

**Project title:** FV 245a

**Project number:** Herbs: Evaluation of herbicides to fill identified gaps, resulting from EC review of pesticides

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**Previous reports:** In 2002 some potential alternatives were identified in project FV 245.

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The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with 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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## **GROWER SUMMARY**

### **Headline**

Safe herbicides:

- pre-emergence Centium CS for parsley (excluding very light soils), coriander, basil;
- pre-emergence Goltix WG for coriander, (lower dose basil)
- Early post-emergence Betanal Flo for parsley, coriander
- Post-emergence Basagran DF for basil

### **Background and commercial objectives**

The loss of herbicide options following the EC review of pesticides has led to collaboration with organisations in other EU states on the research required to find effective replacements. A preliminary trial was funded by HDC to determine the phytotoxicity of possible replacement herbicides for a range of speciality crop and herb species. The preliminary results highlighted the potential for Goltix (metamitron), Centium (clomazone), Totril (ioxynil) and Betanal Flo (phenmedipham) to fill the gap left by pentanochlor and prometryn for the control of groundsel, foals parsley and cleavers in coriander and parsley. The preliminary unreplicated trials took place at the National Herb Centre on sandy loam soils however, previous experience (T.M. Davies) and also trials conducted on light sandy soils (Darryl Shailes) indicated that further trials on lower dose rates of Goltix and an investigation of the effect of early and later sowing dates on the phytotoxicity of Centium on these crops would be required before an application for SOLAs on any of these products should be undertaken. Also the crop-safety of post-emergence treatments of Goltix, Totril and Betanal Flo needs to be established..

The aim of the project was to determine the crop safety of herbicides for the control of annual weeds for the major Umbellifers parsley and coriander and the (Lamiaceae) Labiate herb basil:

- pre-emergence Goltix, Centium and Pyramin
- post-emergence Totril, Goltix, Betanal Flo and Basagran (basil only)

This work will also allow the industry to demonstrate to the European Commission that action has been taken to find alternatives to replace the temporary 'Essential Uses' so that these uses can continue.

### ***Current Herbicide Approval status***

Centium 360 CS (clomazone), Basagran SG (bentazone) and Pyramin DF (chloridazon) have no current approval for UK herbs..

Goltix WG (metamitron) SOLA 3657/2002 for parsley and LTAEU herbs; others SOLAs for parsley and herbs Marquise SOLA 0737/2003; Skater SOLA 0738/2003. All MHI 6 weeks, pre- or post-emergence not specified, all for use on herbs including parsley, coriander and basil.

Betanal Flo (phenmedipham) SOLA 1859/2000 for use on spinach at 1.5 l/ha (MHI 14 days), Long Term Arrangements for Extension of Use (LTAEU) to herbs.

Totril SOLA 1918/2000 restricted to chives only MHI 14 days, no approval for parsley, coriander or basil. (Note: Totril application not permitted with a knapsack sprayer).

Afalon (linuron) & others, full approval on-label for parsley, LTAEU coriander, basil. (Note: linuron application not permitted with hand held sprayer)

Stomp (pendimethalin) & others, full approval on-label for parsley, LTAEU coriander, basil. Stomp 400 SC SOLA 0132/2000; Stomp 400 SC SOLA 2356/2001 for coriander and basil Claymore SOLA 2354/2001 for coriander & basil.

### ***Summary of Results (please note Approval status above)***

A pre-emergence residual herbicide is essential for herbs, particularly slow emerging species, such as parsley. Crop safety of pre-emergence herbicides depends on soil type and drilling depth. On the commercial crops in Norfolk on loamy sands, sown at 1 cm depth the potential for damage was higher than on loamy sand at 2 cm depth and this has been seen in parsley.

Herbicides which on limited data, appear safe to the crop:

### **Parsley (curled)**

1. Safe pre-emergence: Centium (clomazone) 0.25 l/ha on light soil (*may not be safe on very light soil e.g. loamy sand Norfolk, data inconclusive*) Centium needs a tank-mix partner to control a wide weed spectrum: e.g. Stomp (pendimethalin) or Afalon (linuron)
2. Safe pre-emergence: Goltix WG (metamitron) 2 kg/ha on light soil, *not on very light soil (Norfolk)*. A pre-emergence tank-mix partner is also needed or a post-emergence programme
3. Safe post-emergence, growth stage crop 2-3 rough leaf: Betanal Flo 1.5 l/ha. Only controls weeds at cotyledon stage.

Post-emergence Goltix WG (1.0 or 1.5) kg/ha may cause initial temporary damage.

Totril (contact-acting) at 1.0 l/ha post-emergence caused crop damage at NHC, however, a lower dose rate could be tested. Application of Totril could also be tested pre-emergence of parsley, to control weeds emerging before the crop.

### **Coriander**

1. Safe pre-emergence: Centium (clomazone) 0.25 l/ha on light soil, reduce Centium dose to 0.2 l/ha on very light soils) Centium needs a tank-mix partner to control a wide weed spectrum: e.g. Stomp (pendimethalin) or Afalon (linuron).
2. Safe pre-emergence: Goltix WG (metamitron) 2 kg/ha. A pre-emergence tank-mix partner is also needed or a post-emergence programme.
3. Pyramin DF (chloridazon) has a lower margin of crop safety than Centium or Goltix, however it could be useful in coriander fields where black-nightshade is an anticipated problem.
4. Safe post-emergence, growth stage crop 2-3 rough leaf: Betanal Flo 1.5 l/ha; or Goltix WG 1.0 or 1.5 kg/ha. These only control weeds at cotyledon stage. Betanal has a 14 day Harvest Interval on spinach, but Goltix Minimum Harvest Interval is 6 weeks.

A lower dose of Totril than the 1.0 l/ha in the trial could be tested.

## ***Basil***

1. Safe pre-emergence: Centium (clomazone) 0.25 l/ha on light soil, reduce dose to 0.2 l/ha on very light soils). Centium needs a tank-mix partner
2. Safe pre-emergence: Goltix WG 1.0 or 1.5 kg/ha, but MHI is 6 weeks.
3. Safe post-emergence: (growth stage crop 2-4 leaf) Basagran SG 1.65 kg/ha full dose

Less safe post-emergence: Betanal Flo 1.5 l/ha, but a possibility.

Pre-emergence Pyramin DF caused considerable crop loss.

## ***Weed control***

Annex 1 shows weed species controlled and the gaps left by prometryn and pentanochlor.

Centium pre-emergence controls cleavers, groundsel and fools parsley.

Goltix pre- and post-emergence cotyledon stage controls fool's parsley, groundsel.

Betanal controls cotyledon stage groundsel, fumitory.

Totril controls cotyledon stage groundsel, black-nightshade.

Basagran controls cleavers (small), black-nightshade and fools parsley.

## **Action Points for Growers**

- Growers need to review their current weed control strategy for herb crops because the "Essential Uses" for products containing pentanochlor and prometryn will cease 31 December 2007
- The study reported here has identified some potential alternative products which would appear to be safe (non-phytotoxic) to coriander, parsley and basil crop at the timing and rates used. However, there is a greater risk from damage from residual herbicides on very light and sand soils, and on shallow drillings.
- A pre-emergence herbicide is essential for good weed control. Centium & Goltix have a limited weed spectrum and need a partner (linuron or pendimethalin for parsley and coriander)
- Goltix WG & other products containing metamitron, Skater, Marquise have SOLAs (MHI 6 weeks) and appear safe pre-emergence in coriander, basil (lower dose)

- Betanal Flo has a LTAEU (Long Term Arrangement for Extension of Use) to parsley, coriander, basil from the spinach SOLA where maximum dose is 1.5 l/ha (MHI is 14 days).
- **SOLA (Specific Off-Label Approval) applications** may be needed for:  
**Centium 360 CS** in parsley (may not be safe on very light soils or sands), coriander, basil (and possibly other leaf herbs).  
**Basagran SG** in basil  
Two years residues data may be required.
- Pyramin may have a lower margin of crop safety than Centium or Goltix, however it would be useful in coriander where black-nightshade is an anticipated problem. If the application for spinach is approved there should be a LTAEU for herbs.
- Totril at 1.0 l/ha is not as safe as Betanal, but a lower dose rate could be tested. It could be used on weeds emerging before the crop (as for carrot SOLA) e.g. in parsley which is slow to germinate. However, there is no SOLA or LTAEU for the crops in this study.
- Growers may need further work on programmes and tank-mixes (e.g. Betanal + Goltix) in 2004 to assess efficacy against the weed species in commercial crops.

