Project title:	Narcissus: The use of herbicides, singly and in combination, and at different growth stages, for control of volunteer potatoes
Project number:	BOF 46
Project leader:	Mr J B Briggs ADAS Park Farm Ditton, Aylesford, Kent, ME20 6PE
Annual Report:	Year 1 annual report, December 2000
Previous reports and dates:	None
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Location of project:	ADAS Arthur Rickwood. (address as above)
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Date project commenced:	1 August 1999
Date completion due:	31 March 2002
Keywords:	volunteer potato, narcissus, herbicide, weed control, Dow shield, Starane 2, Betosip, Nortron, Totril, Dosaflo

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

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COMMERCIAL BENEFITS OF THE PROJECT

Once completed, this project will provide practical and cost-effective recommendations for the control of volunteer potatoes in narcissus crops.

BACKGROUND AND OBJECTIVES

Narcissus and potatoes are commonly grown within the same rotation to capitalise on shared equipment and facilities. Within the potato industry higher marketing standards now result in more under-sized potatoes being returned to the soil where they compete seriously with narcissus crops. Whilst appropriate control strategies are used in crops preceding narcissus there is no specific information on control in narcissus crops themselves.

The main problems in using herbicides for the control of volunteer potatoes in the narcissus crop are those of timing and the extreme sensitivity of narcissus to treatments applied post-flowering in April-May. Narcissus are particularly sensitive to herbicide damage after flowering as this is the time when next year's leaves and flowers begin to form in the bulb. Unfortunately, this coincides with the first opportunity that the grower has to control the newly emerged, rapidly growing potato volunteers.

A recent LINK project funded by MAFF (BPC 807/151) and the British Potato Council (BPC) has investigated rotational control of potato volunteers within arable rotations. The study evaluated the scale of the problem, the potential for disease and virus carry-over on volunteers, and in-part, the evaluation of strategies for control. Similar studies have also recently been completed by the Sugar Beet Research and Education Council (SBREC) (RG 7394A) on control of volunteer potatoes in rotations containing sugar beet, where, as with narcissus, they exert considerable competitive pressure. These studies have indicated that herbicides are unable to provide consistently reliable control on their own, and that an integrated control strategy is required to control volunteer potatoes, making use of cultivation and crop competition effects as well as a planned approach to chemical control throughout the cropping rotation. Poor control in a single season can undermine good control achieved in previous years.

The integration of control in narcissus crops with measures in other arable crops will achieve an integrated approach to control in the whole-farm situation.

The commercial objectives are to screen potentially effective herbicide active ingredients, at a range of typical dose rates, in various sequences, and at different timings for crop safety and efficiency of volunteer potato control. Table 1 below lists the treatments applied.

Table 1. List of treatments, applied in 450l water/ha, 2000.

Treatment number	Product	Active ingredient	Rate of product/ha (litres)
1	No volunteers and no herbicides	-	-
2	Volunteers present, no herbicide		
3	Dow Shield *	Cloparylid (200g/l)	1
4	Dow Shield **	Cloparylid (200g/l)	1
5	Dow Shield * and **	Cloparylid (200g/l)	1
6	Starane 2 *	Fluroxypyr (200g/l)	2
7	Starane 2 **	Fluroxypyr (200g/l)	2
8	Betosip, Nortron and Dow Shield *	Phenmedipham (114g/l), Ethofumesate (500g/l), Cloparylid (200g/l)	2.5, 1.5, 0.5
9	Betosip, Nortron and Dow Shield **	Phenmedipham (114g/l), Ethofumesate (500g/l) Cloparylid (200g/l)	2.5, 1.5, 0.5
10	Betosip, Nortron and Dow Shield *, then Starane 2 **	Phenmedipham (114g/l), Ethofumesate (500g/l) Cloparylid (200g/l)	2.5, 1.5, 0.5, 2.0
11	Totril and Starane 2 **	Ioxynil (225g/l), Fluroxypyr (200g/l)	1.0, 1.0
12	Dosaflo ***	Metoxuron (500g/l)	5.5

