	p value	L.S.D.
Berberis thunbergii f. *atropurpurea*	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Chaenomeles x *superba*	9.0	9.0	7.3*	8.3	8.0	9.0	8.7	0.020	0.977
Choisya ternata	9.0	8.0	9.0	8.7	9.0	9.0	9.0	(NS)	-
Convolvulus cneorum	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Cotoneaster dammeri	9.0	9.0	9.0	9.0	8.7	8.7	9.0	(NS)	-
Cytisus	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Diervilla splendens	9.0	8.7*	7.7*	8.0*	7.7*	7.3*	9.0	0.003	0.824
Escallonia	9.0	9.0	9.0	8.7	9.0	9.0	9.0	(NS)	-
Hebe x *franciscana*	9.0	6.3*	4.7*	4.7*	8.3	4.7*	7.3*	<.001	1.821
Hypericum	9.0	9.0	7.3	8.7	8.7	9.0	8.7	(NS)	-
Lavandula vera	9.0	9.0	9.0	8.0	9.0	7.0	8.0	(NS)	-
Lavateria Hybrida	9.0	9.0	7.3*	8.0*	8.7*	9.0	9.0	0.002	0.7601
Ligustrum ovifolium	9.0	8.7	8.0	8.3	8.3	9.0	9.0	(NS)	-
Pachysandra terminalis	9.0	6.3*	7.7*	6.3*	8.3	7.0*	9.0	<.001	1.098
Photinia x *fraseri*	9.0	7.3*	6.0*	7.0*	7.0*	7.7	9.0	0.004	1.363
Potentilla fruticosa	9.0	9.0	9.0	9.0	8.7	8.0	8.3	(NS)	-
Pyracantha	9.0	9.0	9.0	8.0	9.0	9.0	9.0	0.050	0.6724
Santolina chamaecyparissus	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Senecio compacta	9.0	9.0	9.0	7.7	9.0	9.0	9.0	(NS)	-
Vinca minor	9.0	6.7*	7.7*	7.7*	8.7	8.3	8.3	0.003	0.938

*** Significantly different to untreated**

3. Container pot screen (2022)

The 2022 container pot screen was carried out as ADAS Boxworth, Cambridgeshire, using eight common annual weeds (**Table 4**) that frequently occur and cause problems on nurseries producing container grown hardy nursery stock. The trial assessed seven residual herbicides applied pre-emergence of weeds (T0), at two to four true leaves (T1) and at six to ten true leaves (T2) (**Table 5**).

Phytotoxicity was assessed at three growth stages (pre emergence, post emergence at 2-4 true leaves and post emergence at 6 – 10 true leaves) after the herbicide treatments were applied.

Table 4 Weed species used in the pot screen

	Weed species
1	Annual meadow grass *(Poa annua)*
2	Hairy bittercress (*Cardamine hirsute*)
3	Common mouse eared chickweed *(Cerastium fontanum)*
4	Common Chickweed (*Stellaria media*)
5	American Willowherb (*Epilobium ciliatum*)
6	Groundsel (*Senecio vulgaris*)
7	Sow thistle (*Sonchus oleraceus*)
8	Procumbent pearlwort *(Sagina procumbens)*

Table 5. Treatment list, active ingredients and timings for the 2022 container pot screen

Treatment		Active ingredient	Approval status	Rate (L/ha)	Timing
1	Untreated	-	-	-	T0, T1, T2
2	Flexidor	isoxaben 500 g/L	Label	0.5	T0, T1, T2
3	Dual Gold	S-metolachlor 960 g/L	EAMU	0.78	T0, T1, T2

4	Sencorex Flow	metribuzin 600 g/L	EAMU	1.15	T0, T1, T2
5	Sencorex Flow	metribuzin 600 g/L	EAMU	0.5	T0, T1, T2
6	Sunfire	flufenacet 500 g/L	EAMU	0.48	T0, T1, T2
7	HDC H43	Confidential	Experimental	1.0	T0, T1, T2
8	Venzar 500 SC	lenacil 500 g/L	EAMU	0.4	T0, T1, T2

* The EAMU for Venzar 500 SC states use before the end of July, therefore Venzar 500 SC was used under an experimental permit in this trial.

This trial has found effective, alternative solutions to weed control that will help to reduce costs associated with hand weeding. The species listed by treatment and timing resulting in 75% or more weed control were considered effective treatments and are listed in **Table 6**. Where less than 75% weed control was achieved weed species are not listed in the table below.

Table 6. Treatments and timings that resulted in 75% or more control by weed species.

Treatment		**T0 21 days**	**T0 42 days**	**T1 7 days**	**T1 14 days**	**T1 42 days**	**T2 7 days**	**T2 14 days**	**T2 42 days**
Flexidor	Hairy bittercress	✓	✓		✓	✓			
	Common mouse eared chickweed	✓	✓						
	Common chickweed	✓	✓						
	Groundsel	✓							
	Sow thistle	✓	✓						
	Pearlwort	✓	✓						
Dual Gold	Common chickweed	✓			✓				
	American willowherb		✓						
	Sow thistle	✓	✓						✓

Sencorex Flow 1.15 L/Ha	Annual meadow grass,	✓	✓		✓	✓	✓	✓	✓
	Hairy bittercress		✓	✓	✓	✓	✓	✓	✓
	Common mouse eared chickweed	✓	✓		✓	✓	✓	✓	✓
	Common chickweed	✓	✓	✓	✓	✓	✓	✓	✓
	American willowherb	✓	✓	✓	✓	✓	✓	✓	✓
	Groundsel	✓	✓	✓	✓	✓	✓	✓	✓
	Sow thistle	✓	✓	✓	✓	✓	✓	✓	✓
	Pearlwort		✓			✓			✓
Sencorex Flow 0.5 L/Ha	Annual meadow grass	✓	✓		✓	✓	✓	✓	✓
	Hairy bittercress		✓	✓	✓	✓	✓	✓	✓
	Common mouse eared chickweed	✓	✓		✓	✓	✓	✓	✓
	Common chickweed	✓	✓	✓	✓	✓	✓	✓	✓
	American willowherb	✓	✓	✓	✓	✓	✓	✓	✓
	Groundsel	✓	✓	✓	✓	✓	✓	✓	✓
	Sow thistle	✓	✓	✓	✓	✓	✓	✓	✓
	Pearlwort					✓			✓
Sunfire	Annual meadow grass		✓						

	Hairy bittercress		✓				✓	✓	
	American willowherb		✓		✓	✓			✓
	Groundsel	✓							
	Sow thistle	✓	✓						
	Pearlwort		✓			✓			
HDC H43	Annual meadow grass	✓	✓						
	Common chickweed	✓			✓				
	American willowherb		✓						
	Sow thistle	✓	✓						
	Pearlwort		✓						
Venzar 500 SC	Sow thistle							✓	✓

Conclusions

1. Field trial (2019), Year 2.

All of the products tested were safe on the species tested (grown on a medium loam). A tank mix of Sencorex Flow, Sunfire and Stomp Aqua is a safe and effective treatment that growers can implement. Coded products also showed potential as tank mix partners and may become available through on label / EAMU authorisations.

2. Hardy Nursery stock container trial (2019), Year 2.

Sencorex Flow showed potential as a dormant season herbicide on 19 of the 20 species tested. Springbok showed potential as an alternative tank mix to Flexidor for Devrinol as a dormant season treatment where Springbok has not previously been applied. The coded product HDC H46 also showed potential as an alternative tank mix partner to Flexidor to be used in conjunction with Devrinol if it is granted either an on label or off label authorisation for use in the production of hardy nursery stock.

3. Container pot screen (2022)

Sencorex Flow proved to be effective against all the weed species tested (depending on growth stage) when used as a pre / post emergence treatment. Sunfire contributed to the control of broad-leafed weed species including Groundsel, Hairy bittercress, American Willowherb and Pearlwort. Although the coded product HDC H43 had little post emergence activity it has useful pre – emergence activity against Common Chickweed, American Willowherb, Sow Thistle and Pearlwort if it is granted either an on label or off label authorisation for use in the production of hardy nursery stock.

Financial Benefits

Hand weeding three times during the growing season is estimated to cost in the region of £33,000 per hectare for field crops, such as trees. The effective use of residual herbicides – minimising the need for hand weeding or the application of direct contact herbicides – will help to reduce costs significantly, contributing to grower profitability. For example, herbicide mixtures of standard and experimental products with Sencorex Flowable appeared to provide improved weed control compared with Sencorex alone. It is estimated that substitution with a product such as Sencorex Flow is likely to reduce the need for hand weeding compared with no substitution by around £11,000 per hectare.

The LTAEU in place for Venzar 500 SC when this trial commenced has been transferred to an EAMU, resulting in the limitation of not being able to apply Venzar 500 SC after the end of July in the year of application. This prevents use at some of the timings detailed within this report, a loss which may slightly reduce the effectiveness of some treatments. The impact on weed control should not be particularly detrimental as the low rates used (0.4 L/ha) would have been limited and with short persistence.

Centurion Max, Devrinol, Dual Gold, Flexidor, Sencorex Flow, Springbok, Sunfire, Venzar 500 SC and HDC H43 and HDC H46 were evaluated for container-grown hardy nursery stock production. Hand weeding is estimated to cost up to £47,000 per hectare per year in container production, which includes three weeding sessions and a clean-up when it comes to dispatch. Any reduction in hand weeding that can be achieved via chemicals will help reduce this cost. An effective herbicide programme could mean that less time is spent on hand weeding sessions which would significantly reduce this cost for all container hardy nursery stock growers. It is estimated that an effective herbicide programme, supported by hand weeding to prevent any weeds that do germinate from setting seed within the crop, to reduce the cost of hand weeding by around 30 percent / £14,000 per hectare.

Action Points

- For budded tree production in the field, herbicide programmes of Sencorex Flow + Stomp Aqua + Venzar 500 SC + Sunfire after planting and Sencorex Flow + Stomp Aqua + Sunfire after heading back are recommended.
- Evaluate whether Sencorex Flow could play a role in weed control in container product as a dormant season treatment which has both pre and post emergence activity on common weeds of container nurseries.
- Review if experimental products receive new EAMUs to facilitate a wider range of herbicides.
- Consider applying 10 mm of irrigation post herbicide application to help minimise the crop damage associated with some of the treatments.
- Note that no attempt was made to wash products off in this trial as this may have minimised the risk of potential damage and determining crop safety was an important aspect of this work.

Science Section

Introduction

The decreasing number of available herbicides available to the Hardy Nursery Stock (HNS) sector is an ongoing challenge with restrictions on the rates, timings, and number of applications of many of the available herbicides all impacting upon chemical weed control options.

Sencorex Flow has performed well in previous trials on field grown nursery stock and has proven its suitability to form the basis of a residual herbicide programme post planting and post heading back on field grown trees as an effective, crop safe alternative to Flexidor. The trials carried out under this programme of work have already assessed the suitability of this herbicide at higher rates than previously used on field grown trees. The final year of trials work on field grown trees assessed Sencorex Flow at the maximum rate permitted on the EAMU alone and as a component of tank mixes. Although Devrinol has recently been issued an Extension of Authorisation for Minor Use (EAMU) for use in ornamentals, its restrictions prevent the product's use in many field-grown production systems. This combined with the restriction of one application of Flexidor per crop has resulted in a pressing need to test replacement products for tree production.

