

**Project title:** Herbs: Evaluation of herbicides for labiate species to fill identified gaps, resulting from the EC review of pesticides

**Project number:** FV 245b (extension of FV 245)

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**Report:** Final report completed December 2004

**Previous report:** some potential alternatives were identified in project FV 245 and FV 245a.

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herbs, coriander

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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.

# **AUTHENTICATION**

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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## **GROWER SUMMARY**

### **Headline**

Herbicides which appear safe to the labiate herb (one year's trial only):

#### Residual herbicides

- only Venzar (lenacil) and Goltix Flowable (and other products containing met amitron); were safe to mint.
- Venzar and Goltix Flowable were very safe to sage. Sage was also tolerant to Raft (oxadiargyl not available yet), Flexidor (isoxaben) and Butisan (metazachlor).
- Centium (clomazone), a cleavers killer, caused temporary yellowing of mint and sage foliage but no other damage.

#### Foliar-acting herbicides

- Asulox (asulam) was safe to mint, but it has a limited weed spectrum

### **Background and commercial objectives**

Mechanical weed control can be damaging in mint and sage crops because mint develops spreading, rhizomatous root systems and sage can spread by aerial layering. Whilst weeds must be controlled to a very high level the options for non-chemical control are limited.

Research is needed to find effective replacements following the EC review of pesticides and the loss of herbicide options. Herb growers will lose terbacil, which only has an Essential Use until the end of 2007 and also simazine after 10 September 2005 because it failed to achieve Annex 1 listing. These herbicides control a wide range of broad-leaved and some grass weeds. Growers of Labiate herbs therefore urgently need residual herbicides to replace terbacil and simazine.

A screening trial in 2002 on a sandy loam at NHC (National Herb Centre) was funded by HDC to determine the phytotoxicity of possible replacement herbicides on a range of herb species (including spearmint transplants and drilled basil) and results

suggested a few possibilities. Potential alternative post-emergence herbicides, Basagran (bentazone) and Betanal (phenmedipham) were also identified in project FV 245a as safe for Labiate herb basil. However these are not necessarily safe in other labiate species.

The aim of the new project FV 245b was to determine the crop safety of herbicides for the control of annual weeds for the major (Lamiaceae) Labiate herbs sage and mint to identify suitable candidates for Specific Off-Label Approval. There are already SOLAs for Kerb (propyzamide) and some graminicides, thus herbicides for broad-leaved weed control were evaluated. The Long Term Arrangements LTAEU will not continue and SOLAs for each crop use will eventually be in place. This project will identify some important uses that will need support and thus minimize cost.

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.

**Table 1.**Herbicide Current Approval status

<b>Product</b>	<b>Active ingredient and formulation</b>	<b>Approval status (Dec2004)</b>
Centium 360 CS	clomazone 360CS	no UK approval for herbs; residue work for SOLA coriander/herbs in progress
Raft	oxadiargyl 400g/L SC	no UK approval on any crop yet
Venzar Flowable	lenacil 440 g/L SC	Venzar Flowable SOLA 0703/97; Cleancrop Lenflow SOLA 1708/01; Lenzar WP SOLA 1158/02 for spinach, LTAEU to herbs
Katamaran	quinmerac/metazachlor 125/375 g/L	no UK approval for herbs
Flexidor 125	isoxaben 125 g/L	no UK approval for herbs
Sencorex WG	70%w/w WG	no UK approval for herbs
Basagran SG	bentazone 87% w/w SG	no UK approval for herbs, residue work for SOLA basil/herbs in progress
Betanal Flow	phenmedipham 160g/L SE	SOLA 1859/00 for spinach (MHI 14 days) maximum dose is 1.5 l/ha. LTAEU to herbs.
Butisan S	metazachlor 500 g/L SC	no UK approval for herbs
Devrinol	napropamide 450 g/L SC	no UK approval for herbs
Afalon & others	linuron 450 g/L SC	UK approval for parsley, LTAEU for mint or

		sage
Goltix Flowable and others	metamitron 700 g/L SC	Goltix Flowable SOLA 2189/04; Goltix WG SOLA 3657/02, SOLA 1756/04; Marquise SOLA 0737/03; Skater SOLA 0738/03. All MHI 6 weeks, pre- or post-emergence not specified, all for use on mint and sage
Asulox	asulam 400 g/L SL	SOLA 1900/00 (0524/04) only for spot treatment mint MHI 6 weeks
Stomp 400 SC& others	pendimethalin 400 g/L SC	Stomp 400 SC SOLA 2313/04 sage, mint; Claymore SOLA 2354/01 mint; Bema SOLA 1058/04 mint
Brasson	propachlor	Full Approval sage; Alpha Propachlor SOLA 2424/00 mint, leaf herbs; Ramrod Flowable SOLA 1159/02 mint, leaf herbs

LTAEU Long Term Arrangements for Extension of Use will not continue; SOLA Specific Off-label Approval

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

Persistent residual herbicides have been used in perennial herbs for many years. However, residual herbicides with soil persistence of more than 60 days are unlikely to be registered in the EU in future, thus an alternative as effective/long-lasting as terbacil (or simazine) will not be found.

Results demonstrated that if one labiate herb is tolerant to a herbicide it cannot be assumed that it is safe in another labiate species. This is because the crops studied have different morphology (leaf type - waxy or hairy etc.). For example, basil in the 2003 trial was tolerant of Basagran, but mint in this trial suffered severe damage. Flexidor completely killed mint, but was safe in sage.

### ***Tolerance to herbicides (limited data - only one trial in one year)***

Residual herbicides:

- for mint, only Venzar (lenacil) 2.0 L/ha and Goltix (metamitron) 5.0 L/ha were safe.
- Flexidor (isoxaben) 2.0 L/ha completely killed mint, and Sencorex (metribuzin) at low dose 0.75 kg/ha caused severe damage.

- In the older, established mint the other residuals Butisan, Katamaran, Raft and Devrinol were all too phytotoxic, but in maiden mint there was harvestable yield from these herbicides (but Katamaran distorted leaves).
- for sage, Venzar and Goltix (and other products) were very safe. Sage was also tolerant to Raft (oxadiargyl not available yet) 1.0 L/ha, Flexidor 2.0 L/ha, Butisan (metazachlor) 2.0 L/ha, Katamaran (metazachlor/quinmerac) 2.0 L/ha, Stomp (pendimethalin) 5.0 L/ha. Afalon (linuron) 2.5 L/ha and Brasson 9.0 L/ha caused scorch.
- Sencorex even at low dose caused severe damage to sage.
- Centium (clomazone) 0.2 L/ha a cleavers killer, only caused yellowing of mint and sage foliage but the colour recovered later with no other effects.

Foliar-acting herbicides:

- Asulox (asulam) was safe to mint.
- Basagran killed the growing points of mint shoots, and Betanal was also too phytotoxic.

### **Weed control**

There were very few weeds on the trial areas. Annex 1 shows product label claims and other information on weed species controlled.

