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CONTRACT REPORT

HERBICIDES FOR BUSH ROSES

Undertaken for
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Project HNS 6a (Part)
1990-1992

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

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HDC HNS 6a (Part)

HERBICIDES FOR BUSH ROSES

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A herbicide programme based on Gardoprim A (atrazine + terbuthylazine) + Butisan S (metazachlor) for all three applications, gave outstanding weed control. Unfortunately, following its withdrawal in late 1991, Gardoprim A is no longer available to UK growers. Further trials with other products containing one of the active ingredients, terbuthylazine, could be worthwhile.

The two 'standard' treatments both performed reasonably well. These were either simazine + Butisan S applied on all three occasions, or a substitution of Ronstar (oxadiazon) for Butisan S for the two spring doses. These programmes will probably remain the best options for growers while triazine herbicides are available and provided there are no known problems with triazine resistant weed populations on the nursery.

A programme using Ronstar + Javelin (diflufenican + isoproturon) for the early spring sprays plus simazine + Butisan S post budding, looked very promising. In Trial 2, it would have been better than the standard regimes but for some *Senecio* and *Stellaria* which was concentrated mainly in a single plot. Also, while Javelin appeared safe on Efford's soil at 1.0 litres/ha, it had caused transient phytotoxicity symptoms in other trials at Luddington and Pershore and should therefore be trialled by individual growers on a small scale first, with particular caution on light soils. Programmes incorporating Javelin, a non-triazine herbicide mixture, may be an option for further grower trials in the future if the triazines simazine or atrazine are withdrawn or weeds resistant to them are a particular problem.

In Trial 2, the two completely triazine free programmes were weakest overall for weed control. *Senecio* was the main weed which was poorly controlled, but smaller numbers of *Capsella*, Mayweeds and other species appeared during the trial. Both programmes used Stomp (pendimethalin) for the two spring applications mixed with either Butisan S (metazachlor) or Devrinol (napropamide). Both programmes used Butisan S for the post budding dose in summer. In Trial 1, it was mainly Mayweeds that the Stomp + Devrinol did not control very well. This trial showed evidence that Devrinol had broken down prematurely following the second mid March application in particular, and this had left gaps in the spectrum of weed control which was not adequately covered by Stomp. Also, that the Butisan S could perform poorly from summer applications, even irrigation followed application, compared to when mixed with simazine.

Another programme which used a triazine free mixture of Butisan S (half rate) + Flexidor (isoxaben) + Kerb (propyzamide) for the two spring applications with a simazine + Butisan S post budding dose, was better than the completely triazine free programmes above, but poorer than the remaining treatments overall. Some *Senecio* germinated through the spring treatments, and also *Stellaria* in the first year but not the second. This treatment would not be a good choice where *Senecio* is known to be a problem as Flexidor and Kerb have known weaknesses against this weed and together with the lower dose of Butisan S, poorer control could be expected.

The herbicide options for effective and safe post-budding summer applications are more limited than for dormant season sprays, and again Butisan S alone was not as effective as when mixed with simazine in this trial. Although not included in this trial, the addition of Dacthal W-75 as a tank mix with Butisan S should improve the weed control spectrum over Butisan S alone, and could be considered as an alternative to simazine. Dacthal W-75 (but not the tank mix with Butisan S) has label approval for use on roses.

The relatively good control of *Senecio* following applications of triazine herbicides indicates that, unlike on many growers' holdings, resistant populations of this weed were not present in this trial.

Action Points

- Triazines, (eg simazine and atrazine), should continue to give good control when used in conjunction with other standard herbicides such as Butisan S and Ronstar for many nurseries, unless resistant weed populations are present.

- Although many of the triazine free herbicides showed no significant improvements over the other products in these trials, they could offer a useful substitution to the armoury for weed control should any of the standard products (including triazines) be withdrawn. Also, where populations of triazine resistant weed species or strains exist, they represent a sensible choice for their control.

- The trial has highlighted the importance of adequate irrigation or rainfall following both spring and summer applications for optimising the performance of most residual herbicides. Also applications of Devrinol, which is so susceptible to degradation by sunlight, should ideally be completed before March if it is to be effective.

- For the post-budding summer application of residual herbicide, if a triazine such as simazine or atrazine is not included with Butisan S, then the addition of Dacthal W-75 to Butisan S is suggested to improve control, even though Dacthal itself will not control *Senecio*.

INTRODUCTION

Simazine and/or atrazine have for a long time been the basis of herbicide programmes used on field roses. Rosaceae, and particularly *Rosa* spp. are known to be relatively tolerant to high doses of triazine herbicides making them an inexpensive option for weed control programmes. However, there are a number of triazine resistant weed species now present on many holdings, particularly groundsel and knotgrass. This, combined with the increasing environmental concerns about triazine products, herbicides in general, and the withdrawal of products from the marketplace, created the pressure to seek a wider range of products for use on roses, including triazine free herbicides.

Three applications of residual herbicides are typically made by growers during the two year crop cycle for bush roses;

- firstly after planting the rootstock,
- secondly a top up herbicide after budding that summer, particularly as this operation disturbs the soil,
- finally a spring application the following year after heading back the stocks.

Simazine plus metazachlor (Butisan S) applied on all three occasions has been a popular standard programme with growers. Simazine plus oxadiazon (Ronstar liquid), applied over dormant plants as the first and third applications, is also a label recommended treatment. Because Ronstar has some contact action, it can not be used post budding as rootstock shoot growth could be damaged. Thus for the second application in summer, the residual herbicide options are more limited to triazines such as simazine with the possible addition of Butisan S which also has some contact action on small weeds but is relatively safe to the crop.

The objectives of the work carried out over two years were to assess the efficacy of a range of herbicide programmes for bush roses, including some which relied largely or entirely on triazine free ingredients, and to check crop safety in terms of both obvious damage symptoms and more subtle effects such as possible poorer shoot numbers and grade-out. This work completed that started under HNS 6 at Luddington EHS.

MATERIALS AND METHODS

Site

Both experiments were grown on a sandy silt loam of the Efford soil series in Field S11 (North and central). Soil analysis results from samples taken prior to each trial were as follows:

	Trial 1 - sampled early Jan 1990		**Trial 2 - sampled early Mar 1991**	
pH	7.3		7.5	
P	51 mg/litre	(ADAS Index 4)	90 mg/litre	(Index 5)
K	250 mg/litre	(ADAS Index 3)	744 mg/litre	(Index 5)
Mg	74 mg/litre	(ADAS Index 2)	119 mg/litre	(Index 3)

A stable manure dressing of 75 tonnes/ha, but no additional fertilisers as a base dressing, was applied to the site before planting Trial 1. No additional organic matter or base dressing fertilisers was applied pre-planting for Trial 2 other than 50 kg/ha N as ammonium nitrate.

Treatments

At Efford, a separate rose crop for each of two trials was planted in 1990 and 1991 respectively, each of two years duration. Each trial included eight herbicide programmes on three cultivars, although with the transition period between the closure of the Luddington EHS site, and the re-establishment of the HDC rose programme at Efford, the treatments for Trial 1 started with the second post budding herbicide application.

Trial 1 (1990 - 1991)

	Post planting 22/3/90	Post budding 22/8/90	Post heading back 26/3/91
A.	Simazine + Butisan S applied overall	Control	Control
B.		Simazine + Butisan S	Simazine + Butisan S
C.		Simazine + Butisan S	Ronstar + Javelin
D.		Simazine + Butisan S	Simazine + Ronstar
E.		Gardoprim A + Butisan S	Gardoprim A + Butisan S
F.		Gardoprim A + Butisan S	Simazine + Butisan S
G.		Simazine + Butisan S	Butisan S + Flexidor + Kerb
H.		Butisan S alone	Stomp 330 + Devrinol

Trial 2 (1991 - 1992)

	Post planting 22/04/91	Post budding 04/09/91	Post heading back 11/03/92
A.	Control	Control	
B.	Simazine + Butisan S	Simazine + Butisan S	Repeat of
C.	Ronstar + Javelin	Simazine + Butisan S	post planting
D.	Simazine + Ronstar	Simazine + Butisan S	treatments
E.	Gardoprim A + Butisan S	Gardoprim A + Butisan S	as spring 1991
F.	Stomp 330 + Butisan S	Butisan S alone	
G.	Butisan S + Flexidor + Kerb	Simazine + Butisan S	
H.	Stomp 330 + Devrinol	Butisan S alone	

Apart from the general overall herbicide treatment post planting in Trial 1, the treatments for each trial were very similar. The exception was that treatment F in Trial 1 compared the substitution of simazine for Gardoprim A for the final post heading back application, and this was changed to a totally triazine free programme relying on Stomp and Butisan S for Trial 2.

Herbicide formulations and rates used

Product name	Active ingredient(s) and concentration in product	Rate of product used
Gesatop 500FW	simazine (500 g/litre)	3.4 litres/ha
Butisan S	metazachlor (500 g/litre)	2.5 litres/ha (1.25 litres/ha with Flexidor + Kerb)
Ronstar Liquid	oxadiazon (250 g/litre)	4.0 litres/ha
Javelin	diflufenican + isoproturon (62.5 : 500 g/litre)	1.0 litre/ha
Flexidor[1]	isoxaben (500 g/litre)	0.25 litres/ha
Kerb 50W	propyzamide (50% w/w)	1.7 kg/ha
Stomp 330[2]	pendimethalin (330 g/litre)	5.0 litres/ha
Devrinol	napropamide (450 g/litre)	9.0 litres/ha

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[1] Since these trials, the product Flexidor has been replaced with a formulation containing a lower concentration of active ingredient, namely Flexidor 125 with 125 g / litre isoxaben.

[2] This product is no longer marketed as Stomp 330 but as Sovereign 330 EC (manufactured by Cyanamid of Great Britain Ltd and distributed by Ciba-Geigy Agrochemicals)

Flowering cultivars

In both trials, the *Rosa* Laxa rootstocks were budded with three cultivars:

Royal William	Deep Crimson	Hybrid Tea
Silver Jubilee	Pink	Hybrid Tea
Amber Queen	Amber	Floribunda

with

Alec's Red	Crimson	Hybrid Tea

substituted for Royal William in Trial 2.

Design and layout

See Appendix I, p. 24 for details of the field plans and layout. The herbicide treatments were laid out in three randomised block arrangements of four replicates, one for each cultivar. There was thus no true replication for cultivars with each therefore comprising a separate sub-trial for some of the statistical analyses, but this arrangement was a practical necessity for the management of budding.