This work allows the industry to demonstrate to the European Commission that action has been taken to find alternatives to replace the temporary 'Essential Uses' so that these uses can continue.

### **Practical and Financial Benefits from this Study**

A recent industry survey, January 2002 estimated an area of over 5,000 ha of herbs grown in the UK which over 2,000 ha, mostly coriander and parsley, were for culinary use. Weed contaminants in harvested produce are uneconomic and virtually impossible to remove. As a result of the EC pesticide review programme growers will lose key herbicides pentachlor and prometryn which control particularly troublesome weeds such as groundsel, foals parsley and cleavers. This study identifies the crop safety of some alternative products and the potential for SOLAs for herbs.

## Appendix 1

**Weed Susceptibility to herbicides** label claims, except Pyramin & Goltix sugar beet data

Key: S = susceptible; MS = Moderately Susceptible; R = Resistant MR = Moderately Resistant;

Prometryn and pentanochlor (as Atlas Brown or Croptex Bronze) will go 31 December 2007.

# Goltix 1kg/ha, Totril 1.4 l/ha, Betanal Flo cotyledon weeds only; \*Totril control less reliable

Common name	Latin name	prometryn	Croptex Bronze	Centium	Pyramin	Goltix	Goltix #	Totril#	Basagran	Betanal#
		pre/post	post	pre	1kg pre	pre	1kg cot post	1.4 L cot post	post	1.5l cot post
Bindweed, black	<i>Fallopia convolvulus</i>	(Spre)	S	MR	S	MR	MR	S	MS	MS
Bugloss	<i>Anchusa arvensis</i>							S		
Charlock	<i>Sinapis arvensis</i>	(MSpre)		R	S	MS	MS	S	S	
Chickweed, common	<i>Stellaria media</i>	S	S	S	S	S	S	S	S	S
Cleavers	<i>Galium aparine</i>	R	S	S	MR	R	R		S	MR
Corn marigold	<i>Chrysanthemum segetum</i>		S		S	S	S		S	
Corn spurrey	<i>Spergula arvensis</i>	S			S	S	S		S	
Crane's-bill, cut-leaved	<i>Geranium dissectum</i>								S	R
Deadnettle, henbit	<i>Lamium amplexicaule</i>		S						MS	
Dead-nettle, red	<i>Lamium purpureum</i>		S	S	S	MS	MS	S*	MS	S
Dock, broad-leaved	<i>Rumex obtusifolius</i>					S	S			
Fat-hen	<i>Chenopodium</i>	S	S	MS	S	S	S	S	MS	S

	<i>album</i>									
Fool's parsley	<i>Aethusa cynapium</i>			S		S	S		S	
Forget-me-not, field	<i>Myosotis arvensis</i>		S			S	S		S	MR
Fumitory, common	<i>Fumaria officinalis</i>	S	MS	R	MS	MS	MS	S*	MS	S
Gallant -soldier	<i>Galinsoga parviflora</i>									
Groundsel	<i>Senecio vulgaris</i>	MS(Spre)		S	MS	S	S	S	MS	S
Hemp-nettle, common	<i>Galeopsis tetrahit</i>	S	S		S		S	S*	MR	S
Knotgrass	<i>Polygonum aviculare</i>	(Spre)		MR	S	S	S		MR	S
Mayweed, scented	<i>Matricaria recutita</i>	(Spre)	MS	R	S	S	S	S	S	
Mayweed, scentless	<i>Tripleurospermum inodorum</i>	(Spre)	MS	R	S	S	S	S	S	MS
Nettle, small	<i>Urtica urens</i>	S	S	MR	S	S	S	S*	S	S
Nightshade, black	<i>Solanum nigrum</i>	S	S		S	MR	MR	S	S	
Orache, common	<i>Atriplex patula</i>	S	S		S	S	S	S	MS	S
Pansy, field	<i>Viola arvensis</i>		S	R	MR	S	S		R	S
Parsley piert	<i>Aphanes arvensis</i>		S							
Pennycress, field	<i>Thlaspi arvense</i>				S	S	S		S	MS
Persicaria, pale	<i>Persicaria lapathifolia</i>	S		MS		MS	MS	S*	S	S
Pimpernel, scarlet	<i>Anagalis arvensis</i>	MS(Spre)	S		MS	MR	MR		S	S
Pineappleweed	<i>Matricaria discoidea</i>		MS	R	S	S	S	S	S	

Poppy, common	<i>Papaver rhoeas</i>	S	S	R	S	S	S		MS	S
Redshank	<i>Persicaria maculosa</i>	S	S		S		MS		S*	S
Shepherd's-purse	<i>Capsella bursa-pastoris</i>	S	S		S		S		S	S
Sow-thistle, smooth	<i>Sonchus oleraceus</i>	(Spre)	S		MS		MR			MS
Speedwell, common, field	<i>Veronica persica</i>	S	S		S	S	S	S	MS	S
Speedwell, ivy-leaved	<i>Veronica hederifolia</i>	S	S		S		MS		S	MR
Sun spurge	<i>Euphorbia helioscopia</i>				MR		S			
Thistle, creeping	<i>Cirsium arvense</i>	R			R		R		R	suppr
Wild radish	<i>Raphanus raphanistrum</i>	Mspre			S		MR		S	S
Annual meadow-grass	<i>Poa annua</i>	(Spre)	S				S		R	R
Blackgrass	<i>Alopecurus myosuroides</i>		S				MR		R	R
Brome, barren	<i>Anisantha sterilis</i>								R	
Wild-oat	<i>Avena fatua</i>	R					R		R	
Vol OSR	<i>Brassica napus</i>		MS	R					S	
Vol Potatoes	<i>Solanum tuberosum</i>									

Goltix early post, [pentanochlor](#): S = wild mignonette;

Goltix early post, MS=white campion

loxynil S=swinecress

## SCIENCE SECTION

### Introduction

The loss of herbicide options following the EC review of pesticides has led to collaboration with organisations in other EU states on the research required to find effective replacements. A preliminary screening trial on a sandy loam soil funded by HDC to determine the phytotoxicity of possible replacement herbicides on a range of herb species, highlighted the potential for Goltix (metamitron), Centium (clomazone), Totril (ioxynil) and Betanal Flo (phenmedipham) to fill the gap left by pentanochlor and prometryn for the control of groundsel, fool's parsley and cleavers in coriander and parsley. Previous experience and information from growers trials (Tom Davies and Darryl Shailes) on light sandy soils indicated that further trials on lower dose rates with sequential treatments of Goltix and an investigation of the effect of early and later sowing dates on the phytotoxicity of Centium on these crops would be required before an application for SOLAs on any of these products should be under taken. Also the crop-safety of post-emergence treatments of Goltix, Totril and Betanal Flo needs to be established. The short-list of products was drawn up by the BHTA.

The aim of the project was to determine the crop safety of herbicides for the control of annual weeds for the major Umbellifers parsley and coriander and (Lamiaceae) Labiate herb basil:

- applied pre-emergence Goltix WG, Centium 360 CS and Pyramin DF (Norfolk only)
- post-emergence at crop growth stage 2 to 4 true leaves Totril, Goltix, Betanal Flo and Basagran SG (basil only)

The full dose recommended for the soil type was used for pre-emergence Centium and Goltix.

A programme of low split dose sprays are used in other crops onions (Totril), sugarbeet (Goltix). In this study a post-emergence programme was not used and a single low dose of post-emergence Totril 1.0 l/ha (full dose 2.8 l/ha), or Goltix 1.5 kg/ha or Betanal Flo at 1.5l/ha (standard low dose for cotyledon weeds 2.5 l/ha) was applied. A fine quality spray and 200 l/ha will give the best cover for small weeds. The full on-label recommended dose of Basagran for other crops was applied.

