Grower Summary

HNS/PO 192

Herbicide screening for ornamental plant production (nursery stock, cut flowers and wallflowers)

Final 2015

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Further information

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Project Number:	HNS PO 192
Project Title:	Herbicide screening for ornamental plant production (nursery stock, cut flowers and wallflowers)
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Grower Summary Cut Flower Trials

Grower Summary Cut Flower Trials – Headlines

- A range of herbicides were tested for crop safety on four key cut-flower crops and wallflowers grown at the Cut Flower Centre, Holbeach St. Johns.
- Results from this trial have highlighted some promising treatments including benfluralin on drilled crops, which would help growers in this industry considerably.

Background

The UK outdoor flower crop area is approximately 800 ha. The UK demand for cut-flowers is growing rapidly, and the production of flowers in the field provides a significant business development opportunity for UK growers. There are no specific on-label herbicide recommendations for outdoor flower crops, which in many cases means growers have to rely on hand-weeding and cultivation, which is expensive and unreliable in wet conditions, or on off-label herbicide usage through EAMUs. The recent loss of Ronstar Liquid and other products containing oxadiazon presents particular problems for sweet william growers who have come to rely on this herbicide.

AHDB (Horticulture) has previously funded herbicide trials on outdoor cut-flowers, with specific studies on the major crops; *Chrysanthemum*, larkspur and sweet william (BOF 29, 30 and 40 respectively) and in 2003-5, a multi-screen study on *Bupleurum*, China aster, cornflower, *Delphinium*, larkspur, love–in–a-mist, *Phlox*, snapdragon, column stocks and *Zinnia* (BOF 51) which followed and further developed an earlier Defra-funded project on tunnel-grown flowers (HH1528SPC). In 2005-7 a further study (BOF 58) was carried out specifically on lilies, however, the recommended treatments are not approved on protected crops. Projects BOF 51, BOF 58 and HH1528SPC provided information on a range of treatments that could be employed by growers at the time, however, following the loss of key herbicide active ingredients such as oxadiazon (Ronstar Liquid), chlorthal-dimethyl (Dacthal W-75) and propachlor (Ramrod) and the impending loss of linuron, it is necessary to find more options for cut-flower and wallflower growers.

In addition, new herbicide actives such as s-metolachlor (Dual Gold), dimethenamid-p (components of Wing-P and Springbok), HDC H22 and benfluralin have become available or are being developed for the UK arable or vegetable market and could be of value for cut-flower crops or wallflowers but need full evaluation on a range of flower crop species.

Some information on weed control spectra is already available for the herbicides to be tested on flower crops from the SCEPTRE project CP 077 vegetable herbicide screening and from project BOF 73 which studied herbicides suitable for narcissus production.

Summary

Work was carried out at the Cut Flower Centre in Holbeach St. Johns, between May and September 2014. A range of herbicides were tested either alone, or in combination, for crop safety on five flower species; drilled China aster (*Callistephus chinensis*; Compositae), transplanted China aster (*Callistephus chinensis*; Compositae), lily (*Lilum spp*; Liliaceae), drilled sweet william (*Dianthus barbartus*; Caryophyllacae) and drilled wallflower (*Erysimum cheiri*; Cruciferae). **Table 1** shows the herbicides used, along with their approval status. Rates of use were at normal maximum approved rates, except for the following where rates were reduced based on previous experience; Devrinol 5.0 L/ha for lily and wallflowers, Gamit 36 CS 0.05 L/ha for sweet william and Butisan S 1.0 L/ha for lily and wallflowers. Each flower species was a trial in its own right, and each trial was fully randomised, with three replicates. A total of 10 treatments were used in each trial. Herbicide treatments covered pre- and post-emergence timings for direct drilled crops, and pre- and post-transplanting (pre- and post-weed-emergence) timings for transplanted crops. Treatment combinations are shown in **Table 2** (drilled crops), **Table 3** (transplanted China aster) and **Table 4** (Lily grown from bulbs).