Other herbicides selected for inclusion in the field tree trials are those for which appropriate EAMUs have recently been granted, e.g., Sunfire (flufenacet), alongside some newer products that are not yet authorised. In 2018, this project looked at the efficacy and crop safety of two-season herbicide programmes, including new products for field tree production. The aim of the current trials was to build on the knowledge gained from the previous trial, and to include new products alongside robust herbicides such as Sencorex Flow in other field-grown ornamentals.

Restrictions on the use of Butisan S (metazachlor) and Venzar 500 SC (under EAMU) have left gaps in the herbicides available to growers of container hardy nursery stock. Flexidor (isoxaben) has in recent years become the mainstay of weed control programmes in container hardy nursery stock production, but it does not offer control of annual meadow grass, groundsel, willowherb, moss, or liverwort, and now only one application is permitted per year. Research in the projects CP 86 *'Weed control in ornamentals, fruit and vegetable crops – maintaining capability to devise suitable weed control strategies'* (Atwood, 2015) and HNS/PO 192 & 192a *'Herbicides screening for ornamental plant production (nursery stock, cut flowers and wallflowers)'* (Atwood 2015, 2016), HNS 198 '*Improving weed control in hardy nursery stock'* (Atwood & Talbot 2016) have investigated promising new actives in

screening trials, and reviewed cultural controls. As a result, Dual Gold (s-metolachlor) and Springbok were developed as container hardy nursery stock treatments (though with limitations). Since then, additional crop safety screening has been carried out within this project. Currently, relatively few new residual herbicides show potential for container hardy nursery stock testing, but two were selected for 2017-18 trials; Sunfire (flufenacet) and Defy (prosulfocarb), both promising for efficacy on key weeds and safety on indicative nursery stock species, additional crop safety screening has continued to demonstrate their potential. Two new herbicide actives (both coded products) were also selected for inclusion in 2018 and 2019 trials; HDC H44 and HDC H46. The withdrawal of Aramo (tepraloxydim), a selective contact herbicide for grass control, has had an impact across both field and container-grown hardy nursery stock. It was used as a post-emergence control of a range of annual grasses, in particular annual meadow grass. A safe and effective replacement, Centurion Max (clethodim) was selected as the most promising candidate and included in phytotoxicity screening on indicative nursery stock species. This was done alone and as a tank mix with Flexidor where it has proved its potential for use within the majority of species tested. Centurion Max has recently been granted an EAMU for use in ornamentals.

HDC H46 is a potential new active for the UK; it is approved in other countries and is used in hardy nursery stock production, and therefore was included in the 2018 and 2019 container screening tests, 2019 field trials and 2022 container pot screen. The UK formulation is likely to be different to the formulation used in hardy nursery stock production in other countries. It gives pre-emergence residual control of a range of annual grasses and broad-leaf weeds including the following weed species: Hairy bittercress, Common chickweed, Mouse eared chickweed, Groundsel, Annual meadow Grass, Clovers, and Italian Ryegrass.

Sencorex Flow (metribuzin) showed potential in trials carried out in Ireland (personal communication, Flanagan, D., 2018) as a winter treatment applied to container grown hardy nursery stock. It had not been included in previous trials due to concerns over crop safety but given potential and the lack of herbicide options Sencorex Flow was included in the 2019-year two herbicide screen and the 2022 container pot screen.

The Long Term Arrangements for Extensions of Use (LTAEU) have now ceased so only herbicides with either on label uses or EAMUs for use in ornamentals can legally be used.

Coded actives that are promising may become available either through on label use or EAMUs (Extension of Authorisation for Minor Use).

Objectives

1. Field Tree Trial (2019). Year 2

- **Objective 1**. To evaluate the efficacy of nine residual herbicide treatments (alone or in combination)
- **Objective 2**. To evaluate the crop safety of nine residual herbicide treatments (alone or in combination) on four field tree species

2. Hardy nursery stock container trial (2019). Year 2

- **Objective 1**. To evaluate the efficacy of six residual herbicide treatments (alone or in combination)
- **Objective 2.** To evaluate the crop safety of six residual herbicide treatments (alone or in combination) on 20 HNS species

3. Container pot screen (2022)

- **Objective 1**. To evaluate the efficacy of seven herbicide combinations on eight weed species at three application timings

1. Field Tree trial (2019). Year 2

Materials and methods

The aim of the work carried out in the second year (2020) of this study was to test the crop safety and efficacy of a number of residual herbicides as alternatives to Flexidor, post heading back rootstocks cut back to just above the bud that was budded the previous season. The trial was set up in 2019 at Frank P Matthews, Tenbury, Worcestershire, on rootstocks planted in a field of medium loam.

Subjects were *Malus mm106* rootstocks budded with *Malus domestica* 'Ticked Pink'; *Prunus colt* rootstocks were budded with *Prunus avium* 'Sunburst'; *Sorbus aucuparia* rootstocks were budded with *Sorbus aucuparia* 'Joseph Rock'; and *Quince A* rootstocks were budded with *Pyrus communis* 'Doyenne Du Comice'. Herbicides were applied either as tank mixtures or alone. Treatments were applied to plots using an OPS knapsack sprayer and 3.5m boom at a medium spray pressure, with 02F110 nozzles applying water at a rate of 400 L/ha. Products were applied alone to gauge crop safety and efficacy where different rates were used. All of the products that were applied alone were also applied as tank mixtures. The trial was set up so that each plot contained all four tree species (e.g. *Malus, Prunus, Quince* and *Sorbus)*. The trial consisted of nine herbicide treatments that were applied as residual

pre-emergence treatments post heading back of rootstocks plus an untreated control (**Table 7**).

The trial was laid out in a fully randomised block design with 3-fold replication. Each plot was 3.5 m wide and 2.4 m long and contained four species of rootstock, planted in rows spanning all plots within the trial. Standard and novel herbicides were applied to the respective plots using a 3.5 m boom sprayer in 400 L/ha over the top of the trees (while still dormant) on 27/03/2020.

Phytotoxicity and weed assessments were carried out at four, six and twelve weeks after treatment (WAT) on 27/03/2020. Phytotoxicity was scored on a scale of 0-9; plants scoring 0 were considered dead, and 9 considered healthy, with plants scoring 7 or more considered to be of commercially acceptable quality. Weed cover was assessed as an overall percentage of the plot.

Data was analysed by ANOVA using Genstat 18.2. Significant differences from the untreated control were determined using the LSD.

Table 7: 2019 Field tree trial. Year 2. Treatment list and percentage weed cover, 4, 6 and 12 WAT (assessed 24/04/20, 07/05/20 and 20/06/20).Post-heading back treatments applied 27/03/20,

Treatment number	Product	Active ingredient	Rate
1.	Untreated	-	Untreated
2.	Sencorex Flow + Sunfire + Stomp Aqua + HDC H47	metribuzin + flufenacet + pendimethalin + confidential	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 3.75 L/ha
3.	Sencorex Flow + Sunfire + Stomp Aqua + HDC H44	metribuzin + flufenacet + pendimethalin + confidential	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 1.75 L/ha
4.	Sencorex Flow + Sunfire + Stomp Aqua	metribuzin + flufenacet + pendimethalin	1.15 L/ha + 0.48 L/ha + 2.9 L/ha
5.	Sencorex Flow + Sunfire + Stomp Aqua + - HDC H43	metribuzin + flufenacet + pendimethalin + confidential	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 2.0
6.	Sencorex Flow + Sunfire + Stomp Aqua + HDC H46	metribuzin + flufenacet + pendimethalin + confidential	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 0.1 L/ha
7.	HDC H46	Confidential	0.1 L/ha
8.	Sencorex Flow + Sunfire + Stomp Aqua + HDC H42	metribuzin + flufenacet + pendimethalin + confidential	1.15 L/ha + 0.48 L/ha + 2.9 L/ha +1.5 L/ha
9.	Sencorex Flow	metribuzin	1.0 L/ha
10.	Sencorex Flow	metribuzin	1.15 L/ha

Results

The results of this trial are presented in **Table 8**, **Table 9** and **Appendix 1** (**Table 16** - **Table 20**).

All the treatments had significantly less weed cover than untreated (water only) control at four ($p<.001$), six ($p<.001$) and twelve ($p<.001$) weeks after treatment. None of the herbicides applied as tank mixes had more than five percent mean weed cover by 12 weeks after treatment. The untreated control had a mean weed cover of over ninety eight percent by twelve weeks after treatment. The most effective treatment combinations are listed in **Table 8** and **Appendix 1,** (**Table 16**).

Table 8. Percentage weed cover, 4, 6 and 12 WAT (assessed 24/04/20, 07/05/20 and 20/06/20). * Significantly different to untreated. The four most effective treatments for weed control are listed in this table but there were no significant differences in weed control between treatments 2,3,4,5,6,8 and 10. All treatments were significantly different from untreated controls at each assessment.

Trt. No.	Post heading back	Rate (L/ha)	Weed cover (%) 4 weeks	Weed cover (%) 6 weeks	Weed cover (%) 12 weeks
1	Untreated	Water only	81.8	88.3	98.3
3	Sencorex Flow + Sunfire + Stomp Aqua + HDC H44	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 1.75 L/ha	0*	0.2*	1*
4	Sencorex Flow + Sunfire + Stomp Aqua	1.15 L/ha + 0.48 L/ha + 2.9 L/ha	0.3*	0.7*	1*
6	Sencorex Flow + Sunfire + Stomp Aqua + HDC H46	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 0.1 L/ha	0.5*	0.5*	0.7*
8	Sencorex Flow + Sunfire + Stomp Aqua + HDC 42 (4, 20, 23)	1.15 L/ha + 0.48 L/ha + 2.9 L/ha +1.5 L/ha	0.2*	0.3*	1*
		p value	<0.001	<0.001	<0.001
		d.f.	18	18	18
		L.S.D.	4.13	4.29	4.79

Sencorex was tested at the maximum rate (1.15 L/ha) on the test species and was applied one week after heading back on 27/03/20. This was a higher rate of Sencorex Flow than previously used in tank mixes and it proved to be crop safe at this higher rate; experimental treatment 3 (HDC H44), applied as part of a tank mix, resulted in initial damage on *Prunus, Quince, Sorbus* that was considered commercially unacceptable at 4 WAT. Experimental treatment 8 (HDC H42), applied as part of a tank mix resulted in initial damage on *Prunus* that was considered commercially unacceptable at 4 WAT. However, all species grew away from the initial damage and were considered comparable with the untreated control by 12 WAT in terms of crop safety. **Table 9** shows that all of the treatments have potential for use

in field-grown tree production. All phytotoxicity scores were the same as the untreated control and the test species were considered tolerant to the herbicides.