With four replicates of eight herbicide treatments for three cultivars, each trial comprised 96 plots in total. Plants were spaced 0.2 m apart in-row in wide double rows 0.8 m apart at 1.83 m wheelings giving a plant density of 54,645 plants/ha (22,114 plants/acre). Plots of four rows wide x 12 plants long (48 total) received the treatments with the central two rows of 10 plants (20 total) used for final quality grading. Two plant gaps in the row between plots was left for Trial 2 as an extra guard area. The trials were also well guarded around the outside with additional side rows and guard plants at row ends.

Culture

Appendix II, p. 26 details the timings for the key operations for each trial.

Application of herbicides

The general application of simazine + Butisan S after planting Trial 1 was carried out with a tractor mounted Allman Unibilt field sprayer with boom mounted 110° flat fan nozzles at 0.45 m spacings in a volume of 500 litres/ha.

All herbicide treatments for both trials were applied with an Oxford Precision Sprayer using compressed CO_2 propellant at 2.2 Bar pressure. A boom with three Lurmark Orange 02-F80 flat fan nozzles 0.30 m apart set at an above ground height of 0.36 m was used. Measurements of walking speeds and pace lengths were used to calibrate applications. A constant walking speed was maintained with the help of an electronic metronome bleeper during spraying to give application volumes of 500 litres/ha. Each pass of the sprayer treated one alley, thus requiring four passes to complete the plot area.

Records

The following records were taken:

1. The budtake of scions on the rootstocks, and the proportion of buds that had 'shot', ie. those that had grown prematurely following budding rather than remained dormant until the following spring.

2. Weed counts/score by species. Because weed distribution varied somewhat over the plot, tending to be less frequent in the more compacted alleys than rows, as large an area as possible was assessed per plot for the sprayed treatments (8 m^2) which included both the row and alley areas. For some records, where weeds were relatively much more numerous in the unsprayed control plots, a smaller central 2 m^2 area was recorded covering both rows and alleys, and counts multiplied up to give an equivalent assessed area as the sprayed treatments before analysis. Some weeds were difficult to identify to species level at the seedling stage and so were typically grouped according to genus such as *Chenopodium* spp. (eg. Fat Hen) or closely related species covering more than one genus such as Mayweeds.

   For Trial 1, an initial weed assessment was carried out in February 1991, after heading back rootstocks, on the control plots only as the herbicide treated plots were clear at this stage. This was followed by single further weed assessment in mid May when scion cultivar growth was beginning to develop.

   For Trial 2, weed counts were taken in mid June 1991, early November 1991, mid May 1992, and a final weed assessment in late July 1992 based on a 1 - 5 score for % area covered.

After each assessment, weeds, once counted, were removed by hand where possible, or light hoeing where weeds were particularly dense. Hoeing was kept to a minimum however, to avoid affecting the layer of residual herbicides on treated plots, and also to minimise the stimulation of further weed germination through bringing new weed seeds to the surface. Because it was impossible to use contact herbicides to kill counted weeds in the cropping situation, some soil disturbance was unavoidable to remove recorded weeds.

3. A count of plant losses due to 'blow-out' of bud unions was made in early June 1991 on Trial 1 following heavy winds.

4. Final records of plant quality prior to lifting. Basal shoots were counted and divided into the number of 'thick' shoots (> 10 mm diameter) and 'thin' shoots (6-10 mm dia.). Shoots less than 6 mm dia. were ignored. Each plant was also given an overall plant grade from Grade 1 (best quality) to Grade 3 (waste) depending on the number and quality of basal shoots present.

In addition to these quantifiable records, observations were made of any scorching or foliage discoloration that might be related phytotoxicity symptoms following herbicide applications.

Analysis of results

Percentage budtake, shot buds, and percent grade-out data were angle transformed before subjection to an analysis of variance (ANOVA). The numbers of 'thin', 'thick' and sum of thin and thick shoots, and the final weed score data for Trial 2, were also analysed by ANOVA.

Because of the sporadic distribution of weeds and consequently the wide spread of counts between and within treatments, weed count results were analysed on log transformed data.

For Trial 2, the plant to plant variability of shoot numbers and quality grades between treatments was investigated by analysing the square root of the treatment variances, since it was of interest to see whether treatments had affected uniformity of cropping.

RESULTS AND DISCUSSION

Budtake and shot buds

Table 1. Mean budtake and shot bud as a proportion of a nominal 20 plants / plot

	Trial 1		Trial 2	
Cultivar	**% taken**	**% shot**	**% taken**	**% shot**
Amber Queen	90.3	45.0	90.9	17.3
Silver Jubilee	95.8	34.1	96.3	5.2
Royal William	95.9	39.5	-	-
Alec's Red	-	-	93.8	1.9

Budtake was recorded 26/4/91 and 8/4/92 for Trials 1 and 2 respectively once new bud growth had begun to develop. Budtake was good for both trials, but in both years Amber Queen showed a slightly lower take than the other two cultivars.

Shot bud was recorded 1/2/91 and 19/2/92 for Trials 1 and 2 respectively shortly after the rootstocks had been headed back, making it easier to see the bud unions. The amount of 'shot bud' appeared unusually high for Trial 1. This record for Trial 1 included those plants with buds which had burst that spring in addition to those which had produced a shoot the previous year. Either way, Amber Queen appears more susceptible to shot bud than the other cultivars. Shot bud is not a significant problem for the grower provided shoots are pruned hard back to about 5 mm before spring growth gets underway in order to encourage strong new basal shoots to develop. This operation is typically done at the same time as heading back the rootstocks.

There were no significant effects of herbicide treatments on budtake or shot bud in either trial.

Weed counts

Trial 1

The site for Trial 1, which had received an overall spray of simazine + Butisan S after planting, remained very clean over the first year. Some large clumps of *Sonchus arvensis* (Perennial Sowthistle) developed in the north west corner of the area during July and August 1990, and were removed by hand prior to application of the post budding herbicide treatments. Regrowth from these patches needed further spot treatment with glyphosate through a weed wiper in November 1990. However, little other weed occurred in the trial until the second year when, to begin with, it was restricted to the untreated control plots.

The initial weed count in February 1991 recorded moderately high numbers of *Senecio vulgaris* (Groundsel), *Capsella bursa-pastoris* (Shepherd's Purse), and *Stellaria media* (Chickweed). In addition low numbers of Mayweed were recorded. No *Polygonum* spp. (e.g. Knotgrass), *Chenopodium* spp. (e.g. Fat Hen), or *Poa* spp. (Annual grasses) were seen at this stage.

Table 2. **Trial 1 - Initial weed count on control plots in February 1991**
(Figures represent weeds for an area of 96m², based on adjusting counts for 2m² recorded)

Polygonum	*Senecio*	*Chenopod'*	Mayweeds	*Poa*	*Sonchus*	*Capsella*	*Stellaria*
0	488	0	36	0	4	204	276

A large number of *Rumex* spp. (Sorrel) and some *Coronopus didymus* (Swine Cress) seedlings were also present over the control plots on the site (equivalent to 372 and 96 of each species for the total treatment area). However these species did not reoccur in significant numbers in the later assessment in May (Table 3).

Table 3. **Trial 1 - Weed count on control plots in May 1991.**
(Figures represent weeds for an area of 96m², based on adjusting counts for 2m² recorded)

Polygonum	*Senecio*	*Chenopod'*	Mayweeds	*Poa*	*Sonchus*	*Capsella*	*Stellaria*
3136	288	2960	672	88	32	160	76

Polygonum, *Chenopodium* and Mayweeds all show low winter germination, and large numbers of these had developed on the control plots by the early summer compared to the earlier assessment in February. Again, all the herbicide treated plots remained remarkably clean with the exception of small numbers of Mayweed which were present at this time on five of the twelve plots of treatment H, i.e. that which had received Butisan S alone post budding in 1990, and Stomp + Devrinol in March 1991. Apart from treatment E (Gardoprim A + Butisan S), each of the remaining herbicide treatments had a single plot with moderate to large numbers of *Sonchus* present. These were all clustered in the area of original patch of *Sonchus* that had been present the previous summer, and had regrown. As this was probably *S. arvensis*, (Perennial Sow-thistle), the residual herbicide treatments would not have been expected to give much control.

The presence of a significant amount of weed in the control plots in February and May 1991 indicated that the original overall herbicide application to the site in March 1990 had ceased to be effective. The virtual absence of weed on the herbicide treatments indicated that they had all worked quite effectively in this trial on most of the species listed in Table 3. The exception was an indication that treatment H showed poorer control of Mayweeds. Stomp is known to be a weak herbicide against Mayweeds, but Devrinol would have been expected to control this weed adequately. The late March application of Devrinol may therefore have been subject to photodegradation before it was adequately washed into the soil. Because the Perennial Sow-thistle was concentrated in a small area of the site, it is not possible to reliably assess the efficacy of the individual herbicide treatments against it, but generally control of this weed was poor.

Trial 2

Table 4, p. 16, details the total numbers of weeds found in each treatment over the three weed count assessments. Table 5, p. 17, shows the statistically analysed transformed data for the total weed numbers (June 1991 - May 1992) for each of the most important weed species found in the trial together with that for the total across all species found.

Statistical analyses were only carried out on the sum total of weeds found on the three assessment dates. The untreated control treatment had significantly more weeds present than any of the herbicide treatments ($P<0.001$). This was the case with the counts for the total of all weed species, and with the individual analyses for the five most important weed species. Differences in weed numbers were very much smaller between herbicide programme treatments, than between the untreated control and the herbicide treatments generally. However, there were some differences of statistical and practical significance. In Table 5, p. 17, the analysis ignored the zero weed count data from treatment E, and also for those treatments for the *Capsella* and *Chenopodium* analysis where there were no weeds recorded.

Treatment E, which used Gardoprim A + Butisan S for all three applications, gave outstanding weed control throughout the trial, and no weed was recorded on any of the plots of this treatment. The Gardoprim A in this mixture had label recommendations for rates up to 15 litres/ha for use in forestry. Even though this product was used at one third of the highest recommended forestry rate, the total amount of triazines applied was still higher than that from the typical rates of simazine (or atrazine alone) products where 3.4 litres/ha is recommended for medium or heavy soils. This, together with the potency of the terbuthylazine component of Gardoprim A, probably accounted for its success. Unfortunately Gardoprim A was withdrawn from the UK market by Ciba Geigy late in 1991 and is therefore no longer available to growers.