* = Treatment applied when the potatoes were 5-10cm tall
** = Treatment applied when the potatoes were 10-20cm tall
*** = Treatment applied when the potatoes were 25-30cm tall

SUMMARY OF RESULTS AND CONCLUSIONS

Herbicide application

Herbicides, both singly and in combinations, were applied to a narcissus crop (cultivar Ice Follies) with potato volunteers (cultivar Maris Piper) when the potatoes were at three different growth stages; 5-10 cm, 10-20 cm and 25-30 cm tall. These related to approved application dates according to product guidelines for volunteer potato control and also provided a range of vigour in potato crop growth at the time of treatment. Potato growth was very rapid and treatments had to be applied in quick succession between 8 and 22 May 2000.

When sufficient potato haulm re-growth was present in the following autumn, an application of glyphosate was planned for half of each plot in the trial during bulb dormancy in September. The autumn flush of potato growth was very slow and adverse weather conditions in October delayed the application of glyphosate until 3 November 2000. When the application was made, there were still only a few potatoes emerged, and they were between 5-10 cm tall. Assessments will be made in 2001.

Control of volunteer potatoes

The pattern of control of volunteer potatoes, as measured by visual phytotoxicity scores, changed over the course of the growth period May to July 2000.
Initially, in June, Starane 2, and mixtures of Betosip + Nortron + Dow Shield at 5-10cm; Betosip + Nortron + Dow Shield + Starane 2 (10-20 cm); Totril + Starane 2 and Dosaflo (10-20 and 25-30cm) gave significantly better control than the untreated controls.

Later in the season in July, only Betosip + Nortron + Dow Shield at 5-10cm, together with all three Dow Shield only treatments demonstrated any residual level of activity on potato volunteers, effects having been out-grown in other treatments.

Crop safety

Betosip + Nortron + Dow Shield at 5-10 cm and the three Dow Shield only treatments showed no visual damage compared with the untreated control treatments.

When the project finishes in spring 2002, after growing on narcissi for a further year and effects on flowering are recorded, it will be possible to make recommendations on the most effective and safe herbicides for control of potato volunteers.

ACTION POINTS FOR GROWERS

Until the project is completed in spring 2002 final conclusions cannot be drawn on issues of crop safety, or on residual levels of volunteer potato control.

ANTICIPATED PRACTICAL AND FINANCIAL BENEFITS

In narcissus, weed competition has been shown in trials to reduce narcissus bulb yield by approximately 10% under normal conditions, with a considerably higher reduction under conditions of water stress. In sugar beet, yield reductions of up to 16% have been recorded in ADAS trials due to volunteer potato competition (Millars and Cleal, 1996). Narcissus bulb yield could be reduced by a similar amount to sugar beet, given the crops' dependence on adequate moisture at the time of bulking from mid-April onwards. This could represent a reduction in output of approximately £1,160/ha for bulbs alone. There could be a further reduction of flower yield, costing the grower some £500/ha, depending on the season. This work should help to provide some indication of the likely losses associated with volunteer potato infestation of narcissi and once completed, will provide practical and cost-effective recommendations for the control of volunteer potatoes in narcissus crops.

SCIENCE SECTION

INTRODUCTION

Narcissus and potatoes are often grown in the same rotation. As a result of the increasing quality demands of potato markets more of the smaller and out-grade potatoes are returned to the soil at harvest. Volunteers arising from potatoes left after harvesting provide significant competition with the narcissus in following years. Volunteer potatoes are notoriously difficult to control. The scientific objectives of this experiment are to determine if herbicides showing activity in other crops could potentially be used to control volunteer potatoes without damaging the narcissus crop.

The following parameters are being evaluated:

- Effectiveness of control of volunteer potatoes.
- Phytotoxicity to narcissus, both in the field and when forced after the second year of the field trial, to determine any residual effects on flowers and leaves.
- Narcissus bulb and flower yield data.
- Residual effects on volunteer potatoes to evaluate cost-effectiveness of treatments.

