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CONTRACT REPORT

STEM SELECTIONS FOR STANDARD ROSES

Undertaken for Horticultural Development Council
Project HNS 6/6a (Part)
1990 - 93

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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 6/6a (Part)

STEM SELECTIONS FOR STANDARD ROSES

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Efford Trials Commenced : April 1990

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RELEVANCE TO GROWERS AND PRACTICAL APPLICATION

Application

This trial completed the work evaluating new selections of stems for full standard rose production, which started under project HNS 6 at Luddington EHS. The traditional stem *Rosa rugosa* has now been outclassed in vigour and quality by four different stem selections when used in a three year crop production cycle involving budding the stems onto *Rosa* Laxa rootstocks. Budwood of two of the recommended stems, Harwhippet and Chestock (a selection of *R. canina* Pfander), are available as the trade names 'Rocket' and 'Chessum's Choice' respectively via the British Association Representing Breeders, under license. The other two recommended selections, *R. canina* Kiese (C & K Jones source) and *R. multiflora* De la Grifferaie, are not subject to royalty payments. Limited quantities of budwood of these is available via HRI Efford.

The availability of these new stems offers growers opportunities to raise good quality stems themselves economically, and not have to rely on imported stems of *R. rugosa* which have, in the past, been of variable quality and health status.

Summary

Seven alternative stem types for standard rose production, including two sources of each of two selections were trialled in a large replicated trial over a three year cropping cycle at HRI Efford. This trial completed work started at Luddington EHS where the traditional stem *Rosa rugosa* was also included, but omitted from the Efford trial because of its comparatively poor performance in Luddington's trials.

Rosa Laxa rootstocks were planted in spring 1990, and the stem selections budded in July that year. After heading back early in 1991, stems were grown and trained up canes supported on a post and wire system, and budded with three hybrid tea (HT) plus three floribunda (FL) flowering cultivars in the summer of the same year. The three HT's were Royal William (crimson), Freedom (yellow) and Silver Jubilee (pink) and the three FL's were Margaret Merril (white), Amber Queen (amber) and Many Happy Returns (white/pink flush). The surplus stem tops were removed by heading back in spring 1992, and the flowering cultivar heads grown that year, with final assessments on quality made that autumn. After undercutting and lifting, a small number of Grade 1 plants of each stem x flowering cultivar combination were transplanted to another position in February 1993 in a simulated 'garden performance' observation that year.

The selection of *R. canina* **Pfander** ('Chessum's Choice') gave very good results and produced the highest overall plant grade-out of budded stems at the end of the trial. However the total yield of Pfander plants was affected by a greater than average number of accumulated plant

losses in this trial (such as poorer initial stem budtake onto Laxa, damage during stem training etc.), but this appeared to be mainly due to chance rather than a defect in the stem selection. Stem straightness and stem thickness, while not as good as De la Grifferaie or Harwhippet, was nevertheless very good, and this stem produced the highest proportion of Grade 1 heads averaged overall. Sideshoot growth during production, and particularly in the garden observation year, was also low.

Harwhippet ('Rocket') produced the thickest stems, with relatively little sideshoot production during the stem growing year. Stems were also very straight, but their extreme thorniness slowed down the budding operation. Excessive callus production after budding appeared to be mainly responsible for a slight reduction in budtake with this stem, which was worst on the cultivars Freedom and Margaret Merril. This consequently caused a small reduction in head quality. Nevertheless overall performance was good and this stem can be recommended for full standard production. Its vigour and stem thickness is likely to make it less suitable for half and quarter standard production of the daintier patio and miniature rose cultivars where an imbalanced looking plant is likely to result.

De la Grifferaie produced some of the straightest stems in the trial which were slightly thicker than Pfander but not as heavy as Harwhippet. However budtake on this stem and subsequent head development was not as good as Pfander and was, on average, similar to Harwhippet. There was no callus problem with De la Grifferaie, and whether the poorer budtake could have been due to an incompatibility problem with this stem is discussed. The otherwise excellent performance of the stem however was reflected in a good plant grade-out, and the stem can be recommended for grower's own trials. Along with the other stem selections, plant material is currently being tested to determine their virus status, as the presence of viruses may possibly be linked to incompatibility problems.

Of the two sources of *R. canina* **Kiese** selections tested, that from C & K Jones was slightly more vigorous and performed a little better than that from E B Le Grice. This may indicate a true clonal difference. Stem characteristics were similar to the closely related Pfander selection, but stems were slightly thinner. Sideshoot production, while still low, was greater than with Pfander in the garden performance observation year. Kiese (Jones) also gave a good overall plant grade-out similar to De la Grifferaie and Harwhippet, and can also be recommended for trial by growers.

Two numbered selections of stem originally produced by the John Innes institute, **G278** (from two sources) and **K2103** produced similar results and were indistinguishable in appearance. Although they were very vigorous and produced good quality heads, they tended to 'wander' from the vertical during the stem growing year making it very difficult to produce straight stems, and thus cannot be recommended for commercial scale use.

The final selection, *R. multiflora* **Dan Whiteside**, while having the virtue of a thornless stem, was far too thin and weak compared to the other selections. It also produced stem sideshoots from virtually every leaf axil, the removal of which would be excessively laborious on a commercial scale.

Several plants in both the main trial and the 'garden observation' were killed by a stem disease which caused a progressive black lesion typically from the base upwards but sometimes from the head down. All stem types appeared to be susceptible. Several laboratory analyses of samples failed to identify any fungal pathogen species. In subsequent trials routine applications of the broad spectrum fungicide prochloraz (Octave) during both the stem and head production years appears to have given useful protection against the disease.

A follow on project HNS 54, which commenced in 1993, is investigating alternative production methods for the production of standard stems suitable for containerised marketing, and is concentrating particularly on the half and quarter standard products.

Action Points

- Growers should consider raising their own standard stems using one or more of the new stem selections, as considerable improvements in quality of the final product can be achieved over those raised using the traditional *Rosa rugosa* stem.

- The selection of stem type should take into account the type of final product being grown. For example, Harwhippet ('Rocket') may be a suitable choice for full or taller trailing standards, but is likely to be too heavyweight for half and quarter standards particularly with patio and miniature cultivars.

- Pfander ('Chessum's Choice') is a good all round selection for standard stem production using the growing system involving budding stems onto Laxa rootstocks. It gives both good stem straightness and head quality. However growers should also consider De la Grifferaie and Kiese (source Jones) as possible alternatives worth trying which are not subject to royalties.

INTRODUCTION

Numbers of standard roses sold are relatively small compared to the 'bread and butter' lines of hybrid tea and floribunda bushes. However total rose sales number some 20 - 25 million plants annually (8% of the total HONS output), and as wholesale prices of standard roses are typically 8 - 10 times that of bush roses per plant, standards represent a valuable proportion of the total rose output.

Traditionally, *Rosa rugosa* was used as the stem upon which the flowering cultivars were budded. These stems were mainly imported from Holland as ready grown stems raised from hardwood cuttings. However growers have become increasingly concerned about the quality (ie straightness, thickness, and health status) and cost of the available material. One grower reported losses of up to 40% of *R. rugosa* stems which failed to establish due to infection with *Gnomonia rubi*. These factors, together with the known existence of a number of alternative species and selections which showed some promise for stem building, led to this project funded through the HDC to properly evaluate them.

The project started as HNS 6 at Luddington EHS when a total of 10 stem selections were collected in 1987 - 88 from Shardlow Hall, Derby, and several growers. As well as *R. rugosa*, selected clones of *R. canina* and *R. multiflora* cultivars, and two numbered seedlings from an early John Innes Institute rose breeding programme were included. Only one three year crop cycle was completed at Luddington before the station closed in November 1989, with a second crop of stems grown but not budded. Along with other rose trials, the standard stem work was transferred to HRI Efford in spring 1990 for completion under Project HNS 6a.

The objective of this trial was to test a wider range of flowering scion cultivars on these stems for compatibility and final quality than had been possible at Luddington EHS. Also to gain more experience of the stem characteristics and further test their vigour and quality over another site and season. Tables of the main results from the Luddington EHS trials which started in 1987 and 1988 are included in Appendices IV and V, pp. 35 and 39, and comparative references with the Efford results have been made where appropriate.

Investigations into alternative production methods, including those for container grown and containerised ½ and ¼ standards, while started under HNS 6a were later developed under a separate project HNS 54 and are not included in this report.

MATERIALS AND METHODS

Site

The trial was grown on a sandy silt loam soil of the Efford soil series in Field S11 (NW). This corner of the field was sheltered to the west by woodland and the north by a windbreak hedge. A soil analysis from a sample in January 1990 was as follows:

pH	7.3	
P	51 mg/litre	(ADAS Index 4)
K	250 mg/litre	(ADAS Index 3)
Mg	74 mg/litre	(ADAS Index 2)

Treatments

The following stem selections were trialled:

Stem selection (source of clone)

1. G278 John Innes (Shardlow)
2. Harwhippet (Harkness)
3. *R. multiflora* Dan Whiteside (Rearsby)
4. G278 John Innes (Rearsby)
5. *R. canina* Pfander (Chessum)
6. *R. canina* Kiese (Le Grice)
7. *R. canina* Kiese (C & K Jones)
8. *R. multiflora* De la Grifferaie (Shardlow)
9. G278 John Innes (Shardlow) (substituted for *R. rugosa*)
10. K2103 John Innes (Shardlow)

These stems were all budded with the following flowering cultivars for assessment of head growth:

Royal William	HT	Crimson red
Many Happy Returns	FL	White/peach flush
Silver Jubilee	HT	Salmon pink
Freedom	HT	Yellow
Margaret Merril	FL	Pearly white
Amber Queen	FL	Amber
Melody Maker	FL	Vermilion red (guards on side rows)

The stem *Rosa rugosa* was replaced by another replicate of G278 (Shardlow) following the poor performance of *R. rugosa* in earlier trials at Luddington. Its fine thorny stem also made it difficult to cut as budwood and therefore less suitable for this production technique.

Design and layout

See Appendix I, p. 30 for details of the field plan and layout. 10 stem treatments x 18 replicates (180 plots) were originally budded onto the *Rosa* Laxa rootstocks in a randomised block design. Plot size was 10 plants/plot. The six flowering cultivar selections were superimposed the following year onto the stem plots in groups of three stem replicates per flowering cultivar. The practicalities of budding necessitated that the flowering cultivars be budded as single blocks, so that although comparisons between flowering cultivars could be made, results had to be treated with some caution in case positional differences in the field were having some effect.

Plants were spaced in rows running north - south, 1.2 m apart x 0.4 m in the row giving a density of 20,833 plants/ha (8,431 plants/acre). This spacing was identical to that used in previous trials at Luddington EHS[1]. The trial was guarded by two rows on each side of the trial, and six plants at each end of the row.

General culture

The main cultural operations are detailed in Appendix II, p. 31.

