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CONTRACT REPORT
FINAL REPORT

Rose, Standard Stem Production Systems suitable for Containerised Marketing 1993 - 1995

Undertaken for Horticultural Development Council
Project HNS 54

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RELEVANCE TO GROWERS AND PRACTICAL APPLICATION

Application

The availability of a range of stem types has opened up several new possibilities for the production of ½ and ¼ standards for marketing in containers, particularly those budded with patio type cultivars. These include the production of stems on their own roots from softwood cuttings, and a rapid method of producing ¼ standards by rooting an already budded portion of stem as a hardwood cutting. The containerisation of stems as dormant eyes can also help overcome problems of poorer establishment from potting finished plants on a large rootstock a year later.

Summary

Improved quality and vigour was shown by several new stem selections for full standard production in project HNS 6/6a. There has been a continuing increase in the numbers of stems containerised before sale, as well as an increase in the proportion of ½ and ¼ standards budded with compact floribunda, patio and miniature cultivars. This offered new production possibilities which were explored in this project, together with an evaluation of some aspects of containerisation of plants from the field, such as potting finished plants at the end of a 3 year growing cycle versus potting up a plant a year younger as a 'dormant eye' stem.

The usual method of producing the standard stem crop is to bud stems onto a Laxa rootstock in year one, grow the stem and bud it with the flowering cultivar in year two, and develop the head in year three. The propagation of stems from softwood cuttings was explored to see whether time could be saved over their production on a rootstock, and to help overcome some of the problems of containerising a large three year old rootstock from the field, which can frequently involve drastic root pruning. From several batches of cuttings taken in summer 1991 and 1993, the promising new stem types Kiese, Harwhippet ('Rocket') and De la Grifferaie all rooted reasonably well, but Pfander ('Chessum's Choice') proved unreliable. It was found that to develop a sufficiently well established root system to grow a vigorous stem the following year, rooted liners either needed potting on or field planting by early autumn in the year cuttings were taken. Leaving this operation until the following spring was too late. Difficulties were also experienced following pruning the liners in the spring, as there was not always a strong basal bud or shoot present, and leaving any 'leg' inevitably resulted in a stem with a kink in the base.

Those grown on for the following two seasons in containers developed adequately strong stems, but there were problems with frost damage early in the head growing year in this trial. It was also concluded that growing the crop for this length of time in containers was less economic than containerising a field grown crop. The liners grown on in the field, when lifted, tended to have

a much shallower root system with more main roots than some of the stems on Laxa, which would sometimes develop one or two thick deep tap roots with little finer root present. It is suggested that if the problems associated with pruning the top growth of a softwood cutting stem could be overcome, then containerising stems on their own roots, either as finished plants or a year earlier as dormant eyes, would involve less pruning and could lead to fewer winter losses.

Standard stems, like bushes, can be containerised at the end of the year that the flowering cultivars are budded, thus potentially saving almost a year in the production cycle, but the development of a shoot framework for the head while in the container means that they are not saleable until mid-late summer. This contrasts with those potted as 'finished plants' which are saleable in early summer in flower, or even as freshly potted dormant plants the previous autumn. The dormant eye technique is more reliable with free branching and free flowering patio cultivars than many floribunda and hybrid tea types. Dormant eye crops from stems grown in 1992, 1993 and 1994 showed that quality of heads developed in the container was as good as those which were developing heads in the field when compared at the same time.

As identified in project HNS 6a, Pfander most consistently produced the best quality heads, although Kiese also gave good results. De la Grifferaie, while being an excellent quality stem, tended to show poorer quality heads with some cultivars such as Sweet Magic. Often buds would appear to take successfully, but some eyes would remain dormant on the stem and fail to develop the following year. The stock of all stem selections were tested for the commonly found rose viruses, and no infection could be detected, so viruses were unlikely to be responsible for the problem.

Stems containerised as dormant eyes in mid January 1993, and in December 1993 and 1994, all established well following overwinter protection under cold glass, with virtually no losses. ¼ standards were potted into 5 litre containers and ½ standards into 7½ litre pots. In contrast, 15% of a sample of ½ and ¼ standards potted as finished plants into the same size containers in December 1994 failed to establish.

Hardwood cuttings were examined as another method of propagating stem selections. Bundles of cuttings were inserted in a heated Garner bin for 4 - 6 weeks with a basal temperature of 18 - 20 °C to encourage callus formation before potting up. Ease of rooting was found to vary significantly between stem selections. Of the three key stem types used in this project, De la Grifferaie was the easiest to root, followed by Kiese. Hardwood cuttings of Pfander, as with softwood cuttings, were most difficult to root. In these trials, callused hardwood cuttings were potted up into deep cell trays and held under glass overwinter with further base heat. However, root development was not rapid enough to ensure good establishment before top growth developed in spring. Also surviving cuttings, which were potted on and pruned back to a basal bud in spring, did not develop sufficiently strong stems that summer.

More success was achieved with a technique for rapid production of ¼ standards from rooting a length of stem already budded with the flowering cultivars. With stems budded onto rootstocks, sufficient stem height was achieved by August to enable a second tier to be budded 0.85 m above the lower tier budded for a ½ or ¼ standard crop (0.75 m or 0.50 m stems). The top portion of the stems were taken as hardwood cuttings in late autumn, complete with their dormant eyes, to yield another crop of ¼ standards which were grown on in containers the following spring and summer. For suitable stem types, therefore, an otherwise wasted portion of stem was used to produce an extra crop of container grown ¼ standards ready for marketing within about a year from budding. This production method also eliminated the potential problems associated with heavily root pruning a field grown rootstock, and the stems were also free of the sometimes unsightly rootstock / stem union at their base.

A pilot study on two-tier budding was undertaken with the 1992 grown stem crop, followed by larger scale trials using stems grown and budded in 1993 and 1994. It was found that taking cuttings in early November, as soon as most of the leaves had fallen from the stem, allowed sufficient time for root development before head growth commenced in spring. No advantage in speed of rooting was found in the 1994 trial by taking cuttings a month earlier in early October, when leaves had to be removed from the cuttings. Cutting bases were split wounded, and a 2500 ppm Synergol hormone quick dip was used. Cuttings were also drenched with Octave (prochloraz) to help reduce stem rots. As with the other hardwood and softwood cuttings, Pfander was found least reliable for this technique, but both Kiese (Jones) and De la Grifferaie produced commercially viable rooting percentages. It was found that potting cuttings up into 1 litre containers after callusing and rooting had begun, before the end of December, and placing them on a heated sand bed insulated with polystyrene packing chips to maintain about 18 °C at the base of the cutting, encouraged root development to continue rapidly. Plants could then be potted on into final size containers by late March and treated as a dormant eye crop. Head development was slightly slower and flowering slightly later than the dormant eye crop potted the previous December, but plants were nevertheless saleable, in flower, by late July / early August.

Some samples of field grown finished plants, those containerised as dormant eyes and those produced from top tier hardwood cuttings were retained and planted in the field in autumn 1994, at the end of their first flowering year, in a simulated 'garden performance' observation. Soil conditions were wet at planting and over the winter, and plants from containers established better, and grew away more rapidly to produce better quality heads in flower earlier than those transplanted as bare root plants from the field. The plants raised from top-tier hardwood cuttings performed at least as well as those containerised as dormant eyes in this second flowering year. There was no evidence that any of the stem types performed consistently better or worse in this second flowering year.

Action Points

- The production of stems by budding onto rootstocks is the most reliable method of ensuring strong stem growth, although the production of stems of easily rooted selections such as Kiese and De la Grifferaie from early summer softwood cuttings shows some potential. However, rooted liners are best grown on in the field from an early autumn planting, and need careful handling and pruning to ensure strong and straight stem shoots from the base.

- Stems grown on a Laxa rootstock and containerised as dormant eyes by December should establish reliably. A proportion of those containerised as finished plants a year later are more likely to fail when potted into 5 or 7½ litre containers due to the severe root pruning required. Larger 10 litre containers may give more consistent results.

- Stems from softwood cuttings on their own roots have a root system which is likely to be easier for containerisation than those grown on a large Laxa rootstock. The rootstock type Inermis has a finer root system, and, while not trialled in this project, may give better results with stems budded onto rootstocks.

- The use of hardwood cuttings for raising stems was not successful in this project. However, a technique for the rapid production of ¼ standards by rooting the top tier of a two-tier budded stem as a hardwood cutting showed considerable promise. The technique requires the use of a heated Garner bin, heated sand beds under protection, and attention to detail to be successful. Nevertheless, a crop of saleable ¼ standards in flower can be produced from an otherwise wasted portion of stem within about a year from budding.

INTRODUCTION

This project has developed from earlier trials under HNS 6/6a, Stem Selections for Standard Roses. Here, several stems showing improvements in quality and vigour over *Rosa rugosa* were identified and tested for field production of full standard roses. The production system concentrated on budding stems onto a Laxa rootstock, growing stems in the second year and budding them with a flowering cultivar, and developing the head in the third year. Within that project, preliminary investigations were undertaken into the potential for propagating stems from summer softwood cuttings. Rooted stem pot liners had the potential to be either grown on in the field, or potted on to produce a completely container grown standard stem crop. The improved vigour of the new stem selections opened up possibilities for reducing the production times for standard stem roses. Certainly, when budded onto Laxa rootstocks, stem growth the following year could readily reach 2.4 m or so, particularly if irrigation was applied, but early observations of stems on their own roots from softwood cuttings also showed potential for vigorous stem growth the following season if handled correctly.

There has been a continuing expansion in the proportion of roses marketed in containers, including standard stems. Sales of ½ and ¼ standards, including those budded with patio and other compact type cultivars, have increased at the same time, these products also being suited to 'patio culture' in tubs or other containers. This, together with the potential for alternative production possibilities opened up by the new stem types, led to the setting up of this project. Another factor requiring consideration within the project were the problems associated with containerising what can often be a very large root system from a Laxa rootstock which has spent three years in the field. A similar problem relating to the containerisation of bush roses is currently being addressed within project HNS 56, but it was hoped that some of the alternative production options for the standard stem crop might offer some solutions.

This report covers work undertaken on several aspects of standard stem production for marketing in containers started under project HNS 6a which finished in 1992, up to 1995. Because of the constraints imposed with wishing to work with a large range of stem types, flowering cultivars, budding heights and systems of production under the resources available, it was not possible to undertake formally randomised trials and statistical analyses with this project. Treatment plots were, however, replicated wherever practical, and means of measurements and records often showed clear cut trends that gave reliable indications of true treatment effects. This was particularly valuable where patterns of results were consistent over two or more seasons. The report is therefore presented in a review format which, together with the photographic illustrations, offers a more easily read digest of the work undertaken.

SOFTWOOD CUTTINGS

1991 Propagation

Cutting propagation

Two batches of softwood cuttings were direct stuck into 90 mm pots in an 80 : 20 medium grade Shamrock peat : Cambark 100 mix containing 3.0 kg/m^3 Osmocote Plus 12-14 months Autumn (15+8+11+2 MgO + trace elements) in May and July 1991, and rooted under mist (Plate 1). 100 cuttings per stem selection per batch, where available, were stuck.

Table 1. Percentage rooting and proportion of good grade liners produced from two batches of softwood cuttings taken in summer 1991

Stem selection	Batch 1 (taken 21 May 1991) % rooted	% good	Batch 2 (taken 1 July 1991) % rooted	% good
G278 (Shardlow)	78	78	83	71
Harwhippet (Harkness)*	97	92	93	89
Dan Whiteside (Rearsby)*	96	95	100	98
G278 (Rearsby)	99	96	51	50
Pfander (Chessum)*	53	36	58	57
Kiese (Le Grice)	88	78	78	72
Kiese (Jones)*	99	97	96	92
De la Grifferaie (Shardlow)*	84	65	91	83
Rosa rugosa (Charles)	94	94	74	66
K2103 (Shardlow)	95	94	87	74

Although the rooting of G278 and Kiese (Le Grice) was variable between batches, Pfander showed poorer rooting from both batches, and this was consistent with observations from softwood cuttings taken in 1990.

Stem growth

Thirty five liners of each stem selection from Batch 1 were field planted in two rows 0.9 m apart x 0.2 m in the row in early October 1991. These were planted alongside two rows of each of Kiese (Jones), Pfander ('Chessum's Choice') and one row of Harwhippet ('Rocket'), which had been budded onto Laxa rootstocks in August 1991 and were at the same spacing.

From earlier results of performance under HNS 6a, it was decided to grow on in containers only the five stem selections marked * above. Thirty liners of each selection from Batch 1 which had rooted well and showed good vigour were potted on into 3 litre containers in early October. The Batch two liners were potted on into either 3 litre (40 - 50 per stem type), 5 litre or 7½ litre containers (20 - 25 per stem type) at the same time (Plate 2). A 70:30 peat:bark mix containing 6.0 kg/m^3 Osmocote Plus 12-14 months Autumn (15+8+11+2 MgO + traces) was used. In

late March 1992, all the 3 litre containers from both batches were potted on into either 5 or 7½ litre pots using a similar mix as in the autumn, but with 8.0 kg/m^3 Osmocote Plus 12-14 months Spring (15+9+11+2 MgO + traces) incorporated. Subsequently no differences in growth or performance were observed between those potted into final size containers in the autumn, or in the spring.

