Project Title	Blackcurrant: Evaluation of Herbicides
Project number:	SF 12 (GSK 204)
Project leader:	John Atwood, ADAS UK Ltd
Report:	Final report, September 2006
Previous report	None
Key staff:	John Atwood, Project leader Jon Carpinini, Field experiments
Location of project:	Charles Wharton Ltd Winsford Hall Stokesby Gt Yarmouth Norfolk NR29 3DG
Project coordinator:	Mr Rob Saunders, GSK
Date project commenced:	1 March 2006
Date completion due:	31 September 2006
Key words:	212H 50WP**,** annual meadow grass, Artist, black bindweed, Blackcurrant, Butisan S, Calaris, *Coronopus squamatus,* diuron, *Fallopia convolvulus,* field pansy, flazasulfuron, flufenacet, Goal, Goltix WG, groundsel, herbicide, knotgrass, linuron, *Matricaria recutita,* mayweed, mesotrione, metamitron, metazachlor, metribuzin, oxyfluorfen, pendimethalin, *Persicaria maculosa, Poa annua,, Polygonum aviculare,* redshank, *Ribes nigra, Senecio vulgaris,* Stomp 400SC, swinecress, terbuthylazine, *Viola arvensis,* weed control

The results and conclusions in this report are based on a series of experiments conducted over a six-month 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.

John Atwood
Senior Horticultural Consultant
ADAS UK Ltd

Signature ..... Date .....

Report authorised by:

Wayne Brough
Acting Horticultural Team Manager
ADAS UK Ltd

Signature ..... Date .....

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Grower Summary

Headline

- Four promising new herbicide combinations (free of diuron) have been identified including Calaris, Flazasulfuron, Stomp 400 SC + Butisan S, Stomp 400 SC + Artist. These may be viable alternatives to the standard programme using diuron + Stomp 400 SC if the use of diuron is restricted in the future.

Background and expected deliverables

Efficient and cost effective weed control is important in blackcurrants, to prevent yield loss caused by competition for water and nutrients and to enable efficient harvesting without impedance by weed growth. The most recent pesticide usage survey for soft fruit showed that the vast majority (92%), of blackcurrants destined for processing were treated with herbicides and that simazine was the most widely used herbicide at that time. Under the on-going EU review of pesticides (91/414), the use of simazine has been reviewed. Having failed to be listed in Annex 1, it has been withdrawn for use on most fruit crops. Essential use derogation for continued use on Beans, rhubarb, asparagus, hardy ornamental nursery stock, hops, strawberries has been authorised until 31.12.2007, use on other fruit crops is not permitted.
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The continuing use of diuron, a low cost alternative to simazine, is also under threat although a final decision has yet to be made. If withdrawn, initial indications suggest that essential use derogation for continued use in blackcurrants would not be granted.

With the loss of simazine and impending loss of diuron for blackcurrants, it is important to develop alternative herbicides for blackcurrants for economical weed control, as the remaining approved products provide incomplete control of the weed spectra or are not cost effective for overall use.

This work is intended to benefit the industry by:

- Providing information on the effectiveness and safety of a range of herbicides and tank mixtures.
- Providing the initial screening of chemicals to enable subsequent GLP residue studies to be focused on the most promising materials for SOLA applications.

All of the proposed new herbicides will require SOLA applications or approval through mutual recognition to permit their use on blackcurrant crops in the UK.

Summary of the project and main conclusions

The project was carried out on a four year old blackcurrant plantation grown for processing in East Norfolk. The experiment was carried out for one year, with a range of nine herbicide combinations being applied to weed free soil to the bush base in early April at growth stage B1 (bud burst) compared with an untreated control.

Phytotoxicity symptoms, weed control and harvested yield were recorded from April – August 2006. Fruit samples were collected for later residue analysis. The treatments are summarized below:

Treatments

Treatment	Product	Active ingredient	Product rate	Approval status
1.	Untreated control			
2.	212H 50WP	Not disclosed	200.0 gm/ha	Experimental
3.	Flazasulfuron	Flazasulfuron 25 % w/w	200.0 ml/ha	Not in UK
4.	Goal	Oxyfluorfen 2 g/L	4.0 L/ha	Not in UK
5.	Calaris	terbuthylazine + mesotrione (70 : 330 g/L)	1.5 L/ha	Approved on maize
6.	Goltix WG	Metamitron 70 % w/w	2.0 kg/ha	Approved on sugar beet
7.	Stomp 400SC + Artist	Pendimethalin 400 g/L Flufenacet + Metribuzin (24 : 17.5 % w/w)	5.0 L/ha + 2.5 kg/ha	Label, Approved on potatoes
8	Stomp 400SC + Butisan S	Pendimethalin + 400 g/L Metazachlor 500 g/L	5.0 L/ha + 2.5 L/ha	Label, Approved on fruit nursery stock
9.	Stomp 400SC + Linuron	Pendimethalin 400 g/L + Linuron 500 g/L	5.0 L/ha + 1.9 L/ha	Label, Approved on vegetables
10.	Stomp 400SC + Diuron	Pendimethalin 400 g/L + Diuron 500 g/L	5.0 L/ha + 2.0 L/ha	Label, SOLA