**Note:** A trial on drilled sage was planned, but no commercial crop was sown in 2004. The trial with 3 foliar-acting herbicides in sage was not carried out - Sencorex was very damaging to emerged sage in the earlier trial. Herbicides applied to unreplicated areas on another field of sage showed that Betanal and Basagran were safe (Darryl Shales, personal observations). Sencorex was also extremely damaging to emerged mint in the earlier trial and was therefore not included in the foliar-acting trial 2.

## Action Points for Growers

- Review current weed control strategy for herbs because the “Essential Use” for terbacil will cease 31 December 2007. Simazine cannot be used after 10 September 2005.
- This work has allowed 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.
- Trials have identified Venzar, Goltix and other potential alternative residual herbicide products that appear to be safe (non-phytotoxic) to sage at the timing and rates used, but only Venzar and Goltix were safe to mint.
- An alternative as effective/long-lasting as terbacil (or simazine) will not be found because in future residual herbicides with soil persistence of more than 60 days are unlikely to be registered in the EU. Growers must rely on programmes using herbicides with residual activity, but which do not damage herb foliage (e.g. Venzar, Goltix, Butisan, Flexidor for sage).
- Post-emergence foliar-acting herbicide Asulox was safe to mint.
- SOLA (Specific Off-Label Approval) applications will be needed for: Venzar for sage and mint because the LTAEU arrangements will not continue; possibly Asulox as an overall application for herbs; other residuals for sage.

## Practical and Financial Benefits from this Study

An industry survey (January 2002) estimated that over 5,000 ha of herbs are grown in the UK - of these over 2,000 ha are for culinary use. Effective weed control is essential in a perennial crop and weedy contaminants in harvested produce are virtually impossible to remove. As a result of the EC pesticide review, growers of perennial herbs will lose key residual herbicides simazine and terbacil. Identification of alternative herbicides is essential for the continued productivity of the UK Herb Industry. This study identifies the crop safety of some alternative products and the potential for SOLAs for herbs. The Long Term Arrangements (LTAEU) will not continue and must eventually be replaced by SOLAs for each crop group. This project has identified an important use under LTAEU (Venzar) that will need support with a SOLA.

**Appendix 1. Weed Susceptibility to herbicides.** S = susceptible; MS = Moderately Susceptible; R = Resistant; MR = Moderately Resistant

Common name	Latin name	Venzar	Goltix	Brasson	Centium	Stomp	Flexidor	linuron	Devrinol	Sencorex	Raft	Butisan	Katamara n	Asulam	Basagran	Betana#
		pre2 - 5 L	pre 5L	pre 9L	pre 0.25L	pre 5L	pre 2L	pre 900 ga.i.	pre 9L	pre1.5 kg	pre1.0 L	pre 2.5 L	pre 2.0 L	foliar2.5L	foliar1.65 kg	foliar1.5L
Bindweed, black	<i>Fallopia convolvulus</i>	S	MR	R	MR	S		S	S	MS	S	MS			MS	MS
Bugloss	<i>Anchusa arvensis</i>		S					S		S						
Charlock	<i>Sinapis arvensis</i>	S	MS	R	R		S	S	R	S	S	MR			S	
Chickweed, common	<i>Stellaria media</i>	S	S	S	S	S	S	S	S	S	R	S	S		S	S
Cleavers	<i>Galium aparine</i>	S	R	S	S	S	MR	S	MS	R		MS	S		S	MR
Corn marigold	<i>Chrysanthemum segetum</i>	S	S	S		S	S	S				S			S	
Corn spurrey	<i>Spergula arvensis</i>	S	S	S			S	S		S	S	MS			S	
Crane's-bill, cut-leaved	<i>Geranium dissectum</i>											S	MR		S	R
Deadnettle, henbit	<i>Lamium amplexicaule</i>		MS	MS		S				S					MS	
Dead-nettle, red	<i>Lamium purpureum</i>	MS	MS	S	S	S	S	S	MS	S	S	S	S		MS	S
Dock, broad-leaved	<i>Rumex obtusifolius</i>		S seedling											S		
Fat-hen	<i>Chenopodium album</i>	MS	S	MR	MS	S	S	S	S	S	S	MS			MS	S
Fool's parsley	<i>Aethusa cynapium</i>		S		S										S	
Forget-me-not, field	<i>Myosotis arvensis</i>		S			S	S	S		S		S	S		S	MR
Fumitory, common	<i>Fumaria officinalis</i>	S	MS	R	R	MS		R	MS	S		R	R		MS	S
Gallant -soldier	<i>Galinsoga parviflora</i>			S				S								
Groundsel	<i>Senecio vulgaris</i>	MS	S	S	S		MS	S	S	S	S	S	S	S	MS	S
Hemp-nettle, common	<i>Galeopsis tetrahit</i>	R		S		S		S		S	R	MR			MR	S
Knotgrass	<i>Polygonum aviculare</i>	S	S	R	MR	S	S	S	S	S	S	R	R		MR	S
Mayweed, scented	<i>Matricaria recutita</i>	S	S	S	R	MS	S	S	S	S	S	S	S	S	S	
Mayweed, scentless	<i>Tripleurospermum inodorum</i>	S	S	S	R	MS	S	S	S	S	S	S	S	S	S	MS
Nettle, small	<i>Urtica urens</i>	MS	S	S	MR		S	S	S	S	S	MS			S	S
Nightshade, black	<i>Solanum nigrum</i>	R	MR	MS		S		S	R	R					S	
Orache, common	<i>Atriplex patula</i>	S	S	MR			S	S		S					MS	S

Pansy, field	<i>Viola arvensis</i>	R	S	R	R	S	S	S	MS	S		MR	MS		R	S
Parsley piert	<i>Aphanes arvensis</i>					S	S					S	S		-	
Pennycress, field	<i>Thlaspi arvense</i>	S	S	R				S	R	S		R	R		S	MS
Persicaria, pale	<i>Persicaria lapathifolia</i>	S	MS		MS			S		S					S	S
Pimpernel, scarlet	<i>Anagalis arvensis</i>	S	MR			S	S	S	R	S	R				S	S
Pineappleweed	<i>Matricaria discoidea</i>		S	S	R	MS	S		S	S	S				S	
Poppy, common	<i>Papaver rhoeas</i>	S	S		R	S	S	S	S	S		S	S		MS	S
Redshank	<i>Persicaria maculosa</i>	S	MS	R	S	S	S	S	MS	S	S	MS			S	S
Shepherd's-purse	<i>Capsella bursa-pastoris</i>	S	S	S	S	S	S	S	MS	S	S	S	S		S	S
Sow-thistle, smooth	<i>Sonchus oleraceus</i>	S		MS	MS	S		S	S	S	S				MS	R
Speedwell, common, field	<i>Veronica persica</i>	MS	S	S		S		S	S	S	S	S	S		MS	S
Speedwell, ivy-leaved	<i>Veronica hederifolia</i>	R	MS		S	S	S	S		S	S	S	S		MR	MS
Sun spurge	<i>Euphorbia helioscopia</i>		S	R						S	S				-	
Thistle, creeping	<i>Cirsium arvense</i>				R			R							suppr	
Wild radish	<i>Raphanus raphanistrum</i>	S	MR	R	S		S	S		S	S				S	S
Annual meadow-grass	<i>Poa annua</i>		S	S	MS	S		S	S	S		S	S		R	R
Blackgrass	<i>Alopecurus myosuroides</i>	R	MR	S		S		R		S	R	S	S		R	
Brome, barren	<i>Anisantha sterilis</i>							R				MS			R	
Wild-oat	<i>Avena fatua</i>		R	R				R	S			MR			R	
Vol OSR	<i>Brassica napus</i>				R	MS	S			S		R			S	

