Project title:	Roses: Triazine-free herbicide programmes
Project number:	HNS 132
Project leader:	Mr C M Burgess, CB Consultant Agronomist
Project collaborator:	Mr J Atwood, Senior Consultant, ADAS
Report:	Annual report Year 1, 2005
Key workers:	Mr C Burgess, Author of report. Project manager for Hampshire site – herbicide treatment applications and weed assessments. Mr J Atwood, Project manager for Norfolk site - weed assessments & herbicide treatment selections. Mr J Carpanini, Senior Scientific Officer, ADAS Arthur Rickwood. Herbicide treatment applications - Norfolk site.
Project locations:	Site 1: Ganger Farm, Jermyns Lane, Hants, SO51 0QA c/o Stewart Pocock Pocock's Roses Jermyns Lane Ampfield Romsey Hampshire, SO51 0QA Tel 01794 367500 Site 2: Weggs Farm, Diss, Norfolk, IP21 4PJ c/o Robert Wharton Wharton's Nurseries Ltd Harleston Norfolk, IP20 9AX Tel 01379 852157
Project co-ordinator:	Stewart Pocock Pocock's Roses Jermyns Lane Ampfield Romsey Hampshire, SO51 0QA Tel 01794 367500
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Key words: Roses, weed control, Artist, Butisan S, Calaris 400 SC, Centium 360 CS, Crystal, Flexidor 125, Javelin, Liberator, Ronstar Liquid, Sipcam Simazine, Skirmish 495 SC, Stomp 400 SC, flufenacet + metribuzin, metazachlor, terbuthylazine + mesotrione, clomazone, flufenacet + pendimethalin, isoxaben, diflufenican + isoproturon, flufenacet + diflufenican, oxadiazon, simazine, terbuthylazine + isoxaben, pendimethalin, hardy nursery stock, field-grown, herbicides, triazine-free, triazine, phytotoxicity, *Anagallis arvensis, Avena* sp*., Capsella bursa-pastoris, Cerastium arvense, Chenopodium album, Conzya canadensis, Cirsium arvense*, *Coronopus squamatus, Cress* spp*., Epilobium angustifolium, Euphorbia* sp*., Galium aparine, Geranium* sp., *Lamium purpureum, Matricaria* spp*., Poa annua, Polygonum aviculare, Polygonum convolvulus, Polygonum lapathifolium, Polygonum persicaria, Senecio vulgaris, Sonchus oleraceus, Stellaria media, Taraxacum officinale*, *Thlaspi arvensis*, *Veronica* spp*., Vicia* sp*., Viola* spp*.*

CONTENTS

Grower Summary

Headline

- Early results have selected two promising triazine-free herbicide programmes (based on Stomp + Butisan S and Artist) and one new permitted triazine-containing programme (Skirmish + Butisan S) for field-grown roses. These may be a viable alternative to a popular standard programme using simazine + Butisan S when the use of simazine is finally revoked in December 2007.

Background and expected deliverables

Herbicides are still required for economic field production of field-grown roses as hand or mechanical weed control is currently not viable in this crop with its 2-year production cycle and growth habit. Rose herbicide programmes have traditionally centred on inexpensive triazines such as simazine or atrazine. The persistent triazines simazine and atrazine were withdrawn from non-agricultural uses in 2002, and a recent EU ruling significantly limited their use in agriculture from 2004. Simazine continues to be approved for use on hardy nursery stock but only until 2007. Triazine-resistant weed populations such as fat hen, groundsel, annual meadow grass, American willowherb and pineapple weed are also a developing problem on some nurseries.

Thus there is a need to re-evaluate some non-triazine herbicide programmes. The last HDC work on this subject was concluded at HRI Efford in 1992, when some triazine-free programmes were moderately successful, but not as good as those incorporating some triazines. Since then, several new non-triazine candidates have come onto the market. Recently the EC has approved two other products containing the triazine, terbuthylazine, for use in pea & bean or forage maize crops, but which may have off-label potential for nursery stock.

Objectives of the project are to:

1 Assess the efficacy and crop safety of a range of herbicide programmes on two commercial production sites for field-grown roses, compared to a typical grower's standard programme, which includes simazine.

2 Identify any specific weaknesses in the weed control spectrum of the herbicides (within the background weed spectra of test sites). This will help growers make informed choices for their site or alert them of extra measures that may be needed to control some weeds.

3 Provide comparative costs of treatments.

Summary of the project (Year 1) and main conclusions to date

The project is using two commercial field sites, one in Hampshire and the other in Norfolk. Over the three-year project duration, two successive trials are being conducted on each site (planted in Year 1 and Year 2). The conventional three timings of herbicides will be applied to each trial over the two-year crop cycle – ie post-planting of rootstocks (spring), post-budding (summer) and post-heading back (following winter). This annual report covers results following the first two herbicide applications to Trial 1.

Table 1 Herbicide Programme Treatments for Trial 1 (2005 / 2006)

Treatment	Post Planting	Post Budding	Post Heading Back
A	Untreated control	Untreated control	Untreated control
B	Grower's standard: Simazine 3.4 L/ha + Butisan 2.5 L/ha	Simazine 3.4 L/ha + Butisan 2.5 L/ha	Simazine 3.4 L/ha + Butisan 2.5 L/ha
C	Skirmish 1.0 L/ha + Butisan 2.5 L/ha	Skirmish 1.0 L/ha + Butisan 2.5 L/ha	Skirmish 1.0 L/ha + Butisan 2.5 L/ha
D	Ronstar 4.0 L/ha + Stomp 3.3 L/ha	Butisan 2.5 L/ha + Flexidor 1.0 L/ha	Ronstar 4.0 L/ha + Stomp 3.3 L/ha
E	Ronstar 4.0 L/ha + Javelin 1.0 L/ha	Butisan 2.5 L/ha + Stomp 3.3 L/ha	Ronstar 4.0 L/ha + Javelin 1.0 L/ha
F	Artist 2.5 kg/ha	Butisan 2.5 L/ha + Stomp 5.0 L/ha	Artist 2.5 kg/ha
G	Stomp 5.0 L/ha + Centium 0.5 L/ha	Butisan 2.5 L/ha + Flexidor 1.0 L/ha	Stomp 5.0 L/ha + Centium 0.5 L/ha
H	Stomp 5.0 L/ha + Butisan 2.5 L/ha	Butisan 2.5 L/ha + Flexidor 1.0 L/ha	Stomp 5.0 L/ha + Butisan 2.5 L/ha
I	Crystal 4.0 L/ha	Butisan 2.5 L/ha + Flexidor 1.0 L/ha	Crystal 4.0 L/ha
J	Flexidor 2.0 L/ha + Butisan 2.5 L/ha	Butisan 2.5 L/ha + Stomp 5.0 L/ha	Flexidor 2.0 L/ha + Butisan 2.5 L/ha
K	Calaris 1.5 L/ha	Calaris 1.5 L/ha	Calaris 1.5 L/ha
L	Liberator 0.6 L/ha	Butisan 2.5 L/ha + Stomp 5.0 L/ha	Liberator 0.6 L/ha

Table 2 Herbicide products and active ingredients

Product name	Active ingredients	a.i. content	Supplier
Artist	flufenacet + metribuzin	24 : 17.5 % w/w	Bayer CropScience
Butisan S	metazachlor	500 g/litre	BASF
Calaris 400 SC	terbuthylazine + mesotrione	330 : 70 g/litre	Syngenta
Centium 360 CS	clomazone	360 g/litre	Belchim
Crystal	flufenacet + pendimethalin	60 : 300 g/litre	BASF
Flexidor 125	isoxaben	125 g/litre	Landseer
Javelin	diflufenican + isoproturon	63.5 : 500 g/litre	Bayer CropScience
Liberator	flufenacet + diflufenican	400 : 100 g/litre	Bayer CropScience
Ronstar Liquid	oxadiazon	250 g/litre	Certis
Simazine (various)	simazine	500 g/litre	various
Skirmish 495 SC	terbuthylazine + isoxaben	420 : 75 g/litre	Syngenta
Stomp 400 SC	pendimethalin	400 g/litre	BASF

Weed control

Sprays were applied post-planting in 23 March 2005 (Site 1) and 21 April (Site 2) with weeds assessed in late June and late May respectively. Post-budding sprays were applied on 9 or 15 August, with a second weed assessment in mid / late November.

The best control over both sites in spring / summer was achieved by the 'Grower's standard' Trt B (Simazine + Butisan), the triazine-free programmes Trt H (Stomp + Butisan) and Trt F (Artist), and the new triazine-containing programme Trt C (Skirmish + Butisan).