Either pinched terminal, or non terminal softwood cuttings had been used, thus creating a more or less branched rooted liner. To encourage a strong stem to develop from the base of the plant, and to minimise the chance of an unsightly basal kink developing in the stem, all plants were pruned hard in mid March 1992. In some cases a strong shoot from below the level of the growing medium had developed, and this was chosen to produce a stem, while the original shoots were pruned away. Most plants, though, had to be pruned to a strong sprouting or dormant bud near to the base of the original stem. In some cases the lowest bud was several cm up the stem, and this usually resulted in a stem with a kink at the base.

The containers were overwintered under a side ventilated polythene tunnel, and moved outside onto a woven polypropylene ground cover area in early April. Despite plenty of ventilation, Dan Whiteside in particular, but also Harwhippet and De la Grifferaie to a lesser extent, had produced appreciable new top growth which had to be removed when pruning to a basal shoot. This may have weakened the plants, which together with frost damage during April, caused some plant losses. Dan Whiteside was the most severely affected, with the later shooting selections, including Kiese, least affected. Of the softwood cuttings grown on in the field, only Dan Whiteside was frost damaged and killed out, but the relatively late development of the remaining selections, compared to the potted plants, resulted in no other losses. A low level 'sidespray' type irrigation tube between pairs of rows was used to irrigate the field grown stems, and drip irrigation used on those in containers.

Table 2. Stem diameter / mm measured at 1.0 m height in late July 1992
means of comparable stem selections. n=no. stems measured

Stem selection	Field grown budded on Laxa dia.	(n)	Field grown from s/wood cuttings dia.	(n)	Container grown from s/wood cuttings dia.	(n)
Kiese (Jones)	10.1	(70)	11.1	(33)	10.3	(42)
Harwhippet	13.5	(26)	10.5	(28)	13.8	(58)
Pfander	11.6	(69)	-		11.6	(56)
De la Grifferaie	-		10.4	(32)	11.5	(98)

Table 2 shows mean stem diameters of some comparable stem types across growing treatments when measured prior to budding. There was an indication that the stems growing in 7½ litre containers were slightly thicker than those in 5 litre containers, but differences were small (less

than 1 mm on average). The means for container grown stems in Table 2 are averaged across container sizes and Batches 1 and 2. Overall, it appeared that it was possible to grow equally vigorous stems on their own roots raised from softwood cuttings, as those budded onto Laxa rootstocks. In this trial as good stem growth, on average, was also obtained from the softwood cutting stems in containers as in the field (Plate 3). However, it appeared likely that establishment of a good root system from the cutting as early as possible from either an autumn planting in the field, or an autumn potting to a large final container was important if sufficiently vigorous spring growth was to be obtained.

Budding with flowering cultivars

Stems were budded in mid August 1992 with the cultivars Silver Jubilee (pink HT) and Pot o' Gold (yellow HT) for full and ½ standard production, and Trumpeter (scarlet dwarf Fl), Sweet Dream (peach patio) and Gingernut (bronze orange patio) for ½ and ¼ standards. The conventional method of applying three buds per stem within a maximum zone of 100 mm of stem length was used. As with the rest of the project, a stem length of 1.0 m to the bottom scion bud was used for full standards, 0.75 m for ½ standards, and 0.5 m for ¼ standards (Plate 4).

Surplus stem growth above the top bud was headed back in late February 1993. A period of relatively mild weather followed by a series of sharp frosts in April damaged new head shoot growth. Some new growth, if not killed outright, showed a transient yellowing, which appeared to check development, although new growth developed normally. Pot o' Gold was damaged more than the other cultivars, and those on container grown stems appeared worse affected than those in the field, possibly because roots were exposed to colder temperatures. Nevertheless, many of the field grown plants also developed a transient yellowing in the new head growth. Some of the container grown stems themselves died. They appeared to develop a disease, which typically developed into a progressive blackening of the stem from the base or from the top, and which looked to be similar to that observed on occasional field grown stems under project HNS 6a. It may have been that the stems grown in containers had suffered some root loss over winter and, with reduced root activity in the spring, were more susceptible to subsequent frost and disease damage. While a good number of the container grown stems went on to make good quality heads, it was difficult to make a meaningful assessment of the final grade-out from the crop and to compare it with the field grown stems. The damage to new growth from late spring frosts did raise questions as to the optimum time to prune off (head back) surplus stem growth, and whether early heading back stimulated early growth which might be more susceptible to damage.

Of the surviving container grown crop, container size appeared to have little effect on the final result. Osmocote Plus Tablets 5-6 months (15+10+12+2 MgO+traces) were inserted at the rate of four per pot for the 5 litre and five per pot for the 7½ litre containers in spring 1993 to top up nutrition levels for the head growing year, and this seemed to be sufficient, producing

good quality growth. It is, however, an expensive option, and more work is required on formulation and rate of CRF required by container roses.

Where direct comparisons were possible between the field grown standards budded on Laxa and those on their own roots, it appeared that head growth was similar.

Finished plants

Five finished plants of each of the stem and scion combinations below were potted up from the field in mid December 1993, and held under a polythene tunnel, along with five of each of the container grown treatments below, for observation of flowering and development in 1994. A peat:bark mix containing 8.0 kg/m^3 Osmocote Plus 12-14 months Autumn was used for the freshly potted plants. Nutrition for the held over container grown plants was topped up again with Osmocote Plus tablets in spring 1994 once moved outside to growing on beds.

Field grown stems on Laxa rootstock

Kiese (Jones)	Pot o' Gold	Full
"	Sweet Dream	½
"	"	¼
"	Silver Jubilee	Full
"	Trumpeter	½
"	Gingernut	¼
Kiese (Le Grice)	Sweet Dream	¼
Pfander	Pot o' Gold	Full
"	Trumpeter	½
"	Gingernut	¼
Harwhippet	Pot o' Gold	Full

Field grown stems from softwood cuttings

Kiese (Jones)	Silver Jubilee	Full std.
De la Grifferaie	Pot o' Gold	Full
"	Sweet Dream	½
Harwhippet	Pot o' Gold	Full
Kiese (Le Grice)	Sweet Dream	½
"	"	¼

Container grown stems

Pfander	Pot o' Gold	Full
Harwhippet	Pot o' Gold	Full
De la Grifferaie	Pot o' Gold	Full
"	Sweet Dream	½
Kiese (Jones)	Pot o' Gold	Full

The root systems of the stems grown on their own roots from the pot liners were very different in character to those on the Laxa stocks. There were more shallower, but spreading roots with the former, whereas the Laxa stocks, whilst being very variable, tended to produce fewer long sinuous and deep roots. In extreme cases they developed a single tap root with only a few fine lateral roots (Plate 13).

In this trial, all containerised plants established satisfactorily from both sources, and together with the held over containers, flowered well in summer 1994. However, the field grown stems from softwood cuttings required less drastic root pruning in general than the stems on Laxa, and it is possible that under less favourable conditions those on Laxa may not have fared so well.

1993 Propagation

Further batches of softwood cuttings were taken in early June and mid July 1993 direct stuck into 90 mm pots. One objective was to see whether long or short terminal softwood cuttings (ie 0.5 - 0.7 m, or 0.2 m long) with the growing point left intact, could be taken so that stem growth could continue both during and after rooting, and possibly stems could be budded as ¼ standards later that same year. Cuttings were stuck under enclosed mist, but even with heavy shading the growing points proved too soft and were scorched. Subsequently *Botrytis* developed on dead tissue. Standard pinched terminal cuttings and basal cuttings were more successful.

Basal and pinched terminal cuttings were also taken of a relatively easy to root selection, Kiese, and a poorer rooting selection, Pfander, to investigate whether the position of the cutting from the current years shoot on the stock plant influenced rooting ability. It did not appear to make any significant difference, and rooting of Pfander was still relatively poor.

The successfully rooted softwood cuttings were overwintered in their liner pots, and after pruning to a basal bud, were potted on in early May 1994 into 3 litre containers in a 100% peat mix containing 6.0 kg/m^3 Osmocote Plus 12-14 months (15+9+11+2 MgO+traces). However, this potting date was too late to allow sufficiently vigorous growth for quality stem production, and by early September, although some stems were sufficiently tall and thick to be budded as ¼ standards, their diameter was considerably poorer than those stems raised in the previous trial.

Table 3. Mean stem diameter by September 1994 from container grown stems from softwood cuttings spring potted on to 3 litre containers in early May 1994

Stem selection	diameter / mm
Kiese (Jones)	6.9
Kiese (Le Grice)	6.3
Pfander	8.0
Harwhippet	8.9
De la Grifferaie	7.7

It is concluded that the use of softwood cuttings for the production of standard stems as an alternative to budding on to Laxa stock, may have some potential, but would appear most

reliable and economic if liners were grown on in the field, rather than used to produce the whole stem crop in containers. There is little saving in production time from rooting summer cuttings compared to budding onto a Laxa rootstock, although if rooted liners were available to be bought in, it would save the recipient nursery a growing season for establishing a rootstock crop. Growing the stem entirely in containers would involve using a standing out area over two growing seasons. The minimum requirement for a well drained site with a ground cover material, and with sprinkler or pot drip irrigation facilities would also be more expensive than the equivalent field production area. The handling, pruning and management of the softwood cutting to produce a good quality stem requires care, and it appears that an autumn establishment in the field is required for best results. Given some of the problems occasionally experienced in containerising a Laxa root system, however, the stem on its own roots offers some potential either lifted as a finished plant, or a year earlier to containerise as a dormant eye.

STEMS CONTAINERISED AS DORMANT EYES VS. FINISHED PLANTS

Lifting and containerising stems from the field at the end of the flowering scion budding year as dormant eyes, can result in a potential saving of nearly one year in production time. This recognised technique in the industry, which is also used for bush rose production, appears to be most successful with the miniature and patio type flowering cultivars. As the flowering framework is developed in the container for marketing later that same year, a naturally bushy and branching habit, such as found in the patio cultivars, appears most suitable for the technique. With both the larger flowering (HT and Fl) cultivars and smaller flowered types, repeated pinching of the new growth from head is required to maintain a compact and good head form. It is easier to achieve a good shaped head in flower for marketing earlier in the summer with patio cultivars than HT's.

Another potential advantage from containerising a dormant eye standard stem, is that if grown on a Laxa rootstock, it should be easier to containerise and stand a better chance of successful establishment, having spent a year less time in the field.

1992 grown stems

A preliminary investigation into the containerisation of stems as dormant eyes was undertaken with the 1992 crop of stems grown on their own roots in the field. 35 ½ standards and 35 ¼ standards, budded with the patio cultivars Sweet Dream and Gingernut on the stem selections Kiese and G278, were containerised in mid January 1993 into 5 litre containers into a 75% : 25% peat : Cambark 100 mix containing 6.0 kg/m^3 Osmocote Plus 12-14 months Spring (15+9+11+2 MgO+traces). They were held under cold glass until the first week of May. Early growth was pinched back to encourage branching and the development of compact heads. By late May / early June plants were of good quality and suitable for sale in flower. Following early protection under cold glass, there were no problems with yellowing or frost damage in contrast to the other plants outside. There was some noticeable paling of the foliage late in the year, however, indicative of nitrogen starvation, despite the use of a recommended rate of controlled release fertiliser. Hot conditions during the summer coupled with frequent watering and an open, freely draining growing medium, may have caused released nutrients to be leached before they could be taken up by the plant.

1993 and 1994 grown stems

Two further standard stem crops, budded onto Laxa rootstocks in 1992 and 1993, were grown to compare the performance of plants lifted and containerised as dormant eyes with those left to develop heads in the field for containerising as a finished crop for sale the following year. In both crops, the most promising stem selections for vigour and quality identified in HNS 6a and the early part of this project, were included in the main trial comparisons involving ½ and ¼

standards budded with patio cultivars. These stems were Pfander ('Chessum's Choice'), De la Grifferaie, and Kiese (Jones). Harwhippet ('Rocket'), while an excellent stem for full standard production, was considered too heavy and vigorous for the lighter and more dainty patio cultivars. However this stem, along with others, were used to observe and gain experience with a range of other cultivars budded as both full and half standards. In all cases, stems were grown in pairs of rows 0.9 m apart (initially bedded out with 1.83 m wide tractor wheelings) with an in-row spacing of 0.2 m. Low level trickle irrigation lines between pairs of rows was used from the stem growing year onwards. Bud guides followed by the taping of stems to bamboo canes was used to encourage straight stem growth, and sideshoots were removed as necessary.