Double (overlap) doses of all these treatments were also evaluated for crop safety.

Assessments were made for any crop damage (phytotoxicity). Weed control was also monitored to identify the potential of each product to control the target weeds.

## Objectives

- To assess crop safety or 'phytotoxicity' to herbicides tested
- To demonstrate to the European Commission that action has been taken to find alternatives to replace the temporary 'Essential Uses' for prometryn and pentachlor so that these uses can continue until 31 December 2007.
- To assess where possible, efficacy against weeds that are problems in culinary herbs
- To identify suitable candidates for SOLAs

### Site Location; Soil type; Sowing date and herbicide application date

Crop	Site	Soil Type (ADAS scale)	Sowing Date	Spray Date
Parsley pre-em	1.NHC Warmington	Sandy Loam	12 May	21 May
Parsley post-em	1.NHC Warmington	Sandy Loam	12 May	26 June
Parsley pre-em	2.Norfolk Hall farm, Garboldisham	Loamy Sand	20 March	4 April
Parsley post-em	3.Norfolk Hall farm, Garboldisham	Loamy Sand	25 February	8 May
Coriander pre-em	4.NHC Warmington	Sandy Loam	12 May	21 May
Coriander post-em	4.NHC Warmington	Sandy Loam	12 May	16 June
Coriander pre-em	5.Norfolk Hall farm, Garboldisham	Loamy Sand	12 July	18 July
Coriander post-em	6.Norfolk Hall farm, Garboldisham	Loamy Sand	3 May	25 May
Basil pre-em	7.Norfolk Warrenhill farm, Oakley, Diss	Sandy Loam	13 June	17 June
Basil post-em	8.Norfolk Field Barn Farm, nr Thetford	Loamy Sand	5 June	12 June

## Herbicide Treatments

No.	Product	active ingredient	formuln	Appl rate/ha		Approval Status	MHI
				NHC SL soil	Norfol k LS soil		
1.	Untreated						
<b>Pre-em</b>							
2.	Centium	clomazone	360CS	0.25L	0.2L	UK on-label carrots etc	
3.	Centium	clomazone	360CS	0.5L	0.4L		
4.	Goltix WG	metamitron#	70%WG	2.0	2.0kg	SOLA (3657/02) outdoor annual/perennial leaf	6 wks
5.	Goltix WG	metamitron#	70%WG	4.0	4.0kg	herbs	
12.	Pyramin DF	chloridazon	65%w/w SG	-	1.0 L	No current Approval	
13.	Pyramin DF	chloridazon	65%w/w SG	-	2.0 L		
<b>Post-em</b>							
6.	Totril	ioxynil	225g/l EC	1.0L	1.0L	UK on-label onions,	14 d
7.	Totril	ioxynil	225g/l EC	2.0L	2.0L	SOLA chives (1918/00) not herbs, SOLA pre-em carrots,	
8.	Goltix WG	metamitron#	70%WG	1.5 kg	1.5 kg	SOLA (3657/02) outdoor annual/perennial leaf	6 wks
9.	Goltix WG	metamitron#	70%WG	3.0 kg	3.0 kg	herbs	
10.	Betanal Flo	phenmedipham	160g/l SE	1.5 L	1.5 kL	SOLA spinach (1859/00),	14 d
11.	Betanal Flo	phenmedipham	160g/l SE	3.0 L	3.0 L	LTAEU to leaf herbs	
14.	BasagranS G	bentazone	87%w/w SG	-	1.65 kg	UK on-label peas etc.	
15.	BasagranS G	bentazone	87%w/w SG	-	3.3 kg		

#also SOLAs Marquise 0737/03; Skater 0738/03

## Crop details

At the NHC coriander and parsley were sown with a Stanhay Singulaire drill, on a 1.83 m bed of 4 rows/plot on 40 cm row width at a population of 3,579,020 seeds /ha for parsley and 2,381,203 seeds /ha for coriander.

Commercial crops in Norfolk were drilled at standard seed rates with various drills. Row widths were 45 cm for parsley, 20 cm for coriander and 50 cm for basil.

Norfolk post-emergence trial sites were treated with a standard pre-emergence herbicide to reduce the risk that the weeds would obscure crop damage effects: coriander with Afalon + Stomp (1.0 + 2.5) L/ha, parsley with Afalon + Stomp (1.25 + 3.5) L/ha.

All sites were rolled after sowing to give a fine, firm seedbed.

### ***Trial Design***

Each plot was 6 m long x 1 bed width (1.8 m) with 3 replicates of each treatment.

### ***Records/Assessments***

The following records and assessments were undertaken following application of the various experimental treatments.

- Weather during and after application.
- Estimates of % crop emergence or delay after pre-emergence applications
- Observations on any phytotoxicity symptoms, crop scores for damage (0=complete kill; 7= acceptable damage; 10=no damage)
- Assessments of crop height and vigour at some sites at harvest
- Observations on weed control achieved and species controlled or not controlled

### ***Application***

NHC sprays were applied with a small plot sprayer fitted with 110° flat fan Hardi 4 110-12 nozzles (BCPC code F110/0.73/3) delivering 480L/ha water volume at 2 bar pressure to give fine spray quality.

Norfolk sprays were applied using a gas pressurised Azo precision sprayer with a 1.8 m boom and four 110° flat fan nozzles (BCPC code F110/0.80/3) delivering 200 L/ha water volume at 2 bar pressure to give fine spray quality.

**Application details:**

<b>Date applied</b>	<b>Weather</b>	<b>GS crop</b>	<b>GS weeds</b>
<b>Pre-emergence Parsley</b>			
<b>NHC 1</b>			
21 May 10.00 am trs 1 - 5	17.2°C; 82% RH; cloud cover; wind 7mph rain after application 22 May 3mm, total 4.6mm in 36h	Pre-em crop Sowing depth 2.5 cm; seedbed fine rolled; surface dry	-
<b>Norfolk site</b>			
<b>2</b>			
<b>Hall Farm</b>			
4 April trs 1 –5, 12,13	14°C; overcast; no rain after application until 11 April 2mm, 4 April to 5 May 36mm	Pre-em crop Sowing depth 1cm seedbed very fine, firm rolled; surface dry	-
<b>Post-emergence Parsley</b>			
<b>NHC 1</b>			
26 June 2pm trs 6 - 11	22°C; 78% RH; cloud cover 0%; wind 4 mph no rain after application until 27 June 0.6mm	2-4 true leaves Sowing depth 2.5 cm; seedbed fine rolled; surface wet	2 true leaves-large plant uneven weed distribution
<b>Norfolk site</b>			
<b>3 Hall Farm</b>			
8 May trs 6 - 11	warm; 56% RH cloud cover 100%; no rain after application until 11 May, 11 to 22 May 39mm	2-3 rough leaf stage; Sowing depth 1cm seedbed very fine, firm rolled;	-

<b>Date applied</b>	<b>Weather</b>	<b>GS crop</b>	<b>GS weeds</b>
<b>Pre-emergence Coriander</b>			
<b>NHC 4</b>			
21 May, 10.00 am trs 1 - 5	17.2°C; 82% RH; cloud cover wind 7mph rain after application 22 May 3mm, total 4.6mm in 36h	Pre-em crop Sowing depth 2.5 cm; seedbed fine rolled; surface dry	-
<b>Norfolk site</b>			
<b>5</b>			
<b>Hall Farm</b>			
18 July trs 1 - 5	Hot & sunny; cloud cover 0%; no rain after application until 19 July 15mm, 19 July to 1 August 76mm	Sowing depth 1cm seedbed very fine, firm rolled; surface dry	-
<b>Post-emergence Coriander</b>			
<b>NHC 4</b>			
16 June, 11 am trs 6 - 11	25°C; 65% RH; cloud cover 0%; wind 2mph no rain after application until 17 June 0.2mm	2-4 true leaves Sowing depth 2.5 cm; seedbed fine rolled; surface dry	2-10 true leaves, uneven weed distribution
<b>Norfolk site</b>			
<b>6</b>			
<b>Hall Farm</b>			
25 May trs 6 - 11	20°C; 65% RH cloud cover 100%; no rain after application until 1 July, 1 to 30 July 77mm	2-3 true leaves Sowing depth 1cm; seedbed very fine, firm rolled	-

