Grower Summary

Weed control in ornamentals, fruit and vegetable crops – maintaining capability to devise sustainable weed control strategies

CP 086

Annual report 2013

Project title:	Weed control in ornamentals, fruit and vegetable crops – maintaining capability to devise sustainable weed control strategies
Project number:	CP 86
Project leader:	John Atwood, ADAS UK Ltd.
Report:	Interim report, March 2013
Previous report:	March 2012
Fellowship staff:	John Atwood, Project leader
	Lynn Tatnell, Assistant project leader
	Harriet Roberts, (fruit) and project management
("Trainees")	Jessica Sparkes, (weed biology)
	David Talbot, (ornamentals)
	Angela Huckle, (vegetables)
Location of project:	ADAS Boxworth
Industry Representative:	Wayne Brough, HDC
Date project commenced:	April 2011
Date project completed (or expected completion date):	March 2016

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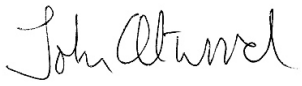
AUTHENTICATION

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

Principal Horticultural Consultant

ADAS UK Ltd



Signature Date 27th March 2013

Report authorised by:

Dr Barry Mulholland

Head of Horticultural

ADAS UK Ltd

Signature Date 27th March 2013

Progress Against Objectives

Objectives

Objective	Original Completion Date	Actual Completion Date	Revised Completion Date
1. To develop and mentor 4 staff in weed biology and control	March 2016	in progress	
1.1 Train next generation horticultural consultants with an expertise in weed control	March 2016	in progress	
1.2 Graduate weed biologist recruited	June 2011	June 2011	
1.2.1 Graduate weed biologist trained and experience in horticultural weed research	March 2016	In progress	
1.3 Recognises the most common problem weed species associated with field crops (horticultural and arable), protected crops and ornamentals.	Sept 2012	Sept 2012	
1.4 Understands the biology and current control strategies for the common weed species of a range of field crops (horticultural and arable), protected crops and ornamentals.	Sept 2012	Sept 2012	
1.5 Visited at least 10 nurseries with J Atwood or another specialist weed	March 2013	Completed, but recommend that visits should	

Objective	Original Completion Date	Actual Completion Date	Revised Completion Date
control expert and discussed/reviewed control strategies for key weeds on each nursery.		continue where thought beneficial	
1.6 BASIS qualified	Sept 2013	Jan 2013	
1.7 Understands requirements for ORETO standard experimental work.	Sept 2013	In progress	
1.8 Designed experiment and drafted experiment protocol to satisfaction of ADAS Biometrician and ORETO Study Manager.	Sept 2013	In progress	
1.9 Organised and managed successful delivery of two experiments from agreed work packages.	Sept 2013	In progress	
1.10 Delivered consultancy advice to growers on control on weeds of the individuals specialist work area protected crops and ornamentals on at least 5 problems.	Sept 2014	In progress	
1.11 Drafted HDC Project Reports on at least 2 projects.	Sept 2013	In progress	
1**.12** Submitted to HDC or elsewhere at least 3 proposals on R&D topics supported by growers.	March 2014	In progress	

Objective	Original Completion Date	Actual Completion Date	Revised Completion Date
1.13 Drafted an HDC Factsheet on biology and control of specific weed species of horticultural crops in specialist work area.	March 2013	At present, no specific requirement - will review in future	March 2016
1.14 Delivered at least 3 talks on weed control to nursery staff, grower groups or an HDC sponsored conference	Sept 2014	In progress, 2 completed	
2. Deliver applied research and KT work packages	March 2016	In progress	
2.1.1 1st pot screening for horticultural weeds set up	Oct 2011	May 2012 (1st set) Feb 2013 (2nd set)	
2.1.2 1st pot screening completed	Aug 2012	March 2013	
2.1.3 2nd pot screening for horticultural weeds set up	Oct 2014		May 2014
2.1.4 2nd pot screening completed	Aug 2015		Aug 2014
2.2.1 1st container plant screening trial set up	Oct 2012	July 2012	
2.2.2 1st container plant screening trial completed	Sep 2013	Nov 2012	
2.2.3 2nd container plant screening trial set up	Oct 2013		June 2013
2.2.4 2nd container plant screening trial completed	Sep 2014		Nov 2013