Table 9: Field tree trial, 2019. Year 2. Mean results, 12 WAT. *Significantly different to untreated control.

Treatment	Percentage weed cover	Phytotoxicity score *Malus*	Phytotoxicity score *Prunus*	Phytotoxicity score *Quince*	Phytotoxicity score *Sorbus*
1	98.3	9.0	9.0	9.0	9.0
2	4.2	9.0	9.0	9.0	9.0
3	1	9.0	9.0	9.0	9.0
4	1	9.0	9.0	9.0	9.0
5	1.7	9.0	9.0	9.0	9.0
6	0.7	9.0	9.0	9.0	9.0
7	10	9.0	9.0	9.0	9.0
8	1	9.0	9.0	9.0	9.0
9	6.7	9.0	9.0	9.0	9.0
10	1.8	9.0	9.0	9.0	9.0
p value	<.001	N/S	N/S	N/S	N/S
(18 df) **L.S.D.**	10.09	-	-	-	-

Discussion

None of the herbicide treatments in this trial showed significant or lasting signs of crop damage and all treatments were considered commercially acceptable by 12 WAT. Sencorex Flow at the 1.15 L/ha rate had the potential to be one of the most damaging herbicides within the trial but appeared to be crop safe at each assessment date with no significant difference between this treatment and the untreated control. Growers should note when interpreting these results, that metribuzin can leach and cause damage by root uptake on some species especially on light soils after heavy rainfall.

All treatments except for HDC H46 (treatment 7) provided good weed control with less than 10% weed cover on all plots 12 WAT. As expected, percentage weed cover was greatest on the control plots by 12 WAT. Weed control was least effective in treatment 7 (HDC H46 applied alone) and treatment 9 (Sencorex Flow applied alone at 1 L/ha).

Interestingly, treatment 6 (HDC H46 applied as part of a tank mix) gave the best weed control 12 WAT, but there were no significant differences in weed control between treatments 2,3,4,5,6,8, and 10.

HDC H46 (treatment 7) and Sencorex Flow at the high rate (1.15 L/ha; treatment 10), and at the lower rate (1.0 L/ha; treatment 9) were all applied without tank mix partners to determine crop safety, but gaps in the weed control spectrums of these products resulted in treatments

7 and 10 having the greatest percentage weed cover. Interestingly, the high rate of Sencorex performed well when applied alone, however it performed best when applied as part of a tank mix. These products and rates have demonstrated their crop safety on the species tested, giving growers the potential to take the maximum rate of Sencorex Flow forward as a post heading back treatment. This should result in improved weed control with greater persistence to continue to provide alternative options to Flexidor post heading back.

Conclusions

Most residual herbicides are generally much safer when applied over the top of dormant crops, particularly deciduous crops. Residual herbicides bind to soil particles and are not generally taken up by plant roots. Tha label for Sencorex Flow states that the textural group of soils known as sands should not be treated and recommends a 24% reduction in rate for potatoes grown on very light and light soils. Reducing the rate on very light and light soils is likely to be necessary to minimise crop damage to a commercially acceptable level.

All the products tested within this trial appear to be safe on the species tested, are effective against common weeds of field production of hardy nursery stock and thus have potential (if approved or granted EAMUs for use in the production of field-grown hardy nursery stock). Even if none of the experimental products are approved, treatment 4 (a tank mix compromising of Sencorex Flow, Sunfire and Stomp Aqua) proved to be one of the most effective treatments that growers can implement now. Experience has shown that some residual herbicides can leach through the soil profile. This highlights the importance of carrying out trials on different soil types, in different seasons, and over several years, to assimilate knowledge of and gain confidence with different herbicides to get the best results. Slight reductions in the growth and girth of rootstocks prior to budding are not likely to be an issue for many growers applying these herbicides at the rates / combinations used in these trials.

2. Hardy nursery stock container trial (2019). Year 2.

Materials and methods

The HNS herbicide trial was set up at Darby Nursery Stock, Norfolk, in May 2019. The trial consisted of twenty container-grown hardy nursery stock species (**Table 10**) potted up into 2 or 3 L pots with ICL peat based growing media (including 5 kg/m³ Osmocote Exact Standard 12 - 14 month).

The treatments applied in 2019 are detailed in the 2019 annual report. In the second year of the trial a further top up application of residual herbicides was applied in late winter (4 March

2020); Devrinol was applied under an experimental permit as unfavourable weather prevented application in February and EAMU 0168/20 specifies application before the end of February. Treatments included an untreated (water only) control and four herbicide products (**Table 11**). Any weeds were removed before residual herbicides were applied.

The trial was set up as a fully randomised split block design with three replicates. Each plot contained 100 plants – five plants from each of twenty species. Treatments were applied to plots using an OPS knapsack sprayer and 1m boom at a medium spray pressure, with 02F110 nozzles applying water at a rate of 1000 L/ha. No attempt was made to wash any treatments from the foliage after application.

Phytotoxicity was assessed at two, six, and twelve weeks after the herbicide treatments were applied. Phytotoxicity was assessed by examining plants for any signs of herbicide damage (e.g., twisting, scorching, stunting), comparing treated plots to untreated.

Data was analysed by ANOVA using Genstat 18.2; significant differences from the untreated control were determined using the LSD.

Table 10. Species and cultivars included in hardy nursery stock container trial 2019 (hereafter referred to by species).

	Species	Cultivar
1	*Berberis thunbergii* f. *atropurpurea*	'Atropurpurea Nana'
2	*Chaenomeles* x *superba*	'Crimson and Gold'
3	*Choisya ternata*	
4	*Convolvulus cneorum*	
5	*Cotoneaster dammeri*	
6	*Cytisus*	'Lena'
7	*Diervilla splendens*	'Diva'
8	*Escallonia*	'Red Elf'
9	*Hebe* x *franciscana*	'Variegata'
10	*Hypericum*	'Hidcote'
11	*Lavandula vera*	
12	*Lavateria Hybrida*	'Barnsley'
13	*Ligustrum ovifolium*	'Aureum'
14	*Pachysandra terminalis*	'Green Sheen'
15	*Photinia* x *fraseri*	'Red Select'
16	*Potentilla fruticosa*	'Abbotswood'
17	*Pyracantha*	'Soleil d'Or'
18	*Santolina chamaecyparissus*	
19	*Senecio compacta*	'Drysdale'
20	*Vinca minor*	

Table 11. Treatment list, active ingredients and for the hardy nursery stock container herbicide trial. * An EAMU was issued for the use of Devrinol in January 2020 however itrestricts use to before the end of February. Devrinol was applied under experimental approval.

Treatment		Active ingredient	Rate (L/ha)
1	Untreated	-	-
2	Sencorex Flow	metribuzin	1.0
3	HDC H46	Confidential	0.1
4	HDC H46 + Devrinol*	Confidential + napropamide	0.1 + 7.0
5	Devrinol*	napropamide	7.0
6	Sencorex Flow	metribuzin	0.5
7	Devrinol* + Springbok	napropamide + dimethenamid-p + metazachlor	7.0 + 1.6

Results

The results for this trials are presented in **Table 12** and **Appendix 2** (**Table 21** -**Table 24**).

At two weeks after treatment (WAT), Sencorex Flow at the higher rate of 1.0 L/ha had resulted in damage that was not considered commercially acceptable on three species: *Diervilla, Pachysandra* and *Photinia.* Commercially acceptable damage was recorded on an additional two species: *Ligustrum* and *Vinca.* The lower rate of Sencorex Flow at 0.5 L/ha was safer on *Pachysandra* resulting in slight damage that was considered commercially acceptable. Damage caused by Sencorex Flow at the lower rate was also less severe on *Photinia* however damage was still considered commercially unacceptable (**Table 12, Table 21**).

The new herbicide HDC H46 had proven to be damaging on some species in previous trials carried out under this programme of work. At the 2WAT assessment seven of the 20 species within the trial treated with HDC H46 were showing signs of phytotoxic damage; however, damage was only considered unacceptable on four species (*Chaenomeles, Diervilla, Ligustrum* and *Photinia). Photinia* were damaged by all treatments resulting in them all being considered commercially unacceptable at the 2WAT assessment.

Devrinol resulted in damage on *Diervilla, Pachysandra* and *Photinia* resulting in average phytotoxicity scores below the commercially acceptable score of 7. Unsurprisingly these three species also showed unacceptable damage where HDC H46 was tank mixed with Devrinol; in fact, damage incurred was slightly worse than encountered within the Devrinol treatments, suggesting a slight synergistic effect.

By 6 WAT most of the species that were damaged by Sencorex Flow at 2WAT and not considered commercially acceptable had started to recover. *Hebe* and *Vinca* had developed

damage that was not considered commercially acceptable by 6 WAT post treatment assessment in the lower rate Sencorex Flow treatment (**Table 22**). By 12 WAT damage on *Hebe* had got worse in both the low and high rate Sencorex Flow treatments and was considered commercially unacceptable, suggesting that this herbicide may not be suitable as a late winter treatment on *Hebe.* The high rate of Sencorex Flow also resulted in lasting damage on *Pachysandra* that was below the threshold of what is considered commercially acceptable at the 12 WAT assessment. Damage that was considered commercially unacceptable had also developed and was evident on Vinca by the 12 WAT assessment.

By 12 WAT all *Photinia* had recovered from the initial damage and all treatments, apart from those treated with HDC H46 were considered commercially acceptable. *Hebe* was also damaged by both HDC H46 and HDC H46 + Devrinol with damage not visible until the 12 WAT assessment. *Pachysandra* treated with HDC H46 + Devrinol were damaged and were not considered commercially acceptable by 12 WAT (**Table 13**)**.** All treatments had significantly less weed cover than the untreated control **(Table 24)** The fact that some annual weeds such as Groundsel has the ability to set seed and die between assessment dates is why the average mean percentage cover varies between assessment dates.

Table 12. Average phytotoxicity scores for HNS species, two weeks after early March treatment application (assessed 18/03/20). NS = no significant differences. * Significantly different to untreated.

Species	UTC	Sencorex Flow 1.0 L	HDC H46	HDC H46 + Devrinol	Devrinol	Sencorex Flow 0.5 L	Devrinol + Springbok	p value	L.S.D.
Berberis thunbergii f. *atropurpurea*	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Chaenomeles x *superba*	9.0	9.0	6.7*	8.3*	9.0	9.0	9.0	<.001	0.5256
Choisya ternata	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Convolvulus cneorum	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Cotoneaster dammeri	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Cytisus	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Diervilla splendens	9.0	6.7*	5.7*	5.3*	6.7*	6.3*	7.3*	0.004	1.504
Escallonia	9.0	9.0	8.7	9.0	9.0	9.0	9.0	(NS)	
Hebe x *franciscana*	9.0	9.0	9.0	9.0	9.0	9.0	8.0*	0.050	0.6724
Hypericum	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Lavandula vera	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Lavateria Hybrida	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Ligustrum ovifolium	9.0	7.3*	6.7*	8.0	8.0	7.7*	7.7*	(NS)	
Pachysandra terminalis	9.0	5.3*	8.0	6.0*	6.3*	8.0	8.0	<.001	1.268
Photinia x *fraseri*	9.0	5.3*	3.3*	5.3*	6.3*	6.7*	6.0*	<.001	0.938
Potentilla fruticosa	9.0	9.0	8.0	9.0	9.0	9.0	9.0	(NS)	
Pyracantha	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Santolina chamaecyparissus	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Senecio compacta	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Vinca minor	9.0	8.7	8.7	9.0	9.0	9.0	9.0	(NS)	

Table 13. Average phytotoxicity scores for hardy nursery species, twelve weeks after early March treatment application (assessed 29/05/20). *NS = no significant differences.* * Significantly different to untreated.