<b>Date applied</b>	<b>Weather</b>	<b>GS crop</b>	<b>GS weeds</b>
<b>Pre-emergence Basil</b>			
<b>Norfolk site</b>			
<b>7</b>			
<b>Warrenhill Farm</b>			
17 June	warm;	Sowing depth 1cm;	-
trs 1 – 5,	no rain after application	seedbed very fine, firm	
12, 13	until 22 July 16mm, 22-31 July 65mm	rolled;	
		surface dry	
<b>Post-emergence Basil</b>			
<b>Norfolk site</b>			
<b>8</b>			
<b>Field Barn Farm</b>			
12 June	20°C; cloud cover	Sowing depth 1cm	A few
trs 6 – 11,	100%;	Crop 2 Leaves;	
14,15	no rain after application	seedbed very fine, firm	
	until 17 June, 17 June	rolled	
	to 17 July 65mm		

## Results: Crop Safety

### *Parsley (curled leaf) pre-emergence herbicides (Tables 1 & 2)*

At the NHC parsley emergence was very slow and poor under the dry conditions. At Norfolk 2, emergence began on 16 April, but was very protracted and establishment was also poor.

At the NHC on a sandy loam soil, there was rain (3mm) the day after application. Centium and Goltix appeared safe to the crop at N and 2N dose rates. No damage was observed from Goltix. One leaf on a small number of plants exhibited bleaching from Centium but subsequent growth was not affected.

It was not possible to draw firm conclusions from the Norfolk site where, in addition to poor establishment, there was damage from a liquid fertilizer application. However the commercial drillings were shallower and on a very light soil there was more damage than at the NHC. Centium caused severe bleaching, which persisted until harvest, Goltix caused severe plant loss and so did the double dose rate of Pyramin. The trial could not be repeated because this was the last commercial drilling.

**Table 1.** Site 1 NHC Curled parsley: percentage phytotoxicity, visual effect and crop score (0 = complete kill; 7 = acceptable; 10 = no damage), mean of 3 replicates

Herbicide	L or Kg /ha	Crop score	% phyto	Crop score	% phyto	Crop Score	% phyto	Crop Score	% phyto
	<b>Crop GS Date</b>	2-4 TL 24/6	2-4 TL 24/6	2-5 TL 7/7	2-5 TL 7/7	3-6 TL 16/7	3-6 TL 16/7	large plant 4/8	large plant 4/8
1. untreated		10	0	10	0	10	0	10	0
<b>Pre-emergence 21/5</b>									
2. Centium	0.25 L	10	0	10	0	10	0	10	0
3 Centium	0.5 L	9.5	b 5.3	9.9	b 1	10	0	10	0
4. Goltix WG	2.0 Kg	10	0	10	0	10	0	10	0
5. Goltix WG	4.0 Kg	9.9	0.4	10	0	10	0	10	0

**Post-emergence  
26/6**

6. Totril	1.0 L	2.7	nec,d	2.7	nec,d	4.3	d50
		68.3		66.7			
7. Totril	2.0 L	1	nec,d 95	1	nec,d 95	2	d90
8. Goltix WG	1.5 Kg	9.2	st,nec 6.7	8.8	st,nec 4	10	0
9. Goltix WG	3.0 Kg	7	st,nec	8	st,nec 20	vr 9	10
		13.3					
10. Betanal Flo	1.5 L	10	0	10	0	10	0
11. Betanal Flo	3.0 L	10	0	10	0	10	0

b occasional leaves bleached; c chlorosis; d death; nec necrosis; st stunting;

TL true (rough) leaves; Untreated: only 1% cover on 24 June, 3% on 7 July

**Table 2.** Site 2 Norfolk Curled parsley: visual effect and crop score (0 = complete kill; 7 = acceptable; 10 = no damage); % emergence; crop height (cm) mean of 3 replicates

Herbicide	L Kg /ha	Crop score		% emerg		ht cm	
		Cot - 1TL	Cot - 1TL	harvest	harvest	harvest	harvest
	<b>Crop GS Date</b>	29/5	29/5	7/7	7/7	7/7	7/7
1. untreated		45	10	10	60	20	
<b>Pre-emergence 4/4</b>							
2. Centium	0.2 L	b 5 - 10	3	(45% b) 6	40	20	
3 Centium	0.4 L	b 5	3	(60% b) 4	20	20	
4. Goltix WG	2.0 Kg	5 - 10	5	7	10	12.5	
5. Goltix WG	4.0 Kg	5	5	6	5	7.5	
12. Pyramin	1.0 L	5 - 10	3	6	40	20	
13. Pyramin	2.0 L	5	2	5	20	10	

b occasional leaves bleached

### **Parsley (curled leaf) post-emergence herbicides (Tables 1 & 3)**

At the Norfolk site 3, parsley was drilled early, on 25 February into a moist seedbed and emergence (25 March) and establishment were good. At the NHC, where emergence was poor and uneven under dry conditions, parsley was at a range of growth stages when sprayed.

At both sites, NHC and Norfolk 3, damage from Betanal at 1.5 or 3.0 l/ha was negligible. At NHC, Goltix at 1.5 kg/ha caused initial chlorosis, scorch and stunting but the parsley recovered. Effects from 3.0 kg/ha were increased and there was some vigour reduction and thinning by 4 August but the crop was acceptable. Damage was more severe at Norfolk site 3 with vigour loss, thinning and height reduction of the crop from the 3.0 kg/ha dose. Totril applied at NHC when the temperature was 21°C caused severe damage in the form of scorch at 1.0 l/ha, but the damage was related to plant size and the largest parsley plants suffered less damage and recovered. There was almost total crop kill at 3.0 l/ha. Totril was less damaging at Norfolk site 3 and initial effects were less than from Goltix.

**Table 3.** Site 3 Norfolk Curled parsley: percentage phytotoxicity, visual effect and crop score (0 = complete kill; 7 = acceptable; 10 = no damage); crop height (cm); % ground cover (untreated = 100%) as a mean of 3 replicates

<b>Herbicide</b>	<b>L Kg /ha</b>	<b>Crop score</b>	<b>Crop score</b>	<b>ht cm</b>	<b>Crop score</b>	<b>ht cm</b>	<b>% cover</b>
	<b>Crop GS</b>	Small plant			Near harvest		
	<b>Date</b>	26/5	29/5	29/5	7/7	7/7	7/7
1. untreated		10	10	8	10	38	100
<b>Post-emergence 8/5</b>							
6. Totril	1.0 L	c 6	6.7	5	7	36	86
7. Totril	2.0 L	severe c 3.7	5	3	vr 7	33	75
8. Goltix WG	1.5 Kg	severe c 5.3	5.6	4	6.7	36	88
9. Goltix WG	3.0 Kg	severe c 2.7	3.3	3	vr 6.7	27	66
10. Betanal Flo	1.5 L	9.7	9	8	10	39	98
11. Betanal Flo	3.0 L	8.7	9	8	10	38	97

c chlorosis; vr vigour reduction/thinning

### **Coriander pre-emergence herbicides (Tables 4 & 5)**

Coriander at both sites emerged and grew evenly. On the sandy loam soil at NHC (Table 4) both pre-emergence Centium 0.25 l/ha and Goltix 2.0 kg/ha had no effect on coriander, and at double dose rates the damage (bleaching of one leaf on a small number of plants from Centium or scorch from Goltix) was negligible. A late assessment of crop height indicated that weeds suppressed growth on the untreated and there was little difference in height between coriander treated with Centium or Goltix pre-emergence.