The three year production system used involved planting *Rosa* Laxa rootstocks in spring, and budding them in the summer of Year 1 (1990), growing the stems and budding them with flowering cultivars in the summer of Year 2, and growing the flowering heads in Year 3. The Laxa rootstocks were 'headed back' to the dormant stem bud early in Year 2, and likewise the unwanted stem above the flowering cultivar buds headed back in early spring in Year 3. Other important features of the cultural method were, firstly, the use of bud guides applied to the Laxa stocks after heading back to encourage vertical stem growth and reduce the incidence of a basal kink. Secondly, were the use of tall bamboo canes attached to a post and wire support system with regular taping of the stems to encourage straight growth in the stem growing year. Regular removal of unwanted sideshoots was also important to maintain the vigour of a single apically dominant shoot, and to produce a 'clean' stem free from scars and large 'knuckles' left from cutting out very large sideshoots later on. In the head growing year, tipping back flowering shoots at an early stage was important to encourage a compact well branched head, and also

[1] In subsequent trials, a closer spacing, identical to that used at Efford for bush roses, has been used successfully. I.e. wide double rows 80 cm apart on beds at 1.83 m wheelings with 0.2 m in-row spacings. A trickle irrigation system between the rows during the stem and head growing years has ensured adequate vigour was maintained.

minimise wind damage. Removal of stem sideshoots as required was also necessary during the head growing year.

Irrigations were applied to the trial with Wright Rain type sprinklers initially, then a lower output rate 'Mamsat' type rotary sprinklers applying about 2.5 mm/hr from mid August in the second year. Irrigation was required prior to budding both the rootstocks and stems to maintain a good sap flow to encourage good budtake. Once stems had grown to above about 2.1 m, they were tipped back, and allowing sideshoots to develop at the top of the stems above head height prior to budding the flowering cultivars also helped maintain sap flow prior to budding.

A high volume fungicide spray programme against Rust and Powdery Mildew on the rootstocks, stems and flowering heads was applied. Benodanil (Calirus 1.0 g/litre) was applied three times in the rootstock year in 1990 with two additional applications of myclobutanil (Systhane 1.0 g/litre), but the fungicide programme centred around Systhane and bupirimate + triforine (Nimrod T 3.2 ml/litre) in rotation in 1991 and 1992 with a few additional sprays of Calirus. Sprays were applied at approximately two to three week intervals according to weather conditions and evidence of disease, starting from early June in 1991 and early May in 1992. Iprodione (Rovral Flo 2.0 ml/litre) was also used in August and November 1991 when some *Botrytis* lesions appeared on some stems.

Aphids were controlled with the addition of compatible insecticides with the fungicide sprays as required. In 1990, cypermethrin (Ambush 0.3 ml/litre) was used once in early May followed by two sprays of dimethoate (Dimethoate 40, 0.85 ml/litre) in June. Pirimicarb (Aphox 1.0 g/litre) was used twice in June 1991 and once in August, while in 1992 a spray of heptenophos (Hostaquick 0.75 ml/litre) in April was followed by three sprays of oxydemeton-methyl (Metasystox R 0.38 ml/litre) between early May and late July.

Observations of 'garden performance' on finished standard stems

Following the main trial, a small number of plants of each treatment were lifted and re-planted in February 1993 to observe 'garden performance' following planting out. Of particular interest was to observe the amount of further sideshoots that the 'mature' stems might produce, as well as to see whether there were any further influences of the stems on flowering.

Three Grade 1 plants of each stem x scion combination were planted out in rows 3.0 m apart x 0.8 m in the row. A total of 3 rows 47 m long were required which included 2 guard plants of cv. Melody Maker at each end. The 'finished plants' had been undercut while in the main trial site the previous autumn, and had heads pruned. Planting furrows were drawn out and a liberal dressing of stable manure spread along the base. Plants were supported individually with stakes inserted in position prior to planting. Alleys between the rows were grassed down in the spring

and kept mown that year, leaving an approximately 1 m strip down the row kept weed free with an application of residual herbicide backed up by occasional hand weedings.

Sprays for Aphids, Powdery Mildew, Black Spot etc. were applied during the year as required using products as for the main trial.

Records and analysis of results

The following records were taken during the trial:

1. The budtake of stem selections on the Laxa rootstocks (April 1991).
2. The diameter of stems in July 1991 at 1.1 m height.
3. A grade for stem straightness in August 1991, prior to budding.
4. A record of the number of "viable" stems, ie those of sufficient height and diameter to have been budded with the flowering cultivars.
5. The budtake of flowering cultivars on the stems (early May 1992).
6. Flower production (July 1992).

Final assessments (November/December 1992):

7. Number of intact scion unions and number of main shoots per head.
8. Quality grade of head (overall shape, vigour and shoot number).
9. Final quality grade for stem straightness.
10. Counts of side shoots removed between May and September 1993 from the 'garden performance' observation plants.

In addition to the quantifiable records above, observations were made of any susceptibility of stems to diseases, stem thorniness, the degree of sideshoot removal required (both in the stem training year 1991, and the final year 1992), and the ease of managing the stems.

The % budtake, and % in each Grade 1 - 3 as well as mean grade were calculated on the basis of both the nominal number of 12 plants per plot, and the number of plants present or budded as appropriate. Mean stem or head grades were calculated as a weighted mean:

$$\text{Mean grade} = \frac{(\text{No. in Grade 1}) + (2 \times \text{No. in Grade 2}) + (3 \times \text{No. in Grade 3})}{\text{No. plants present}}$$

Analyses of variance (ANOVA's) were carried out on data where appropriate, with angular transformations of percentages in grade data where required. Regression analysis using a binomial model were used to analyse the percentage budtake of stems onto the Laxa rootstock.

RESULTS AND DISCUSSION

Budtake of stems on Laxa rootstocks

The mean percentage of successful budtakes and 'shot buds' (ie those that had grown the previous autumn), from a nominal 12 rootstocks per plot as recorded on 25 April 1991 were as follows:

Table 1: Budtake and 'shot bud' of stem selections on Laxa rootstocks

Stem selection		Proportions from a nominal 12 rootstocks per plot % budtake	% shot buds
1/9	G278 (Shardlow)	93.3	5.3
2	Harwhippet	94.0	0.6
3	Dan Whiteside	90.7	8.9
4	G278 (Rearsby)	88.9	3.3
5	Pfander	88.9	10.0
6	Kiese (Le Grice)	95.8	17.2
7	Kiese (Jones)	96.3	15.0
8	De la Grifferaie	88.0	10.6
10	K2103	89.3	5.6
	Approx. SED (154 df)	*2.55*	*n.a.*
	LSD (5%)	*5.04*	
	Significance, P	*<0.01*	

Regression analysis showed that there were differences between stem selections in their budtake on the rootstock ($P<0.01$). The stem selection Kiese (both sources) had the highest budtake, and De la Grifferaie, G278 (Rearsby) and Pfander, the lowest. Throughout the trial, only one person (an experienced contract rose budder) was responsible for all budding, to minimise variability in the operation. Although all budwood was collected from the same stock plants, differences in the quality of wood between stem types (such as sap flow) may have contributed to budtake success as well as possible compatibility differences. Also a few stem buds developed later from the rootstocks which, although too late to produce good stems, accounted for the apparent reduction in missing plants for some stems between this budtake record and the data in Table 3 (p. 12).

The proportion of 'shot buds' was highest for the Kiese stem selections. This was noted too in a previous trial at Luddington where the *R. multiflora* stem types including De la Grifferaie and Dan Whiteside also produced a high proportion of shot buds. This early shooting of buds in the

budding year has not proved a significant problem provided they are pruned back to about 5 mm of the base of the shoot prior to growth the following spring (typically when stocks are headed back). This then reduces the likelihood of a kink developing in the base of the stem.

Diameter and straightness grade of stems prior to budding

Table 2: Mean stem diameter, and stem straightness grade prior to budding

	Stem selection	26 July 1991 Mean diameter mm at 1.1 m	1 August 1991 Straightness grade %Gd1	%Gd2	%Gd3	Mean straightness grade
1/9	G278 (Shard.)	11.6 +	46.4	44.3	9.3	1.63
2	Harwhippet	13.4 +	93.9	6.1	0.0	1.06
3	Dan Whiteside	8.6 -	67.0	25.6	7.5	1.41
4	G278 (Rears.)	11.2	40.9	46.3	12.8	1.72
5	Pfander	10.7	90.3	9.2	0.5	1.10
6	Kiese (Le Grice)	9.9 -	85.9	14.1	0.0	1.14
7	Kiese (Jones)	10.0 -	87.4	12.0	0.6	1.13
8	De la Grifferaie	11.2	97.4	2.6	0.0	1.03
10	K2103	11.6 +	48.0	43.2	8.8	1.61
	Mean	*10.96*				
	SED (154 df)	*0.23*				*0.063*
	LSD (5%)	*0.5*				*0.12*
	Significance, P	*<0.001*				*<0.001*

\+ = significantly > mean (P<0.05)
\- = significantly < mean (P<0.05)

Grade 1 = Good stem straightness
2 = Some slight bend or kinks, but acceptable
3 = Bad bends or kinks; unmarketable

The data in the table above are means of stems of sufficient height to be recorded at that time, although budding actually took place about four weeks later when a few more of the shorter stems were available for budding, and stems had generally thickened further. Harwhippet was clearly the thickest stem, followed by G278, K2103 and De la Grifferaie. Pfander and Kiese were slightly thinner, but in most cases quite thick enough for budding. Dan Whiteside was by far the thinnest stem and a significant number could not be budded.

De la Grifferaie gave the highest percentage of Grade 1 and best mean straightness grade, followed by Harwhippet. Pfander and Kiese also produced a good proportion of straight stems with 85 - 90% in Grade 1. Dan Whiteside only had 67% of the assessed stems in Grade 1 while

both the John Innes selections G278 and K2103 were particularly poor with 41 - 48% Grade 1 stems. These latter selections also produced a significant number of very crooked Grade 3 stems regarded as 'unmarketable'.

The data for stem diameters in Table 2 compares very well to the Luddington data in Appendix IV, Table 1 p. 35 and Appendix V, Table 1 p. 39 for the 1987 and 1988 planted trials. A very similar ranking of stem diameter was found confirming Harwhippet as the thickest stem, followed by G278, K2103 and De la Grifferaie of similar thickness. Pfander followed, and was slightly thicker than Kiese. Of the two Kiese sources, that from C&K Jones appeared to be slightly more vigorous. Apart from *Rosa rugosa,* Dan Whiteside was, in nearly all cases the weakest stem, although in the 1988 Luddington trial, its mean height and diameter were slightly greater than for Kiese (Le Grice).

The Luddington results for stem straightness is in Appendix IV and V, Table 2 pp. 36 and 40. As with the Efford results, De la Grifferaie emerged as the straightest stem closely followed by Harwhippet then Pfander which gave slightly straighter stems than Kiese, again with Kiese (Jones) performing slightly better than the Le Grice source. These differences between the two Kiese sources suggests that they may indeed represent true clonal differences, although visually they appear identical. Their history prior to being obtained for this trial work is unclear.

Proportion of "viable" stems at budding

Table 3, p.12 indicates the proportion of stems successfully budded, not budded or missing as a percentage of the rootstocks planted. Some missing plants were due to budding failures on the rootstock, and others due to breakages of the stem near or from the stock, typically in the early stages of training. The stems present but not budded were due to either stems that were too short or thin at the time of budding, including a few where terminal points had been lost below the budding height of 1.1 m.