There are no other products of similar formulation to Gardoprim A that would make a satisfactory direct substitute, but since the withdrawal of the product, two others containing terbuthylazine have been introduced for agricultural applications and would be worth considering in any future trials. These are Skirmish 495 SC (isoxaben 75 g/litre + terbuthylazine 420 g/litre) and Angle 567 SC (cyanazine 306 g/litre + terbuthylazine 261 g/litre), both marketed by Ciba Agriculture.

For the total of all weed species, treatments F and H, i.e. those that included Stomp 330 for the spring applications, had significantly more weed than treatments B and D, i.e. those based on simazine with the addition of Butisan S or Ronstar. The weeds found in treatment C were concentrated in plot 89, a single plot of the twelve replicates in the NW corner of the trial. This may have been a localised problem caused by damage to the herbicide layer from hoeing, an area of particularly high weed seed pressure etc. for that plot rather than evidence of a genuine failure of control by the treatment. Therefore the overall control from treatment C can be regarded as somewhat better than indicated by the data. Treatment G, Butisan S + Flexidor + Kerb applied in spring, showed an intermediate level of overall control, i.e. better than F and H, but not as good as B, C or D.

Most of the weaknesses in treatments F and H were in controlling *Senecio*, and to a lesser extent *Capsella*. Examination of Table 4, p. 16, shows that for *Senecio*, treatments F and H failed to control this weed after the post budding treatment when Butisan S alone was applied in early September. Normally this herbicide would be expected to give good control of *Senecio*, but may have failed to perform so well in the relatively dry summer conditions of the post budding application, even though irrigation was applied after treatments. Treatment H was also letting through large numbers of *Senecio* in spring 1992 following the Stomp + Devrinol application. Stomp's major weakness is against *Senecio* which is known to be resistant to it. The fact that the Devrinol did not control it in spring suggests that some photodegradation may have occurred following the mid March application as appears to have happened in Trial 1. At this time soil conditions were quite moist and there had been some rainfall in mid February and early March before herbicides were applied. However following application on 11 March there were only small amounts of rainfall totalling 12 mm until a further 13 mm of rain on 29 March. No additional irrigation was applied. There may have been insufficient rain in this period from mid to late March to wash the Devrinol into the soil well enough to protect it from photodegradation to which this herbicide can be prone.

Treatment G, included partly to achieve good control of annual grasses from the Kerb constituent, failed to give very good control of *Senecio* following the two spring applications. In this herbicide combination, Flexidor is known to be weaker against this weed than against others, and it is well known it is resistant to Kerb. The half rate of Butisan S used could also have been sub-optimal.

It is noteworthy that those treatments containing triazines gave good control of *Senecio* in this trial indicating that this population was triazine susceptible, unlike that found on many growers' holdings where resistance problems are now commonplace. This is clearly shown in the November 1991 *Senecio* count in Table 4 where the two triazine free treatments F and H showed considerably poorer control compared to those treatments, including G, where simazine or Gardoprim A had been included in the post budding spray.

The herbicide options for the post budding spray are more limited than those for the dormant season applications of residual herbicides, where products with potentially phytotoxic contact action such as Ronstar, or chemicals subject to sunlight degradation such as Devrinol, can be used. Although not included in this trial, the addition of Dacthal W-75 to Butisan S for use post-budding would extend the weed control spectrum at this time, and could be worth considering as an alternative to simazine. However like Butisan S, it requires plenty of soil moisture to activate it, and Dacthal would not be expected to improve control of *Senecio*.

With *Stellaria*, differences in control between herbicide treatments were not statistically significant (see Table 5, p. 17). The poor control shown in treatment C in June 1991 was restricted to a single plot, as previously described, and is therefore probably not significant. The control from treatment G from the first application was generally good apart from four of the 12 plots which contained some *Stellaria*. This is not easily explained as the herbicides applied would have been expected to have performed well against this weed.

Control of *Capsella* was weakest with treatment H which received Butisan S alone post budding and Stomp + Devrinol post planting and post heading back ($P<0.001$). Control was good following the first application, but poorer following the second two sprays. The post budding spray of Butisan S alone let through some *Capsella* as well as *Senecio* on treatment F as well as treatment H, which suggested that the herbicide may not have been activated sufficiently, as in theory it ought to have controlled these weeds better. Likewise, the poorer control in spring 1992 from treatment H may be a reflection of the drier conditions following application. The other herbicides appear to have been less affected by the conditions at that time.

For Mayweed and *Chenopodium*, distribution across treatments was erratic and no significant differences were found. Mayweeds are known to be resistant to Kerb, but susceptible to other herbicides used in the treatment G mixture. Control of Mayweeds can be poor with Stomp following spring applications, and if the Devrinol also applied in treatment H was degraded, it may account for some Mayweeds being found in spring 1992. *Chenopodium* is only classified as 'moderately susceptible' to Butisan S, but clearly was not a problem with any of the herbicide programmes in this trial.

No statistical analyses were done on the *Poa, Polygonum* or *Taraxacum* (Dandelion) counts, as numbers found were all very low in the herbicide plots. The slight weakness known to exist with Stomp against weeds in the *Compositae* family may account for the small numbers of *Taraxacum* seedlings which developed in treatment H. None of the herbicides showed any significant weaknesses against the mainly spring germinating *Polygonum* spp. (e.g. Knotgrass), which are important weeds. Apart from the initial assessment in June 1991 when all the herbicides gave good control, even untreated plots had very low numbers recorded. However it should be recognised that resistance to triazines (in particular simazine) is common with *Polygonum*, and neither will Devrinol nor Butisan S control them well.

Final weed assessment, Trial 2

See Table 6, p. 18. Control of *Senecio* continued to be weakest in treatment H, followed by treatment F. There were no significant differences between other herbicides.

Treatment D which had received simazine + Ronstar in spring, showed particularly poor control of *Stellaria* by July with most plots showing an appreciably amount of this weed, even though the herbicide had given good control up until the first assessment in mid May. *Stellaria* is well known to be resistant to Ronstar, but it was surprising that the simazine was failing to control it quite so early in the season. Although smaller numbers of *Stellaria* were found in the other herbicide treatments, there was an indication that treatments B, C and G were showing poorer control than treatments F and H, although this was not statistically significant.

Quantities of the other weed species in Table 6 were low and did not warrant statistical analysis, although generally mean scores for the control plots were higher than those for the herbicide treatments. Also, mean scores for treatment H were higher than the other treatments for *Capsella, Taraxacum, Sonchus* and *Solanum*, although this could not be verified statistically.

If weed control has been good following the standard three applications of residual herbicides, no further measures are normally required before the crop is lifted. A small amount of weed present at lifting is usually acceptable, particularly as it is unlikely to have any detrimental effects on rose growth towards the end of the crop. Another application of herbicide in the second summer may be warranted, however, if previous weed control has been poor for any reason, or if it is desired to keep the crop very clean up until lifting. The presence of excessive weed may be detrimental to the nursery's image if crops are being viewed by the public or other potential customers. Applications of herbicide can be awkward in summer when there is a lot of top growth present, and drop arms on the sprayer boom or careful application with a hand lance may be required. There is also limited scope for killing existing weed with contact herbicides unless spot treating patches with a weedwiper containing glyphosate for example. If previous weed control has been poor at this time, often the only viable option is hand weeding and hoeing followed by a spray of residuals using a wide angle nozzle which can be run in between rows below the arching top growth, to give adequate soil coverage.

Table 4: **Trial 2 - Total numbers of weeds per 96 m² treatment area (12 reps. x 8 m²)**

Treatment	20/06/91	04/11/91	19/05/92	Total	20/06/91	04/11/91	19/05/92	Total
		Senecio				*Stellaria*		
A. Control	2912	1328	254	**4494**	3156	1860	252	**5268**
B.	0	0	16	**16**	0	0	10	**10**
C.*	20	0	0	**20**	95	0	0	**95**
D.	0	3	12	**15**	2	0	4	**6**
E.	0	0	0	**0**	0	0	0	**0**
F.	0	199	19	**218**	0	6	0	**6**
G.	35	1	21	**57**	37	1	0	**38**
H.	14	352	119	**485**	1	9	0	**10**
		Capsella				Mayweeds		
A. Control	208	756	160	**1124**	492	64	49	**605**
B.	0	0	5	**5**	0	0	3	**3**
C.	0	0	0	**0**	0	1	0	**1**
D.	0	0	5	**5**	0	0	1	**1**
E.	0	0	0	**0**	0	0	0	**0**
F.	0	20	2	**22**	0	6	0	**6**
G.	0	0	0	**0**	5	0	4	**9**
H.	1	33	64	**98**	1	2	12	**15**
		Chenopodium				Annual grasses		
A. Control	380	44	2	**426**	44	80	66	**190**
B.	0	0	3	**3**	0	0	1	**1**
C.	0	0	0	**0**	0	0	0	**0**
D.	0	0	0	**0**	0	0	0	**0**
E.	0	0	0	**0**	0	0	0	**0**
F.	0	6	0	**6**	0	1	0	**1**
G.	7	0	0	**7**	0	0	0	**0**
H.	1	0	1	**2**	0	0	0	**0**
		Polygonum				*Taraxacum*		
A. Control	68	0	16	**84**	0	64	26	**90**
B.	0	0	3	**3**	0	1	1	**2**
C.	1	0	2	**3**	0	2	0	**2**
D.	0	0	1	**1**	0	2	0	**2**
E.	0	0	0	**0**	0	0	0	**0**
F.	0	0	0	**0**	0	2	1	**3**
G.	5	0	2	**7**	0	0	1	**1**
H.	0	0	2	**2**	0	9	9	**18**
		Total of all species						
A. Control	7260	4196	825	**12281**				
B.	0	1	42	**43**				
C.*	116	3	2	**121**				
D.	2	5	23	**30**				
E.	0	0	0	**0**				
F.	0	240	22	**262**				
G.	89	2	28	**119**				
H.	18	405	207	**630**				

* Nearly all these weeds on treatment C occurred in a single plot only

Table 5: **Trial 2 - Log transformed data for total weed counts over 3 assessments from June 1991 - May 1992 for the most important weeds**
(Figures are based on a mean of 12 replicates)