The main weeds present, which were well controlled, were Annual Meadow Grass, other grasses including volunteer cereals, Chickweed, Cleavers, Fat Hen, Groundsel, Mayweeds, Scarlet Pimpernel, Sowthistle, and Redshank,

The poorest treatments overall were Trt L (Liberator) and Trt I (Crystal) with several annuals including some grasses and volunteer cereals, Redshank, and, for Crystal, Mayweed being less well controlled, particularly at Site 2.

Any weed remaining on plots after budding was removed prior to the post-budding herbicide application. Weed numbers were generally very low in herbicide treated plots on both sites at the November assessment.

Phytotoxicity

Calaris as a post-budding spray caused serious yellowing, scorch and leaf drop on the rootstocks in late summer, due to its mesotrione component. It is too early to know whether this will have any knock-on effect on scion growth vigour in the maiden bush year, but it is likely that this treatment will not be repeated in Trial 2, especially as Calaris appears to have no efficacy advantage over the other herbicides.

There was some much less serious transient yellowing, leaf tip scorch or interveinal chlorosis observed with other treatments – Trt E (containing Javelin), Trt G (containing Centium), and Trt C (containing Skirmish). However not all treated plants were affected, nor was it consistent on both sites. Rootstock vigour does not appear to have been affected, but further information is required following the post-heading back sprays in spring 2006 and Trial 2 before safety to the crop can be fully assessed.

There was no phytotoxicity observed from the other treatments, including the promising non-triazine treatment F (containing Artist in spring and Stomp + Butisan S in summer) and H (containing Stomp + Butisan S in spring and Butisan S + Flexidor in summer).

Financial benefits

It is too early in the life of the project to fully assess these yet. However pesticide material costs for the various herbicide programmes varied from about £130/ha to £480/ha in total for the three applications. The promising Treatments H, F and C appeared good value at about £300, £180 and £250/ha respectively with the Std Trt B at £215/ha.

Action points for growers

- Remember that simazine cannot be used after 2007 so use up existing stocks by then.
- Consider trying out some of the promising treatments listed above, but note that some of these are off-label uses at grower's own risk.
- Some of these programmes may have wider applicability to other field-grown woody shrub and tree subjects, but further advice and small scale trialling may be necessary first to assess their safety to the crop.
- Please feed back experiences of efficacy and especially any phytotoxicity symptoms observed, to the Project leaders or HDC.

Science Section

INTRODUCTION

Field-grown roses remain one of the most important crop groups within the HNS sector with an estimated farm-gate value of £24 mill (Defra, 2002), of which most are eventually containerised for sale and form a significant proportion of the container HNS market valued at £286 mill.

Herbicides are still required for economic field production, and hand or mechanical weed control is currently not viable in this crop with its 2-year production cycle and growth habit. Rose herbicide programmes have traditionally centred on inexpensive triazines such as simazine or atrazine. The persistent triazines simazine and atrazine were withdrawn from non-agricultural uses in 2002, and a recent EU ruling significantly limited their use in agriculture from 2004. Simazine continues to be approved for use on hardy nursery stock but only until 2007.

Triazine-resistant weed populations such as fat hen, groundsel, annual meadow grass, American willowherb and pineapple weed are also a developing problem on some nurseries.

Thus there is a need to re-evaluate some non-triazine herbicide programmes. The last HDC work on this subject was concluded at HRI Efford in 1992, when some triazine-free programmes were moderately successful, but not as good as those incorporating some triazines. Since then, several new non-triazine candidates have come onto the market. Recently the EC has approved two other products containing the triazine, terbuthylazine, for use in pea & bean or forage maize crops, but which may have off-label potential for nursery stock.

OBJECTIVES

1 Assess the efficacy and crop safety of a range of herbicide programmes on two commercial production sites for field-grown roses, compared to a typical grower's standard programme, which includes simazine.

2 Identify any specific weaknesses in the weed control spectrum of the herbicides (within the background weed spectra of test sites). This will help growers make informed choices for their site or alert them of extra measures that may be needed to control some weeds.

3 Provide comparative costs of treatments.

MATERIALS AND METHODS

Overview

The project is using two commercial field sites, one in Hampshire and the other in Norfolk. Over the three-year project duration, two successive trials are being conducted on each site (planted in Year 1 and Year 2). The conventional three timings of herbicides will be applied to each trial over the two-year crop cycle – ie post-planting of rootstocks (spring), post-budding (summer) and post-heading back (following winter). Thus in Year 2 of the project, Trials 1 and 2 will be running concurrently.

This first annual report covers results following the first two herbicide applications to Trial 1.

Sites

Site 1. Hampshire

Ganger Farm
Jermyns Lane
Ampfield
Romsey
Hants SO51 0QA

c/o Stewart Pocock, Pocock's Roses, Romsey.

Roses form part of a rotation with soft fruit, vegetables and sweetcorn on a PYO holding. The field for Trial 1 was cropped with sweetcorn in 2004.

Soil texture: Clay loam

Site 2. Norfolk

Weggs Farm
Common Road
Dickleburgh
Diss
Norfolk IP21 4PJ

c/o Robert Wharton, Wharton's Nurseries Ltd, Harleston.

The site for Trial 1 was previously cropped with winter wheat in 2004.

Soil texture: Sandy clay loam

Treatments

The herbicide treatments with rates of use for Trial 1 are detailed in Table 1 and Table 2 details the active ingredients and suppliers of the products used. Untreated controls were included to give a measure of the background weed pressure and range of species present. The range of herbicide treatments tested included active ingredients relatively new to the UK and currently only approved on arable crops, alongside existing horticultural herbicides in combinations designed to give a comprehensive weed control spectrum.

Treatment B, simazine + Butisan S for each application, was the standard programme against which other treatments were being compared. This is a commonly used treatment where simazine is supplemented with Butisan S to provide control of resistant weeds such as Groundsel (*Senecio vulgaris*) and Rosebay Willowherb, (*Epilobium angustifolium*) plus improved control of polygonum weeds.

In treatment C, Skirmish replaces simazine, employing the alternative triazine terbuthylazine only available in mixtures with a small amount of isoxaben.

Treatments D and E are based around Ronstar Liquid. An effective herbicide but relatively weak on Chickweed (*Stellaria media*) and grasses. The supplements Stomp or Javelin are designed to give Chickweed and grass control. Because of the contact action of Ronstar liquid, it is not possible to use this post-budding, so either Butisan S + Stomp or Butisan S + Flexidor were used, the latter to avoid double applications of Stomp.

In treatment F the new potato and vegetable herbicide Artist (flufenacet + metribuzin) is used after planting and post heading back. Metribuzin is a long established active used on potatoes, the addition of flufenacet in the new product improves Cleavers (*Galium aparine*) and grass control. Metribuzin has shown some promise in other nursery stock experiments (HNS 111) when used on dormant crops and is used on some ornamentals in Germany. It has a strong contact action, so Butisan + Stomp was used instead as the post-budding treatment.

Treatments G, H and I are based around Stomp (pendimethalin) either as tank mixtures or as the formulated product Crystal (pendimethalin + flufenacet). The addition of Centium (treatment G) or Butisan (metazachlor) is designed to improved control of composite weeds such as Mayweed (*Matricaria* spp.) and Groundsel for which Stomp is weak.

Treatment J utilises the existing horticultural herbicides Flexidor and Butisan in combination to achieve a reasonable weed control spectrum.

Treatment K tests the new active ingredient mesotrione with terbuthylazine in the formulated product Calaris. As little is known of the safety on ornamentals it was decided to apply a three spray programme including use after budding.

Treatment L tests the new arable product Liberator comprising the active ingredients diflufenican and flufenacet, both of which are thought to be reasonably safe for use on dormant roses.

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E	Ronstar 4.0 L/ha + Javelin 1.0 L/ha	Butisan 2.5 L/ha + Stomp 3.3 L/ha	Ronstar 4.0 L/ha + Javelin 1.0 L/ha
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H	Stomp 5.0 L/ha + Butisan 2.5 L/ha	Butisan 2.5 L/ha + Flexidor 1.0 L/ha	Stomp 5.0 L/ha + Butisan 2.5 L/ha
I	Crystal 4.0 L/ha	Butisan 2.5 L/ha + Flexidor 1.0 L/ha	Crystal 4.0 L/ha
J	Flexidor 2.0 L/ha + Butisan 2.5 L/ha	Butisan 2.5 L/ha + Stomp 5.0 L/ha	Flexidor 2.0 L/ha + Butisan 2.5 L/ha
K	Calaris 1.5 L/ha	Calaris 1.5 L/ha	Calaris 1.5 L/ha
L	Liberator 0.6 L/ha	Butisan 2.5 L/ha + Stomp 5.0 L/ha	Liberator 0.6 L/ha

Table 2 Herbicide products and active ingredients

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Stomp 400 SC	pendimethalin	400 g/litre	BASF

Trial design

See Appendix 1 for details of layouts and plans.

On both sites a randomised block design was used with 12 treatments x 4 blocks = 48 plots.