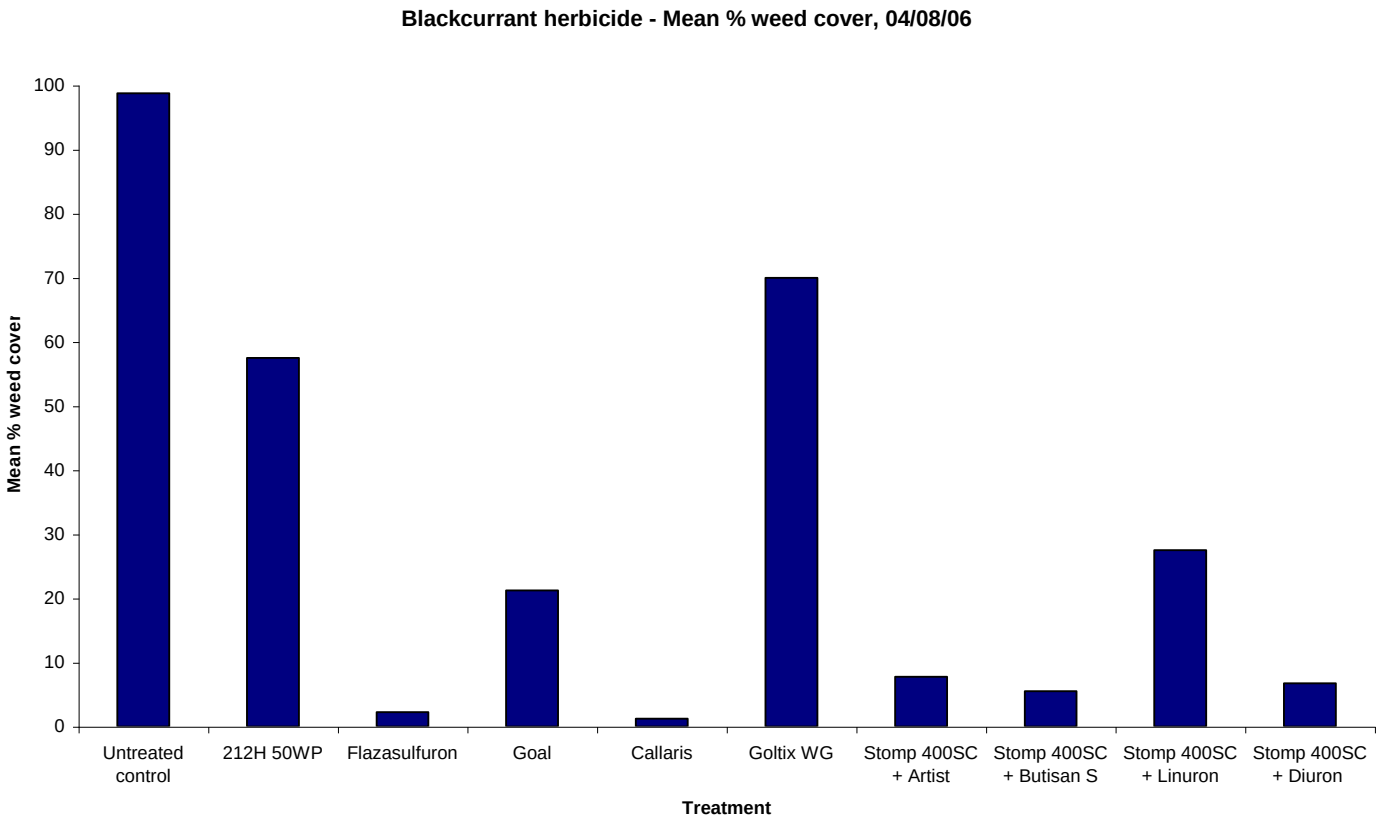
All treatments were applied on 12 April 2006 in a water volume of 200 L/ha at 2 bar pressure using a CO2-pressurised Oxford Precision Sprayer with a 1.5 metre boom and F02-110 spray nozzles.

Results

The most effective treatments were Calaris, Flazasulfuron, Stomp 400 SC+ Butisan S, Stomp 400 SC + Diuron and Stomp 400 SC + Artist. Both Calaris and Flazasulfuron maintained almost complete weed control through to harvest. The few weed species that were present in these plots were predominantly annual meadow grass. The alternative Stomp 400 SC mixtures, with Butisan S or Artist, performed as well as the standard Stomp 400 SC + Diuron.

The Stomp 400 SC + Artist and Stomp 400 SC + Butisan S mixtures allowed a few annual meadow grass weeds to germinate as did the standard Stomp 400 SC + Diuron treatment. The latter also completely failed to control groundsel and redshank. A few redshank and groundsel weeds also developed later in the Stomp 400 SC + Artist and Stomp 400 SC + Butisan S plots.

The predominant weed species were annual meadow grass, blackcurrant seedlings and mayweed. Redshank, black bindweed, knotgrass and groundsel were also present. Weed cover was slow to build up. However by harvest the weed cover on the untreated plots had reached 100%. The results are summarized in the graph below.



The 212H 50 WP, Goal, Goltix WG and Stomp 400 SC + Linuron treatments did not give adequate weed control. 212H 50 WP failed to control blackcurrant seedlings, annual meadow grass and knotgrass. The latter two species developed extensively in these plots. Goal failed to control annual meadow grass and blackcurrant seedlings. The Linuron mixture with Stomp 400 SC was less effective than the other partners Butisan S or Artist, failing to adequately control annual meadow grass, blackcurrant seedlings and groundsel. Black bindweed and mayweed also developed later in these plots.

Two weeks after treatment slight marginal yellowing was noted on the lowest leaves of bushes in the Calaris treated plots. At subsequent monitoring the symptoms disappeared. No other phytotoxic symptoms were noted.

Yields in the untreated plots were 14.5 T/ha. Differences in yield between treatments were relatively small. There was an indication that the standard treatment Stomp 400 SC + Diuron had reduced yield slightly at 13.8 T/ha.

Calaris has shown good potential for use as a blackcurrant herbicide. The product is already approved for use in the UK on Maize and its active ingredients are listed in Annex 1 of 91/414/EC. One of the active ingredients, terbuthylazine is already used on blackcurrants in New Zealand. Flazasulfuron could also be developed for use in blackcurrants, but at present is not sold in the UK. It is available in continental Europe as a vineyard herbicide and the active is on Annex 1. Two other products, Butisan S and Artist could be developed for use in blackcurrants, principally as tank mix partners with Stomp 400 SC which adds improved control of polygonum weeds and nightshades.