A proportion of both crops were budded at two heights on the same stem, so that the top-tier could be rooted as a separate crop from hardwood cuttings (see later section for details). Budding took place in late August in both 1993 and 1994. Approximately equal proportions of both the ½ and ¼ standards budded 0.75 m and 0.5 m from the ground were left *in situ* to develop heads in the field in the third year, while the other half were containerised as dormant eyes. In both years dormant eyes were potted in mid December into 5 litre (Optipot 23T) containers for ¼ standards and 7½ litre (Optipot 26T) containers for ½ standards. Growing media mixes varied slightly, a 75 : 25 peat : bark mix containing 8.0 kg/m^3 Osmocote Plus 12-14 months Autumn (15+8+11+2 MgO+traces) for the 1993 potting, and a 100% peat mix with 6.0 kg/m^3 of the same CRF for the 1994 potting. Because the dormant eye crop was given winter protection and should not require holding for an extended period before sale, more economical growing medium mixes were recommended later on in the project.

Dormant eyes from both years' crops were held under cold (frost protected) glass until early April (1994) or late April (1995). Regular pinching and shaping of head shoots and removal of stem sideshoots was carried out as necessary from early April onwards on both containerised and field grown plants.

The 1994 flowering crops were recorded for head and stem quality in September 1994. The cultivars Sweet Magic, and Sweet Dream (¼ standards), and Amber Queen and Gentle Touch (½ standards) were used for the main trial. Table 4, p.14, shows the results of stem and head grades averaged across flowering cultivars. Heads and stems were graded on 1 - 3 scale:

Head grade:	
1	3 scions, well balanced
2	2 or 3 scions, acceptable shape
3	1 scion and/or small, unbalanced

Stem grade:	
1	Stem straight and thick
2	Stem slightly thin / curved
3	Stem crooked / thin

Table 4. Head and stem grades for plants budded August 1993 and containerised as dormant eyes or left in the field. Mean of flowering cultivars. Containers recorded 2/9/94, field crop recorded 21/9/94.

	Containerised dormant eyes				Field grown			
Stem selection	*No. plants*	%1	%2	%3	*No. plants*	%1	%2	%3
				Head grades				
Kiese (Jones)	*106*	76	18	6	*97*	71	18	11
Pfander	*102*	93	6	1	*100*	77	18	5
De la Grifferaie	*108*	67	24	9	*107*	49	33	18
				Stem grades				
	dia stem/mm				**dia stem/mm**			
Kiese (Jones)	13.3	59	32	9	13.2	67	25	7
Pfander	13.9	74	23	3	13.7	88	11	1
De la Grifferaie	14.7	81	17	2	14.9	81	17	2

The De la Grifferaie stems, both in the field and in containers, gave a poorer mean head grade-out. Some indications of poorer head growth on this stem had been observed in earlier trials (see HNS 6a Standard Stem Selection report), but performance has varied between cultivars. In this trial heads of Sweet Magic on De la Grifferaie were poorest both in the field and container, followed by Amber Queen. Sweet Dream and Gentle Touch were generally good. On Kiese, Sweet Dream was variable between plots. Pfander produced the greatest proportion of Class 1 heads on average, although some of the field grown Amber Queen were not as good. Gentle Touch appeared the most reliable overall.

While seasonal differences in budwood quality between cultivars can often greatly influence bud take, there did appear to be a suggestion of some incompatibility between Sweet Magic and De la Grifferaie. Although noticed occasionally on all stems, a proportion of buds and bud shields on De la Grifferaie would appear alive but remain small and dormant and fail to develop. A greater understanding is needed into some of the causes behind apparent incompatibility in such cases, but anecdotal evidence from growers suggests that wounding the bud union with a careful vertical knife cut through the offending bud can sometimes induce one or two secondary buds to develop.

It appeared that stem thickness (measured 250 mm below the head) was equally good from the containerised crop as those left in the field in this trial.

For the 1995 flowering crop, the plants containerised as dormant eyes were recorded earlier, around the time when most of the crop was of saleable size, on 25 July 1995. Head development on the field grown crop was recorded 11 September 1995 (Plate 16 - 18). Table 5

summarises the head grades for the plants containerised as dormant eyes and those left to develop heads in the field.

Table 5. Head grades for plants budded August 1994 and containerised as dormant eyes or left in the field. Containers recorded 25/7/95, field crop recorded 11/9/95.

			Potted as Dormant Eyes			Field Grown		
Stem	Ht	Cultivar	*No. plants*	% Gd. 1 head shape	% breaks from 3 unions	*No. plants*	% Gd. 1 head shape	% breaks from 3 unions
Pfander	¼	Mandarin	*15*	93	93	*14*	64	100
Pfander	¼	Red Rascal	*16*	75	88	*16*	69	100
Pfander	½	O. Sunblaze	*15*	73	73	*16*	56	88
Pfander	½	Mandarin	*16*	88	100	*16*	62	94
De la Griff.	½	Cider Cup	*16*	75	81	*16*	75	62
De la Griff.	¼	Sweet Magic	*15*	47	53	*15*	53	33
De la Griff.	¼	Rosy Future	*17*	77	88	*18*	72	78
De la Griff.	½	Sweet Magic	*16*	81	75	*18*	67	72
Kiese (Le Gr.)	¼	B & H Special	*15*	67	100	*15*	80	80
Kiese (Le Gr.)	½	Hakuun	*15*	80	80	*16*	100	88
Kiese (Le Gr.)	½	Red Rascal	*16*	88	94	*15*	93	93
Kie. (Jones)	½	Pretty Polly	*9*	100	100	*9*	89	78
Kie. (Jones)	¼	Top Marks	*11*	91	81	*11*	100	91
Kie. (Jones)	¼	Mandarin	*11*	91	100	*9*	100	100
Kie. (Jones)	½	Top Marks	*11*	100	82	*13*	92	85
Harwhippet	Full	Suma	*17*	82	94	*17*	100	100
Harwhippet	½	Hertfordshire	*22*	96	91	*21*	100	100

Although the data in Table 5 is variable, it does not show a consistent difference in head quality or budtake (% with breaks from three unions) from dormant eyes or field grown plants when plants from the same plot are compared. There is evidence, as shown in the previous year, that some heads on De la Grifferaie were poorer, including those of Sweet Magic. In general, although it is clearly preferable that all three buds on a stem should take, two surviving bud unions are capable of producing a good head, particularly if the surviving buds are not both on the same side of the stem. In practice, it is easier to apply the top and bottom buds vertically in line on one side of the stem, and the middle bud on the opposite side, when working down both sides of a row. However better results are more likely if budders can be persuaded to apply buds at equal spacings around the circumference.

Viruses, as a possible cause of poor budtake, were investigated further in 1994 and 1995. Leaf samples from stock plants of the commercially promising cultivars were tested at HRI East

Malling for the three most commonly found rose viruses, namely Prunus necrotic ringspot virus, Arabis mosaic virus, and Strawberry latent ringspot virus. Neither serology tests nor sap inoculation onto sensitive host plants revealed any positive evidence that stocks were infected.

Containerisation of stems as finished plants

Six plants of each of the combinations of four flowering cultivars (Amber Queen, Sweet Dream, Sweet Magic, and Gentle Touch) on each of three stems (De la Grifferaie, Kiese and Pfander) which first flowered in the field in 1994, were potted as finished plants into 5 litre (¼ standards) and 7½ litre (½ standards) containers in mid December that year. The potting mix was the same as used for the dormant eye crop. Plants were held under glass with frost protection overwinter.

Establishment of most plants was good, and these were saleable in flower by early June 1995. However, a total of three plants of Sweet Dream on De la Grifferaie, six plants of Gentle Touch on Pfander, and two plants of Gentle Touch on De la Grifferaie out of the total of 72 containerised, ie 15%, failed to establish (Plate 14). This contrasted with no losses from the following years crop containerised as dormant eyes at the same time. It is likely that a larger proportion of the total root system was pruned away when potting the finished plants, and because they already had a structure of head shoots to support when growth started in the spring, they were subjected to greater stress than those potted as dormant eyes. The size of containers used was chosen to give an overall balanced appearance to the final product, however some nurseries will use larger containers of up to 10 litres even for ¼ standards to more easily accommodate the root system. Although the use of these large containers will add a significant cost to the production and transport of the product, they have become accepted by many retail outlets and will probably continue to be used if they reduce the risk of overwintering losses from containerising finished plants with large Laxa rootstock root systems.

In project HNS 56, aspects of containerisation of bush roses in relation to improving root structure is being investigated. The rootstock *R. canina* Inermis has been shown to have a much finer root system than Laxa requiring less drastic pruning at potting. Although not investigated in this project, it is possible that using this rootstock instead of Laxa for a standard stem crop would help. The increased sucker production attributed to Inermis may be a less serious problem for the stem crop which in any case requires routine attention for the training of stems and removal of sideshoots.

HARDWOOD CUTTINGS AND THE TWO-TIER BUDDING TECHNIQUE

Winter 1992 / 1993 hardwood cuttings

The potential for rooting hardwood cuttings of the new stem selections from autumn and winter strikes, so that stems could be run up the following year, was tried as a means of saving time over the summer softwood cutting procedure. Cuttings of a range of stems types were taken from the stock beds at HRI Efford on 4 February 1993. Comparisons of basal and non-basal, split wounded and non wounded, and two rooting hormone levels (1250 and 5000 ppm IBA quick dips) were also made on standard 0.4 m length cuttings. As well as standard length cuttings, some long cuttings of 0.8 - 0.9 m were tried to see whether, if rooted, buds could be inserted directly into them early in the summer for a ¼ standard crop. Cuttings were root initiated at HRI East Malling in a specialised Garner Bin which applied base heat while keeping cutting tops in a cool and humid environment. After about one month, cuttings were removed and returned to HRI Efford for growing on.

Major differences in rooting ability were observed between the clones (Plate 8), with G278 showing exceptionally good rooting followed by De la Grifferaie and Dan Whiteside. Pfander and Harwhippet rooted poorly in this trial, as did Kiese, although Kiese (Jones) showed better callusing and rooting potential than Kiese (Le Grice). The stem selections that rooted most easily were either selected directly from *R. multiflora* or had it in their parentage.

There was no clear trend between the basal or non-basal cuttings. 5000 ppm IBA gave better results on average than the 1250 ppm rate. Effects due to a 25 - 50 mm basal slit wound using secateurs were also variable, but on average about twice as many wounded cuttings showed good callus or root development than the non-wounded cuttings in this trial.

Promising standard length cuttings were potted up into Bowmont rootrainer trays, ie with deep cells of 110 mm depth and 275 ml capacity, and placed in a glasshouse with base heat, on 9 March 1993. The long cuttings were potted into deeper Fleet rootrainer cells (200 mm deep of 350 ml capacity).

Most cuttings subsequently failed to establish in the rootrainers, except for some cuttings of the stem selections Dan Whiteside, De la Grifferaie and G278 which already had a significant amount of young root present at the time of potting, rather than just callus. Although the glasshouse environment was shaded, air temperatures were probably too high and humidity to low to prevent the stems desiccating before sufficient root had been formed.

Construction of Garner bin

The following year, a heated Garner bin was constructed at HRI Efford for hardwood cutting work (Plate 6). This was constructed on a pallet to allow it to be moved with fork lifts. A wooden box was lined with polythene wrapped polystyrene sheets for insulation. A perforated drainage pipe in the base with outflows was covered with a layer of coarse aggregate and then filled with a sandy grit mixture similar to that used in nursery stock sand beds. Heating cable was secured onto the underside of a layer of 'Weldmesh' laid on top of the sand to protect it from spades etc. when renewing and cleaning the top layer of sand. A final layer of fine silver sand, about 100 mm deep, was used to ensure good capillary contact with the bases of the bundles of cuttings inserted to about 50 mm depth. Research on the rooting of hardwood cuttings at HRI East Malling has shown that by using a deeply drained system as described above, bundles of cuttings could be watered quite freely to keep them moist, without danger of waterlogging. The 'capillary pull' that develops in the base of the cutting when surplus water drains away, is important in encouraging the development of callus and roots. A bark mulch was used initially on top of the sand to help retain heat and moisture, but this proved messy to handle and made it difficult to ensure bundles of cuttings maintained good contact with the sand when replaced if removed for inspection. Subsequently coarse polystyrene packing chips were used which were more successful, although they needed handling in a sheltered site!

The ideal environment for root initiation for the cuttings is a warm base of about 20 °C, but keeping tops cool (eg. 5 - 10 °C) to minimise development of top growth. The rod thermostat was set at a level just above the 'Weldmesh' to ensure close temperature control. The cutting bin was sited in a shaded corner of an unheated, but frost free, packing shed building for this project.