For Site 1 (Hants), plots were 3.67 m wide x 4.0 m long comprising four crop rows on two 1.83 m wide beds. This gave a treated area of 14.7 m^2 per plot. Rootstock spacings were nominally 150 mm in-row giving approx 108 plants per treated plot.

A 0.5 m buffer zone at each end of the plot was ignored for weed assessments leaving an area for recording of 3.0 m length x 3 alleys (2.5 m) width = 7.5 m^2.

An uncropped tractor access alley was left either side of the 8 row trial area which was sprayed with the standard Simazine + Butisan S treatment.

For Site 2 (Norfolk), plots were 4 m wide x 4 m long containing six crop rows. As at Site 1, weed records were restricted to a central area within each plot.

Application of herbicide treatments

At Site 1, herbicides were applied using a Flow Techniques nursery sprayer powered by a 12V pump. The pressure regulator was set to maintain 2.0 Bar at the boom fitted with F80/1.6/3 nozzles. A double pass was used to ensure even coverage and sprays were applied in a water volume of 720 L/ha for the post-planting spray, and 680 L/ha for the post-budding spray.

At Site 2, treatments were applied with an Oxford Precision Sprayer using compressed CO_2 to maintain a constant output. Herbicides were applied at 2.0 Bar using 03-F110 nozzles in a volume of 750 L/ha for both spray applications.

Weed assessments

Weeds were recorded once in the summer and again in the autumn to assess efficacy of the post-planting and post-budding treatments respectively:

	Site 1 Hants	Site 2 Norfolk
Post-planting record	20 & 27 June 2005	27 May 2005
Post-budding record	23 November 2005	14 November 2005

Site 1
Background weed levels were high, and the untreated control plots developed a heavy growth of weeds in spring. By the time herbicide treated plots had sufficient weed to merit a record in June, untreated plots were overgrown making counting of individual weed numbers impossible. Therefore the proportions of the main weed species present on Trt A plots were estimated visually. For the other treatment plots, numbers of annual weeds, by species, within the central 7.5 m^2 area were recorded. Weeds were removed by hand as they were recorded. The overgrown Trt A plots were cleared by hand prior to budding, and also hoed clean again in mid September.

For the November record, two 0.25 m^2 quadrats per plot were recorded for Trt A because of the high numbers of weeds present. For the remaining treatments, weeds were counted within a 7.5 m^2 area as in the summer.

Site 2
Weed numbers, particularly on the untreated plots, were moderately high for the first record in late May. Annual weeds were counted on 0.16 m^2 quadrats per plot across all treatments. All plots were hoed clean prior to budding.

For the November record, weed numbers were much lower and were counted over an area of 10.8 m^2 per plot.

Phytotoxicity observations

Rootstocks were observed for any signs of damage such as leaf scorching, yellowing, distorted growth etc. following herbicide applications. Any damage was noted and photographed where possible.

A bud-take assessment will be made following the heading back of rootstocks in Year 2.

Analysis of results

Weed count data were converted to a standard scale of weeds per m^2. For Site 1, Hants, the Trt A untreated plots were not included in the statistical analyses because weed numbers were obviously so much larger than the other treatments.

As is typical in field experiments on weed control, the distribution of weeds as patchy and variable, and for individual species there were a lot of zero count plots. A $\log_{10}$ (number + 1) transformation was thus used to improve the non-normality of the data and make it better suited to an analysis of variance.

Individual ANOVA's for the most abundant weed species recorded were carried out as well as for total weed numbers.

Diary of key operations

Table 3 Dates of main activities

Activity	Site 1, Hampshire	Site 2, Norfolk
Plant rootstocks	w/c 7/3/05	11/4/05
Post-planting herbicide treatments	23/3/05	21/4/05
Summer weed assessment	20-27/6/05	27/5/05
Rootstocks budded	w/c 25/7/05	w/c 18/7/05
Post-budding herbicide treatments	9/8/05	15/8/05
Autumn weed assessment	23/11/05	14/11/05

At Site 1, some perennial weeds began to develop from mid May. Thistles were most abundant, particularly across about three plots depth at the west end of the trial. Other perennials including Dandelion (*Taraxacum officinale*), Buttercup (*Ranunculus repens*), and Dock (*Rumex* spp.) were present throughout the trial in much smaller numbers. Individual weeds were spot treated by hand with a brush using glyphosate as Roundup Biactive on 17 May, but thistles required re-treatment on 29 June. Patches of the perennial Creeping Cinquefoil (*Potentilla repens*) also developed in the trial from about mid June but were less easy to treat and control with glyphosate. Further spot treatments of this perennial will be needed in Year 2 of the trial.

RESULTS

Summer 2005 weed records

Site 1, Hampshire

Weed cover in the Trt A (Untreated) plots was too dense to be formally assessed (see Photos Appx 2). However, the most visibly abundant species present on 20 June 2005 were noted (Table 4).

Table 4 Site 1, Hants. Main weed species visible in untreated plots 20/6/05

	Plot no.			
Weed species	**3**	**20**	**25**	**42**
Scarlet Pimpernel (*Anagallis arvensis*)	XXX	XXX	XXX	XXX
Fat Hen (*Chenopodium album*)	XXX		XXX	
Annual Meadow Grass (*Poa annua*)		XXX		XX
Other Grasses	XX	XX		
Sowthistle (*Sonchus oleraceus*)		XX	XX	XX
Mayweed (*Matricaria* spp.)	XX	X	X	XX
Groundsel (*Senecio vulgaris*)	XX		X	
Redshank (*Polygonum persicaria*)	X	XX		
Knotgrass (*Polygonum aviculare*)			X	XX
Spurge (*Euphorbia* sp.)	X	X		
Vetch (*Vicia* sp.)	XX		XX	

XXX – Very abundant (> 40% coverage)
XX – Abundant or 4+ large plants visible
X – 1 to 3 large plants visible

Annual weed control across all the herbicide treatments on Site 1 was very good despite the obviously high background weed pressure as demonstrated on the untreated Trt A plots. Although the Trt A plots were covered by a lot of Scarlet Pimpernel and Fat Hen, no Scarlet Pimpernel and very few of Fat Hen were present on the other treatments.

While annual weed numbers were very low for all herbicide treatments (ie less than 4/m^2), there were some small differences in control levels between treatments. Some Sowthistle was present across the site, but was particularly bad in one plot of Trt G. All Sowthistles were recorded as annuals (*Sonchus oleraceus*), although it is likely that some were Perennial Sow-Thistle (*Sonchus arvensis*). Table 5 below summarises the results for species or groups where treatment differences were statistically significant.

The best treatments overall (Total weeds) were B, J, C, H & F, with the B, the Grower's standard simazine + Butisan S having less than 0.1 weeds/m^2 to F (Artist) with 1.0 weeds/m^2. The poorest treatments were G (Centium + Stomp high rate) and L (Liberator). About 30% of the weed in Trt G was due to a large amount of Sowthistle in a single plot. Annual Meadow Grass was also less well controlled (1.0/m^2) with Trt G, although other grasses were. The weed in Trt L, Liberator, were mainly 'other annuals' especially Groundsel, Fat Hen and Spurge, and 'other grasses'.

Table 5 Site 1, Hants. Mean weed numbers on herbicide treated plots June 2005.
Transformed data as $\log_{10}$ (weeds/m^2 + 1). Back-transformed data as weeds/m^2 in brackets

Treatment (post-planting)	Annual Meadow Grass	Other grasses	Other annuals[1]	Total weeds[2]
B. Simazine + Butisan S	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.04 (0.09)
C. Skirmish + Butisan S	0.00 (0.00)	0.06 (0.15)	0.00 (0.00)	0.11 (0.28)
D. Ronstar + Stomp lo	0.19 (0.55)	0.26 (0.81)	0.08 (0.19)	0.46 (1.88)
E. Ronstar + Javelin	0.12 (0.32)	0.36 (1.29)	0.10 (0.25)	0.46 (1.88)
F. Artist	0.00 (0.00)	0.12 (0.31)	0.06 (0.15)	0.30 (0.99)
G. Stomp hi + Centium	0.30 (1.00)	0.07 (0.19)	0.09 (0.22)	0.69 (3.84)
H. Stomp hi + Butisan S	0.00 (0.00)	0.07 (0.16)	0.01 (0.03)	0.16 (0.46)
I. Crystal	0.06 (0.15)	0.22 (0.66)	0.23 (0.70)	0.44 (1.78)
J. Flexidor + Butisan S	0.03 (0.06)	0.01 (0.03)	0.01 (0.03)	0.09 (0.23)
K. Calaris	0.21 (0.62)	0.29 (0.94)	0.09 (0.24)	0.43 (1.71)
L. Liberator	0.04 (0.09)	0.25 (0.79)	0.36 (1.29)	0.59 (2.93)
SED (30 df)	*0.076*	*0.079*	*0.104*	*0.170*
LSD (5%)[3]	*0.16*	*0.16*	*0.21*	*0.35*
Significance, P[4]	*0.003*	*<0.001*	*0.042*	*0.006*

[1] Other annuals = Fat Hen, Mouse-eared Chickweed, Groundsel, Spurge, Scarlet Pimpernel, Mayweeds, Cleavers, Redshank, but not Sowthistle.
[2] Total weeds includes Sowthistle, but not Creeping Cinquefoil or other perennials.
[3] Least significant difference for comparing transformed treatment means at P<0.05
[4] Overall significance of treatment effects in ANOVA.