	Log_e (1 + total no. weeds per $8m^2$ plot)					
Treatment	*Senecio*	*Stellaria*	*Capsella*	Mayweed	*Chenopodium*	All Weeds
A. Control	5.74	5.89	3.95	3.22	2.98	6.86
B.	0.56	0.20	0.29	0.17	0.12	1.10
C.	0.47*	0.38*	-	0.06	-	0.90*
D.	0.38	0.23	0.15	0.06	-	0.62
E.	-	-	-	-	-	-
F.	2.59	0.23	0.60	0.29	0.27	2.76
G.	1.30	0.70	-	0.41	0.22	1.85
H.	3.17	0.41	1.66	0.60	0.12	3.59
Mean of B-H where weeds present	1.41	0.36	0.68	0.27	0.18	1.80
Statistical comparisons:						
Between individual herbicide treatments.						
SED (66 df)	*0.368*	*0.317*	*0.342 (44df)*	*0.274*	*0.273 (44df)*	*0.448*
LSD (5%)	*0.73*	*0.63*	*0.69*	*0.55*	*0.55*	*0.89*
Significance, P	*<0.001*	*NS*	*<0.001*	*NS*	*NS*	*<0.001*
A vs mean B-H						
SED (66df)	*0.281*	*0.242*	*0.272 (44df)*	*0.209*	*0.216 (44df)*	*0.317*
LSD (5%)	*0.56*	*0.48*	*0.55*	*0.42*	*0.44*	*0.63*
Significance, P	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*

* Nearly all these weeds on treatment C occurred in a single plot only

Table 6: **Trial 2 - Mean scores* for weed cover - recorded 28 July 1992**

Treatment	*Senecio*	*Stellaria*	*Capsella*	Mayweeds	*Chenopodium*	*Polygonum*	*Taraxacum*	*Sonchus*	*Solanum*
A. Control	2.33	3.75	1.00	1.00	0.83	1.00	0.58	1.33	0.83
B.	1.08	0.92	0.17	0.25	0.17	0.83	0.08	0.25	0.17
C.	0.83	0.83	0.25	0.33	-	0.67	0.08	-	0.17
D.	1.08	1.92	0.08	0.33	-	0.17	0.08	0.17	0.33
E.	-	-	-	-	-	-	-	-	-
F.	1.47	0.17	0.17	0.17	0.25	-	0.33	0.17	0.08
G.	1.08	0.67	-	0.17	0.25	0.83	0.17	0.17	0.17
H.	2.42	0.25	1.08	0.25	0.17	0.33	0.42	0.42	0.50
Mean of B-H where weeds present	1.32	0.79	0.35	0.25	0.21	0.57	0.19	0.23	0.20
*Statistical comparisons***									
Between individual trts									
SED (66df)	*0.319*	*0.402*							
LSD (5%)	*0.64*	*0.80*							
Significance, P	*<0.001*	*<0.001*							
A vs mean B-H									
SED (66df)	*0.244*	*0.307*							
LSD (5%)	*0.49*	*0.61*							
Significance, P	*<0.001*	*<0.001*							

* Means of 12 replicates/treatment

** Statistical data has not been provided for those weed species where mean scores were very generally low and comparisons of means might be misleading

Weed cover scores:

0 = Clean
1 = <10%
2 = 10-25%
3 = 26-40%
4 = 41-50%
5 = > 50%

Plant losses due to 'blow-out' in Trial 1

High winds in early June 1991 caused significant damage to rose bushes in Trial 1 by breaking shoots off at their base at the union with the rootstock. 'Blow-out' losses like this can be severe in rose crops if windy weather occurs at the critical growth period when shoots are tall enough to offer wind resistance, but the bud union has not strengthened sufficiently to prevent breakages. An assessment was made on 10 June of complete plant losses (i.e. where all shoots had been broken) for the nominal 20 assessed plants per plot. This was an estimate based on the numbers of broken unions visible at that time, and ignoring previous losses due to budtake failure. Losses varied with cultivar, and were worst for the vigorous Royal William which had the tallest growth and averaged 15% plant losses at this stage. Silver Jubilee and Amber Queen were less affected with 3% and 5% losses respectively.

Final grade-out and shoot number records

See Appendix III, p. 30 for tables of grade-outs, and of shoot numbers per plant.

Grade-out criteria was based on specifications detailed in BS 3936 Part 2 (1990). This standard gives only a minimum specification which approximated to the Grade 2 used in this trial, with higher specifications required for Grade 1 bushes defined as follows:

Grade 1 =	Minimum of 3 main basal shoots. The sum of the diameters of 2 of the shoots > 20 mm.
Grade 2 =	Minimum of 2 basal shoots. Sum of diameters > 20 mm.
Grade 3 = (waste)	1 shoot only, or sums of diameters of 2 shoots < 20 mm.

As Amber Queen was a relatively thin shooted cultivar, the grading was modified:

Grade 1 =	Minimum of 4 shoots of 6-10 mm dia. if no 10 mm + shoots present, or 1 x 10+mm shoot plus 2 x 6-10 mm dia. shoots.
Grade 2 =	3 x 6-10 mm shoots or 2 shoots with sum of dia. > 20 mm.
Grade 3 = (waste)	As above.

The cultivar Amber Queen in Trial 1 was affected by a severe outbreak of Rust disease (*Phragmidium tuberculosum*) which developed in September 1991. Although this occurred relatively late in the trial, it would have had a debilitating effect on late season growth which is important to final shoot length and thickness, and hence final grade. The net effect of this, together with the 10% losses from failed budtakes, and losses due to blow-outs, was to reduce the number of plants finally graded to an average of 13.6 out of a nominal 20 plants/plot (i.e. 68%) (see Table 7, p. 30). This compared with 16.2 plants (81%) for Silver Jubilee, and 14.4 plants (72%) for Royal William, this cultivar having been worst affected by blow-out losses.

There were significant differences between replicate means for the final number of graded plants per plot, with highest plant losses in Replicate IV on the east side of the trial, and least in Replicate I on the west side of the trial. Blow-out losses were worst on the east side from the predominantly easterly winds which caused the damage in early June.

There were no significant differences for the final number of plants present at grading for Silver Jubilee and Royal William. Although differences were apparently significant for Amber Queen, this is unlikely to be due to any harmful effects of the herbicide treatments because the untreated A treatment plots had the lowest mean number of surviving plants.

Apart from the control plots of Amber Queen having a lower percentage of Class 1 bushes than the herbicide treatments ($P<0.019$), there were no significant effects of treatments on the grade-out of bushes in this trial (Table 7, p. 30). The mean shoot numbers in Table 8, p. 32 showed that the Amber Queen control plots had fewer thick shoots (> 10 mm dia.) than the herbicide plots, but the difference in total shoot numbers was not significant. Apart from treatment G on Silver Jubilee where there were fewer thick shoots, there were no other significant differences found.

In view of the plant to plant variability and plant losses due to blow-out etc, these few significant results should not be overemphasised. It may have been that the poorer grade-out on the Amber Queen was due to competition from weed growth on the control plots, but this did not occur on the other two cultivars. In general, however, there was no evidence that any of the herbicides were having a deleterious effect on plant growth, and no evidence of phytotoxicity such as scorching or foliage discolouration attributable to the herbicides was observed.

Trial 2 did not suffer the plant losses due to wind damage or disease that occurred in Trial 1, and the final stand was in most cases over 90% of the nominal 20 assessed plants per plot. The grade-out was also much better for Amber Queen in this trial with over 67% Grade 1 plants on average. Grade-outs for Silver Jubilee and Alec's Red were broadly similar to that for Silver Jubilee and Royal William in Trial 1 as a % of the final plant stand, but there were fewer losses in Trial 2.

Examination of Tables 9 and 10, pp. 34 and 36, show no significant treatment effects on either grade-out, or the numbers of shoots. There was an indication that the herbicide treatments overall increased the proportion of marketable bushes (Grade 1 + 2) by 10% from 82% to 92% compared to the control (approaching significance at P = 0.075). The overall picture though, as in Trial 1, was that herbicide treatments had little effect on plant growth. It should be noted, that while total weed numbers were significantly greater than on the herbicide treated plots, in these trials weeds were removed at intervals following assessments, and therefore they probably only had a very limited competitive effect on the growth of the rose crop. The use of a herbicide programme in this, as in other crops, is clearly justified as it is well established from early work on a wide range of crops that severe competition and yield depression can be expected if weeds are left unchecked.

No phytotoxic symptoms were observed on either rootstock or scion growth in Trial 2. In earlier trials at Luddington EHS, and at a trial at Pershore College, Javelin produced some transient leaf yellowing and vein clearing symptoms in the rootstock year. Ronstar at 4.0 litres/ha plus Javelin at either 2.0 litres/ha (Luddington) or 2.0 and 1.0 litres/ha rates (Pershore) were used in these trials. Symptoms were worse at the 2.0 litres/ha rate (hence the lower rate used at Efford). Although plants recovered from these symptoms later in the season, and no problems were observed in the Efford trials, which were on a slightly less open and sandy soil, growers would be advised to try this treatment on a small scale first and not exceed 1.0 litres/ha.

Variation between plants within plots

Plant to plant variation within plots (ie. crop uniformity) was similar regardless of herbicide treatment. There were differences between scion cultivars, with Amber Queen being the most variable in terms of total shoot numbers > 6 mm dia. and Alec's Red the least.

Label approval of herbicides for roses

Many of the herbicide products or mixtures used did not carry specific label recommendations for use on roses, or even nursery stock in general. However, in common with many other pesticide uses for non-edible crops and plants, they can be legally used under the Off-label Approval arrangements within the FEPA regulations provided the other statutory conditions of use including operator and environment safety procedures are met. These Off-label Approvals, however, are carried out at grower's own risk, and do not carry the safeguards provided by full approval and manufacturers label recommendations in respect of efficacy and crop safety. The application for Full Approval for specific uses is largely the responsibility of, and at the discretion of, the product supplier/manufacturer. This project was carried out to evaluate a range of herbicide programme options, and not to specifically test a product on behalf of a manufacturer for the purposes of obtaining data for Approval. Thus, although the main objective of the trials was to evaluate herbicide efficacy and safety, they were carried out against this background, and any recommendations for non-label approved uses arising from the work are understood to be subject to the limitations applicable to Off-label Approvals.