## **SCIENCE SECTION**

### **Introduction**

Research is required to find effective replacements following the EC review of pesticides and the loss of herbicide options. Herb growers will lose simazine after 2005 because it did not achieve Annex 1 listing, and terbacil only has an Essential Use until the end of 2007. These herbicides control a wide range of broad-leaved and some grass weeds, therefore alternative residual herbicides are urgently needed. There will also be gaps left by pentachlor and prometryn (Essential Use until the end of 2007) for the control of groundsel, fools parsley and cleavers. A screening trial in 2002 on a sandy loam at NHC was funded by HDC to determine the phytotoxicity of possible replacement herbicides on a range of herb species (including spearmint transplants and drilled basil) suggested a few possibilities. Further trials FV 245a in 2003 were in parsley and coriander where alternatives were identified. Only one labiate herb, basil, was tested on a loamy sand soil in a Norfolk commercial crop where pre-emergence Centium (clomazone) and a low dose of Goltix (metamitron) and post-emergence Basagran (bentazone) (recommendation for SOLA) and Betanal Flow (phenmedipham) appeared promising. However these are not necessarily safe in other labiate species. Work is needed on other labiates to find safe alternative residual herbicides in particular, and to evaluate foliar-acting herbicides as well. The crops suggested were Labiates sage and mint.

This work also 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.

The aim of the project was to determine the crop safety of residual soil-acting herbicides and foliar-acting herbicides for the control of annual weeds for the perennial Labiate herbs mint and sage.

## Objectives

- To assess crop safety or 'phytotoxicity' to herbicides tested
- To identify suitable candidates for SOLAs
- To assess where possible, efficacy against weeds
- To demonstrate to the European Commission that action has been taken to find alternatives to replace the temporary 'Essential Uses' for terbacil so that this use can continue until 31 December 2007.

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

Crop	Site	Soil Type (ADAS scale)	Spray Date
Mint pre-em	<b>1a &amp; 1b</b> Hamrow farm, Whissonsett, Norfolk	Sandy Clay Loam (medium soil type)	26 March 04
Mint post-em	<b>2.</b> Hamrow farm, Whissonsett, Norfolk	Sandy Clay Loam (medium soil type)	29 Sept 04
Sage pre-em	<b>3.</b> Warrenhills farm, Oakley, Diss, Norfolk	Sandy Loam (light soil type)	5 July 04

## Herbicide Treatments and Current Approval status

### 1. Mint: Residual Herbicides

No	Product	active ingredient	Company	formuln	Rate L/ha kg/ha	Approval Status
1	untreated				-	
2	Centium 360CS	clomazone	Belchim	360g/LCS	0.2 L	no UK approval for herbs; residue work for SOLA coriander/herbs in progress
3	Centium 360CS	clomazone			0.4 L	
4	Venzar Flowable	lenacil	Dupont	440 g/L	2.0 L	Venzar Flowable SOLA 0703/97; Cleancrop Lenflow SOLA 1708/01; Lenazar WP SOLA 1158/02 for spinach, LTAEU to herbs
5	Venzar	lenacil			4.0 L	
6	Sencorex WG	metribuzin	Bayer	87% w/w WG	0.75 kg	no UK approval for herbs
7	Sencorex WG	metribuzin			1.25 kg	
8	Raft	oxadiargyl	Bayer	400g/L SC	1.0 L	no UK approval for any crop yet
9	Raft	oxadiargyl			2.0 L	
10	Flexidor 125	isoxaben	Landseer	125 g/LSC	2.0 L	no UK approval for herbs
11	Flexidor 125	isoxaben			4.0 L	
12	Katamaran	metazachlor/ quinmerac	BASF	125/375 g/L SC	2.0 L	no UK approval for herbs
13	Katamaran	metazachlor/ quinmerac			4.0 L	
14	Butisan	metazachlor	BASF	500 g/L SC	2.0 L	no UK approval for herbs
15	Butisan	metazachlor			4.0 L	
16	Goltix Flowable	metamitron	Makhteshim	700 g/L SC	5.0 L	Goltix Flowable SOLA 2189/04; Goltix WG SOLA 3657/02, SOLA 1756/04; Marquise SOLA 0737/03; Skater SOLA 0738/03. All MHI 6 weeks, pre- or post-emergence not specified, all for use on mint and sage
17	Goltix Flowable	metamitron			10.0 L	
18	Devrinol	napropamide	United Phosphorus	450 g/L SC	7.0 L	no UK approval for herbs
19	Devrinol	napropamide			14.0 L	

LTAEU Long Term Arrangements for Extension of Use will not continue; SOLA Specific Off-label Approval

## 2. Mint: Post-emergence foliar-acting herbicides#

<i>N</i>	<i>Product</i>	<i>active</i>	<i>Company</i>	<i>formuln</i>	<i>Rate</i>	<i>Approval Status</i>
<i>o.</i>		<i>ingredient</i>			<i>L</i>	
					<i>kg/h</i>	
					<i>a</i>	
1	untreated					
2	Basagran SG	bentazone	BASF	87%w/w SG	1.6 kg	no UK approval for herbs, residue work for SOLA basil in progress
3	Basagran SG	bentazone			3.3 kg	
4	Betanal Flow	phenmedipham	Bayer & others	160g/l SE	2.5 L	SOLA 1859/2000 for spinach (MHI 14 days) maximum dose is 1.5 l/ha. LTAEU to herbs
5	Betanal Flow	phenmedipham			5.0 L	
6	Asulox	asulam	Bayer	400 g/L SL	2.5 L	SOLA 1900/00 (0524/04) only for spot treatment mint MHI 6 weeks
7	Asulox	asulam			5.0 L	