The weed control spectra for the products tested is show below for reference. Information was taken from the manufacturers' product labels. For some products not sold in the UK the information on UK weeds is incomplete. No information relevant to UK conditions was available for Flazasulfuron

S = Susceptible
MS = Moderately susceptible
MR = Moderately resistant
Blank = No information available

Common name	212H	Calaris	Goal	Goltix	Stomp + Butisan	Stomp + Artist	Stomp + Diuron	Stomp + Linuron
Bindweed, black		S	S	MR	S	S	S	S
Bugloss								S
Charlock				MS				S
Chickweed, common	S	S		S	S	S	S	S
Cleavers			S	R	S	S	S	S
Corn marigold				S	S	S	S	S
Corn spurrey				S			S	S
Crane's-bill, cut-leaved			S		S			
Deadnettle, henbit					S	S	S	S
Dead-nettle, red		S		MS	S	S	S	S
Dock(seedling), broad-			S	S				
Fat-hen	S	S	S	S	S	S	S	S
Fool's parsley				S		S		
Forget-me-not, field		S		S	S	S	S	S
Fumitory, common			S	MS	MS	S	MS	MS
Gallant-soldier								S
Groundsel	S		S	S		S	S	S
Hemp-nettle, common		S		S	S	S	S	S
Knot-grass		MS	S	S	S	S	S	S
Mayweed, scented	S	S	S	S	S	S	S	S
Mayweed, scentless	S		S	S	S	S	S	S
Nettle, small			S	S			S	S
Nightshade, black	S	S	S	MR	S	S	S	S
Orache, common		S	MS	S		S	S	S
Pansy, field	S	S		S	S	S	S	S
Parsley piert					S	S	S	S
Pennycress, field	S	S		S			S	S
Persicaria, pale		S	S	MS				S
Pimpernel, scarlet				MR	S	S	S	S
Pineappleweed	S			S	S	MS	S	S
Poppy, common				S	S	S	S	S
Redshank		S	S	MS	S	S	S	S
Shepherd's-purse		S	S	S	S	S	S	S
Sow-thistle, smooth	S		S		S	S	S	S
Speedwell, common, field		S	S	S	S	S	S	S
Speedwell, ivy-leaved				MS	S	S	S	S
Sun spurge				S				
Thistle, creeping				R				
Wild radish				MR				S
Annual meadow-grass	S	S		S	S	S	S	S
Black-grass					S	S	S	S
Brome, barren								
Wild-oat								
Volunteer oil-seed rape					MS	MS		MS

Financial benefits

In this experiment the best treatment for weed control Calaris, was £20/ha cheaper than the standard treatment Stomp 400 SC + Diuron. The costs of some programs are compared below:

- Calaris (1.5 L/ha) £35/ha
- Stomp 400 SC (5 L/ha) + Artist (2.5 L/ha) £77/ha
- Stomp 400 SC (5 L/ha) + Diuron (2 L/ha) £53/ha

Compared with typical "horticultural" products Flexidor 125 and Ronstar Liquid the cost savings from using Calaris are more significant:

- Stomp 400 SC (5 L/ha) + Flexidor (2 L/ha) £141/ha
- Stomp 400 SC (5 L/ha) + Ronstar Liquid (4 L/ha) £194/ha

The cost of a Casaron Granule treatment would be greater than above at £650/ha, for an overall application at 125 kg/ha but could offer a wider range of perennial weed control.

Action points for growers

- When a SOLA becomes available for the use of Calaris, this product should be considered the primary choice for row or alleyway weed control. Should any SOLA become available to the industry, care would need to be taken given that some slight phytotoxicity occurred to the crop using this product. All SOLAs are used at growers own risk.

- If Flazasulfuron becomes available in the UK either through SOLA or mutual recognition, this product could be considered as an alternative to Calaris.

Science Section

Introduction

Efficient and cost effective weed control is important in blackcurrants, to prevent yield loss from competition for water and nutrients and to enable efficient harvesting without impedance by weed growth. The most recent pesticide usage survey for soft fruit showed that the vast majority, (92%), of blackcurrants for processing were treated with herbicides and that simazine was the most widely used herbicide at that time. Under the on-going EU review of pesticides (91/414), simazine has been reviewed and having failed to be placed on Annex 1 has since been withdrawn for use on most fruit crops. Emergency extension for minor use has only been applied for strawberries, nursery stock and forestry.

The other low cost alternative to simazine, diuron, is also under threat although a final decision has yet to be made. If withdrawn, initial indications are that emergency extension for minor use on blackcurrants would not be granted.

With the loss of simazine and likely loss of diuron for blackcurrants it is important to develop alternative herbicides for blackcurrants for economical weed control, as the remaining approved products have incomplete weed control spectra or are not cost effective for overall use.

This work is intended to benefit the industry by:

- Providing information on the effectiveness and safety of a range of herbicides and tank mixtures.
- Providing the initial screening of chemicals to enable subsequent GLP residue studies to be focused on the most promising materials for SOLA applications.

Materials and Methods

Site Location

Over Lane Field, Filby

Charles Wharton Ltd
Winsford Hall
Stokesby
Gt Yarmouth
Norfolk
NR29 3DG

Soil Type

Fine sandy loam

Crop

Blackcurrant 'Ben Alder'
Planted Autumn 2001
Spacing 3m x 0.3m

Crop husbandry

Prior to the start of the experiment all existing weed cover was removed by an application of Gramoxone 100 at 5 L/ha using a shielded knapsack sprayer avoiding all contact with the bush. This application was made on 5 April 2006

Apart from the experimental treatments no other herbicides were applied to the plots and no hand-weeding was carried out. The guard rows and adjacent plantation rows were treated with Casaron G granules 125 kg/ha.