Winter 1993 / 1994 hardwood cuttings

100 cuttings, about 0.4 m long of each of Kiese (Jones), Kiese (Le Grice), De la Grifferaie, Pfander and Harwhippet were taken from stock plants on 6 January 1994. Bases and tops of cuttings were trimmed to the nearest node, and basal buds from the lower 100 mm were removed to avoid the problem of unwanted suckers developing. Bases were split wounded and bundled in groups of 20 - 25 with elastic bands. Cutting bundles were drenched with Octave (prochloraz) fungicide at 0.5 g/litre concentration to reduce the risk of basal rots developing. Bundles were wrapped in a polythene sleeve leaving about a 150 mm gap at the base, but extending the sleeve above the top of the bundles to maintain humidity. The unwrapped zone at the base of the cuttings was to allow for insertion into the sand in the Garner Bin, and still allow a small gap above a mulch layer on top of the sand. This was to allow some ventilation and to prevent condensation collecting around the base of the cuttings to minimise risks of rotting. After ensuring the cutting bases were level, the bottom 10 mm of the bundles were then given a hormone quick dip in Synergol at 2500 ppm for 5 seconds and excess hormone shaken off.

Sand in the cutting bin was thoroughly pre-wetted, and the cuttings bundles inserted and then watered in. Perforated polythene was draped over the cuttings initially to help maintain humidity, but it was found that this was not necessary provided the sleeves on the cutting bundles extended a little above the tops of the cuttings. The perforated polythene could also trap unwanted heat around the cutting tops.

Cuttings were removed six weeks later and recorded for callusing and the numbers of roots present (Plate 7).

Table 6. Hardwood cuttings recorded 17/2/94, percentage of basal circumference showing callus, and number of roots visible. Mean of 100 cuttings per stem type.

Stem selection	% callus	No. roots
Kiese (Jones)	84	0.46
Kiese (Le Grice)	73	0.61
De la Grifferaie	11	2.57
Pfander	51	0.12
Harwhippet	57	0.07

Rooting of De la Grifferaie was again strongest, even though the amount of callus actually present was low. It was found, however, that the roots from the hardwood cuttings were extremely soft and delicate (Plate 7), and could easily break off. As with the rooting of hardwood cuttings of fruit rootstocks where this technique was first developed, it appears that the best time to remove cuttings from the bin is when callus is well formed and rooting out is just beginning, but before is has become too advanced.

Cuttings were then potted up into Fleet rootrainers in a 100% peat mix containing a low rate of 1.0 kg/m^3 Osmocote Plus 12-14 months Autumn (15+8+11+2 MgO+traces), and placed on a heated sand bed in a polythene tunnel, with polythene and shade netting draped across hoops over the bed. Despite the care taken to wean these cuttings, subsequent root development was poor except for De la Grifferaie, and most cuttings, as in the previous year, did not survive. One possibility was that basal temperatures provided by the heated sand bed were not high enough to continue the root development started in the Garner bin. Also, the later striking of these cuttings meant that top growth began to push in the warmer conditions of early spring before they had established sufficient new root.

Thirty of the successfully rooted De la Grifferaie hardwood cuttings were potted on from the rootrainers into 3 litre pots in mid May 1994 together with the 1993 propagated softwood cuttings. They were pruned back to a promising basal node or bud, and stems were trained up canes during the remainder of the summer. As with the softwood cuttings, however, the late

strike and potting on date meant that insufficient growth occurred during the season, and stems only averaged 6.7 mm diameter when measured in September.

¼ standards from top-tier hardwood cuttings

A novel technique was developed in this project which made use of the vigorous growth achieved in the field when stems are budded onto rootstocks. Stem height was sufficient by August to enable a second tier to be budded above a lower tier at ½ or ¼ standard height (0.75 m or 0.50 m). The second tier was budded about 0.85 m above the lower tier budding height (Plate 5). The top portion of the stems were taken as hardwood cuttings in late autumn, complete with their dormant eyes, to yield another crop of ¼ standards which were grown on in containers the following spring and summer. The technique involved using heated cutting bins as described above followed by holding material on heat assisted propagation beds to encourage rapid rooting and root development. For the suitable stem types, therefore, an otherwise wasted portion of stem was used to produce an extra crop of container grown ¼ standards ready for marketing within about a year from budding. This production method also eliminated the potential problems associated with heavily root pruning a field grown rootstock, and the stems were also free of the sometimes unsightly rootstock / stem union at their base.

A pilot study into the technique was carried out using some of the field grown stems on Laxa rootstock and from softwood cuttings which were two tier budded in mid August 1992. A total of 80 Sweet Dream and 20 Gingernut were budded as a top-tier on stems of Kiese (Jones), Kiese (Le Grice) and G278. These were taken as long hardwood cuttings on 23 November 1992, and following a 2500 ppm IBA quick dip, were root initiated at HRI East Malling with a basal temperature of 18 °C rising to 20 °C for the final week. Most of the Kiese callused well, and some roots were present when assessed, but this batch of G278 were variable. They were returned to Efford and potted into 2 litre containers on 22 December in a peat : bark mix containing 2.0 kg/m^3 Osmocote Plus 12-14 months Autumn (15+8+11+2 MgO+traces). They were stood on a heated sand bed in a polythene tunnel along with other hardwood cuttings as described above. Subsequent rooting out was slow, and faster root development might have been achieved with higher base temperatures. However sufficient root had been produced and head growth developed sufficiently for plants to be moved out to a standing out area by late May 1993, along with other plants containerised as dormant eyes, and the container grown stems from softwood cuttings. The plants were left in 2 litre containers to see whether the technique showed potential as a relatively cheap method of producing 'miniature' standards. Additional feeding was given in the form of 1 x 7.5 g Osmocote Plus Tablet 5-6 months (15+10+12+2 MgO+traces) per pot. The small container size and feed levels proved insufficient to maintain good foliage colour right through the season, and leaves began to pale by September.

Although heads developed more slowly and flowered later than the equivalent cultivars containerised in December as dormant eyes, results were sufficiently encouraging to extend trials with the technique.

Top-tier cuttings from 1993 grown stems

Half of each plot in the main trial used for the experiment comparing containerisation of stems as dormant eyes vs. leaving heads to develop in the field, were also top-tier budded, mainly with equal numbers of the patio cultivars Sweet Dream and Sweet Magic, but also a few Top Marks. Hardwood cuttings were taken on 15 November 1993 and treated in the Efford Garner bin in the same way as other hardwood cuttings taken that winter as described above.

Callusing and rooting was recorded on removal from the bin a month later on 14 December. Approximately 100 top-tier cuttings were taken on each of Kiese (Jones), De la Grifferaie and Pfander plus 30 of Kiese (Le Grice). Nearly all showed good callusing with 50% or more of the circumference of the cutting base with callus, plus some callus emerging from the split wounds. Very little root was present, however, except for De la Grifferaie, where 69% of cuttings had 1 or more roots present, and 11% with 6 or more.

Cuttings were potted on in a peat:bark mix into 1 litre pots containing 2.0 kg/m^3 Osmocote Plus 12-14 months Autumn (15+8+11+2 MgO+traces) and stood on a heated sand bed in a polythene tunnel. Root development was sufficiently good by mid May 1994 for them to be potted on into 3 litre containers into a 100% peat mix containing 6.0 kg/m^3 Osmocote Plus 12-14 months Spring (15+9+11+2 MgO+traces).

A rootball score on the 1 litre containers using the following scale was done on 12 May 1994 before potting on:

1 No root visible
2 Very slight rooting
3 Small amount of root around base of pot
4 Moderate rooting around pot
5 Strong rooting around most of potball
6 Very strong rooting around all of potball

Mean scores were De la Grifferaie 4.9, Kiese (Jones) 2.6, Kiese (Le Grice) 2.0, Pfander 1.4.

Plants were held under cold glass for about a week and then moved on to an outside Mypex covered growing area with pot drip irrigation, with stems secured to lines of non-slip cord running down the bed. Although all plants which showed rooting potential were potted on to the final size 3 litre container, a number failed to root out sufficiently, and invariably developed a basal rot. Pfander was the worst affected stem in this respect.

As in the pilot study which flowered in 1993, the top tier hardwood cuttings developed more slowly than those containerised as dormant eyes, but had nevertheless made sufficient growth and flower to be saleable by late July or early August (Plate 10 - 11). Table 7 shows the final grade-out achieved.

Head grade:
1 3 scions, well balanced
2 2 or 3 scions, acceptable shape
3 1 scion and/or small, unbalanced

Table 7 Survival and grade-out of top-tier hardwood cuttings flowering in 1994, 31/8/94

Stem selection	Flowering cultivar	Survival, % of cuttings taken	*Final no. plants*	Grade-out of heads %1	%2	%3
Kiese (Jones)	Sweet Dream	60	*31*	32	32	36
	Sweet Magic	74	*40*	80	15	5
De la Griff.	Sweet Dream	95	*53*	70	26	4
	Sweet Magic	87	*46*	93	0	7
Pfander	Sweet Dream	8	*4*	100	0	0
	Sweet Magic	15	*8*	100	0	0
Kiese (Le Gr.)	Top Marks	56	*18*	61	28	11

The relatively easy to root De la Grifferaie showed the best survival from hardwood cuttings, and also produced a good proportion of plants with good quality heads in this trial. Some of the problems experienced with apparent incompatibility with Sweet Magic in other experiments were not observed here. Kiese also showed promise with the technique, although the quality of heads of Sweet Dream were disappointing. The few cuttings of Pfander which rooted all produced good heads, although the difficulty in rooting this stem from hardwood cuttings reflected that shown with softwoods.

Top-tier cuttings from 1994 grown stems

It was decided to try a wider range of flowering cultivars for top-tier budding on the stems grown in 1994. As it was clear that early rooting of cuttings was important to achieve a sufficiently well established root system early in the spring to support good head growth, an early and late batch of cuttings was taken, the first on 7 October 1994 before stems were completely dormant, the second on 11 November when most leaves had fallen from the stems. Cutting bases were given a 2 cm split wound followed by immersion of the whole cutting for 10 seconds in a fungicide bath containing 0.5 g/litre Octave (prochloraz). Finally, cutting bases were given a 5 sec. 2500 ppm Synergol hormone quick dip.

Cuttings were potted up initially into 1 litre pots in the following mix:

75% Medium Irish Shamrock peat
25% SHL bark
1.0 kg/m^3 Osmocote Plus 12-14 months (15+8+11+2 MgO+traces)
2.4 kg/m^3 Magnesian limestone

Care was taken during potting to ensure the bases of the cuttings were at least 25 mm above the base of the pot to encourage a good rootball. Cuttings were supported with bamboo canes inserted into proprietary plastic cane supports in the base of each pot. After subsequent potting on into the final size 3 litre containers, and once stems were secured to the anti-slip cord on the outdoor container beds, the bamboo canes were removed.

The first batch of cuttings were potted into 1 litre pots on 23 November, the second on 21 December, and both were placed on a heated sand bed in a polytunnel. Polystyrene chips were used to insulate uncovered bed areas around the pots, and a temperature of 18 °C was successfully maintained at the cutting bases. The temperature was then lowered during February when it was clear that rooting had progressed well, and was much better than in previous experiments (Plate 8). Experience had shown that roots could begin to deteriorate if excessively high basal temperatures were maintained for too long after vigorous root growth was evident around the outside of the potball, but before top growth had developed sufficiently to manufacture new assimilates to the cutting.

The rooted cuttings in 1 litre pots were then potted on into 3 litre containers in a 100% Medium Irish Peat mix containing 6.0 kg/m^3 Osmocote Plus 12-14 months Spring (15+9+11+2 MgO+traces) on 21 March 1995. There appeared to be no advantage in taking the cuttings early before the leaves had fallen, as when plants were assessed for rooting at the 1 litre to 3 litre potting on stage, the cuttings from the later batch gave slightly higher mean visible root cover scores (Plate 9). Table 8, p. 24, shows the mean scores for callusing and mean number of roots visible prior to potting into 1 litre pots, and the mean score for potball root cover prior to the final potting on averaged over batches and flowering cultivars.

Callus score:
1 No callus visible
2 Callus visible in split wound
3 Callus visible in split wound and <25% of base circumference
4 Callus visible in split wound and 25-75% of base circumference
5 Callus visible in split wound and >75% of base circumference

Potball root cover:
0 - 4 scale

Table 8. Mean callus score and number of roots per cutting visible at potting up, and root cover score when potting on.

Stem selection	At potting into 1 litre pots Callus	No. roots	At potting on into 3 litre pots Root cover
Kiese (Jones)	2.8	0.15	1.3
Kiese (Le Grice)	3.7	0.15	1.3
De la Grifferaie	2.3	1.53	3.1
Pfander	2.4	0.05	0.7

Plants in 3 litre containers were held under glass initially, where first pinching and stem sideshooting was carried out. They were then moved to the outdoor Mypex covered beds in mid May 1995 and fitted with pot drip irrigation.