CONCLUSIONS

The objectives of the trials were to test a range of herbicide programmes for bush roses, including some consisting partly or entirely of triazine free ingredients, for their efficacy and crop safety.

1. All the herbicide programmes used were safe to the rose crop on Efford's soil. However, given experience of some transient leaf symptoms in other trials where Javelin was used, growers wishing to try this herbicide should use it on a small scale first, and probably not exceed 1.0 litres/ha, particularly on light soils.

2. The herbicide programme based on Gardoprim A + Butisan S gave outstanding weed control with no evidence of crop damage, but as Gardoprim A is no longer available to UK growers further trials with other products containing one of the active ingredients, terbuthylazine, could be worthwhile.

3. Triazines should continue to give good control when used in conjunction with other standard herbicides such as Butisan S and Ronstar. Provided resistant weeds are not a particular problem on the nursery, they will continue to be the first choice for many growers. The relatively good control of *Senecio* following applications of triazine herbicides indicates that, unlike on many growers' holdings, resistant weed populations were not present in this trial.

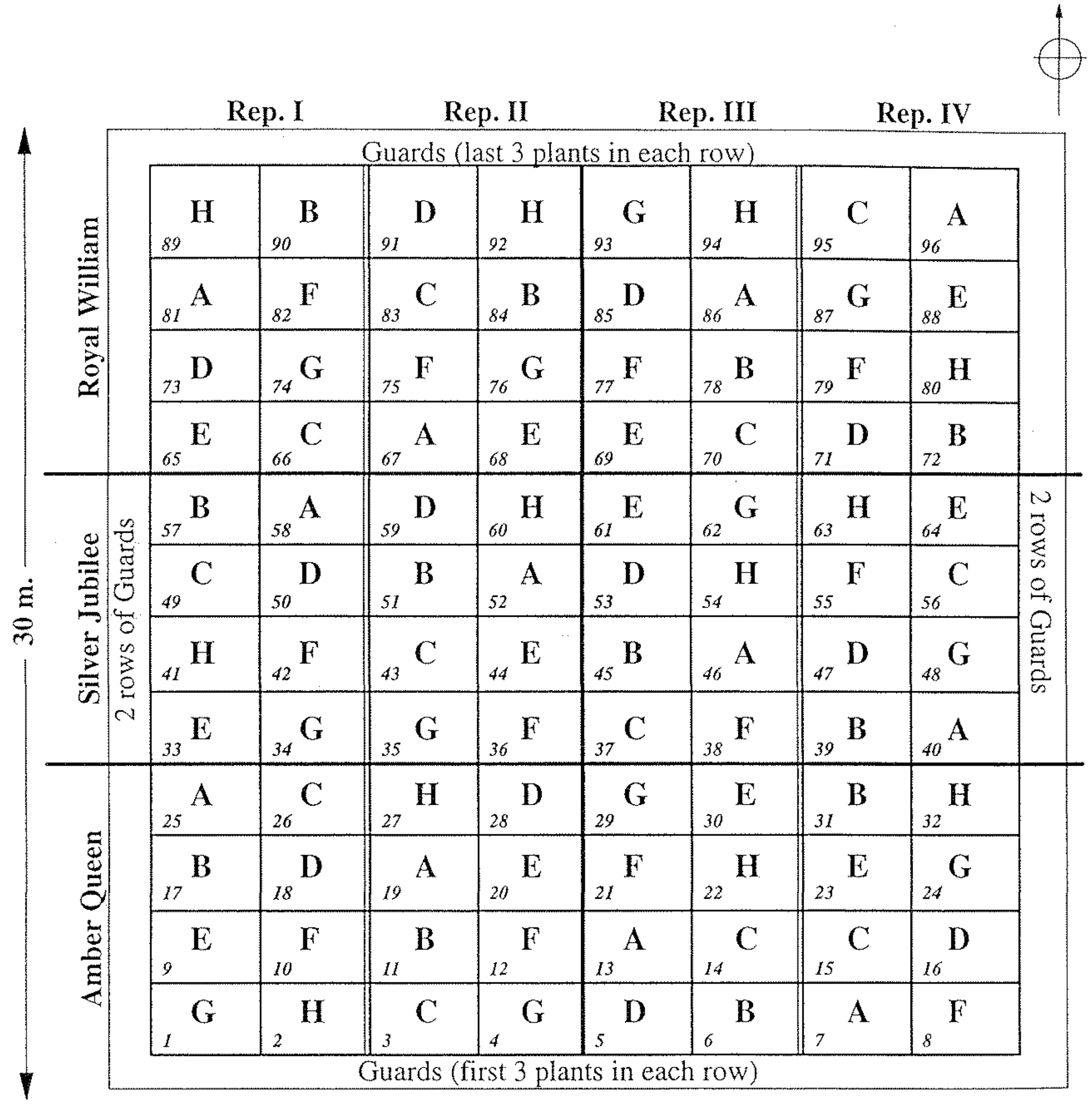
4. The triazine free herbicide options did not give as good control as the standard programmes, with *Senecio,* followed by *Capsella* and Mayweeds being the main weeds missed in this trial. Some gaps in the weed control spectrum of Stomp, Kerb and Flexidor were partly to blame, but also a poor result from Devrinol following the spring applications, thought to be associated with photodegradation of the chemical. In addition, the trial showed that weed control from summer applications of Butisan S, when used alone, could be poorer than when it was mixed with simazine, even with irrigation after spraying.

5. The choices for effective post budding summer applied residual herbicides are more limited than for spring. Although not trialled here, the addition of Dacthal W-75 (chlorthal-dimethyl) to Butisan S as a tank mix is suggested to improve weed control over Butisan S alone, if simazine or atrazine is not used. However, the addition of Dacthal would not be expected to give improved activity against *Senecio*.

APPENDICES

APPENDIX I **Planting plans and layouts**

TRIAL 1 LAYOUT 1990/91



	Rep. I		Rep. II		Rep. III		Rep. IV	
Royal William	H 89	B 90	D 91	H 92	G 93	H 94	C 95	A 96
	A 81	F 82	C 83	B 84	D 85	A 86	G 87	E 88
	D 73	G 74	F 75	G 76	F 77	B 78	F 79	H 80
	E 65	C 66	A 67	E 68	E 69	C 70	D 71	B 72
Silver Jubilee	B 57	A 58	D 59	H 60	E 61	G 62	H 63	E 64
	C 49	D 50	B 51	A 52	D 53	H 54	F 55	C 56
	H 41	F 42	C 43	E 44	B 45	A 46	D 47	G 48
	E 33	G 34	G 35	F 36	C 37	F 38	B 39	A 40
Amber Queen	A 25	C 26	H 27	D 28	G 29	E 30	B 31	H 32
	B 17	D 18	A 19	E 20	F 21	H 22	E 23	G 24
	E 9	F 10	B 11	F 12	A 13	C 14	C 15	D 16
	G 1	H 2	C 3	G 4	D 5	B 6	A 7	F 8

Treatments:

1) August 1990: **Post budding**	**2) March 1991:** **Post heading back**
A. Control	Control
B. Simazine/Butisan	Simazine/Butisan
C. Simazine/Butisan	Ronstar/Javelin
D. Simazine/Butisan	Simazine/Ronstar
E. Gardoprim A/Butisan	Gardoprim A/Butisan
F. Gardoprim A/Butisan	Simazine/Butisan
G. Simazine/Butisan	Butisan/Flexidor/Kerb
H. Butisan only	Stomp/Devrinol

All treatments (inc. Control) had Simazine/Butisan in March 1990 post planting

East and West guard rows given treatment B

Guard plants at North and South ends of rows given same treatment as adjacent plots.

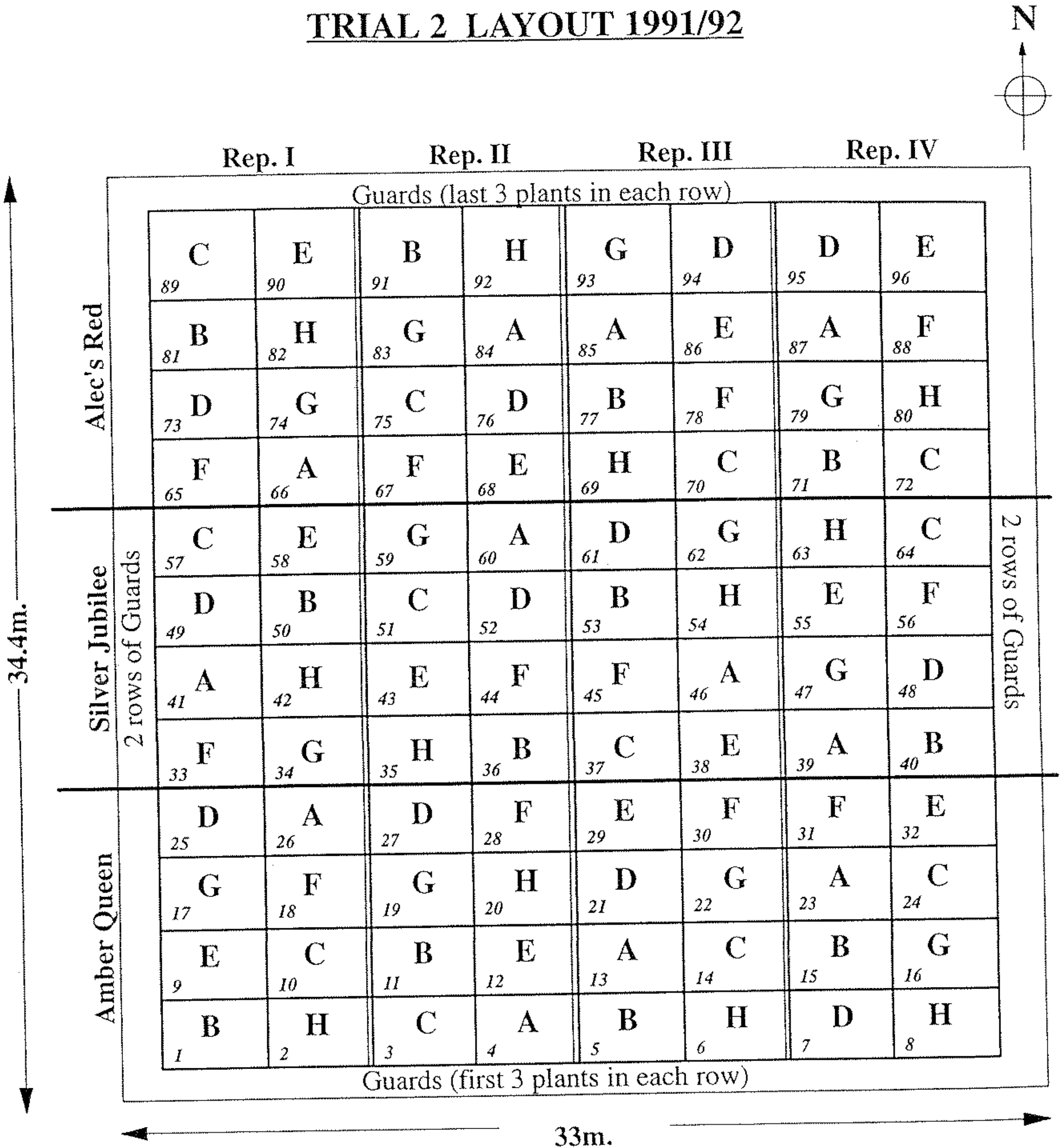
Spacing:

Trial area = 990m^2
36 rows wide, 150 plants deep

Plot = 4 rows wide @ 0.9m,
12 plants deep @ 0.2m.