The control of volunteer potatoes has been widely studied in arable rotations and vegetable crops, and the most effective treatments are summarised below:

Cereals

Roundup (glyphosate) applied pre-harvest of cereals at 1.44kg a.i./ha to control volunteer potatoes has been approved for many years. The presence of soft lush growth of potatoes in wet seasons improves the control (Lutman, 1993).

The use of Roundup pre-harvest of cereals has a place in controlling volunteer potatoes. The potatoes must have active foliage growth to allow efficient uptake of the chemical leading to effective reductions in foliage and tubers (Cleal, Hayward and Rawlings, 1993).

Sugar beet

In sugar beet Betanal (phenmedipham) and Dow Shield (clopyralid) has proved to be an effective combination to suppress potato volunteers. Overall, Dow Shield has given the most effective suppression of potato foliage when applied in mixtures with herbicides for broad-leaved weed control. The timing of application affected suppression of potato foliage and survival of tubers in the soil. Earlier application targeting potatoes before tuber initiation suppressed foliage well, but later applications during tuber initiation reduced tuber numbers returned to the soil (May and Hilton, 1993).

Onion

Products which have proved to be effective against volunteer potatoes in onions include Starane 2 (fluroxypyr), Dow Shield, Totril (ioxynil) and Dosaflo (metoxuron) (HDC projects FV 54, FV 54b, FV 54c). Dosaflo was used on peat soil in 1991 to suppress potatoes in onions. It was used when the onions were well-established (Runham, Davies and Leatherland, 1993).

Vegetable crops

Sequential sprays of Totril, Starane 2 and Dow Shield were evaluated for their control of potatoes in a range of vegetable crops by Bond (1993). Of these, mixtures containing Starane 2 gave the best suppression of potatoes, but no treatment controlled them completely. Onions and leeks were tolerant of these products but other broad-leaved crops were more susceptible.

MATERIALS AND METHODS

Trial location

The trial site was at ADAS Arthur Rickwood, the soil containing 25% organic matter. The site was chosen to be free of any possible contaminating sulfonyl urea residues.

Trial design

The trial was laid out as a randomised block split-plot design with four replicates, with a total of 112 sub-plots. Each plot measured two ridges by 5m, with a 1m guard between plots and a 5m guard around the trial area. Treatments consisted of 12 herbicide regimes, with a glyphosate or non-glyphosate treatment for each plot (see Appendix 1 for trial plan and Table 1 for treatment list). Treatment 2 was repeated three times for each replicate.

Planting dates

To ensure an even flush of potato volunteers across the site potatoes (cv. Maris Piper) were planted at the rate of 33,000 tubers/ha. Half of the tubers were planted together with the bulbs on 17 October 1999 at 20cm depth, and the other half were planted on 9 March 2000 at 10cm depth to simulate a staggered flush of potato emergence, more typical of a field situation.

The narcissus cultivar used was Ice Follies, grade 12-14cm, hot water treated on 8-9 September 1999. The Ice Follies were planted in standard ridges at a rate of 17.5t/ha on 17 October 1999.

Treatment/emergence dates

Standard herbicide treatments of Fortrol (cyanazine) at 5.2l/ha and Profalon (chlorpropham + linuron)at 8.4l/ha were applied to all plots on 2 and 25 February 2000 respectively.

The potatoes began to emerge on 16 March. The narcissus began to emerge on 21 January and were in full flower on 14 March.

The herbicide treatments at 5-10cm were applied on 8 May, the 10-20cm treatments were applied on 15 May, and the 25-30cm treatment was applied on 22 May.

The narcissus flowers began to senesce on 3 April 2000 and the plants were in the later stages of senescence on 6 July 2000.

Any remaining potato growth was flailed on 3 August. Glyphosate was applied to selected plots on 3 November as Stocato at 4.0l/ha in 450l/ha water. This was due to be applied earlier, but was delayed due to the lack of potato emergence after flailing, and the unusually wet autumn which prevented spray application.

Treatments

Table 1. List of treatments, applied in 450l water/ha, 2000.