No damage was observed from Centium or Goltix at either dose rate on Norfolk. Site 5 on a loamy sand (Table 5), where a slightly lower dose (0.2 l/ha) of Centium was used.

Although there was chlorosis and a slight reduction in emergence from both dose rates of Pyramin, the crop soon recovered and 14 days later there was no difference between treated and untreated coriander. On 26 August, just before harvest, there were no differences between any treated and untreated coriander in terms of height, vigour or degree of bolting.

**Table 4.** Site 4 NHC Coriander: percentage phytotoxicity, crop score (0 = complete kill; 7 = acceptable; 10 = no damage), crop height, mean of 3 replicates

Herbicide	L Kg /ha	Crop score	% phyto	Crop score	% phyto	Crop score	Ht cm
	<b>Crop GS</b>	5 TL	5 TL	Lge plant	Lge plant	harvest	harvest
	<b>Date</b>	24/6	24/6	7/7	7/7	16/7	16/7
1. untreated		10	0	10	0	10	71.8
<b>Pre-emergence 21/5</b>							
2. Centium	0.25 L	10	0	10	0	10	78.4
3. Centium	0.5 L	9.9	b 0.7	10	0	10	76.8
4. Goltix WG	2.0 Kg	10	0	10	0	10	81.9
5. Goltix WG	4.0 Kg	9.7	c 0.5	10	0	10	80.9
<b>Post-emergence 16/6</b>							
6. Totril	1.0 L	3.7	nec 50	5	50	vr5	73.6
7. Totril	2.0 L	2	nec 83.3	2.7	vr 63.3	vr3.3	75.3
8. Goltix WG	1.5 Kg	10	0	10	0	10	75.1
9. Goltix WG	3.0 Kg	10	0	7.3	vr 20	vr5	69.6
10. Betanal Flo	1.5 L	10	0	10	0	10	74.8
11. Betanal Flo	3.0 L	10	0	10	0	10	75.0

b occasional leaves bleached; c chlorosis; nec necrosis; vr vigour reduction/thinning

**Table 5** Site 5 Norfolk Coriander: percentage phytotoxicity, crop score (0 = complete kill; 7 = acceptable; 10 = no damage), % emergence, crop height (cm) mean 3 replicates

<b>Herbicide</b>	<b>L , Kg /ha</b>	<b>Crop score</b>	<b>% phyto</b>	<b>% emerge</b>	<b>Crop score</b>	<b>% emerge</b>	<b>ht cm</b>
	<b>Crop GS Date</b>	2-4 TL 11/8	2-4 TL 11/8	2-4 TL 11/8	harvest 26/8	harvest 26/8	harvest 26/8
1. untreated		10	0	100	10	100	35
<b>Pre-emergence 18/7</b>							
2. Centium	0.2 L	10	0	100	10	100	35
3 Centium	0.4 L	10	0	100	10	100	35
4. Goltix WG	2.0 Kg	10	0	100	10	100	35
5. Goltix WG	4.0 Kg	10	0	100	10	100	35
12. Pyramin	1.0 L	8	c, re 20	90	10	100	35
13. Pyramin	2.0 L	8	c, re 30	90	10	100	35

c chlorosis; re reduced emergence

### ***Coriander post-emergence herbicides (Tables 4 & 6)***

At the Norfolk Site 6, coriander was quick to emerge and emergence was good, but growth was rather uneven.

Betanal at 1.5 or 3.0 l/ha appeared very safe to coriander at both sites and there were no differences between treated and untreated crop.

Crop safety for 1.5 kg/ha of Goltix was only just acceptable at Norfolk site 6, where reduced vigour and crop thinning was observed although the crop made a good recovery.

For Goltix at 3.0 kg/ha rate the effects were more severe, with some plant loss at the early assessment and damage was still unacceptable by harvest. At the NHC there was no damage from Goltix initially, but later the crop appeared to suffer thinning and vigour and plant height reduction. A lower dose could perhaps be considered.

Totril caused chlorosis and necrosis. Damage was more severe at NHC than at the Norfolk site 6, where the coriander made a good recovery. Damage was not acceptable at NHC. However a lower dose could be considered.

**Table 6.** Site 6 Norfolk Coriander: percentage phytotoxicity and crop score (0 = complete kill; 7 = acceptable; 10 = no damage); crop height, crop cover compared with untreated (=100%), mean of 3 replicates

<b>Herbicide</b>	<b>L Kg /ha</b>	<b>Crop score</b>	<b>ht cm</b>	<b>Crop score</b>	<b>ht cm</b>	<b>% Crop cover</b>
	<b>Crop GS Date</b>	3-4 TL 5/6	3-4 5/6	harvest 7/7	harvest 7/7	harvest 7/7
1. untreated		10	5	10	45	100
<b>Post-emergence 25/5</b>						
6. Totril	1.0 L	c 7.5	4	8.8	43	93
7. Totril	2.0 L	c 6.2	3	8.8	43	86
8. Goltix WG	1.5 Kg	7.5	5	8.8	43	85
9. Goltix WG	3.0 Kg	c, d 3.7	5	vr 6.7	22.5	50
10. Betanal	1.5 L	10	4	10	43	91
Flo						
11. Betanal	3.0 L	10	2	10	45	100
Flo						

c chlorosis; d some plant death; vr vigour reduction/thinning

### ***Basil pre-emergence herbicides (Table 7)***

The trials in basil were only sited in Norfolk crops but the results were conclusive. Rain after drilling ensured good, even emergence and growth.

At Norfolk site 7 Centium caused slight bleaching initially of some plants, but these recovered and subsequent growth was unaffected.

There was no crop damage from 2.0 or 4.0 kg/ha dose rates of Goltix.

At harvest there were no crop effects from Centium or Goltix, from single or double dose rates and the crop was as dense and tall as the untreated basil.

Basil suffered plant loss from Pyramin applied at 1.0 or 2.0 l/ha – emergence was reduced and plants which did emerge were chlorotic. By harvest any basil remaining were very stunted and unharvestable.

**Table 7** Site 7 Norfolk Basil: percentage phytotoxicity; crop score (0 = complete kill; 7 = acceptable; 10 = no damage); % crop emergence; crop height (cm) mean of 3 replicates

Herbicide	L Kg /ha	Crop score	% phyto	% crop p em	Crop score	ht cm	Crop score	% phyto	% crop em	Crop score	ht cm		
	<b>Crop GS Date</b>	2 leaf	9/7	4 leaf	20/7	20/7	4-6 leaf	31/7	31/7	harvest	26/8	26/8	26/8
1. untreated		10	0	100	10	7.5	10	0	100	10	45		
<b>Pre-emergence</b>													
2. Centium	0.25 L	7.2	b 16.7	90	9	6	10	0	100	10	45		
3 Centium	0.5 L	7	b 20	70	8	6	9	st 5	100	10	45		
4. Goltix	2.0 Kg	10	0	100	10	7.5	10	0	100	10	45		
5. Goltix	4.0 Kg	10	0	100	10	7.5	10	0	100	10	45		
6. Pyramin	1.0 L	6.3	re c 18.3	40	4	2	3	re 77	30	3	5		
7. Pyramin	2.0 L	3.3	re c 73.3	10	3	2	1	re 95	20	2	3		

b occasional leaves bleached; c chlorosis; st stunting; re reduced emergence

### ***Basil post-emergence herbicides, (Table 8)***

The widest margin of crop safety was from Basagran. The full dose of 1.65 kg/ha, and the double dose were applied at 2 leaf stage (i.e. 1 leaf pair) of the crop, on a warm day (20°C) and the crop recovered from slight initial scorch.

Totril at 1.0 and 2.0 l/ha scorched the basil. Later there was some plant loss, remaining plants had reduced vigour and crop height.

Goltix at 1.5 kg/ha caused temporary scorch and thinning but the basil recovered to give an acceptable crop. Lower doses could be considered for very light soils (previous work on heavier soil indicated Goltix was safe at 1.5 kg/ha). At the double dose there was severe damage, initially as necrosis and later there was some plant loss and considerable reduction in vigour and crop height.