Species	UTC	Sencorex Flow 1.0 L	HDC H46	HDC H46 + Devrinol	Devrinol	Sencorex Flow 0.5 L	Devrinol + Springbok	p value	L.S.D.
Berberis thunbergii f. *atropurpurea*	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Chaenomeles x *superba*	9.0	9.0	7.3	8.3	8.0	9.0	8.7	(NS)	-
Choisya ternata	9.0	8.0	9.0	8.7	9.0	9.0	9.0	(NS)	-
Convolvulus cneorum	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Cotoneaster dammeri	9.0	9.0	9.0	9.0	8.7	8.7	9.0	(NS)	-
Cytisus	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Diervilla splendens	9.0	8.7*	7.7*	8.0*	7.7*	7.3*	9.0	0.003	0.824
Escallonia	9.0	9.0	9.0	8.7	9.0	9.0	9.0	(NS)	-
Hebe x *franciscana*	9.0	6.3*	4.7*	4.7*	8.3	4.7*	7.3*	<.001	1.821
Hypericum	9.0	9.0	7.3	8.7	8.7	9.0	8.7	(NS)	-
Lavandula vera	9.0	9.0	9.0	8.0	9.0	7.0	8.0	(NS)	-
Lavateria Hybrida	9.0	9.0	7.3*	8.0*	8.7*	9.0	9.0	0.002	0.7601
Ligustrum ovifolium	9.0	8.7	8.0	8.3	8.3	9.0	9.0	(NS)	-
Pachysandra terminalis	9.0	6.3*	7.7*	6.3*	8.3	7.0*	9.0	<.001	1.098
Photinia x *fraseri*	9.0	7.3*	6.0*	7.0*	7.0*	7.7	9.0	0.004	1.363
Potentilla fruticosa	9.0	9.0	9.0	9.0	8.7	8.0	8.3	(NS)	-
Pyracantha	9.0	9.0	9.0	8.0	9.0	9.0	9.0	0.050	0.6724
Santolina chamaecyparissus	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Senecio compacta	9.0	9.0	9.0	7.7	9.0	9.0	9.0	(NS)	-
Vinca minor	9.0	6.7*	7.7*	7.7*	8.7	8.3	8.3	0.003	0.938

Discussion

Crop safety of residual herbicides depends on plant species; this trial has developed options for late winter treatments other than Flexidor for some hardy nursery stock species which will expand options for weed control within the sector.

The foliage of treated plants was dry at the point of application and herbicides were not washed off the foliage with overhead irrigation, this technique (10 mm of irrigation post application) could be adopted by growers to help minimise crop damage associated with some of the treatments.

Devrinol + Springbok resulted in some initial damage at the 2WAT assessment however damage was minimal and all species within the trial were commercially acceptable by the 12 WAT assessment.

Sencorex Flow has potential for use as a late winter, dormant season treatment on the following species: *Berberis thunbergii* f. *atropurpurea, Chaenomeles* x *superba, Choisya ternata, Convolvulus cneorum, Cotoneaster dammeri, Cytisus, Diervilla splendens, Escallonia, Hypericum, Lavandula, Lavateria Hybrida, Ligustrum ovifolium, Photinia fraseri, Potentilla fruticosa, Pyracantha, Santolina chamaecyparissus* and *Senecio compacta.*

The new herbicide HDC H46 has potential for use on species as a later winter treatment including *Berberis thunbergii* f. *atropurpurea, Chaenomeles* x *superba, Choisya ternata, Convolvulus cneorum, Cotoneaster dammeri, Cytisus, Diervilla splendens, Escallonia, Hypericum, Lavandula, Ligustrum ovifolium, Potentilla fruticosa, Pyracantha, Santolina chamaecyparissus, Senecio compacta* and *Vinca minor* and gives control of a useful range of common weeds of container nurseries. Short-term scorch may be a problem on some species.

Growers should be aware of the possibility of short-term scorch from Devrinol but should note that all species treated with Devrinol were considered commercially acceptable by the 12WAT assessment.

Conclusions

Sensitive species should only be treated with herbicides where crop safety has been proven, alternatively cultural methods and pot toppers are likely to deliver crop safe weed control on such species.

Sencorex Flow had mostly been used in field grown crops in this programme of work prior to this trial. This trial has demonstrated the product's potential for use as an alternative

residual herbicide in container production of hardy nursery stock when applied as a dormant season treatment. Where the higher rate treatment of 1 L/ha appeared to be too damaging (*Pachysandra* and *Vinca),* the lower rate of 0.5 L/ha appears to be relatively crop safe with only slight damage recorded at the 12WAT assessment that was deemed to be commercially acceptable. Sencorex Flow is not suitable for use on *Hebe* x *franciscana* however it has potential on the other 19 species within this trial.

Devrinol tank mixed with Springbok showed potential as tank mix partners where Springbok has not previously been applied to a crop. This tank mix appeared to be relatively safe when applied as a dormant season treatment. Where Springbok has already been applied Devrinol proved to be a safe stand-alone treatment on the species tested.

If authorised for use in ornamentals, HDC H46 has potential as a residual herbicide in programmes with Flexidor and as a tank mix with Devrinol. HDC H46 should provide residual control of most of the main weeds of container nurseries. Additional work to continue to build information relating to the crop safety of this herbicide within container hardy nursery stock production would be useful, particularly if the active gained an authorisation / EAMU for use in ornamental production.

All the herbicide treatments within the trial contributed significantly to weed control.

3. Container pot screen (2022)

Materials and methods

Herbicide weed screens were carried out at ADAS Boxworth, Cambridgeshire on eight species of weed that are commonly found in container grown HNS and included: Annual meadow grass *(Poa annua),* Hairy bittercress *(Cardamine hirsute),* Common mouse eared chickweed *(Cerastium fontanum),* Common Chickweed *(Stellaria media),* American Willowherb *(Epilobium Ciliatum),* Groundsel *(Senecio vulgaris),* Procumbent pearlwort *(Sagina procumbens),* Sow thistle *(Sonchus oleraceus).* Weeds were sown into both 9 cm pots and seed trays; for the post emergence treatments 3 seedlings were transplanted from seed trays to 9 cm pots at the first true leaf stage and were allowed to grow on prior to treatment.

Each weed screen had seven different treatments, including untreated and three different treatment timings. Active ingredients are listed in **Table 14**. Each weed trial was set up as a randomised block design with four replicates and was grown under a polytunnel at ADAS Boxworth.

The pre-emergence treatments were sown and watered on 22/09/22 and pre-emergence (T0) treatments applied on 23/09/22. Post emergence treatments were sown on 22/09/22 and were transplanted (3 per 9 cm pot) as soon as the weeds were large enough. The first post emergence treatments (T1) were applied to all weed species excluding Procumbent pearlwort *(Sagina procumbens)* on 18/10/22, most of the weed species were at 2-4 true leaves. The second post emergence treatments (T2) were applied to all weed species excluding Procumbent pearlwort *(Sagina procumbens)* on 25/10/22, most of the weed species were at 6-10 true leaves. Procumbent pearlwort *(Sagina procumbens)* was slower to germinate than other weed species within the trial so T1 was applied on 15/11/22 and T2 on 06/12/22. Treatments were applied using an OPS knapsack sprayer with a single lance flat fan F02/100 nozzle as a medium quality spray at a water rate of 200 L/ha.

For the pre-emergence (T0), assessments percentage control was assessed twice (21 and 42 days after treatment). For T1 and T2 post emergence applications three assessments of percentage control were carried out at 7, 14 and 42 days after treatment.

Data was analysed by ANOVA using Genstat 18.2. Significant differences from the untreated control were determined using the LSD.

Table 14. Treatment list, active ingredients and timings for the 2022 container pot screen. * The EAMU for Venzar 500 SC states use before the end of July so Venzar 500 SC was used under an experimental permit in this

Treatment		Active ingredient	Approval status	Rate (L/ha)	Timing
1	Untreated	-	-	-	T0, T1, T2
2	Flexidor	isoxaben 500 g/L	Label	0.5	T0, T1, T2
3	Dual Gold	S-metolachlor 960 g/L	EAMU	0.78	T0, T1, T2
4	Sencorex Flow	metribuzin 600 g/L	EAMU	1.15	T0, T1, T2
5	Sencorex Flow	metribuzin 600 g/L	EAMU	0.5	T0, T1, T2
6	Sunfire	flufenacet 500 g/L	EAMU	0.48	T0, T1, T2
7	HDC H43	confidential	Experimental	1.0	T0, T1, T2
8	Venzar 500 SC	lenacil 500 g/lL	EAMU	0.4	T0, T1, T2

Table 15. Weed species used in the pot screen.

Weed species
Annual meadow grass *(Poa annua)*
Hairy bittercress (*Cardamine hirsute*)
Common mouse eared chickweed *(Cerastium fontanum)*
Common Chickweed (*Stellaria media*)
American Willowherb (*Epilobium ciliatum*)
Groundsel (*Senecio vulgaris*)
Sow thistle (*Sonchus oleraceus*)
Procumbent pearlwort *(Sagina procumbens)*

Results

Annual meadow grass **(Appendix 3, Table 25**)

- **T0 application (pre-emergence) 22 September 2022, 42 days after treatment.**

Dual Gold, Sencorex at both rates, Sunfire and HDC H43 applied pre-emergence all significantly reduced the number of annual meadow grass seedlings emerging. All these treatments resulted in significant control at 42 days post treatment (P<0.001, L.S.D 26.03). Both the higher and lower rates of Sencorex Flow gave complete control and prevented any seedlings emerging. Neither Flexidor nor Venzar 500 SC resulted in any reductions in the numbers of annual meadow grass seedlings germinating.

- **T1 application (post emergence at 2 – 4 true leaves) 18 October 2022, 42 days after treatment.**

Sencorex Flow at both rates reduced the number of emerged seedlings when applied at 2-4 true leaves to zero at the assessment carried out at 14 days post treatment. These plots remained clean with no annual meadow grass from the 14-day assessment onwards. Dual Gold, Sunfire and HDC H43 also gave significant control compared with untreated control however these treatments were significantly different from both Sencorex Flow treatments which gave 100 percent control (P<0.001, L.S.D. 17.51).