Treatment number	Product	Active ingredient	Rate of product/ha (litres)
1	No volunteers and no herbicides	-	-
2	Volunteers present, no herbicide		
3	Dow Shield *	Cloparylid (200g/l)	1
4	Dow Shield **	Cloparylid (200g/l)	1
5	Dow Shield * and **	Cloparylid (200g/l)	1
6	Starane 2 *	Fluroxypyr (200g/l)	2
7	Starane 2 **	Fluroxypyr (200g/l)	2
8	Betosip, Nortron and Dow Shield *	Phenmedipham (114g/l), Ethofumesate (500g/l), Cloparylid (200g/l)	2.5, 1.5, 0.5
9	Betosip, Nortron and Dow Shield **	Phenmedipham (114g/l), Ethofumesate (500g/l) Cloparylid (200g/l)	2.5, 1.5, 0.5
10	Betosip, Nortron and Dow Shield *, then Starane 2 **	Phenmedipham (114g/l), Ethofumesate (500g/l) Cloparylid (200g/l)	2.5, 1.5, 0.5, 2.0
11	Totril and Starane 2 **	Ioxynil (225g/l), Fluroxypyr (200g/l)	1.0, 1.0
12	Dosaflo ***	Metoxuron (500g/l)	5.5

* = Treatment applied when the potatoes were 5-10cm tall
** = Treatment applied when the potatoes were 10-20cm tall
*** = Treatment applied when the potatoes were 25-30cm tall

Assessments

The number of flowers per plot were counted on 16 March and 7 April. Potato emergence was assessed on 26 April.

Phytotoxicity on narcissus and potatoes was assessed 21 days after treatment (DAT) and also on 2 other occasions.

The phytotoxicity assessments to assess damage to both the narcissus and potatoes were done using a score for each plot. The scores represented levels of damage to the plant as shown in Table 2.

Table 2. Scoring system for assessing phytotoxicity in narcissus and potatoes.

Score	Symptom
0	No damage
1	Slight twisting/yellowing
2	Moderate twisting/yellowing
3	Severe twisting/yellowing
4	Dead

Data analysis

The data was analysed using analysis of variance (ANOVA). Where the ANOVA showed statistical significance, Duncan's Multiple Range test was used to assess pairwise differences between treatments. In this test, treatment means are calculated for each treatment and these are ordered in ascending order together with their standard error. Duncan's test then systematically makes a pair-wise comparison of these ordered means and places treatments in the same (assigned the same suffix letter) or different (different suffix letter) group depending on whether the treatment pair is adjudged not to be statistically significantly different or otherwise respectively. This test can be regarded as a 'batting order' for treatment effects but a real assessment of any two treatments can only properly be assessed using a trial designed for this purpose.

Score data is not appropriate for ANOVA, and was analysed using Friedman's test, a non-parametric ANOVA-style test. In this test, where score data rather than continuous data are available, treatment effects are ranked relative to each other rather than in each block and ranks are then summed or averaged over blocks. Where the Friedman's test showed statistical difference, a multiple range test for non-parametric data was performed. Using pair-wise treatment comparisons of say the sum of ranks, it can be assessed whether a particular pair of treatments is significantly different. (Siegel and Castellan 1988).

RESULTS AND DISCUSSION

Table 3. Mean narcissus flower counts, 2000.

Treatment	Mean number of flowers per treatment on 16 March 2000	Mean number of flowers per treatment on 7 April 2000
1. No volunteers and no herbicides	222.8	370.1
2. Volunteers, no herbicides	214.1	352.1
2. Volunteers, no herbicides	222.6	364.5
2. Volunteers, no herbicides	212.0	358.3
3. Dow Shield 5-10cm	221.1	351.4
4. Dow Shield 10-20cm	218.8	353.1
5. Dow Shield at 5-10 and 10-20cm	217.8	361.4
6. Starane 2 at 5-10cm	215.8	352.6
7. Starane 2 at 10-20cm	231.6	365.9
8. Betosip+Nortron+Dow Shield at 5-10cm	219.1	372.9
9. Betosip+Nortron+Dow Shield at 10-20cm	209.3	366.0
10. Betosip+Nortron+Dow Shield at 5-10cm and Starane 2 at 10-20cm	207.9	356.3
11. Totril +Starane 2 at 10-20cm	214.3	359.5
12. Dosaflo at 25-30cm	217.6	347.1
SED (78df)	13.41	9.91
p-value	NS	NS

Note: Treatments 2 were analysed as separate treatments and the data was analysed as a split-plot.

