Project title:	Herbicide screening for ornamental plant production (nursery stock, cut flowers and wallflowers)
Project number:	HNS PO 192
Project leader:	John Atwood, ADAS
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Key staff:	John Atwood, Harriet Roberts, David Talbot, Emma Worrall, Chloe Whiteside,
Location of project:	Darby Nursery Stock Ltd, Norfolk. Hawkesmill Nursery c/o Webbs of Wychbold, Worcs. Cut Flower Centre, Lincs.
Industry Representative:	Mark Cade, Coles Nurseries, Leics.
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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.

John Atwood

Principal Horticultural Consultant

ADAS UK Ltd.

Signature Date 5 December 2014

Report authorised by:

Barry Mulholland

Head of Horticulture

ADAS UK Ltd.

Signature Date 5 December 2014

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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.

The HDC 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]

Product	Active	Rate kg/ha or L/ha	Approval status
Flexidor 125	125 g/L isoxaben	2	Label[4]
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**

Treatment	Phytotoxicity 10 WAT	Emergence (seedling no.)	% weed cover (assessed 20.06.14)
7. Untreated / Kerb Flo 400	7.7	32.7	**8.0**
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

Treatment	Phytotoxicity 10 WAT	% weed cover (10 WAT)
9. Unt / Stomp Aqua + Dual Gold	8.7	6.7
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

Treatment	Phytotoxicity 10 WAT 'Dynamite'	Phytotoxicity 10 WAT 'White Triumph'	% weed cover 5 WAT
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.

Science Section Cut flower trials

Science Section Cut flower trials - Introduction

There are currently no on-label herbicide recommendations for outdoor flower crops, which 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 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. However, the lack of technical information for the wide diversity of traditional and novel species being grown is a major factor limiting expansion of the sector. With improved knowledge, either the cost of ineffective treatments would be saved, or treatments that were effective would result in labour saving (reduced hand weeding) and a better quality crop. The recent loss of Ronstar Liquid for sweet williams growers has made the need to develop new treatments more urgent.

The aim of this project was to develop new herbicide options for ornamental plant growers in order to achieve effective, economic weed control with minimal crop damage. The products used in this trial are listed in Table 1. Ten new herbicide treatments were tested either alone, or in combinations, for crop safety on five flower species (three drilled, one transplanted and one bulb). Herbicide trials were carried out at the Cut Flower Centre, Holbeach St Johns, which is a site local to a large part of UK outdoor flower growing.

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]	LTAEU 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 Williams trial

Species 1: Drilled China aster

Materials and methods

The trial was carried out on a crop of drilled China aster, variety Matsumoto, at the Cut Flower Centre between May and July 2014. The crop was grown on a Lincolnshire silt. The trial was a fully randomised block design with 10 treatments, including an untreated control (**Table 1.1**), replicated three times. Each plot was 3 m long and 1.2 m wide and consisted of four rows of plants.

Table 1.1 Detail of herbicide treatments applied pre or post drilling to China aster seed - 2014

Trt no.	Pre – drilling	Rate kg/ha or L/ha	Post drilling	Rate kg/ha or L/ha
1	Untreated	-	Untreated	-
2	Untreated	-	Defy	5
3	Untreated	-	Dual Gold	0.78
4	Untreated	-	HDC H22	X
5	Benfluralin (incorp)	2	Untreated	-
6	Benfluralin (incorp)	2	Dual Gold	0.78
7	Untreated	-	Kerb Flo 400	4.25
8	Untreated	-	Nirvana	4.5
9	Untreated	-	Shark (post em of crop & weeds)	0.33
10	Untreated	-	Stomp Aqua + Gamit 36 CS	2 + 0.25

Prior to drilling, the site was marked out and the pre-drilling treatments were applied on 16 May 2014. The treatments were applied to the soil using an OPS sprayer and a 1 m single nozzle lance with an 02f110 nozzle, to achieve a medium spray quality at 200 L/ha. Treatments five and six were then incorporated into the soil using a rake, and were lightly irrigated.

The trial was drilled on 17 May 2014, and the post–drilling treatments were applied on 20 May 2014 to slightly damp soil. The same sprayer and lance were used, to achieve a medium spray quality at 200 L/ha. All treatments were lightly irrigated afterwards, and the trial was covered with clear polythene. The polythene was removed on 1 June, as plants began to emerge.

Treatment nine, a contact acting herbicide, was applied on 30 June 2014, once weeds had emerged and the crop was at four true leaves. The same spray equipment and water volume were used.

The trial was assessed at five, seven and 10 weeks after treatment (20 June, 7 July and 25 July 2014 respectively). Phytotoxicity was assessed on each plot, using a scale of zero to nine, whereby nine showed no effect, seven was commercially acceptable damage, one was a very severe effect and zero was plant death. Plots were also assessed for the number of emerged asters and percentage weed cover on 20 June 2014. Plots were then hand weeded to prevent competition between weeds and the crop. Data was analysed by ANOVA.

Results

HDC H22 applied post-drilling (T4) was the most phytotoxic treatment, with plants consistently scoring below the commercial standard of seven. Typical symptoms consisted of yellowing to foliage. At the first assessment, five weeks after treatment (WAT), Defy applied post-drilling (T2) also showed signs of phytotoxicity, with slight yellowing and distortion to plants (**Figure 1.1**).

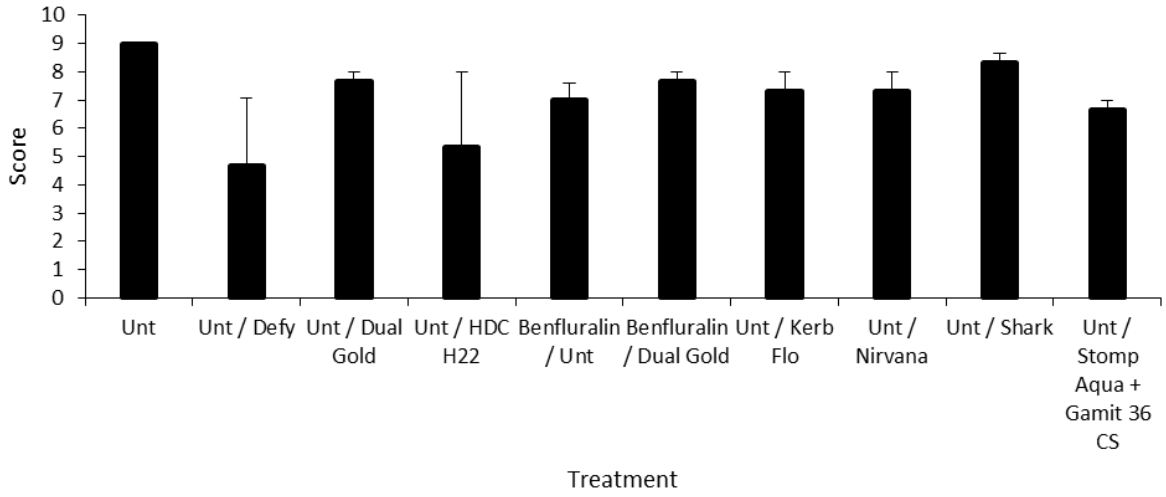

Figure 1.1. Phytotoxicity scores for each treatment 5 WAT – Drilled China asters 20 June 2014

At the second assessment seven WAT, plots treated with Benfluralin pre-drilling, followed by Dual Gold (T6), were beginning to show signs of phytotoxicity, with yellowing and distortion to leaves, and some scorch to leaf edges. However, plants treated with Defy (T2), had recovered well and grown away from their original symptoms.

Treatment nine was applied on 30 June, and initially this had a significant impact on the plants, with yellowing and speckling of foliage, and some scorch to leaf edges seen one week

after application. However, at the final assessment on 25 July, these plants were beginning to recover, although there was still some leaf yellowing present (**Figure 1.2**). At the final assessment, 10 WAT, all treatments apart from HDC H22 were commercially acceptable, scoring 7 or above (**Figure 1.3**).

Figure 1.2. (LHS) Drilled China asters plants one week after being treated over the foliage with Shark (30 June) and (RHS) showing recovery three weeks later.

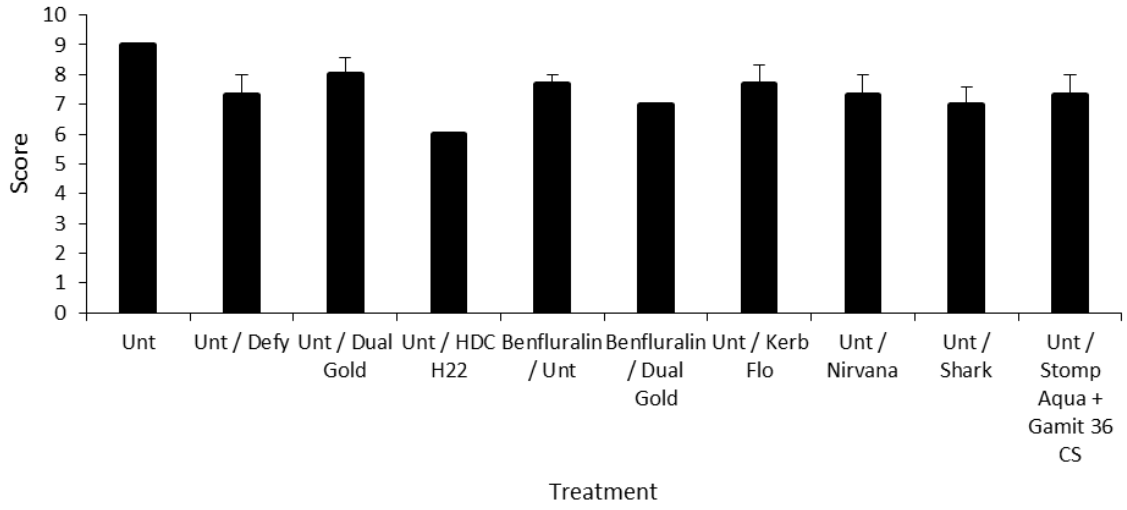

Figure 1.3. Phytotoxicity scores for each treatment 10 WAT – Drilled China asters 25 July 2014

Emergence was poor in plots treated with HDC H22 post-drilling (T4). Emergence was also affected in plots treated with Defy (T2), Dual Gold (T3), Benfluralin / Dual Gold (T6) and Stomp Aqua + Gamit 36 CS (T10) (**Figure 1.4**). Plots treated with Benfluralin (T5) and Kerb Flo 400 (T7), showed good levels of emergence. Emergence was high in plots treated with Shark (T9), as this treatment was applied post-emergence.