Central 2 rows of 10 plants/plot
to be assessed.

TRIAL 2 LAYOUT 1991/92



	Rep. I		Rep. II		Rep. III		Rep. IV	
Alec's Red	C 89	E 90	B 91	H 92	G 93	D 94	D 95	E 96
	B 81	H 82	G 83	A 84	A 85	E 86	A 87	F 88
	D 73	G 74	C 75	D 76	B 77	F 78	G 79	H 80
	F 65	A 66	F 67	E 68	H 69	C 70	B 71	C 72
Silver Jubilee	C 57	E 58	G 59	A 60	D 61	G 62	H 63	C 64
	D 49	B 50	C 51	D 52	B 53	H 54	E 55	F 56
	A 41	H 42	E 43	F 44	F 45	A 46	G 47	D 48
	F 33	G 34	H 35	B 36	C 37	E 38	A 39	B 40
Amber Queen	D 25	A 26	D 27	F 28	E 29	F 30	F 31	E 32
	G 17	F 18	G 19	H 20	D 21	G 22	A 23	C 24
	E 9	C 10	B 11	E 12	A 13	C 14	B 15	G 16
	B 1	H 2	C 3	A 4	B 5	H 6	D 7	H 8

Treatments:

1) April 1991: Post planting	2) Sept. 1991: Post budding	3) March 1992: Post heading back
A. Control	Control	Control
B. Simazine/Butisan	Simazine/Butisan	Simazine/Butisan
C. Ronstar/Javelin	Simazine/Butisan	Ronstar/Javelin
D. Simazine/Ronstar	Simazine/Butisan	Simazine/Ronstar
E. Gardoprim A/Butisan	Gardoprim A/Butisan	Gardoprim A/Butisan
F. Stomp/Butisan	Butisan only	Stomp/Butisan
G. Butisan/Flexidor/Kerb	Simazine/Butisan	Butisan/Flexidor/Kerb
H. Stomp/Devrinol	Butisan only	Stomp/Devrinol

East and West guard rows given treatment B

Guard plants at North and South ends of rows given same treatment as adjacent plots.

Spacing:

Trial area = 1135m^2
Total of 5400 plants.

36 rows wide, 150 plants deep with gaps of 2 plants between plots, in-row.

Plot = 4 rows wide @ 0.9m.
12 plants deep @ 0.2m.

Central 2 rows of 10 plants/plot to be assessed.

APPENDIX II Diary of main cultural operations

Trial 1

1990

6 Mar	Stable manure applied to site at 75 tonnes/ha.
15 Mar	*Rosa* Laxa rootstocks planted and earthed up.
22 Mar	Simazine + Butisan S applied overall.
30 Mar - 1 Apr	About 20 mm irrigation applied.
17 Apr	Nitrogen top dressing at 50 kg/ha N as Nitram applied.
5 May	Benodanil as Calirus 1 g/litre plus 0.25 ml/litre Agral wetter applied at HV.
11 May	Cypermethrin as Ambush C 0.3 ml/litre + 0.25 ml/litre Agral wetter applied HV for aphids.
18 May	Calirus as above.
5 Jun	Myclobutanil as Systhane 6W 1 g/litre + dimethoate as Dimethoate 40 0.85 ml/litre HV spray to run-off applied for powdery mildew and aphids.
19 Jun	Systhane + Dimethoate 40 as above.
3 Jul	Dodemorph as F238 4.4 ml/litre HV spray for powdery mildew.
6 Jul	Calirus as above.
16 Jul	F238 as above.
21 - 23 Jul	Budded stocks with Amber Queen, Silver Jubilee and Royal William.
30 Jul	Systhane 6W as above.
22 Aug	Herbicide treatments applied. About 10 mm irrigation applied.
27 Nov	Spot treatment of *Sonchus arvensis* patches with glyphosate as Roundup (diluted 1 + 2 with water).

1991

24 Jan	Headed back rootstocks.
12 Feb	Shot buds pruned back to first visible bud.
21 Mar	Top dressing 75 tonnes/ha N + 25 tonnes/ha K_2O as Nitram + sulphate of potash.

26 Mar	Herbicide treatments applied.
15 May	Bupirimate + triforine as Nimrod T 3.2 ml/litre + pirimicarb as Aphox 1.0 g/litre HV for powdery mildew, blackspot, rust and aphids.
5 Jun	Removed windblown rose shoots.
8 Jun	Systhane 6W + Aphox; rates as above.
13 Jun	Cut back Royal William shoots to 1/3 height to avoid further windblow damage. Removed rootstock suckers from trial.
19 Jun	Nimrod T + Aphox as above.
1 Aug	Systhane 6W + Aphox as above.
14 Aug	Removal of rootstock suckers.
12 Sept	Systhane 6 W + pirimicarb as Pirimor 1 g/litre HV.
18 Sept	Systhane 6 W spray as above.
27 Sept	Removal of further suckers, and additional weeding of (mainly) untreated control plots.
4 Oct	Calirus + Agral wetter spray.
14 Oct	Systhane 6 W spray as above.
14 - 22 Nov	Trimmed back bushes to approximately 30 cm in preparation for lifting.
18 Nov on	Undercut trial with Damcon undercutter and commenced lifting guard bushes.

1992

13 - 17 Jan	Final grading and shoot count records taken.

Trial 2

1991

14 Mar	*Rosa* Laxa rootstocks received. Roots plunged in peat to hold until soil conditions suitable for planting. Tops sprayed with iprodione as Rovral 1.5 g/litre HV.
27 Mar	Fallow ground site chisel ploughed.
1 Apr	Site cultivated with spading machine.
2 Apr	50 kg/ha N base dressing as Nitram applied.
9 Apr	Rootstocks planted and earthed up.
12 - 21 Apr	About 25 mm irrigation applied in total in preparation for herbicide treatments.
22 Apr	Herbicide treatments applied.
23 - 26 Apr	About 10 mm irrigation applied.
29 May	Systhane 6W 1.0 g/litre HV spray.
5 May	Top dressed with 50 kg/ha N as Nitram.
14 Jun	Calirus spray 1.0 g/litre + Agral wetter 0.3 ml/litre HV.
29 Jun	Systhane 6W as above.
2 Jul	Completed weeding control plots following June assessment.
16 Jul	Calirus + Agral wetter spray as above.
30 Jul	Systhane 6W spray as above.
10 - 13 Aug	Budded stocks with Amber Queen, Silver Jubilee and Alec's Red.
15 Aug	Calirus + Agral wetter spray as above.
27 Aug	Systhane 6W spray as above.
4 Sept	Applied herbicide treatments.
5 Sept	Applied about 10 mm irrigation.
17 Sept	Systhane 6W spray as above.
25 Sept	Calirus + Agral wetter spray as above.
2 Oct	Systhane 6W spray as above.

10 Oct	Calirus + Agral wetter spray as above.
19 Oct	Systhane 6W spray as above.
7 Nov	Weeded mainly control plots following November weed assessment.

1992

17 - 19 Feb	Headed back rootstocks.
27 Feb	Removed any existing weed from trial (mainly control plots) prior to applying post heading back treatments. Also shot buds pruned.
11 Mar	Herbicide treatments applied.
5 May	Systhane 6W + demeton-S-methyl as Metasystox 0.38 ml/litre HV spray applied for powdery mildew, rust, blackspot and aphids.
14 May	Nimrod T 3.2 ml/litre HV applied for diseases as above.
10 Jun	Systhane 6W + Metasystox spray as above.
24 Jun	Removed rootstock suckers.
28 Jun	Systhane spray as above.
7 Jul	Nimrod T spray as above.
24 Jul	Systhane 6W spray as above.
4 Aug	All treatments weeded following July weed assessment.
11 Aug	Nimrod T spray as above.
1 Sept	Systhane 6W spray as above.
15 Sept	Systhane 6W spray as above.
29 Sept	Nimrod T spray as above.
23 Oct	Undercut trial in preparation for lifting.
early Nov onwards	Final grade-out and quality records. Lifting bushes.

Additional irrigations were also applied to the crop as required in addition to those listed above following herbicide applications.