Table 3 shows there were no significant differences (NS at the 5% probablity level) between the treatments in full flower counts.

Table 4. Numbers and height of potatoes during emergence, 2000.

Treatment	Potato emergence count 10 April 2000 per plot	Average height of potatoes 10 April 2000 (cm)	Potato emergence count 26 April 2000 per plot
1. No volunteers and no herbicides	0.00 (a)	0.00 (a)	0.00 (a)
2. Volunteers, no herbicides	3.75 (e)	4.62 (e)	17.87 (b)
2. Volunteers, no herbicides	2.00 (bcd)	2.12 (bc)	17.50 (b)
2. Volunteers, no herbicides	3.37 (cde)	2.49 (bcd)	16.87 (b)
3. Dow Shield 5-10cm	2.00 (bcd)	2.49 (bcd)	14.88 (b)
4. Dow Shield 10-20cm	1.75 (bc)	2.24 (bcd)	16.00 (b)
5. Dow Shield at 5-10 and 10-20cm	2.63 (bcde)	3.00 (bcd)	18.37 (b)
6. Starane 2 at 5-10cm	2.50 (bcde)	2.68 (bcd)	18.37 (b)
7. Starane 2 at 10-20cm	3.87 (e)	2.97 (bcd)	15.88 (b)
8. Betosip+Nortron+Dow Shield at 5-10cm	3.12 (bcde)	3.68 (cde)	18.12 (b)
9. Betosip+Nortron+Dow Shield at 10-20cm	1.88 (bc)	2.39 (bcd)	18.12 (b)
10. Betosip+Nortron+Dow Shield at 5-10cm and Starane 2 at 10-20cm	3.62 (de)	3.50 (cde)	16.50 (b)
11. Totril +Starane 2 at 10-20cm	3.37 (cde)	3.84 (de)	15.00 (b)
12. Dosaflo at 25-30cm	1.63 (b)	1.55 (b)	16.87 (b)
SED (78df)	0.731	0.719	2.029
p-value	<0.001	<0.001	<0.001

Note: Values that share a common letter do not differ significantly at the 5% probability level. Duncan's suffixes are shown in parenthesis.

The emergence figures for both dates show statistical significance. The first assessment was done during emergence and following autumn and spring planting, so some variation over the trial area was to be expected. The significance at the second count only arises in Treatment 1 as can be expected as no tubers were planted in this treatment. All other plots had similar amounts of potatoes, and emergence and the potato population was constant. This provided an ideal basis for later herbicide comparisons.

Table 5. Mean percentage weed cover on 26 June, 2000.

Treatment	Mean percentage weed cover on 26 June 2000 **	Transformed mean percentage weed cover
1. No volunteers and no herbicides	54.1	47.5 (f)
2. Volunteers, no herbicides	50.0	45.0 (ef)
2. Volunteers, no herbicides	45.0	41.2 (def)
2. Volunteers, no herbicides	55.0	47.6 (f)
3. Dow Shield 5-10cm	34.1	35.4 (cdef)
4. Dow Shield 10-20cm	39.5	38.4 (def)
5. Dow Shield at 5-10 and 10-20cm	45.7	42.4 (ef)
6. Starane 2 at 5-10cm	26.6	30.4 (bcd)
7. Starane 2 at 10-20cm	46.6	42.7 (ef)
8. Betosip+Nortron+Dow Shield at 5-10cm	14.6	20.6 (ab)
9. Betosip+Nortron+Dow Shield at 10-20cm	32.2	34.1 (cde)
10. Betosip+Nortron+Dow Shield at 5-10cm and Starane 2 at 10-20cm	21.3	26.6 (bc)
11. Totril +Starane 2 at 10-20cm	17.3	23.8 (bc)
12. Dosaflo at 25-30cm	5.5	12.6 (a)
SED (78df)	8.33	5.31
p-value	NS	<0.001

** Percentage data was unsuitable for analysis, so was transformed using an angular (arcsine) transformation. Duncan's suffixes are shown in parenthesis.