Betanal at 1.5 l/ha and 3.0 l/ha caused slight scorch initially, but the basil recovered from both dose rates to give slight reduction in vigour but a marketable crop.

**Table 8.** Site 8 Norfolk Basil: crop score (0 = complete kill; 7 = acceptable; 10 = no damage); crop height (cm) mean of 3 replicates

<b>Herbicide</b>	<b>L Kg /ha</b>	<b>Crop score</b>	<b>ht cm</b>	<b>Crop score</b>	<b>ht cm</b>
	<b>Crop GS Date</b>	4 leaf 26/6	26/6	harvest 14/7	14/7
1. untreated		10	10		185
<b>Post-emergence 12/6</b>					
6. Totril	1.0 L	nec 4.4	6	vr 6	106
7. Totril	2.0 L	nec 4.4	4	vr 5	75
8. Goltix WG	1.5 Kg	nec 5.6	5	vr 8.3	170
9. Goltix WG	3.0 Kg	nec 2.2	3	vr 2.3	2
10. Betanal Flo	1.5 L	nec 5.6	6	8.3	135
11. Betanal Flo	3.0 L	nec 4.4	4	7	135
12. Basagran SG	1.65Kg	8.8	10	10	175
13. Basagran SG	3.30 Kg	nec 8.8	10	10	185

nec necrosis; vr vigour reduction/thinning

## **Results: Weed Control**

### **NHC (Table 9)**

Weed populations were high at this site, but distribution was too uneven to do meaningful counts or weed cover assessments and only a list of species which appear to be tolerant, or possibly controlled, are given. By the time crops reached a safe stage for post-emergence herbicide application, the weeds had become far too large for effective control by Goltix or Betanal – at the dose rates tested these products only control cotyledon and small (1 to 2 leaf) weeds. There was a wide range of species: fat-hen, redshank, pineappleweed, chickweed, field pansy, groundsel, shepherd's purse; on the parsley trial, Korean mint, black-nightshade.

### ***Parsley***

Pre-emergence: Centium performed best but it normally needs a tank-mix partner. Goltix pre-emergence was less effective.

Post-emergence: The slow and uneven emergence of the parsley meant considerable delay by the time the crop was at 2 true leaf stage and weeds were large (redshank 4-12 leaves; shepherds purse 4 –10 leaves, pineappleweed 2-8 leaves, fat-hen 6-12 leaves) with weed cover about 20%. Consequently weed control with Goltix or Betanal was poor, and these only gave some control of smaller shepherd's purse. By harvest the crop was completely smothered by weeds. A pre-emergence herbicide is thus essential as part of a programme for parsley.

Totril was more effective – it achieved 100% control of shepherd's purse, groundsel; no control of knotgrass but only scorching large fat-hen and pineappleweed.

**Table 9.** Site 1 NHC Curled parsley: weed control scores (0= no control, 7 = acceptable control, 10 = complete control) mean of 3 replicates

Herbicide	L Kg /ha	Weed control score			
		<i>Crop GS</i>	2-4 TL	2-5 TL	3-6 TL
		<i>Date</i>	24/6	7/7	16/7
1. untreated		0	0	0	
<b>Pre-emergence</b>					
<b>21/5</b>					
2. Centium	0.25 L	9	9	8	
3 Centium	0.5 L	9	9	9	
4. Goltix WG	2.0 Kg	9.8	8	6	
5. Goltix WG	4.0 Kg	9.9	9.2	7	
<b>Post-emergence</b>					
<b>26/6</b>					
6. Totril	1.0 L		6	5	
7. Totril	2.0 L		9.2	9	
8. Goltix WG	1.5 Kg		0	0	
9. Goltix WG	3.0 Kg		2	1	
10. Betanal Flo	1.5 L		1	0	
11. Betanal Flo	3.0 L		1.3	1	

### **Coriander**

As in the parsley trial pre-emergence, Centium was more effective than Goltix but both gave acceptable control. Unlike the parsley, the coriander emergence was quick and the crop grew vigorously, competing well with weeds. Centium did not achieve good control of fat-hen or pineappleweed; Goltix of redshank. When the crop was at 2 true leaf stage, weeds were already large (2-10 leaves) and beyond the growth stage for control with post-emergence Betanal or Goltix. Thus the level of weed control was unacceptable, although by 16 July the vigorous coriander was smothering weeds. Main species remaining after Goltix were groundsel and fat-hen; after Betanal pineappleweed and fat-hen. Totril was more effective on weeds, but more phytotoxic to the crop.

**Table 10.** Site 4 NHC Coriander: weed control scores (0 = no control, 7 = acceptable control, 10 = complete control) on 24 June and 16 July

Herbicide	L or Kg /ha	Weed control score	
		5 TL 24 June	Large plant 16 July
1. untreated		0	0
<b>Pre-emergence</b>			
<b>21/5</b>			
2. Centium	0.25 L	9.5	9
3 Centium	0.5 L	9.5	9.5
4. Goltix WG	2.0 Kg	9.9	7.3
5. Goltix WG	4.0 Kg	9.9	9.8
<b>Post-emergence</b>			
<b>15/6</b>			
6. Totril	1.0 L	6	6.3
7. Totril	2.0 L	9.8	8.8
8. Goltix WG	1.5 Kg	1	3.7
9. Goltix WG	3.0 Kg	2	5
10. Betanal Flo	1.5 L	1	4
11. Betanal Flo	3.0 L	1	4.7

### **Weed Control: Norfolk sites**

A standard pre-emergence herbicide was applied overall at the post-emergence coriander and parsley trial sites so the populations of species which escaped control were low.

#### ***Parsley***

The pre-emergence site was abandoned.

#### ***Coriander***

There were few weeds on the late sown pre-emergence site 5, mainly groundsel, fat-hen, charlock and volunteer evening primrose. The lower doses of Centium, Goltix and Pyramin controlled all species except evening primrose. At post-emergence site 6, no weeds escaped control after the standard pre-emergence application

## ***Basil***

There were very low numbers of groundsel, field speedwell, fat-hen and mayweeds at pre-emergence site 7. At post-emergence site 8, weed populations were also low and distribution uneven. Efficacy was poor for: Totril on annual meadow-grass; Betanal on small nettle and Basagran did not control fat-hen or annual meadow-grass.

## **Discussion**

Herb growers have relied on herbicides prometryn and pentanochlor to control troublesome weeds (groundsel, fool's parsley, fumitory and cleavers) but the "Essential Uses" expire 31 December 2007, and alternatives are sought. These one season trials have provided some information on crop safety on a light soil (sandy loam) and a very light soil (loamy sand).

The full dose recommended for the soil type was used for pre-emergence Centium and Goltix.

A programme of split, low dose sprays are used in other crops onions (Totril), sugarbeet (Goltix, Betanal). In this study a post-emergence programme was not used and a single low dose of post-emergence Totril 1.0 l/ha (full dose 2.8 l/ha), or Goltix 1.5 kg/ha or Betanal Flo at 1.5l/ha (standard low dose for cotyledon weeds 2.5 l/ha) was applied. A fine quality spray at 200 l/ha will give the best cover for small weeds.

The full on-label recommended dose of Basagran for other crops was applied in basil.

## ***Crop safety***

### ***Parsley (curled leaf) pre-emergence herbicides Centium 360 CS, Goltix WG, Pyramin DF***

A pre-emergence residual herbicide is essential for parsley - at both sites, the parsley was very slow to emerge and emergence was poor. It was not possible to draw conclusions from the Norfolk site but Pyramin and Goltix may not be safe to parsley on very light soil and Centium may cause too much bleaching. On the light soil, a sandy loam, Centium and Goltix appeared safe to the crop at N and 2N dose rates. Warning: one leaf on a small number of plants exhibited bleaching from Centium but subsequent growth was not affected at NHC. This effect is seen in other crops on-label for Centium but there is no reduction in yield. Neither Centium nor Goltix will control the whole weed spectrum and both need a tank mix partner.

