HDC Project BOF 52
Annual Report (2004)

Narcissus: Seeking replacements for 'Fortrol' (cyanazine) and sulphuric acid

Gordon R Hanks[1], Cathy Knott[2] and Pippa Hughes[1]
[1]Warwick HRI, University of Warwick, [2]Herbicide Consultant

Project title:	**Narcissus: Seeking replacements for 'Fortrol' (cyanazine) and sulphuric acid**
HDC project number:	**BOF 52**

Project leaders		
	Gordon R Hanks Warwick HRI (University of Warwick) The Kirton Research Centre Kirton Boston Lincolnshire PE20 1NN Tel: 01205 724603 Fax: 01205 724957 Email: Gordon.Hanks@warwick.ac.uk	Cathy Knott 55 Church Street Werrington Peterborough Cambridgeshire PE4 6QU Tel: 01733 575001 Fax: 01733 328793 Email: cathy.knott@btinternet.com

Report:	BOF 52 Annual Report (2004)
Previous reports:	None
Key workers:	Gordon R Hanks BSc, MPhil, MHort, CBiol, MIBiol – Joint Project Leader (Warwick HRI) Cathy Knott BSc(Hons), MIAgrE - Joint Project Leader (Consultant) Pippa Hughes BSc – Research Assistant (Warwick HRI)
Location:	Warwick HRI, Kirton
Project co-ordinators:	Brian Taylor Roy Willingham
Date commenced:	October 2003
Date completion due:	March 2006
Keywords:	Narcissus, replacement, herbicides, cyanazine, Fortrol, florasulam, Boxer, desiccants, sulphuric acid, carfentrazone-ethyl, Shark.

CONTENTS Page no.

BOF 52

Narcissus: Seeking replacements for 'Fortrol' (cyanazine) and sulphuric acid

GROWER SUMMARY

Headline

In the first year of the trial:

- Boxer (florasulam) was shown to be safe to use on narcissus – there was no damage to flowers or leaves
- Unlike Fortrol, Boxer has no residual activity, so a follow-up treatment with a residual herbicide is needed
- A post-flower cropping application of tank-mix Flexidor 125 + Butisan S, following Boxer, appeared to be safe

Background and expected deliverables

Discussions with growers of ornamentals almost invariably highlight a need for advice on herbicides. As with other 'minor' crops, there are very few herbicide recommendations for flower-bulbs, since agrochemical companies do not consider the relatively small economic value of such specialist crops sufficient to justify the cost of the development and approval process. As a consequence, growers rely heavily on off-label usage, and herbicide applications are often made on the basis of *ad hoc* trials. The aim of this project was to:

- Determine whether Boxer is safe to use on narcissus, and if it could substitute for Fortrol
- Discover appropriate rates and timings for Boxer on narcissus
- Determine whether it is safe to apply post-flower cropping Flexidor 125 + Butisan S after a Boxer application
- Evaluate Shark as a desiccant for narcissus, suitable for replacing sulphuric acid

Summary of the project and main conclusions in the first year

- In the first year of the trial no crop damage was observed at any growth stage from any herbicide treatment.
- Boxer appeared to be very safe to narcissus at all timings at 50ml/ha (half the normal dose rate recommended for cereals). It was also safe at the cereal dose (100ml/ha), although this rate was tested only at the early timing, when leaves were 7cm tall. A tank-mix of Flexidor + Butisan (2.0 + 2.5L/ha), applied post-flowering, was also safe. However, it will be necessary to determine if there are any adverse effects of these treatments on flowering and bulb yield in the second year of the crop.
- There were no weeds on untreated plots before the post-emergence treatments were applied at the 7-10cm leaf stage and before rapid bud growth. Therefore, it was not possible to assess the herbicide efficacy of contact-acting Boxer. A few weeds emerged on all plots (except those treated with Fortrol) during April. Thus it appeared that the residual activity of Fortrol was useful in controlling weeds throughout the flowering period.
- Flexidor + Butisan (which is mainly residual soil-acting) was not as effective on emerged weeds as Boxer. Butisan did not control emerged black bindweed and knotgrass, and the tank-mix did not prevent weeds emerging after 6 May. Flexidor, with mainly residual activity, did not control emerged weeds. Residual action did not appear to prevent another flush of weeds emerging later in May.