Table 1. Products used during the trial - 2014

Product	Active	Rate kg/ha or L/ha	Approval status
Benfluralin	60% w/w benfluralin	2	Not approved
Butisan S	500 g/L metazachlor	1	Label[1]
Butryflow	401.58 g/L bromoxynil	1	EAMU outdoor
Defy	800 g/L prosulfocarb	5	EAMU outdoor[2]
Devrinol	450 g/L napropamide	5	EAMU outdoor and protected
Dual Gold	960 g/L s-metolachlor	0.78	EAMU outdoor[3]
Flexidor 125	125 g/L isoxaben	2	Label[4]

Product	Active	Rate kg/ha or L/ha	Approval status
Gamit 36 CS	360 g/L clomazone	0.25[5]	EAMU outdoor
HDC H22	confidential	X	Not approved
HDC H24	confidential	X	Not approved
HDC H28	confidential	X	EAMU outdoor[2]
HDC H31	confidential	X	LTAEU outdoor
Kerb Flo 400	400 g/L propyzamide	4.25	Not approved
Nirvana	250 g/L pendimethalin + 16.7 g/L imazamox	4.5	EAMU outdoor
Shark	60 g/L carfentrazone ethyl	0.33	EAMU outdoor and protected
Stomp Aqua	455 g/L pendimethalin	2	EAMU outdoor
Wing-P	250 g/L pendimethalin + 212.5 g/L dimethenamid-p	3.5	EAMU outdoor[2]

[1]Label only covers use on outdoor trees and shrubs but other ornamentals may be treated outdoors at grower's risk. Other formations of metazachlor can be used under protection providing the label does not specifically exclude such use.

[2]Pre-emergence only

[3]Use only permitted during May

[4]Label only covers use on trees and shrubs but other ornamentals may be treated indoors and outdoors at grower's risk.

[5]Rate was reduced to 0.05 L/ha in the sweet william trial

Table 2. Drilled crop treatments all post-drilling and pre-emergence unless stated – Cut Flower Centre summer 2014

Herbicide	**China aster**	**Sweet william**	**Wallflower**
Defy (prosulfocarb)	✓	✓	
Devrinol (napropamide) (pre-drill incorporation)		✓	✓
Dual Gold (s-metolachlor)	✓		✓
HDC H22 (confidential)	✓	✓	✓
Benfluralin (pre-drill incorporation)	✓	✓	✓
Benfluralin (pre-drill incorp) followed by Butisan S (metazachlor)			✓
Benfluralin (pre-drill incorp) followed by Dual Gold (s-metolachlor)	✓		✓
Benfluralin (pre-drill incorp) followed by Gamit 36 CS (clomazone)			✓
Kerb Flo 400 (propyzamide)	✓		
Nirvana (pendimethalin + imazamox)	✓	✓	
Shark (carfentrazone ethyl) (post-emergence)	✓	✓	
Stomp Aqua (pendimethalin)		✓	✓
Stomp Aqua (pendimethalin) + Gamit 36 CS (clomazone)	✓	✓	✓
Wing-P (pendimethalin + dimethenamid-p)		✓	
Untreated control	✓	✓	✓

Table 3. Transplanted China aster treatments all applied post-planting and pre-emergence of weeds unless stated – Cut Flower Centre summer 2014

Herbicide
Defy (prosulfocarb) (pre-plant)
HDC H22 (confidential)
Benfluralin (pre-plant incorporation)
Benfluralin (pre-plant incorporation) followed by Dual Gold (s-metolachlor)
Kerb Flo 400 (propyzamide) (pre-plant)
Stomp Aqua (pendimethalin)
Stomp Aqua (pendimethalin) + Dual Gold (s-metolachlor)
Stomp Aqua (pendimethalin) + Gamit 36 CS (clomazone)
HDC H31 (confidential) + Dual Gold (s-metolachlor)
Untreated control

Table 4. Lily treatments all applied post-planting and pre-emergence of weeds unless stated -– Cut Flower Centre summer 2014