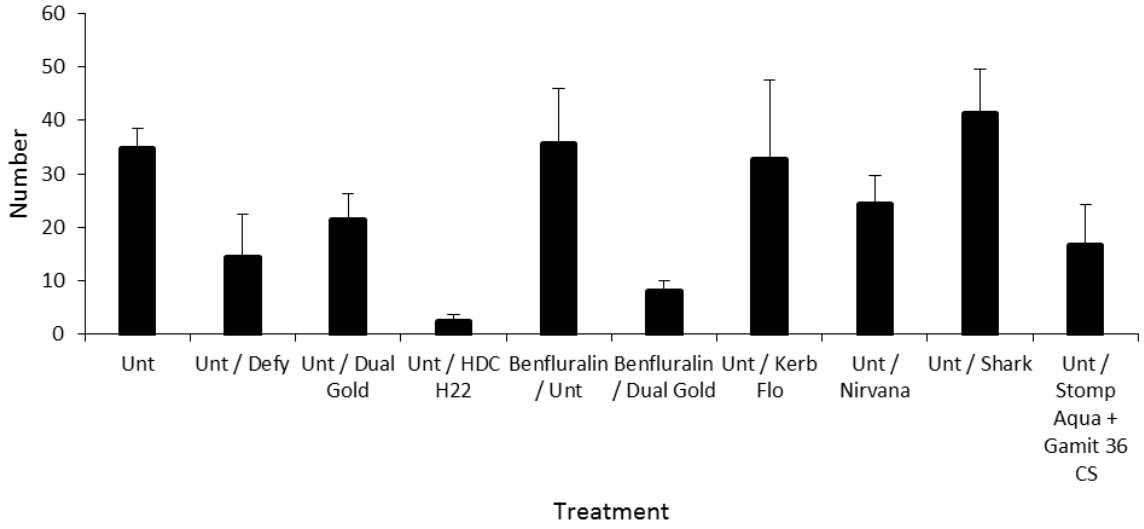

Figure 1.4. Average number of emerged seedlings per plot for each treatment – Drilled China asters 20 June 2014

A weed assessment was carried out on 20 June, and the results can be seen in **Figure 1.5**. Weed control was good in all treatments apart from Benfluralin, which was only slightly better than the control plots. The treatments that gave the best control were generally the ones that had the biggest effect on emergence (HDC H22, Defy and Dual Gold).

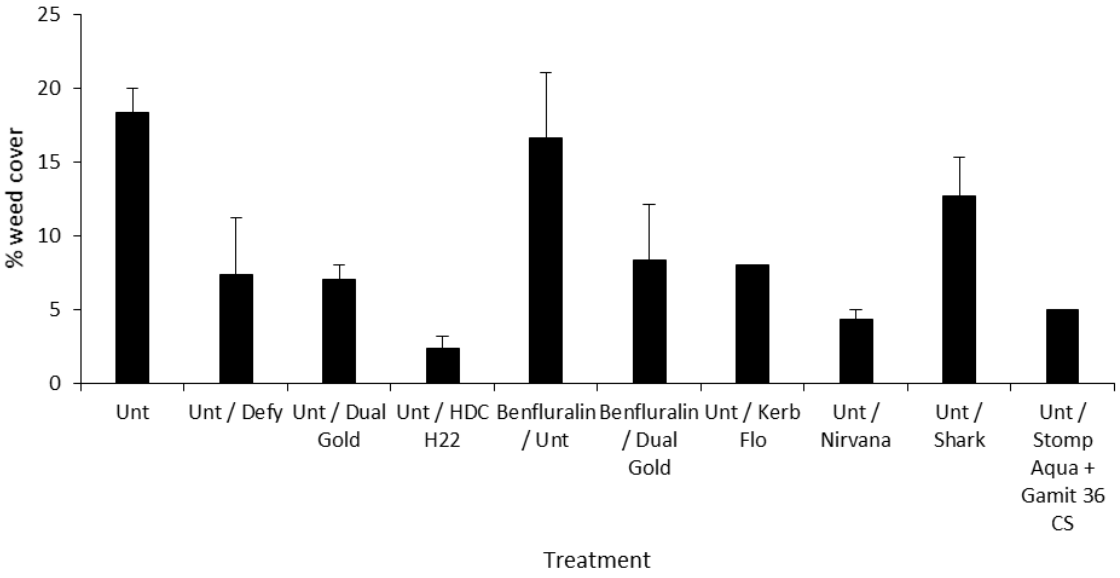

Figure 1.5. Average weed cover for each treatment – Drilled China asters 20 June 2014

Discussion

In the drilled China aster trial, HDC H22 proved to be the most phytotoxic, and severely affected crop emergence, making it unsafe for use on this crop. Benfluralin (T5), 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 (T5), Kerb Flo 400 (T7) and Nirvana (T8) all looked acceptable treatments overall, although weed control was not as good for Benfluralin. When Shark was applied as a post-emergence treatment, there was some damage initially, mainly leaf yellowing and scorch to leaf edges, but these plants recovered well, so Shark could be considered for use as a selective contact herbicide in this crop. Plants treated with Stomp Aqua + Gamit 36 CS looked healthy, but crop emergence was reduced. In previous work, Stomp Aqua + Gamit 36 CS has been safe for use on China aster, Stomp Aqua alone is thought to be safe (although not tested alone in this trial) so it may be that the rate of Gamit 36 CS was too high in this trial. The use of Stomp Aqua with a reduced rate of Gamit 36 CS might mitigate the reduction in crop emergence.

Species 2: Transplanted China aster

Materials and methods

The trial was carried out on a crop of transplanted China aster, variety Matsumoto, at the Cut Flower Centre between May and July 2014. The crop was grown on a Lincolnshire silt. The trial was a fully randomised block design with 10 treatments, including an untreated control (Table 2.1), replicated three times. Each plot was 3 m long and 1.2 m wide. The trial was planted by hand, with eight rows of plants per plot, giving a total of 64 plants per sq. / m.

Table 2.1. Detail of herbicide treatments applied pre or post transplanting to a China aster crop - 2014

Trt no.	**Pre – planting**	**Rate kg/ha or L/ha**	**Post planting**	**Rate kg/ha or L/ha**
1	Untreated	-	Untreated	-
2	Defy	5	Untreated	-
3	Untreated	-	HDC H22	X
4	Benfluralin (incorp)	2	Untreated	-
5	Benfluralin (incorp)	2	Dual Gold	0.78
6	Kerb Flo 400	4.25	Untreated	-
7	Untreated	-	Stomp Aqua	2

Trt no.	Pre – planting	Rate kg/ha or L/ha	Post planting	Rate kg/ha or L/ha
8	Untreated	-	Stomp Aqua + Gamit 36 CS	2 + 0.25
9	Untreated	-	Stomp Aqua + Dual Gold	2 + 0.78
10	Untreated	-	HDC H31 + Dual Gold	X + 0.78

Seeds of China aster were sown into cellular trays by a plant propagator, and grown on to 2-3 true leaves. Prior to transplant, the site was marked out and the pre-planting treatments were applied on 16 May 2014. The treatments were applied to the soil using an OPS sprayer and a 1 m single nozzle lance with an 02f110 nozzle, to achieve a medium spray quality at 200 L/ha. Treatments 4 and 5 were then incorporated into the soil using a rake, and were lightly irrigated.

The trial was planted by hand on the same day and each plot contained eight rows of plants. The plants were watered in before the post–planting treatments were applied. The same sprayer and lance were used, to achieve a medium spray quality at 200 L/ha.

The trial was assessed at 2, 6 and 10 weeks after treatment (2 June, 30 June and 25 July respectively). Phytotoxicity was assessed on each plot, using a scale of zero to nine, whereby nine showed no effect, seven was commercially acceptable damage, one was a very severe effect and zero was plant death. Plots were also assessed for percentage weed cover on 25 July 2014. Plots were then hand weeded to prevent competition between weeds and the crop. At harvest on 5 August, the height and weight of 10 stems per plot were assessed, to see if there were any significant differences between treatments. Data was analysed by ANOVA.

Results

At the first assessment, two WAT, Defy (T2) was the most phytotoxic treatment, with leaf yellowing and distortion, stunted plants and some plants dying off (Figure 2.1). HDC H22 (T3), Benfluralin / Dual Gold (T5), Stomp Aqua (T7) and HDC H31 + Dual Gold (T10) all showed phytotoxic symptoms. Plants were generally smaller in these plots, with some leaf yellowing and distortion.