Table 9. Survival and grade-out of top-tier hardwood cuttings flowering in 1995, 25/7/95

Stem	Cultivar	Survival % of original cuttings	*Final no. plants*	% Grade 1 head shape	% breaks from 3 unions
Pfander	Sweet Dream	10	*3*	100	100
Pfander	Gentle Touch	26	*8*	75	88
De La Griff.	Top Marks	93	*28*	64	64
De La Griff.	Pretty Polly	97	*29*	97	72
De La Griff.	Sweet Dream	100	*34*	94	98
De La Griff.	Gingernut	91	*32*	84	66
Kiese (Le G.)	Top Marks	77	*24*	67	54
Kiese (Le G.)	Pretty Polly	71	*22*	82	73
Kiese (Jones)	Pretty Polly	82	*14*	100	79
Kiese (Jones)	Gingernut	77	*17*	94	65

Overall, head grade-out and survival of cuttings was better than in the previous year, although Pfander, once again, proved difficult to root, and cannot therefore be recommended for this technique. The earlier potting into 3 litre containers with this crop meant that while head development was still slightly later than plants potted from the field as dormant eyes, differences were small by July (Plate 12).

Table 10 Stem diameter (250 mm below head), 25/9/95. Comparison of stems from potted dormant eyes, grown on in field, and top-tier hardwood cuttings.

Stem selection	Stem diameter, mm (mean of plants in comparable selected plots) Dormant eye	Field	Hardwood Cuttings
Pfander	12.4	13.0	12.1
De la Grifferaie	12.2	14.2	13.4
Kiese (Le Grice)	12.3	13.1	11.5
Kiese (Jones)	12.0	12.8	11.5
Harwhippet	17.8	18.1	-

Table 10 indicates that while the hardwood cuttings did not develop quite as thick a final stem diameter as those plants lifted as dormant eyes, differences in diameter were only slight. Unlike the previous years trial, where stem diameters from containerised dormant eyes and field grown stems were similar (Table 4, p.14), diameters were somewhat greater from the field grown plants in this trial. The increase in stem growth the year following budding of the flowering cultivars was relatively small. Provided stems had developed sufficient girth by that stage, it appears that subsequent treatment has relatively little influence and all should produce sufficient weight for a good quality final product.

GARDEN PERFORMANCE OBSERVATION

A sample of 5 plants of each of the stem x flowering cultivar combinations from the main trial of the ½ standards (Amber Queen and Gentle Touch) and ¼ standards (Sweet Magic and Sweet Dream) which developed heads and flowered first in 1994, were field planted in a simulated garden performance observation between October and December 1994. Plants were spaced 0.5 m apart in two rows and supported by stakes (Plate 19 - 22). One row was planted from stems containerised as dormant eyes, or produced from hardwood cuttings (¼ standards of Sweet Magic and Sweet Dream), and the adjacent row were transplanted from the field site.

Similar numbers of plants of each treatment, which were containerised from the field in December 1994 as 'finished plants', were also retained to observe flowering in 1995 and to compare with those field planted in the garden performance site. These plants, along with the others containerised at the same time, were held under cold glass until early April 1995, and consequently flowered earlier than those in the garden performance field site. A total of 15 ¼ standards of Sweet Magic only, produced in 1994 from top tier hardwood cuttings, were also retained on the outdoor beds to observe flowering in the second year.

The flowering head size was graded on a 1 - 5 scale (5 = largest), and the number of flowers counted (buds showing colour + open or 'blown' flowers) on 6 June 1995 (Table 11, p. 27). The flower count only was repeated for the garden performance observation field site a month later on 6 July 1995 (Table 12. p. 28).

Table 11. Head size grade and number of flowers for containerised plants, and ex-container and ex-field planted material in simulated garden performance field site, 6/6/95.
Means of typically 5 plants per treatment

Stem	Cultivar	Plants in garden performance field site: Transplanted ex-field as finished plants Head gd	Flwr no.	Planted ex-containerised dormant eyes Head gd	Flwr no.	Retained in container: Containerised as finished plants Head gd	Flwr no.
	De la Griff. Sw. Dream	3.6	0.6	5.0	16.2	5.0	28.0
	Kiese (J)	3.4	1.6	4.8	9.4	4.7	17.2
	Pfander	3.6	0.8	4.6	17.2	5.0	21.7
	Mean	*3.5*	*1.0*	*4.8*	*14.3*	*4.9*	*22.3*
	De la Griff. Sw. Magic	4.0	5.8	4.2	7.2	4.8	18.2
	Kiese (J)	2.2	3.2	4.4	7.0	4.2	10.7
	Pfander	2.2	3.8	4.0	5.2	5.0	18.5
	Mean	*2.8*	*4.3*	*4.2*	*6.5*	*4.7*	*15.8*
	De la Griff. A. Queen	3.8	1.6	3.0	2.6	5.0	4.7
	Kiese (J)	3.4	1.6	3.0	2.6	5.0	1.0
	Pfander	4.0	2.4	3.2	4.4	5.0	2.7
	Mean	*3.7*	*1.9*	*3.1*	*3.2*	*5.0*	*2.8*
	De la Griff. G. Touch	3.0	7.0	2.4	11.0	4.8	50.3
	Kiese (J)	2.2	3.0	3.0	21.2	5.0	59.8
	Pfander	3.4	7.0	3.6	16.0	4.7	35.3
	Mean	*2.9*	*5.7*	*3.0*	*16.1*	*4.8*	*48.5*
Plants from top-tier hardwood cuttings							
	De la Griff. Sw. Dream	-	-	4.4	20.2	-	-
	Kiese (J)	-	-	4.2	11.0	-	-
	Pfander	-	-	4.4	15.0	-	-
	Mean	-	-	*4.3*	*15.4*	-	-
	De la Griff. Sw. Magic	-	-	4.0	5.4	-	-
	Kiese (J)	-	-	3.6	6.2	4.0	26.3
	Pfander	-	-	4.2	12.4	4.0	26.0
	Mean	-	-	*3.9*	*8.0*	*4.0*	*26.2*

Soil conditions at planting and over the winter were wet, and growth in spring was slow to get away. However the plants from containers appeared to establish better than those transplanted from the field. This is shown by the better mean head size grade data in Table 11, particularly with Sweet Dream and Sweet Magic. The three patio cultivars field planted from containers also had higher flower counts than those transplanted from the field at that time. The patio cultivars containerised as finished plants, and given an early start under glass, had considerably more advanced flowering heads by early June, particularly Sweet Dream and Gentle Touch. The

floribunda Amber Queen, which typically develops more slowly, and is less free flowering than the patio types, showed surprisingly little difference between treatments.

Where possible, good plants from each stem type were retained for this second flowering year observation. Although the means between stem types were variable, there was no evidence that any particular stem type performed consistently better or worse than the others.

The Sweet Dream and Sweet Magic raised from top-tier hardwood cuttings performed equally well as those planted from ex-containerised dormant eyes in this second flowering year, even though they were slower to develop and later to flower than the containerised dormant eyes in their first flowering year in 1994.

Table 12. Number of flowers on ex-container and ex-field planted material in simulated garden performance field site, second assessment 6/7/95.

Means of 5 plants per treatment

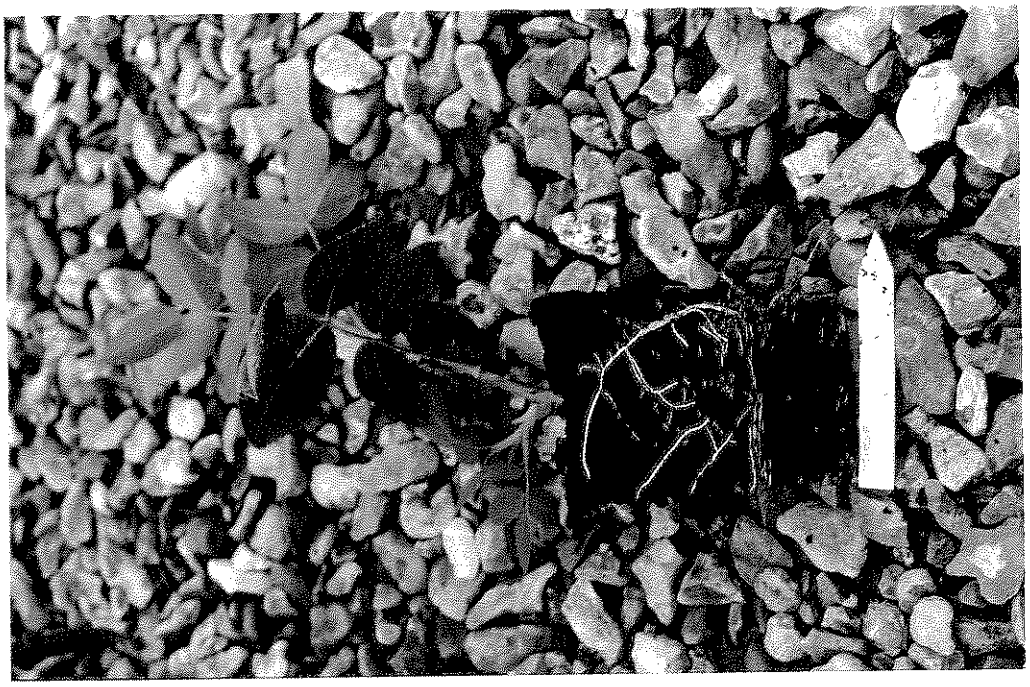
Stem	Cultivar	Transplanted ex-field as finished plants Flwr no.	Planted ex-containerised dormant eyes Flwr no.	Planted ex-container top-tier h/wood cuttings Flwr no.
De la Griff.	Sw. Dream	13.8	22.4	24.2
Kiese (J)		13.0	27.8	31.4
Pfander		16.6	26.8	37.8
Mean		***14.5***	***25.7***	***31.1***
De la Griff.	Sw. Magic	17.2	25.0	19.0
Kiese (J)		12.6	25.4	31.6
Pfander		12.8	24.0	31.2
Mean		***14.2***	***24.8***	***27.3***
De la Griff.	A. Queen	14.2	13.5	-
Kiese (J)		8.0	17.6	-
Pfander		11.6	19.4	-
Mean		***11.3***	***16.8***	-
De la Griff.	G. Touch	54.0	42.0	-
Kiese (J)		38.0	75.4	-
Pfander		57.8	70.6	-
Mean		***49.9***	***62.7***	-

While flower numbers were greater when recorded for the second assessment a month later (Table 12), the data indicated a similar trend to the June record, with greater numbers of flowers per plant present on the ex-container planted stems rather than the bare root transplanted stems.

APPENDICES

APPENDIX I

Plate 1



Rooted 9 cm liner of Kiese (Le Grice), 28/7/93

Softwood stem cuttings under mist

APPENDIX I

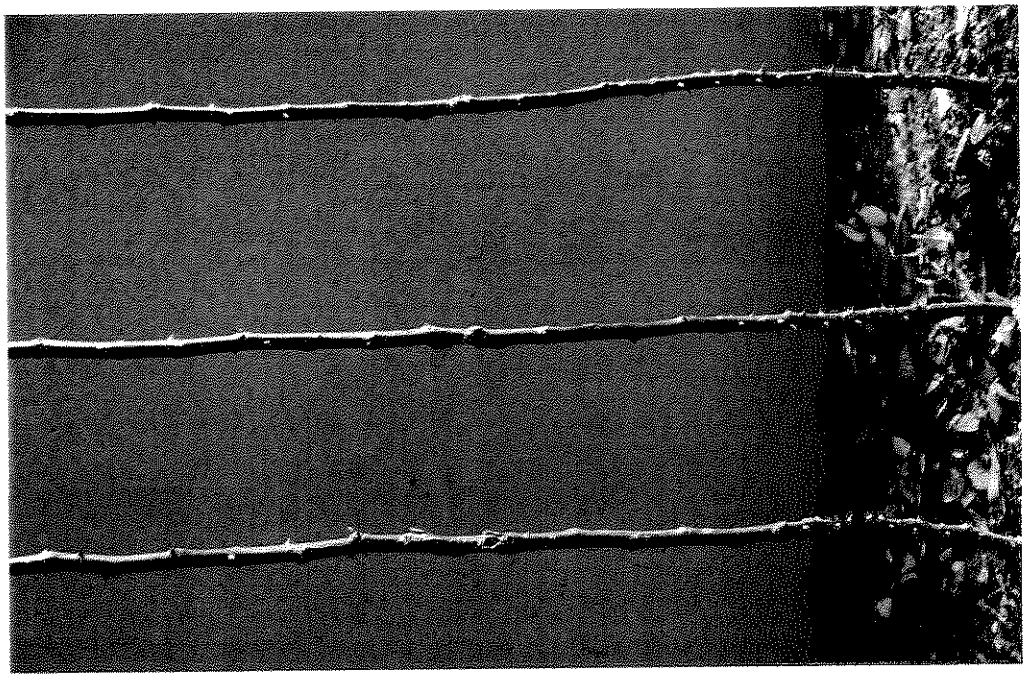
Plate 2

Root growth in 3 litre and 7½ litre containers by mid March 1992
from softwood cutting liners potted the previous October