Table 3: Proportions of budded, not budded and missing plants, as % of rootstocks planted, after budding with flowering cultivars in August 1992

Stem Selection		% Budded	% Not Budded	% Missing
1/9	G278 (Shard.)	91.9	3.2	4.9
2	Harwhippet	88.0	6.0	6.0
3	Dan Whiteside	69.4	13.9	16.7
4	G278 (Rears.)	89.8	3.7	6.5
5	Pfander	79.6	5.1	15.3
6	Kiese (Le Grice)	94.4	0.5	5.1
7	Kiese (Jones)	88.4	1.9	9.7
8	De la Grifferaie	87.5	1.9	10.6
10	K2103	94.0	1.9	4.1

Kiese (Le Grice), K2103 and G278 (Shardlow) had in excess of 90% of the original rootstock stand of stems budded, followed by G278 (Rearsby), Kiese (Jones), Harwhippet and De la Grifferaie with 87 - 90% buddable. Plots of Pfander had less than 80% buddable stems with over 15% of plants missing. A few losses were due to budtake failures of Pfander buds on the rootstock, but some additional losses occurred during the stem production year. The reasons for these subsequent losses with Pfander are unclear, but breakages of the stem growing points before they were secured to the canes by taping may have been partly responsible. There appeared to be a slight positional effect to these losses, with more in the north west and north central blocks (subsequently budded with Royal William and Many Happy Returns), but none in the north east block (later budded with Silver Jubilee). This is consistent with the erratic wind damage effects that have been observed with bush roses, although there has been no evidence (from earlier trials at Luddington, nor subsequent trials at Efford) that Pfander stems are more 'brittle' and therefore susceptible to breakage.

Less than 70% of the original stand of Dan Whiteside plots had buddable stems with some 17% of plants missing and 14% of stems unbuddable due to being too short, spindly or damaged.

Budtake of flowering cultivars on stems

Apart from a few exceptions, all stems that made the grade were budded with 3 scions per stem. The proportion of budded stems where two or more buds out of three took, gave an indication of the potential final success of the heads, as a minimum of two bud unions per stem is required for standard roses under British Standard BS 3936 Part 2. Regression analysis indicated significant differences between the flowering cultivars ($P<0.001$), but overall differences between the stem selections were smaller and not significant. There was however a significant interaction between stem selection and flowering scion cultivar ($P<0.01$). The mean proportion

of "two plus" takes for scion type is shown in Table 4, and was poorest for Freedom and Margaret Merril. Within these two flowering cultivars, the smallest proportions of 'two plus' takes were on the stems De la Grifferaie and Harwhippet (79 - 86 %) with some poor takes of Margaret Merril on G278 (84 and 89 % for the Rearsby and Shardlow selections respectively), and 89 % with Freedom on G278 (Shardlow). In addition, Many Happy Returns on Pfander had a low mean of 76 % 'two plus' takes on budded stems. This scion/stem combination also had a large number of missing or not budded stems within the three replicate plots.

Table 4: Mean proportion of budded stems for each scion where two or more (out of 3/stem) buds took, May 1992

Scion cultivar	% of stems with 2+ buds taken
Royal William	97.1
Many Happy Returns	96.4
Silver Jubilee	98.7
Freedom	90.5
Margaret Merril	90.5
Amber Queen	97.8
SED (114df)	*1.67*

When budtake is examined in terms of all three scion buds per stem rather than the proportion of stems with two or more successful takes, the pattern is broadly similar with Freedom and Margaret Merril showing poorer mean budtake (mean of 2.52 buds/stem = 84%) than the remaining scions (mean of 2.82 buds/stem = 94%) ($P<0.001$), (see Table 5, p. 14). However, there is also an indication of an effect of the stem selection, with Harwhippet and De la Grifferaie giving a slightly lower average of 2.60 budtakes per stem (87%) than most of the remaining stems (2.74 budtakes per stem or 91%).

Table 5: Budtake of scion buds on budded stems May 1992; means of main treatment effects.

Stem selection		Mean taken buds/stem	% budtake	Flowering scion	Mean taken buds/stem	% budtake
1/9	G278 (Shard.)	2.71	90.2	Royal William	2.81	93.8
2	Harwhippet	2.60	86.8	Many Happy Returns	2.73	92.5
3	Dan Whiteside	2.77	94.2	Silver Jubilee	2.87	95.6
4	G278 (Rears.)	2.73	91.0	Freedom	2.54	84.8
5	Pfander	2.68	89.8	Margaret Merril	2.47	82.5
6	Kiese (Le Grice)	2.75	91.7	Amber Queen	2.79	92.9
7	Kiese (Jones)	2.75	91.6			
8	De la Grifferaie	2.60	86.6			
10	K2103	2.74	91.4			
	SED (114df)	*0.063*		*SED (10df)*	*0.067*	
	LSD (5%)	*0.12*		*LSD (5%)*	*0.15*	
	Significance, P	*0.057*		*Significance, P*	*<0.001*	

For the Luddington data for the 1987 planted trial, apart from *Rosa rugosa* which had poor budtake, generally there was no significant difference in budtake between the other stem selections apart from Silver Jubilee which was somewhat poorer on Harwhippet and Kiese (Le Grice). Harwhippet had been reported as sometimes producing excessive callus following budding which, when severe, appeared to 'push' the bud away from the stem. Elsewhere, the callus has been found to grow round the bud shield and in extreme cases obscure the bud. This, together with possible tissue damage to budding sites following dethorning prior to budding, could account for the slightly poorer budtake observed with Harwhippet.

From earlier work at Shardlow Hall, Derbyshire, De la Grifferaie was said to have exhibited some incompatibility problems. No documentary evidence of this has been found, and while there appeared to be no problems with budtake on this stem in the 1987 Luddington trial, a slightly poorer budtake was found at Efford with the cultivars Freedom and Margaret Merril, which were not used at Luddington. The causes of incompatibility are not well understood, but viruses within either stock, scion or both are sometimes thought to be involved. The virus status of all the stem selections were unknown at the time of this project. Efforts are currently under way to test these selections for the most widespread viruses known to infect roses.

Head development and flower production

It was observed during early growth of the scion buds in April 1992 that heavy callus production around some scion buds on Harwhippet following budding, was inhibiting the development of

some shoots. Most, however, were breaking through, albeit with some delay. By late June this effect was still apparent with generally smaller heads on Harwhippet, particularly with the cvs. Margaret Merril and Silver Jubilee. Heads on Dan Whiteside were also noted as being later to start flowering with those budded with Margaret Merril, Freedom and Amber Queen, although no clear difference was apparent with the other head cultivars.

The overall flowering seasons (June / July flush) for each head was characteristic of the cultivar:

Freedom	early/mid
Margaret Merril	early
Amber Queen	mid
Royal William	late
Many Happy Returns	mid
Silver Jubilee	mid
Melody Maker (guards)	late

A count of flowers was made on samples of plants with three intact unions in the flowering head. Three plants in each of the three replicates of each head/stem combination were recorded in mid July 1992 prior to any shoots being taken as budwood. Unopened buds, open flowers and dead flowers were included, and the number of main shoots bearing flowers counted. Although not statistically analysed, there did not appear to be any interaction between stem and head types, and the main effects are presented in Table 6, p. 16.

The head cultivar had the largest effect on flower numbers present at that time. As to be expected the floribundas, especially Many Happy Returns, had the greatest numbers of flowers, and the hybrid teas, especially Royal William, the least.

Mean differences in flower number between stems was small. Dan Whiteside and De la Grifferaie had the largest number of flowers per shoot, but with Pfander averaging more flowering shoots per plant, the net effect was that Pfander had slightly more flowers per plant than the other stems on average. The data only reflects flowering at one point through a long flowering season, and as differences between stems were only small and the data was not subject to statistical analysis, no conclusive effect of stem type on flowering can be said to have been observed.

Table 6: **Flower and head shoot numbers, mid-July 1992 (means of 9 plants per scion/stem treatment)**

Treatment		Flowering shoots per plant	Flowers per plant	Flowers per shoot
Stem selection				
1/9	G278 (Shard.)	6.3	27.2	4.4
2	Harwhippet	5.6	25.8	4.6
3	Dan Whiteside	5.9	33.4	5.8
4	G278 (Rears.)	6.3	28.0	4.5
5	Pfander	7.0	36.0	5.2
6	Kiese (Le Grice)	6.6	32.6	5.0
7	Kiese (Jones)	6.0	30.6	5.2
8	De la Grifferaie	5.2	29.8	5.7
10	K2103	6.6	31.0	4.7
Scion cultivar				
	Royal William	6.2	11.2	1.9
	Many Happy Returns	7.1	64.2	9.3
	Silver Jubilee	6.1	16.3	2.8
	Freedom	5.8	18.3	3.3
	Margaret Merril	5.1	29.7	5.9
	Amber Queen	6.8	41.2	6.4

Wind damage to heads ('blow-out')

In mid to late June strong winds caused the shoots on some heads to break at the bud union (commonly known as 'blow-out'). While not severe over the trial as a whole, Amber Queen appeared to be the worst affected followed by Many Happy Returns and Royal William. Wind damage can be very localised, and although a positional effect cannot be ruled out, Amber Queen and Royal William have shown susceptibility to blow-out in other trials, and in this case they were in opposite corners of the plantation. There did not seem to be any clear indication of stem influence observed at that stage although Silver Jubilee heads on De la Grifferaie were damaged more than on other stems.

Final grade-out:

Number of intact scion unions and blow-out

Table 7: Number of intact scion unions at final grade-out / budded stem

Stem selection		Mean scions / budded stem, ('blow-out' losses > 0.2 / stem)						
	Flowering cv.	Freedom	M. Merril	A. Queen	R. Will.	M. H. R.	S. Jubilee	Mean
1/9	G278 (Shard.)	2.81	2.53	2.56 (0.26)	2.81	2.57 (0.29)	2.83	*2.68*
2	Harwhippet	2.38	2.29	2.21 (0.43)	2.37 (0.55)	2.46 (0.29)	2.69	*2.40*
3	Dan Whiteside	2.74	2.72	2.09 (0.69)	2.04 (0.80)	2.33 (0.33)	2.80	*2.45 (0.32)*
4	G278 (Rears.)	2.66	2.31	2.51 (0.32)	2.77	2.69	2.97	*2.65*
5	Pfander	2.64	2.74	2.63	2.70	2.27	2.92	*2.65*
6	Kiese (Le Grice)	2.38	2.53	2.08 (0.72)	2.66 (0.23)	2.55	2.82	*2.50 (0.25)*
7	Kiese (Jones)	2.55	2.44	2.56 (0.34)	2.66	2.71	2.81	*2.62*
8	De la Grifferaie	2.58	2.42	2.26 (0.55)	2.51	2.47 (0.22)	2.37 (0.48)	*2.43*
10	K2103	2.82	2.60	2.50 (0.35)	2.86	2.50 (0.30)	2.91	*2.70*
Mean		*2.64*	*2.51*	*2.39 (0.39)*	*2.62*	*2.51 (0.22)*	*2.79*	*2.58*

Statistical comparisons of scions / budded stem:

Scion x stem selection comparisons:	*Significance, P*	*0.003*
	Approx. SED (114df)	*0.164*
	LSD (5%)	*0.32*
Comparing main scion effect means:	*Significance, P*	*<0.001*
	SED (10df)	*0.056*
	LSD (5%)	*0.12*
Comparing main stems effect means:	*Significance, P*	*<0.001*
	Approx. SED (114df)	*0.066*
	LSD (5%)	*0.13*

Harwhippet, Dan Whiteside, and De la Grifferaie showed lower than average mean numbers of intact scion unions per budded stem, whereas G278, Pfander, and K2103 were above average, though not significantly so. With the scion cultivars, Amber Queen was significantly below average, whereas Silver Jubilee was significantly above average. With Silver Jubilee, an exception to good scion number occurred with De la Grifferaie where a large number of blow-outs were recorded. Blow-outs also appeared to be mainly responsible for the lower numbers of intact scion unions on Amber Queen, and Many Happy Returns, although on Royal William blow-out damage was most significant on Harwhippet and Dan Whiteside. There is some indication that heads on De la Grifferaie, Dan Whiteside and to a lesser extent Harwhippet stems, were slightly more susceptible to blow-out damage than the other selections, possibly indicating a slightly weaker stem union. This appeared particularly so with the De la Grifferaie / Silver Jubilee combination, and may be a further indication of some incompatibility problems

with this stem. However, due to the sporadic nature of the blow-out damage, and because losses by blow-out were not formally analysed, this, at present, is only speculation. No problems with budtake or head quality were observed with De la Grifferaie at Luddington EHS in the 1987 trial where three scion cultivars, including Silver Jubilee, were used (see Appendix IV Tables 3 and 4, pp. 37 and 38).