- A tank-mix or programme of Boxer with a residual herbicide is therefore needed, and it is proposed that this is tested in year 2.

Financial benefits

A full assessment of the benefits of this project must await the results of the second year's work, in which the effect of herbicide treatments on flower cropping and bulb yields will be evaluated. However, Boxer appears to have a wide margin of safety on narcissus at the dose rates and timings tested. Boxer, a cereal herbicide, is considerably cheaper than Fortrol. However, Fortrol has contact action and not very persistent residual activity, while Boxer has only contact action and will need to be used in a tank-mix with, or to follow, a residual herbicide and this will be investigated in the second year.

Action points for growers

While noting that these results are from only one year's trial and the effects on the following year's flower cropping and bulb yield and quality are as yet unknown, Boxer could be tested (at the grower's risk) on small areas of commercial flower crops.

BOF 52

Narcissus: Seeking replacements for 'Fortrol' (cyanazine) and sulphuric acid

INTRODUCTION

The UK is the world leader in the production of narcissus bulbs and flowers, a high proportion of its output being exported, and the rest supplying a traditional home market that is becoming dominated by the multiple retailer sector. Like other of the smaller crop sectors, bulb growers suffer from a shortage of suitable pesticides and approvals, but these are essential for the efficient production of high quality products. For example, bulb growers aim to achieve a high level of weed control, which:

- Increases yield by eliminating competition from weeds, which can reduce bulb yields by about 10%, or much more when under stress in dry conditions
- Increases flower quality, as the stem does not become weak by excessive elongation trying to outgrow weeds
- Makes bulb lifting and sorting operations more effective by eliminating weeds that clog machinery
- Removes weed hosts of the stem nematode

Herbicides

Numerous herbicide trials with narcissus were reported in the 1970s and 1980s. The UK findings were incorporated into the former ADAS booklets and leaflets, but all these sources are becoming out-dated. The HDC funded a project (BOF 35, completed in 1995) aimed specifically at identifying late-season (post-flowering) herbicide treatments. The only other recent UK trials were HDC-funded projects dealing with the control of volunteer potatoes in narcissus and of volunteer narcissus in winter wheat (BOF 46 and 47, both completed in 2002). None of the recent work specifically addressed weed control in the earlier stages of growth (post-shoot-emergence), where Fortrol (cyanazine) has proved so useful.

There are only six active substances that specifically state on-label "for use on narcissus": bentazone, chlorpropham, cycloxydim, pendimethalin, cyanazine and pentanochlor. Of these, the last two cannot be used after 2007. Cyanazine has a derogation for 'Essential Use' until the end of 2007 on narcissus, and pentanochlor for ornamentals. Bentazone and pendimethalin have approval on-label for additional use in narcissus grown for galanthamine production. There are 19 other active ingredients, including 'total' herbicides, with on-label use for ornamental plant production (see Table 1). Under the current Long Term Arrangements for Extension of Use (LTAEU), subject to specific restrictions and at their own risk, growers of non-edible crops can also use pesticides approved for any growing crop; however, the LTAEU are under review and this situation is likely to change.

Table 1. Active substances for outdoor narcissus.

Active substance	*Approval status*
Dormant period	
Amitrole	on-label ornamental plant production
Glufosinate-ammonium	on-label ornamental plant production
Glyphosate	on-label ornamental plant production
Paraquat	on-label ornamental plant production
Diquat	on-label ornamental plant production
Dichlobenil	on-label ornamental plant production
Triclopyr	on-label ornamental plant production
Residual pre-crop-emergence	
Chlorpropham	on-label for outdoor narcissus
Trifluralin	SOLA ornamental plant production
Lenacil	on-label ornamental plant production
Diuron	on-label ornamental plant production
Oxadiazon	on-label ornamental plant production
Propyzamide	on-label ornamental plant production
Propachlor	on-label ornamental plant production
Simazine	Revoked, use up by 10 September 2005
Post-emergence crop (7-10 cm leaves) and weed	
Cyanazine	Essential Use on-label for outdoor narcissus until end-2007
Pentanochlor	Essential Use on-label for ornamental plant production until end-2007
Post-flowering residual	
Isoxaben	ornamental plant production (+ protected ornamentals)
Metazachlor	on-label ornamental plant production
Post-flowering foliar acting	
Bentazone	on-label for outdoor narcissus
Clopyralid	on-label ornamental plant production
Fluroxypyr	on-label ornamental plant production
Grass weed killers post-emergence crop	
Cycloxydim	on-label for outdoor narcissus
Fluazifop-P-butyl	SOLA ornamental plant production
Desiccant	
Sulphuric acid	Commodity substance, bulbs

For use on narcissus, herbicide treatments generally fall into three categories:

- *Pre-crop-emergence residual herbicides*

The aim is to apply a residual as late as possible before shoot emergence, though emergence dates vary greatly between cultivars and there is a danger of missing the ideal spray date. CIPC + Linuron tank-mix is the most widely used herbicide at this stage.