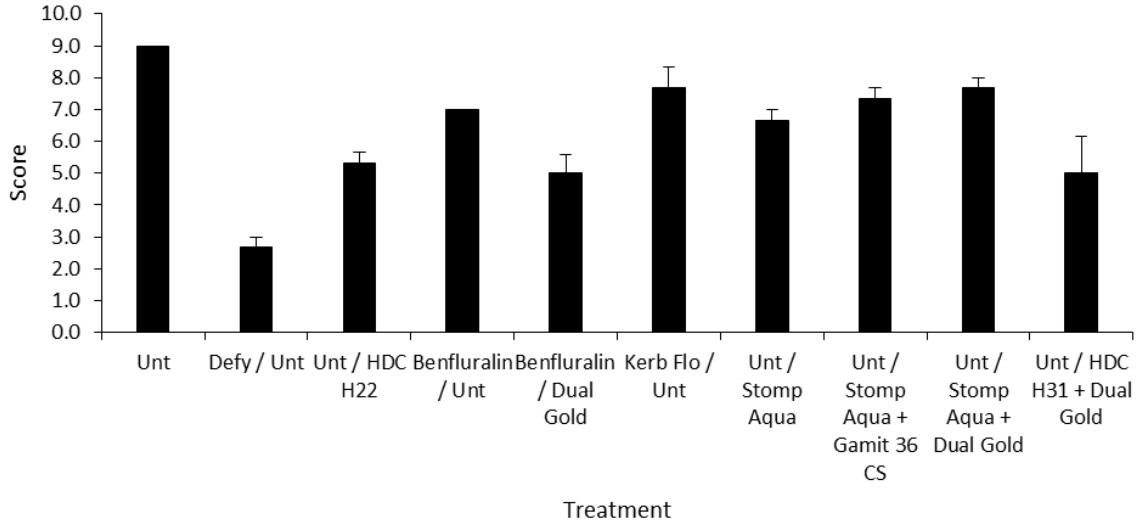

Figure 2.1. Phytotoxicity scores for each treatment 2 WAT – Transplanted China aster 2 June 2014

At the second assessment, six WAT, plants had recovered well from the initial phytotoxic symptoms, including those treated with Defy (T2). All treatments scored commercially acceptable or above.

At the final assessment, 10 WAT, plants had grown away from their original phytotoxicity and there was very little difference between any of the treatments (**Figure 2.2**). All treatments scored eight or above.

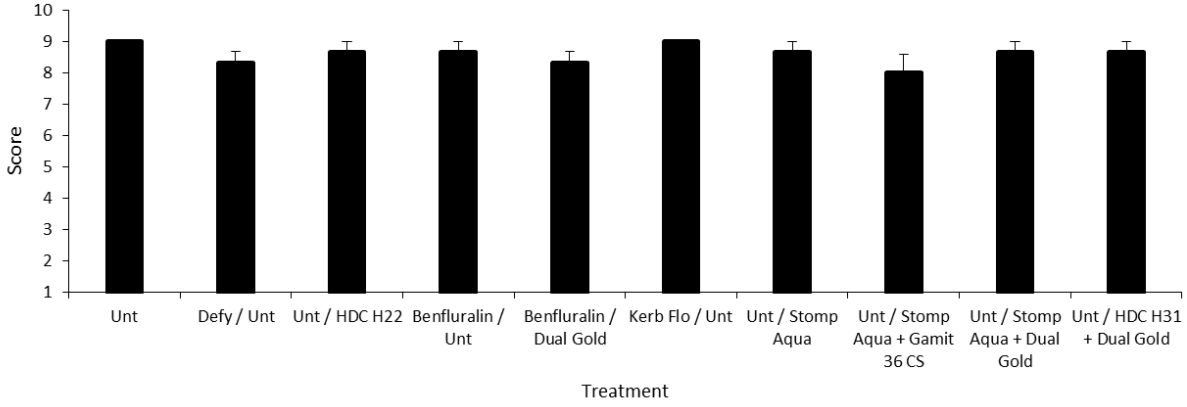

Figure 2.2. Phytotoxicity scores for each treatment 10 WAT – Transplanted China aster 25 July 2014

A weed assessment was carried out on 25 July, and the results can be seen in **Figure 2.3**. Weed pressure was relatively low across the trial, although most treatments did help to reduce the number of weeds slightly. Benfluralin / Dual Gold (T5) was the best treatment for weed control.

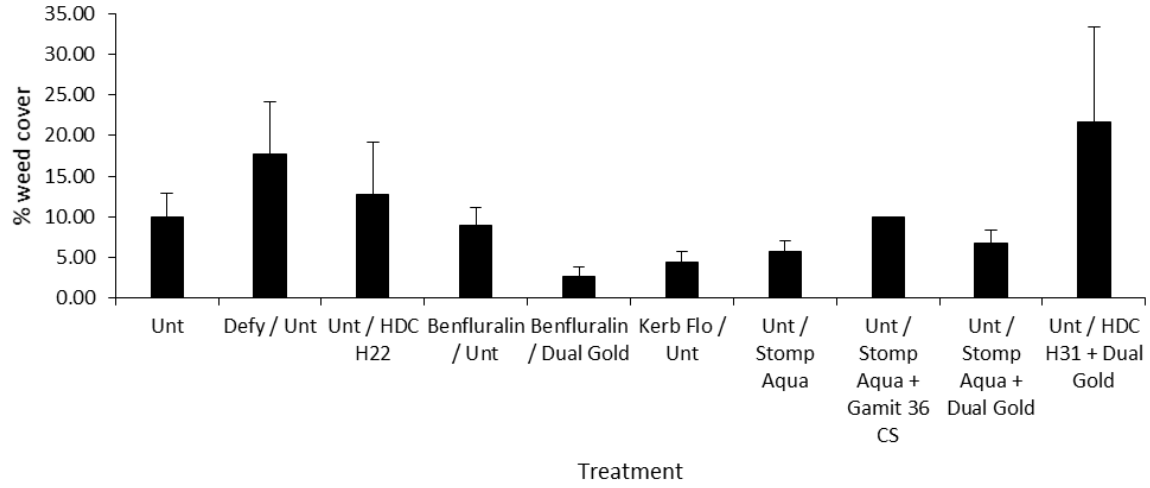

Figure 2.3. Average weed cover for each treatment – Transplanted China aster 25 July 2014

At harvest on 5 August, stem height and weight were assessed for each treatment (**Figure 2.4 and 2.5**). There was some variation in plant height, although all stems exceeded the 60 cm height specification in all treatments.

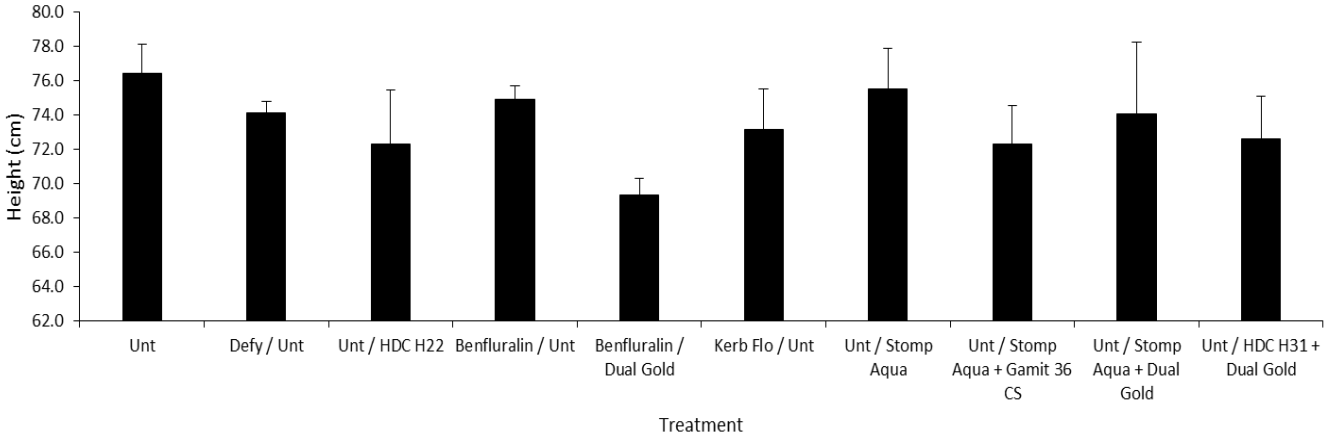

Figure 2.4. Average stem height at harvest – Transplanted China aster 5 August 2014

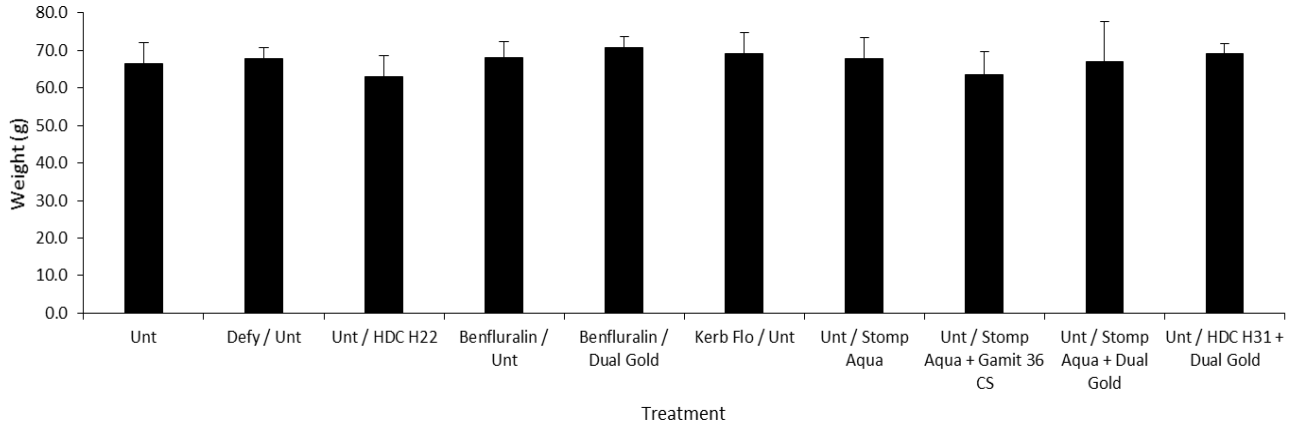

Figure 2.5. Average stem weight at harvest – Transplanted China aster 5 August 2014

There was very little difference in the weight of individual stems between treatments. However, Benfluralin / Dual Gold (T5) resulted in both the shortest and heaviest stems. Therefore, less stems would be needed to produce a weighted bunch.