What is clearer is that the lower budtake found with Margaret Merril and the good budtake found with Silver Jubilee in Table 5 (p. 14), is reflected in the number of intact scions present at the final grading, whereas Freedom, which also had a relatively poor budtake, suffered few losses by blow-out and had better final bud union numbers than Amber Queen where budtake was better, but where blow-out damage was severe.

Number of main basal shoots per intact scion

Table 8, shows the mean number of basal shoots produced per intact scion union. Both stem selection and scion cultivar produced significant main treatment effects ($P<0.001$), but there was no significant stem x scion interaction ($P=0.114$).

Table 8: Mean number of shoots per intact scion at final grading. Main treatment effects.

Stem selection		Mean number shoots / scion	Flowering scion	Mean number shoots / scion
1/9	G278 (Shard.)	2.55	Royal William	2.30
2	Harwhippet	2.95	Many Happy Returns	2.86
3	Dan Whiteside	2.75	Silver Jubilee	2.96
4	G278 (Rears.)	2.69	Freedom	2.47
5	Pfander	3.32	Margaret Merril	2.03
6	Kiese (Le Grice)	2.69	Amber Queen	3.64
7	Kiese (Jones)	2.39		
8	De la Grifferaie	2.64		
10	K2103	2.58		
	Approx. SED (114df)	*0.132*	*SED (10df)*	*0.101*
	LSD (5%)	*0.26*	*LSD (5%)*	*0.20*
	Significance, P	*<0.001*	*Significance, P*	*<0.001*

For those buds that had taken, Pfander produced more shoots per bud on average than any of the other stems, followed by Harwhippet. Although both De la Grifferaie and Harwhippet had slightly lower budtakes on average than the remaining stem selections (Table 5, p. 14), final shoot production for buds which took appeared unaffected. However, a lack of competition for space, nutrients and water resources, both within plants where fewer buds had taken, and

between plants where there were missing or unbudded stems, may have favoured growth from the remaining buds.

Amber Queen clearly produced the greatest number of main shoots per bud. This is characteristic of this cultivar, although shoots are thinner than other more vigorous cultivars. Silver Jubilee and Many Happy Returns followed, then Freedom and Royal William, with Margaret Merril producing the fewest shoots per bud, only two thirds the number of the first three cultivars. This is also characteristic of Margaret Merril where a lower than average grade-out of bushes is also often found. Royal William, although very vigorous, frequently produces relatively few, but tall, shoots.

Final head, stem and overall plant grades

Stems were graded on the same basis as used in August 1991. Heads were graded as follows:

Grade 1 = 2 or 3 intact scion unions, with at least 2 unions each producing at least 2 basal breaks, and an overall well balanced head shape.

2 = At least 2 intact scion unions. A slightly imbalanced head shape acceptable.

3 = Less than 2 scion unions and / or an unacceptably imbalanced head shape. These plants regarded as unmarketable.

An overall plant grade was given on the basis of the combination of stem and head grades, taking the lower of the two grades as the overall plant grade. Thus a Grade 1 plant overall would need both a Grade 1 head and stem, and a Grade 1 head + Grade 3 stem would be downgraded to Grade 3 overall.

The following tables summarise main effects of the combined stem and scion analysis. Stem x scion interactions in nearly all cases were not statistically significant for the combined analyses. However individual treatment means and % of stems present in Grade 2 are given in Appendix III, p. 33 where separate analyses for individual scions were carried out.

Table 9: **Final stem grade-out December 1992. Main treatment effects showing % Grade 1 and mean grade of plants present. % Grade 1 is angle transformed data (actual % in brackets).**

Stem selection		% Grade 1 angle transf.	Mean grade	Flowering scion	% Grade 1 angle transf.	Mean grade
1/9	G278 (Shard.)	30.5 (27)	1.92	Royal William	42.0 (49)	1.74
2	Harwhippet	71.6 (85)	1.19	Many Happy Returns	47.5 (56)	1.63
3	Dan Whiteside	34.2 (33)	1.86	Silver Jubilee	48.8 (58)	1.53
4	G278 (Rears.)	30.8 (27)	2.02	Freedom	49.5 (58)	1.53
5	Pfander	68.6 (83)	1.20	Margaret Merril	53.9 (63)	1.50
6	Kiese (Le Grice)	56.8 (66)	1.40	Amber Queen	45.2 (51)	1.66
7	Kiese (Jones)	60.8 (75)	1.28			
8	De la Grifferaie	68.1 (82)	1.20			
10	K2103	26.5 (22)	2.00			
Approx. SED (114df)		*3.44*	*0.059*	*SED (10df)*	*3.48*	*0.072*
LSD (5%)		*6.8*	*0.12*	*LSD (5%)*	*7.8*	*0.16*
Significance, P		*<0.001*	*<0.001*	*Significance, P*	*0.084*	*0.046*

The scion cultivar would not be expected to directly influence the stem straightness, especially as the stem had grown its basic form prior to being budded, and indeed there are no significant differences in the overall % Grade 1 stems between scions. However as a mean grade-out score, stems budded with Freedom, Silver Jubilee, and Margaret Merril were somewhat straighter than Royal William by the end of the trial ($P=0.046$). Although statistically significant, it is difficult to explain this as other than a chance result.

The differences in stem straightness between selections apparent in August 1991 were still present at the final grading, and the increased girth that the stems had made did not 'iron out' any stem kinks present. For all selections, the % Grade 1 stems were lower at the final grade-out, although as some subjective judgement was involved in the grading process, a slightly stricter judgement may have been applied to the later grading resulting in lower scores. Nevertheless, the overall pattern was broadly similar with Harwhippet, Pfander and De la Grifferaie giving the straightest stems closely followed by the two Kiese clones with Dan Whiteside, the G278 clones and K2103 giving the least straight stems ($P<0.001$).

Table 10: Final head grade-out December 1992. Main treatment effects showing % Grade 1 and mean grade of plants present. % Grade 1 is angle transformed data (actual % in brackets).

Stem selection		% Grade 1 angle transf.	Mean grade	Flowering scion	% Grade 1 angle transf.	Mean grade
1/9	G278 (Shard.)	56.5 (60)	1.40	Royal William	55.6 (66)	1.45
2	Harwhippet	46.1 (52)	1.69	Many Happy Returns	45.6 (52)	1.64
3	Dan Whiteside	53.4 (62)	1.49	Silver Jubilee	64.8 (78)	1.27
4	G278 (Rears.)	56.8 (69)	1.44	Freedom	52.3 (68)	1.50
5	Pfander	67.8 (82)	1.22	Margaret Merril	60.7 (75)	1.35
6	Kiese (Le Grice)	51.9 (62)	1.50	Amber Queen	49.4 (56)	1.60
7	Kiese (Jones)	51.5 (61)	1.56			
8	De la Grifferaie	48.2 (55)	1.63			
10	K2103	58.7 (71)	1.36			
Approx. SED (114df)		*3.45*	*0.072*	*SED (10df)*	*2.20*	*0.052*
LSD (5%)		*6.8*	*0.14*	*LSD (5%)*	*4.9*	*0.12*
Significance, P		*<0.001*	*<0.001*	*Significance, P*	*<0.001*	*<0.001*

Table 10 shows both stem selection and flowering scion cultivar had a significant effect on final head grade-out both as % of Grade 1 heads and mean grade ($P<0.001$). Silver Jubilee and Margaret Merril produced a higher % of Grade 1 heads than Freedom, Amber Queen and Many Happy Returns with Royal William giving and intermediate result. Mean head grade followed a similar pattern. Although Margaret Merril produced fewer basal shoots per bud than some other scions, and budtake was poorer on average, the lower losses from blow-outs clearly helped to ensure a relatively good final head grade.

Pfander produced clearly the highest proportion of Grade 1 heads on average, and the best mean head grade, although mean head grade was not significantly better than K2103. Harwhippet and De la Grifferaie produced disappointing mean head grades, and this was probably a reflection of the poorer budtake on these stems.

The Luddington 1987 trial data for head quality was not formally analysed, but mean results for each stem (averaged across the three scion cultivars used) is given in Appendix IV, Table 4, p. 38. Generally, head grades appeared to be good. The poorer budtake of *Rosa rugosa* is reflected in slightly poorer % of top and mean head grades. Harwhippet also had a slightly lower head grade-out similar to *R. rugosa*, and this may have been a reflection of slightly poorer budtake or shoot development following callus problems as observed at Efford. Otherwise there did not appear to be any noticable differences in head quality between the stems.

Table 11: Final overall plant grade-out December 1992. Main treatment effects showing % Grade 1 and mean grade of plants present.

	Stem selection	% Grade 1	Mean grade	Flowering scion	% Grade 1	Mean grade
1/9	G278 (Shard.)	34	2.02	Royal William	36	1.93
2	Harwhippet	46	1.77	Many Happy Returns	35	1.93
3	Dan Whiteside	24	2.03	Silver Jubilee	48	1.67
4	G278 (Rears.)	22	2.13	Freedom	44	1.86
5	Pfander	72	1.33	Margaret Merril	49	1.71
6	Kiese (Le Grice)	47	1.69	Amber Queen	33	1.96
7	Kiese (Jones)	51	1.67			
8	De la Grifferaie	50	1.69			
10	K2103	20	2.06			
	Approx. SED (114df)		*0.072*	*SED (10df)*		*0.079*
	LSD (5%)		*0.14*	*LSD (5%)*		*0.18*
	Significance, P		*<0.001*	*Significance, P*		*0.015*

As reflected in the head grade-out, stems budded with Silver Jubilee and Margaret Merril gave the best overall plant grade out ($P=0.015$). The stem selection main effect was highly significant ($P<0.001$), with Pfander producing the best % Grade 1 plants (averaging 72% of stems present), and the best mean overall plant grade. There was no significant difference between the mean overall plant grades for both sources of Kiese, De la Grifferaie and Harwhippet, but all showed significant improvements over both sources of G278, Dan Whiteside and K2103.