Site 2, Norfolk

Weeds were recorded in late May, almost a month earlier than at Site 1, when Untreated plots averaged about 200 weeds/m^2 in total. Weeds were generally less well controlled by the herbicide treatments on this site, with total annuals reaching levels of up to 35 weeds / m^2 for the poorest treatment (Table 6).

Of the three weakest treatments, Trt J, Flexidor + Butisan, gave relatively poor control of Redshank, 'other grasses' – mainly volunteer cereals, and 'other annuals' – mainly cleavers and knotgrass. Trt L, Liberator, was poorest for Redshank and 'other annuals'- mainly volunteer wheat, and Trt I, Crystal, for Redshank, Mayweed and Cleavers. Trt G, Stomp + Centium, was also poorest for Mayweed control.

The best treatments overall in rank order were Trts B (Simazine + Butisan), Trt H (Stomp high rate + Butisan), Trt F (Artist), Trt C (Skirmish + Butisan), Trt E (Ronstar + Javelin), Trt D (Ronstar + Stomp low rate) and Trt K (Calaris).

Table 6 Site 2, Norfolk. Mean weed numbers May 2005.
Transformed data log_{10} (weeds/m^2 + 1). Back-transformed data weeds/m^2 in brackets

Treatment (post-planting)	Redshank	Other grasses	Mayweeds	Cleavers	Other annuals[1]	Total annuals
A. Untreated	1.54 (33.44)	0.88 (6.50)	1.35 (21.59)	0.73 (4.38)	1.55 (34.32)	2.30 (197.15)
B. Simazine + Butisan S	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.32 (1.11)	0.41 (1.56)	0.45 (1.83)
C. Skirmish + Butisan S	0.57 (2.71)	0.28 (0.92)	0.00 (0.00)	0.00 (0.00)	0.22 (0.64)	0.89 (6.82)
D. Ronstar + Stomp lo	0.00 (0.00)	0.82 (5.64)	0.22 (0.64)	0.78 (5.03)	0.00 (0.00)	1.06 (10.51)
E. Ronstar + Javelin	0.22 (0.64)	0.50 (2.15)	0.00 (0.00)	0.22 (0.64)	0.88 (6.50)	1.03 (9.79)
F. Artist	0.00 (0.00)	0.00 (0.00)	0.43 (1.69)	0.50 (2.15)	0.43 (1.69)	0.85 (6.10)
G. Stomp hi + Centium	0.00 (0.00)	0.54 (2.46)	0.94 (7.75)	0.22 (0.64)	0.22 (0.64)	1.26 (17.24)
H. Stomp hi + Butisan S	0.00 (0.00)	0.57 (2.71)	0.22 (0.64)	0.22 (0.64)	0.22 (0.64)	0.70 (3.78)
I. Crystal	0.63 (3.25)	0.43 (1.69)	0.88 (6.50)	0.71 (4.16)	0.43 (1.69)	1.52 (32.34)
J. Flexidor + Butisan S	0.82 (5.64)	0.96 (8.12)	0.00 (0.00)	0.54 (2.46)	0.78 (5.08)	1.49 (29.83)
K. Calaris	0.00 (0.00)	0.71 (4.16)	0.22 (0.64)	0.65 (3.45)	0.00 (0.00)	1.16 (13.49)
L. Liberator	0.73 (4.38)	0.78 (5.03)	0.00 (0.00)	0.22 (0.64)	0.86 (6.19)	1.56 (35.14)
SED (33 df)	*0.332*	*0.331*	*0.264*	*0.264*	*0.372*	*0.338*
LSD (5%)	*0.68*	*0.67*	*0.54*	*0.54*	*0.76*	*0.69*
Significance, P	*<0.001*	*0.083*	*<0.001*	*0.071*	*0.009*	*<0.001*

[1] Other annuals = Pansy (*Viola* spp.), Fat Hen, Cress spp., Black Bindweed (*Polygonum convolvulus*), Knotgrass, Annual Meadow Grass, Chickweed, Swinecress (*Coronopus squamatus*) and Speedwell (*Veronica* spp.).

Autumn 2005 weed records

Although it is likely that there would have been some carry-over effects from the 12 herbicide treatments used in spring, the post-budding treatments fall into 3 main groups. Butisan + Flexidor (Trts D, G, H & I) and Butisan + Stomp (Trts E, F, J & L with Stomp at the lower rate for Trt E). The third group, Trts B, C and K, all contained triazines and were the same as used in spring.

Site 1, Hampshire

After the post-budding treatments had been applied in early August, the untreated Trt A plots had been hoed clean again in mid-September to prevent excessive growth before the autumn weed assessment. By the 23 November record, there were high numbers of weeds present, but they were small enough to be recorded using a sample quadrat. Most of the Dandelion recorded at this time had probably emerged as seedlings since the summer record

Table 7 Site 1, Hants. Weed numbers and species in untreated Trt A. plots November 2005

Mean of eight 0.25 m^2 quadrats as weeds/m^2

Annual Meadow Grass	Speedwell	Dandelion	Sowthistle	Common chickweed	Willowherb
290	136	54	27	23	13
Mouse-eared chickweed	Groundsel	Other grasses	Buttercup	Mayweed	Shepherd's purse[1]
10	5	4	3	2	2
Clover	Pansy	Knapweed	Dock	Scarlet pimpernel	**Total weeds**
2	2	1	0.5	0.5	572

[1] (*Capsella bursa-pastoris*)

Annual weed numbers were, again, low on all the herbicide treated plots, with no significant treatment differences apparent for individual weeds except for those in Table 8 below.

While weed control was still generally good for all herbicide treatments, Treatments I, D, L and E had the highest mean weed numbers of 2.4, 1.8, 1.2 and 1.0 weeds/m^2 respectively. These post-budding treatments were either Butisan + Flexidor or Butisan + Stomp. For Trts I, D & L, Dandelions accounted for 1.4, 0.9 and 0.7 of these weeds/m^2 respectively. Trt H (Butisan + Flexidor) was also amongst the highest four treatments for numbers of Dandelion present. Trt E had the most 'other grasses' present.

The three treatments containing triazines, ie Trts B, C and K, had the lowest total weed numbers on average. The perennial weeds Buttercup and Perennial Thistle were also counted; although populations were low at this time, and treatment differences were not significant, Trts I and H containing Butisan + Flexidor had the most on average, whereas the two new triazine treatments Trt C (Skirmish + Butisan) and Trt K (Calaris) had none.

Table 8 Site 1, Hants. Mean weed numbers on herbicide treated plots November 2005. Transformed data as $\log_{10}$ (weeds/m^2 + 1). Back-transformed data as weeds/m^2 in brackets

Treatment (post-budding)	Dandelion	Other grasses	Total weeds[1]
B. Simazine + Butisan S	0.01 (0.03)	0.00 (0.00)	0.06 (0.15)
C. Skirmish + Butisan S	0.01 (0.03)	0.00 (0.00)	0.06 (0.15)
D. Butisan S + Flexidor	0.28 (0.92)	0.03 (0.06)	0.45 (1.80)
E. Butisan S + Stomp lo	0.13 (0.34)	0.19 (0.55)	0.30 (1.00)
F. Butisan S + Stomp hi	0.11 (0.29)	0.01 (0.03)	0.26 (0.80)
G. Butisan S + Flexidor	0.03 (0.06)	0.05 (0.13)	0.12 (0.33)
H. Butisan S + Flexidor	0.22 (0.64)	0.01 (0.03)	0.24 (0.74)
I. Butisan S + Flexidor	0.37 (1.37)	0.06 (0.15)	0.53 (2.42)
J. Butisan S + Stomp hi	0.12 (0.32)	0.01 (0.03)	0.26 (0.83)
K. Calaris	0.00 (0.00)	0.10 (0.26)	0.12 (0.32)
L. Butisan S + Stomp hi	0.24 (0.75)	0.04 (0.10)	0.33 (1.15)
SED (30 df)	*0.082*	*0.041*	*0.123*
LSD (5%)	*0.17*	*0.08*	*0.25*
Significance, P	*<0.001*	*0.002*	*0.008*

[1] Includes Annual Meadow Grass, Groundsel, Shepherd's Purse, Speedwells, Sowthistle, Pansy, Mouse-eared Chickweed (*Cerastium arvense*), Willowherb and Cranesbill (*Geranium* sp.) as well as Dandelion and Other Grasses. Excludes other perennials including Creeping Cinquefoil, Buttercup, & Creeping Thistle (*Cirsium arvense*).