Objective	Original Completion Date	Actual Completion Date	Revised Completion Date
2.2.5 3rd container plant screening trial set up	Oct 2015		June 2015
2.2.6 3rd container plant screening trial completed	Sep 2016		Sep 2012
2.3.1 1st Tree field herbicide trial set up	April 2012	April 2012	
2.3.2 1st Tree field herbicide trial completed	June 2013	In progress	
2.3.3 2nd Tree field herbicide trial set up	April 2013	Replaced with herbicide trial in stocks for cut flowers	
2.3.4 2nd Tree field herbicide trial completed	June 2013	Replaced with herbicide trial in stocks for cut flowers	
2.4.1 1st vegetable herbicide trial set up	May 2013	March 2013	
2.4.2 1st vegetable herbicide trial completed	Aug 2013	In progress	
2.4.3 2nd vegetable herbicide trial set up	May 2014		
2.4.4 2nd vegetable herbicide trial completed	Aug 2014		
2.4.5 3rd vegetable herbicide trial set up	May 2015		
2.4.6 3rd vegetable herbicide trial completed	Aug 2015		
2.5.1 Top fruit herbicide trial set up	April 2015		

Objective	Original Completion Date	Actual Completion Date	Revised Completion Date
2.5.2 Top fruit herbicide trial completed	Sept 2015		
2.6.1 Ground cover trial set up	April 2013	In progress (initial trial run in 2012)	
2.6.2 Ground cover trial completed	Aug 2015		
2.7.1 Perennial weed trial set up	March 2013	Delayed due to late spring	April 2013
2.7.2 Perennial weed trial completed	Sept 2015		
3. Set up a working group within the European Weed Research Society	March 2012	Not fully functional yet	March 2016

Summary of Progress

A full training programme has continued in 2012 for the most recent recruits; Jessica Sparkes, Harriet Roberts and Angela Huckle with refresher training for the more experienced David Talbot. Training has consisted of general ADAS courses and more specific technical training. It is pleasing to note that all three recent recruits passed their BASIS qualification for horticulture in January 2013. David Talbot is already BASIS qualified. For the trainees based at Boxworth there has been the opportunity to gain further experience by working on a wide range of weed control projects not just those specifically planned through the fellowship.

The work programme continued through 2012 to March 2013 with pot herbicide screening experiments for specific horticultural weeds (Objective 2.1). As before, there were difficulties with germination of some of the weed species but the experiments were successfully completed in March 2013.

The nursery stock experiments for 2012 in the West Midlands were successfully planned and written up by David Talbot. The container nursery experiment (Objective 2.2) was concluded in November 2012 and the budded tree herbicide experiment (Objective 2.3) is still underway. A follow up container nursery experiment is being planned by David Talbot for 2013, further developing some treatments first tested in 2012 and introducing a new experimental compound.

A start was made looking at possible species to be grown as living mulches with potential for use within the crop rows of bush and top fruit (Objective 2.6). This work will be continued by Jessica Sparkes and Harriet Roberts in 2013 examining different species for growth parameters, nitrogen balance and water usage. Following pot trials during summer 2013, field sowings in commercial holdings are planned from autumn 2013.

Following liaison with the industry, Angela Huckle is planning a programme of herbicide trials for improved control of groundsel in salad leaf rocket (Objective 2.4). These trials are based on growers' holdings.

At the request of the cut flower industry, an additional project has been included in the programme of work for 2013. Angela Huckle and Jessica Sparkes will be managing a herbicide trial for stocks as cut flowers at the Cut Flower Centre Spalding in liaison with Lyndon Mason. This trial will be run instead of a second field tree herbicide trial, as it is thought that sufficient information will be gained from the first tree trial which runs for two seasons.