- *Early-post-emergence herbicides*

Just one of the several available chlorpropham products is recommended for use at shoot heights of up to 5cm. Fortrol is recommended for use at shoot heights of 5-10cm. Due to the variability of emergence across a field, spray dates have to be judged carefully. Later application must be avoided because of the possibility of damage to the flower buds, but this may conflict with a requirement for weed control that persists until after flowering.

- *Post-flowering herbicides*

There are on-label recommendations at this stage for chlorpropham (one product) and bentazone, the latter being contact-acting and for application at or after flowering, but not

during flower bud formation. Chlorpropham and bentazone would not substitute for the post-emergence role of cyanazine. In an earlier HDC project (BOF 35), trials showed that, of several materials tested, only an isoxaben + metazachlor tank-mix was safe at all application dates, including post-flowering. Isoxaben and metazachlor have mainly residual activity.

The triazine herbicide cyanazine (as 'Fortrol' or various other cyanazine products) is widely relied on by bulb growers as a post-crop-emergence herbicide with contact and residual action. The Defra Pesticide Usage Survey showed that cyanazine was used on 2,275ha of bulb crops in 2001, 44% of the crop (see Table 2). Cyanazine's derogation for 'Essential Use' in narcissus runs until the end of 2007, with sale and supply ceasing by 30 June 2007. To meet the 2007 deadline, alternative herbicides need to be tested for their safety on narcissus, starting with crops planted in 2003. Narcissus are grown as two-year-down crops, or often longer, and it is important to test herbicide-treated field-grown bulbs for the absence of detrimental side-effects when they are forced under glass in winter/spring after lifting. Some herbicides are known to damage the flower bud, which in narcissus is initiated in the bulb in May, close to possible herbicide application dates. However, florasulam, a triazolopyrimidine herbicide for cereals marketed by Dow AgroSciences as 'Boxer', has shown promise as a post-emergence herbicide on onions and leeks, and appears to be a useful candidate as a replacement for Fortrol on narcissus. Dow AgroSciences have carried out some preliminary trials of florasulam on narcissus, but no information is available on suitable rates of use or of its possible subsequent effects on bulbs and flowers (Dow AgroSciences, personal communication). Other novel herbicides for use on narcissus were also considered for inclusion in this trial, but they were all eliminated on the basis of the likelihood of phytotoxicity or inappropriate weed control spectra.

Post-emergence herbicides are usually applied to narcissus when the crop leaves are no longer than 7-10 cm. Therefore, in the proposed trial, a late-season application of Boxer (florasulam) was tested as well as early applications.

The successful testing of Boxer or other alternative herbicides on narcissus crops would have a number of benefits for growers:

- Maintaining a post-crop-emergence weed control programme once Fortrol is no longer available
- Knowledge of the effects of Boxer as a late-season herbicide
- Avoiding making ineffective herbicide applications as 'better than nothing', taking risks with herbicides, or carrying out *ad hoc* tests.

Desiccants

A related need of bulb growers is the lack of a suitable desiccant for pre-harvest use. Some means of foliage removal is vital, as marketing requirements mean that narcissus bulbs must be lifted before the foliage dies down. The only desiccant approved, sulphuric acid, has the obvious disadvantages of requiring application by a specialist contractor, and the stringent precautions that are necessary, while mechanical defoliation or burning also have disadvantages. The potato desiccant/herbicide carfentrazone-ethyl (formulated as 'Spotlight 24 EC' or 'Shark') is a candidate for use on narcissus.

Table 2. The use of herbicides on outdoor bulbs grown in Great Britain in 2001. Herbicides used on 10% or more of the crop or more are shown in bold. The data are from the CSL Pesticide Usage Survey for Defra (2003).