**# Note:** Sencorex was extremely damaging to emerged mint in the earlier trial and was not included.

### 3. Sage: Residual Herbicides

<b>No.</b>	<b>Product</b>	<b>active ingredient</b>	<b>Company</b>	<b>formuln</b>	<b>Rate L kg/ha</b>	<b>Approval Status</b>
1.	untreated				-	
2.	Centium	clomazone	Belchim	360 g/L CS	0.2 L	no UK approval for herbs; residue work for SOLA coriander/herbs in progress
3.	Centium	clomazone			0.4 L	
4.	Venzar Flowable	lenacil	Dupont	440 g/L SC	2.0 L	Venzar Flowable SOLA 0703/97; Cleancrop Lenflow SOLA 1708/01; Lenazar WP SOLA 1158/02 for spinach, LTAEU to herbs
5.	Venzar Flowable	lenacil			4.0 L	
6.	Sencorex WG	metribuzin	Bayer CropScience	87% w/w WG	0.75 kg	no UK approval for herbs
7.	Sencorex WG	metribuzin			1.25 kg	
8.	Raft	oxadiargyl	Bayer CropScience	400g/L SC	1.0 L	no UK approval for any crop yet
9.	Raft	oxadiargyl			2.0 L	
10.	Flexidor 125	isoxaben	Landseer	125 g/LSC	2.0 L	no UK approval for herbs
11.	Flexidor 125	isoxaben			4.0 L	
12.	Katamaran	metazachlor/ quinmerac	BASF	125/375 g/L SC	2.0 L	no UK approval for herbs
13.	Katamaran	metazachlor/ quinmerac			4.0 L	
14.	Butisan S	metazachlor	BASF	500 g/L SC	2.0 L	no UK approval for herbs
15.	Butisan S	metazachlor			4.0 L	
16.	Goltix Flowable	metamitron	Makhteshim	700 g/L SC	5.0 L	Goltix Flowable SOLA 2189/04; Goltix WG SOLA 3657/02 , SOLA 1756/04; Marquise SOLA 0737/03; Skater SOLA 0738/03. All MHI 6 weeks, pre- or post-emergence not specified, all for use on mint and sage
17.	Goltix Flowable	metamitron			10.0 L	
18.	Stomp 400 SC	pendimethalin	BASF	400 g/L SC	5.0 L	Stomp 400 SC SOLA 2313/04 sage, mint; Claymore SOLA 2354/01 mint; Bema SOLA 1058/04 mint
19.	Stomp 400 SC	pendimethalin			10.0 L	
20.	Afalon *	linuron	Makhteshim	450 g/L SC	2.5 L	UK approval for parsley, LTAEU for mint or sage
21.	Afalon *	linuron			5.0 L	
22.	Brasson	propachlor	Monsanto	480 g/L	9.0 L	Full Approval sage; Alpha Propachlor SOLA 2424/00 mint, leaf herbs; Ramrod Flowable SOLA 1159/02 mint, leaf herbs
23.	Brasson	propachlor			18 L	

LTAEU Long Term Arrangements for Extension of Use will not continue; SOLA Specific Off-label Approval

\*application not permitted with hand held sprayer

**Note:** A trial on drilled sage was planned, but no commercial crop was sown in 2004. The trial with 3 foliar-acting herbicides in sage was not carried out - Sencorex was extremely damaging to emerged sage in the earlier trial. Herbicides applied to unreplicated areas on another field of sage showed that Betanal and Basagran were safe (Darryl Shailes, personal observations).

## **Crop details**

### ***Sites***

Commercial crops: Mint near Whissonsett, Norfolk: Sage, Oakley, Suffolk

Trial sites were treated with a persistent residual soil-acting herbicide; except for maiden mint (trial 1b) with a less persistent residual.

### ***Trial Design***

Each plot was 8 m long x 1.8 m wide 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.
- Observations on any phytotoxicity symptoms, crop scores for damage (0=complete kill; 7= acceptable damage; 10=no damage), crop colour, height compared with the untreated
- Assessments of % crop cover
- Observations on weed control

### **Application:**

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:

Date applied	Weather	GS crop
<b>Pre-emergence residual herbicides Mint</b>		
<b>Norfolk site 1a &amp; 1b</b>		
1a. 26 March 04	7.5°C; RH% 64; 100% cloud cover; rain after application 2.4 mm, total rainfall 14 days after 31.2 mm ; soil surface wet	Established mint crop some new growth beginning after being cut hard, 5% crop cover
1b. 26 March 04	7.5°C; RH% 64; 100% cloud cover; rain after application 2.4 mm, total rainfall 14 days after 31.2 mm ; soil surface wet	Maiden mint planted from plugs in 2003 30% crop cover
<b>Post-emergence foliar-acting herbicides Mint</b>		
<b>Norfolk site 2</b>		
2. 29 Sept 04	14°C, overcast 100% cloud cover; no rain after application	Established mint after 3 <sup>rd</sup> cut, 95% crop cover

Date applied	Weather	GS crop
<b>Pre-emergence residual herbicides Sage</b>		
<b>Suffolk site 3</b>		
3. 5 July 04	16°C RH% 51; cloud cover 25%; soil dry; leaf surface dry; rainfall next day 1.4 mm; total rainfall 6 – 10 July 58.8 mm	After first cut, post- flowering, crop cover 95%

## Results

### ***Crop Safety***

For safety, there should be no or negligible/transient damage at a recommended dose rate and acceptable effects at the “overlap” double dose.

### **Trial 1a, b mint**

Extra residual treatments pre-weed-emergence were: Butisan (metazachlor), Goltix (metamitron) and Devrinol (napropamide) used in mint in the USA,

**Trial 1a established mint:** Assessments for crop safety are shown in Table 2. The mint in Trial 1a had been cut hard and was beginning to shoot (less than 5% cover) at the time of residual herbicide application on 26 March. A period of rapid growth on untreated plots followed.

Effects from Venzar were negligible even for the 2N dose rate throughout the trial period and the mint was indistinguishable from mint on untreated plots. There was little damage from Goltix except for slight stunting from the 2N dose later (on 26 April).

All other treatments caused crop damage. Leaf colour was assessed relative to untreated mint (=10). Herbicides caused chlorotic (yellow) or darker leaves.

On 8 April foliage of mint treated with Sencorex was chlorotic (yellow), on 13 April 70% of the plant and 100% from the single and double dose respectively. The latter dose also severely scorched the leaf tips. There was very little growth at later assessments (26 April and 7 May) , the mint treated with the 2N dose was almost dead. There was little harvestable yield from mint treated with Sencorex (21 May).

Initial effects from Centium were chlorosis of the centres of the growing points of mint shoots, and by 13 April 40% and 70% of the leaf area was chlorotic on plants treated with single and double dose respectively. Centium appeared to have no lasting effect on vigour and the mint developed normally. By 7 May mint had outgrown most of the chlorosis and by 21 May Centium plots were indistinguishable from the untreated.

The effects from Raft were: darker leaves, height reduction and vigour loss and the stunting persisted until at least 21 May when height reduction was 30% compared with

untreated mint. The plots treated with Raft at the single dose could perhaps have been harvested but yields would have been lower than the untreated.

Flexidor caused the most severe damage - leaves had dark green/purple colouration, leaf margins were distorted and curled down on 8 and 13 April and plants soon died completely even for single dose rates.

Devrinol also caused chlorosis in the from the single and double dose respectively but leaves became darker and smaller later on. The main effect from Devrinol was severe stunting and delay in growth development (7 and 21 May).

There was some chlorosis from Katamaran at 2N dose rates. Mint became stunted (26 April) and suffered vigour reduction from both dose rates. Butisan caused similar vigour loss but damage was less severe.