Herbicide
Devrinol (napropamide) (pre-plant incorporation)
Devrinol (napropamide) (pre-plant incorporation) followed by Flexidor 125 (isoxaben)
Devrinol (napropamide) (pre-plant incorporation) followed by Flexidor 125 (isoxaben) + Butisan S (metazachlor)
Flexidor 125 (isoxaben) + Butisan S (metazachlor)
HDC H24 (confidential) + HDC H31 (confidential)
HDC H28 (confidential) + Stomp Aqua (pendimethalin)
HDC H28 (confidential) + Stomp Aqua (pendimethalin) + Gamit 36 CS (clomazone)
HDC H28 (confidential) + Stomp Aqua (pendimethalin) + HDC H31 (confidential)
HDC H28 (confidential) + Stomp Aqua (pendimethalin) followed by Butryflow (bromoxynil)
Untreated control

Trials were assessed for phytotoxicity symptoms approximately two, six and 10 weeks from sowing or transplanting. Drilled crops were also assessed for emergence. A weed assessment was carried out on each trial. The height and weight of the transplanted China aster and the lily stems was assessed at harvest to see if there were any significant differences between treatments.

Tables 5 – 9, below, show the final phytotoxicity score for each treatment 10 weeks after treatment (WAT), the average number of emerged seedlings per plot for drilled crops, and the percentage weed cover, to give an overall summary for each treatment.

Drilled China aster

For the drilled China aster crop (**Table 5**), Benfluralin (T5) and Kerb Flo 400 (T7) plots had the best crop emergence and minimal phytotoxicity. Dual Gold had the least phytotoxicity on emerged seedlings and good weed control, although emergence was reduced compared to other treatments in the trial. Benfluralin, Kerb Flo 400 and Nirvana (T8) all looked acceptable treatments overall, although weed control was not as good for Benfluralin. There was some initial damage from Shark (T9), which was applied post-emergence, but the plants quickly grew away from this, which makes Shark a possibility for use as a selective contact treatment in drilled China asters. Stomp Aqua + Gamit 36 CS has previously been used on China aster in BOF 51 and was considered safe, but in this trial, emergence was reduced. The plants looked healthy, so it is possible that this treatment could be reconsidered if the application rate was reduced. HDC H22 was the most phytotoxic treatment and emergence was greatly reduced.

Table 5. Drilled China aster - Mean scores for phytotoxicity 10 WAT, number of emerged seedlings per plot and percentage weed cover - 2014

Treatment	**Phytotoxicity 10 WAT**	**Emergence (seedling no.)**	**% weed cover (assessed 20.06.14)**
1. Untreated	9.0	34.7	18.3
2. Untreated / Defy	**7.3**	14.3	**7.3**
3. Untreated / Dual Gold	8.0	21.3	**7.0**
4. Untreated / HDC H22	**6.0**	**2.3**	**2.3**
5. Benfluralin / Untreated	7.7	35.7	16.7
6. Benfluralin / Dual Gold	**7.0**	**8.0**	**8.3**
7. Untreated / Kerb Flo 400	7.7	32.7	**8.0**

Treatment	Phytotoxicity 10 WAT	Emergence (seedling no.)	% weed cover (assessed 20.06.14)
8. Untreated / Nirvana	**7.3**	24.3	**4.3**
9. Untreated / Shark (post-emergence)	**7.0**	41.3	12.7
10. Untreated / Stomp Aqua + Gamit 36 CS	**7.3**	16.7	**5.0**

Figures in **bold** show statistical significance at the 95% level compared with the untreated

Transplanted China aster

In the transplanted China aster crop (**Table 6**), very little phytotoxicity was seen from any of the treatments. There was some yellowing of foliage and stunting of plants noted two weeks after treatment, from Defy (T2), Benfluralin / Dual Gold (T5) and HDC H31 + Dual Gold (T10), but the plants grew away from this. At the harvest assessment, all treatments exceeded the 60 cm height specification, and there was very little difference in weight between any of the treatments. Benfluralin / Dual Gold produced both the heaviest and shortest stems, whilst still being above the 60 cm height spec, meaning that to produce a weighted bunch, less stems would be needed.