Examination of the head grade and overall plant grade results from the individual scion analyses in Appendix III, p. 33, shows a good degree of consistency in the pattern of the top four rankings in the % of plants in Grade 1 (highlighted in bold type). For the head grade out, Pfander and the similar G278 and K2103 selections feature in the top four rankings. For the overall plant grade-out taking stem straightness into consideration however, in nearly all cases Pfander comes out as the clear leader, followed by Kiese, De la Grifferaie and Harwhippet in a varying ranking order.

For a full economic consideration of the data, final grade-outs should be considered in terms of the % in each grade as a proportion of the original numbers of rootstocks planted (ie in this trial 12 plants / plot). The data in Appendix III allows grades to be converted if required, and for some stem / scion combinations the 'bottom line' yields of quality plants would be significantly reduced. For example with Many Happy Returns and Amber Queen on Pfander where there were only 6.0 and 8.7 plants / plot on average respectively, the Grade 1 plant yield would fall

from 58% and 71% as a proportion of plants present to only 29% and 51% Grade 1 plants as a proportion of rootstocks planted.

Where plants were missing due to an inherent stem characteristic, then it is valid to take this into account when comparing stems for performance. In this trial, many of the losses with Dan Whiteside were due to such weak stem growth that they failed to make a grade for budding. However for the other stems it is likely that most losses were attributable to random damage by wind or during training. The other main source of losses is from the original budtake on the *Rosa* Laxa rootstocks (see Table 1, p. 9) where up to 12% of plant losses occurred. Although there were statistically significant differences between stems in % take on the rootstock, there is not enough evidence from this or previous trials to indicate that these reflected true differences between the stem selections, or whether it was a feature of variations in the quality of budwood peculiar to that particular season. As a study to investigate and compare inherent performances of the stem selections, it is therefore reasonable to compare grades on the basis of plants present and thus eliminate extra variability due to differences in plant stands.

Other characteristics of stem selections

Some of the other important stem characteristics observed during the trial are summarised in Table 12, p. 24.

During the stem growing year in particular, Harwhippet and De la Grifferaie produced relatively few sideshoots in the leaf axils, in contrast to Dan Whiteside which sideshooted very freely. K2103 and G278 produced rather more than Kiese and Pfander. The number of sideshoots requiring removal, and the frequency that this operation needs to be carried out clearly has significant implications for the labour requirement for management of the crop. During the stem growing year, regular taping of shoots to canes and sideshoot removal can take up a large proportion of the labour input into the crop.

The degree of thorniness of the stems had implications for the ease of preparation for budding. Thorns had to be removed from the budding zone, and ideally buds needed to be inserted into 'T' cuts made in-between thorn scars. Occasionally there was some tissue browning underneath thorn scars, and it was believed that this could affect successful budtake. The large and densely packed thorns on Harwhippet made finding such areas virtually impossible, necessitating budding into areas with thorn scars. Dethorning the budding zones on Harwhippet was also more time consuming than on other cultivars. A well protected gloved hand run around the stem was found to be the best method for coping with Harwhippet thorns, whereas on other selections they were removed individually with a thumb. The thorniness associated with Harwhippet is inherited from one of its parents, the climbing rose 'Maigold'. The other parent is a Harkness seedling of a mixed floribunda line.

Table 12: Summary of sideshoot production, stem thorniness, leaf and flower characteristics of stem selections

Stem selection	Side shoots	Stem thorniness	Leaves	Flowers
G278	* * *	*	Long, pale green leaflets	Clusters of white / tinged pink, double flowers
K2103	* * *	*	Long, pale green leaflets	Clusters of white / tinged pink, double flowers
Harwhippet	*	* * * * *	Large, glossy, dark / mid green leaflets	Clusters of white, double flowers, late
Dan Whiteside	* * * * *	nil	Long, rugose, pale / mid green leaflets with feathered petiole.	Clusters of single white flowers
Kiese	* *	* *	Large, dark green glossy leaflets with rugose upper surface	Small clusters of single pink flowers
Pfander	* *	* *	Slightly smaller leaflets than Kiese, less glossy and with doubly serrate margins	Small clusters of white / pink edged single flowers. Later than Kiese
De la Grifferaie	*	* *	Large, matt, dark green leaflets	Large showy clusters of double flowers, dark turning to pale pink

The stem selections show differences in the degree to which they develop autumn and winter colour. All are green when actively growing in the spring and summer. In winter, particularly where stems have been exposed to full sunlight, Pfander develops a bright crimson colouring not unlike that of *Cornus alba* 'Sibirica' (syn. 'Westonbirt'). Kiese also develops a red colouring, but is a much darker maroon colour rather similar to *Cornus alba* 'Elegantissima'. There is a little tingeing of red colour on the G278 and K2103 clones. De la Grifferaie remains green.

Diseases affecting stems

Leaf diseases were not a significant problem in the trial at Efford, although a fungicide programme effective against Rust, Powdery Mildew and Black Spot was used. From observations on the stock plants however, where dense growth later in the season makes frequent spraying impossible, it appears that the stem selections were generally trouble free under field conditions.

Where some plants have been kept under protection, however, Powdery Mildew has seriously infected De la Grifferaie in particular, and to a lesser extent G278 and K2103.

Although not attributable to any pathogen, a notable feature of Pfander was the progressive loss of leaves from the bottom up which occurred during the stem growing year from early August onwards. Leaves desiccated, turning a dull green colour from the tip backwards while still firmly attached to the stem. They eventually died completely and dropped off. Sap flow to the growing points of the stem higher up appeared to be unaffected however, and during budding the stem appeared to be as full of sap at the budding position as the other stems. In addition, this selection was the first to lose its leaves in the autumn, in contrast to the closely related *R. canina* Kiese. This observation has also been noted in commercial crops with this stem and subsequent trials at Efford.

Of more serious nature was the occurrence of some diseases on the stems themselves. During a prolonged wet spell in the summer of the stem growing year 1991, *Botrytis* lesions affected several stems of Dan Whiteside, girdling the stem completely and killing the top growth in some cases. Where these lesions occurred low down stems could not be budded and were wasted.

Some stems were affected in the following head growing year by a very different lesion which either appeared at the top of the stem or within the head and spread downwards, or more typically spread upwards from the base of the stem at the union with the rootstock. The lesion started as a darkening discoloration of the stem which turned black as it progressed. Where stems were affected early in the season, head shoots failed to develop more than 10 cm or so before the whole stem and head died. Most stems that were affected developed symptoms during late July and August onwards, after head development was advanced, and further growth was stunted, foliage began to yellow and brown followed by eventual death of the head. The woody stem tissue was stained brown when leading edges of the lesion were cut.

This disease affected several plants of a range of selections, and none appeared to show any resistance to it. Several plant samples were analysed by ADAS pathology laboratories. A *Phomopsis* sp. was isolated from one sample, and *Phomopsis mali* has been found to cause cankers in rose in the USA and Italy. However, a positive identification of a pathogen to species

level could not be made from the Efford samples. Several samples from commercial nurseries have also failed to provide positive disease identification. The disease may have entered through budding or heading back wounds at either the rootstock union at the base or scion unions or cut stem position higher up. This disease appears to be different from some others caused by species such as *Leptosphaeria* and *Coniothyrium* spp. which can form other types of discoloured or stem cracking lesions. More recently trials have been given regular protectant sprays of the broad spectrum fungicide prochloraz (Octave) during both the stem and head growing year, and this appears to have given effective control of the problem, though work is still required to isolate and identify the disease involved.

Observations of subsequent 'garden performance'

Stem sideshoots were removed and counted on four occasions during the 1993 season, ie. 6 May, 8 June, 5 August and 6 September, and the totals for each stem type and scion cultivar are summarised in Table 13. Stem type was plainly still affecting sideshoot production in the first 'garden year', ie. a number of stem types had not 'settled down' and active buds on the stem were still developing. The two stems from originating from John Innes, G278 and K2103, produced the greatest number of sideshoots on average. Dan Whiteside, which in the stem growing year in particular had sideshooted the most freely produced a smaller number in this observation, but still averaged over 4 per plant. De la Grifferaie and Harwhippet, which had developed few sideshoots in their first year produced more in 1992 and 1993. This may have been a reflection of their inherent vigour which, once not directed into production of a tall single stem, was expressed in the production of more sideshoots. There appeared to be differences in the two Kiese sources with Kiese (Jones) growing more sideshoots than Kiese (Le Grice). The stem that produced the least sideshoots was Pfander.

Table 13: Mean numbers of sideshoots removed between May and September 1993

		Mean total sideshoots removed / plant		
Stem selection			**Flowering cultivar**	
1/9	G278 (Shard.)	10.1	Royal William	7.1
2	Harwhippet	3.2	Many Happy Returns	5.4
3	Dan Whiteside	4.2	Silver Jubilee	3.3
4	G278 (Rears.)	8.8	Freedom	3.7
5	Pfander	0.4	Margaret Merril	3.7
6	Kiese (Le Grice)	0.8	Amber Queen	6.6
7	Kiese (Jones)	2.7		
8	De la Grifferaie	2.6		
10	K2103	11.9		

Flowering scion cultivar also appeared to have an effect on sideshoot production. On average, sideshoots were produced more abundantly on Royal William, Amber Queen and Many Happy Returns than on plants of Margaret Merril, Freedom and Silver Jubilee. This result should be treated with some caution, however, as numbers of plants recorded were relatively small compared with the main trial, and no statistical analysis has been applied to the results. Nevertheless, although it is difficult to explain precisely the 'reverse' influence of the flowering scion on the stock or stem, it is possible that the differences in vigour and flower production between the cultivars may be reflected in the partitioning and balance of photosynthetic assimilates between different parts of the plant, and in some cases more may be available to the stems for sideshoot production.

No differences could be seen between stem types on the timing or quality of flowering within a flowering cultivar in 1993.

A small number of plants were lost due to progressive stem diseases as described on p. 25 in 1993 and subsequently in 1994, despite having been apparently healthy at the time of planting. This, together with the unknown virus status of any of the stem selections, suggests that further investigation into rose stem diseases would be beneficial. As standard stem roses represent a valuable investment to the customer, good health status of the planting stock is of particular importance. At present not enough is known about the range of diseases affecting the stems and the effectiveness of preventive control measures both during the production phase and subsequently after planting by the customer.

CONCLUSIONS

The overall objective of this trial was to compare a range of stems for full standard rose production, which, from prior work at Luddington EHS, all showed promising improvements over the traditional stem *Rosa rugosa.* As well as providing further evidence of stem performance from initial trials, an objective was also to test them with a wider range of flowering cultivars than had been possible at Luddington, and to follow plants through with a further years observation for garden performance.

1 The following stem selections gave the best overall performance and are suitable for full standard production using the 3 yr production cycle on Laxa rootstocks:

Rosa canina Pfander (trade name Chessum's Choice, regd. *Chestock*)
Rosa multiflora Harwhippet (trade name Rocket, regd. *Harwhippet)*
Rosa canina Kiese (in particular the clone/source from C&K Jones)
Rosa multiflora De la Grifferaie

Budwood of 'Chessum's Choice' and 'Rocket' is available via the British Association Representing Breeders and is subject to Royalty payments under B.A.R.B.'s standard conditions. Limited quantities of budwood of Kiese and De la Grifferaie is available from HRI Efford, and is not subject to Royalties.

2 The overall yield of Grade 1 plants on **Pfander** was affected by a greater than average number of accumulated plant losses during the trial, but this appeared to be mainly due to chance rather than a defect in the stem itself. Stem straightness, while not as good as Harwhippet or De la Grifferaie, was nevertheless still good, as was the quality of heads produced. The other notable feature of merit with this stem was its low sideshoot production, both during the growing cycle, and of finished plants. Overall, it can be highly recommended for this production method.