Site 2, Norfolk

Table 9 Site 2, Norfolk. Mean weed numbers on herbicide treated plots November 2005. Transformed data as $\log_{10}$ (weeds/m^2 + 1). Back-transformed data as weeds/m^2 in brackets

Treatment (post-budding)	Total annuals
A. Untreated	0.92 (7.22)
B. Simazine + Butisan S	0.06 (0.14)
C. Skirmish + Butisan S	0.00 (0.00)
D. Butisan S + Flexidor	0.02 (0.05)
E. Butisan S + Stomp lo	0.02 (0.05)
F. Butisan S + Stomp hi	0.02 (0.04)
G. Butisan S + Flexidor	0.00 (0.00)
H. Butisan S + Flexidor	0.05 (0.11)
I. Butisan S + Flexidor	0.04 (0.09)
J. Butisan S + Stomp hi	0.00 (0.00)
K. Calaris	0.23 (0.71)
L. Butisan S + Stomp hi	0.06 (0.15)
SED (33 df)	*0.063*
LSD (5%)	*0.13*
Significance, P	*<0.001*

At Site 2, the herbicide treatments also had very low numbers of weeds at the autumn assessment, with most ranging from only 0.15 – zero weeds/m^2. Trt. K, Calaris, had more than the other treatments averaging 0.71 weeds/m^2, but 0.6 weeds/m^2 of this was due to Cleavers in just two of the replicates.

There were no significant treatment effects amongst the very low numbers of weeds scattered over the remaining herbicide treated plots. On the Untreated Trt A plots, Willowherb averaged

2.0/m^2, Mayweed 1.2/m^2, Groundsel 0.8/m^2, Pansy 0.3/m^2, Cleavers 0.2/m^2 with small numbers of Annual meadow grass, Sowthistle, Pale Persicaria (*Polygonum lapathifolium*), Pennycress (*Thlaspi arvensis*), Canadian Fleabane (*Conzya canadensis*), Red Deadnettle (*Lamium purpureum*), Chickweed and Speedwell making up the remainder.

Summary of Weed Results over Sites 1 & 2.

Summer 2005

The best treatments overall were Trt B, (Simazine + Butisan), Trt H (Stomp high rate + Butisan), Trt F (Artist) and Trt C (Skirmish + Butisan).

The poorest treatments on both sites were Trt L (Liberator) and Trt I (Crystal). Liberator did not give as good control of 'other grasses' particularly volunteer cereals, Redshank or several 'other annuals', but did control Mayweeds well, whereas Crystal was poorer on Mayweeds, Redshank 'other grasses' and Cleavers.

Trt J (Flexidor + Butisan) was poor at Site 2 for 'other grasses' – mainly volunteer wheat, 'other annuals' and Redshank, but performed better at Site 1 where cereals, redshank and cleavers were less prevalent, while Trt E (Ronstar + Javelin) was moderately good at Site 2 but relatively poor at Site 1 due to 'other grasses', some Annual Meadow Grass and 'other annuals'.

The following treatments gave intermediate performance overall at both sites. Trt D (Ronstar + Stomp low rate) showed some weakness against Annual Meadow Grass, 'other grasses' and Cleavers. Trt G (Stomp high rate + Centium) was weakest against Annual Meadow Grass, 'other grasses' and Mayweeds. Trt K (Calaris) was good against most weeds but showed some weaknesses against Annual Meadow Grass, 'other grasses' and Cleavers.

Autumn 2005

All herbicide treatments gave generally good weed control into the autumn following the post-budding spray. On Site 1, however, a few weeds, especially some dandelion seedlings and some grasses, were less well controlled in some of the Flexidor + Butisan and Stomp + Butisan treatments than those containing the triazine terbuthylazine – Calaris or Skirmish .

Phytotoxicity Observations

See also photographs in Appendix 2.

The most significant phytotoxic effects were caused by the Calaris treatment. Some slight scorch and yellowing, particularly on leaf tips was observed in late May about 1 month after the post-planting treatment at Site 2, Norfolk, but nothing was observed at Site 1. However following the post-budding sprays onto leafy plants in August, significant foliage yellowing was apparent within a week or so of treatment on both sites. This was first evident at the tops of the plants, with scorch and leaf distortion developing. Subsequently, premature leaf-drop occurred starting with the older leaves. It was noticeable that late-season powdery mildew and rust infection was also more severe on Calaris damaged plants. It was likely that the mesotrione component of the Calaris herbicide was responsible for the damage, as little or no damage was observed with the other product containing terbuthylazine, Trt C Skirmish.

Some much less severe and transient damage was also observed in the trial. At Site 1, Hampshire, the Javelin component of Trt E caused some transient scorching and twisting of young rootstock leaves. Trt D, which also contained Ronstar with Stomp did not cause any damage. No phytotoxicity was observed with Javelin at Site 2.

Some temporary marginal yellowing was also seen in mid May, eight weeks after applying the post-planting herbicides, on some plants in Trt G Stomp + Centium plots on Site 1 but not Site 2.

This yellowing was also apparent on some perennial thistles in these plots (before any spot treating with glyphosate was undertaken). Any affected rootstocks developed normally subsequently.

On Site 2, Norfolk, but not Site 1, Trt C Skirmish + Butisan showed some interveinal yellowing and slight marginal scorch on some plants following the post-budding summer spray. Damage was slight, however, and vigour did not appear to be affected.

Bud-take will be recorded in spring 2007 and subsequent growth and vigour of the flowering cultivars observed to help determine how far damage in the rootstock year may affect final bush quality.

Rootstocks were significantly weakened by the heavy weed infestation that developed on the untreated Trt A plots at Site 1, Hampshire prior to budding. Most plants did survive and were successfully budded, but it is likely that scion growth will be adversely affected in 2007.

DISCUSSION

As a general comment, weed control has been good to excellent overall from most of the herbicide treatments, although none were quite as effective as the 'grower's standard' Trt B (simazine + Butisan S), and weed levels on some treatments on Site 2 (Norfolk) by the summer could have developed to an economically significant level if these plots had not been cleared by hand following the late May assessment. Overall the most promising treatments for post planting weed control were Trts C (Skirmish + Butisan), F (Artist), H (Stomp + Butisan) and K (Calaris).

All treatments provided good general weed control at both sites the only weaknesses being partial control of redshank at site 1 (Trt C), partial control of cereals at site 1 (Trts H and K) and poor control of cereals and grass both sites and cleavers at site 1 (Trt K). Weed levels were very low and of little economic significance on both sites by November following the post-budding summer treatments.

Specific weaknesses of programmes

There is insufficient data yet from the project to conclusively identify specific weed spectrum weaknesses in the various herbicide treatments, but the following comments can be made about observations to date.

Trt L, Liberator, was one of the poorest herbicide treatments on both sites. It's label indicates that it should have given good control of groundsel, and most annual grasses, though it was weaker on these and some other annuals in this trial. As a cereal herbicide it is not surprising that there was poor control of volunteer wheat at site 2. The theoretically good control of Mayweeds was, however, borne out by the results. Liberator requires moist conditions both at and after application for best results. Soil conditions were dry on both sites when for the post-planting treatments, and although some rain fell within a week of application, it is possible that conditions were not optimal for this herbicide.

Trt I, Crystal. Mayweeds and Cleavers are only stated as being moderately susceptible to this herbicide, which was supported by the trial results, but the label indicates it should have controlled annual grasses better than it did in these trials. Crystal has also performed poorly in other trials (eg BOF 51) and it may be that the level of pendimethalin in the product is too low to give long-term weed control for horticultural crops.

Trt J, Flexidor + Butisan, was not good at Site 2 due partly to volunteer cereals from the previous crop and also poorer control of cleavers. This fits with the label information for both these products stating that volunteer cereals are resistant. However, Flexidor might have been expected to give better control of Redshank, as the herbicide should control polygonum weeds, in practice it is generally weaker on polygonums than Stomp. Control of cleavers would be dependant on the Butisan, which gives only moderate control At Site 1, Hampshire, in November, the Flexidor + Butisan treatments did not control Dandelion seedlings nor some grasses as well as other programmes. Butisan would be expected to give good control, but it does have a relatively short persistence of about 3 months, and control may have been weakening by the time of the assessment. Where Stomp + Butisan was used post-budding, the Stomp component would not be expected to give good control of Compositae such as dandelion.