An experiment investigating the control of perennial weeds (Objective 2.7) by the allelopathic effects of cover crops will start in 2013, managed by Jessica Sparkes and follows a research area initially developed by Lynn Tatnell.

Liaison with researchers in other European countries has started (Objective 3.0). Angela Huckle attended a European Weed Research Society workshop on vegetable crops in Spain in September 2011 and made several useful contacts. Jessica Sparkes and Lynn Tatnell will be presenting posters on cover crops and herbicide resistance, respectively, at a European Weed Research Society Symposium in Turkey in June 2013 and Lynn will have a platform to present work on electrical weed control.

Initially through contacts made at the minor crops working group Brussels March 2012, John Atwood has made contact with researchers in the Netherlands and Germany and set up a sharepoint web site to share outline details of current research projects. Currently we have access to horticultural research reports from Germany and these have proved useful in developing treatments for the salad leaf rocket experiments.

The Netherlands

Wageningen University and Research Centre, Wageningen Campus, Droevendaalsesteeg 4, 6708 PB Wageningen, Netherlands

Ornamentals: Fons van Kuik

Vegetables: Rommie van der Weide, Marleene Riemens

Fruit: Bart Heijne

General (Principal contact): Corne Kempenaar

Germany

Dienstleistungszentrum Ländlicher Raum - Rheinpfalz -(DLR), Berufsbildende Schule für Wein- und Gartenbau, Breitenweg 71, 67435 Neustadt/Weinstrasse (Germany)

Vegetables (Princiapl contact): Ingeborg Koch

Fruits: Michael Glas

Vines: Friedrich Louis

Ornamentals: Bernd Böhmer

Contacts from Denmark and France are being sought. The most active interest so far has come from researchers in the Netherlands and Germany. Good links exist with researchers in Eire and the US working on ornamentals and foliage crops.

Milestones not being reached

The pot screening experiment for horticultural weed (Objective 2.1) was delayed due to poor germination of some of the weed seeds, but has now been completed.

The working group of European weed control researchers was not set up by March 2012 as planned. The timing of this target was too optimistic but progress is being made in building links with researchers from the Netherlands and Germany. It is planned to continue building links with researchers in continental Europe through the life of the project by attendance at EWRS workshops and informal contacts, so a revised target of March 2016 is proposed.

Do remaining milestones look realistic?

1.5. Nursery visits (10). The milestone of 10 nursery visits has been met for the group as a whole. It is proposed to add further accompanied visits over the entire period of the fellowship project as the opportunity arises.

1.10. Consultancy advice. This should be broadened beyond protected crops and ornamentals.

1.13. Drafting HDC factsheets. This will depend on HDC requirements. Nothing is planned at present, but there are possible gaps that could be filled e.g. weed control in cut flowers.

1.14. Delivering talks; this aspect is now on track. Jessica Sparkes and Harriet Roberts have both presented talks at grower meetings. The HDC studentship conference will be another opportunity for presentations.

2.3.3. 2nd Field tree herbicide trial. This experiment has been replaced with a herbicide trial on stocks grown for cut flowers at the request of the industry.

Training undertaken

During the year the four fellowship trainees undertook a range of training activities and 'on-the-job' work experience in the field of weed control research and consultancy. Activities included formal training courses, a seminar with an overseas researcher, attendance at conferences in the UK and abroad, and field visits with experienced consultants. The trainees' training activities are listed in Appendix 1.

Expertise gained by trainees

In addition to the formal non-technical ADAS training programme the trainees have gained practical experience of drafting protocols to the ADAS standard, setting up and managing experiments and drafting experimental reports. The main experience gained during the two years of the fellowship is summarised below:

Jessica Sparkes

- Improved background knowledge of UK agriculture and horticulture
- Experienced in weed resistance testing
- Seedling weed identification
- Giving consultancy advice
- Researched non-chemical weed control methods
- Gained BASIS qualification for Horticulture
- Spoken on weed control topic at grower meeting