- **T2 application (post emergence at 6 – 10 true leaves) 25 October 2022, 42 days after treatment.**

Sencorex Flow at both rates reduced the number of emerged seedlings when applied at 6 – 10 true leaves to zero. Sunfire also gave significant control when compared to the untreated control, however these treatments were significantly different from both Sencorex Flow treatments which gave 100 percent control (P<0.001, L.S.D. 3.271).

Hairy bittercress **(Appendix 3, Table 26)**

- **T0 application (per-emergence) 22 September 2022, 42 days after treatment.**

Dual Gold, Sencorex at both rates, Sunfire and HDC H43 applied pre-emergence all significantly reduced the number of hairy bittercress seedlings that germinated by 42 days after treatment (P<0.001, L.S.D. 12). Both the higher and lower rates of Sencorex Flow gave complete control and prevented any seedlings emerging. Venzar 500 SC did not result in any reduction in the number of Hairy bittercress seedlings germinating by 42 days after treatment.

- **T1 application (post emergence at 2 – 4 true leaves) 18 October 2022, 42 days after treatment.**

Sencorex Flow at both rates reduced the number of emerged seedlings when applied at 2-4 true leaves to zero at the assessment carried out at 14 days post treatment. These plots remained clean with no hairy bittercress seedlings from the 14-day assessment onwards. Although Flexidor or Dual Gold, did not result in total control of bittercress seedlings at this growth stage, control was significant at over fifty percent compared with the untreated control. Control with Sunfire and HDC H43 was still significant compared with untreated control, but these treatments only controlled ten percent of bittercress seedlings at this growth stage (P<0.001, L.S.D. 7.318)

- **T2 application (post emergence at 6 – 10 true leaves) 25 October 2022, 42 days after treatment.**

Sencorex Flow at both rates reduced the number of emerged seedlings when applied at 6 – 10 true leaves to zero. Sunfire also gave significant control which was statistically comparable with Flexidor at this growth stage. Dual Gold was also resulted in statistically significant control when compared with the untreated control, however all treatments were significantly different from both Sencorex Flow treatments which gave 100 percent control (P<0.001, L.S.D.16.86).

Common mouse eared chickweed **(Appendix 3, Table 27)**

- **T0 application (per-emergence) 22 September 2022, 42 days after treatment.**

Sencorex at both rates, Flexidor, Dual Gold and Sunfire all resulted in statistically significantly control compared to the untreated (P <0.001, L.S.D. 15.91). Sencorex Flow at the high and lower rates resulted in complete control, although Flexidor is statistically comparable with Sencorex Flow it resulted in ninety five percent control. Dual Gold resulted in over fifty percent control. HDC H43 did not result in any significant weed control and Venzar 500 SC did not contribute to the control of common mouse eared chickweed (P<0.001, L.S.D.15.91).

- **T1 application (post emergence at 2 – 4 true leaves) 18 October 2022, 42 days after treatment.**

Sencorex Flow at both rates reduced the number of emerged seedlings when applied at 2-4 true leaves to zero at the assessment carried out at 14 days post treatment. These plots remained clean with no common mouse eared chickweed seedlings from the 14-day assessment onwards.

Venzar 500 SC and Dual Gold also gave significant weed control compared with the untreated control with Venzar 500 SC resulting in 30% control and Dual Gold giving 12.5% control (P<0.001, L.S.D. 9.34).

- **T2 application (post emergence at 6 – 10 true leaves) 25 October 2022, 42 days after treatment.**

Sencorex Flow at both the high and low rates resulted in 100% control of common mouse eared chickweed. Venzar 500 SC and HDC H43 were also significantly different from untreated control with Venzar 500 SC giving 26.25% control however HDC H43 only gave 6.88% control (P<0.001, L.S.D. 4.460).

Common chickweed **(Appendix 3,Table 28)**

- **T0 application (per-emergence) 22 September 2022, 42 days after treatment.**

Sencorex Flow at both rates, Flexidor, Dual Gold and HDC H43 all resulted in statistically significantly control compared with the untreated control (P <0.001, L.S.D. 9.97). Flexidor and Sencorex at the higher rate both resulted in 100% control when applied pre-emergence. Sencorex at the lower rate resulted in over 90% control, Dual Gold resulted in over 50% control and HDC H43 resulted in 15% control.

- **T1 application (post emergence at 2 – 4 true leaves) 18 October 2022, 42 days after treatment.**

Sencorex Flow at both the high and low rates resulted in total control by 14 days after treatment. HDC H43 was also statistically significantly different from untreated control, resulting in 60% control at this growth stage (P<0.001, L.S.D. 36.48).

- **T2 application (post emergence at 6 – 10 true leaves) 25 October 2022, 42 days after treatment.**

Sencorex Flow at both the high and low rates resulted in complete weed control by 14 days after treatment at this growth stage which carried through to the 42 days after treatment assessment. Flexidor was also statistically significantly different from untreated control and resulted in 35% control (P<0.001, L.S.D. 22.97).

American willowherb **(Appendix 3, Table 29)**

- **T0 application (per-emergence) 22 September 2022, 42 days after treatment.**

Sencorex Flow at both rates, Dual Gold and HDC H43 all resulted in statistically significantly control compared with the untreated (P <0.001, L.S.D. 9.97). Sencorex Flow

at both the high and low rates resulted in total control at this growth stage. Dual Gold and Sunfire both resulted in over 90% weed control at this growth stage. HDC H43 was also an effective treatment which gave 85% control.

- **T1 application (post emergence at 2 – 4 true leaves) 18 October 2022, 42 days after treatment.**

Sencorex Flow at both the high and low rate resulted in complete control of Willowherb at 2 – 4 true leaves 14 days after treatment which carried through to the 42-day assessment. Sunfire, Venzar 500 SC, HDC H43 and Dual Gold also resulted in statistically significant control compared with the untreated control (P<0.001, L.S.D. 21.67). Sunfire resulted in 85% control while Venzar 500 SC, HDC H43 and Dual Gold all resulted in over 40% control.

- **T2 application (post emergence at 6 – 10 true leaves) 25 October 2022, 42 days after treatment.**

Sencorex Flow at both the high and low rate resulted in complete control of Willowherb at 2 – 4 true leaves 7 days after treatment which carried through to the 42-day assessment. Sunfire and Venzar 500 SC also resulted in statistically significant control compared with the untreated control (P<0.001, L.S.D. 13.00). Sunfire resulted in 80% control whilst Venzar 500 SC gave 70% control at 6 – 10 true leaves.

Groundsel **(Appendix 3, Table 30)**

- **T0 application (per-emergence) 22 September 2022, 42 days after treatment.**

Sencorex Flow at both rates prevented germination, resulting in complete control as a pre-emergence treatment. HDC H43, Sunfire, Flexidor and Dual Gold also resulted in statistically significantly control compared to the untreated (P <0.001, L.S.D. 29.84). HDC H43 and Sunfire both resulted in over 60 % control, Flexidor resulted in over 50% control and Dual Gold resulted in over 40% control.

- **T1 application (post emergence at 2 – 4 true leaves) 18 October 2022, 42 days after treatment.**

Sencorex Flow at both the high and low rates resulted in complete control as a post emergence treatment of groundsel at 2 – 4 leaves. Venzar 500 SC also resulted in statistically significant control compared with the untreated control, but this treatment only resulted in 10% control (P <0.001, L.S.D. 6.976).

- **T2 application (post emergence at 6 – 10 true leaves) 25 October 2022, 42 days after treatment.**

Sencorex Flow at both the high and low rates resulted in complete control as a post emergence treatment of groundsel at 6-10 true leaves. Venzar 500 SC 13.75% and Dual Gold also resulted in statistically significant control compared to the untreated control; Venzar 500 SC resulted in 13.75% control whereas Dual Gold only resulted in 7.5% control (P <0.001, L.S.D. 6.090).

Sow thistle **(Appendix 3, Table 31)**

- **T0 application (per-emergence) 22 September 2022, 42 days after treatment.**

Sencorex Flow at both rates prevented germination, resulting in complete control as a pre-emergence treatment. HDC H43, Dual Gold, Flexidor and Sunfire also resulted in statistically significant weed control compared with the untreated control. HDC H43 and Dual Gold both resulted in over 90% weed control when applied pre-emergence. Both Flexidor and Sunfire resulted in over 80% weed control as pre-emergence treatments (P <0.001, L.S.D. 9.49).

- **T1 application (post emergence at 2 – 4 true leaves) 18 October 2022, 42 days after treatment.**

Sencorex Flow at both the high and low rates resulted in complete control as a post emergence treatment of Sow thistle at 2-4 true leaves. HDC H43 and Venzar 500 SC also resulted in significant weed control at this growth stage with HDC H43 resulting in over 70% control and Venzar 500 SC giving over 50% control (P <0.001, L.S.D. 16.53).

- **T2 application (post emergence at 6 – 10 true leaves) 25 October 2022, 42 days after treatment.**

Sencorex Flow at both the high and low rates resulted in complete control as a post emergence treatment of sow thistle at 6 -10 true leaves. Venzar 500 SC, Dual Gold and Sunfire all resulted in significant weed control compared with the untreated control. Venzar 500 SC resulted in over 80% control, Dual Gold delivered 75% control and Sunfire resulted in nearly 29% control (P <0.001, L.S.D. 28.15).

Pearlwort **(Appendix 3, Table 32)**

- **T0 application (pre-emergence) 22 September 2022, 42 days after treatment.**

HDC H43 and Flexidor prevented seedlings germinating, Sencorex Flow at both rates prevented germinating seedlings surviving; all these four treatments resulted in complete control as a pre-emergence treatment. Dual Gold and Sunfire also resulted in statistically significant weed control compared to the untreated control with Dual Gold resulting in 99.5% control and Sunfire giving 80% control (P <0.001, L.S.D.15.19).

- **T1 application (post emergence at 2 – 4 true leaves) 15 November 2022, 42 days after treatment.**

Sencorex Flow at both the high and low rates resulted in complete control as a post emergence treatment of pearlwort. Sunfire, Dual Gold, Flexidor and HDC H43 also gave significant weed control compared to the untreated control (P <0.001, L.S.D. 9.34). Sunfire resulted in over 80% control, Dual Gold resulted in 70% control, Flexidor resulted in over 38% control and HDC H43 gave 15% control of pearlwort at this growth stage.

- **T2 application (post emergence at 6 – 10 true leaves) 6 December 2022, 42 days after treatment.**

Sencorex Flow at both the high and low rates resulted in complete control as a post emergence treatment of pearlwort at this growth stage. HDC H43, Dual Gold and Flexidor also resulted in significant weed control compared with the untreated control (P <0.001, L.S.D. 4.460). HDC H43 and Dual Gold resulted in over 10 % weed control and Flexidor resulted in 10% weed control.