3 **Harwhippet** produced the thickest stems and was extremely vigorous, and, along with De la Grifferaie, produced very straight stems. Its thorniness slowed the budding operation, and the tendency to produce excessive callus could upset budtake or subsequent growth of buds, resulting in poorer head quality. There may be ways of reducing some of the excess callus production, possibly by budding earlier or later in the season, but this would require further investigation. With the reservation about budtake in mind, Harwhippet can be recommended for full standard production. Although untested at Efford, the thick stem may be strong enough to be self supporting in a sheltered final planting position. Harwhippet may be unsuitable for half and quarter standard

production, particularly with the daintier patio and miniature cultivars, where vigour and thickness of the stem could produce an imbalanced looking plant.

4 **De la Grifferaie**, as a stem, performed very well producing excellent quality straight stems of good thickness with few sideshoots. However the poorer budtake of Freedom and Margaret Merril in particular, added to speculation that there may be some incompatibility problems with this cultivar. This affected final head quality grade-out, but in terms of overall plant grade at the end of the trial, De la Grifferaie remained within the top four in most cases. Virus testing of this and other selections is currently under way. If viruses were found to be present in this stem, cleaning up the stock might improve budtake if the viruses were involved in any incompatibility effects.

5 There did appear to be some differences in performance between the two sources of **Kiese** stock, with that from C & K Jones showing slightly more vigour and overall performance than the Le Grice source. In other respects Kiese had similar characteristics to Pfander, to which it is related through its *Rosa canina* parentage, although overall performance was not quite as good, and it produced more sideshoots during the garden performance observation year. Along with De la Grifferaie, this selection does not attract royalty payments for the producer, and offers a useful alternative for standard stem production.

6 There appeared to be very little difference between the two numbered stems, **G278** and **K2103**, originating from the John Innes institute, nor any differences between the two sources of G278. Although these stems were very vigorous, and produced good quality heads, their tendency to 'wander' from the vertical during the stem growing year made it very difficult to produce straight stems, and would downgrade them for their suitability for commercial production.

7 **Dan Whiteside**'s performance was disappointing both in Luddington and Efford trials, the vigour generally being too weak to produce good quality straight stems of sufficient thickness, and cannot therefore be recommended.

8 Diseases affecting these stems require further investigation. There is no evidence to suggest the stem selections are any more or less susceptible than *Rosa rugosa*, but until further work has been done, routine applications of a broad spectrum fungicide such as prochloraz (Octave) during the stem and head growing seasons appears to be a sensible precautionary measure.

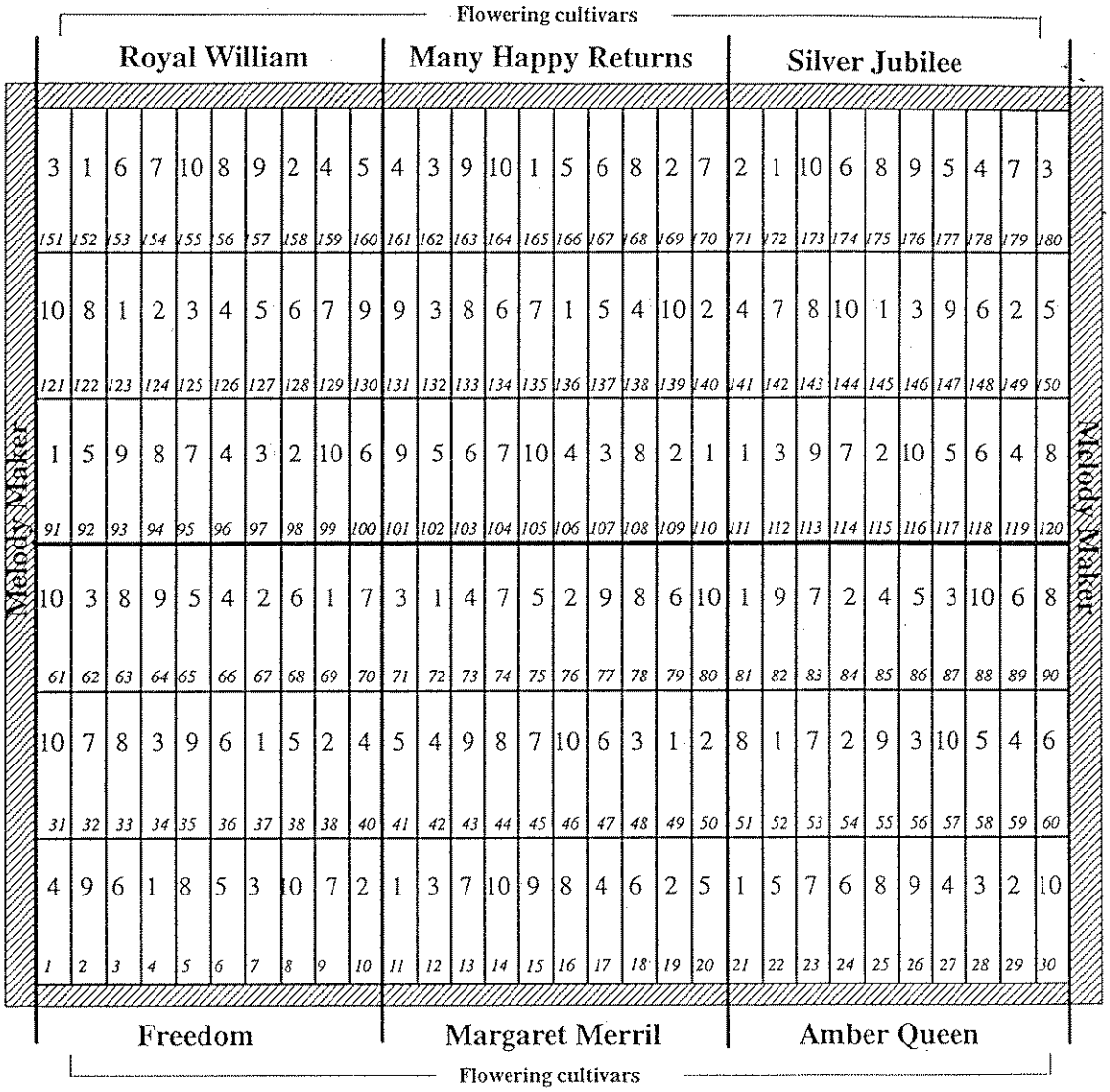
APPENDIX I

Planting plan and layout

HDC HNS 6a Stem Selections for Standard Roses
HRI Efford 1990-1992

N

Field S11
(N.E.)



3	1	6	7	10	8	9	2	4	5	4	3	9	10	1	5	6	8	2	7	2	1	10	6	8	9	5	4	7	3				
151	*152*	*153*	*154*	*155*	*56*	*157*	*158*	*159*	*160*	*161*	*162*	*163*	*164*	*165*	*166*	*167*	*168*	*169*	*170*	*171*	*172*	*173*	*174*	*175*	*176*	*177*	*178*	*179*	*180*				
10	8	1	2	3	4	5	6	7	9	9	3	8	6	7	1	5	4	10	2	4	7	8	10	1	3	9	6	2	5				
121	*122*	*123*	*124*	*125*	*126*	*127*	*128*	*129*	*130*	*131*	*132*	*133*	*134*	*135*	*136*	*137*	*138*	*139*	*140*	*141*	*142*	*143*	*144*	*145*	*146*	*147*	*148*	*149*	*150*				
1	5	9	8	7	4	3	2	10	6	9	5	6	7	10	4	3	8	2	1	1	3	9	7	2	10	5	6	4	8				
91	*92*	*93*	*94*	*95*	*96*	*97*	*98*	*99*	*100*	*101*	*102*	*103*	*104*	*105*	*106*	*107*	*108*	*109*	*110*	*111*	*112*	*113*	*114*	*115*	*116*	*117*	*118*	*119*	*120*				
10	3	8	9	5	4	2	6	1	7	3	1	4	7	5	2	9	8	6	10	1	9	7	2	4	5	3	10	6	8				
61	*62*	*63*	*64*	*65*	*66*	*67*	*68*	*69*	*70*	*71*	*72*	*73*	*74*	*75*	*76*	*77*	*78*	*79*	*80*	*81*	*82*	*83*	*84*	*85*	*86*	*87*	*88*	*89*	*90*				
10	7	8	3	9	6	1	5	2	4	5	4	9	8	7	10	6	3	1	2	8	1	7	2	9	3	10	5	4	6				
31	*32*	*33*	*34*	*35*	*36*	*37*	*38*	*38*	*40*	*41*	*42*	*43*	*44*	*45*	*46*	*47*	*48*	*49*	*50*	*51*	*52*	*53*	*54*	*55*	*56*	*57*	*58*	*59*	*60*				
4	9	6	1	8	5	3	10	7	2	1	3	7	10	9	8	4	6	2	5	1	5	7	6	8	9	4	3	2	10				
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	*30*				

Note: all numbers in italics are plot no.s
other numbers are stem selection no.s

Guard area

All guards have stem selection as per adjacent plot.
2 rows on East & West sides.
6 plants at North & South ends of each row.

12 plants/plot
34 rows x 84 deep = 2856 plants in total
Spacing: 0.4m in row * 1.2m between rows
Trial area 45m wide x 35m deep = 1575m²

Replication : 18 replicates of stems split into 6 flowering cultivar sub-trials, each with 3 replicates of stem

Stem Selection (source of clone)

1. G278 John Innes (Shardlow)
2. Harwhippet (Harkness)
3. *R.multiflora* Dan Whiteside (Rearsby)
4. G278 John Innes (Rearsby)
5. *R.canina* Pfander (Chessum)
6. *R.canina* Kiese (le Grice)
7. *R canina* Kiese (C&K Jones)
8. *R. multiflora* De la Grifferaie (Shardlow)
9. G278 John Innes (Shardlow)(substituted for *R.rugosa*)
10. K2103 John Innes (Shardlow)

APPENDIX II

Diary of cultural operations

Year 1 - 1990

6 Mar	Stable manure applied to site at 75 tonnes/ha.
13 Mar	*Rosa* Laxa rootstocks planted by hand.
22 Mar	Residual herbicide applied; simazine (Gesatop 500 FW 3.4 litres/ha) + metazachlor (Butisan S 2.5 litres/ha).
17 Apr	Nitrogen top dressing at 50 kg/ha N as Nitram.
23 - 26 Jul	Rootstocks budded with stem selections.
7 Aug	Herbicide Gesatop 500 FW + Butisan S applied as above.