Harriet Roberts

- Technical writing improved
- Experienced in contract management, protocol development, managing herbicide trials and drafting reports
- Seedling weed identification
- Trained in aspects of herbicide advice in fruit and nursery stock crops
- Gained BASIS qualification for Horticulture
- Presented fruit weed control research results at SCEPTRE project management meeting
- Presented weed control research results at HDC hardy ornamentals panel meeting

Angela Huckle

- Networking with European researchers
- Staff management and quality systems
- Gave seminar to staff following visit to EWRS workshop in Spain
- Trained in weed control in nursery stock and fruit

- Gained BASIS qualification for Horticulture

David Talbot

- Increased confidence and skill in giving 'on-nursery' advice on weed control programmes in nursery stock and protected ornamentals
- Gaining experience in ADAS quality management systems when running 'off site' experiments
- Consolidated existing skill in identification of seedling weeds

Other achievements in the last year not originally in the objectives

Harriet Roberts has taken the lead in drafting protocols, setting up experiments and drafting reports under John Atwood's supervision for several important weed control projects outside of the fellowship including weed control in Rhubarb (SF 129), residual weed control in Raspberries (SF 119) and SCEPTRE projects on residual weed control in strawberries and perennial weed control in bush and cane fruit.

Jessica Sparkes has undertaken a comprehensive literature review of non-chemical weed control methods for CRD. She has managed commercially funded herbicide trials in oilseed rape and winter wheat and has led a CRD funded project examining the economics of various non-chemical methods of weed control. She has also worked with ADAS colleagues running a commercial programme of screening for herbicide resistance in grass weeds such as black-grass.

Changes to Project

Are the current objectives still appropriate for the Fellowship?

Broadly speaking the current objectives are still appropriate for the fellowship but some adjustments to the timing of the milestones have been requested.

Grower Summary

Headline

- Wing-P (dimethenamid–p + pendimethalin) has potential for use as a residual herbicide in nursery stock, both for container-grown and field–grown crops.
- Wing-P controls weeds such as groundsel (*Senecio vulgaris*) and American willowherb (*Epilobium ciliatum*) that are important in nursery stock and soft fruit production. Authorisation for use is being sought by the HDC for use in these crops.

Background

The HDC/EMT/HTA Horticultural Fellowship – Weeds is designed to provide training for four recently recruited ADAS consultants / researchers to develop specific expertise in weed control research, and thereby maintain research and consultancy expertise in the UK in this sector.

To help achieve this aim a programme of experimental work is planned and in the second year this has focused on the testing of new herbicide products for potential use in nursery stock production, both container-grown and field-grown. Herbicides were tested for control of specific weeds of particular importance in nursery stock and fruit soft fruit production and for phytotoxicity in container and field-grown nursery stock species.

Following encouraging results for efficacy against key weed species in year one of the fellowship project, seed-meal treatments were included in the container-grown nursery stock trial to test for phytotoxicity in commonly grown crop species.

Work relevant to fruit production was started in the second year with an initial screening of plant species with potential for use as a living mulch within crop rows of bush, cane and tree fruit.

Summary

Pot weed screen

In seeded pot experiments at ADAS Boxworth led by Harriet Roberts, two new herbicide treatments HDC H14 and Wing-P (dimethenamid-p + pendimethalin) were compared against Flexidor 125 (isoxaben) on eight common weeds of horticultural interest both pre and post emergence of the weeds in 2012-13 (Table 1). Wing-P gave good control of groundsel and annual meadow grass (*Poa annua*), neither of which were controlled by Flexidor 125; however Wing-P did not give effective control of any of the three bittercress species tested. HDC H14 delayed germination of the weed species tested but with the exception of mouse-ear chickweed (*Cerastium fontanum*) and pearlwort (*Sagina subulata*) did not give good pre-emergence control. It may have been adversely affected by the high organic level of the growing media. HDC H14 performed more consistently as a post emergence application performing well on three species of bittercress (*Cardamine hirsuta*, *C. corymbosa*, and *C. flexuosa*). Both Wing-P and HDC H14 showed better or equivalent control to Flexidor 125 as a post emergence treatment on weeds that were either 4-5 true leaf or 7-10 true leaf stage.