Table 6. Transplanted China aster - Mean phytotoxicity 10 WAT and percentage weed cover - 2014

Treatment	Phytotoxicity 10 WAT	% weed cover (10 WAT)
1. Untreated	9.0	10.0
2. Defy / untreated	8.3	17.7
3. Untreated / HDC H22	8.7	12.7
4. Benfluralin / untreated	8.7	9.0
5. Benfluralin / Dual Gold	8.3	2.7
6. Kerb Flo 400 / untreated	9.0	4.3
7. Unt / Stomp Aqua	8.7	5.7
8. Unt / Stomp Aqua + Gamit 36 CS	**8.0**	10.0
9. Unt / Stomp Aqua + Dual Gold	8.7	6.7

Treatment	Phytotoxicity 10 WAT	% weed cover (10 WAT)
10. Untreated/ HDC H31 + Dual Gold	8.7	21.7

Figures in **bold** show statistical significance at the 95% level compared with the untreated

Lily

Two varieties were used in the lily trial, 'Dynamite' and 'White Triumph'. 'Dynamite' showed slightly more phytotoxicity than 'White Triumph' from most treatments, but they grew away from it by harvest (**Table 7**). All treatments were safe on 'White Triumph'. At the harvest assessment, stems of 'Dynamite' were shorter and lighter than 'White Triumph', but there was little difference between treatments for the two varieties. Height and weight were reduced in both varieties by Devrinol / Flexidor 125 + Butisan S (T4).

Table 7. Lily - Mean phytotoxicity 10 WAT for both varieties and percentage weed cover - 2014

Treatment	Phytotoxicity 10 WAT 'Dynamite'	Phytotoxicity 10 WAT 'White Triumph'	% weed cover 5 WAT
1. Untreated	9.0	9.0	21.7
2. Devrinol / untreated	**7.3**	**8.0**	**5.3**
3. Devrinol / Flexidor 125	**7.0**	**7.7**	**4.3**
4. Devrinol / Flexidor 125 + Butisan S	**7.0**	**7.7**	**0.7**
5. Untreated / Flexidor 125 + Butisan S	**6.7**	**7.3**	**2.7**
6. Untreated / HDC H28 + Stomp Aqua	**7.0**	**8.0**	**2.7**
7. Untreated / HDC H28 + Stomp Aqua + HDC H31	**7.3**	**8.0**	**0.3**
8. Untreated / HDC H28 + Stomp Aqua + Gamit 36 CS	**7.3**	**7.7**	**1.3**
9. Untreated / HDC H28 + Stomp Aqua followed by Butryflow post-emergence	**7.3**	**8.0**	25.0
10. Untreated / HDC H24 + HDC H31	**7.7**	**7.7**	**1.7**

Figures in **bold** show statistical significance at the 95% level compared with the untreated

Sweet william

In the drilled sweet william crop (**Table 8**), Defy (T2) and Benfluralin (T5) were generally safe, with minimal effect on emergence, although there was some slight phytotoxicity from Defy. Devrinol (T3) also showed minimal phytotoxicity although emergence was reduced by this treatment and a subsequent small scale trial confirmed the risk of poor emergence from the use of Devrinol. There was some initial damage from Shark (T7), which was applied post-emergence, with scorching of leaves, but the plants recovered well from this, making Shark a possibility for use in sweet william production. HDC H22 (T4), Nirvana (T6), Stomp Aqua (T8), Stomp Aqua + Gamit 36 CS (T9) and Wing-P (T10), all reduced emergence and were also phytotoxic to emerged plants.

Table 8. Drilled sweet william - Mean phytotoxicity 10 WAT, number of emerged seedlings per plot and percentage weed cover - 2014

Treatment	**Phytotoxicity 10 WAT**	**Emergence (seedling no.)**	**% weed cover 3 WAT**
1. Untreated	9.0	75.3	12.7
2. Untreated / Defy	6.0	54.7	10.7
3. Devrinol / untreated	7.0	37.0	9.0
4. Untreated / HDC H22	**3.7**	**7.7**	**3.7**
5. Benfluralin / untreated	7.7	58.3	9.7
6. Untreated / Nirvana	**3.0**	**17.3**	**2.0**
7. Untreated / Shark post-emergence	6.7	70.7	13.3
8. Untreated / Stomp Aqua	**3.3**	**10.0**	**5.0**
9. Untreated / Stomp Aqua + Gamit 36 CS	**4.0**	**16.0**	**3.7**
10. Untreated / Wing-P	**3.7**	**5.0**	**0.7**

Figures in **bold** show statistical significance at the 95% level compared with the untreated