There were statistical differences between treatments at the end of the first year. Dosaflo had the lowest % weed cover, followed by treatments 6,8,10 and 11 which were equally effective although not as effective as Dosaflo. There were no significant differences between the control treatments and the Dow Shield treatments. Starane appears to be more effective on weed control when applied at the 5-10cm stage.

The main weeds present were fat hen, knotgrass and pale persicaria with some annual meadow grass and field pansy. These results show that with the exception of Dosaflo, additional broad-leaved weed control may still be required in addition to the chemicals applied for volunteer potato control.

Table 6. Mean Potato and narcissus phytotoxicity scores 21 days after treatment (DAT). Data was analysed using Friedman's Test, 2000. 0 = no damage; 4 = dead

Treatment	Potato phytotoxicity 21 DAT	Narcissus phytotoxicity 21 DAT
1. No volunteers and no herbicides	0.00	0.00
2. Volunteers, no herbicides	0.00	0.00
2. Volunteers, no herbicides	0.00	0.00
2. Volunteers, no herbicides	0.00	0.00
3. Dow Shield 5-10cm*	1.00	1.00
4. Dow Shield 10-20cm**	1.00	1.25
5. Dow Shield at 5-10 and * 10-20cm**	1.25	1.00
6. Starane 2 at 5-10cm*	3.00	3.00
7. Starane 2 at 10-20cm**	1.75	2.25
8. Betosip+Nortron+Dow Shield at 5-10cm*	2.00	1.87
9. Betosip+Nortron+Dow Shield at 10-20cm**	1.25	1.37
10. Betosip+Nortron+Dow Shield at 5-10cm* and Starane 2 at 10-20cm**	2.75	2.87
11. Totril +Starane 2 at 10-20cm**	3.00	2.37
12. Dosaflo at 25-30cm***	2.62	3.00
p-value (df=13, n=4)++	<0.001	<0.001
p-value (Tl-2 omitted) (df=9, n=4)	<0.001	<0.001

Note: As the sprays were applied on three dates, the 21DAT dates are *2 June, **5 June and ***12 June 2000
++ Treatments 2 were analysed as separate treatments.

There were significant differences between the herbicide treatments. The multiple range tests for potato phytotoxicity 21 DAT showed that there were significant differences between the controls (treatments 1-2) and treatments 6,8,10,11 and 12.

With narcissus phytotoxicity, the multiple range tests 21 DAT showed there were significant differences between the control treatments and treatments 6,8,10,11 and 12. Treatments 3,4,5,7 and 9 were not, however, significantly different from the controls.

The most effective herbicides against potatoes also caused the most visible damage to narcissi. In terms of volunteer potato control (haulm phytotoxicity), with the exception of Dosaflo and Totril, early applications of herbicides gave the strongest effects at 21 DAT with herbicides such as Starane, Betosip and Nortron. Initially effects of Dow Shield were poor in comparison with the other herbicides tested.

Table 7. Potato phytotoxicity scores. Data was analysed using Friedman's Test. Numbers are mean scores, 2000. 0 = no damage; 4 = dead

Treatment	Potato phytotoxicity 6 July 2000	Potato phytotoxicity 24 July 2000
1. No volunteers and no herbicides	0.00	0.00
2. Volunteers, no herbicides	0.00	0.00
2. Volunteers, no herbicides	0.00	0.00
2. Volunteers, no herbicides	0.00	0.00
3. Dow Shield 5-10cm	2.12	2.25
4. Dow Shield 10-20cm	2.00	2.37
5. Dow Shield at 5-10 and 10-20cm	1.75	2.25
6. Starane 2 at 5-10cm	1.12	1.25
7. Starane 2 at 10-20cm	1.12	1.75
8. Betosip+Nortron+Dow Shield at 5-10cm	1.50	2.00
9. Betosip+Nortron+Dow Shield at 10-20cm	1.37	1.87
10. Betosip+Nortron+Dow Shield at 5-10cm and Starane 2 at 10-20cm	1.25	2.00
11. Totril +Starane 2 at 10- 20cm	0.75	1.00
12. Dosaflo at 25-30cm	0.50	0.37
p-value (df=13,n =4)	<0.001	<0.001
p-value (T1-2 omitted) (df=9, n=4)	NS	<0.05