Table 1. Herbicide pot screen results (R resistant <40% control, MS moderately susceptible 40 -70 % control, S susceptible >70% control)

	Pre emergence			**Post emergence**		
Weed species	Wing P	HDCH14	Flexidor 125	Wing P	HDCH14	Flexidor 125
Bittercress, hairy	R	R	S	R	S	R
Bittercress, flexuous	R	R	S	MS	S	R
Bittercress, NZ	R*	R*	S	MS	R*	R
Groundsel	S	R	R	S	MS	S
Willowherb, American	S*	S*	R	R	S	R
Chickweed, common	R	R	S	MS	R	S
Annual meadow grass	S	R	R	R	R*	R
Chickweed, mouse-ear	MS	S	S	S	S	S
Pearlwort	MS	S	S	Not tested		

*Very low overall germination but some significant phytotoxicity to the weeds was observed, subsequently killing the few germinated seedlings

Container plant screening

A weed control trial led by David Talbot was carried out on container-grown nursery stock at Wyevale Container Plants, Hereford. The main objective of the trial was to assess the crop safety of new herbicides Wing-P and HDC H14 and a high glucosinolate mustard seed meal (*Sinapsis alba*) to a range of container-grown nursery stock species (Table 3). A commercial standard treatment; Ronstar 2G was included for comparison.

Table 2. Treatments used in HNS container trial 2012

Product name	**Active substance**	**Rate (L/ha or kg/ha)**	**Approval Status (Outdoor ornamentals)**
Untreated			
Wing-P	dimethenamid-p (212.5 g/L) + pendimethalin (250 g/L)	4.0 L	Not approved
HDC H14			Not approved
Sinapsis alba 'Braco' seed meal	glucosinolates	24g/3L pot or 20g/2L pot.	Used as a fertiliser
Ronstar 2G	oxadiazon (2% w/w)	200 kg/ha	Approved

Table 3. Plant cultivars tested

Aucuba japonica 'Variegata'	*Escallonia rubra* var. *macrantha*
Buddleja davidii 'Buzz Ivory'	*Hebe pinguifolia* 'Sutherlandii'
Buxus sempervirens	*Hydrangea macrophylla* 'Mariesii Perfecta'
Ceanothus thyrsiflorus 'Skylark'	*Hypericum* 'Hidcote'
Cistus x *pulverulentus* 'Sunset'	*Olearia macrodonta* 'Major'
Cornus alba 'Sibirica'	*Spiraea nipponica* 'Snowmound'
Cupressocyparis leylandii 'Excalibur Gold'	

The Wing-P treatment was relatively safe, only *Olearia* was slightly damaged with some tip burn to the growing points. HDC H14 and the *Sinapsis alba* seed meal treatments were more damaging and therefore may only be suitable for a limited number of container-grown nursery stock species at the rates used.

Interestingly, seed meal caused leaf scorch on *Hypericum* initially but plants grew away from the damage quickly, whereas damage took longer to show on other plant species (e.g. *Cistus*). It was noted that seed meal resulted in improved leaf colour in *Hydrangea* but the

effect on *Escallonia* was inconsistent; scorching the foliage of the latter in some plots whilst improving foliage colour in others. It is known that the seed meal can act as a slow release nitrogen fertiliser.

Overall the most promising treatment was Wing-P and this treatment will be further tested in 2013 both alone and in tank mixture with Flexidor 125 in an attempt to achieve a full weed control spectrum. The Herbicide HDC H14 is still some way from market in the UK and as its potential applications appear more limited in container-grown nursery stock it will not be included in the 2013 experiments.

2.3 Tree field herbicide trial

A weed control trial led by David Talbot commenced in 2012 on field-grown *Malus*, *Prunus*, Quince and *Sorbus* at Frank P Matthews Ltd, Tenbury Wells.