**Table 2. Trial 1a mint established** Residual treatments applied 26 March 2004 Crop vigour score (10 = untreated no damage, 0 = crop death)

Colour (10 = untreated, 0 = completely yellow); Phytotoxicity (damage) score (0 = untreated none, 7 = acceptable damage, 10 = crop death)

Herbicide	L/ha or kg/ha	Crop	Crop	Crop	Crop vigour	% crop	Crop	% crop	Crop	Crop	Crop	% crop	Height	Crop	%	Harvestabl	
		vigour	colour	damag e	(% chlorosis)	cover	vigour	cover	vigour	damag e	colour	cover	cm	vigour	crop cover	e	
		13 DAT 8 April				18 DAT 13 April			31 DAT 26 April				42 DAT 7 May			56 DAT 28 May	
1	untreated -	10	10	0	10	30	10	50	10	0	10	60	20	10	100	Y	
2	Centium 0.2 L	7	3y	2	5 (40)	30	10 bl	50	10	1	9.5	60	20	10	100	Y	
3	Centium 0.4 L	6.5	2y	2	1.5 (70)	30	10 bl	50	10	1	9.5	60	20	10	100	Y	
4	Venzar 2.0 L	10	10	0	10	30	10	50	10	0	10	60	20	10	100	Y	
5	Venzar 4.0 L	9	10	0.5	9.5	30	9	50	8	2	10	50	20	9.5	90	Y	
6	Sencorex 0.75 kg	5.5	1.5y	4.5	5 (70)	15	3.5	3.5	2.5	8	4	10	10	3.5	40	N	
7	Sencorex 1.25 kg	4.5	1.5y	5.5	2.5 (100)	15	2	3.5	1	9	2	10	7	1	10	N	
8	Raft 1.0 L	6	7	2	7	10	6	20	5	5	8	25	10	7	80	N?	
9	Raft 2.0 L	5	6	5.5	4	4	2	5	5	6	8	15	10	5 st	50	N	
10	Flexidor 2.0 L	4.5	6 dk	4.5	3	2	0	0	0	10	0	0	0	0	0	N	
11	Flexidor 4.0 L	4.5	5.5 dk	5	1.5	2	0	0	0	10	0	0	0	0	0	N	

12	Katamara	2.0 L	9.5	9	1	9.5	20	5	20	6	4	9	25	10	6	70	N
	n																
13	Katamara	4.0 L	7	6.5	1.5	9	15	2.5 st	10	4	6	8	15	10	5	40	N
	n																
14	Butisan	2.0 L	9.5	9	1	8 st del	10	6	20	6	4	9	25	10	6	70	N
15	Butisan	4.0 L	8	7.5	1.5	8 st del	10	4	15	5	6	8	20	10	5 st	50	N
16	Goltix	5.0 L	10	9.5	0.5	10	30	9.5	45	10	1	10	60	20	10	100	Y
17	Goltix	10.0 L	10	9	1	10	30	8.5	40	9	1	10	50	20	9.5	90	Y
18	Devrinol	7.0 L	8.5	7	2	10	25	4.5	20	5	5	8	25	15	6.5 st del	70	N
19	Devrinol	14.0 L	7.5	6.5	2	8.5	17.5	2.5	7.5	4	6	5	25	15	6 st del	60	N

y= yellowing, sc = scorch, dist = distortion; st = stunted; del = delay; narrow lv = narrow leaves; dk = dark leaves



**Trial 1b maiden mint:** Trial 1b was on a field adjacent to Trial 1a. Assessments for crop safety are shown in Table 3. Maiden mint (planted from plugs in 2003) was emerging after a dormant period and crop cover was about 30% at the time of residual herbicide application on 26 March 2004. A period of rapid growth followed. Herbicide effects were assessed until harvest in the last week of May.

Herbicide effects were very similar to those for Trial 1a, but chlorosis from Centium was greater. The colour for mint treated with Centium was restored by 7 May. Katamaran caused leaf narrowing and distortion later (26 April and 21 May).

Growth was more vigorous on this field and by harvest stage (21 May) and, with the exception of Flexidor and Sencorex, all plots were harvestable the last week in May. The crop cover (and probably yield) was greatest for mint treated with Venzar, Goltix and Centium.

Recovery from residual herbicides in the trial was better on this area probably because no very persistent residual herbicides had been applied to the mint the previous autumn.

### ***Weed Control***

There were no weeds on the Trial areas 1a or 1b

**Table 3. Trial 1b mint established (maiden mint)** Residual treatments applied 26 March 2004. Crop vigour (10 = untreated no reduction, 0 = crop death); Colour (10 = untreated, 0 = completely yellow); Phytotoxicity (damage) score (0 = untreated none, 7 = acceptable damage, 10 = crop death); Crop score overall (0 = untreated, 7 = acceptable damage, 10 = crop death)

	Herbicide	L/ha or kg/ha	Crop	Crop	Crop score	Crop score	% crop	Crop	Crop	Crop	% crop	Height	Crop	% crop	Harvestabl e
			colour	damage	(% chlorosis)	(% chlorosis)	cover	vigour	damage	colour	cover	cm	vigour	cover	
			13 DAT 8 April		18 DAT 13April	31 DAT 26April		42 DAT 7 May					56 DAT 21 May		
1	untreated	-	10	0	10	10	90	10	0	10	100	10	10	100	Y
2	Centium	0.2 L	2y	3	3 (60)	6(5)	90	10	0	10	100	10	10	100	Y
3	Centium	0.4 L	2y	2	2 (90)	5(20)	90	10	0	10	100	10	10	100	Y
4	Venzar	2.0 L	10	0	10	10	90	10	0	10	100	10	10	100	Y
5	Venzar	4.0 L	10	0	10	10	90	10	0	10	100	10	10	100	Y
6	Sencorex	0.75 kg	1y	3 sc	4 (100) sc	3	20	5	5	10	20	4	4	40	N
7	Sencorex	1.25 kg	1y	3 sc	2 (100) sc	1	10	1	9	1	5	1	1.5	15	N
8	Raft	1.0 L	7	2	7	6	60 st del	7	3	10	60	7	8	90	Y
9	Raft	2.0 L	6	4	5	3	40	7	3	10	60	2	7	80	Y
10	Flexidor	2.0 L	5	7 dist	3 dist	1	1	0	10	0	0	0	0	0	N
11	Flexidor	4.0 L	5	7 dist	2 dist	0	0	0	10	0	0	0	0	0	N
12	Katamaran	2.0 L	10	0	9	7	70	8	2	10	80	8	7 dist	80	Y
13	Katamaran	4.0 L	10	0	8.5	4	20 n lv	5	5	7	60	4	5 dist	60	Y

14	Butisan	2.0 L	10	1	10	8	80	8	2	10	90	8	8	90	Y
15	Butisan	4.0 L	10	2	10	5	30	7	3	9	70	5	6	70	Y
16	Goltix	5.0 L	10	1	10	9	90	10	0	10	100	10	10	100	Y
17	Goltix	10.0 L	9	1	10	8	60	10	0	10	100	10	10	100	Y
18	Devrinol	7.0 L	8	2	9 (5)	5 dk	80	6	4	7	80	5	7	80	Y
19	Devrinol	14.0 L	7	3	8 (5)	4 dk	70	5	5	5	60	4	6	70	Y

y= yellowing, sc = scorch, dist = distortion; st = stunted; del = delay; n lv = narrow leaves; dk = dark leaves

A period of rapid, vigorous growth followed after sprays were applied



**Trial 2 Mint established: post-emergence foliar-acting herbicides.**

**Table 4.** Crop tolerance to post-emergence foliar-acting herbicides Crop score (10 = no damage, 7 = acceptable damage, 0 =complete kill) and damage symptoms.