The multiple range test indicated that there were significant differences between the control treatments (treatments 1-2) and Dow Shield (treatments 3,4 and 5) on 6 July 2000. By 24 July, however, treatments with Betosip + Nortron + Dow Shield applied at 5-10cm (treatment 8) was also, with treatments 3,4 and 5, significantly different from the control treatments. Differences between treatments 6,7,9,10,11 and 12 were not significant.

As time progressed, the effects of Totril, Dosaflo and Starane were outgrown and damage levels decreased. In contrast, effects of Dow Shield increased with time after treatment, and the data suggests Dow Shield performed better on its own than in tank mix with Betosip and Nortron. However, any possible phytotoxic effects on narcissus will be revealed in future seasons.

CONCLUSIONS

- Potato phytotoxicity scores 21 days after treatment (2, 6 and 12 June 2000) were significantly higher for those herbicide treatments that were applied earlier in the season.

- As the season advanced, however, changes in potato phytotoxicity were recorded. Of the most effective treatments 21 days after application, the effects of Totril, Dosaflo and Starane were outgrown. Dow Shield seemed to be more effective when applied alone, rather than in a tank mix with Betosip and Nortron.

- Phytotoxicity in narcissus was significantly greater than the controls in treatments Starane 2 at 5-10cm and 10-20cm (treatments 6 and 7); Betosip + Nortron + Dow Shield at 5-10cm and Starane 2 at 10-20cm (treatment 10); Totril + Starane 2 at 10-12cm (treatment 11), and Dosaflo at 25-30cm (treatment 12). No other treatments were significantly different from the controls. The three straight Dow Shield treatments (treatments 3, 4 and 5), together with Betosip + Nortron + Dow Shield at 5-10cm (treatment 8), which recorded significantly higher scores for potato phytotoxicity by 24 July did not record significantly higher damage scores in narcissus than the controls.

- Dosaflo provided the best control of weeds other than volunteer potatoes. The Starane 2 and Betosip + Nortron + Dow Shield treatments also reduced weed cover, with greater effect when applied in early May than in mid-May.

Due to the sensitivity of narcissus bulbs to herbicides, especially when applied post-flowering, effects on next season's leaves and flowers will be assessed in 2001 . This will enable full statistical analysis of bulb yields on lifting in 2001, and determination of any continuing residual effects in the bulbs into the 2001-2002 season (by forcing).

Furthermore, potato haulm re-growth will be recorded in 2001 to identify treatments giving the most effective control. When the project finishes in spring 2002 it will be possible to make recommendations on efficiency of control of potato volunteers combined with crop safety to the narcissus crop.

TECHNOLOGY TRANSFER

1. Growers' walk held at ADAS Arthur Rickwood on 24 May 2000.

2. Project presented to HDC Bulb Seminar on 21 November 2000.

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The HDC has previously funded related work on other horticultural crops:

- Bulb onions: Control of volunteer potatoes (FV54, 54b, 54c)

- Spray rate screening of herbicide combinations for control of volunteer potatoes and oilseed rape in onions and leeks (FV 120, FV 120a, (Year 2), FV 120a Part 1 Onions - organic soil type, FV 120a - Year 2 Part II (onions), Part III (leeks).

Appendix 1: Plan of the trial.