This trial was carried out to assess nine herbicide treatments; seven of which were novel herbicides (Table 4). All treatments were combined with a standard programme of Devrinol (napropamide) and Flexidor 125 (isoxaben), and applied post planting to dormant tree rootstocks for budding. The control treatment was the Devrinol and Flexidor commercial standard without any additional treatment.

Table 4. Post-planting treatments used in field tree HNS trial 2012

Product	Active substance	Rate	Approval status outdoor ornamental
Chikara	flazasulfuron (25% w/w)	0.150 kg/ha	Not approved
Devrinol	napropamide (450 g/L)	7L/ha	Label
Flexidor 125	isoxaben (125 g/L)	2L/ha	Label
Gamit 36 CS	clomazone (360 g/L)	0.25 L/ha	LTAEU
HDC H13	not disclosed		Not approved
HDC H14	not disclosed		Not approved
HDC H15	not disclosed		Not approved
Ronstar Liquid	oxadiazon (250 g/L)	4 L/ha	Label
Sencorex WG	metribuzin (70% w/w)	0.75 kg/ha	LTAEU

Stomp Aqua	pendimethalin (455 g/L)	2.9L/ha	EAMU
Wing-P	dimethenamid-p (212.5 g/L) + pendimethalin (250 g/L)	4 L/ha	Not approved

EAMU – Extension of authorisation for minor use
LTAEU – Long term arrangements for extension of use

When recorded three months after treatment the growers standard treatment had weed cover of around 10% with predominant weeds including black bindweed (*Fallopia convolvulus*), knotgrass (*Polygonum aviculare*), groundsel and dandelion (*Taraxacum officinalis*). The best additional treatments for weed control were Ronstar Liquid, Chikara and Wing P with 1.25, 2.25 and 2.75% weed cover respectively. Although Chikara looked promising in terms of weed control it caused significant stunting to the *Malus* and moderate stunting to *Prunus*, *Quince*, and *Sorbus*. The experimental treatments will be applied again after the rootstocks are headed back this spring and the results will be monitored.

Living mulch pot screen

A preliminary pot-based study led by Jessica Sparkes was conducted at ADAS Boxworth in spring/summer 2012 to evaluate the potential of four living mulch species for inclusion in 2013 trials. The living mulches tested included *Trifolium repens*, *Medicago lupulina*, *Festuca rubra*, *Lotus corniculatus* and a mixture of *F. rubra* and *L. corniculatus*. The purpose of this preliminary experiment was to determine if these species could be suitable for use as living mulches in top fruit and thus should be included in future studies. To be considered potentially suitable the living mulch should be low-growing and form a dense ground cover. Three sowing densities were tested which corresponded with the commercial recommendation, half the commercial recommendation and double the commercial recommendation for each species. After the living mulches were well established they were cut back to 3 cm and allowed to re-grow. This encouraged a dense cover across the soil surface in several of the treatments. None of the species tested grew more than 20 cm tall. Overall, all of the species included showed promise and will be taken forward in 2013. Germination of all species was lower than hoped so the lowest sowing density will be excluded from future work.

Financial Benefits

Further work is needed to obtain an authorisation for the use of Wing-P in ornamental and soft fruit production before it can be recommended to growers. Therefore there are no financial benefits at this stage.

Action Points

- Wing-P has good potential for use as a summer herbicide for the control of groundsel and annual meadow grass in ornamentals and soft fruit production but its use will depend on obtaining an authorisation for use in these crops.

Future projects

In year 3 (2013) there will be seven experimental projects:

- Control of groundsel in salad leaf rocket – novel herbicide combinations
- Herbicide screening for residual weed control in transplanted stocks for cut flowers
- Phytotoxicity testing of new active ingredients in a container-grown nursery stock, on a commercial nursery
- Control of perennial weeds by growing allelopathic crops in the preceding fallow
- Control of perennial weeds in Peony for cut flowers
- Residual effects from herbicides used for perennial weed control before planting fruit crops
- Water usage and nitrogen balance in living mulch species with potential for in-row planting in bush and top fruit