Herbicide	L/ha or kg/ha	Crop Symptoms		Crop score	Crop score	Safety
		18 Oct 19 DAT	18 Oct 19 DAT			
1. untreated		10	-	10	10	
2. Basagran	1.65 kg	7.7	Growing point killed 20% plants	7	6	not safe
3. Basagran	3.30 kg	4	Growing point killed 80% plants, scorch	4	4	not safe
4. Betanal	2.5 L	8.7	Pale chlorotic a little scorch	8	7	not safe
5. Betanal	5.0 L	6	Pale chlorotic more scorch 10% vigour reduction	6	5	not safe
6. Asulox	2.5 L	10	No damage = untreated	10	10	safe
7. Asulox	5.0 L	9	Very slight stunting	10	10	safe

DAT Days After Treatment

Foliar acting treatments were applied to the same field as Trial 1a. Assessments for crop safety are shown in Table 4.

Sencorex caused severe damage to mint in Trial 1a and 1b, so it was not included in the post-emergence trial. Asulox (asulam) was included as an extra treatment.

Basagran was extremely phytotoxic and killed the tips of the new mint shoots. The mint still had not recovered 61 days after treatment. Basagran is safe in another labiate herb, basil, where the waxy leaves gave protection from the contact acting herbicide.

The dose rate used for Betanal was low 2.5 L/ha (as used in sugarbeet low repeat dose programmes) even so, Betanal caused crop chlorosis (yellowing) and vigour reduction. The mint did not recover and the yellowing remained at 28 November.

Crop effects were negligible from Asulox - the only safe herbicide treatment. However it only has a narrow weed spectrum, controlling groundsel, mayweeds and docks.

Application of herbicides earlier in the season during a period of more vigorous mint growth might have resulted in a better recovery from damage.

### **Weed Control**

There were no weeds on the Trial area.

### **Trial 3 Sage established: pre-emergence residual herbicides.**

**Table 5. Sage.** Crop tolerance to residual herbicides applied on 22 June pre-emergence of weeds. Mean of 3 replicates. Crop vigour score (10=untreated, 7=acceptable, 0=complete kill) and damage symptoms; % phytotoxicity (scorch) (0=untreated, 10 severe), colour (10=untreated, 0=completely yellow)

Herbicide	L/ha or kg/ha	Crop vigour (colour) 21 DAT 14 July	% Scorch	Crop vigour (colour) 31 DAT 23 July	Crop vigour 50 DAT 18 Aug flowering	Crop vigour 93 DAT 1 Oct harvest	Safety
1 untreated	-	10 (10)	0	10 (10)	10	10	
2 Centium	0.2 L	10 (5 y)	0	10 (5 y)	10	10	(safe later)
3 Centium	0.4 L	10 (3 y)	0	10 (3 y)	10	10	(safe later)
4 Venzar	2.0 L	10	0	10	10	10	safe
5 Venzar	4.0 L	10	0.7	10	10	10	safe
6 Sencorex WG	0.75 kg	4.3	7	4	4	4.7	not safe

7	Sencorex WG	1.25 kg	1.7	9	1.3	1	3	not safe
8	Raft	1.0 L	8.7	0.7	10	10	10	safe
9	Raft	2.0 L	8.7	0.7	10	10	10	safe
10	Flexidor 125	2.0 L	9	0.7	10	10	10	safe
11	Flexidor 125	4.0 L	8	3	9	9.3	10	safe
12	Katamaran	2.0 L	8.7	1.3	9.3	9.7	10	safe
13	Katamaran	4.0 L	8	2	7	8.7	10	not safe
14	Butisan	2.0 L	9	0.7	10	10	10	safe
15	Butisan	4.0 L	8.7	1.3	10	10	10	safe
16	Goltix	5.0 L	9.7	0.3	10	10	10	safe
17	Goltix	10.0 L	9.3	0.3	10	10	10	safe
18	Stomp	5.0 L	8.3	1.7	9.3 dist	10	10	safe
19	Stomp	10.0 L	7.7	2.3	8.7 dist	9.7	10	not safe
20	Afalon	2.5 L	7	3.3	8.7	9.3	10	safe
21	Afalon	5.0 L	4.7	6.7	4.7	4 y st	10	not safe
22	Brasson	9.0 L	5.7	4.3	7	8.3	10	marginal
23	Brasson	18 L	4.7	6	3	6 y st	10	not safe

DAT Days After Treatment ; y = yellowing, dist = slight distortion, st = stunting; No yellowing from Centium 50 DAT

Residual herbicides were applied on 5 July, after the first cut post- flowering, when the crop cover was 95%.

Assessments for crop tolerance are shown in Table 5. At the first assessment 21 Days After Treatment (DAT), effects from Venzar were negligible. Centium at both dose rates caused yellowing of the sage foliage, but there was no scorch or reduction in plant vigour.

All other treatments caused slight scorch initially, but the sage recovered later.

However, Sencorex caused very severe scorch and at the double dose rate most foliage died.

Stomp caused slight distortion of the growing point and vigour reduction. There was severe scorch and vigour reduction from Afalon but the sage soon recovered. Brasson, which has a label recommendation for sage, also caused severe vigour reduction and scorch at both dose rates and the effects persisted.

Katamaran reduced vigour and the sage was slow to recover, Butisan appeared to be safer than Katamaran and the effects were less persistent.

Sage was very tolerant of Venzar, Goltix and Butisan and at the single dose rates there was only slight initial damage from Flexidor and Raft.

On 23 July, 31 DAT, sage treated with Venzar, Raft, Flexidor, Butisan, Goltix were indistinguishable from untreated sage, and although sage was still yellow after Centium treatment no vigour reduction was observed. Stomp and Katamaran at the single dose rates appeared safe.

Sage, assessed on 18 August (50 DAT), had recovered from Stomp damage. Brasson was slow to recover. The yellowing of the sage foliage from Centium at both dose rates was no longer visible 50 DAT.

At harvest stage on 1 October (93 DAT) there were still symptoms of scorch and severe vigour reduction on the sage treated with Sencorex but there was recovery from all other treatments at single and double rates with no obvious yield reduction.

### ***Weed Control***

A residual herbicide was applied to the sage the previous autumn and there were very few weeds at this site until August, when small nettle became a problem. The distribution over the trial area was uneven and a formal assessment was not possible. However, the following appeared ineffective: Centium, Venzar, Katamaran, Butisan, Flexidor and Brasson, Afalon. Sencorex gave good control (but was not safe to the crop), so did Raft and Stomp. Weed spectra for the herbicides in trial (information from labels and other sources) are shown in Appendix 1.

### **Conclusions**

Persistent residual herbicides have been used in perennial herbs for many years. However, residual herbicides with soil persistence of more than 60 days are unlikely to be registered in the EU in future, thus an alternative as effective/long-lasting as terbacil (or simazine) will not be found.

The Trial results demonstrated that if one labiate herb is tolerant to a herbicide it cannot be assumed that it is safe in another labiate species. This is because the crops studied have different morphology (leaf type - waxy or hairy etc.). For example, basil in the 2003 HDC trial FV 245a, was tolerant of Basagran, but mint in this trial suffered severe damage. In Trials 1a and 1b Flexidor completely killed mint, but was safe in Trial 3 in sage.