Trts D and E, Ronstar + Stomp or Javelin, performed quite well in spring, but did let through some annual grasses including Annual Meadow Grass at Site 1, which these herbicides would normally be expected to control. Ronstar normally performs better than in this trial, but grasses and cereals are not always well controlled. The addition of low rate Stomp or Javelin was not sufficient to give good grass control, although Javelin proved an effective partner for cleavers control

Trt G, Stomp + Centium. Centium's main strengths are against cleavers, chickweed, shepherd's purse and a few other annuals, but needs to be mixed with e.g. Stomp to widen its activity. Some mayweeds and sowthistle were not so well controlled in the trial by this treatment, which fits in with Stomp's known weaknesses against Compositae, but the few Annual Meadow Grass and other annual grasses observed would normally be expected to be controlled by this herbicide mixture. The Stomp + Butisan mixture has proved more effective.

Trt K, Calaris, was generally one of the better performers in the trial and has a wide weed control spectrum in theory. It did show some weakness, however, against annual grasses (including, unexpectedly, Annual Meadow Grass), and Cleavers.

Phytotoxicity

It is too early to tell whether the minor and transient phytotoxicity symptoms observed with from Javelin in Trt E, Stomp + Centium in Trt G, and Skirmish + Butisan in Trt C are significant. Observations on the growth of the flowering cultivars following the post-heading back treatments in 2006, plus Trial 2 to be planted in spring 2006, will help determine this. Meanwhile, it is likely that the Calaris treatment will be too phytotoxic to justify repeating it in Trial 2. Also Calaris, as one of the two new triazine containing herbicides, does not appear so far to have any weed control advantages over other herbicide combinations, and so there is little to be gained from trialling it further for roses.

Herbicide Costs

Tables 10 & 11 below give examples of product prices and total herbicide costs for the range of treatment programmes used. It is important to note that these prices should only be used as an approximate guide; actual prices paid can vary significantly between suppliers and according to quantities ordered etc. Growers should substitute their own prices and calculations if more precise costings are required.

Table 10 Guideline Product prices (ex-VAT)[1]

Product	£ per pack	Pack size	£ / litre or kg
Artist	87.82	5 kg	17.56
Butisan S	121.00	5 litre	24.20
Calaris 400 SC	148.00	5 litre	29.60
Centium 360 CS	100.00	1 litre	100.00
Crystal	85.20	10 litre	8.52
Flexidor 125	53.98	1 litre	53.98
Javelin	57.50	5 litre	11.50
Liberator	180.00	3 litre	60.00
Ronstar Liquid	39.88	1 litre	39.88
Simazine	16.89	5 litre	3.38
Skirmish 495 SC	112.90	5 litre	22.58
Stomp 400 SC	67.00	10 litre	6.70

[1] Prices supplied by Bartholomews (Chichester) Ltd, except for Javelin (UAP Ltd, Alconbury, Cambs) and Skirmish (Syngenta Crop Protection UK Ltd).

Table 11 Cost of herbicides for Treatment programmes based on Table 10 prices.

	Post planting			Post budding			Post heading back			
Treatment Code	Product	Rate/ha	Cost/ha	Product	Rate/ha	Cost/ha	Product	Rate/ha	Cost/ha	Total Cost/ha
B	Simazine	3.4	£11.49	Simazine	3.4	£11.49	Simazine	3.4	£11.49	
	Butisan S	2.5	£60.50	Butisan S	2.5	£60.50	Butisan S	2.5	£60.50	
			£71.99			*£71.99*			*£71.99*	£215.96
C	Skirmish 495 SC	1	£22.58	Skirmish 495 SC	1	£22.58	Skirmish 495 SC	1	£22.58	
	Butisan S	2.5	£60.50	Butisan S	2.5	£60.50	Butisan S	2.5	£60.50	
			£83.08			*£83.08*			*£83.08*	£249.24
D	Ronstar Liquid	4	£159.52	Butisan S	2.5	£60.50	Ronstar Liquid	4	£159.52	
	Stomp 400 SC	3.3	£22.11	Flexidor 125	1	£53.98	Stomp 400 SC	3.3	£22.11	
			£181.63			*£114.48*			*£181.63*	£477.74
E	Ronstar Liquid	4	£159.52	Butisan S	2.5	£60.50	Ronstar Liquid	4	£159.52	
	Javelin	1	£11.50	Stomp 400 SC	3.3	£22.11	Javelin	1	£11.50	
			£171.02			*£82.61*			*£171.02*	£424.65
F	Artist	2.5	£43.91	Butisan S	2.5	£60.50	Artist	2.5	£43.91	
	-		£0.00	Stomp 400 SC	5	£33.50	-		£0.00	
			£43.91			*£94.00*			*£43.91*	£181.82
G	Stomp 400 SC	5	£33.50	Butisan S	2.5	£60.50	Stomp 400 SC	5	£33.50	
	Centium 360 CS	0.5	£50.00	Flexidor 125	1	£53.98	Centium 360 CS	0.5	£50.00	
			£83.50			*£114.48*			*£83.50*	£281.48
H	Stomp 400 SC	5	£33.50	Butisan S	2.5	£60.50	Stomp 400 SC	5	£33.50	
	Butisan S	2.5	£60.50	Flexidor 125	1	£53.98	Butisan S	2.5	£60.50	
			£94.00			*£114.48*			*£94.00*	£302.48
I	Crystal	4	£34.08	Butisan S	2.5	£60.50	Crystal	4	£34.08	
	-		£0.00	Flexidor 125	1	£53.98	-		£0.00	
			£34.08			*£114.48*			*£34.08*	£182.64
J	Flexidor 125	2	£107.96	Butisan S	2.5	£60.50	Flexidor 125	2	£107.96	
	Butisan S	2.5	£60.50	Stomp 400 SC	5	£33.50	Butisan S	2.5	£60.50	
			£168.46			*£94.00*			*£168.46*	£430.92
K	Calaris 400 SC	1.5	£44.40	Calaris 400 SC	1.5	£44.40	Calaris 400 SC	1.5	£44.40	
	-		£0.00	-		£0.00	-		£0.00	
			£44.40			*£44.40*			*£44.40*	£133.20
L	Liberator	0.6	£36.00	Butisan S	2.5	£60.50	Liberator	0.6	£36.00	
	-		£0.00	Stomp 400 SC	5	£33.50	-		£0.00	
			£36.00			*£94.00*			*£36.00*	£166.00

The material costs for the various programmes range from about £130 / ha to £480 / ha, ie a factor of over 3½. However, the cost of the herbicide materials is, of course, only a proportion of the full costs of applying the programmes, as is the value of the benefit of good weed control. The labour costs of any additional hand weeding or spot treating operations necessary due to the failure of any of the herbicide programmes to adequately control a particular weed problem is likely to outweigh these price differences.

Further data from the project is required, but based on the efficacy and price information to date, Trt F incorporating Artist, Butisan and Stomp, would appear to be a cost-effective non-triazine herbicide programme. Trt C including the newly approved triazine containing herbicide Skirmish, also appears to be good value.

Trial 2 Treatments

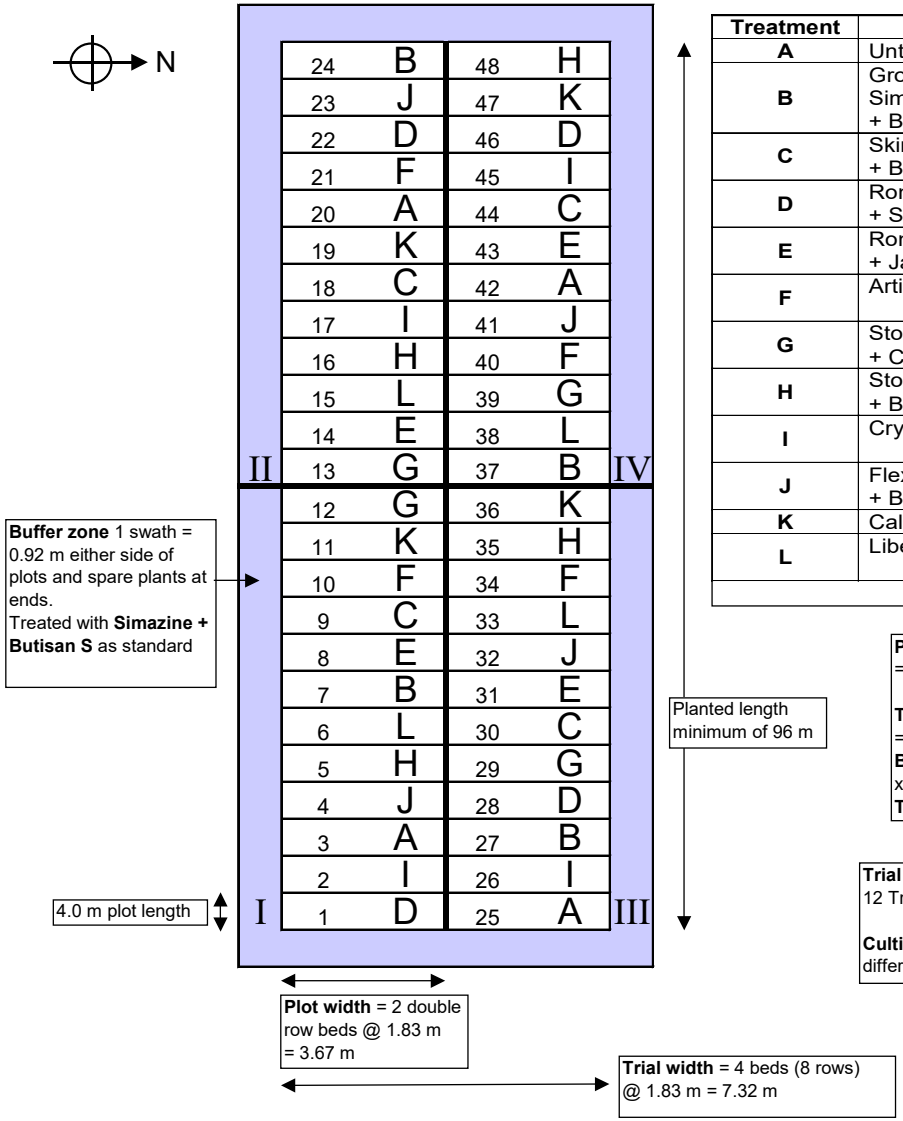
Trial 2 will be planted in Spring 2006. Since the start of the project, other promising new herbicides have been identified. Based on results to date, it is likely that Calaris, Crystal and Liberator will not be taken into Trial 2 to make way for some new alternatives.