Discussion

Sencorex Flow at both the low and high rate appears to offer the most effective weed control across the species tested and may play an increasingly important role in weed control in the production of HNS in the future. This herbicide has contact and residual properties, which contribute to its effectiveness across a range of problematic weed species frequently occurring in container production. The product's contact action and restrictions on the EAMU limits its use as a dormant season treatment on outdoor crops or before crop emergence on protected crops. Experience to date with this herbicide when used over crops has shown that it can result in a slight reduction in vigour and may damage some species, especially if they are not fully dormant. In these trials the product was used at both the full rate and less than half rate and broadly speaking efficacy was similar. Reducing rates further may help to improve crop safety whilst maintaining useful efficacy but may reduce the longevity of the products residual effects. Legislation has resulted in a reduction in herbicide options which causes problems due to limited options in different herbicide groups as classified by the Herbicide resistance action committees (HRAC mode of action codes). Sencorex provides a

useful alternative HRAC code for grass weed control in the production of HNS which is important as acute problems with herbicide resistance have developed in grass weeds in certain combinable crops (e.g., Blackgrass).

The industry standard residual herbicide, Flexidor has useful pre-emergence efficacy against some common and problematic weeds of field and container nurseries, but relatively recent label changes have restricted its use to one application per crop. This fact combined with gaps in the product's weed control spectrum lends its use in tank mixes and as part of a programme of herbicides for weed control.

Dual Gold is known to give useful pre – emergence residual control of some important weeds (e.g., American willowherb) of container nursery stock and is said to have little contact action on emerged weeds. Previous work has indicated that bittercress is not well controlled; however interestingly in this trial Dual Gold gave a useful percentage reduction of bittercress as a pre-emergence and post emergence treatment at the growth stages tested. This trial also highlighted useful post emergence activity at T1 against Pearlwort, resulting in a useful percentage of the weed population being controlled. The EAMU restriction of use in May only and a maximum of one application per crop restricts when Dual Gold can be applied in weed control programmes.

Sunfire is often tank mixed with other herbicides such as Sencorex Flow as there are some gaps in its weed control spectrum. This trial raises the question as whether there is much benefit in tank mixing Sunfire with Sencorex Flow which gave good control of most common weeds of container nurseries when used alone. Given the lack of herbicide options and the fact that Sunfire when used alone in this trial, contributed to the control of weeds where control is not well documented, including hairy bittercress, willowherb, groundsel, and pearlwort. Although there are more effective options for the control of some of these weeds such as Flexidor and Dual Gold for pearlwort, multiple applications of residual herbicides per crop is often required as most residual herbicides are of relatively short persistence (up to around 12 weeks).

The relatively new EAMU for Venzar 500 SC restricted the rate to 0.4L/ha and the total quantity that can be applied over three years. These trials have demonstrated weed control efficacy at these previously untested lower rates. This has shown that Venzar 500 SC has contributed to weed control, notably useful percentage reductions in American willowherb and sow thistle when applied as a post emergence treatment. Restrictions on the timings of Venzar 500 SC application may limit its use against American willowherb as the main flush of seedlings are likely to emerge later than Venzar 500 SC can be applied outdoors. Previous

trials in this programme of weed research have tested Venzar 500 SC as a tank mix partner with other residual herbicides (e.g., Flexidor). The reduced rates of Venzar 500 SC have proved relatively crop safe when used alone or in tank mixes.

HDC H43 is a relatively new residual herbicide for the UK (not yet authorised) and shows potential for use in container production of hardy nursery stock. These trials have shown that HDC H43 has contributed to weed control with useful percentage reductions in annual meadow grass, American willowherb, groundsel, pearlwort, and sow thistle when applied pre - emergence and a reduction in common chickweed and sow thistle when applied post emergence. Trials carried out in this programme of work have demonstrated this herbicide's potential for use as a tank mix partner with other residual herbicides (e.g. Springbok) to broaden weed control spectrums.

Conclusions

- Sencorex Flow was found to be effective against all of the weed species tested both as a pre and post emergence treatment. Crop safety on untested species needs to be determined prior to treatment but can only be used as a dormant season treatment.
- Flexidor was confirmed as giving good pre-emergence control of hairy bittercress, common chickweed, mouse eared chickweed, pearlwort, sow thistle and groundsel. Interesting groundsel is normally considered to be resistant to Flexidor so this result should be interpreted with caution and may not be repeatable. Useful post emergence control of hairy bittercress was also obtained.
- Dual Gold gave good pre-emergence control of annual meadow grass, common chickweed, mouse eared chickweed, American willowherb, groundsel, pearlwort, and sow thistle. Dual Gold also seemed to contribute to pre and post emergence control of hairy bittercress, this result should be interpreted with caution as previous work has indicated that hairy bittercress is not well controlled. Applying Dual Gold in late May could help to maximise the products residual effect against some key weed species that the product has activity against.
- Sunfire resulted in a useful percentage reduction of annual meadow grass. It also contributed to the control of weeds where control is not well documented, including hairy bittercress, willowherb, groundsel, and pearlwort so has the potential to contribute to both the control of annual meadow grass and some important broad-leafed weeds.
- Venzar 500 SC was most effective against sow thistle and American willowherb as a post emergence treatment. The restriction on the current EAMU for Venzar 500 SC restricts its application to before the end of July; given that American willowherb does

not tend to produce seed outdoors until June or July in an average growing season growers may get best results by using this product in late July where possible.

- HDC H43 gave useful pre-emergence control of a useful range of weeds so has potential for use as a late autumn / winter top up either alone or as a component of a tank mix.

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Appendix 1. Field tree trial (2019). Year 2.

Table 16. Percentage weed cover, 4, 6 and 12 WAT (assessed 24/04/20, 07/05/20 and 20/06/20). * Significantly different to untreated control, no significant differences in weed control between treatments 2,3,4,5,6,8 and 10.

Trt. No.	Post heading back	Rate (L/ha)	Weed cover (%) 4 weeks	Weed cover (%) 6 weeks	Weed cover (%) 12 weeks
1	Untreated	Untreated	81.8	88.3	98.3
2	Sencorex Flow + Sunfire + Stomp Aqua + HDC H47	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 3.75 L/ha	0.5*	2.0*	4.2*
3	Sencorex Flow + Sunfire + Stomp Aqua + HDC H44	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 1.75 L/ha	0.0*	0.2*	1.0*
4	Sencorex Flow + Sunfire + Stomp Aqua	1.15 L/ha + 0.48 L/ha + 2.9 L/ha	0.3*	0.7*	1.0*
5	Sencorex Flow + Sunfire + Stomp Aqua + HDC H43	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 2.0	0.7*	0.8*	1.7*
6	Sencorex Flow + Sunfire + Stomp Aqua + HDC H46	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 0.1 L/ha	0.5*	0.5*	0.7*
7	HDC H46	0.1 L/ha	0.8*	2.0*	10.0*
8	Sencorex Flow + Sunfire + Stomp Aqua + HDC 42	1.15 L/ha + 0.48 L/ha + 2.9 L/ha +1.5 L/ha	0.2*	0.3*	1.0*
9	Sencorex Flow	1.0 L/ha	0.8*	1.3*	6.7*
10	Sencorex Flow	1.15 L/ha	0.7*	0.8*	1.8*
		p value	<0.001	<0.001	<0.001
		d.f.	18	18	18
		L.S.D.	4.13	4.29	4.79

*Significantly different to untreated.

Table 17. Average phytotoxicity scores for Malus, assessed 4, 6 and 12 WAT (assessed 24/04/20, 07/05/20 and 20/06/20). Phytotoxicity scale of zero to nine; plants scoring zero considered dead, and nine considered healthy, with those scoring seven or more considered to be of commercially acceptable quality. NS = no significant differences. * Significantly different to untreated.

Trt. No.	Planting	Rate (Kg/ha or L/ha)	Phytotoxicity score 4 weeks	Phytotoxicity score 6 weeks	Phytotoxicity score 12 weeks
1	Untreated	Untreated	9.0	9.0	9.0
2	Sencorex Flow + Sunfire + Stomp Aqua + HDC H47	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 3.75 L/ha	9.0	9.0	9.0
3	Sencorex Flow + Sunfire + Stomp Aqua + HDC H44	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 1.75 L/ha	8.6	9.0	9.0
4	Sencorex Flow + Sunfire + Stomp Aqua	1.15 L/ha + 0.48 L/ha + 2.9 L/ha	9.0	9.0	9.0
5	Sencorex Flow + Sunfire + Stomp Aqua + - HDC H43	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 2.0	9.0	9.0	9.0
6	Sencorex Flow + Sunfire + Stomp Aqua + HDC H46	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 0.1 L/ha	9.0	9.0	9.0
7	HDC H46	0.1 L/ha	9.0	9.0	9.0
8	Sencorex Flow + Sunfire + Stomp Aqua + HDC H42	1.15 L/ha + 0.48 L/ha + 2.9 L/ha +1.5 L/ha	7.6*	8.6	9.0
9	Sencorex Flow	1.0 L/ha	9.0	9.0	9.0
10	Sencorex Flow	1.15 L/ha	9.0	9.0	9.0
		p value	<0.001	N/S	N/S
		(18 df) **L.S.D.**	0.4176	-	-

Table 18. Average phytotoxicity scores for *Prunus*, assessed 4, 6 and 12 WAT (assessed 24/04/20, 07/05/20 and 20/06/20). Phytotoxicity scale of zero to nine; plants scoring zero considered dead, and nine considered healthy, with those scoring seven or more considered to be of commercially acceptable quality. NS = no significant differences. * Significantly different to untreated.

Trt. No.	Planting	Rate (Kg/ha or L/ha)	Phytotoxicity score 4 weeks	Phytotoxicity score 6 weeks	Phytotoxicity score 12 weeks
1	Untreated	Untreated	9.0	9.0	9.0
2	Sencorex Flow + Sunfire + Stomp Aqua + HDC H47	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 3.75 L/ha	8.3	9.0	9.0
3	Sencorex Flow + Sunfire + Stomp Aqua + HDC H44	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 1.75 L/ha	5.3*	7.7*	9.0
4	Sencorex Flow + Sunfire + Stomp Aqua	1.15 L/ha + 0.48 L/ha + 2.9 L/ha	8.6	9.0	9.0
5	Sencorex Flow + Sunfire + Stomp Aqua + - HDC H43	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 2.0	9.0	9.0	9.0
6	Sencorex Flow + Sunfire + Stomp Aqua + HDC H46	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 0.1 L/ha	9.0	9.0	9.0
7	HDC H46	0.1 L/ha	9.0	9.0	9.0
8	Sencorex Flow + Sunfire + Stomp Aqua + HDC 42	1.15 L/ha + 0.48 L/ha + 2.9 L/ha +1.5 L/ha	6.0	7.3*	9.0
9	Sencorex Flow	1.0 L/ha	8.6	8.7*	9.0
10	Sencorex Flow	1.15 L/ha	9.0	9.0	9.0
		p value	<0.001	0.023	N/S
		(18 df) **L.S.D.**	0.8545	1.080	-

Table 19. Average phytotoxicity scores for Quince, assessed 4, 6 and 12 WAT (assessed 24/04/20, 07/05/20 and 20/06/20). Phytotoxicity scale of zero to nine; plants scoring zero considered dead, and nine considered healthy, with those scoring seven or more considered to be of commercially acceptable quality. NS = no significant differences. * Significantly different to untreated.