Active substances	*Spray area (ha)*
Total weeds	
Diquat	147
Diquat/paraquat	**2,043**
Glyphosate	**5,104**
Paraquat	**916**
Grasses	
Fluazifop-P-butyl	469
Broad-leaved weeds	
Bentazone	**1,950**
Chlorpropham	**1,604**
Chlorpropham/linuron[1]	179
Cyanazine[2]	**2,275**
Diuron	**536**
Isoxaben	157
Lenacil	**1,072**
Linuron	**2,680**
Metamitron	**1,911**
Pendimethalin	**531**
Simazine[2]	274
Total area treated with herbicide (ha)	*22,134*
Crop area 2001(ha)	*5,237*
Herbicides as % area grown	*422.6*

[1] No longer available

[2] Not supported, or not achieving Annex 1 listing in the EC Review

MATERIALS AND METHODS

Bulbs and husbandry

A crop of the standard narcissus cultivar 'Carlton' was used to test herbicides over the period summer 2003 to summer 2004. The trial site was on a medium silty marine alluvial soil at Warwick HRI, Kirton, Boston, Lincolnshire, UK, and was typical of the South Lincolnshire agricultural area where narcissus are widely grown. Prior to setting up the trial, the site was ploughed, cultivated and treated with paraquat + diquat. Standard soil sampling (0-15cm depth) across the site gave the following analysis: pH 7.1, nitrate index 0, P index 4, K index 2-, Mg index 3 and conductivity index 0. Following a winter wheat crop, the nitrogen index was taken as 0. Potash (as sulphate of potash) was applied pre-cultivation at a rate of 150kg K_2O/ha, and nitrogen (as ammonium nitrate) was applied as a top-dressing pre-emergence at a rate of 125kg N/ha.

Herbicide treatments

The test herbicide treatments formed part of an overall herbicide programme. Thus, all plots received 'dormant season' and pre-crop-emergence herbicides as follows:

- 'Dormant season' glyphosate (as 2 L/ha 'Roundup' in 250L water/ha on 9 December 2003)
- Pre-crop-emergence CIPC + linuron (as 4.2L/ha MSS CIPC40 EC + 1.68L/ha Alpha Linuron 50 SC in 450L water/ha on 7 January 2004)

The experimental treatments comprised various rates and timings of Boxer, compared with a standard treatment of Fortrol (at early post-emergence stage), all applied in 250L water/ha. A further treatment was Flexidor 125 + Butisan S, applied post-flower-cropping in 450L water/ha. In trials of this type it is important to check for crop safety in a 'worst-case' scenario, so it is planned to apply the Boxer test treatments in both the first and second years of the crop (as growers would use the herbicide in practice). Shark will be applied as a pre-harvest desiccant in year two only, following a 50 ml/ha Boxer application. All herbicide treatments were applied using an 'Oxford' precision sprayer fitted with 02/F80 nozzles. Table 3 (below) summarises these herbicide applications. Information on the status of these herbicides is given in Table 4, while the key dates for the trial are shown in Table 5.

The trial design was a randomised block with three replicates x 12 treatments, each plot consisting of two adjacent ridges 6.6m long, with a guard ridge between each treated plot. The data presented in this report are the means of the three replicates of each treatment, and no formal statistical analysis was deemed necessary at this stage.

Table 3. Post-emergence and post-flower cropping herbicide treatments, and pre-harvest defoliation treatments, applied in 2003-2004. All treatments were preceded by dormant season application of glyphosate and pre-emergence application of CIPC + Linuron (see text).

Treatment	*Herbicide application rate (product per ha)*			*Pre-harvest defoliation (year 2 only; method or product per ha)*
	Standard early-post-emergence stage (leaves 7-10 cm long)	*Late-post-emergence stage (before rapid bud growth)*	*Post-flower-cropping stage*	
1. Untreated control	-	-	-	Flailing
2. Hand-weeded control	-	-	-	Flailing
3. Standard Fortrol	Fortrol (5.2L)	-	-	Flailing
4. Boxer, low-rate	Boxer (25ml)	-	-	Flailing
5. Boxer, mid-rate	Boxer (50ml)	-	-	Flailing
6. Boxer, cereal dose	Boxer (100ml)	-	-	Flailing
7. Boxer, mid-rate (late)	-	Boxer (50ml)	-	Flailing
8. Boxer, mid-rate split-dose	Boxer (25ml)	Boxer (25ml)	-	Flailing
9. Boxer, high-rate split-dose	Boxer (50ml)	-	Boxer (50ml)	Flailing
10. Boxer, mid-rate, followed by Flexidor 125 + Butisan S	Boxer (50ml)	-	Flexidor 125 (2.0L) + Butisan S (2.5L)	Flailing
11. Boxer, mid-rate, with Shark	Boxer (50ml)	-	-	Shark (1.6L)
12. Boxer, mid-rate, with split-dose Shark	Boxer (50ml)	-	-	Shark (1.0L and 0.6L 7 days later)