APPENDIX 1

TRIAL PLANS

HNS 132 - Roses: Triazine-free herbicide programmes

Trial 1 - Planted Spring 2005 **Site 1 - Hampshire, c/o Pocock's Roses**



Treatment	Post Planting	Post Budding	Heading Back
A	Untreated control	Untreated control	Untreated control
B	Grower's standard: Simazine 3.4 l/ha + Butisan 2.5 l/ha	Simazine 3.4 l/ha + Butisan 2.5 l/ha	Simazine 3.4 l/ha + Butisan 2.5 l/ha
C	Skirmish 1.0 l/ha + Butisan 2.5 l/ha	Skirmish 1.0 l/ha + Butisan 2.5 l/ha	Skirmish 1.0 l/ha + Butisan 2.5 l/ha
D	Ronstar 4.0 l/ha + Stomp 3.3 l/ha	Butisan 2.5 l/ha + Flexidor 1.0 l/ha	Ronstar 4.0 l/ha + Stomp 3.3 l/ha
E	Ronstar 4.0 l/ha + Javelin 1.0 l/ha	Butisan 2.5 l/ha + Stomp 3.3 l/ha	Ronstar 4.0 l/ha + Javelin 1.0 l/ha
F	Artist 2.5 kg/ha	Butisan 2.5 l/ha + Stomp 5.0 l/ha	Artist 2.5 kg/ha
G	Stomp 5.0 l/ha + Centium 0.5 l/ha	Butisan 2.5 l/ha + Flexidor 1.0 l/ha	Stomp 5.0 l/ha + Centium 0.5 l/ha
H	Stomp 5.0 l/ha + Butisan 2.5 l/ha	Butisan 2.5 l/ha + Flexidor 1.0 l/ha	Stomp 5.0 l/ha + Butisan 2.5 l/ha
I	Crystal 4.0 l/ha	Butisan 2.5 l/ha + Flexidor 1.0 l/ha	Crystal 4.0 l/ha
J	Flexidor 2.0 l/ha + Butisan 2.5 l/ha	Butisan 2.5 l/ha + Stomp 5.0 l/ha	Flexidor 2.0 l/ha + Butisan 2.5 l/ha
K	Calaris 1.5 l/ha	Calaris 1.5 l/ha	Calaris 1.5 l/ha
L	Liberator 0.6 l/ha	Butisan 2.5 l/ha + Stomp 5.0 l/ha	Liberator 0.6 l/ha

Plot area 3.67 m x 4.0 m = 14.68 m2

Trial area = 96 m x 7.32 m = 703 m2
Buffer zone = 214 m perimeter x 0.92 m = 197 m2
Total area = **900 m2**.

Number of plants per plot:
4 rows wide x approx 27 plants long (assuming 15 cm in-row spacing) = approx 108 plants

Trial Design - Randomised block.
12 Treatments x 4 replicate blocks = 48 plots total

Cultivars budded along complete rows. Up to 4 different cvs. per plot may be used.

HNS 132 - Roses: Triazine-free herbicide programmes

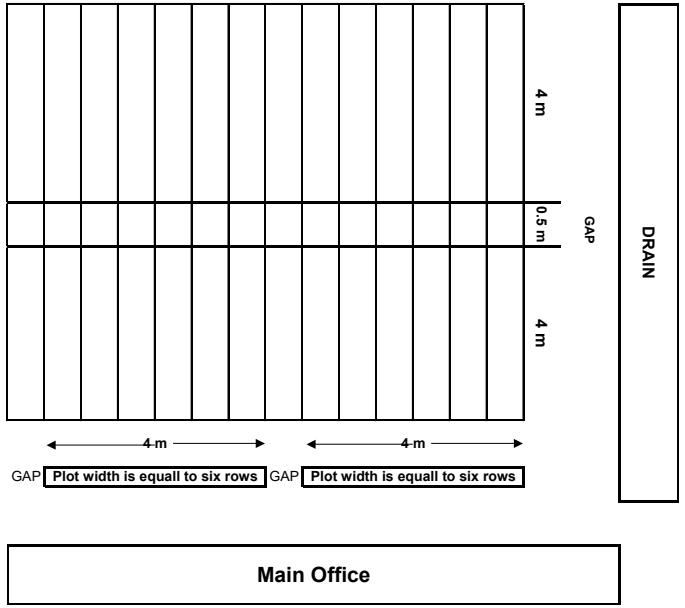
Trial 1 - Planted Spring 2005 Site 2 - Norfolk c/o Wharton's Roses

Main Office

Plot no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Block	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Treatment	L	D	H	B	G	C	F	E	I	A	J	K	I	L	E	G	C	K	H	B	A	F	D	J
Plot no.	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Block	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4
Treatment	A	I	C	F	K	G	D	E	H	J	B	L	J	G	K	A	L	B	I	C	F	D	E	H

Drain

	Treatment - Post planting	Treatment - Post budding	Treatment - Heading back
A	Untreated control	**Untreated control**	**Untreated control**
B	Simazine 3.4 l/ha + Butisan 2.5 l/ha	Simazine 3.4 l/ha + Butisan 2.5 l/ha	Simazine 3.4 l/ha + Butisan 2.5 l/ha
C	Skirmish 1 l/ha + Butisan 2.5 l/ha	Skirmish 1 l/ha + Butisan 2.5 l/ha	Skirmish 1 l/ha + Butisan 2.5 l/ha
D	Ronstar 4 l/ha + Stomp 3.3 l/ha	Butisan 2.5 l/ha + Flexidor 1 l/ha	Ronstar 4 l/ha + Stomp 3.3 l/ha
E	Ronstar 4 l/ha + Javelin 1 l/ha	Butisan 2.5 l/ha + Stomp 3.3 l/ha	Ronstar 4 l/ha + Javelin 1 l/ha
F	Artist 2.5 kg/ha	Butisan 2.5 l/ha + Stomp 5 l/ha	Artist 2.5 kg/ha
G	Stomp 5 l/ha + Centium 0.5 l/ha	Butisan 2.5 l/ha + Flexidor 1 l/ha	Stomp 5 l/ha + Centium 0.5 l/ha
H	Stomp 5 l/ha + Butisan 2.5 l/ha	Butisan 2.5 l/ha + Flexidor 1 l/ha	Stomp 5 l/ha + Butisan 2.5 l/ha
I	Crystal 4 l/ha	Butisan 2.5 l/ha + Flexidor 1 l/ha	Crystal 4 l/ha
J	Flexidor 2 l/ha + Butisan 2.5 l/ha	Butisan 2.5 l/ha + Stomp 5 l/ha	Flexidor 2 l/ha + Butisan 2.5 l/ha
K	Calaris 1.5 l/ha	Calaris 1.5 l/ha	Calaris 1.5 l/ha
L	Liberator 0.6 l/ha	Butisan 2.5 l/ha + Stomp 5 l/ha	Liberator 0.6 l/ha



APPENDIX 2

PHOTOGRAPHS

Photographs from Site 1, Hampshire – Trial 1 2005

Photo 1 Trial 17 May 2005, 8 weeks after spraying showing untreated Trt A plots.