Discussion

In the transplanted China aster trial, there was very little phytotoxicity seen from any of the treatments. There was some yellowing and leaf distortion caused by Defy (T2), which was noted two weeks after treatment, but the plants grew away from this, and by harvest all plants were looking healthy, showing that all treatments were safe on this crop. Benfluralin / Dual Gold resulted in both the shortest and heaviest stems, so this combination of herbicides could be useful to produce a weighted bunch with less stems. This treatment also gave the best weed control.

Species 3: Lily

Materials and methods

The trial was carried out on a crop of planted Lily bulbs grown in a Spanish tunnel at the Cut Flower Centre between May and July 2014. Two varieties were used in the trial, White Triumph and Dynamite. The crop was grown on a Lincolnshire silt. The trial was a fully randomised block design with 10 treatments, including an untreated control (**Table 3.1**), replicated three times. Each plot was 3 m long and 1.2 m wide, and consisted of four rows of White Triumph and two rows of Dynamite.

Table 3.1. Detail of herbicide treatments applied pre or post planting to a crop of Lily bulbs - 2014

Trt no.	Pre – planting	Rate kg/ha or L/ha	Post planting	Rate kg/ha or L/ha
1	Untreated	-	Untreated	-
2	Devrinol (incorp)	5	Untreated	-
3	Devrinol (incorp)	5	Flexidor 125	2

4	Devrinol (incorp)	5	Flexidor 125 + Butisan S	2 + 1
5	Untreated	-	Flexidor 125 + Butisan S	2 + 1
6	Untreated	-	HDC H28 + Stomp Aqua	X + 2
7	Untreated	-	HDC H28 + Stomp Aqua + HDC H31	X + 2 + X
8	Untreated	-	HDC H28 + Stomp Aqua + Gamit 36 CS	X + 2 + 0.25
9	Untreated	-	HDC H28 + Stomp Aqua + Butryflow (post em of crop & weeds)	X + 2 + 1
10	Untreated	-	HDC H24 + HDC H31	X + X

Prior to planting, the site was marked out and the pre-planting treatments were applied on 16 May. The treatments were applied to the soil using an OPS sprayer and a 1 m single nozzle lance with an 02f110 nozzle, to achieve a medium spray quality at 200 L/ha. Treatments two, three and four were then incorporated into the soil using a rake, and were lightly irrigated.

The trial was planted by hand on the same day and each plot contained six rows of bulbs. There were four rows of White Triumph and two rows of Dynamite. The bulbs were watered in before the post–planting treatments were applied. The same sprayer and lance were used, to achieve a medium spray quality at 200 L/ha.

In treatment 9, Butryflow a contact acting herbicide, was applied on 20 June, once weeds had emerged and the crop was approximately 10 cm tall. The same spray equipment and water volume were used.

The trial was assessed at 5, 7 and 10 weeks after treatment (20 June, 7 July and 25 July respectively). Phytotoxicity was assessed on each plot, using a scale of zero to nine, whereby nine showed no effect, seven was commercially acceptable damage, one was a very severe effect and zero was plant death. Each variety was assessed separately. Plots were also assessed for percentage weed cover on 20 June. Plots were then hand weeded to prevent competition between weeds and the crop. At harvest on 5 August, the height and weight of 10 stems per plot for each variety were assessed, to see if there were any significant differences between treatments. Data was analysed by ANOVA.

Results

At the first assessment five WAT, there was only a small amount of phytotoxicity to be seen, with some yellowing to foliage on the Dynamite variety, caused by Devrinol (T2) (**Figure 3.1**).

All other treatments scored above the commercial standard of seven, although Dynamite was affected slightly more than White Triumph in each treatment.

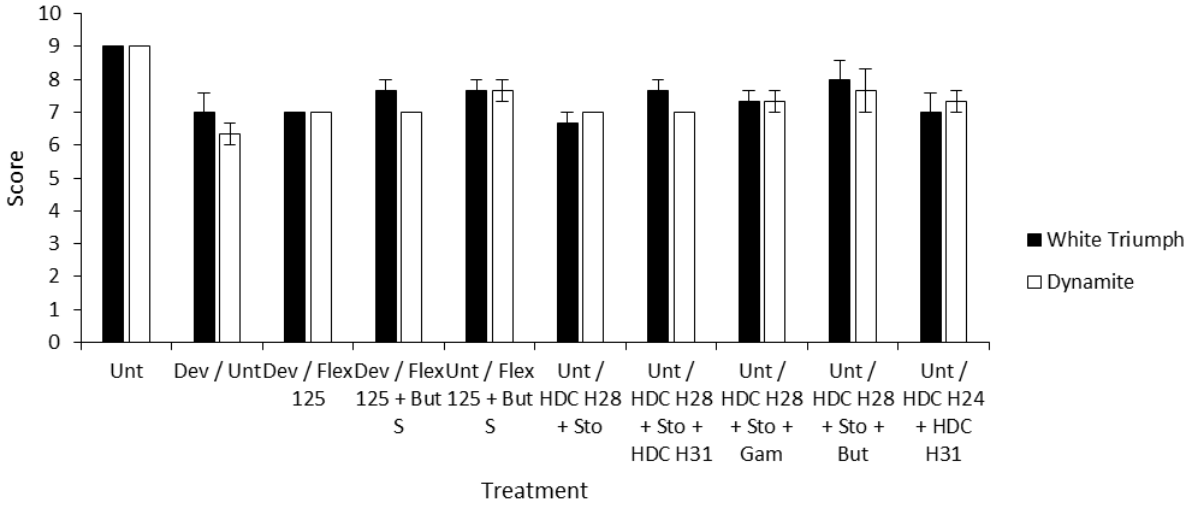

Figure 3.1. Phytotoxicity scores for each treatment 5 WAT – Lily bulbs 20 June 2014

Butryflow (T9) was applied on 20 June, and this had minimal impact on the plants. There was little difference between treatments at the second phytotoxicity assessment, seven WAT. The foliage of Dynamite was noticeably more yellow, but by the final assessment, 10 WAT, plants were recovering from this (**Figure 3.2**).

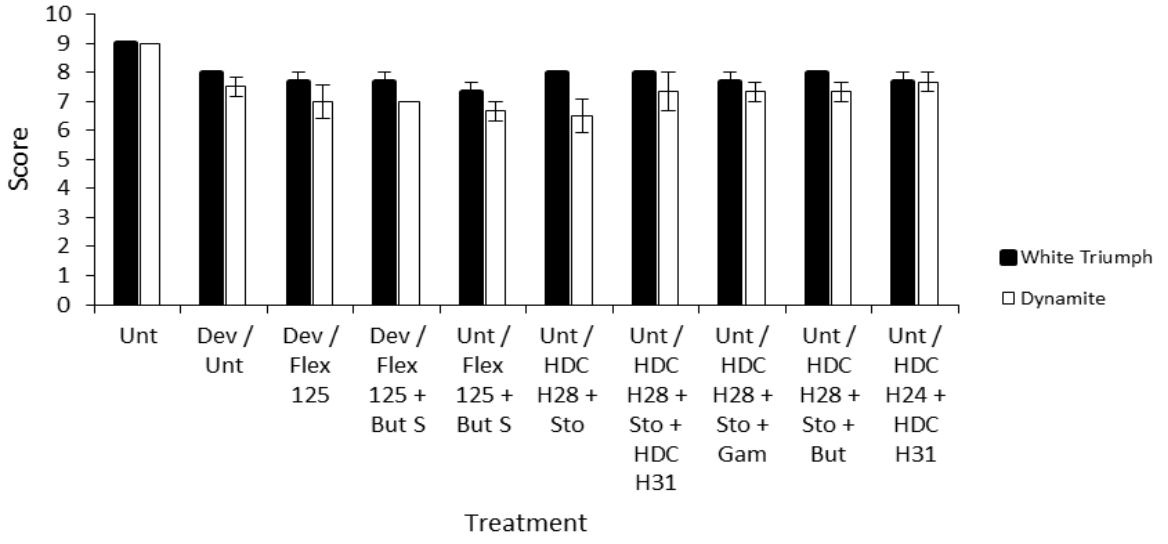

Figure 3.2. Phytotoxicity scores for each treatment 10 WAT – Lily bulbs 25 July 2014

A weed assessment was carried out on 20 June and the results can be seen in Figure 3.4. All treatments gave very good weed control, apart from HDC H28 + Stomp Aqua + Butryflow, although Butryflow hadn't been applied when the assessment was completed. The poor result for HDC H28 + Stomp Aqua + Butryflow at this stage was influenced by one very weedy plot, the other plots were similar to treatment 6 which received the same herbicide treatment at this stage. Following the application of Butryflow it was noted 10 days later that emerged groundsel in the plots had died.