Trt. No.	Planting	Rate (Kg/ha or L/ha)	Phytotoxicity score 4 weeks	Phytotoxicity score 6 weeks	Phytotoxicity score 12 weeks
1	Untreated	Untreated	9.0	9.0	9.0
2	Sencorex Flow + Sunfire + Stomp Aqua + HDC H47	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 3.75 L/ha	8.3	8.7	9.0
3	Sencorex Flow + Sunfire + Stomp Aqua + HDC H44	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 1.75 L/ha	6.0*	8.3	9.0
4	Sencorex Flow + Sunfire + Stomp Aqua	1.15 L/ha + 0.48 L/ha + 2.9 L/ha	8.7	9.0	9.0
5	Sencorex Flow + Sunfire + Stomp Aqua + - HDC H43	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 2.0	8.7	9.0	9.0
6	Sencorex Flow + Sunfire + Stomp Aqua + HDC H46	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 0.1 L/ha	8.3	8.6	9.0
7	HDC H46	0.1 L/ha	8.7	9.0	9.0
8	Sencorex Flow + Sunfire + Stomp Aqua + HDC 42	1.15 L/ha + 0.48 L/ha + 2.9 L/ha +1.5 L/ha	6.3*	7.7*	9.0
9	Sencorex Flow	1.0 L/ha	9.0	9.0	9.0
10	Sencorex Flow	1.15 L/ha	8.3	8.7	9.0
		p value	<0.001	0.018	N/S
		(18 df) **L.S.D.**	0.8286	0.7157	-

Table 20. Average phytotoxicity scores for Sorbus, assessed 4, 6 and 12 WAT (assessed 24/04/20, 07/05/20 and 20/06/20). Phytotoxicity scale of zero to nine; plants scoring zero considered dead, and nine considered healthy, with those scoring seven or more considered to be of commercially acceptable quality. NS = no significant differences. * Significantly different to untreated.

Trt. No.	Planting	Rate (Kg/ha or L/ha)	Phytotoxicity score 4 weeks	Phytotoxicity score 6 weeks	Phytotoxicity score 12 weeks
1	Untreated	Untreated	9.0	9.0	9.0
2	Sencorex Flow + Sunfire + Stomp Aqua + HDC H47	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 3.75 L/ha	8.6	8.7	9.0
3	Sencorex Flow + Sunfire + Stomp Aqua + HDC H44	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 1.75 L/ha	6.7*	8.3	9.0
4	Sencorex Flow + Sunfire + Stomp Aqua	1.15 L/ha + 0.48 L/ha + 2.9 L/ha	9.0	9.0	9.0
5	Sencorex Flow + Sunfire + Stomp Aqua + - HDC H43	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 2.0	8.7	9.0	9.0
6	Sencorex Flow + Sunfire + Stomp Aqua + HDC H46	1.15 L/ha + 0.48 L/ha + 2.9 L/ha + 0.1 L/ha	9.0	9.0	9.0
7	HDC H46	0.1 L/ha	8.7	8.7	9.0
8	Sencorex Flow + Sunfire + Stomp Aqua + HDC 42	1.15 L/ha + 0.48 L/ha + 2.9 L/ha +1.5 L/ha	7.7*	8.3	9.0
9	Sencorex Flow	1.0 L/ha	9.0	9.0	9.0
10	Sencorex Flow	1.15 L/ha	8.7	8.7	9.0
		p value	<0.001	(NS)	N/S
		(12 d.f.) **L.S.D.**	0.7233	-	-

Appendix 2. Hardy nursery stock container trial (2019). Year 2

Table 21. Average phytotoxicity scores for hardy nursery species, two weeks after March treatment application (assessed 18/03/20). Phytotoxicity scale of zero to nine; plants scoring zero considered dead, and nine considered healthy, with those scoring seven or more considered to be of commercially acceptable quality. NS = no significant differences. * Significantly different to untreated

Species	UTC	HDC Sencorex Flow 1.0 L/Ha	HDC H46	HDC H46 + Devrinol	Devrinol	Sencorex Flow 0.5 L/Ha	Devrinol + Springbok	p value	(d.f. 12) L.S.D.
Berberis thunbergii f. atropurpurea	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Chaenomeles x *superba*	9.0	9.0	6.7*	8.3*	9.0	9.0	9.0	<.001	0.5256
Choisya ternata	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Convolvulus cneorum	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Cotoneaster dammeri	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Cytisus	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Diervilla splendens	9.0	6.7*	5.7*	5.3*	6.7*	6.3*	7.3*	0.004	1.504
Escallonia	9.0	9.0	8.7	9.0	9.0	9.0	9.0	(NS)	-
Hebe x *franciscana*	9.0	9.0	9.0	9.0	9.0	9.0	8.0*	0.050	0.6724
Hypericum	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Lavandula vera	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Lavateria Hybrida	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Ligustrum ovifolium	9.0	7.3*	6.7*	8.0	8.0	7.7*	7.7*	0.012	1.027
Pachysandra terminalis	9.0	5.3*	8.0	6.0*	6.3*	8.0	8.0	<0.001	1.268
Photinia x *fraseri*	9.0	5.3*	3.3*	5.3*	6.3*	6.7*	6*	<0.001	0.938
Potentilla fruticosa	9.0	9.0	8.0	9.0	9.0	9.0	9.0	(NS)	-
Pyracantha	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Santolina chamaecyparissus	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Senecio compacta	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Vinca minor	9.0	8.7	8.7	9.0	9.0	9.0	9.0	(NS)	-

Table 22. Average phytotoxicity scores for hardy nursery species, six weeks after March treatment application (assessed 17/04/20). Phytotoxicity scale of zero to nine; plants scoring zero considered dead, and nine considered healthy, with those scoring seven or more considered to be of commercially acceptable quality. NS = no significant differences. * Significantly different to untreated

Species	**UTC**	**HDC Sencorex Flow 1.0 L/Ha**	**HDC H46**	**HDC H46 + Devrinol**	**Devrinol**	**Sencorex Flow 0.5 L/Ha**	**Devrinol + Springbok**	**p value**	**(d.f. 12) L.S.D.**
Berberis thunbergii f. *atropurpurea*	9.0	9.0	8.7	9.0	9.0	9.0	9.0	(NS)	-
Chaenomeles x *superba*	9.0	9.0	7.0*	8.0*	9.0	8.7*	8.7*	0.002	0.839
Choisya ternata	9.0	9.0	9.0	8.7	9.0	9.0	9.0	(NS)	-
Convolvulus cneorum	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Cotoneaster dammeri	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Cytisus	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Diervilla splendens	9.0	8.0	6.0*	5.7*	7.3*	6.7*	8.3	<0.001	1.075
Escallonia	9.0	9.0	8.7	9.0	9.0	9.0	8.7	(NS)	-
Hebe x *franciscana*	9.0	8.3	9.0	9.0	8.7	6.0*	8.7	0.091	2.138
Hypericum	9.0	8.3	7.7*	8.7	9.0	9.0	9.0	0.009	0.7088
Lavandula vera	9.0	9.0	9.0	8.0	9.0	9.0	9.0	(NS)	-
Lavateria Hybrida	9.0	8.0*	6.3*	6.3*	9.0	8.7*	9.0	<0.001	0.7088
Ligustrum ovifolium	9.0	7.7*	7.7*	6.3*	8.7	8.3	8.0	0.006	1.143
Pachysandra terminalis	9.0	6.3*	8.7	7.7*	7.0*	8.3	9.0	0.003	1.238
Photinia x *fraseri*	9.0	7.0*	4.7*	4.7*	6.7*	8.7	7.7	<0.001	1.326
Potentilla fruticosa	9.0	9.0	9.0	9.0	9.0	8.0	8.67	(NS)	-
Pyracantha	9.0	9.0	8.3	9.0	9.0	9.0	9.0	(NS)	-
Santolina chamaecyparissus	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Senecio compacta	9.0	8.6	9.0	9.0	9.0	9.0	9.0	(NS)	-
Vinca minor	9.0	7.0*	7.7*	6.2*	8.7	6.3*	8.3	<0.001	1.038

Table 23. Average phytotoxicity scores for hardy nursery species, twelve weeks after March treatment application (assessed 29/05/20). Phytotoxicity scale of zero to nine; plants scoring zero considered dead, and nine considered healthy, with those scoring seven or more considered to be of commercially acceptable quality. NS = no significant differences. * Significantly different to untreated

Species	UTC	HDC Sencorex Flow 1.0 L/Ha	HDC H46	HDC H46 + Devrinol	Devrinol	Sencorex Flow 0.5 L/Ha	Devrinol + Springbok	p value	d.f. 12) L.S.D.
Berberis thunbergii f. *atropurpurea*	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Chaenomeles x superba	9.0	9.0	7.3*	8.3	9.0	9.0	8.7	0.020	0.977
Choisya ternata	9.0	9.0	9.0	8.7	9.0	9.0	9.0	(NS)	-
Convolvulus cneorum	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Cotoneaster dammeri	9.0	9.0	9.0	9.0	8.7	8.7	9.0	(NS)	-
Cytisus	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Diervilla splendens	9.0	8.7	7.7*	8.0*	7.7*	7.3*	9.0	0.003	0.824
Escallonia	9.0	9.0	9.0	8.7	9.0	9.0	9.0	(NS)	-
Hebe x *franciscana*	9.0	6.3*	4.7*	4.7*	8.3	4.7*	7.3	<0.001	1.821
Hypericum	9.0	9.0	7.3*	8.7	8.7	9.0	8.7	(NS)	-
Lavandula vera	9.0	9.0	9.0	8.0	9.0	7.0*	9.0	(NS)	-
Lavateria Hybrida	9.0	9.0	7.3*	8.0*	8.7*	9.0	9.0	0.002	0.7601
Ligustrum ovifolium	9.0	8.7	8.0	8.3	8.3	9.0	9.0	(NS)	-
Pachysandra terminalis	9.0	6.3*	7.7*	6.3*	8.3	7.0*	9.0	<0.001	1.098
Photinia x *fraseri*	9.0	7.3*	6.0*	7.0*	7.0*	7.7	9.0	0.004	1.363
Potentilla fruticosa	9.0	9.0	9.0	9.0	8.7	8.0	8.3	(NS)	-
Pyracantha	9.0	9.0	9.0	8.0*	9.0	9.0	9.0	0.050	0.6724
Santolina chamaecyparissus	9.0	9.0	9.0	9.0	9.0	9.0	9.0	(NS)	-
Senecio compacta	9.0	9.0	9.0	7.7	9.0	9.0	9.0	(NS)	-
Vinca minor	9.0	6.7*	7.7*	7.7*	8.7	8.3	8.3	0.003	0.938

* Significantly different to untreated.