Photo 2 Untreated plots 3 & 25 by 17 May 2005

Photo 3 Some scorch on Trt E Ronstar + Javelin treated stocks, 28 April 2005, 5 weeks after treatment.

Photo 4 Transient marginal yellowing of rootstock foliage on Trt G Stomp + Centium. 17 May 2005, 8 weeks after treatment.

Photo 5 Weed growth on Untreated plot 42 when weeds assessed 20 June 2005

Photo 6 Phytotoxicity from Trt K Calaris, 16 August 2005, 7 days after post budding herbicide treatment.

Photo 7 Close-up of damage on Trt K Calaris 16 June 2005.

Photo 8 Premature leaf fall on Trt K Calaris plot by 8 September 2005, 4½ weeks after treatment.

APPENDIX 3

RAW DATA – WEED RECORDS

Site 1, Hampshire. Original data June 2005

		Recorded 20-27/6/05 weeds per 7.5 sq m														
Plot no.	Treatment	Block	Annual Meadow Grass	Cinquefoil Creeping	Cleavers	Clover	Fat Hen	Groundsel	Mayweed	Mouse Eared Chickweed	Other grass	Redshank	Scarlet Pimpernel	Sowthistle	Spurge	
7	B	I		1										2		
24	B	II												1		
27	B	III														
37	B	IV														
9	C	I		55												
18	C	II									4					
30	C	III												4		
44	C	IV									1					
1	D	I	8		1			1			4			5		
22	D	II									1			1		
28	D	III	2				1			2	15			5		
46	D	IV	9							1	8			1		
8	E	I	1	5							4					
14	E	II	5							2	13					
31	E	III	2	48							5		1	2		
43	E	IV	2							2	22					
10	F	I		4												
21	F	II												20		
34	F	III		6						4	4					
40	F	IV								1	7					
12	G	I	6						1				2			
13	G	II	20	1							1					
29	G	III	2	3					1		1			160		
39	G	IV	7						1	1	4					
5	H	I					1				2			11		
16	H	II									2			1		
35	H	III		2							1					
48	H	IV		2												
2	I	I	2					1			4			1		
17	I	II					7	1		1	4			5		
26	I	III	3				4	1			10			2		
45	I	IV						1		1	3					
4	J	I		1							1			2		
23	J	II	2	1												
32	J	III		3												
41	J	IV					1							1		
11	K	I	3	13							6					
19	K	II	2							2	6		1			
36	K	III	1								3					
47	K	IV	18	9						2	16		3	2		
6	L	I				1	26	6		4	2	1	3	7	12	
15	L	II					3	4		1	5		1	2		
33	L	III	2	55							10			3		
38	L	IV	1				2			1	8				1	

Site 1, Hampshire. Original data November 2005

			Recorded 23/11/05 weeds per 7.5 sq m												Perennials					
Plot no.	Treatment		Annual Meadow Grass	Cranesbill	Dandelion	Groundsel	Mouse Eared Chickweed	Other grass	Pansy	Persicaria	Shepherd's purse	Sowthistle	Speedwell	Willowherb	Buttercup	Bramble	Cinquefoil	Clover	Dock	Thistle
7	B	I	4												1		7			
24	B	II															7			1
27	B	III																		
37	B	IV			1															
9	C	I															40			
18	C	II			1											1				
30	C	III				2														
44	C	IV																		
1	D	I	5		10	2					1				2				1	2
22	D	II			4	3											1			4
28	D	III	2		13			2												
46	D	IV	3	1	3	1														2
8	E	I			5			4							1		10			2
14	E	II	5		7	1		7							1					
31	E	III															40			
43	E	IV						7												
10	F	I			1												20			
21	F	II			1	10	1													1
34	F	III			1												24			
40	F	IV			7			1							3		3			
12	G	I	1					1				1								
13	G	II						1									4			
29	G	III			2				1						1		5			
39	G	IV						2						1			2			
5	H	I			7			1												2
16	H	II			7										5	2				
35	H	III	2		4												4			
48	H	IV			2												5			5
2	I	I	2		29						3				24		2			6
17	I	II			3				2	4					1	1				
26	I	III			15	4		4				8	1		1	1				
45	I	IV			4	1		1								1				
4	J	I			4								27				16			
23	J	II			1										1		5			2
32	J	III			4												15			1
41	J	IV			1			1								2	4			
11	K	I						1									24			
19	K	II				1		2												
36	K	III						1												
47	K	IV						4									11			
6	L	I			8	1											6		1	2
15	L	II			3	1		1										1		
33	L	III			3	2		1									32			
38	L	IV			10			1												

Site 1, Hampshire. Original data November 2005 – Untreated plots

			Untreated Trt A Plots														Perennials			
			Annual Meadow Grass	Common Chickweed	Dandelion	Groundsel	Knapweed	Mayweed	Mouse Eared Chickweed	Other grass	Pansy	Scarlet pimp	Shepherd's purse	Sowthist.	Speedwell	Willowherb	Buttercup	Clover	Dock	
3a	**A**	**I**	34	1	29	1			4					24	3				1	
3b	**A**	**I**	55	1	38	1		1	1	1			4	10	8		2			
20a	**A**	**II**	37		4	4			3	1				1	23	1				
20b	**A**	**II**	200		1	1						1		2	170					
25a	**A**	**III**	58	34	7				1		1			3	11	2				
25b	**A**	**III**	66	7	18			1	1					9	20	4				
42a	**A**	**IV**	60	2	7	1	2	2		1	2			4	32	5	2			
42b	**A**	**IV**	70		4	1			9	4				1	5	13	2	4		

Site 2, Norfolk. Original data May 2005

		Recorded 27/5/05 weeds per 0.16 sq m														
Plot No	TRT	Block	Annual Meadow Grass	Black Bindweed	Chickweed	Cleavers	Cress	Fat Hen	Knotgrass	Mayweed	Other grass/cereal	Pansy	Red Deadnettle	Redshank	Speedwell	Swinecress
10	A	I		2	2	4	4	1		3	5			2	3	
21	A	II				5	2	1	1	11	2	43		3		
25	A	III	4	1			1	2		4				5		3
40	A	IV								1	1			26		
4	B	I														
20	B	II				3						7				
35	B	III														
42	B	IV														
6	C	I														
17	C	II									2	1				
27	C	III												4		
44	C	IV												1		
2	D	I				2				1	1					
23	D	II				1					3					
31	D	III														
46	D	IV				2					2					
8	E	I					2							1		
15	E	II		2	3	1					2					
32	E	III							1		1					
47	E	IV														
7	F	I		1		2				1						
22	F	II				1										
28	F	III	1							1						
45	F	IV														
5	G	I					1			2						
16	G	II				1				5	3					
30	G	III								2						
38	G	IV									1					
3	H	I														
19	H	II				1				1	4					
33	H	III							1		1					
48	H	IV														
9	I	I	1			2					1			1		
13	I	II				1				5	1					
26	I	III					1			2				7		
43	I	IV				1				1						
11	J	I		1		1					4			2		
24	J	II				3					3			3	1	
34	J	III							3		2					1
37	J	IV												1		
12	K	I				3					2					
18	K	II				3					1					
29	K	III								1						
39	K	IV									1					
1	L	I									1			4		
14	L	II		2		1		6			2					
36	L	III							1		2					
41	L	IV						1						5		

Site 2 – Norfolk. Original data November 2005

			Recorded 14/11/05 weeds per 10.8 sqM												
Plot No	TRT	Block	Annual Meadow Grass	Chickweed	Cleavers	Fleabane	Groundsel	Mayweed	Pale Persicaria	Pansy	Pennycress	Red deadnettle	Sowthistle	Speedwell	Willowherb
10	A	I	15			1	2	12		2				17	28
21	A	II		1	2	1	6	21		6			3	2	20
25	A	III		1		2	25	17	28	3	1	2	27	2	13
40	A	IV	5		6		8	5		2			7	3	27
4	B	I													
20	B	II								6					
35	B	III								1					
42	B	IV													
6	C	I													
17	C	II													
27	C	III													
44	C	IV													
2	D	I					1								
23	D	II													
31	D	III					1								
46	D	IV													
8	E	I													
15	E	II													
32	E	III					1								
47	E	IV						1							
7	F	I					2								
22	F	II													
28	F	III													
45	F	IV													
5	G	I													
16	G	II													
30	G	III													
38	G	IV													
3	H	I											1		
19	H	II			2										
33	H	III					2								
48	H	IV													
9	I	I													
13	I	II			2										
26	I	III													
43	I	IV					1			1					
11	J	I													
24	J	II													
34	J	III													
37	J	IV													
12	K	I			20		1			2					
18	K	II			16										
29	K	III													
39	K	IV								1					
1	L	I													
14	L	II			2										
36	L	III					4								
41	L	IV					1								