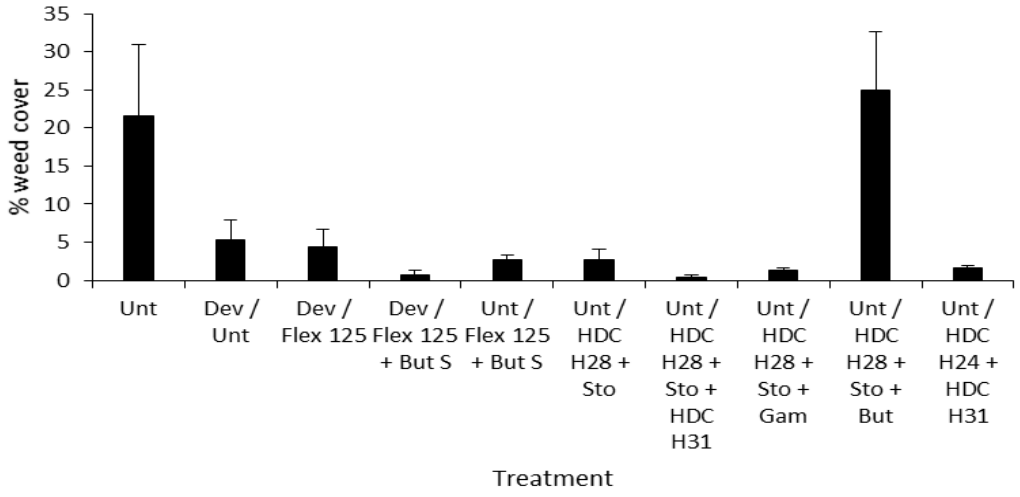

Figure 3.4. Average weed cover for each treatment – Lily bulbs 20 June 2014

At harvest on 5 August, stem height and weight were assessed for each treatment (Figure 3.5 and 3.6). The Dynamite variety was shorter than White Triumph, but there was little difference between the treatments for the two varieties. Devrinol / Flexidor 125 + Butisan S reduced the height for both varieties, although this was more noticeable in White Triumph.

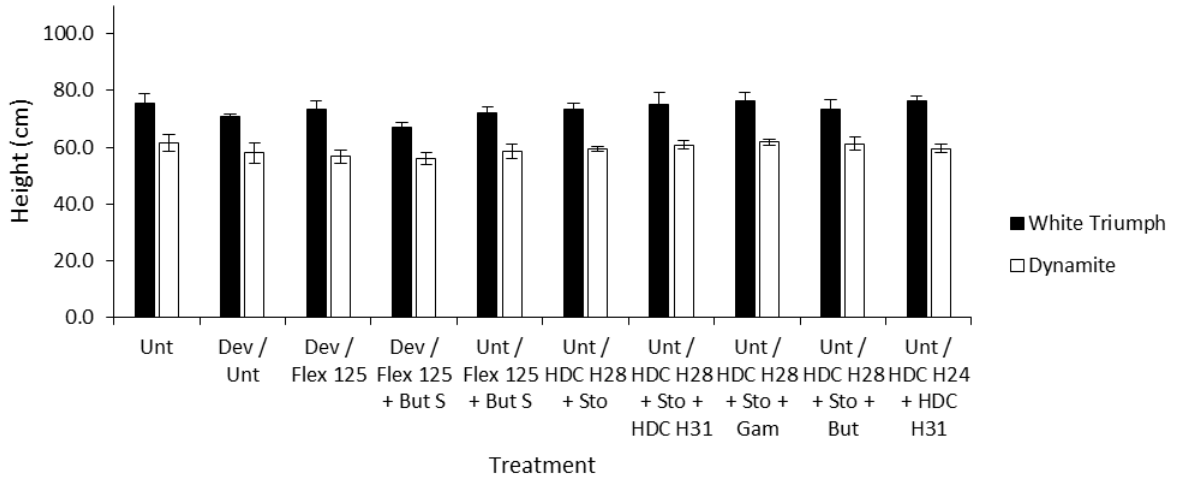

Figure 3.5. Average stem height at harvest – Lily bulbs 5 August 2014

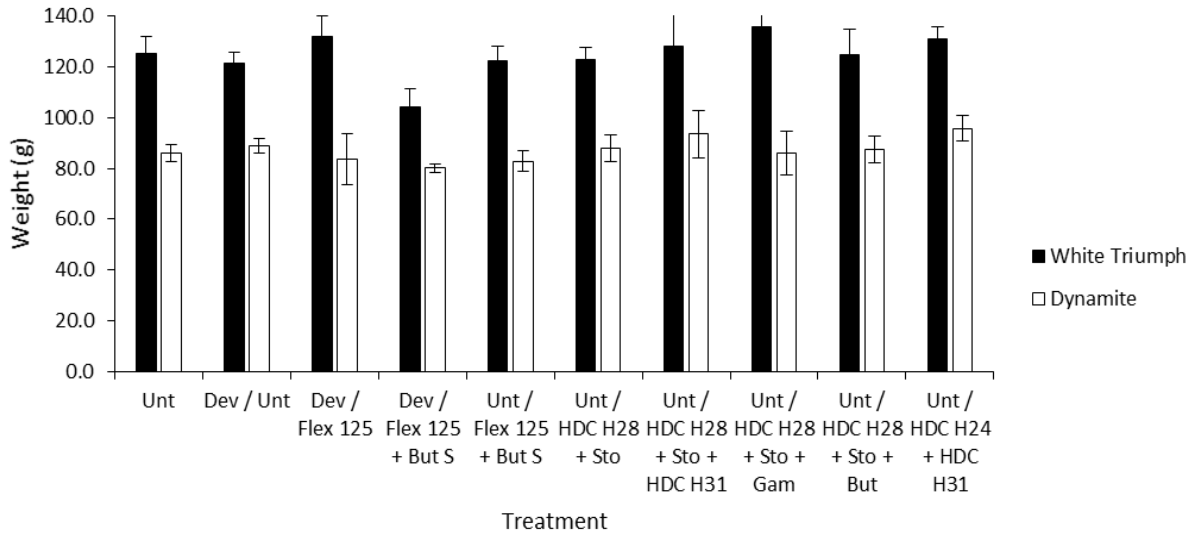

Figure 3.6. Average stem weight at harvest – Lily bulbs 5 August 2014

Dynamite stems were lighter than White Triumph, but there was little difference between treatments for both varieties. Again, Devrinol / Flexidor 125 + Butisan S reduced the weight in both varieties, but only slightly for Dynamite. However, this was not statistically significant.

Discussion

In the Lily trial, all treatments were safe to use on White Triumph. Dynamite showed slightly more phytotoxicity, with most treatments causing yellowing to foliage, but the plants had grown away from this by harvest. The height and weight of the stems were reduced in both varieties by Devrinol / Flexidor 125 + Butisan S.

Species 4: Drilled Sweet Williams

Materials and methods

The trial was carried out on a crop of drilled Sweet Williams at the Cut Flower Centre between July and September 2014. The crop was grown on a Lincolnshire silt. The trial was a fully randomised block design with 10 treatments, including an untreated control (**Table 4.1**), replicated three times. Each plot was 3 m long and 1.2 m wide and consisted of four rows of plants.

Table 4.1. Detail of herbicide treatments applied pre or post drilling to Sweet Williams seed - 2014

Trt no.	Pre – drilling	Rate kg/ha or L/ha	Post drilling	Rate kg/ha or L/ha
1	Untreated	-	Untreated	-
2	Untreated	-	Defy	5
3	Devrinol (incorp)	5	Untreated	-
4	Untreated	-	HDC H22	X
5	Benfluralin (incorp)	2	Untreated	-
6	Untreated	-	Nirvana	4.5
7	Untreated	-	Shark (post em of crop & weeds)	0.33
8	Untreated	-	Stomp Aqua	2
9	Untreated	-	Stomp Aqua + Gamit 36 CS	2 + 0.05
10	Untreated	-	Wing - P	3.5

Prior to drilling, the site was marked out and the pre-drilling treatments were applied on 4 July. The treatments were applied to the soil using an OPS sprayer and a 1 m single nozzle lance with an 02f110 nozzle, to achieve a medium spray quality at 200 L/ha. Treatments 3 and 5 were then incorporated into the soil using a rake, and were lightly irrigated.

The trial was drilled on 6 July, and the post-drilling treatments were applied on 7 July, using the same spray equipment to achieve a medium spray quality at 200 L/ha.

In treatment 7, Shark, a contact acting herbicide, was applied on 7 August, once weeds had emerged and the crop was at 4 true leaves. The same spray equipment and water volume were used.

The trial was assessed at three, six and 10 weeks after treatment (25 July, 18 August and 15 September respectively). Phytotoxicity was assessed on each plot, using a scale of 0–9, whereby 9 showed no effect, 7 was commercially acceptable damage, 1 was a very severe effect and 0 was plant death. Plots were also assessed for the number of emerged Sweet Williams and percentage weed cover on 25 July. Plots were then hand weeded to prevent competition between weeds and the crop. Data was analysed by ANOVA.

Results

At the first phytotoxicity assessment 3 WAT, there was little difference between treatments, apart from Defy (T2), Nirvana (T6) and Wing-P (T10), which all scored below the commercial standard of 7 (**Figure 4.1).**

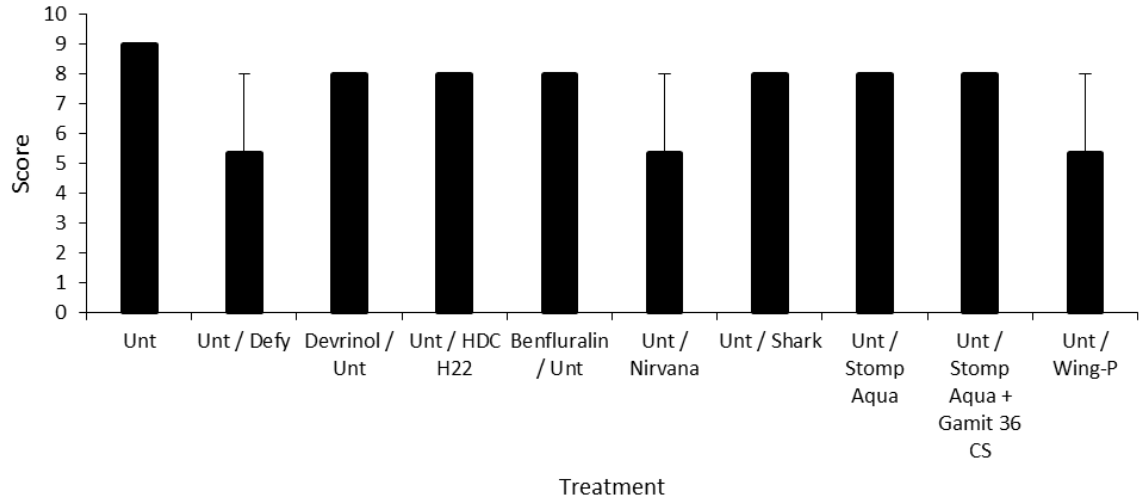

Figure 4.1. Phytotoxicity scores for each treatment 3 WAT – Sweet Williams 25 July 2014. Note this was assessed **before** Shark was applied 07 August 2014.