### ***Parsley (curled leaf) post-emergence herbicides Betanal Flo, Totril, Goltix WG***

At both sites, there was negligible damage from Betanal at 1.5 l/ha (or 3.0 l/ha). Therefore parsley would tolerate 2.5 l/ha (but not necessarily any overlaps). Betanal is seldom used alone and it may be safe to use in tank mix with a low dose of Goltix but this has not been evaluated.

Goltix at 1.5 kg/ha caused more damage than Betanal at both sites but was still acceptable.

Totril applied at NHC when the temperature was 21°C caused severe damage in the form of scorch at 1.0 l/ha and almost total crop kill at 3.0 l/ha. Weed control at NHC was better than Betanal or Goltix. There was less damage from Totril in Norfolk. However perhaps a lower dose rate (as used in onions), or application at a later growth stage, could be investigated.

### ***Coriander pre-emergence herbicides Centium 360 CS, Goltix WG, Pyramin DF***

Pre-emergence Centium 0.25 l/ha and Goltix 2.0 kg/ha sandy loam and on loamy sand had no effect on coriander, and at double dose rates the damage was negligible. Neither Centium, nor Goltix will control the whole weed spectrum and both need a tank mix partner.

In Norfolk site 5, although there was chlorosis and a slight reduction in emergence from both dose rates of Pyramin, the crop soon recovered and 14 days later there was no difference from untreated coriander. Pyramin may have a lower margin of crop safety than pre-emergence Centium or Goltix, however it would be useful in fields where black-nightshade is an anticipated problem.

### ***Coriander post-emergence herbicides Betanal Flo, Totril, Goltix WG***

Betanal at 1.5 l/ha (or 3.0 l/ha) appeared very safe to the coriander crop at both sites. Therefore 2.5 l/ha would be safe (but not necessarily on overlaps) but the maximum dose for spinach (and hence herbs) is 1.5 l/ha. Betanal is seldom used alone and it may be safe to use in tank mix with a low dose of Goltix but this has not been evaluated.

Goltix at 1.5 kg/ha caused reduced vigour and crop thinning particularly in Norfolk. At the NHC there was no damage from Goltix initially, but later the crop appeared to suffer thinning, vigour and height reduction. A lower dose could be considered.

Totril caused chlorosis and necrosis which was more severe at NHC than at the Norfolk site. However, weed control at NHC was better than Betanal or Goltix and a lower dose could be considered.

### ***Basil pre-emergence herbicides Centium 360 CS, Goltix WG, Pyramin DF***

Centium caused slight bleaching initially on some plants, but subsequent growth was unaffected.

Goltix at 2.0 or 4.0 kg/ha dose rates was safe to basil.

Pyramin at dose rates of 1.0 l/ha (or 2.0 l/ha) were not safe to use in basil. Basil suffered severe plant loss, emergence was reduced and any plants which did emerge were chlorotic.

### ***Basil post-emergence herbicides Betanal Flo, Totril, Goltix WG, Basagran SG***

The widest margin of crop safety was for Basagran. The full dose of 1.65 kg/ha, and the double dose were applied at 2 leaf stage (i.e. 1 leaf pair) of the crop, on a warm day (20°C) and basil only suffered slight initial scorch.

Totril at 1.0 and 2.0 l/ha scorched the basil, and later caused some crop loss, vigour and crop height reduction. Totril damage was unacceptable

There was a large dose response to Goltix. The 1.5 kg/ha rate caused temporary scorch and thinning, 3.0 kg/ha caused severe damage as necrosis and thinning. A lower dose could be considered.

Betanal at 1.5 l/ha caused a growth check, and at 3.0 l/ha chlorosis, but eventually recovered to produce an acceptable crop.

### ***Weed Control***

There were very low numbers of weeds on untreated plots at the Norfolk pre-emergence sites. At the Norfolk parsley and coriander post-emergence sites a standard pre-emergence herbicide was applied overall, so the population of species which escaped control were low.

There were high weed populations at the NHC, but the distribution was too uneven for meaningful weed assessments. In addition, by the time the crop reached a suitable stage for application of post-emergence herbicides, the weeds had become far too large for effective control— these only kill cotyledon and very small (1 to 2 leaf) weeds. There was a wide range of species: fat-hen, redshank, pineappleweed, chickweed, groundsel; and on the parsley trial, Korean mint, black-nightshade as well. List in the NHC trials:

**Centium pre-emergence 0.25 l/ha:** did not control: Korean mint, black-nightshade, field pansy, pineappleweed, knotgrass. Controlled: shepherd's purse, fool's parsley, groundsel, annual meadow-grass, chickweed, redshank, fat-hen.

**Goltix pre-emergence 2.0 kg/ha:** did not control fat-hen, Korean mint, black-nightshade, fool's parsley, redshank, annual meadow-grass. Controlled: shepherd's purse, groundsel, chickweed.

Post-emergence herbicides were applied at a low dose recommended for weeds at the cotyledon stage. When crops reached a suggested stage for spraying the weeds were way beyond this stage at NHC and Betanal and Goltix controlled few species. However Totril was more effective at this site.

**Post-emergence Totril 1.0 l/ha** did not control Korean mint, large pineappleweed, field pansy, knotgrass, annual meadow-grass, large fat-hen; controlled groundsel, redshank, shepherds purse. Only the 2.0 l/ha dose rate controlled black-nightshade.

**A Table given in Annex 1 shows data on labels and from the sugar beet sector, for weed susceptibility, for all herbicides in the trials, compared with prometryn and Croptex Bronze (pentanochlor).**

## Conclusions

This study reported here has identified potential alternative products which would appear to be safe (non-phytotoxic) to coriander, parsley and basil crop at the timing and rates used.

This work allows the industry to demonstrate to the European Commission that action has been taken to find alternatives to replace the temporary 'Essential Uses' so that these uses can continue.

Annex 1 shows weed species controlled.

Centium controls cleavers, groundsel and fools parsley

Goltix controls fool's parsley, groundsel

Betanal controls cotyledon stage groundsel, fumitory

Totril controls cotyledon stage groundsel, black-nightshade

Basagran controls cleavers (small), black-nightshade and fools parsley

A pre-emergence residual herbicide is essential for herbs particularly species which are slow to emerge, such as parsley.

Crop safety of pre-emergence herbicides depends on soil type and drilling depth. On the commercial crops in Norfolk on loamy sands, sown at 1 cm depth the potential for damage was higher than on loamy sand at 2 cm depth and this has been seen in parsley.

Herbicides which on limited data, appear safe to the crop:

### ***Parsley (curled)***

Safe pre-emergence: Centium 360 CS (clomazone) 0.25 l/ha on light soil (data for loamy sand inconclusive) Centium needs a tank-mix partner to control a wide weed spectrum: e.g. Stomp (pendimethalin) or Afalon (linuron)

Safe post-emergence (growth stage crop 2-3 rough leaf): Betanal Flo 1.5 l/ha. Only controls weeds at cotyledon stage.

Post-emergence Goltix WG (1.0 or 1.5) kg/ha may cause initial temporary damage.

Totril (contact-acting) at 1.0 l/ha post-emergence caused crop damage at NHC, however a lower dose rate could be assessed. (Totril application not permitted with a knapsack sprayer). Application of Totril could be evaluated pre-emergence of parsley, to control weeds emerging before the crop.

### ***Coriander***

Safe pre-emergence: Centium (clomazone) 0.25 l/ha on light soil, reduce Centium dose to 0.2 l/ha on very light soils) Centium needs a tank-mix partner to control a wide weed spectrum: e.g. Stomp (pendimethalin) or Afalon (linuron)

Safe pre-emergence: Goltix WG (metamitron) 2 kg/ha. A pre-emergence tank-mix partner is also needed or a post-emergence programme.

Pyramin DF (chloridazon) has a lower margin of crop safety than Centium or Goltix, however it could be useful in fields where black-nightshade is an anticipated problem.

Safe post-emergence, growth stage crop 2-3 rough leaf: Betanal Flo 1.5 l/ha; or Goltix WG 1.0 or 1.5 kg/ha. These only control weeds at cotyledon stage. Betanal has a 14 day Harvest Interval on spinach, but Goltix Minimum Harvest Interval is 6 weeks.