Year 2 - 1991

Jan	Support posts for trellis erected.
23 - 24 Jan	Rootstocks headed back.
29 Jan	Residual herbicide applied; Gesatop 500 FW + Butisan S as above.
mid Feb	Single 3.15 mm dia. wire at 0.9 m height tensioned between posts.
21 Mar	Top dressing with 75 kg/ha N as Nitram + 25 kg/ha K_2O as sulphate of potash.
22 - 28 Mar	Bud guides (Brinkmans aluminium 90 mm wide) applied to stocks to encourage upright early stem growth. Any multiple basal shoots singled to the strongest.
1 May	Started training stems. 2.4 m bamboo canes inserted close to the base of the shoot to minimise the formation of a bend in the stem. Canes attached to the wire. Stems taped at roughly 0.3 - 0.5 m intervals as they grew. Also regular removal of stem sideshoots to maintain stem vigour and shape.
20 Jul	Top dressing with 50 kg/ha N as Nitram.
late Jul / early August	Preparations for budding. Topped stems as they reached top of cane (about 2.1 m) Sideshoots allowed to develop above 1.7 m to maintain sap flow. Within a day or two of budding, stems were deleafed in a band from about 0.9 m - 1.2 m height, stems marked with lower and maximum upper bud height at 1.0 and 1.1 m, and thorns removed in the budding zone.
26 - 31 Aug	Budded stems with flowering varieties. Three buds per stem spaced around stem. Patched with Fleishhauer Speed-Easy R21 or O40 patches from Rapidex Products Ltd.

12 Sept	Herbicide Gesatop 500FW + Butisan S applied as above.
25 Sept	Removed budding patches.
mid Sept - mid Nov	Removed excess stem growth, trimming back laterals at top of canes to reduce wind damage.

Year 3 - 1992

4 Mar	Herbicide Gesatop 500FW and Butisan S applied as above.
12 - 18 Mar	Bamboo canes removed and stem tops cut back to within 25 mm of top flowering scion bud. Stems tied to wires with nylon stocking material.
21 Mar	Started removing unwanted stem sideshoots. Continued as required throughout season including removal of some stem shoots arising from within head.
14 Apr	Trial top dressed with 75 kg/ha N, 19 kg/ha P_2O_5 and 56 kg/ha K_2O applied as 20:5:15 compound fertiliser.
late Apr - early May	Scion shoots tipped back to about 50 mm to help maintain a compact flowering head and reduce the risk of shoots blowing out later in the season.
1 Aug	Herbicide Gesatop 500FW and Butisan S applied as above.
late Oct	Undercut trial with Damcon undercutter.
early Nov	Heads trimmed back to facilitate final recording and lifting.

Year 4 - 1993

5 Feb	Land chisel ploughed for finished standard stem garden performance observation.
11 Feb	Planting furrows drawn out and stable manure added. Stakes driven into planting positions.
25 Feb	Planted, pruned heads to approx 150 - 200 mm, secured stems to stakes and watered in.
13 Apr	Top dressed with 20:5:15 applying equivalent of 75 kg/ha N, 19 kg/ha P_2O_5 and 56 kg/ha K_2O.
29 May	Residual herbicide atrazine + terbuthylazine (Gardoprim A 5.0 litres/ha) plus metazachlor (Butisan S 2.5 litres/ha) applied.
20 Jul	Hand weeded.
8 Aug	Dead headed.

APPENDIX III

Table 1: Final grade-out of heads, and overall plant (head+stem) grade for each scion cultivars based on stems present

	Stem selection	Mean no./ plot present (nominally 12)	Head grade %1*	%2	%1 (angle trans)	Mean grade	Overall plant grade %1*	%2	Mean grade
				cv. Freedom					
1/9	G278 (Shard)	11.2	**72**	22	58.8	1.34	26	59	1.88
2	Harwhippet	10.0	42	35	40.0	1.81	**38**	39	1.85
3	Dan Whiteside	9.0	**70**	27	56.9	1.33	3	83	2.11
4	G278 (Rears)	10.0	66	23	55.4	1.45	20	44	2.17
5	Pfander	10.0	**76**	18	61.0	1.30	**67**	24	1.43
6	Kiese (Le Grice)	10.0	63	24	52.7	1.50	**47**	37	1.69
7	Kiese (Jones)	9.3	45	21	42.0	1.89	**45**	21	1.89
8	De la Grifferaie	9.7	45	38	42.0	1.73	**45**	38	1.73
10	K2103	11.3	**67**	30	55.7	1.36	24	61	1.91
	SED (19df)				*8.96*	*0.202*			*0.213*
	LSD (5%)				*18.8*	*0.42*			*0.45*
	Significance, P				*N.S*	*0.035*			*0.079*
				cv. Margaret Merril					
1/9	G278 (Shard)	10.5	62	30	51.8	1.46	20	52	2.07
2	Harwhippet	10.0	60	24	50.6	1.57	54	30	1.63
3	Dan Whiteside	8.3	**96**	4	83.5	1.04	57	27	1.59
4	G278 (Rears)	10.7	71	13	58.7	1.45	16	52	2.16
5	Pfander	10.3	**90**	7	71.9	1.13	**84**	13	1.19
6	Kiese (Le Grice)	10.7	74	23	59.8	1.28	**65**	32	1.38
7	Kiese (Jones)	9.7	**76**	17	60.8	1.31	**62**	31	1.45
8	De la Grifferaie	9.3	60	22	50.9	1.58	**60**	22	1.58
10	K2103	10.3	**84**	7	66.8	1.26	23	60	1.94
	SED (19df)				*5.33*	*0.110*			*0.152*
	LSD (5%)				*11.2*	*0.23*			*0.32*
	Significance, P				*<0.001*	*<0.001*			*<0.001*
				cv. Amber Queen					
1/9	G278 (Shard)	10.7	**62**	31	52.5	1.44	22	57	2.00
2	Harwhippet	9.3	46	28	42.8	1.79	**46**	24	1.84
3	Dan Whiteside	7.3	36	41	36.5	1.87	3	46	2.48
4	G278 (Rears)	11.3	**65**	15	53.8	1.55	23	36	2.17
5	Pfander	8.7	**86**	8	72.0	1.21	**71**	22	1.36
6	Kiese (Le Grice)	10.7	47	22	42.4	1.84	**34**	32	2.00
7	Kiese (Jones)	10.0	56	27	48.8	1.60	**44**	33	1.78
8	De la Grifferaie	9.7	40	35	38.4	1.84	**37**	38	1.88
10	K2103	10.7	**66**	22	54.2	1.47	19	47	2.15
	SED (19df)				*8.74*	*0.223*			*0.209*
	LSD (5%)				*18.3*	*0.47*			*0.44*
	Significance, P				*0.020*	*0.068*			*0.004*

* The top 4 ranking for mean % Grade 1 heads, and overall plant grade in bold type

continued .....

APPENDIX III

Table 1 (continued): Final grade-out of heads, and overall plant (head+stem) grade for each scion cultivars based on stems present

Stem selection		Mean no./ plot present (nominally 12)	Head grade %1*	%2	%1 (angle trans)	Mean grade	Overall plant grade %1*	%2	Mean grade
				cv. Royal William					
1/9	G278 (Shard)	11.2	**78**	19	62.8	1.25	21	50	2.08
2	Harwhippet	9.7	48	24	43.5	1.80	**41**	23	1.95
3	Dan Whiteside	7.7	52	21	46.4	1.74	22	44	2.13
4	G278 (Rears)	10.3	**73**	16	59.1	1.37	22	31	2.25
5	Pfander	7.7	**83**	13	65.7	1.21	**70**	26	1.34
6	Kiese (Le Grice)	9.7	66	21	54.1	1.48	31	45	1.93
7	Kiese (Jones)	10.0	64	20	53.3	1.53	**57**	23	1.62
8	De la Grifferaie	9.7	58	34	50.2	1.50	**41**	51	1.67
10	K2103	11.3	**71**	23	58.6	1.34	14	43	2.29
	SED (19df)				*8.55*	*0.172*			*0.192*
	LSD (5%)				*17.9*	*0.36*			*0.40*
	Significance, P				*N.S*	*0.020*			*0.001*
				cv. Many Happy Returns					
1/9	G278 (Shard)	11.3	48	34	44.0	1.69	10	54	2.25
2	Harwhippet	10.3	44	33	41.5	1.79	**41**	36	1.81
3	Dan Whiteside	5.7	38	48	32.4	1.77	21	45	2.13
4	G278 (Rears)	11.0	**52**	30	46.2	1.66	24	40	2.11
5	Pfander	6.0	**65**	28	54.2	1.42	**58**	35	1.48
6	Kiese (Le Grice)	10.3	52	39	45.9	1.58	39	45	1.77
7	Kiese (Jones)	10.3	52	36	46.1	1.60	**46**	42	1.66
8	De la Grifferaie	10.7	**66**	12	54.6	1.56	**66**	12	1.56
10	K2103	11.3	**53**	36	46.6	1.59	9	59	2.24
	SED (19df)				*9.75*	*0.189*			*0.159*
	LSD (5%)				*20.4*	*0.40*			*0.33*
	Significance, P				*N.S*	*N.S*			*<0.001*
				cv. Silver Jubilee					
1/9	G278 (Shard)	10.3	81	14	68.8	1.24	27	60	1.85
2	Harwhippet	10.7	71	23	58.5	1.35	**57**	30	1.57
3	Dan Whiteside	7.3	**82**	18	64.9	1.18	37	51	1.74
4	G278 (Rears)	11.3	**86**	14	67.8	1.14	26	53	1.95
5	Pfander	12.0	**94**	3	82.0	1.08	**83**	14	1.19
6	Kiese (Le Grice)	11.0	69	28	56.5	1.33	**64**	33	1.39
7	Kiese (Jones)	10.7	71	16	58.2	1.42	49	38	1.64
8	De la Grifferaie	9.7	63	18	52.9	1.55	**52**	24	1.71
10	K2103	11.0	**88**	12	70.0	1.12	31	55	1.84
	SED (19df)				*10.27*	*0.172*			*0.168*
	LSD (5%)				*21.5*	*0.36*			*0.35*
	Significance, P				*N.S*	*N.S*			*0.004*

* The top 4 ranking for mean % Grade 1 heads, and overall plant grade in bold type

APPENDIX IV

Luddington EHS 1987 Trial Results

Table 1: Mean stem heights and diameters in budding and head production years

	Stem selection	6/7/88 Ht/cm	12/8/88 Dia at 1.0 m/mm	28/6/89 Dia at budding height/mm cv. N. Trust	Mountbatten	S. Jubilee
1	G278 (Shard)	166 +	11.3 +	14.4	14.4	14.1
2	Harwhippet	170 +	14.6 +	19.6 +	20.0 +	20.8 +
3	Dan Whiteside	164 +	9.6 -	12.8	12.1 -	12.8
4	G278 (Rears)	168 +	12.1 +	14.4	14.9 +	15.3
5	*R.rugosa* (Shard)	96 -	6.9 -	9.2 -	10.1 -	9.9 -
6	Kiese (Le Grice)	156	9.5 -	12.2 -	12.3 -	12.7
7	Kiese (Jones)	167 +	10.6	13.2	13.7	13.9
8	De la Grifferaie	161	12.2 +	15.2 +	14.9 +	15.5
9	*R.rugosa* (Charles)	96 -	7.7 -	10.5 -	10.5 -	10.6 -
10	K2103	174 +	12.3 +	15.3 +	15.2 +	15.0
	Mean	*151.9*	*10.69*	*13.68*	*13.82*	*14.06*
	SED (71df)	*5.3*	*0.24*	*0.42 (18df)*	*0.46 (18df)*	*0.72 (17df)*
	LSD (5%)	*11*	*0.5*	*0.9*	*1.0*	*1.5*
	Significance, P	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*

\+ = significantly > mean ($P<0.05$)
\- = significantly < mean ($P<0.05$)

APPENDIX IV

Luddington EHS 1987 Trial Results

Table 2: Stem straightness, 19/9/89

	Stem selection	Total no. stems assessed	Mean % in each grade* Gd 1	2	3	4	5	Weighted mean grade
1	G278 (Shard)	75	1.3	10.7	41.3	30.7	16.0	3.5
2	Harwhippet	85	0.0	2.4	9.4	27.1	61.2	4.5
3	Dan Whiteside	70	1.4	7.1	15.7	28.6	47.1	4.1
4	G278 (Rears)	75	1.3	4.0	36.0	46.7	12.0	3.6
5	*R.rugosa* (Shard)	38	5.3	7.9	42.1	44.7	0.0	3.3
6	Kiese (Le Grice)	77	1.3	5.2	15.6	46.7	31.2	4.0
7	Kiese (Jones)	65	0.0	0.0	3.1	33.8	63.1	4.6
8	De la Grifferaie	77	0.0	0.0	2.6	7.8	89.6	4.9
9	*R.rugosa* (Charles)	38	7.9	10.5	31.6	44.7	5.3	3.3
10	K2103	73	0.0	11.0	37.0	34.2	17.8	3.6

*In this trial, the following grading was used:

1 = Very bent.
2 = Double kink.
3 = Average bend.
4 = Slight kink.
5 = Straight.

i.e. the *higher* the grade, the better the quality. Although not directly comparable, approximate equivalent grades to the Efford trial are:

4/5	≡	1	-	Good stem straightness.
3	≡	2	-	Slight bend or kinks, but acceptable.
1/2	≡	3	-	Bad bends or kinks, unmarketable.