At the second assessment 6 WAT, plants treated with HDC H22 (T4), Nirvana (T6), Stomp Aqua (T8), Stomp Aqua + Gamit 36 CS (T9) and Wing-P (T10) were all showing signs of phytotoxicity, with yellowing of foliage or slight leaf distortion.

Shark (T7) was applied on 7 August, and this initially had a significant impact on the plants, resulting in severe chlorosis. However, at the final assessment on 15 September, these plants had fully recovered and were looking healthy (**Figure 4.2**). Those treatments that had shown signs of phytotoxicity 3 and 6 WAT remained the same (**Figure 4.3**).

Figure 4.2. Plants treated with Shark (T7) at 1 WAT and 5 WAT - Sweet Williams

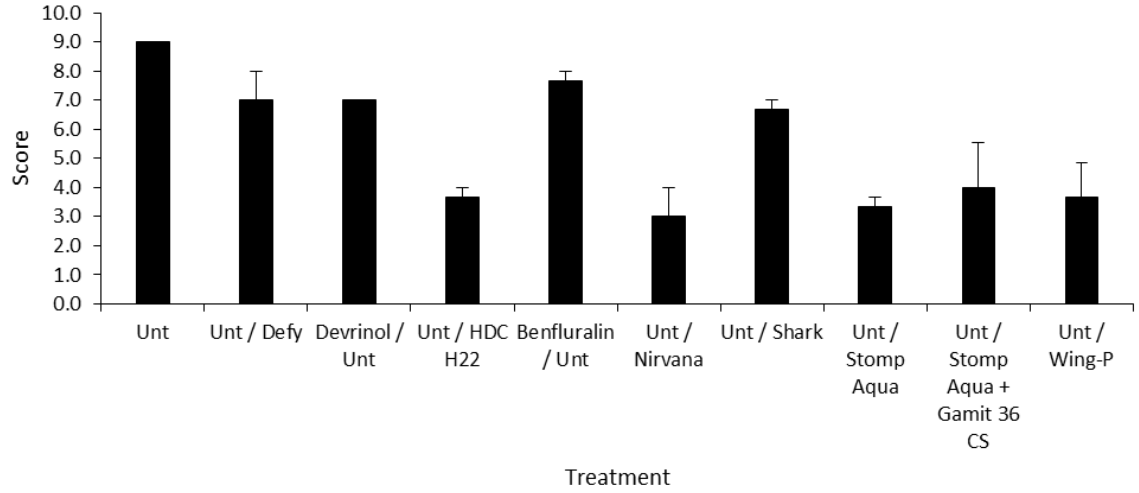

Figure 4.3. Phytotoxicity scores for each treatment 10 WAT – Sweet Williams 15 September 2014

Emergence was very poor in plots treated with HDC H22 (T4). Emergence was also suppressed in plots treated with Nirvana (T6), Stomp Aqua (T8), Stomp Aqua + Gamit 36 CS (T9) and Wing-P (T10) (**Figure 4.4**). Plots treated with Defy (T2) and Benfluralin (T5) showed good levels of crop emergence. Emergence was high in plots treated with Shark (T7), as this treatment was applied post-emergence.

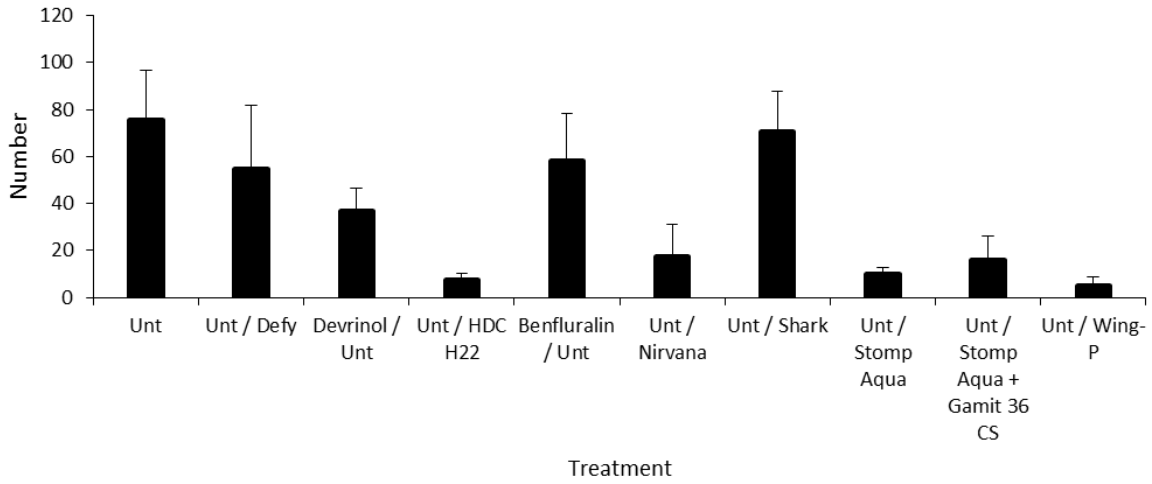

Figure 4.4. Average number of emerged seedlings per plot for each treatment – Sweet Williams 25 July 2014

A weed assessment was carried out on 25 July, and the results can be seen in **Figure 4.5**. Weed control was good in HDC H22 (T4), Nirvana (T6), Stomp Aqua (T8), Stomp Aqua + Gamit 36 CS (T9) and Wing-P (T10), which all had an impact on crop emergence. Weed control was relatively good in plots treated with Devrinol (T3) and Benfluralin (T5).

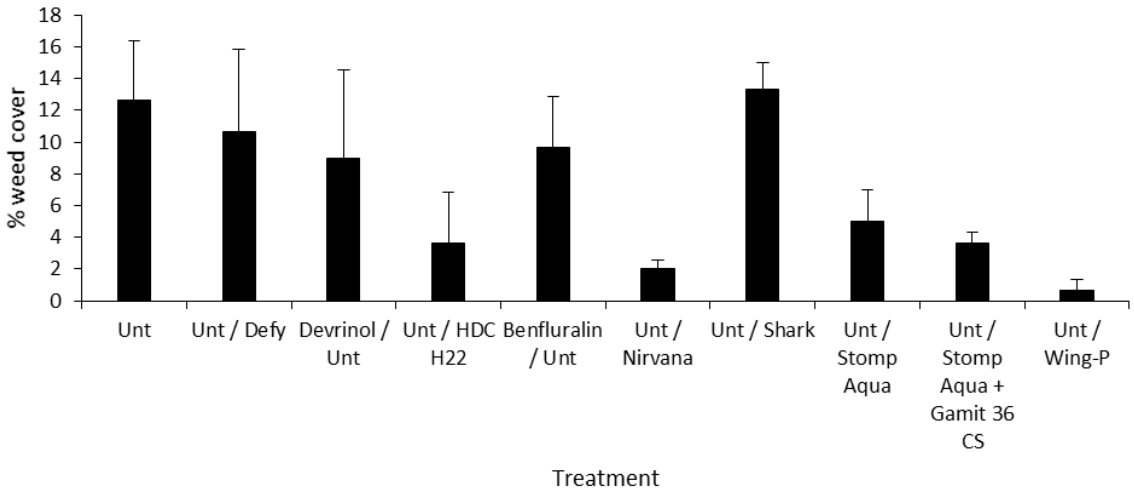

Figure 4.5. Average weed cover for each treatment – Sweet Williams 25 July 2014

Discussion

In the drilled Sweet Williams trial, HDC H22, Nirvana, Stomp Aqua, Stomp Aqua + Gamit 36 CS and Wing-P all reduced emergence and also showed phytotoxicity to plants that had emerged. There was initially some phytotoxicity caused by Shark, but these plants recovered well from the damage. There was minimal phytotoxicity caused by Devrinol, and weed control was relatively good, although emergence of Sweet Williams was reduced. Defy and

Benfluralin were generally safe, with minimal effect on emergence. However, there was some phytotoxicity from Defy, with yellowing to some of the foliage.

Species 5: Drilled Wallflowers

Materials and methods

The trial was carried out on a crop of drilled Wallflowers, variety Fair Lady mixed, at the Cut Flower Centre between July and September 2014. The crop was grown on a Lincolnshire silt. The trial was a fully randomised block design with 10 treatments, including an untreated control (Table 5.1), replicated three times. Each plot was 3 m long and 1.2 m wide and consisted of four rows of plants.

Table 5.1. Detail of herbicide treatments applied pre or post drilling to wallflower seed - 2014

Trt no.	Pre – drilling	Rate kg/ha or L/ha	Post drilling	Rate kg/ha or L/ha
1	Untreated	-	Untreated	-
2	Devrinol (incorp)	5	Untreated	-
3	Untreated	-	Dual Gold	0.78
4	Untreated	-	HDC H22	X
5	Benfluralin (incorp)	2	Untreated	-
6	Benfluralin (incorp)	2	Butisan S	1
7	Benfluralin (incorp)	2	Dual Gold	0.78
8	Benfluralin (incorp)	2	Gamit 36 CS	0.25
9	Untreated	-	Stomp Aqua	2
10	Untreated	-	Stomp Aqua + Gamit 36 CS	2 + 0.25

Prior to drilling, the site was marked out and the pre-drilling treatments were applied on 4 July 2014. The treatments were applied to the soil using an OPS sprayer and a 1 m single nozzle lance with an 02f110 nozzle, to achieve a medium spray quality at 200 L/ha. Treatments two, five, six, seven and eight were then incorporated into the soil using a rake, and were lightly irrigated.