The crop received fertiliser 13:7:23+10Mg 500 kg/ha on 18 March 2006 and the normal fungicide and insecticide programme as applied to the rest of the plantation, including applications of Sulphur, Karamate, Bravo, Elvaron, Meothrin, Scala, Stroby, Systhane, Masai, Aphox and Teldor.

Treatments

Treatment	Active ingredient	Product rate	Approval status
Untreated control			
212H 50WP	Not disclosed	200.0 gm/ha	Experimental
Flazasulfuron	Flazasulfuron 25 % w/w	200.0 ml/ha	Not in UK
Goal	Oxyfluorfen 2 g/L	4.0 L/ha	Not in UK
Calaris	terbuthylazine + mesotrione (70 : 330 g/L)	1.5 L/ha	Approved on maize
Goltix WG	Metamitron 70 % w/w	2.0 kg/ha	Approved on sugar beet
Stomp 400SC + Artist	Pendimethalin 400 g/L Flufenacet + Metribuzin (24 : 17.5 % w/w)	5.0 L/ha + 2.5 kg/ha	Label, Approved on potatoes
Stomp 400SC + Butisan S	Pendimethalin + 400 g/L Metazachlor 500 g/L	5.0 L/ha + 2.5 L/ha	Label, Approved on fruit nursery stock
Stomp 400SC + Linuron	Pendimethalin 400 g/L + Linuron 500 g/L	5.0 L/ha + 1.9 L/ha	Label, Approved on vegetables
Stomp 400SC + Diuron	Pendimethalin 400 g/L + Diuron 500 g/L	5.0 L/ha + 2.0 L/ha	Label, SOLA

All treatments were applied as two 1.5 metre bands either side of the bush row, spraying up to the base of the bush, on 12 April 2006 in 200 L/ha water at 2 bar pressure using a CO2-pressurised Oxford Precision Sprayer with a 1.5 metre boom and F02-110 spray nozzles.

At the time of application the blackcurrants were at growth stage B1 (bud break).

Experiment Design

The experiment was laid out in a randomised block design with four replicate blocks.

Plots were a total of 3m wide and 5m long, applied as two 1.5m bands sprayed up to the base of the bush either side of 5m of a row of blackcurrant bushes. There was one internal guard row between each treated row of blackcurrants.

Assessments

Weed assessments were carried out within two 1m x 4m areas either side of the bush row, being the centre of each sprayed swath.

The first assessment (12 June 2006) for weed seedlings numbers was carried out using 0.16 sq. m. quadrats. The second assessment was carried out at harvest (4 August 2006) for whole plot % weed cover assessed visually with the aid of quadrats.

The crop was mechanically harvested with a Joonas harvester from each plot (15 sq. m) weighed in trays and yield calculated per ha.

Results and Discussion

Weed Control

Figure 2: Weed assessment 12 June 2006 (seedlings / m^2)

ProductTreatment	Annual Meadow grass	Black bindweed	Balckcurrant seedling	Groundsel	Knotgrass	Mayweed	Pansy	Redshank	Weed seedlings (No./ m^2)	Weed seedlings (No./ m^2) Log transform
Calaris			1.0						1.0	0.151
Stomp 400SC + Artist	1.0								1.0	0.301
Flazasulfuron	3.0		1.0						4.0	0.573
Stomp 400SC + Butisan S	2.0		1.0			1.0			4.0	0.663
Goal	6.0		4.0						10.0	0.881
Stomp 400SC + Diuron	4.0		1.0	4.0				1.0	11.0	1.015
Stomp 400SC + Linuron	8.0		20.0						27.0	1.352
212H 50WP	23.0		8.0						31.0	1.465
Goltix WG	20.0	2.0	38.0				3.0		64.0	1.761
Untreated control	65.0*		20.0	1.0	1.0	11.0		4.0	102.0	1.974
p										<.001
df										27.0
SED										0.235

The predominant weed was annual meadow grass (*Poa annua*), blackcurrant seedlings (*Ribes nigra*) and mayweed (*Matricaria recutita*). Redshank (*Persicaria maculosa*), black bindweed (*Fallopia convolvulus*), knotgrass (*Polygonum aviculare*) and groundsel (*Senecio vulgaris*) were also present. Weed cover was slow to build up however by harvest the weed cover on the untreated plots had reached 100%.

The most effective treatments were Calaris, Flazasulfuron, Stomp + Butisan, Stomp + Diuron and Stomp + Artist. Both Calaris and Flazasulfuron maintained almost complete weed control through to harvest. The few weeds that were present in these plots were mainly annual meadow grass. The alternative Stomp mixtures, with Butisan or Artist, performed as well as the standard Stomp + Diuron. The Stomp + Artist and Stomp + Butisan mixtures allowed a few annual meadow grass through as did the standard Stomp + Diuron treatment. The latter also failed to completely control groundsel and redshank. A few redshank and groundsel also developed later on the Stomp + Artist and Stomp + Butisan plots.

The 212H, Goal, Goltix and Stomp + Linuron treatments did not give adequate weed control. 212H failed to control blackcurrant seedlings, annual meadow grass and knotgrass, the latter two species developed extensively on these plots. Goal failed to control annual meadow grass and blackcurrant seedlings.

The Linuron mixture with Stomp was less effective than the other partners Butisan or Artist, failing to control adequately annual meadow grass, blackcurrant seedlings and groundsel. Black bindweed and mayweed also developed later on these plots. Goltix was the least effective herbicide and failed to give adequate control of any of the weeds present.