Drilled wallflower

In the drilled wallflower crop, Benfluralin (T5), Benfluralin / Butisan S (T6), Stomp Aqua (T9) and Stomp Aqua + Gamit 36 CS (T10) all look promising, with little phytotoxic damage, and minimal effect on emergence (**Table 9**). Weed control was fair in most treatments, although slightly poorer in treatments 8 and 10. HDC H22 (T4) was the most phytotoxic treatment and reduced emergence. Devrinol (T2) and Dual Gold (T3) also showed some phytotoxicity and emergence was reduced by Devrinol. Benfluralin / Dual Gold (T7) and Benfluralin / Gamit 36 CS (T8) both reduced emergence.

Table 9. Drilled wallflower - Mean phytotoxicity 10 WAT, number of emerged seedlings per plot and % weed cover - 2014

Treatment	**Phytotoxicity 10 WAT**	**Emergence (seedling no.)**	**% weed cover 3 WAT**
1. Untreated	9.0	30.7	7.7
2. Devrinol / untreated	**6.7**	12.3	4.7
3. Untreated / Dual Gold	**6.7**	21.3	7.3
4. Untreated / HDC H22	**6.0**	16.0	4.0
5. Benfluralin / untreated	7.3	34.0	8.0
6. Benfluralin / Butisan S	7.0	31.3	9.3
7. Benfluralin / Dual Gold	7.3	15.0	7.7
8. Benfluralin / Gamit 36 CS	7.7	21.7	11.0
9. Untreated / Stomp Aqua	7.7	29.0	7.7
10. Untreated / Stomp Aqua + Gamit 36 CS	7.3	27.7	11.0

Figures in **bold** show statistical significance at the 95% level compared with the untreated

Conclusions

Overall, HDC H22 proved to be highly phytotoxic to drilled crops, as well as reducing emergence, and therefore is not suitable for use as an herbicide in drilled ornamental crops, although it would be safer in transplanted crops. Benfluralin looks promising, with good seedling emergence and little phytotoxicity on drilled crops or transplanted asters. Shark is a possible selective contact treatment, with China aster and sweet william recovering from initial damage. All treatments used on lily and transplanted China asters were safe, with

minimal effect on stem height and weight. Stomp Aqua + Gamit 36 CS looked particularly promising on drilled wallflower, and are already authorised for use on ornamentals under EAMU and LTAEU respectively.

Financial Benefits

An increase in the options available for weed control will enable growers to produce outdoor cut-flowers without excessive hand or mechanical weeding costs currently estimated at around £2000 per ha. Finding herbicides suitable for use on a crop of drilled China asters would benefit growers, as although the crop is not commercially drilled at the moment, the development of an herbicide which would enable growers to grow in this way, would provide a significant cost saving compared with the cost of producing a transplanted crop. Having more herbicides available for weed control would be beneficial to all cut-flower growers as weed control is a continual hindrance across this industry.

Action Points

- Nirvana was fairly safe on drilled asters and has an EAMU for ornamental plant production, a reduced rate could therefore be tried to avoid reduction in emergence.
- Kerb Flo 400 was safe and effective on drilled aster and could be useful on other drilled compositae flowers, therefore an EAMU should be applied for to enable pre-emergence use in ornamental plant production.
- Stomp Aqua was safe to use on transplanted asters, and the addition of Gamit 36 CS or Dual Gold was also safe.
- All treatments used in the Lily trial were safe and apart from HDC H24, all can be used on the outdoor crop.
- Flexidor 125 + Metazachlor or Devrinol incorporated followed by Flexidor 125 are suitable treatments that are authorised for use under protection for lilies. EAMUs would be needed to enable HDC H28, HDC H31, Butryflow, Gamit 36 CS and Stomp Aqua to be used under protection.
- Defy was safe in terms of emergence on drilled sweet william but there was some phytotoxicity. A small follow up trial indicated that reduced rates should be tried.
- Stomp Aqua with or without Gamit 36 CS was safe on drilled wallflower and emergence was good with these treatments.

- Benfluralin proved to be safe and effective for all drilled crops tested in this trial, therefore an EAMU should be applied for to enable pre-emergence use in ornamental plant production.