Block one was drilled on 6 July and blocks two and three were hand broadcast on 7 July. Post-drilling treatments were applied on 7 July, using the same spray equipment to achieve a medium spray quality at 200 L/ha.

The trial was assessed at three, six and 10 weeks after treatment (25 July, 18 August and 15 September respectively). Phytotoxicity was assessed on each plot, using a scale of zero to nine, whereby nine showed no effect, seven was commercially acceptable damage, one was a very severe effect and zero was plant death. Plots were also assessed for the number of emerged Wallflowers and percentage weed cover on 25 July. Plots were then hand weeded to prevent competition between weeds and the crop, and the Wallflowers were thinned. Data was analysed by ANOVA.

Results

At the first phytotoxicity assessment, three WAT, there was little difference between the treatments, with all treatments scoring eight. There were no visible signs of damage to the crop. There were some differences between treatments at the second assessment, six WAT, with HDC H22 (T4) proving to be the most phytotoxic treatment. Plants had mostly recovered by the final assessment, 10 WAT, but HDC H22 was still notably the most damaging (Figure 5.1).

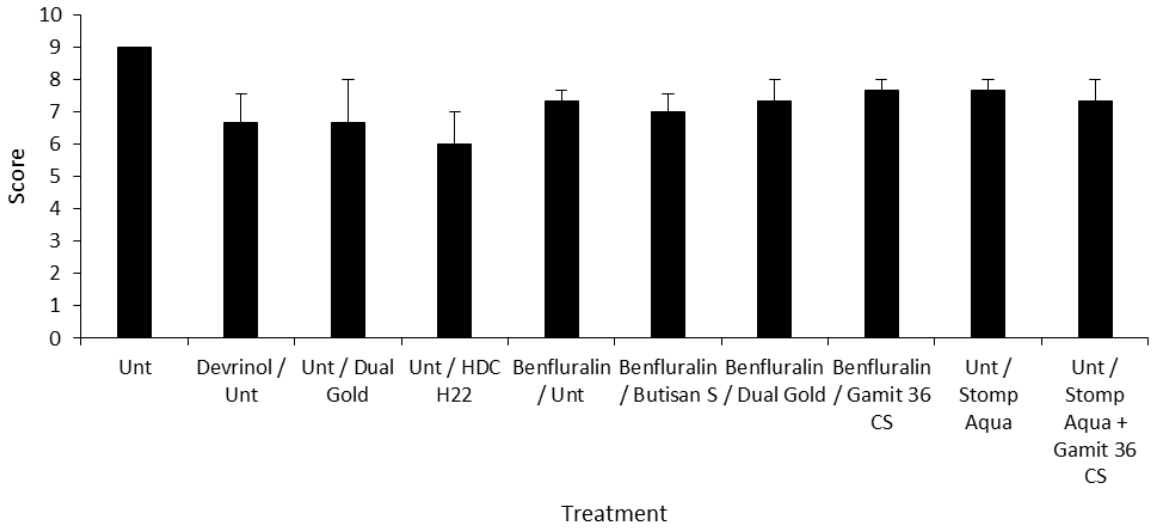

Figure 5.1. Phytotoxicity scores for each treatment 10 WAT – Wallflowers 15 September 2014

Crop emergence was rather low in plots treated with Devrinol (T2), HDC H22 (T4), Benfluralin / Dual Gold and Benfluralin / Gamit 36 CS (Figure 5.2). When Benfluralin was applied either on its own (T5) or followed up with Butisan S (T6), crop emergence remained high. There was also good emergence from Stomp Aqua (T9) and Stomp Aqua + Gamit 36 CS (T10).

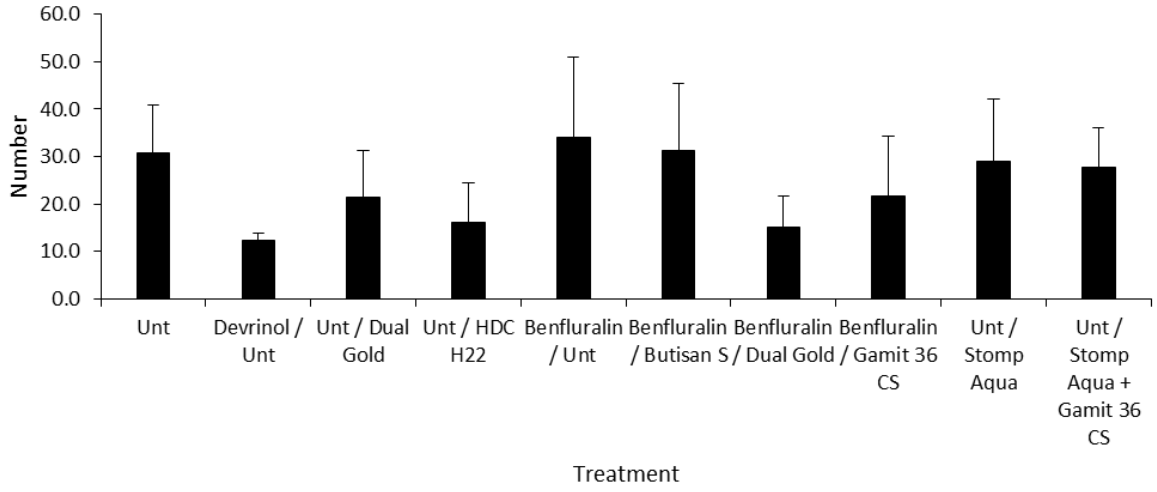

Figure 5.2. Average number of emerged seedlings per plot for each treatment – Wallflowers 25 July 2014

A weed assessment was carried out on 25 July, and the results can be seen in Figure 5.3. Weed cover was light and variable making it difficult to make comparisons of efficacy of the treatments.

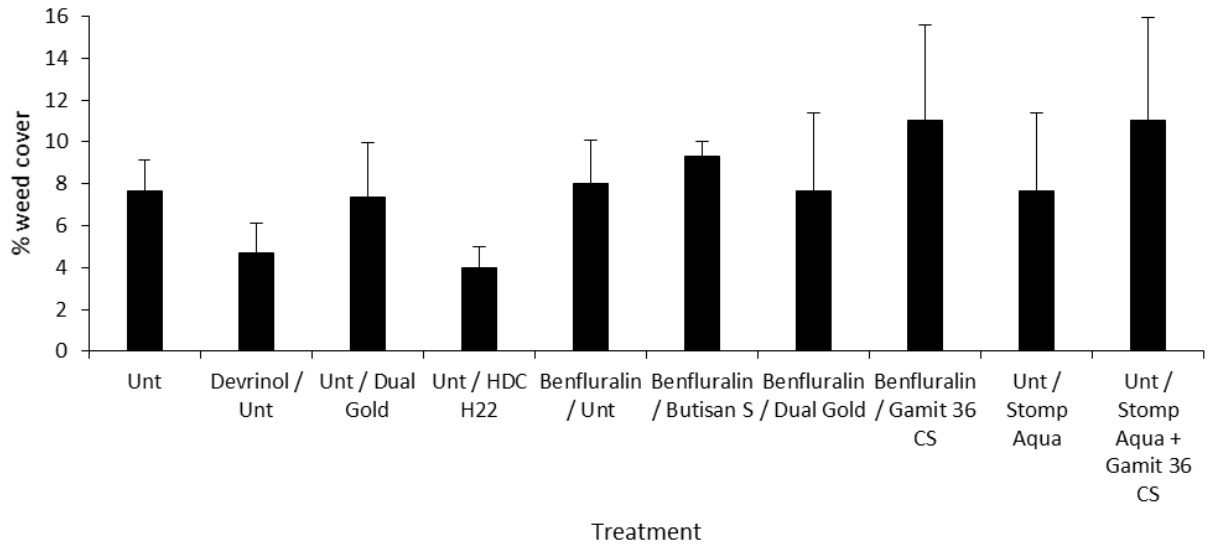

Figure 5.3. Average weed cover for each treatment – Wallflowers 25 July 2014

Discussion

In the drilled Wallflower trial, HDC H22 proved to be the most phytotoxic, and reduced crop emergence, making it unsafe for use on this crop. Benfluralin, Benfluralin / Butisan S, Stomp Aqua and Stomp Aqua + Gamit 36 CS all look promising in terms of crop safety and emergence. Devrinol and Dual Gold showed some phytotoxicity and emergence was reduced by Devrinol. Benfluralin / Dual Gold and Benfluralin / Gamit 36 CS both reduced

emergence, but it is possible that reducing the product rates could help to improve emergence.

Conclusion

Overall, HDC H22 proved to be highly phytotoxic to the drilled crops tested, as well as reducing emergence, whilst it is not suitable for use as an herbicide in drilled ornamental crops it has however proved safer in transplanted crops. Benfluralin looks promising, with good emergence and little phytotoxicity on drilled crops or transplanted asters although for a more complete weed control spectrum a follow up treatment would be required. Shark is a potential selective contact treatment, with China aster and Sweet Williams recovering from original 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 promising on drilled Wallflowers, which is already authorised for use on ornamentals under EAMU and LTAEU respectively.