Training stem growth from softwood cuttings, 9/6/92

APPENDIX I

Plate 3



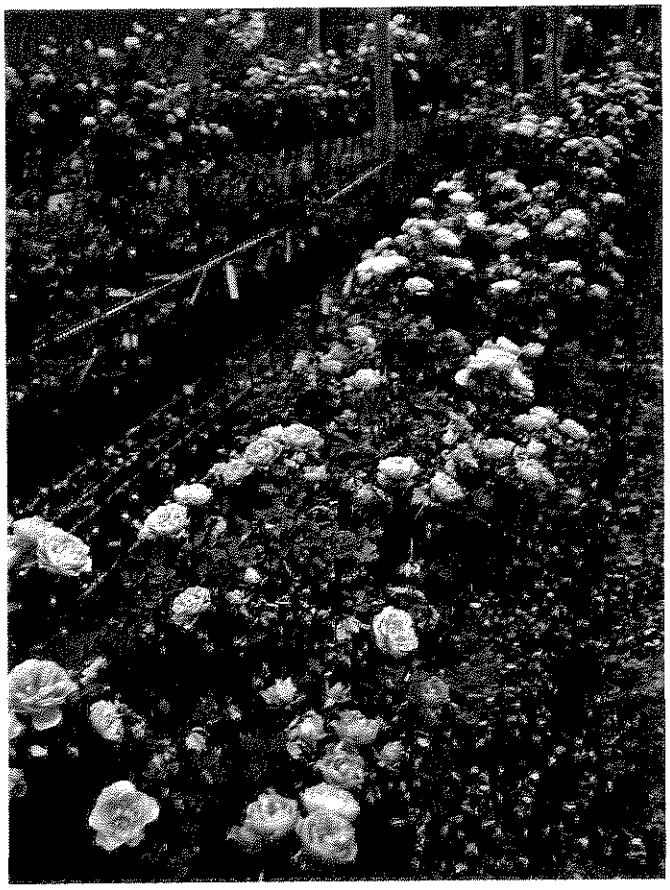
Kiese (Jones) stems from field grown softwood cuttings, 19/11/92

Silver Jubilee as full standards on softwood cutting raised stems from initial pilot study, 9/7/92

APPENDIX I

Plate 4

Flowering heads developing on full, ½ and ¼ standards on field grown stems from softwood cuttings, 10/6/93

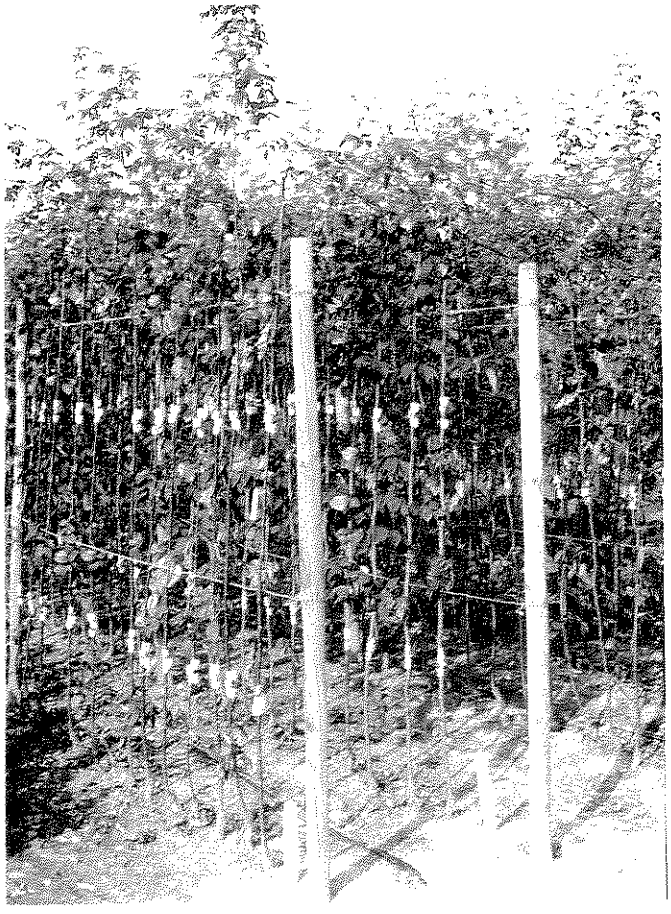


Late flush of flower of Sweet Dream on field grown stems from softwood cuttings, 9/11/93

APPENDIX I

Plate 5

Stem growth by late June, aided by low level irrigation

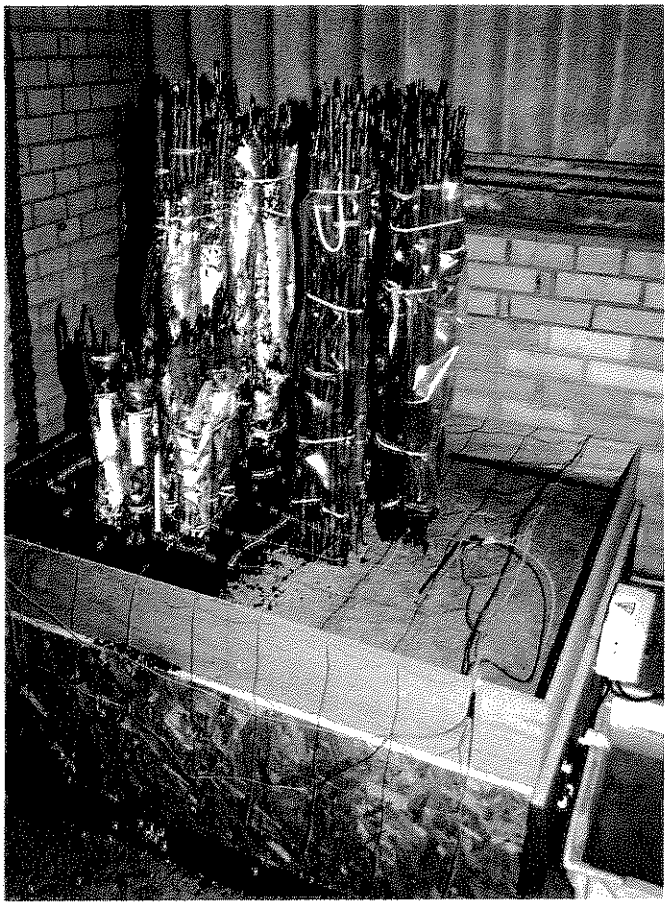


Two-tier budded stems in September

APPENDIX I

Plate 6

Construction of hardwood cutting bin showing heating cable on weldmesh, rod thermostat, and drainage pipe in base



Bundles of cuttings plunged into top layer of fine sand. Refinements included extending polythene sleeves over tops of cuttings, and using a mulch of polystyrene chips to retain base heat

APPENDIX I

Plate 7

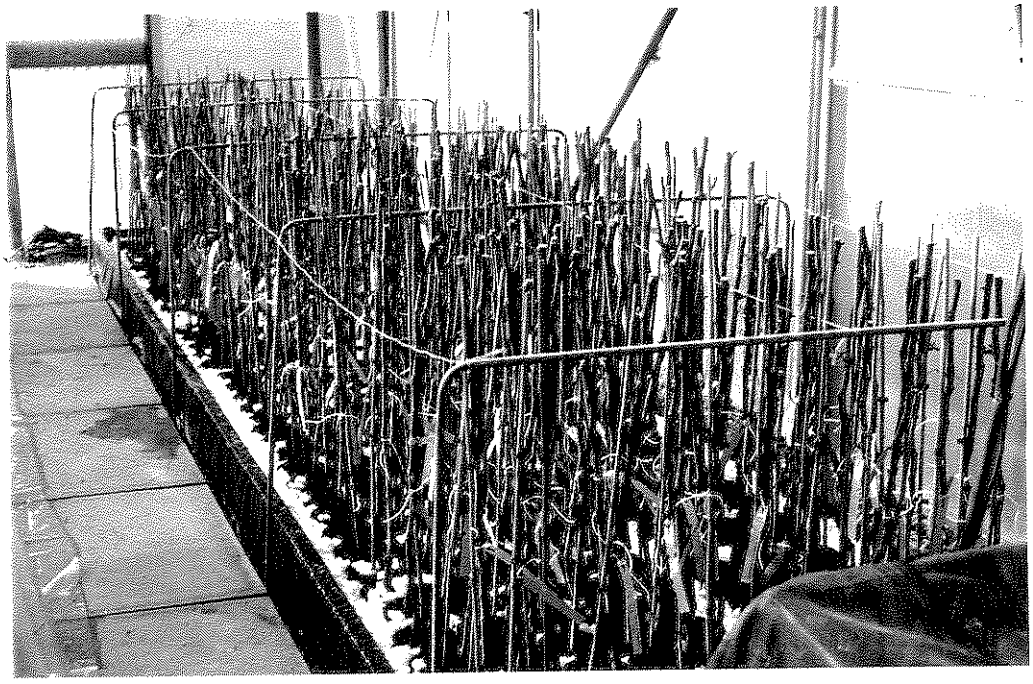
Kiese (Jones) bundles of hardwood cuttings on removal from bin

Detail showing callus and new root. Note split wounding in base of callus

APPENDIX I

Plate 8

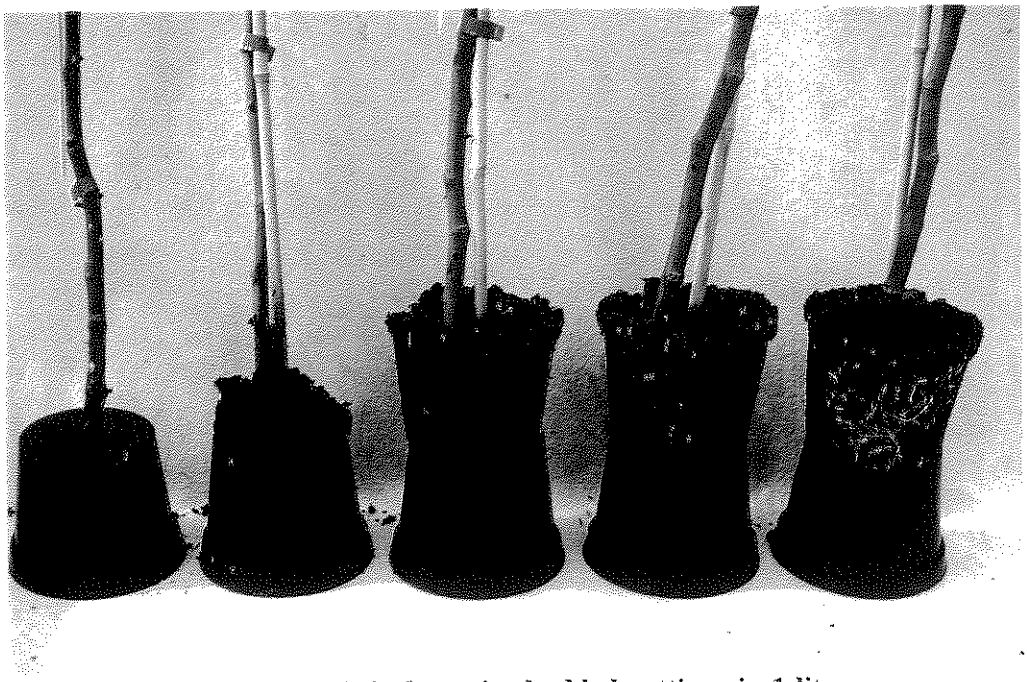
Comparative callusing and rooting of long hardwood cuttings on removal from bin 10/3/93.
L to R: Harwhippet, Pfander, Kiese (Le Grice), De la Grifferaie, G278, Dan Whiteside



Top-tier budded hardwood cuttings potted into 1 litre pots on heated sand bed.
Note polystyrene packing chip insulation

APPENDIX I

Plate 9



Rooting grades 0-4 of top tier budded cuttings in 1 litre pots prior to potting on to 3 litre, 20/3/95

Scion shoots overdue for first pinching. Note slower development of lowest bud

APPENDIX I

Plate 10

Early development of scion shoots 29/3/94 following removal of top tier budded hardwood cutting the previous autumn. Surplus stem growth will be trimmed to node above top scion shoot

Sweet Dream ¼ standards, from lower tier stem containerised as dormant eye in 5 litre pots (left) and top tier hardwood cuttings in 3 litre pots (right), late September 1994

APPENDIX I

Plate 11

Sweet Magic ¼ standard from top tier hardwood cutting, Kiese stem, in 3 litre pot, 10/10/94

Sweet Magic ¼ standard containerised as a dormant eye plant in 5 litre pot. Note bud union with Laxa stock at base of Kiese stem, 10/10/94