	REP1		REP2		REP3		REP4	
	P1 **T10**	P15 **T9**	P29 **T4**	P43 **T2**	P57 **T2**	P71 **T7**	P85 **T7**	P99 **T2**
	P2 **T2**	P16 **T7**	P30 **T1**	P44 **T2**	P58 **T2**	P72 **T5**	P86 **T10**	P100 **T9**
	P3 **T4**	P17 **T11**	P31 **T9**	P45 **T2**	P59 **T9**	P73 **T10**	P87 **T1**	P101 **T11**
	P4 **T11**	P18 **T2**	P32 **T2**	P46 **T11**	P60 **T7**	P74 **T11**	P88 **T11**	P102 **T7**
	P5 **T1**	P19 **T5**	P33 **T2**	P47 **T10**	P61 **T12**	P75 **T1**	P89 **T12**	P103 **T12**
	P6 **T7**	P20 **T6**	P34 **T6**	P48 **T4**	P62 **T3**	P76 **T2**	P90 **T2**	P104 **T1**
	P7 **T6**	P21 **T2**	P35 **T10**	P49 **T5**	P63 **T8**	P77 **T8**	P91 **T8**	P105 **T8**
	P8 **T12**	P22 **T12**	P36 **T12**	P50 **T8**	P64 **T6**	P78 **T6**	P92 **T2**	P106 **T2**
	P9 **T3**	P23 **T2**	P37 **T3**	P51 **T9**	P65 **T11**	P79 **T2**	P93 **T6**	P107 **T2**
	P10 **T2**	P24 **T8**	P38 **T11**	P52 **T6**	P66 **T4**	P80 **T2**	P94 **T4**	P108 **T5**
	P11 **T5**	P25 **T10**	P39 **T8**	P53 **T12**	P67 **T2**	P81 **T12**	P95 **T9**	P109 **T10**
	P12 **T9**	P26 **T4**	P40 **T7**	P54 **T1**	P68 **T10**	P82 **T4**	P96 **T2**	P110 **T3**
1m guard→	P13 **T2**	P27 **T1**	P41 **T5**	P55 **T7**	P69 **T5**	P83 **T3**	P97 **T3**	P111 **T6**
5M↑ ↓	P14 **T8**	P28 **T3**	P42 **T2**	P56 **T3**	P70 **T1**	P84 **T9**	P98 **T5**	P112 **T4**

2 ridges

2 ridge guard (Not planted) between replicates

= no Glyphosate treatment

= Glyphosate treated

Appendix 2: Trial diary.

Date	Trial Operation
16.09.1999	Trial area subsided and ploughed
05.10.1999	Plot area power harrowed and ridged
07.10.1999	Trial planted
14.10.1999	Blank ridges flattened by rotavator
01.12.1999	Trial observation; No potatoes emerged, no narcissus emerged
20.12.2000	Trial observation; No potatoes emerged, no narcissus emerged
21.01.1999	Trial observation; Very little narcissus emergence, weeds present
24.01.2000	Trial hand sprayed to treat weeds, used Parable at 250ml/20l water.
06.03.2000	Trial observation; Narcissus 10 - 15 cm tall No potato emergence observed, weeds dead.
07.03.2000	Trial observation; Potato chits at 5cm below soil
09.03.2000	Other half of potatoes planted in the ridges
14.03.2000	Trial observation; Narcissus in full flower
16.03.2000	Full flower counts carried out on narcissus
21.03.2000	Trial observation; Potato emergence observed
03.04.2000	Trial observation; Narcissus flowers deteriorating
07.04.2000	Second full flower counts of narcissus carried out
26.04.2000	Potato emergence assessment carried out
08.05.2000	Spray treatments of treatments 3,5,6,8,and 10 carried out
12.05.2000	Routine treatment with Bravo at 3l/ha in 300 l water/ha
15.05.2000	Treatments 4,5,7,9,10 and 11 applied
22.05.2000	Treatment 12 applied
02.06.2000	First phytotoxicity assessment (5-10cm treatments)
06.06.2000	Second phytotoxicity assessment (10-20 cm treatments)
12.06.2000	Third phytotoxicity assessment (25-30 cm treatments)
26.06.2000	Weed assessment
06.07.2000	Phytotoxicity assessment
24.07.2000	Phytotoxicity assessment
03.08.2000	Potato top growth flailed
03.11.2000	Glyphosate treatment applied

Farm Spray and Fertiliser Applications

Date	Application Product	Amount
23.09.1999	P fertiliser	50kg
23.09.1999	K fertiliser	100kg
02.02.2000	Fortrol	5.2 l
23.02.2000	Profalon	8.4 l