Figure 3: Weed assessment 4 August 2006

ProductTreatment	% Weed cover 4/08/06	% Weed cover 4/08/06 Angular transformation	Annual Meadow	Black bindweed	Balckcurrant	Chickweed	Cleavers	Groundsel	Knotgrass	Mayweed	Pansy	Redshank	Swinecress
Calaris	1.0	6.3	x	x	x								
Flazasulfuron	2.0	8.1	x										
Stomp 400SC + Butisan S	5.0	13.1	x		x		x	x		x			
Stomp 400SC + Diuron	7.0	14.5	x	x	x			x				x	
Stomp 400SC + Artist	8.0	15.0	x		x			x		x		x	
Goal	21.0	26.8	x				x	x		x			
Stomp 400SC + Linuron	27.0	29.0	x	x	x	x	x	x		x		x	
212H 50WP	57.0	49.8	x		x				x				
Goltix WG	70.0	58.3	x	x	x			x	x	x	x	x	
Untreated control	99.0	86.8	x	x	x	x	x	x	x	x	x	x	
p		<.001											
df		27.0											
SED		8.33											

X = weed present in quadrat

Phytotoxicity

The bushes were monitored monthly following treatment for signs of phytotoxicty. On 25 April, two weeks after treatment slight marginal yellowing was noted on the lowest leaves of bushes in the Calaris treated plots (see below). At subsequent monitoring the symptoms disappeared. No other phytotoxic symptoms were noted.

Harvest Yields

ProductTreatment	Yield (T/ha)
CallarisCalaris	15.4
Stomp 400SC + Artist	15.4
Goal	15.2
Stomp 400SC + Linuron	15.1
Goltix WG	15.0
212H 50WP	14.9
Stomp 400SC + Butisan S	14.7
Untreated control	14.6
Flazasulfuron	14.2
Stomp 400SC + Diuron	13.8
	not.significant (at 1% level)

Yields were exceptionally good in this plantation. Differences in yield were relatively small, and not significant, there was an indication that the standard treatment Stomp + Diuron had reduced yield slightly.

Conclusions

Calaris has shown good potential for use as a blackcurrant herbicide. The product is already approved for use in the UK on Maize and the actives are on Annex 1. One of the active ingredients, terbuthylazine is already used on blackcurrants in New Zealand. Flazasulfuron could also be developed for on blackcurrants, but at present is not sold in the UK. It is available in continental Europe as a vineyard herbicide, the active is on Annex 1. Two other products, Butisan and Artist could be developed for use in blackcurrants, principally as tank mix partners with Stomp which adds improved control of polygonum weeds and nightshades.

The new products Goal and 212H were disappointing. Both are known to have some weakness in grass control, which was one of the main weeds in this experiment. The active ingredients in 212H and Goal are also both known to be less effective under dry conditions, which were experienced for the first two months following treatment.

The Stomp + Linuron mix did not perform well. The rate of use of Linuron will in future be limited to the 1.9 L/ha used in this experiment, probably not sufficient for the seasons' weed control. Goltix did not give sufficient residual activity in this experiment it is best used as a short term herbicide.

Technology transfer

No technology transfer activities were carried out during this project.