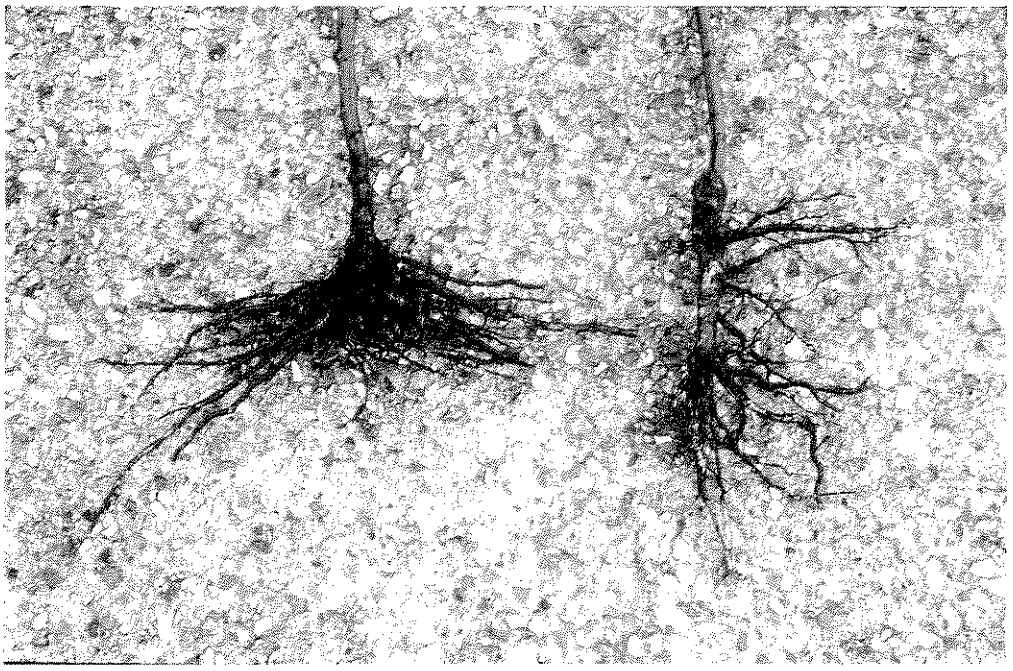
APPENDIX I

Plate 12

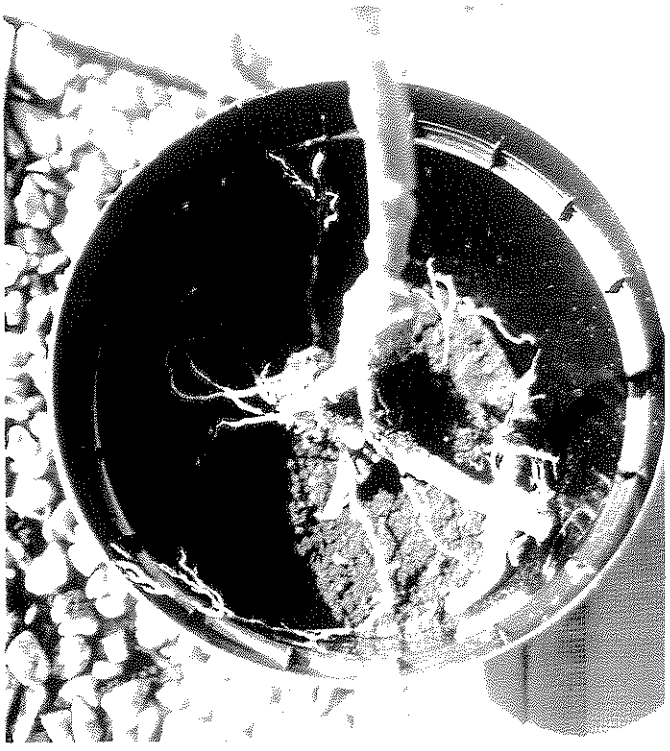
Pretty Polly top tier hardwood cutting (left) and Sweet Magic containerised dormant eye (right), 31/7/95

Top Marks from top tier hardwood cutting (left) and Benson and Hedges Special potted as dormant eye (right), 31/7/95

APPENDIX I Plate 13



Field grown standard stems before containerisation. Stem on own roots from softwood cuttings (left) vs budded on Laxa (right)

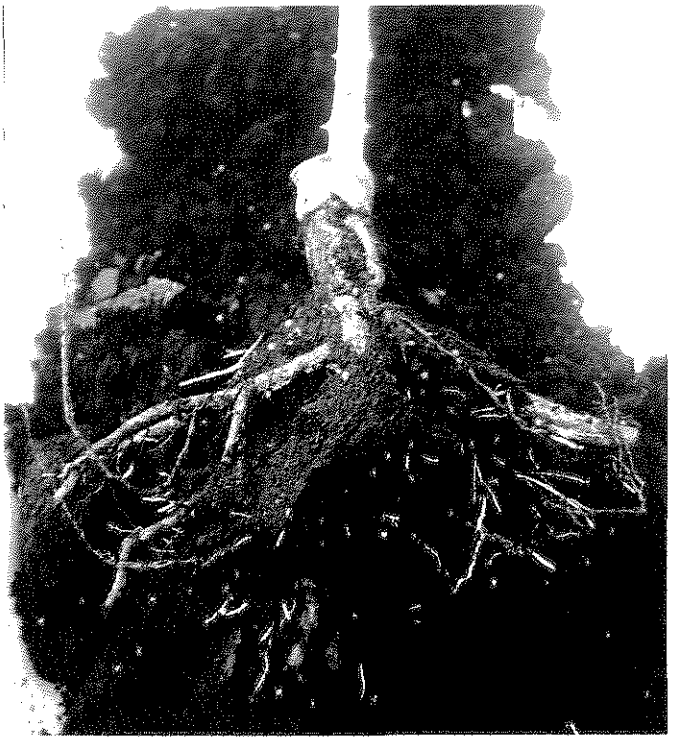


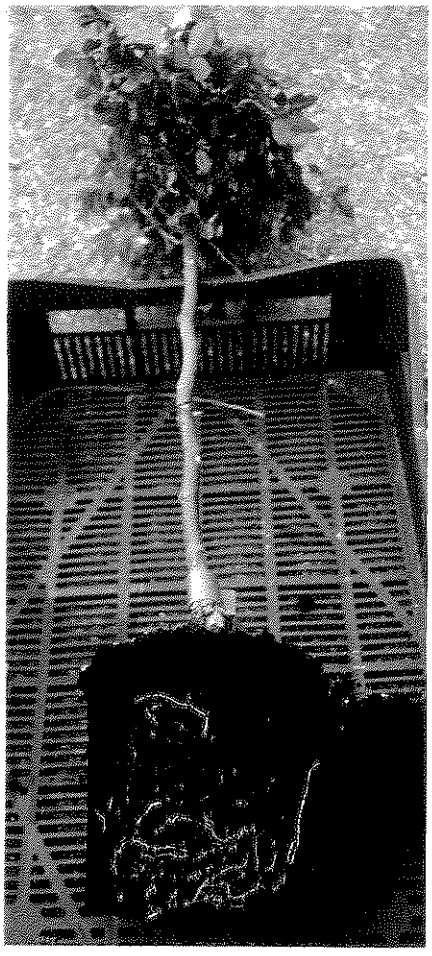
Severe root pruning required to containerise a stem on a 3 yr old Laxa rootstock

APPENDIX I

Plate 14

Finished standards, all potted in December 1994. L to R: dead, severely checked, well established by late May 1995

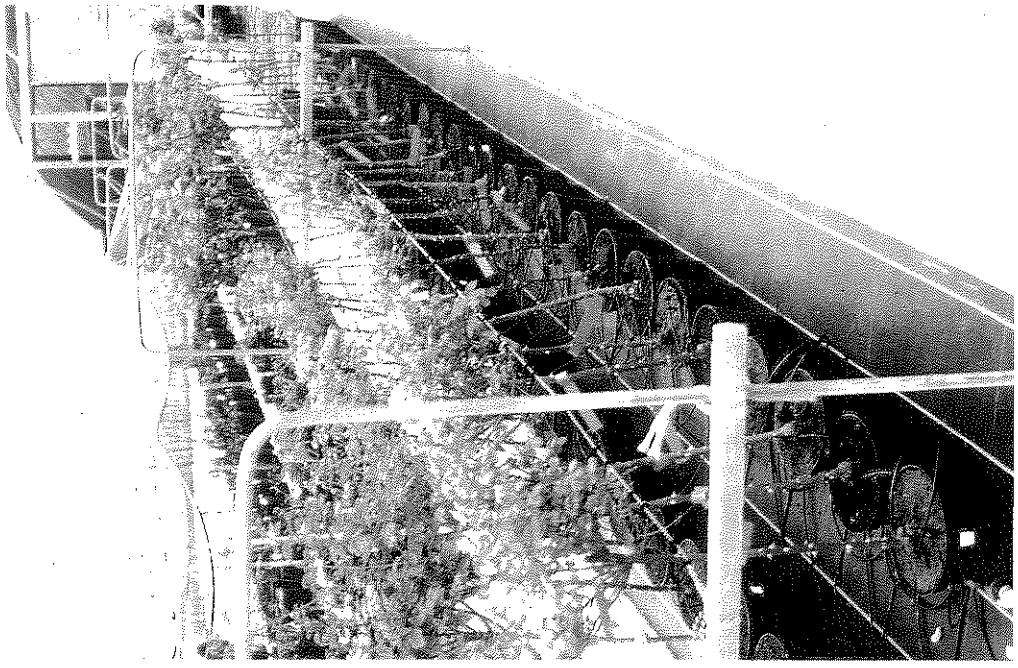




Late new white root on severely checked plant (left) compared to good rootball on well established plant (right)

APPENDIX I

Plate 15



More advanced growth on standards containerised as finished plants, 6/4/95

Early development of head growth (plus unwanted stem side shoot) from top tier hardwood cutting, 6/4/95. Surplus stem above top union 'absorbs' premature bud development during rooting before being subsequently trimmed

APPENDIX I

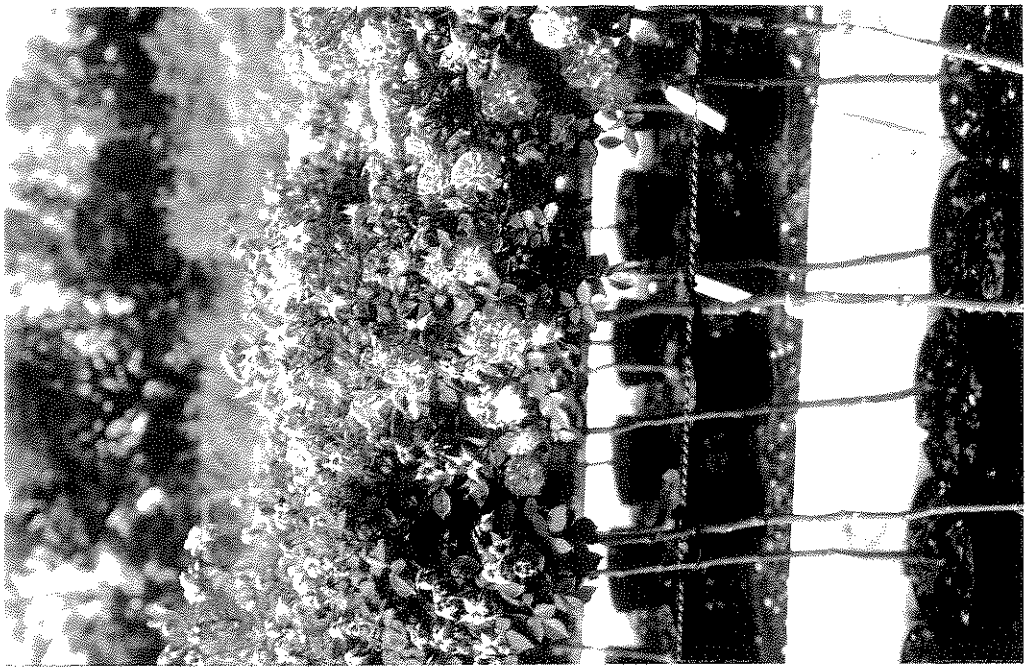
Plate 16

Container standard rose site in late July

Field grown standard roses in late July

APPENDIX I

Plate 17



¼ standard of Mandarin containerised as a dormant eye, 18/9/95

¼ standard of Mandarin in the field 8/9/95

APPENDIX I

Plate 18

¼ standard of Gentle Touch containerised as dormant eyes, 8/9/95

¼ standard of Gentle Touch in the field, 8/9/95

APPENDIX I

Plate 19

Assorted container standards before sale, early November 1995

'Garden Performance' observation. Top Marks from two-tier hardwood cutting system, planted ex-containers autumn 1994. Photograph 27/6/95