APPENDIX III Final grade-out and shoot numbers

Table 7: Trial 1 - Mean proportions of plants in each quality grade of those present (recorded)
Angle transformed data (actual % in brackets). Mean number of plants graded/plot of nominal 20

Treatment	Grade 1	Grade 2	Grade 3	No. plants present
		Amber Queen		
A. Control	14.6 (8.5)	51.4 (60.7)	32.1 (30.8)	12.0
B.	33.0 (30.5)	43.6 (47.5)	27.6 (21.9)	16.0
C.	25.8 (19.3)	55.6 (67.1)	18.4 (13.6)	11.3
D.	25.3 (19.7)	51.3 (60.6)	25.9 (19.6)	14.5
E.	27.6 (22.6)	52.5 (62.7)	19.2 (14.7)	15.3
F.	21.0 (16.9)	43.4 (47.2)	36.5 (35.9)	14.3
G.	29.2 (25.7)	39.0 (40.9)	34.1 (33.5)	12.3
H.	24.2 (17.7)	52.9 (63.2)	25.1 (19.1)	13.0
Mean B.-H.	26.2 (21.8)	48.3 (55.6)	26.7 (22.6)	13.8
Statistical comparisons:				
Between individual trts.				
SED (21 df)	*6.24*	*6.77*	*9.72*	*1.33*
LSD (5%)	*13.0*	*14.1*	*20.2*	*2.8*
Significance, P	*NS*	*NS*	*NS*	*0.021*
A vs mean B.-H.				
SED (21 df)	*4.72*	*5.12*	*7.35*	*1.01*
LSD (5%)	*9.8*	*10.6*	*15.3*	*2.1*
Significance, P	*0.019*	*NS*	*NS*	*0.091*
		Silver Jubilee		
A. Control	53.7 (64.6)	32.2 (28.7)	10.7 (6.7)	15.0
B.	55.0 (67.1)	31.2 (27.0)	12.1 (6.0)	17.5
C.	47.1 (53.6)	35.4 (34.1)	20.3 (12.3)	16.0
D.	54.1 (65.4)	29.9 (25.2)	15.1 (9.3)	17.3
E.	58.3 (72.1)	25.3 (18.5)	15.2 (9.4)	16.5
F.	59.0 (71.8)	27.5 (23.0)	9.2 (5.1)	15.0
G.	47.5 (53.3)	35.0 (33.2)	20.4 (12.5)	16.0
H.	52.3 (61.9)	32.0 (30.0)	16.2 (8.0)	16.3
Mean B.-H.	53.3 (63.3)	30.9 (27.3)	15.5 (9.0)	16.4
Statistical comparisons:				
Between individual trts.				
SED (21 df)	*4.83*	*5.80*	*5.05*	*1.49*
LSD (5%)	*10.0*	*12.1*	*10.5*	*3.1*
Significance, P	*NS*	*NS*	*NS*	*NS*
A vs mean B.-H.				
SED (21 df)	*3.65*	*4.38*	*3.82*	*1.12*
LSD (5%)	*7.6*	*9.1*	*7.9*	*2.3*
Significance, P	*NS*	*NS*	*NS*	*NS*

continued .....

Table 7: (continued)

Treatment	Grade 1	Grade 2	Grade 3	No. plants present
		Royal William		
A. Control	57.1 (70.2)	27.9 (22.0)	13.9 (7.8)	13.3
B.	57.2 (69.2)	26.8 (21.6)	14.8 (9.2)	12.5
C.	44.9 (50.5)	38.2 (38.6)	19.0 (10.9)	14.0
D.	60.3 (75.1)	23.2 (15.8)	17.1 (9.1)	17.5
E.	57.6 (70.8)	24.5 (17.7)	19.5 (11.6)	16.0
F.	58.0 (71.5)	29.9 (25.2)	7.5 (3.3)	15.3
G.	57.5 (69.6)	25.7 (19.4)	16.4 (11.0)	13.0
H.	50.7 (59.5)	33.3 (30.7)	18.1 (9.8)	13.5
Mean B.-H.	55.2 (66.6)	28.8 (24.1)	16.0 (9.3)	14.5
Statistical comparisons:				
Between individual trts.				
SED (21 df)	*7.02*	*5.13*	*5.90*	*2.39*
LSD (5%)	*14.6*	*10.7*	*12.3*	*5.0*
Significance, P	*NS*	*0.084*	*NS*	*NS*
A vs mean B.-H				
SED (21 df)	*5.30*	*3.88*	*4.46*	*1.81*
LSD (5%)	*11.0*	*8.1*	*9.3*	*3.8*
Significance, P	*NS*	*NS*	*NS*	*NS*

Table 8: Trial 1 - Mean numbers of main basal shoots per graded plant

Treatment	6-10 mm dia.	> 10 mm dia.	Total 6+ mm dia.
		Amber Queen	
A. Control	2.50	0.67	3.17
B.	1.91	1.16	3.07
C.	2.81	0.85	3.65
D.	2.52	0.99	3.51
E.	2.32	1.08	3.40
F.	1.96	0.85	2.80
G.	2.58	0.81	3.39
H.	2.68	0.82	3.50
Mean B.-H.	2.40	0.94	3.33
Statistical comparisons:			
Between individual trts.			
SED (21 df)	*0.448*	*0.161*	*0.457*
LSD (5%)	*0.93*	*0.33*	*0.95*
Significance, P	*NS*	*NS*	*NS*
A vs Mean B.-H.			
SED (21 df)	*0.339*	*0.121*	*0.345*
LSD (5%)	*0.71*	*0.25*	*0.72*
Significance, P	*NS*	*0.040*	*NS*
		Silver Jubilee	
A. Control	1.84	2.25	4.09
B.	1.67	2.12	3.79
C.	1.87	1.94	3.81
D.	1.71	2.20	3.91
E.	1.72	2.18	3.90
F.	1.54	2.34	3.88
G.	2.05	1.76	3.81
H.	1.74	2.17	3.91
Mean B.-H.	1.76	2.10	3.86
Statistical comparisons:			
Between individual trts.			
SED (21 df)	*0.275*	*0.158*	*0.254*
LSD (5%)	*0.57*	*0.33*	*0.53*
Significance, P	*NS*	*0.030*	*NS*
A vs mean B.-H.			
SED (21 df)	*0.208*	*0.119*	*0.192*
LSD (5%)	*0.43*	*0.25*	*0.40*
Significance, P	*NS*	*NS*	*NS*

continued .....

Table 8: (continued)

Treatment	6-10 mm dia.	> 10 mm dia.	Total 6+ mm dia.
		Royal William	
A. Control	0.62	2.67	3.29
B.	0.64	2.75	3.38
C.	0.57	2.26	2.83
D.	0.48	2.72	3.19
E.	0.82	2.30	3.12
F.	0.58	2.88	3.46
G.	0.38	2.62	3.00
H.	0.36	2.54	2.90
Mean B.-H.	0.55	2.58	3.13
Statistical comparisons:			
Between individual trts.			
SED (21 df)	*0.148*	*0.313*	*0.294*
LSD (5%)	*0.31*	*0.65*	*0.61*
Significance, P	*0.069*	*NS*	*NS*
A vs mean B.-H.			
SED (21 df)	*0.112*	*0.237*	*0.222*
LSD (5%)	*0.23*	*0.49*	*0.46*
Significance, P	*NS*	*NS*	*NS*

Table 9: Trial 2 - Mean proportions of plants in each quality grade of those present (recorded)

Angle transformed data (actual % in brackets). Mean number of plants graded/plot of nominal 20

Treatment	Grade 1	Grade 2	Marketable (Gd. 1 + 2)	No. plants present
		Amber Queen		
A. Control	52.1 (62.2)	31.4 (27.2)	71.2 (89.4)	18.5
B.	54.2 (65.1)	31.6 (69.6)	80.5 (94.7)	18.5
C.	56.7 (69.6)	22.9 (16.9)	68.6 (86.5)	18.8
D.	55.9 (67.5)	26.6 (21.0)	73.6 (88.5)	19.5
E.	59.5 (74.1)	20.8 (13.6)	72.1 (87.7)	18.5
F.	53.1 (63.7)	26.9 (20.8)	67.1 (84.5)	19.3
G.	55.8 (68.0)	24.9 (18.1)	69.7 (86.1)	19.0
H.	50.4 (59.2)	28.7 (23.9)	66.5 (83.1)	19.0
Mean B.-H.	55.1 (66.7)	26.1 (20.6)	71.2 (87.3)	18.9
Statistical comparisons:				
Between individual trts.				
SED (21 df)	*4.46*	*4.94*	*5.94*	*na*
LSD (5%)	*9.3*	*10.3*	*12.4*	
Significance, P	*NS*	*NS*	*NS*	
A vs mean B.-H.				
SED (21 df)	*3.37*	*3.73*	*4.49*	*na*
LSD (5%)	*7.0*	*7.8*	*9.3*	
Significance, P	*NS*	*NS*	*NS*	
		Silver Jubilee		
A. Control	52.6 (62.9)	35.8 (34.5)	83.5 (97.4)	19.5
B.	46.9 (53.2)	42.3 (45.4)	86.6 (98.6)	19.3
C.	55.2 (66.8)	30.5 (26.6)	75.2 (93.3)	18.8
D.	49.5 (57.8)	36.8 (36.0)	80.1 (93.8)	19.5
E.	50.0 (58.6)	38.5 (38.9)	83.5 (97.4)	19.3
F.	47.9 (54.9)	40.6 (42.4)	85.3 (97.4)	19.5
G.	55.3 (66.9)	33.1 (30.6)	83.5 (97.5)	19.5
H.	51.8 (61.7)	35.5 (34.2)	81.7 (95.8)	18.8
Mean B.-H.	50.9 (60.0)	36.7 (36.3)	82.3 (96.3)	19.2
Statistical comparisons:				
Between individual trts.				
SED (21 df)	*4.70*	*4.79*	*5.96*	*na*
LSD (5%)	*9.8*	*10.0*	*12.4*	
Significance, P	*NS*	*NS*	*NS*	
A vs mean B.-H.				
SED (21 df)	*3.55*	*3.62*	*4.51*	*na*
LSD (5%)	*7.4*	*7.5*	*9.4*	
Significance, P	*NS*	*NS*	*NS*	

continued .....