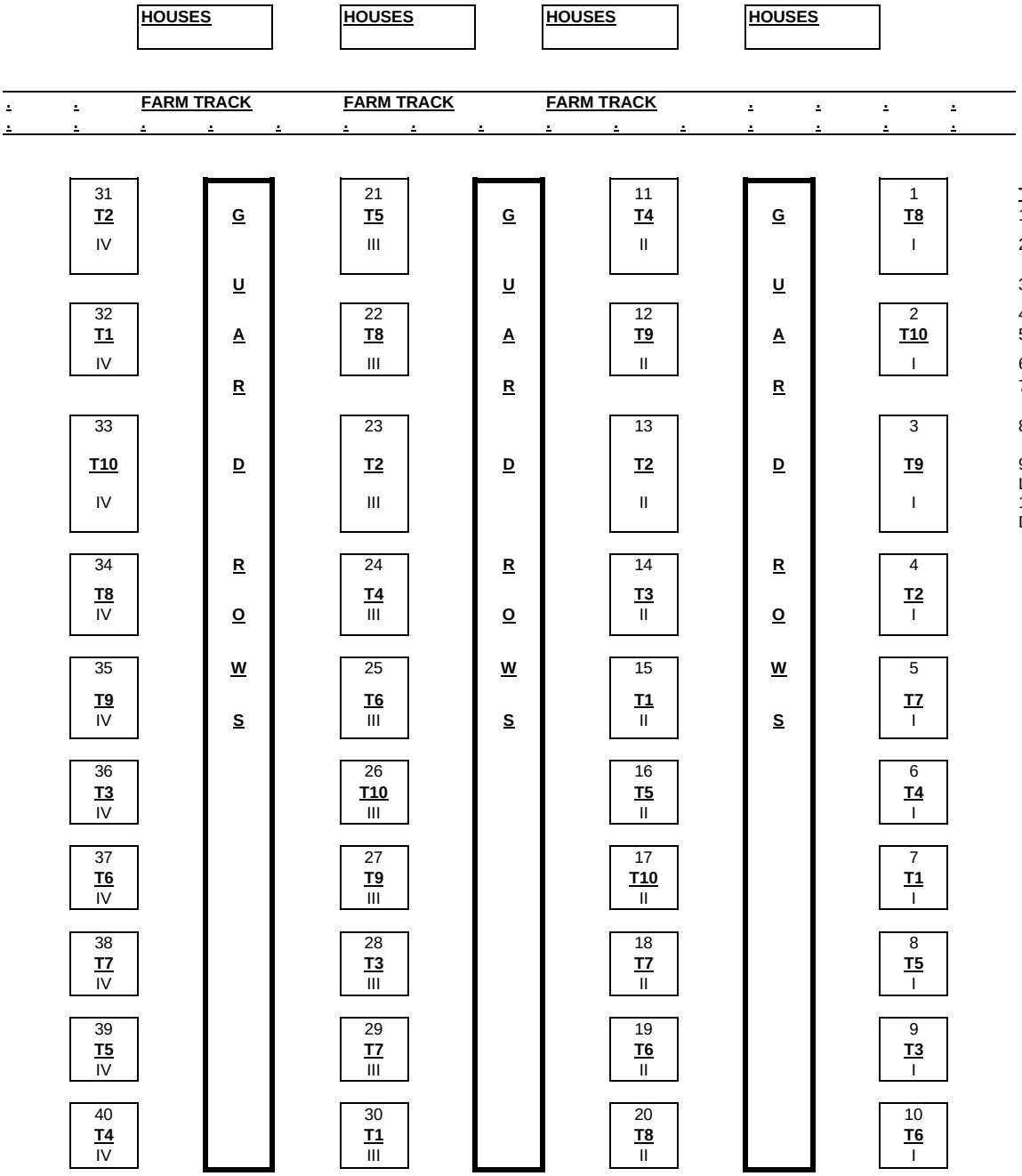
References

Garthwaite DG & Thomas MR 2001 Pesticide Usage Survey Report 181 Soft Fruit in Great Britain 2001.

Appendices

Appendix 1: Experimental layout

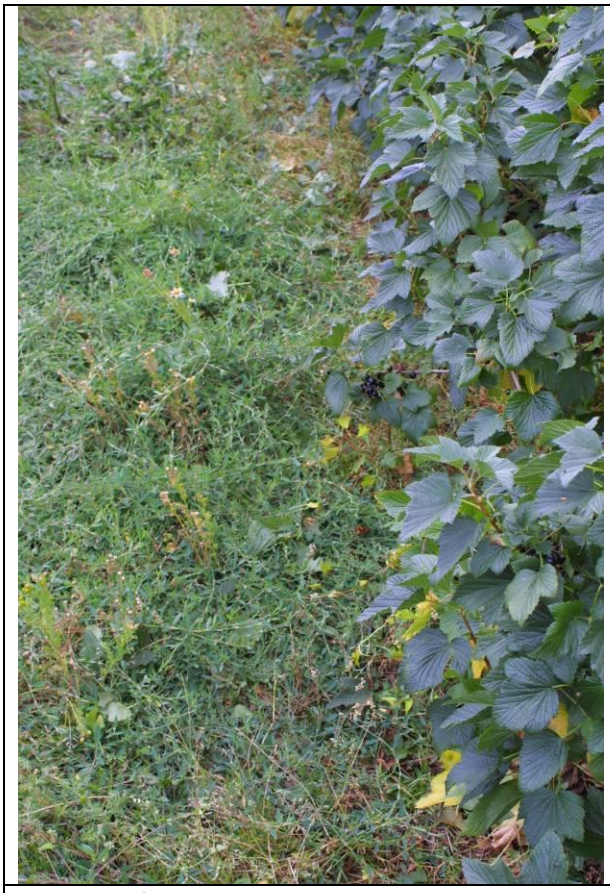
Blackcurrant Herbicide Trial, Filby. 2006.



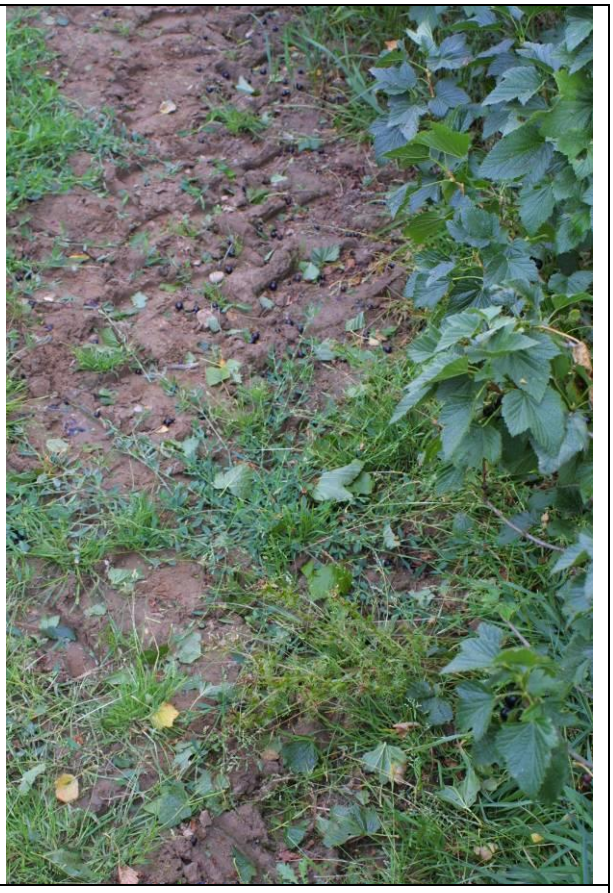
Treatments

1. Untreated Control
2. 212H 50WP
3. Mission
4. Goal
5. Calaris
6 Goltix WG
7. Stomp 400SC + Artist
8. Stomp 400SC + Butisan S
9. Stomp 400SC + Linuron
10. Stomp 400SC + Diuron