Table 24. Average mean percentage weed cover by treatment and assessment date after March treatment application (assessed 18/03/20, 17/04/20, 29/05/20). NS = no significant differences. * Significantly different to untreated

Assessment date	UTC	HDC Sencorex Flow 1.0L/Ha	HDC H46	HDC H46 + Devrinol	Devrinol	Sencorex Flow 0.5L/Ha	Devrinol + Springbok	p value	(d.f. 12) L.S.D.
2 WAT	7.3	2.2*	2.3*	1.3*	2.8*	4.0*	4.0*	0.017	2.978
6 WAT	9.0	1.8	2.3	1.3	5.8	0.6	1.2	(NS)	-
12 WAT	8.17	0.7*	1.3*	1.2*	1.2*	0.7*	1.2*	<.001	2.490

Appendix 3. Container pot screen (2022)

Table 25. Annual meadow grass percentage control pre (TO) and post emergence (T1 & T2). NS = no significant differences. *Weeds were stunted

Treatment		21 days post treatment (T0)	42 days post treatment (T0)	7 days post treatment (T1)	14 days post treatment (T1)	42 days post treatment (T1)	7 days post treatment (T2)	14 days post treatment (T2)	42 days post treatment (T2)
1	Untreated	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Flexidor	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Dual gold	73.75	74.5*	0.0	11.25	25.0	0.0	3.75	0.0
4	Sencorex Flow at 1.15 L/Ha	86.25	100.0	37.5	100.0	100.0	82.5	97.75	100.0
5	Sencorex Flow at 0.5 L/Ha	90.75	100.0	45.0	100.0	100.0	82.5	97.75	100.0
6	Sunfire	67.5	76.25	0.0	5.0	19.5*	2.5	13.75	33.75
7	HDC H43	98.25	97.0	0.0	5.0	16.25	0.0	0.0	0.0
8	Venzar 500 SC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	p value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	d.f.	21	21	21	21	21	21	21	21
	L.S.D.	25.90	26.03	3.889	7.967	17.51	2.600	3.685	3.271

Table 26. Hairy bittercress percentage control pre (TO) and post emergence (T1 & T2). NS = no significant differences. *Weeds were stunted

Treatment		21 days post treatment (T0)	42 days post treatment (T0)	7 days post treatment (T1)	14 days post treatment (T1)	42 days post treatment (T1)	7 days post treatment (T2)	14 days post treatment (T2)	42 days post treatment (T2)
1	Untreated	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Flexidor	97.0	92.5	62.5*	91.25*	90.75	61.25*	73.75*	66.25*
3	Dual gold	5.0	68.75*	38.75*	47.5*	68.75	30*	33.75*	35.0*
4	Sencorex Flow at 1.15 L/Ha	61.25	100.0	89.5*	100.0	100.0	98.25	100.0	100.0
5	Sencorex Flow at 0.5 L/Ha	61.25	100.0	100.0	100.0	100.0	99.0	100.0	100.0
6	Sunfire	8.75	81.25*	38.33*	31.6*	10.0	76.25*	83.75*	80.5*
7	HDC H43	0.0	36.25*	37.5	15.0*	10.0*	6.25*	15.0*	2.5
8	Venzar 500 SC	0.0	0.0	35.0*	2.5*	2.5	13.3*	18.3*	5.0
	p value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	d.f.	21	21	20	20	20	21	21	21
	L.S.D.	2.546	12	7.758	9.66	7.318	5.345	11.6	16.86

Table 27. Common mouse eared chickweed percentage control pre (TO) and post emergence (T1 & T2). NS = no significant differences. *Weeds were stunted

Treatment		21 days post treatment (T0)	42 days post treatment (T0)	7 days post treatment (T1)	14 days post treatment (T1)	42 days post treatment (T1)	7 days post treatment (T2)	14 days post treatment (T2)	42 days post treatment (T2)
1	Untreated	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Flexidor	91.25	95.0	0.0	0.0	0.0	5.0	6.25	5.0
3	Dual gold	60.0	57.5	0.0	10.0	12.5	7.5*	11.25*	2.5
4	Sencorex Flow at 1.15 L/Ha	99.0	100.0	64.75	100.0	100.0	88.75*	99.0	100.0
5	Sencorex Flow at 0.5 L/Ha	100.0	100.0	67.25	100.0	100.0	90.0*	100.0	100.0
6	Sunfire	35.0	32.5	5.0	18.75*	5.0*	1.25*	12.5*	1.25*
7	HDC H43	28.75	12.5*	21.25	6.25	1.25	5.0*	21.25*	6.88*
8	Venzar 500 SC	20.0	0.0	17.5	23.75*	30.0*	15.0*	31.25*	26.25*
	p value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	d.f.	21	21	21	21	21	21	21	21
	L.S.D.	7.524	15.91	2.882	5.113	9.34	5.042	8.120	4.460

Table 28. Common chickweed percentage control pre (TO) and post emergence (T1 & T2). NS = no significant differences. *Weeds were stunted

Treatment		21 days post treatment (T0)	42 days post treatment (T0)	7 days post treatment (T1)	14 days post treatment (T1)	42 days post treatment (T1)	7 days post treatment (T2)	14 days post treatment (T2)	42 days post treatment (T2)
1	Untreated	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Flexidor	98.5	100.0	25.0*	56.25*	25.0*	10.0*	60.0*	35.0*
3	Dual gold	75.0	57.2	20.0*	76.25	38.75	7.5*	8.75*	15.0*
4	Sencorex Flow at 1.15 L/Ha	99.0	100.0	91.75*	100.0	100.0	100.0	100	100.0
5	Sencorex Flow at 0.5 L/Ha	94.0	92.5	88.75*	100.0	100.0	99.5	100	100.0
6	Sunfire	2.5	0.0	0.0	5.0*	0.0	10.0*	16.25*	11.25*
7	HDC H43	78.75	15.0	50.0*	82.5*	60.0	18.75*	16.25*	5.0*
8	Venzar 500 SC	53.75	2.5	32.5*	67.5*	27.5	5.0*	21.25*	21.25*
	p value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	d.f.	21	21	21	21	21	21	21	21
	L.S.D.	18.82	9.97	11.09	11.99	36.48	5.220	11.78	22.97

Table 29. American willowherb percentage control pre (TO) and post emergence (T1 & T2). NS = no significant differences. *Weeds were stunted

Treatment		21 days post treatment (T0)	42 days post treatment (T0)	7 days post treatment (T1)	14 days post treatment (T1)	42 days post treatment (T1)	7 days post treatment (T2)	14 days post treatment (T2)	42 days post treatment (T2)
1	Untreated	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Flexidor	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Dual gold	27.5	95.25*	0.0	12.5	41.25*	3.75	6.25*	12.5*
4	Sencorex Flow at 1.15 L/Ha	98.5	100.0	97.0	100	100	100	100	100
5	Sencorex Flow at 0.5 L/Ha	99.5	100.0	96.0	100.0	100.0	100.0	100.0	100.0
6	Sunfire	23.75	94.5*	0.0	81.25*	85.0*	13.75*	65.0*	80.0*
7	HDC H43	12.5	85.0*	0.0	35.0*	43.75*	6.25*	6.25*	5.0
8	Venzar 500 SC	0.0	0.0	0.0	43.75	46.25*	38.75*	48.75*	70*
	p value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	d.f.	21	21	21	21	21	21	21	21
	L.S.D.	7.066	3.072	1.002	17.51	21.67	10.87	17.01	13.00

Table 30. Groundsel percentage control pre (TO) and post emergence (T1 & T2). *****Weeds were stunted

Treatment		21 days post treatment (T0)	42 days post treatment (T0)	7 days post treatment (T1)	14 days post treatment (T1)	42 days post treatment (T1)	7 days post treatment (T2)	14 days post treatment (T2)	42 days post treatment (T2)
1	Untreated	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Flexidor	77.5	55.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Dual gold	53.75	43.75*	0.0	5.0*	2.5	3.75*	6.25*	7.5*
4	Sencorex Flow at 1.15 L/Ha	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
5	Sencorex Flow at 0.5 L/Ha	100.0	100.0	99.5	100.0	100.0	100.0	100.0	100.0
6	Sunfire	75.75	62.5*	0.0	7.5*	1.25	2.5	6.25*	2.5
7	HDC H43	72.5	65.0*	0.0	3.75*	7.5	1.25	5.0*	0.0
8	Venzar 500 SC	46.25	21.25	0.0	16.25	10.0	12.5*	27.5*	13.75
	p value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	d.f.	21	21	21	21	21	21	21	21
	L.S.D.	33.72	29.84	0.5199	6.240	6.976	4.467	7.309	6.090

Table 31. Sow thistle percentage control pre (TO) and post emergence (T1 & T2). NS = no significant differences. *Weeds were stunted.

Treatment		21 days post treatment (T0)	42 days post treatment (T0)	7 days post treatment (T1)	14 days post treatment (T1)	42 days post treatment (T1)	7 days post treatment (T2)	14 days post treatment (T2)	42 days post treatment (T2)
1	Untreated	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Flexidor	94.25	88.25	23.75*	7.5	0	10.0	20.0*	3.75
3	Dual gold	85.0	94.25*	23.75*	8.75*	1.25	17.5*	31.25*	75.0*
4	Sencorex Flow at 1.15 L/Ha	100.0	100.0	88.75	100.0	100.0	99.5	100.0	100.0
5	Sencorex Flow at 0.5 L/Ha	100.0	100.0	92.75	100.0	100.0*	100.0	100.0	100.0
6	Sunfire	80.0	86.25*	0.0	2.5*	13.75*	6.66*	20*.0	28.75*
7	HDC H43	83.75	94.5	35.0*	22.5*	73.75*	23.75*	36.25*	37.5*
8	Venzar 500 SC	50.0	0.0	7.5	56.25	57.5*	40*	79.5*	82.5
	p value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	d.f.	21	21	21	21	21	21	21	21
	L.S.D.	6.20	9.49	8.83	13.41	16.53	13.60	19.34	28.15

Table 32. Pearlwort percentage control pre (TO) and post emergence (T1 & T2). NS = no significant differences. *Weeds were stunted

Treatment		21 days post treatment (T0)	42 days post treatment (T0)	7 days post treatment (T1)	14 days post treatment (T1)	42 days post treatment (T1)	7 days post treatment (T2)	14 days post treatment (T2)	42 days post treatment (T2)
1	Untreated	Only just emerging	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Flexidor	No emergence	100.0	0.0	0.0	38.75	0.0	0.0	10.0
3	Dual gold	Some emergence	99.5	11.3*	16.3*	70.0*	0.0	0.0	11.4
4	Sencorex Flow at 1.15 L/Ha	Some emergence	100.0	5.0*	11.3	100.0	0.0	11.3	100.0
5	Sencorex Flow at 0.5 L/Ha	Some emergence and control	100.0	10.0	15.0	100.0	0.0	5.0	100.0
6	Sunfire	Emerging	80.0*	1.25	7.5*	83.75	0.0	0.0	2.5
7	HDC H43	No emergence	100	0.0	5.0	15.0	0.0	0.0	12.5
8	Venzar 500 SC	Emerging	7.5	0.0	0.0	0.0	0.0	0.0	0.0
	p value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	d.f.	21	21	21	21	21	21	21	21
	L.S.D.	7.524	15.19	2.882	5.113	9.34	5.042	8.120	4.460