A lower dose of Totril than the 1.0 l/ha in the trial could be tested.

## **Basil**

Safe pre-emergence: Centium (clomazone) 0.25 l/ha on light soil, reduce dose to 0.2 l/ha on very light soils) Centium needs a tank-mix partner.

Safe pre-emergence: Goltix WG 1.0 or 1.5 kg/ha , but MHI is 6 weeks.

Centium could be added if there is likely to be a cleavers problem,

Pre-emergence Pyramin DF caused crop loss.

Safe post-emergence (growth stage crop 2-4 leaf): Basagran SG 1.65 kg/ha full dose

## **Current Herbicide Approval status**

Centium 360 CS (clomazone), Basagran SG (bentazone) and Pyramin DF (chloridazon) have no current approval for UK herbs.

Goltix WG (metamitron) SOLA 3657/2002 for parsley and LTAEU herbs; others SOLAs for parsley and herbs Marquise SOLA 0737/2003; Skater SOLA 0738/2003. All MHI 6 weeks, pre- or post-emergence not specified, all for use on herbs including parsley, coriander and basil.

Betanal Flo (phenmedipham) SOLA 1859/2000 for use on spinach at 1.5 l/ha (MHI 14 days), Long Term Arrangements for Extension of Use (LTAEU) to herbs.

Totril SOLA 1918/2000 restricted to chives only MHI 14 days, no approval for parsley, coriander or basil. (Note: Totril application not permitted with a knapsack sprayer).

Afalon (linuron) & others, full approval on-label for parsley, LTAEU coriander, basil. (Note: linuron application not permitted with hand held sprayer)

Stomp (pendimethalin) & others, full approval on-label for parsley, LTAEU coriander, basil.  
Stomp 400 SC SOLA 0132/2000; Stomp 400 SC SOLA 2356/2001 for coriander and basil  
Claymore SOLA 2354/2001 for coriander & basil.

## Recommendations

Goltix WG & other products containing metamitron, Skater , Marquise have SOLAs (MHI 6 weeks) could be used pre-emergence coriander, basil

Betanal Flo has a LTAEU (Long Term Arrangement for Extension of Use) to parsley, coriander, basil, from the spinach SOLA where maximum dose is 1.5 l/ha and MHI is 14 days.

**SOLA (Specific Off-Label Approval) applications** may be needed for:

**Centium 360 CS** in parsley (although it may not be safe on very light soils or sands), coriander, basil (and possibly leaf herbs).

**Basagran SG** in basil

Two years residues data may be required.

Pyramin may have a lower margin of crop safety than Centium or Goltix, however it might be useful in coriander where black-nightshade is an anticipated problem. If the application for spinach is approved there will be a LTAEU for herbs.

Growers may need further work on programmes and tank-mixes (e.g. Betanal + Goltix) in 2004 to assess efficacy against the weed species in commercial crops.

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## Appendix 1

**Weed Susceptibility to herbicides** label claims, except Pyramin & Goltix sugar beet data

Key: S = susceptible; MS = Moderately Susceptible; R = Resistant MR = Moderately Resistant;

Prometryn and pentanochlor (as Atlas Brown or Croptex Bronze) will go 31 December 2007.

# Goltix 1kg/ha, Totril 1.4 l/ha, Betanal Flo cotyledon weeds only; \*Totril control less reliable

Common name	Latin name	prometryn	Croptex Bronze	Centium	Pyramin	Goltix	Goltix #	Totril#	Basagran	Betanal#
		pre/post	post	pre	1kg pre	pre	1kg cot post	1.4 L cot post	post	1.5l cot post
Bindweed, black	<i>Fallopia convolvulus</i>	(Spre)	S	MR	S	MR	MR	S	MS	MS
Bugloss	<i>Anchusa arvensis</i>							S		
Charlock	<i>Sinapis arvensis</i>	(MSpre)		R	S	MS	MS	S	S	
Chickweed, common	<i>Stellaria media</i>	S	S	S	S	S	S	S	S	S
Cleavers	<i>Galium aparine</i>	R	S	S	MR	R	R		S	MR
Corn marigold	<i>Chrysanthemum segetum</i>		S		S	S	S		S	
Corn spurrey	<i>Spergula arvensis</i>	S			S	S	S		S	
Crane's-bill, cut-leaved	<i>Geranium dissectum</i>								S	R
Deadnettle, henbit	<i>Lamium amplexicaule</i>		S						MS	
Dead-nettle, red	<i>Lamium purpureum</i>		S	S	S	MS	MS	S*	MS	S
Dock, broad-leaved	<i>Rumex obtusifolius</i>					S	S			

Fat-hen	<i>Chenopodium album</i>	S	S		MS	S	S	S	S	MS	S
Fool's parsley	<i>Aethusa cynapium</i>				S		S	S		S	
Forget-me-not, field	<i>Myosotis arvensis</i>		S				S			S	MR
Fumitory, common	<i>Fumaria officinalis</i>	S	MS		R	MS	MS		S*	MS	S
Gallant -soldier	<i>Galinsoga parviflora</i>										
Groundsel	<i>Senecio vulgaris</i>	MS(Spre)			S	MS	S	S	S	MS	S
Hemp-nettle, common	<i>Galeopsis tetrahit</i>	S	S			S		S	S*	MR	S
Knotgrass	<i>Polygonum aviculare</i>	(Spre)			MR	S		S		MR	S
Mayweed, scented	<i>Matricaria recutita</i>	(Spre)	MS		R	S		S	S	S	
Mayweed, scentless	<i>Tripleurospermum inodorum</i>	(Spre)	MS		R	S	S	S	S	S	MS
Nettle, small	<i>Urtica urens</i>	S	S		MR	S	S	S	S*	S	S
Nightshade, black	<i>Solanum nigrum</i>	S	S			S	MR	MR	S	S	
Orache, common	<i>Atriplex patula</i>	S	S			S		S	S	MS	S
Pansy, field	<i>Viola arvensis</i>		S		R	MR	S	S		R	S
Parsley piert	<i>Aphanes arvensis</i>		S								
Pennycress, field	<i>Thlaspi arvense</i>					S		S		S	MS
Persicaria, pale	<i>Persicaria lapathifolia</i>	S			MS		MS	MS	S*	S	S
Pimpernel, scarlet	<i>Anagalis arvensis</i>	MS(Spre)	S			MS	MR	MR		S	S
Pineappleweed	<i>Matricaria</i>		MS		R	S	S	S	S	S	

	<i>discoidea</i>									
Poppy, common	<i>Papaver rhoeas</i>	S	S	R	S	S	S		MS	S
Redshank	<i>Persicaria maculosa</i>	S	S		S		MS		S*	S
Shepherd's-purse	<i>Capsella bursa-pastoris</i>	S	S		S		S		S	S
Sow-thistle, smooth	<i>Sonchus oleraceus</i>	(Spre)	S			MS		MR		MS
Speedwell, common, field	<i>Veronica persica</i>	S	S		S	S	S	S	S	MS
Speedwell, ivy-leaved	<i>Veronica hederifolia</i>	S	S		S		MS	MS	S	MR
Sun spurge	<i>Euphorbia helioscopia</i>					MR		S		
Thistle, creeping	<i>Cirsium arvense</i>	R			R		R	R	R	suppr
Wild radish	<i>Raphanus raphanistrum</i>	Mspre			S		MR	MR	S	S
Annual meadow-grass	<i>Poa annua</i>	(Spre)	S					S		R
Blackgrass	<i>Alopecurus myosuroides</i>		S				MR		R	R
Brome, barren	<i>Anisantha sterilis</i>								R	
Wild-oat	<i>Avena fatua</i>	R					R		R	
Vol OSR	<i>Brassica napus</i>		MS	R						S
Vol Potatoes	<i>Solanum tuberosum</i>									

Goltix early post, [pentanochlor](#): S = wild mignonette;

Goltix early post, MS=white campion

loxynil S=swinecress