Table 4. Status of the herbicides used in this project (as at October 2004).

Product name	*a.i. and formulation*	*Marketing company*	*EC Review of a.i.*	*Approval other crops / narcissi*
Fortrol	cyanazine 500g/L SC	Makhteshim, etc.	Not supported; revoked	Essential Use narcissus until end-2007
Flexidor 125	isoxaben 125g/L SC	Landseer, etc.	Supported	UK ornamentals
CIPC 40 EC	chlorpropham 400g/L EC	Whyte Agrochemicals, etc.	Annex 1	UK narcissus
Alpha Linuron 50SC	linuron 500g/L SC	Makhteshim, etc.	Annex 1	UK some vegetables LTAEU
Butisan S	metazachlor 500g/L SC	BASF, etc.	Supported	UK ornamentals
Boxer	florasulam 50g/l	Dow AgroSciences	Annex 1	UK cereals LTAEU
Shark	carfentrazone-ethyl 60g/L ME	Belchim	Annex 1	UK potato haulm destruction and cereals LTAEU
Sulphuric acid	Sulphuric acid soluble concentrate	Commodity substance	Supported, round 4 of review	Unlikely to continue?

Table 5. Diary of operations and sprays (year 1, 2003-2004, only).

Operation	*Date*	*Temp. (°C)*[1]	*Growth stage – crop*	*Growth stage - weeds*
Narcissus planted	26 September 2003	-	-	-
Glyphosate on all plots	9 December 2003	5.2	Pre-emergence	-
Pre-emergence CIPC + Linuron on all plots	7 January 2004	6.6	Pre-emergence	-
Mean shoot emergence	18 January 2004	3.8	-	-
Standard early post-emergence treatment	9 Feb 2004	3.3	Leaves average 6-8 cm tall (range 2-15 cm)	No weeds
Late-post-emergence (before rapid bud growth) treatment	24 Feb 2004	3.6	Stem extended but not at rapid bud growth	No weeds
Post-flower-cropping treatment	6 May 2004	9.8	Post-flower-cropping, seed heads, 70% crop cover	Very few weeds. Knot-grass 2TL[2]

[1] Mean daily values
[2] 2TL, two true-leaves

Records

The crop was examined in the field for symptoms of phytotoxicity in year one (2003-2004). Any other adverse effects on flower and bulb yield will be assessed in year two (2004-2005), and for subsequent bulb performance when forced in a glasshouse in 2005-2006.

In the first year, frequent *ad hoc* examinations were made, along with the following formal assessments:

- Crop and weed stage of development at the time of treatments
- Crop tolerance (i.e. phytotoxic symptoms and crop stand) was assessed at intervals after each herbicide application using the scores given below:

Crop tolerance score	*% Phytotoxicity*
0	Complete kill
1	80 – 95% damage
2	70 – 80% damage
3	60 – 70% damage
4	50 – 60% damage
5	40 – 50% damage
6	25 – 40% damage
7	20 – 25% damage (considered unlikely to cause reduction in yield or quality at cropping)
8	10 – 20% damage
9	5 – 10% damage
10	No damage (as untreated controls)

The main assessment dates were 16 February (buds visible), 24 February (leaves 20cm high, buds showing), 8 March (late-bud stage), 17 March (50% flowers open), 12 May (seed heads, 70% crop cover), 27 May (mid die-down) and 11 June 2004 (late die-down).