Appendix 2: Photos

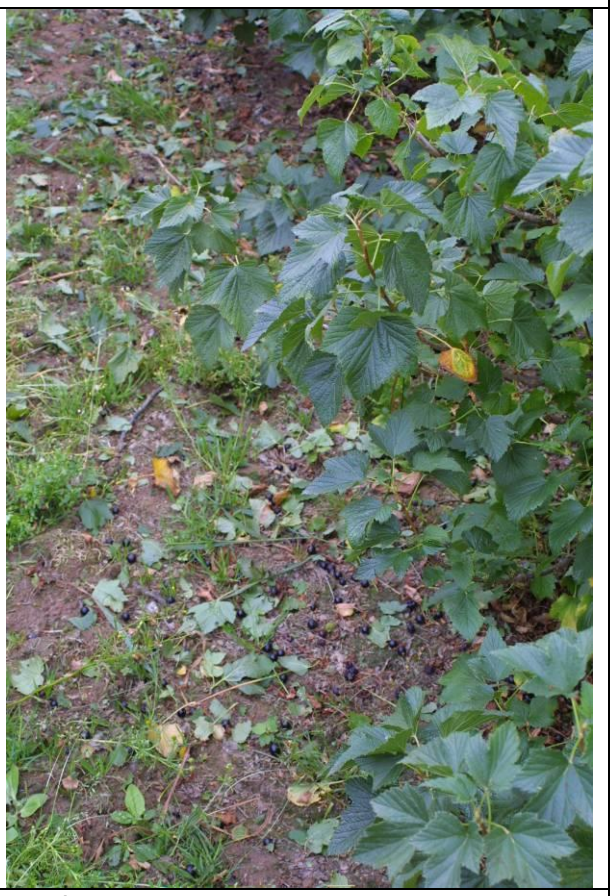


Untreated

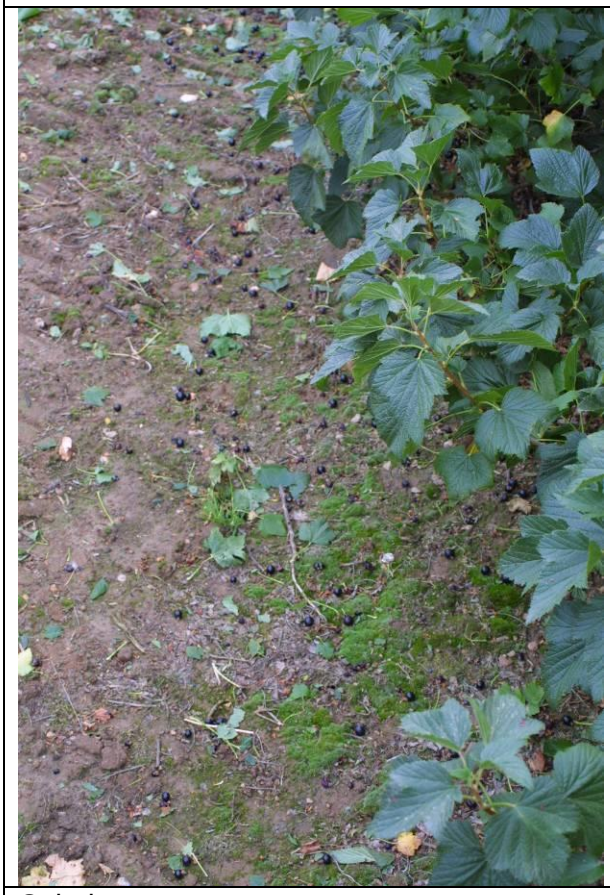
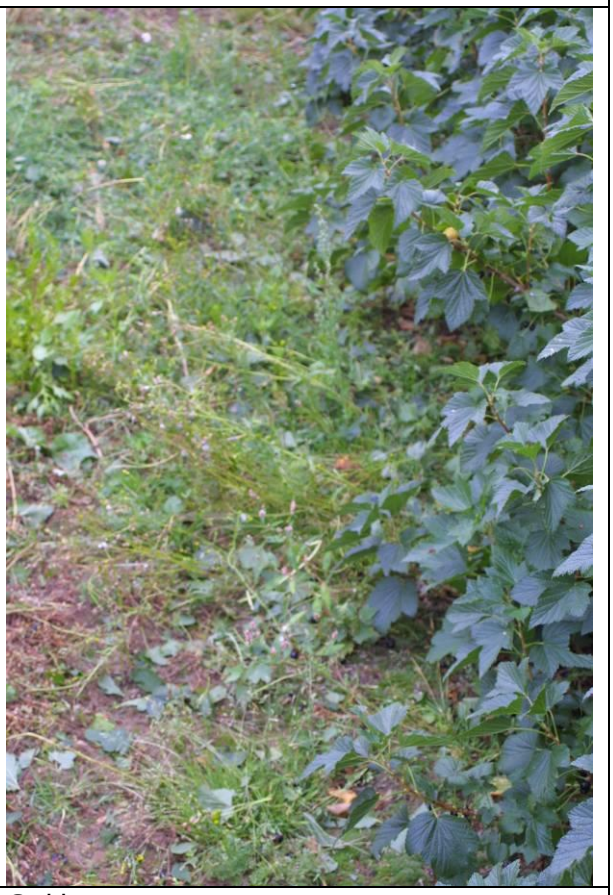