APPENDIX IV

Luddington EHS 1987 Trial Results

Table 3: Mean % budtake of scion buds inserted*. Angle transformed data (actual % in brackets)

Stem selection	N. Trust	Recorded 28/6/89 Mountbatten	S. Jubilee
1 G278 (Shard)	79.1 (94.8)	76.0 (94.0)	72.4 (90.3)
2 Harwhippet	70.7 (88.1)	73.5 (87.8)	63.3 (78.8)
3 Dan Whiteside	71.6 (89.4)	77.2 (92.6)	84.4 (97.2)
4 G278 (Rears)	79.7 (95.3)	82.6 (97.5)	82.0 (94.4)
5 *R.rugosa* (Shard)	56.6 (68.6)	58.5 (71.6)	40.6 (41.7)
6 Kiese (Le Grice)	66.1 (81.5)	77.0 (92.2)	63.1 (77.3)
7 Kiese (Jones)	70.2 (83.3)	78.7 (94.0)	80.0 (95.2)
8 De la Grifferaie	82.1 (97.2)	80.8 (96.1)	73.2 (91.4)
9 *R.rugosa* (Charles)	56.5 (69.4)	58.1 (72.1)	55.9 (67.2)
10 K2103	69.1 (87.2)	75.3 (93.3)	73.4 (91.5)
SED (18df)	*8.10*	*8.08*	*9.33 (17df)*
LSD (5%)	*17.0*	*17.0*	*20.0*
Significance, P	*0.055*	*0.069*	*0.006*

* The total number of possible takes, or buds inserted, was considerably lower for both *R. rugosa* selections, due mainly to the availability of stems of sufficient quality for budding. This varied from a total of only 24 possible takes on *R. rugosa* (Shard) with Silver Jubilee to 60 possible takes for this selection with National Trust. The number of possible takes for the other stem selection/scion combinations varied from 63 to 90 except for Kiese (Jones) with National Trust (39).

APPENDIX IV

Luddington EHS 1987 Trial Results

Table 4: Mean head quality across 3 scion cultivars, 19/9/89

	Stem selection	Total no. heads assessed	Mean % in each grade* (mean of 3 reps x 3 scions) Gd 0	1	2	3	Weighted mean grade
1	G278 (Shard)	75	0.0	1.3	5.3	93.3	2.9
2	Harwhippet	85	1.2	2.4	11.8	84.7	2.8
3	Dan Whiteside	70	0.0	0.0	0.0	100.0	3.0
4	G278 (Rears)	75	0.0	0.0	2.7	97.3	3.0
5	*R.rugosa* (Shard)	38	2.6	2.6	10.5	84.2	2.8
6	Kiese (Le Grice)	77	0.0	1.3	5.2	93.5	2.9
7	Kiese (Jones)	65	0.0	0.0	1.5	98.5	3.0
8	De la Grifferaie	77	0.0	0.0	5.2	94.8	2.9
9	*R.rugosa* (Charles)	38	2.6	2.6	10.5	84.2	2.8
10	K2103	73	0.0	0.0	2.7	97.3	3.0

*In this trial, the following grading was used:

0 = No intact scions
1 = 1 scion union, poor head
2 = 2 scion unions with lopsided head or 1 scion union with good head
3 = 3 scion unions or 2 scion unions with good head

i.e. the *higher* the grade, the better the quality. A slightly stricter grading system was used for the Efford trial.

3	≡	1 at Efford
2	≤	2 at Efford, where at least 2 unions were required and a slightly uneven shaped head acceptable
1	≤	3 at Efford, i.e. less than 2 unions and/or unacceptably uneven head shape

APPENDIX V

Luddington EHS 1988 Trial Results

Table 1: Mean stem heights and diameter in stem production year

Stem selection	11/7/89 Ht/cm	17/7/89 Dia at budding ht/mm
1 G278 (Shard)	214 +	11.5 +
2 Harwhippet	202	11.9 +
3 Dan Whiteside	198	8.5 -
4 G278 (Rears)	208 +	11.2 +
5 Pfander	205 +	10.4 +
6 Kiese (Le Grice)	185 -	8.3 -
7 Kiese (Jones)	204 +	9.6
8 De la Grifferaie	214 +	10.8 +
9 *R.rugosa* (Charles)	117 -	6.0 -
10 K2103	201	11.3 +
Mean	*194.9*	*9.96*
SED (152df)	*4.6*	*0.21*
LSD (5%)	*9*	*0.4*
Significance, P	*<0.001*	*<0.001*

\+ = significantly > mean ($P<0.05$)
\- = significantly < mean ($P<0.05$)

APPENDIX V

Luddington EHS 1988 Trial Results

Table 2: Stem straightness, 28/9/89

	Stem selection	Total no. stems assessed	Mean % in each grade* Gd 1	2	3	4	5	Weighted mean grade
1	G278 (Shard)	152	1.3	2.0	12.5	41.4	42.8	4.2
2	Harwhippet	174	0	0.6	4.0	18.4	77.0	4.7
3	Dan Whiteside	146	0	2.1	8.9	39.0	50.0	4.4
4	G278 (Rears)	161	0	1.2	17.4	48.5	32.9	4.1
5	Pfander	132	0	0	1.5	23.5	75.0	4.7
6	Kiese (Le Grice)	166	0.6	0.6	18.1	32.5	48.2	4.3
7	Kiese (Jones)	170	0	1.8	4.1	34.1	60.0	4.5
8	De la Grifferaie	168	0	0	0.6	16.7	82.7	4.8
9	*R.rugosa* (Charles)	115	1.7	3.5	26.1	60.0	8.7	3.7
10	K2103	167	2.4	3.0	10.2	41.9	42.5	4.2

*In this trial, the following grading was used:

1 = Very bent.
2 = Double kink.
3 = Average bend.
4 = Slight kink.
5 = Straight.

i.e. the *higher* the grade, the better the quality. Although not directly comparable, approximate equivalent grades to the Efford trial are:

4/5	≡	1	-	Good stem straightness.
3	≡	2	-	Slight bend or kinks, but acceptable.
1/2	≡	3	-	Bad bends or kinks, unmarketable.

APPENDIX VI

Copy of contract, terms and conditions and schedule

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 1991-2 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.

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

PROPOSAL

1. **TITLE OF PROJECT**

Contract No: HNS/6a (Extension to cover 1993/94 work at Efford)
Contract date: 2.4.93

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

2. **BACKGROUND AND COMMERCIAL OBJECTIVE OF THE 1993/4 WORK AT EFFORD**

This project has successfully identified and evaluated a number of improved selections for standard stem rose production, and has started evaluating new (seedling) rootstocks for bush roses which may show improved resistance to rust compared to *Rosa* 'Laxa' with possibly improved bush grade out and an equally low tendency to produce suckers. Although rose rootstocks are raised from seedlings, the maintenance of selected stock plants, and the unusual inheritance mechanism involved with eg. *R. canina* ensures that seedling populations are relatively uniform, and progeny remain true to type.

The main aims of standard stem selection will have been completed by the end of 1992 for the production system involving budding stems onto 'Laxa' rootstocks. However, it is desirable that samples of each stem and flowering scion combination be transplanted and retained to observe their performance regarding vigour of the head and sideshoot production. During the production seasons, there were differences in the extent to which unwanted stem sideshoots were produced, and it will be valuable to know whether or not these differences persist or whether the stems "settle down" as they mature. It is proposed that 3 of each of 9 stems x 6 scion combinations be retained (162 plants in total).

An extension of the project is also required to complete the rootstock comparison trial budded in 1992, to monitor sucker production in the production year, and final bush gradeout. Two complete crops will then have been trialled on this topic.

3. **POTENTIAL FINANCIAL BENEFIT TO THE INDUSTRY OF 1993/4 WORK AT EFFORD**

It is important to follow through the performance of new standard stems in order to identify any potential problems following planting, in advance of the customer. This is particularly appropriate with a high value product like the standard rose.

An alternative rootstock to 'Laxa' which combines the favourable features such as low sucker production and ease of budding with an improved or at least similar grade out and better resistance to rose rust will be of considerable value to the industry.

4. SCIENTIFIC/TECHNICAL TARGET OF THE WORK OF 1993/4 WORK AT EFFORD

a) Continue assessment on the finished standard stems.

b) Complete the bush rootstock work which was started in 1992.

5. CLOSELY RELATED WORK - COMPLETED OR IN PROGRESS

None in progress in the UK.

This work follows on from previous work at Luddington (HNS 6) and Efford (HNS 6a) on standard stem selection.

6. DESCRIPTION OF THE 1993/4 WORK AT EFFORD

a) The finished standard stems will be assessed for winter hardiness, head vigour, and sideshoot production.

b) The bush rootstock trial which was started in 1992 will be completed. This will involve the comparison of a range of mainly *R. canina* selections from Rosaco, Boskoop, Holland with R. 'Laxa' for general performance, concentrating particularly on improved rust resistance, low sucker production, and high final gradeout.

7. COMMENCEMENT DATE AND DURATION

Project start date 01.04.90; duration 4 years. Work at Efford will finish at the end of March 1994. Work at East Malling will finish at the end of December 1993 as planned.

8. STAFF RESPONSIBILITIES

As for HNS6a.

9. LOCATION

As for HNS6a.

Contract No: HNS/6a-ext

TERMS AND CONDITIONS

The Council's standard terms and conditions of contract shall apply.

Signed for the Contractor(s)

Signature.....P O'Reilly.....

Position..Commercial & Marketing Manager HRI

Date.....21/6/93.....

Signed for the Contractor(s)

Signature.....

Position.....

Date.....

Signed for the Council

Signature.....

Position.....CHIEF EXECUTIVE

Date.....2.4.93.....

APPENDIX V

Luddington EHS 1988 Trial Results

Table 2: Stem straightness, 28/9/89

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