Rainfall was above the long-term average throughout most of the growing season, adequate for good activity of residual herbicides and also increasing the potential for herbicide leaching through soil and consequent damage to sage and mint. The soil type for mint was a sandy clay loam ADAS classification medium soil), sage a sandy loam (light soil).

### **Tolerance to herbicides (*limited data only one trial in one year*)**

For safety, there should be no or negligible/transient damage at a recommended dose rate and acceptable effects at the “overlap” double dose.

### **Residual herbicides mint:**

Residual soil-acting herbicides applied in Trial 1a had more effect on the mint than Trial 1b perhaps because a very persistent residual was applied in 2003. Although maiden mint (Trial 1b) eventually recovered from some other residuals to give some harvestable yield there was a vigour reduction.

- only Venzar (lenacil) 2.0 L/ha and Goltix Flowable (metamitron) 5.0 L/ha were safe
- Centium (clomazone) 0.2 L/ha caused yellowing of mint but did not appear to reduce yield although foliage took about 5-6 weeks to recover colour.
- there was a delay of before the mint recovered colour.
- Flexidor 125 (isoxaben) 2.0 L/ha completely killed mint in only 30 days.
- Sencorex WG (metribuzin) has residual soil and contact activity and although a low dose of 0.75 kg/ha was used on a medium soil type it caused severe scorch to leaves, and damage to plants through root uptake.
- In the older, established mint the other residuals Butisan S, Katamaran, Raft and Devrinol were all too phytotoxic, but in maiden mint there was some harvestable yield (although Katamaran distorted leaves).

### **Foliar-acting herbicides mint:**

- Asulox (asulam) was safe to mint but it has a limited weed spectrum.
- Basagran killed the growing points of mint shoots, Betanal at low dose 2.5 L/ha (for weeds at very early growth stages) was also too phytotoxic.
- Goltix (in Trial 1a,b) was the only safe herbicide with contact as well as residual activity for control of a wider range of weed species.

### **Residual herbicides sage:**

- The safest residual soil-acting herbicides were Venzar (2.0 L/ha) and Goltix (5.0 L/ha).
- Centium (a cleavers killer) only caused yellowing of foliage but sage took about 5-6 weeks to recover colour.
- Sage was also tolerant to Raft (oxadiargyl not available yet) 1.0 L/ha, Flexidor 2.0 L/ha and Butisan S (metazachlor) 2.0 L/ha. Katamaran (metazachlor/quinmerac) 2.0 L/ha and Stomp (pendimethalin) 5.0 L/ha were not quite as safe.
- Residuals Goltix, Butisan and Katamaran also have contact action and will kill some emerged weeds.
- Afalon (linuron) 2.5 L/ha caused scorch, Brasson 9.0 L/ha, with Full Approval for sage caused severe scorch and the crop was slow to recover.
- Sencorex even at low dose caused severe damage to sage.

*In the future, growers must rely on programmes using herbicides with residual activity, but which can be applied in the non-dormant period and do not damage herb foliage (e.g. Venzar, Goltix, Butisan, Flexidor for sage)*

### **Weed control and herbicide activity:**

There were very few weeds on the trial areas. Annex 1 of this report shows product label claims and other information on weed species controlled.

Centium(residual soil-acting): controls cleavers, groundsel and fools parsley.

Asulam (contact translocated): only controls a few species (groundsel, docks and mayweeds).

Venzar (residual soil-acting): small nettle, groundsel, fat-hen and speedwells are only moderately susceptible.

Goltix (residual soil-acting, and contact acting): controls fool's parsley, groundsel, fat-hen and small nettle.

Flexidor (residual soil-acting): good control of crucifers, polygonums and small nettle.

Raft (residual soil-acting, and contact-acting): controls a wide range of weeds, not chickweed.

Katamaran, Butisan (residual soil-acting, and contact action on some emerged weeds); do not control crucifers (charlock), knotgrass, poor control of pansy. Good control of groundsel. Katamaran (residual soil-acting and contact action on some emerged weeds): controls cleavers.

Devrinol (residual soil-acting): poor control crucifers.

Brasson (residual soil-acting short persistence 6-8 weeks): does not control crucifers (charlock), knotgrass, pansy, weak on fat-hen. Good control small nettle, groundsel, cleavers.

Stomp (mainly residual soil-acting): controls polygonums, some control of cleavers. No control of groundsel, poor on mayweeds.

### **Suggested herbicide programmes for the future (\* not approved yet)**

Some of the following herbicides are already used by growers; others could be tested with caution:

#### **Mint**

A safe programme would be Centium\* pre-weed emergence in the dormant period at the higher dose rate of 0.3 L/ha applied (not on sands) where cleavers are anticipated, Venzar and others pre-weed emergence (or a Venzar + Centium\* tank-mix) followed by Goltix. Venzar and Goltix have complementary weed spectra. Stomp (not included

in the trial) useful for knotgrass control. Foliar-acting Asulox spot treatment, or overall application\* if needed for docks, groundsel, mayweeds; Shield (clopyralid) is useful for thistle control.

## **Sage**

A safe programme would be Centium\* where cleavers are a problem, pre-weed emergence in the dormant period. There is a wider choice of safe soil-acting residual herbicides than mint: Venzar (or a Venzar + Centium\* tank-mix) followed by Goltix. Flexidor\* followed by Goltix, (complementary weed spectra), or Butisan\* controls some emerged weeds, and other combinations. Stomp useful for knotgrass control. Foliar-acting Asulox spot treatment, or overall application\* for docks, groundsel, mayweeds; Shield (clopyralid) for thistle control.

## **Current Herbicide Approval status (full list see Table 1)**

Centium 360 CS (clomazone) has no current approval for UK herbs, residue work for SOLA coriander in progress, if a SOLA is granted for coriander then this could be extrapolated to sage and mint.

Goltix Flowable (metamitron) SOLA 2189/04; Goltix WG SOLA 3657/02, SOLA 1756/04; Marquise SOLA 0737/03; Skater SOLA 0738/03. All MHI 6 weeks, pre- or post-emergence not specified, all for use on mint and sage.

Venzar Flowable (lenacil) SOLA 0703/97; Cleancrop Lenflow SOLA 1708/01; Lenazar WP SOLA 1158/02 for spinach, LTAEU to herbs.

Asulox (asulam) SOLA 1900/00 (0524/04) only for spot treatment in mint MHI 6 weeks.

Flexidor (isoxaben), Katamaran (quinmerac/metazachlor), Butisan (metazachlor) no UK approvals for herbs.

Raft (oxadiargyl) not available yet no UK approval, on Annex1 EC positive pesticide list.

Devrinol (napropamide) no UK approval for herbs.

Stomp 400 SC (pendimethalin) SOLA 2313/04 sage, mint; Claymore SOLA 2354/01 mint; Bema SOLA 1058/04 mint.

Brasson (propachlor) Full Approval sage; Alpha Propachlor SOLA 2424/00 mint, leaf herbs; Ramrod Flowable SOLA 1159/02 mint, leaf herbs.  
Afalon etc. (linuron): UK approval for parsley, LTAEU for mint or sage.