- Weed cover was assessed as the percentage of the soil area on the ridge covered by weeds
- Numbers of each weed species present counted in random 0.17m^2 quadrats, six counts per plot, at appropriate intervals after each application

RESULTS AND DISCUSSION

Crop tolerance in year 1 (2004)

No crop damage was observed at any growth stage from any herbicide treatment. Boxer appeared to be very safe to narcissus at all timings at 50ml/ha (half the normal dose rate recommended for cereals). It was also safe at the cereal dose (100ml/ha) when tested at the early timing - when leaves were 7cm tall. Flexidor + Butisan (2.0 + 2.5L/ha), applied post-flowering, was also safe. However, since narcissus are generally grown for two years before lifting, it will be necessary to determine any adverse effects on flowering and bulb yield in a year's time.

Weed assessments

The weed distribution was uneven over the trial area, and weed numbers were low. Greater numbers of weeds are expected in the second year of the crop, when treatments and assessments will be repeated.

The overall pre-crop-emergence treatment, CIPC + Linuron, was effective in controlling weeds. Although a few seedlings began to appear at the beginning of February, they later died as a result of severe frost. There were no weeds on untreated plots before post-emergence treatments were applied on 9 and 24 February 2004. There were no emerged weeds for Boxer to control when applied on these dates. It was not possible to assess the herbicide efficacy of contact-acting Boxer applied on 9 or 24 February, because there were no weeds present. A few weeds emerged on all plots (except those treated with Fortrol) during April. Thus it appeared that the residual activity of Fortrol was useful in controlling weeds throughout the flowering period.

Weed counts on 3 May and 11 June 2004 are shown in Table 6. Assessments on 3 May showed that, as expected, Fortrol, with its residual activity, was the most effective treatment, persisting until 11 June. There were no weeds on two of the three replicates of this treatment. Boxer was shown to be as effective as Fortrol when used at either the 100ml/ha rate or as a split-dose application (2 x 50ml/ha), the other Boxer treatments being less effective.

Table 6. Weed numbers before and after the post-flower cropping herbicide applications.

	Herbicide timing and dose rate/ha		*Weed numbers /m²*	
Leaves 7-10 cm (9 Feb.)	*Before rapid bud growth (24 Feb.)*	*Post-flower cropping (6 May)*	*3 May**	*11 June*
1 Untreated	-	-	24	20
2 Hand weed	-	-	0	0
3 Fortrol 5.2L	-	-	2	5
4 Boxer 25ml	-	-	13	22
5 Boxer 50ml	-	-	8	22
6 Boxer 100ml	-	-	4	12
7 -	Boxer 50ml	-	14	12
8 Boxer 25ml	Boxer 25ml	-	8	18
9 Boxer 50ml	-	Boxer 50ml	-	5
10 Boxer 50ml	-	Flexidor 2.0L + Butisan 2.5L	-	12

* Numbers in six random 0.17m² quadrats.

The weed species present on 3 May and 11 June 2004 are shown in Tables 7 and 8, respectively. Before post-flowering treatments were applied (6 May), weed populations remained very low, with only 24/m^2 on untreated plots, mainly black bindweed and knotgrass. After post-flowering treatments had been applied a few weeds emerged. Assessments on 11 June showed that Boxer (at 50ml/ha) applied on 5 May was effective in controlling black bindweed but not knotgrass, and the remaining weeds numbered less than 5/m^2. Flexidor + Butisan was not as effective on emerged weeds, 12/m^2 remaining. Butisan did not control emerged black bindweed and knotgrass, and Flexidor, with mainly residual activity, did not control emerged weeds. Residual action did not appear to prevent another flush of weeds emerging later in May. Next year it is proposed to add another residual herbicide, either as a tank-mix or in a programme with Boxer.

Table 7. Weed numbers of each species and total numbers present, 3 May 2004.

Herbicide timing and rate/ha		*Weed numbers /m^2*							
Leaves 7-10 cm (9 Feb.)	*Before rapid bud growth (24 Feb.)*	Black-bindweed	Knot grass	Speed-well	Ground-sel	Chick-weed	May weeds	Red dead-nettle	*Total*
1 Untreated	-	6	7	1	2	4	4	0	24
2 Hand weed	-	0	0	0	0	0	0	0	0
3 Fortrol 5.2L	-	2	0	0	0	0	0	0	2
4 Boxer 25ml	-	4	2	1	3	0	2	1	13
5 Boxer 50ml	-	1	4	3	0	0	0	0	8
6 Boxer 100ml	-	1	3	0	0	0	0	0	4
7 -	Boxer 50ml	4	4	4	1	0	1	0	14
8 Boxer 25ml	Boxer 25ml	4	4	0	0	0	0	0	8
9 Boxer 50ml	-	9	9	0	0	0	1	0	19
10 Boxer 50ml	-	2	7	0	0	0	0	0	9