Knowledge and Technology Transfer

Cut Flower Centre Open Day – Crop Walk. 6 August 2014

HDC News Article – due early 2015

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Appendices

Appendix 1. Raw data for charts

Drilled China aster

Table 1. Mean phytotoxicity scores at 5 WAT and 10 WAT - Drilled China aster 2014

Treatment	Phyto 5WAT	Phyto 10WAT
1. Untreated	9.0	9.0
2. Unt / Defy	4.7	7.3
3. Unt / Dual Gold	7.7	8.0
4. Unt / HDC H22	5.3	6.0
5. Benfluralin / Unt	7.0	7.7
6. Benfluralin / Dual Gold	7.7	7.0
7. Unt / Kerb Flo 400	7.3	7.7
8. Unt / Nirvana	7.3	7.3
9. Unt / Shark	8.3	7.0
10. Unt / Stomp Aqua + Gamit 36 CS	6.7	7.3
F pr.	**0.339**	**0.004**
l.s.d (18 d.f)	**3.477**	**1.473**

Table 2. Mean number of emerged seedlings per plot and % weed cover - Drilled China aster 2014

Treatment	Emergence (No.)	% weed cover
1. Untreated	34.7	18.3
2. Unt / Defy	14.3	7.3
3. Unt / Dual Gold	21.3	7.0
4. Unt / HDC H22	2.3	2.3
5. Benfluralin / Unt	35.7	16.7
6. Benfluralin / Dual Gold	8.0	8.3

7. Unt / Kerb Flo 400	32.7	8.0
8. Unt / Nirvana	24.3	4.3
9. Unt / Shark	41.3	12.7
10. Unt / Stomp Aqua + Gamit 36 CS	16.7	5.0
F pr.	**0.041**	**0.002**
l.s.d (18 d.f)	**23.86**	**6.978**

Transplanted China aster

Table 3. Mean phytotoxicity scores at 2 WAT and 10 WAT and % weed cover - Transplanted China aster 2014

Treatment	**Phyto 2WAT**	**Phyto 10WAT**	**% weed cover**
1. Untreated	9.0	9.0	10.0
2. Defy / Unt	2.7	8.3	17.7
3. Unt / HDC H22	5.3	8.7	12.7
4. Benfluralin / Unt	7.0	8.7	9.0
5. Benfluralin / Dual Gold	5.0	8.3	2.7
6. Kerb Flo 400 / Unt	7.7	9.0	4.3
7. Unt / Stomp Aqua	6.7	8.7	5.7
8. Unt / Stomp Aqua + Gamit 36 CS	7.3	8.0	10.0
9. Unt / Stomp Aqua + Dual Gold	7.7	8.7	6.7
10. Unt / HDC H31 + Dual Gold	5.0	8.7	21.7
F pr.	**<.001**	**0.329**	**0.252**
l.s.d (18 d.f)	**1.509**	**0.815**	**14.84**

Table 4. Average height and weight of stems at harvest - Transplanted China aster 2014

Treatment	**Height (cm)**	**Weight (g)**
1. Untreated	76.4	66.4

Treatment	Height (cm)	Weight (g)
2. Defy / Unt	74.1	67.7
3. Unt / HDC H22	72.3	63.0
4. Benfluralin / Unt	74.9	68.1
5. Benfluralin / Dual Gold	69.3	70.6
6. Kerb Flo 400 / Unt	73.1	69.1
7. Unt / Stomp Aqua	75.5	67.9
8. Unt / Stomp Aqua + Gamit 36 CS	72.3	63.5
9. Unt / Stomp Aqua + Dual Gold	74.1	66.8
10. Unt / HDC H31 + Dual Gold	72.6	69.0
F pr.	**0.319**	**0.985**
l.s.d (18 d.f)	**5.311**	**14.89**

Lily

Table 5. Mean phytotoxicity scores at 5 WAT and 10 WAT – Lily 2014

Treatment	Phyto 5WAT White Triumph	Phyto 5WAT Dynamite	Phyto 10 WAT White Triumph	Phyto 10WAT Dynamite
1. Untreated	9.0	9.0	9.0	9.0
2. Devrinol / Unt	7.0	6.3	8.0	7.3
3. Devrinol / Flexidor 125	7.0	7.0	7.7	7.0
4. Devrinol / Flexidor 125 + Butisan S	7.7	7.0	7.7	7.0
5. Unt / Flexidor 125 + Butisan S	7.7	7.7	7.3	6.7
6. Unt / HDC H28 + Stomp Aqua	6.7	7.0	8.0	7.0
7. Unt / HDC H28 + Stomp Aqua + HDC H31	7.7	7.0	8.0	7.3
8. Unt / HDC H28 + Stomp Aqua + Gamit 36 CS	7.3	7.3	7.7	7.3

Treatment	Phyto 5WAT White Triumph	Phyto 5WAT Dynamite	Phyto 10 WAT White Triumph	Phyto 10WAT Dynamite
9. Unt / HDC H28 + Stomp Aqua + Butryflow	8.0	7.7	8.0	7.3
10. Unt / HDC H24 + HDC H31	7.0	7.3	7.7	7.7
F pr.	**0.037**	**0.001**	**0.013**	**0.054**
l.s.d (18 d.f)	**1.222**	**0.892**	**0.716**	**1.222**

Table 6. Mean % weed cover – lily 2014

Treatment	% weed cover
1. Untreated	21.7
2. Devrinol / Unt	5.3
3. Devrinol / Flexidor 125	4.3
4. Devrinol / Flexidor 125 + Butisan S	0.7
5. Unt / Flexidor 125 + Butisan S	2.7
6. Unt / HDC H28 + Stomp Aqua	2.7
7. Unt / HDC H28 + Stomp Aqua + HDC H31	0.3
8. Unt / HDC H28 + Stomp Aqua + Gamit 36 CS	1.3
9. Unt / HDC H28 + Stomp Aqua + Butryflow	25.0
10. Unt / HDC H24 + HDC H31	1.7
F pr.	**0.001**
l.s.d (18 d.f)	**11.58**

Table 7. Average height and weight of stems at harvest – lily2014

Treatment	Height (cm) White Triumph	Height (cm) Dynamite	Weight (g) White Triumph	Weight (g) Dynamite
1. Untreated	75.4	61.6	125.2	86.0
2. Devrinol / Unt	70.7	58.0	121.6	89.0
3. Devrinol / Flexidor 125	73.2	56.7	132.2	83.6
4. Devrinol / Flexidor 125 + Butisan S	67.1	55.9	104.1	80.3
5. Unt / Flexidor 125 + Butisan S	72.2	58.4	122.2	82.7
6. Unt / HDC H28 + Stomp Aqua	73.3	59.5	122.7	87.8
7. Unt / HDC H28 + Stomp Aqua + HDC H31	75.2	60.8	128.1	93.6
8. Unt / HDC H28 + Stomp Aqua + Gamit 36 CS	76.3	61.9	135.8	86.1
9. Unt / HDC H28 + Stomp Aqua + Butryflow	73.6	61.3	124.7	87.5
10. Unt / HDC H24 + HDC H31	76.2	59.6	131.2	95.8

Sweet Williams

Table 8. Mean phytotoxicity scores at 3 WAT and 10 WAT – Sweet William 2014

Treatment	Phyto 3WAT	Phyto 10WAT
1. Untreated	9.0	9.0
2. Unt / Defy	5.3	6.0
3. Devrinol / Unt	8.0	7.0
4. Unt / HDC H22	8.0	3.7
5. Benfluralin / Unt	8.0	7.7
6. Unt / Nirvana	5.3	3.0

Treatment	Phyto 3WAT	Phyto 10WAT
7. Unt / Shark	8.0	6.7
8. Unt / Stomp Aqua	8.0	3.3
9. Unt / Stomp Aqua + Gamit 36 CS	8.0	4.0
10. Unt / Wing-P	5.3	3.7
F pr.	**0.539**	**0.001**
l.s.d (18 d.f)	**4.340**	**2.710**

Table 9. Mean number of emerged seedlings per plot and % weed cover – Sweet William 2014

Treatment	Emergence (No.)	% weed cover
1. Untreated	75.3	12.7
2. Unt / Defy	54.7	10.7
3. Devrinol / Unt	37.0	9.0
4. Unt / HDC H22	7.7	3.7
5. Benfluralin / Unt	58.3	9.7
6. Unt / Nirvana	17.3	2.0
7. Unt / Shark	70.7	13.3
8. Unt / Stomp Aqua	10.0	5.0
9. Unt / Stomp Aqua + Gamit 36 CS	16.0	3.7
10. Unt / Wing-P	5.0	0.7
F pr.	0.020	0.009
l.s.d (18 d.f)	46.53	7.075

Wallflower

Table 10. Mean phytotoxicity 10 WAT, number of emerged seedlings per plot and % weed cover – Wallflower 2014

Treatment	Phytotoxicity 10WAT	Emergence (No.)	% weed cover
1. Untreated	9.0	30.7	7.7
2. Devrinol / Unt	6.7	12.3	4.7
3. Unt / Dual Gold	6.7	21.3	7.3
4. Unt / HDC H22	6.0	16.0	4.0
5. Benfluralin / Unt	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. Unt / Stomp Aqua	7.7	29.0	7.7
10. Unt / Stomp Aqua + Gamit 36 CS	7.3	27.7	11.0
F pr.	**0.241**	**0.530**	**0.294**
l.s.d (18 d.f)	**1.972**	**23.77**	**5.936**

Appendix 2. Crop husbandry

The Cut Flower Centre took care of irrigation requirements of the plants, which was done as and when required, overhead by hand.

The transplanted China Asters were treated for aphids with Chess at 2g / 100L on 24 June, Movento at 1.2ml / L on 7 July and Calypso at 1ml / L on 17 July.

The Wallflowers were treated for flea beetle with Pemasect at 1ml / L on 25 July, 30 July and 4 August.