## Recommendations

Growers should review current weed control strategy for herbs because the “Essential Use” for terbacil will cease 31 December 2007. Simazine use on herbs ceases 10 September 2005.

The projects, FV 245, 245a and b, have allowed the industry to demonstrate to the European Commission that action has been taken to find alternatives to replace the temporary ‘Essential Uses’ so that this use can continue.

An alternative as effective/persistent as terbacil (or simazine) will not be found because in future residual herbicides with soil persistence of more than 60 days is unlikely to be registered in the EU. In the future, growers must rely on programmes using herbicides with residual activity, but which can be applied in the non-dormant period and do not damage herb foliage (e.g. Venzar, Goltix, Butisan, Flexidor etc. for sage). Programmes need to be developed with regard to weed species anticipated (see Annex 1 this report), and bearing in mind that only Goltix (mint) has contact action to kill small, emerged weeds, and for sage Goltix, Butisan, Katamaran, Afalon (less safe). Some suggestions are given in the Conclusions p 17 this report.

This study FV 245b identifies some safe residual herbicides (*based on one year’s data only*) and the potential for SOLAs for herbs mint and sage. The Long Term Arrangements (LTAEU) will not continue

- Trials have identified Venzar, Goltix and other potential alternative residual herbicide products that appear to be safe (non-phytotoxic) to sage at the timing and rates used, but only Venzar and Goltix were safe to mint.
- SOLA (Specific Off-Label Approval) applications will be needed for Venzar for sage and mint because the LTAEU extrapolation from spinach will not continue (after 2005?) and must eventually be replaced by SOLAs for each crop group.
- SOLA applications for other residuals for sage may be needed.

- Post-emergence foliar-acting herbicide Asulox was safe to mint. A SOLA for Asulox as an overall application for mint and other herbs could be useful for a few weeds such as groundsel and docks, but Asulox has a very narrow weed spectrum.

This study also identifies some potentially damaging herbicides in mint and sage. Results also demonstrated that if one labiate herb is tolerant to a herbicide it cannot be assumed that another labiate species is also tolerant. SOLAs are applied at 'Growers Risk' and in many cases are for a wide range of herbs, therefore information on safety in a specific herb is needed to avoid risk of crop loss.

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**Appendix 1 Weed Susceptibility to herbicides.** S = susceptible; MS = Moderately Susceptible; R = Resistant; MR = Moderately Resistant

Common name	Venzar Katamaran Latin name pre 2.5 L	Goltix Asulam pre2 - 5 L pre 2.0 L	Brasson Basagran pre 5L foliar2.5L	Centium Betanal# pre 9L pre 0.25L foliar1.65 kg	Stomp pre 5L foliar1.5L	Flexidorlinuron pre 2L	Devrinol pre 900 ga.i.	Sencorex pre 9L	Raft pre1.5 kg	Butisan pre1.0 L			
Bindweed, black	Fallopia convolvulus MS MS	S	MR	R	MR	S	S	MS	S	MS			
Bugloss	Anchusa arvensis		S			S		S					
Charlock	Sinapis arvensis	S	MS	R	R	S	S	R	S	MS	S		
Chickweed, common	Stellaria media	S	S	S	S	S	S	S	R	S	S	S	
Cleavers	Galium aparine MR	S	R	S	S	S	MR	S	MS	R	MS	S	S
Corn marigold	Chrysanthemum segetum S		S	S	S	S	S	S				S	
Corn spurrey	Spergula arvensis	S	S	S		S	S	S	S	MS			S
Crane's-bill, cut-leaved	Geranium dissectum R								S	MR			S
Deadnettle, henbit	Lamium amplexicaule MS		MS	MS		S		S					
Dead-nettle, red	Lamium purpureum MS S	MS	MS	S	S	S	S	S	MS	S	S	S	S
Dock, broad-leaved	Rumex obtusifolius		S seedling										S
Fat-hen	Chenopodium album MS S	MS	S	MR	MS	S	S	S	S	S	S	MS	
Fool's parsley	Aethusa cynapium		S		S								S
Forget-me-not, field	Myosotis arvensis MR		S			S	S	S	S		S	S	S
Fumitory, common	Fumaria officinalis MS S	S	MS	R	R	MS		R	MS	S		R	R
Gallant -soldier	Galinsoga parviflora			S				S					
Groundsel	Senecio vulgaris MS S	MS	S	S	S		MS	S	S	S	S	S	S

Hemp-nettle, common	Galeopsis tetrahit	R		S		S		S		S		R	MR			
	MR S															
Knotgrass	Polygonum aviculare	S	S	R	MR	S	S	S	S	S	S	S	R	R		
	MR S															
Mayweed, scented	Matricaria recutita	S	S	S	R	MS	S	S	S	S	S	S	S	S	S	S
Mayweed, scentless	Tripleurospermum inodorum	S	S	S	R	MS	S	S	S	S	S	S	S	S	S	S
	S MS															
Nettle, small	Urtica urens	MS	S	S	MR		S	S	S	S	S	MS			S	S
Nightshade, black	Solanum nigrum	R	MR	MS			S		S	R	R					S
Orache, common	Atriplex patula	S	S	MR			S	S		S					MS	S
Pansy, field	Viola arvensis	R	S	R	R	S	S	S	MS	S		MR	MS		R	S
Parsley piert	Aphanes arvensis						S	S					S	S		-
Pennycress, field	Thlaspi arvense	S	S	R				S	R	S		R	R		S	
	MS															
Persicaria, pale	Persicaria lapathifolia	S	MS		MS				S		S					S
	S															
Pimpernel, scarlet	Anagalis arvensis	S	MR				S	S	S	R	S	R				S
	S															
Pineappleweed	Matricaria discoidea		S	S	R	MS	S			S	S	S				S
Poppy, common	Papaver rhoeas	S	S		R	S	S	S	S	S		S	S		MS	S
Redshank	Persicaria maculosa	S	MS	R	S	S	S	S	MS	S	S	MS				S
	S															
Shepherd's-purse	Capsella bursa-pastoris	S	S	S	S	S	S	S	MS	S	S	S	S			S
	S															
Sow-thistle, smooth	Sonchus oleraceus	S		MS	MS	S		S	S	S	S					
	MS R															
Speedwell, common, field	Veronica persica	MS	S	S		S		S	S	S	S	S	S			
	MS S															
Speedwell, ivy-leaved	Veronica hederifolia	R	MS		S	S	S	S		S	S	S	S			
	MR MS															
Sun spurge	Euphorbia helioscopia		S	R						S	S					-
Thistle, creeping	Cirsium arvense					R				R						
	suppr															
Wild radish	Raphanus raphanistrum	S	MR	R	S		S	S		S	S					S
	S															
Annual meadow-grass	Poa annua	S	S	MS	S		S	S	S	S	S	S		R	R	

Blackgrass	Alopecurus myosuroides	R	MR	S		S		R	S	R	S	S
Brome, barren	Anisantha sterilis						R			MS		R
Wild-oat	Avena fatua	R	R			R	S			MR		R
Vol OSR	Brassica napus			R	MS	S		S		R		S