Black-bindweed *(Fallopia convolvulus)*, Knotgrass (*Polygonum aviculare)*, Common field speedwell *(Veronica persica)*, Groundsel (*Senecio vulgaris*), Chickweed *(Stellaria media)*, Mayweed, scentless (*Tripleurospermum inodorum)*, Pineappleweed (*Matricaria discoidea)*, Red dead-nettle (*Lamium purpurium)*.

Table 8. Weed species present and percentage weed cover on 11 June 2004.

Herbicide timing and dose rate/ha			*Weed assessments on 11 June*	
Leaves 7-10 cm (9 Feb.)	*Before rapid bud growth (24 Feb.)*	*Post-flower cropping (6 May)*	*Main weed species*	*% cover*
1 Untreated	-	-	Black-bindweed, knotgrass, chickweed, redshank, groundsel, nettle, mayweeds, shepherd's purse	20
2 Hand weed	-	-	None	0
3 Fortrol 5.2L	-	-	Black-bindweed, knotgrass	<3
4 Boxer 25ml	-	-	As untreated	12
5 Boxer 50ml	-	-	As untreated	10
6 Boxer 100ml	-	-	As untreated	5
7 -	Boxer 50ml	-	Black-bindweed, knotgrass	5
8 Boxer 25ml	Boxer 25ml	-	As untreated	7
9 Boxer 50ml	-	Boxer 50ml	As untreated	<5
10 Boxer 50ml	-	Flexidor 2.0 L+ Butisan 2.5L	As untreated	8

Black-bindweed *(Fallopia convolvulus)*, Knotgrass (*Polygonum aviculare)*, Chickweed *(Stellaria media)*, Redshank (*Persicaria maculosa)*, Groundsel (*Senecio vulgaris*), Small nettle *(Urtica urens,)* Mayweed, scentless (*Tripleurospermum inodorum)*, Pineappleweed (*Matricaria discoidea)*, Shepherd's purse *(Capsella bursa-pastoris.*

CONCLUSIONS

No crop damage was observed at any growth stage from any herbicide treatment in this, the first year of the trial. Boxer appeared to be very safe to narcissus at all timings at 50ml/ha (half the normal dose rate recommended for cereals). It was also safe at the cereal dose (100ml/ha), but this rate was tested only at the early timing, when leaves were 7cm tall. Flexidor + Butisan (2.0 + 2.5L/ha), applied post-flowering, was also safe. However, it will be necessary to determine any adverse effects on flowering and bulb yield in the second year of the crop, 2005-2006.

The overall pre-crop-emergence treatment, CIPC + Linuron, was effective in controlling weeds. However, from experience, this is not always the case at Kirton.

There were no weeds on untreated plots before post-emergence treatments were applied on 9 and 24 February 2004. Therefore, it was not possible to assess the herbicide efficacy of contact-acting Boxer. A few weeds emerged on all plots (except those treated with Fortrol) during April. Thus it appeared that the residual activity of Fortrol was useful in controlling weeds throughout the flowering period. A tank-mix or programme of Boxer with a residual herbicide is, therefore, needed.

Weed assessments on 3 May showed that, as expected, Fortrol, with its residual activity, was the most effective treatment, persisting until 11 June. There were no weeds on two of the three replicates of this treatment. Boxer was shown to be as effective as Fortrol on the low population of emerged weeds when used at the 100ml/ha rate or as 2 x 50ml/ha applications, the other Boxer treatments being less effective. Boxer at 50ml/ha was effective in controlling black bindweed but not knotgrass.

Flexidor + Butisan - mainly residual soil-acting - was not as effective on emerged weeds as Boxer, Butisan did not control emerged black bindweed and knotgrass, and the tank-mix did not prevent weeds emerging after 6 May. Flexidor, with mainly residual activity, did not control emerged weeds. Residual action did not appear to prevent another flush of weeds emerging later in May.

Next year it is proposed to add another residual herbicide, either as a tank-mix or in a programme with Boxer. Some candidates could include Skirmish (terbuthylazine/isoxaben), Stomp (pendimethalin), Goltix (metamitron), Pyramin DF (chloridazon), Sencorex (metribuzin) and Kerb (propyzamide).