Table 9: (continued)

Treatment	Grade 1	Grade 2	Marketable (Gd. 1 + 2)	No. plants present
		Alec's Red		
A. Control	46.0 (51.8)	33.2 (30.1)	65.9 (81.9)	18.3
B.	55.9 (68.2)	29.0 (23.8)	76.0 (92.0)	19.0
C.	45.5 (51.1)	38.1 (38.6)	73.7 (89.6)	19.5
D.	48.3 (55.6)	35.6 (34.3)	71.4 (89.9)	19.8
E.	51.6 (61.3)	29.9 (25.0)	69.2 (86.3)	20.0
F.	56.4 (68.7)	30.3 (26.1)	78.6 (94.7)	19.3
G.	52.5 (62.6)	33.7 (31.0)	77.4 (93.6)	18.3
H.	55.8 (67.7)	31.4 (27.8)	81.5 (95.6)	18.0
Mean B.-H.	52.3 (62.2)	32.6 (29.5)	75.4 (91.7)	19.1
Statistical comparisons:				
Between individual trts.				
SED (21 df)	*5.48*	*4.67*	*6.70*	*na*
LSD (5%)	*11.4*	*9.7*	*13.9*	
Significance, P	*NS*	*NS*	*NS*	
A vs mean B.-H				
SED (21 df)	*4.14*	*3.53*	*5.07*	*na*
LSD (5%)	*8.6*	*7.3*	*10.5*	
Significance, P	*NS*	*NS*	*0.075*	

Table 10: Trial 2 - Mean numbers of main basal shoots per graded plant

Treatment	6-10 mm dia.	> 10 mm dia.	Total 6+ mm dia.
		Amber Queen	
A. Control	3.86	0.23	4.08
B.	4.17	0.23	4.40
C.	4.43	0.24	4.68
D.	4.19	0.16	4.35
E.	4.71	0.18	4.89
F.	4.03	0.18	4.21
G.	4.24	0.21	4.45
H.	4.17	0.18	4.36
Mean B.-H.	4.28	0.20	4.48
Statistical comparisons:			
Between individual trts.			
SED (21 df)	*0.293*	*0.106*	*0.303*
LSD (5%)	*0.61*	*0.22*	*0.63*
Significance, P	*NS*	*NS*	*NS*
A vs Mean B.-H.			
SED (21 df)	*0.221*	*0.080*	*0.229*
LSD (5%)	*0.467*	*0.17*	*0.48*
Significance, P	*0.073*	*NS*	*NS*
		Silver Jubilee	
A. Control	3.03	1.83	4.87
B.	3.37	1.67	5.04
C.	2.58	1.93	4.51
D.	2.99	1.84	4.83
E.	3.27	1.90	5.16
F.	3.12	1.85	4.97
G.	3.02	1.97	4.99
H.	3.06	1.93	4.99
Mean B.-H.	3.06	1.87	4.93
Statistical comparisons:			
Between individual trts.			
SED (21 df)	*0.304*	*0.254*	*0.252*
LSD (5%)	*0.63*	*0.53*	*0.52*
Significance, P	*NS*	*NS*	*NS*
A vs mean B.-H.			
SED (21 df)	*0.230*	*0.192*	*0.190*
LSD (5%)	0.48	0.40	0.40
Significance, P	*NS*	*NS*	*NS*

continued .....

Table 10: (continued)

Treatment	6-10 mm dia.	> 10 mm dia.	Total 6+ mm dia.
		Alec's Red	
A. Control	1.14	1.92	3.06
B.	0.74	2.44	3.18
C.	1.18	1.99	3.16
D.	1.04	2.09	3.14
E.	1.14	2.03	3.16
F.	0.85	2.37	3.23
G.	0.98	2.20	3.19
H.	1.22	2.28	3.50
Mean B.-H.	1.02	2.20	3.22
Statistical comparisons:			
Between individual trts.			
SED (21 df)	*0.264*	*0.223*	*0.203*
LSD (5%)	*0.55*	*0.46*	*0.42*
Significance, P	*NS*	*NS*	*NS*
A vs mean B.-H.			
SED (21 df)	*0.200*	*0.169*	*0.154*
LSD (5%)	*0.41*	*0.35*	*0.32*
Significance, P	*NS*	*NS*	*NS*

APPENDIX IV Copy of contract

Contract between BSHR (hereinafter called the "Contractor") and the Horticultural Development Council (hereinafter called the "Council") for a research/development project.

PROPOSAL

1. TITLE OF PROJECT: Contract No: HNS 6a

CLONAL ROOTSTOCKS FOR TREES AND ROSES TO IMPROVE QUALITY AND QUANTITY OF PRODUCTION

2. BACKGROUND AND COMMERCIAL OBJECTIVE:

A significant proportion of the £100 million FGV derived from field production in the Nursery Stock Sector involves bud-grafting. The rootstock has an important role in determining quality and quantity of production, which in turn influences marketable yield. Clonal rootstocks also offer the opportunity to screen for resistance to soil-borne diseases (such as Verticillium wilt), for compatibility with the scion, and for effects on size and flowering, the last of relevance to open ground and containerised production. Most progress on this topic has been made to date with fruit trees, and the uptake of the rootstock Colt for flowering cherries is an example of the benefits that can derive from this work. The objective is to develop similar benefits in important groups of hardy nursery stock trees and shrubs, especially roses.

3. POTENTIAL FINANCIAL BENEFIT TO THE INDUSTRY:

Successful introduction of clonal rootstocks will increase the uniformity of nursery production and remove the variation introduced by seedling rootstocks in terms of responses to budding and other processes. Realistically, it will only be possible to address this opportunity for a few key species and complementary work to upgrade the performance of seedling populations is also required (see HNS 7a - budding). The extent to which implementation of clonal rootstocks will be cost-effective will depend on acceptance of the long-term nature of this type of work, and the need for industry to absorb the relatively small increase in the cost of clonal rootstocks compared to seedlings, set against the clear rewards.

4. SCIENTIFIC/TECHNICAL TARGET OF THE WORK:

Ways need to be found of identifying naturally occurring genotypes with useful rootstock characteristics (clean stems, prolific cutting production) and developing screening methods based on current technology for other essential characteristics (propagation, compatibility, growth control, disease resistance). There may be advantages in identifying unrelated provenances and/or carrying out controlled crosses if parents with desirable features can be identified.

5. CLOSELY RELATED WORK - COMPLETED OR IN PROGRESS:

Resume of work in HNS 6, 1987-1990: The HDC-funded project to compare ten sources of clonally produced standard rose rootstocks was described to nurserymen at Luddington EHS in July 1989. Rosa rugosa clones were less vigorous and had poorer bud-take than other selections. While there were no outstanding selections 'Harwhippet'. 'Kiese' and 'De La Grifferiae' showed promise and evaluation will continue. Rootstock material has now been transferred to Efford EHS. A herbicide evaluation trial was also undertaken at Luddington of budded varieties on Rosa laxa rootstocks.

At East Malling a previously MAFF funded project has developed clonal rootstocks for Tilia spp. and is making progress with Acer platanoides. This work, previously co-ordinated with complementary work at Luddington EHS, will not be funded by MAFF from 19~~8~~91-2 and there is the need for HDC to take over its support.

Strategic studies:

The essential and complementary strategic studies will be in place at East Malling to devise techniques to create new varieties and rootstocks for HNS. This is likely to be based on tissue culture and breeding systems aimed at the methodology rather than the actual production of rootstocks, and disease resistance is included in the objectives.

It is unlikely that in the HDC programme all desirable characters will be combined in one genotype from a nature source. In this case, the product will be introduced into the strategic programme for refining.

6. DESCRIPTION OF THE WORK:

A co-ordinated East Malling-Efford approach will be undertaken. Regular reviews will address the balance of rose and tree work between sites, and with respect to funding within each site.

East Malling - Initially to work on all non-fireblight susceptible trees:-

a) Continue to develop and screen current selections of Tilia spp. and Acer platanoides, and test commercially.

b) Liaise with pathologists to effect screening for Verticillium wilt via HNS 29.

c) Develop cost-effective screening for rootstocks of other genera.

d) Liaise with HNS 7a to develop the complementary approach of upgrading seedling populations as an interim stage towards clonal rootstocks.

Efford - Initially to work on roses and fireblight susceptible trees, with the likelihood of diverting most funding to roses:-

a) Complete existing programmes to select rose clonal standard stems ex Luddington.

b) Propagate selected clones by summer cuttings to provide self-rooted stocks for comparison with grafted stems. (East Malling facilities will be used if winter cuttings are attempted).

c) Screen new selections of bush rose rootstocks to find replacements for Rosa laxa with respect to improved resistance to rose rust and winter cold.

d) Seek replacements for herbicides such as Clout (being withdrawn), triazine-based materials (environmental concerns) and simazine (resistant groundsel). (East Malling work in HNS 7a on improved rose budding will be relevant to the rose programme at Efford).

7. COMMENCEMENT DATE AND DURATION:

Efford	01-04-90 for 3 years
East Malling	01-01-91 for 3 years

8. STAFF RESPONSIBILITIES:

Efford	C M Burgess
East Malling	B H Howard

9 LOCATION:

BSHR, East Malling and Efford sites.

RELEVANCE TO GROWERS AND PRACTICAL APPLICATION

Application

Simazine and atrazine have for a long time been the basis of inexpensive and effective herbicide programmes used on field grown roses. However, there are a number of triazine resistant weed species now present on many holdings such as some populations of groundsel (*Senecio*) knotgrass (*Polygonum*) and others. Also, there are increasing environmental concerns about triazine products, herbicides in general, and the withdrawal of some products from the marketplace. This work covers trials carried out between 1990 and 1992 on two crops of bush roses at HRI Efford. It builds on experience from earlier trials carried out at Luddington EHS on herbicide programmes for roses, and evaluated the most promising options available to growers as well as pointing to future alternatives should any or all of the triazine group of herbicides become unavailable in future. As well as assessing the efficacy of various products and combinations against some widespread annual weed species, crop safety was also an important consideration in the trials.

Summary

A range of herbicide programmes for bush roses, including some based mainly or entirely on triazine free active ingredients, were assessed for their efficacy and crop safety over two overlapping two year cropping cycles. Flowering cultivars Royal William, Silver Jubilee and Amber Queen were budded onto the *Rosa* Laxa rootstocks for Trial 1 with Alec's Red, Silver Jubilee and Amber Queen used for Trial 2. The three standard timings for residual herbicide applications for the rose crop were used, namely post planting (spring), then post budding (summer) in Year 1 followed by a final application post heading back (spring) in Year 2.

Background weed levels in both trials were sufficient to make a valid assessment of herbicide efficacy, with a good representation of important annual weed species including *Senecio, Stellaria, Capsella,* Mayweeds, *Chenopodium*, and *Polygonum*. The untreated control treatments gave significantly higher levels of weed than all the herbicide programmes in both trials. Trial 1, treatments of which did not commence until the post budding spray, did not show very large differences between herbicide regimes with treated plots remaining very clean well into the second year. Also some wind damage to the crop in the second year, and severe Rose Rust on cv Amber Queen, affected final plant grade-outs. Trial 2 yielded more information on herbicide efficacy and crop safety.

In both trials, there were no signs of phytotoxicity or evidence of poorer crop growth in terms of shoot numbers or final grade-out from any of the herbicides applied. However in trials on other sites, transient phytotoxicity symptoms have been seen with Javelin.