212H

Flazasulfuron



Goal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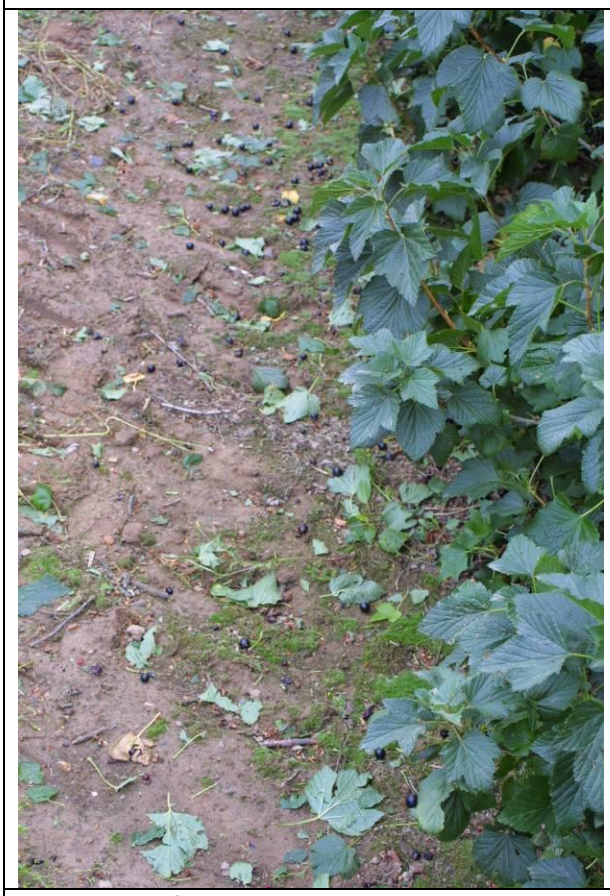
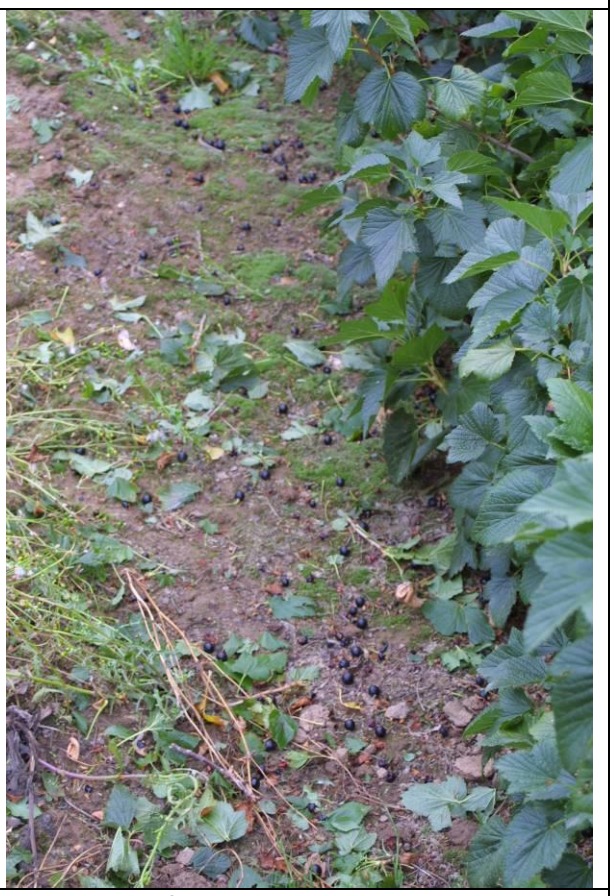
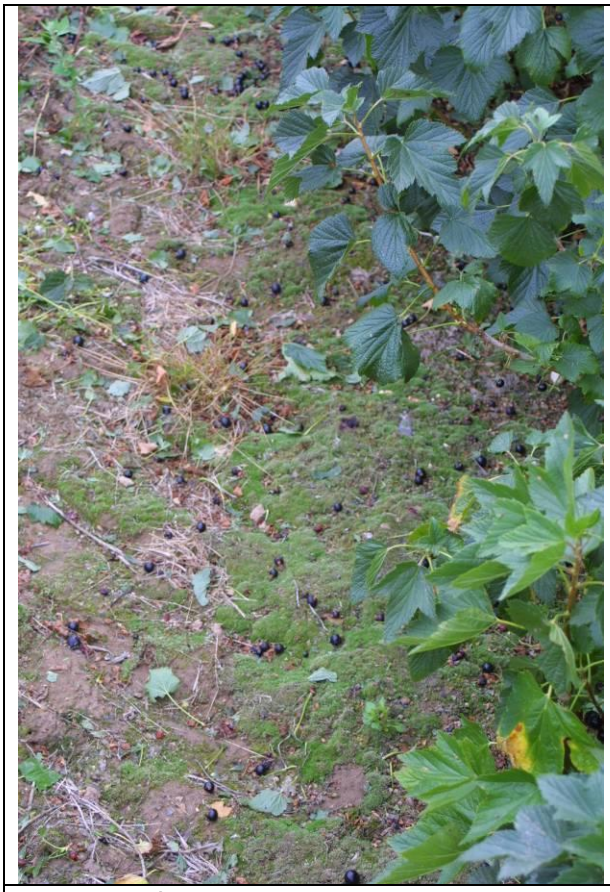
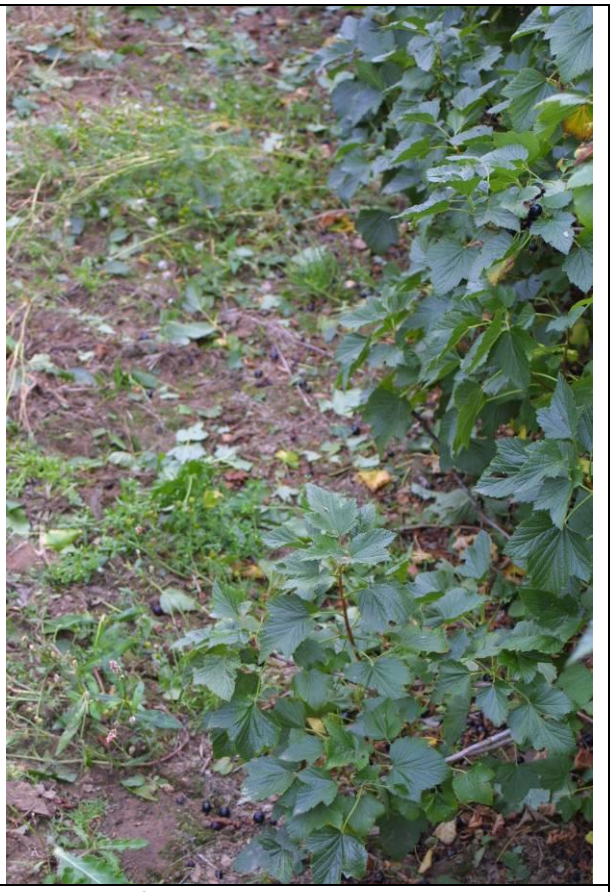
	
Stomp + Artist	Stomp + Butisan

	
Stomp + Diuron	Stomp + Linuron