ACKNOWLEDGEMENTS

We thank Mr Rodney Asher (Warwick HRI) for carefully carrying out the field work for this project.

APPENDIX 1

Boxer efficacy data (Dow AgroSciences)

Boxer (florasulam): susceptible weeds at 50ml product/ha
Cleavers - up to 10cm
Chickweed - six true-leaves
Mayweeds - rosette stage
Volunteer OSR - four true-leaves
Charlock - four true-leaves.

At 25ml product/ha the weed spectrum would be similar, though the weed sizes controlled would be smaller.

Boxer (florasulam): susceptible weeds at 100ml product/ha (the supported rate in cereals)
Cleavers – 20cm
Chickweed - flowering
Hedge mustard – 10cm
Mayweeds - flower buds visible
Shepherd's purse – 10cm
Volunteer OSR - flower buds visible
Runch – 10cm
Black-bindweed – 10cm
Black-nightshade – 5cm
Charlock - before flower buds visible
Corn marigold – up to rosette stage
Clover – 10cm
Forget-me-not – 10cm
Groundsel – 5cm
Hemp nettle - four true-leaves
Parsley piert – 10cm
Shepherd's needle – 10cm
Sowthistle (annual) – 10cm
Thale cress - six true-leaves
Wild carrot - six true-leaves
Volunteer peas – 10cm
Weed beet - six true-leaves

Boxer (florasulam): resistant weeds at 100ml product/ha (R, resistant; MR, moderately Resistant; MS, moderately susceptible)
Fat-hen - R
Small (annual) nettle - R
Common poppy - MR
Knotgrass - MS

Shark – susceptible weeds

Shark: susceptible weeds at desiccation stage
Fat-hen
Knotgrass
Redshank
Black-bindweed
Speedwells
Cleavers
Volunteer OSR
Volunteer potatoes (suppressed, but tubers not destroyed)

Shark: resistant weeds at desiccation stage
Grasses

APPENDIX 2

Common and Latin weed names

Common name	Latin name
Bindweed, black-	*Fallopia convolvulus*
Bugloss	*Anchusa arvensis*
Charlock	*Sinapis arvensis*
Chickweed, common	*Stellaria media*
Cleavers	*Galium aparine*
Corn marigold	*Chrysanthemum segetum*
Corn spurrey	*Spergula arvensis*
Crane's-bill, cut-leaved	*Geranium dissectum*
Dead-nettle, henbit	*Lamium amplexicaule*
Dead-nettle, red	*Lamium purpureum*
Dock, broad-leaved	*Rumex obtusifolius*
Fat-hen	*Chenopodium album*
Fool's parsley	*Aethusa cynapium*
Forget-me-not, field	*Myosotis arvensis*
Fumitory, common	*Fumaria officinalis*
Gallant -soldier	*Galinsoga parviflora*
Groundsel	*Senecio vulgaris*
Hemp-nettle, common	*Galeopsis tetrahit*
Knotgrass	*Polygonum aviculare*
Mayweed, scented	*Matricaria recutita*
Mayweed, scentless	*Tripleurospermum inodorum*
Nettle, small	*Urtica urens*
Nightshade, black-	*Solanum nigrum*
Orache, common	*Atriplex patula*
Pansy, field	*Viola arvensis*
Parsley piert	*Aphanes arvensis*
Pennycress, field	*Thlaspi arvense*
Persicaria, pale	*Persicaria lapathifolia*
Pimpernel, scarlet	*Anagalis arvensis*
Pineappleweed	*Matricaria discoidea*
Poppy, common	*Papaver rhoeas*
Redshank	*Persicaria maculosa*
Shepherd's-purse	*Capsella bursa-pastoris*
Sow-thistle, smooth	*Sonchus oleraceus*
Speedwell, common, field	*Veronica persica*
Speedwell, ivy-leaved	*Veronica hederifolia*
Sun spurge	*Euphorbia helioscopia*
Thistle, creeping	*Cirsium arvense*
Wild radish	*Raphanus raphanistrum*
Annual meadow-grass	*Poa annua*
Blackgrass	*Alopecurus myosuroides*
Brome, barren	*Anisantha sterilis*
Wild-oat	*Avena fatua*