APPENDIX I

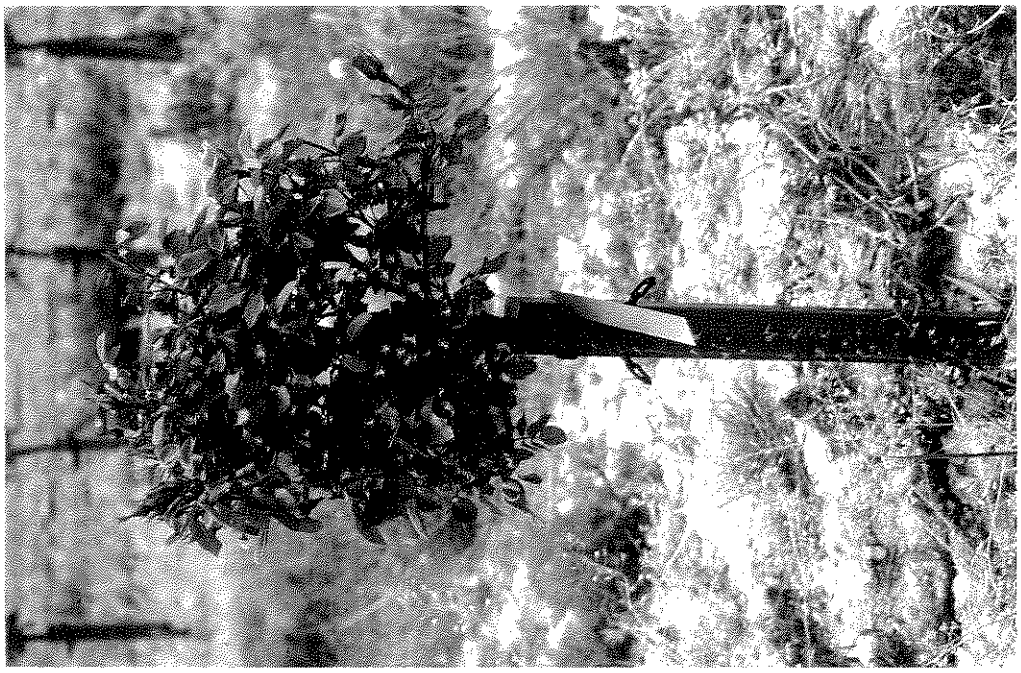
Plate 20

Garden Performance Observation. Amber Queen ½ standards transplanted from the field (front) and ex-containerised dormant eyes (rear), 27/6/95. Full standard garden observation (HNS 6a) in background

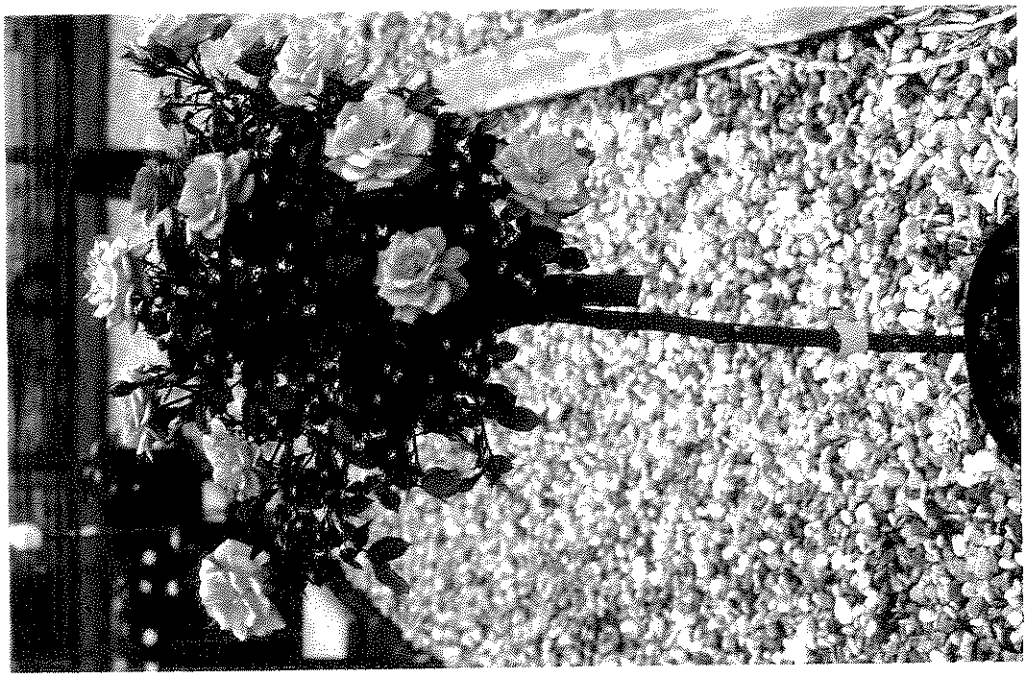
Garden Performance Observation. ½ standard Gentle Touch ex-field (front) and ex-container (rear), 27/6/95

APPENDIX I

Plate 21



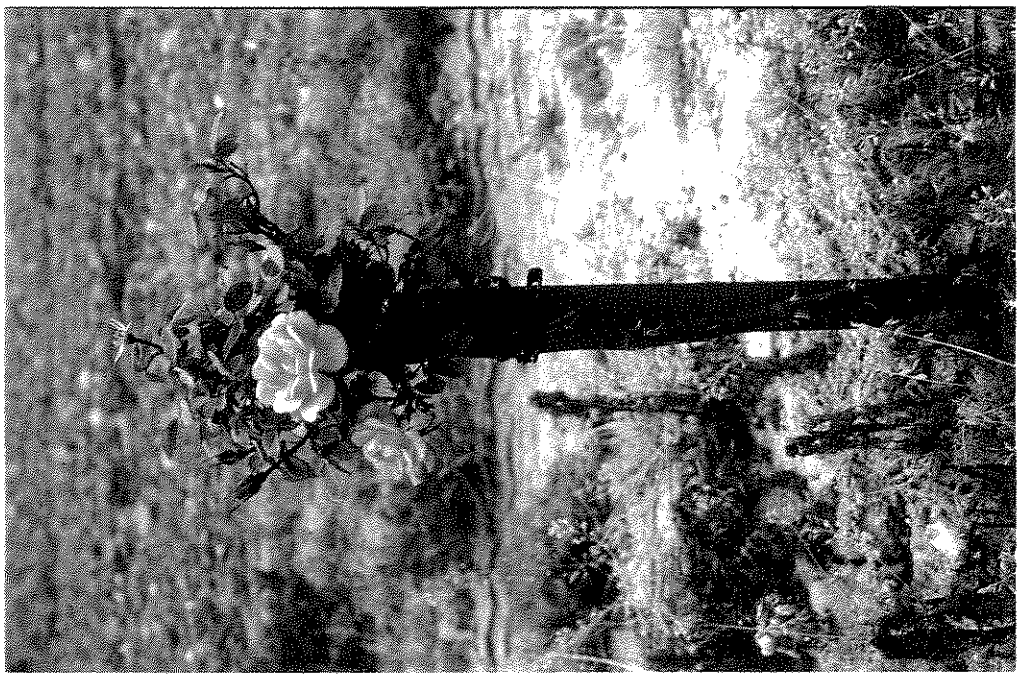
Sweet Magic, ex dormant eye potted plant, as left photo, in Garden Performance Observation, 9/6/95



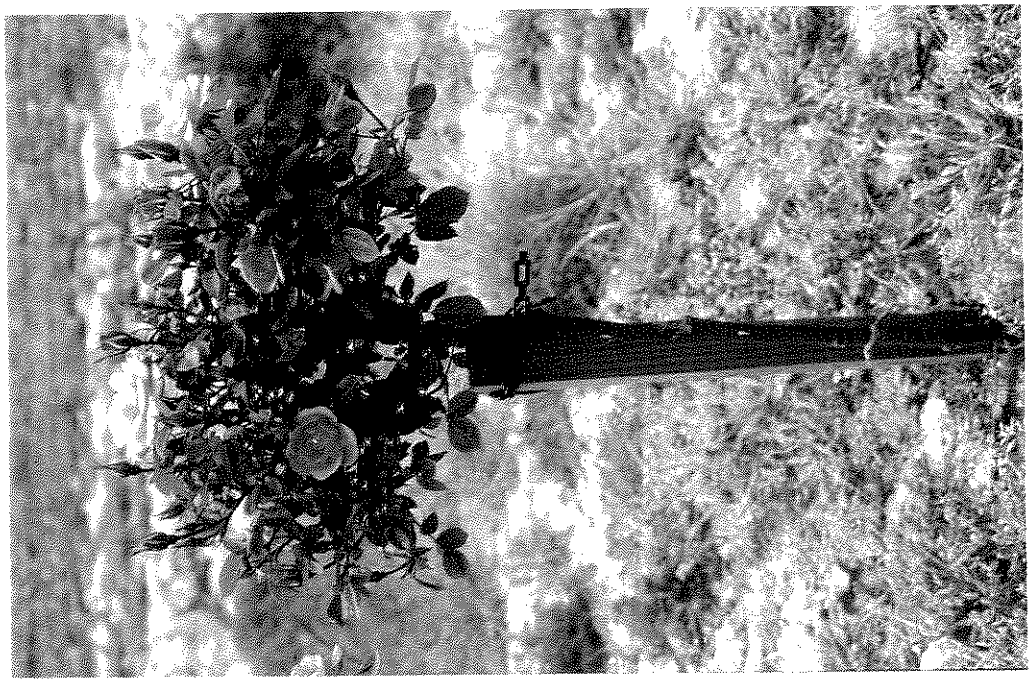
Sweet Magic, held over to second flowering year in container from December 1993 potted dormant eye, 9/6/95

APPENDIX I

Plate 22



Sweet Magic, transplanted from field in autumn 1994, showing small second year head growth resulting from slow field establishment



Sweet Magic in Garden Performance Observation, produced from top tier hardwood cutting winter 1993/94, 9/6/95

APPENDIX II Copy of contract and schedule

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/54
Contract date: 29.3.93

ROSE STANDARD STEM PRODUCTION SYSTEMS SUITABLE FOR CONTAINERISED MARKETING

2. BACKGROUND AND COMMERCIAL OBJECTIVE

The number of field grown roses produced in England and Wales is about 22.5 million annually, worth some £17 million farm gate value (1990) compared to a container grown nursery stock fgv of £123 million. It is not clear from the statistics whether the roses containerised before sale from nurseries are included in the fgv for container grown stock or not, but the trend is clear in that the proportion of roses containerised or container grown continues to increase. Typically 25-30% of plants are now containerised before sale, with well over 50% on some nurseries. Garden centre sales are largely responsible for this increase in containerisation, but increasingly landscape and amenity markets are buying their plants in pots. As with bush roses, the demand for containerised standard roses is increasing. The proportion of shorter stemmed ½ and ¼ standards being sold is also increasing, particularly those budded with 'patio' and miniature varieties. These products are particularly suited to the container market, and may indeed be purchased for planting and growing on in tubs and other containers.

3. POTENTIAL FINANCIAL BENEFIT TO THE INDUSTRY

The proportion of small standard roses being demanded is steadily increasing, as are the numbers required in containers. Since the newer stem selections have become available, more growers are now beginning to raise their own stems rather than rely on imported *R. rugosa*, and there exist opportunities for expanding and developing the new market for high quality small standard stems in containers. Certainly we have a lead in the UK in this area which if left undeveloped by growers here, is likely to be exploited abroad. Although standard stem production still involves relatively few growers, there should be room for production to expand as demand increases without loss of profitability, particularly if the techniques being examined result in shorter production times or lower costs.

4. SCIENTIFIC/TECHNICAL TARGET OF THE WORK

a) Examine the suitability of particular stem selections for propagation and ½ or ¼ stem production from both hardwood and softwood cuttings with reference, to rootability, subsequent vigour, handling in containers

or field, pruning technique and quality of the final product (eg. balance of stem and head). Compare stem cuttings with those budded on 'Laxa' rootstocks.

b) Develop schedules of production comparing the use of total container systems with containerising from the field at different stages in the production cycle, including the potting up of 'dormant eyes'.

5. CLOSELY RELATED WORK - COMPLETED OR IN PROGRESS

Small scale observations under project HNS 6a looked at arrange of possibilities, and provided valuable experience to enable future work to be concentrated on the most promising areas. HRI East Malling are collaborating with these observations by providing hardwood cutting root initiation facilities after which material can be grown on at HRI Efford.

6. DESCRIPTION OF THE WORK

a) Work which has already been started under HNS 6a, and which needs to continue under this new proposal includes various stem selections growing on 'Laxa' rootstocks in the field, and on their own roots from softwood cuttings both in the field and containers (see Project News 14 - 16 for progress to date). These stems were budded with a range of scion varieties including patio, floribunda and HT types as full, ½ and ¼ standards as appropriate in August 1992. Some will be lifted early as 'dormant eyes' this winter. All these require growing on and assessing during 1993.

b) Approximately 1400 more 'Laxa' rootstocks were budded with a range of stem selections in summer 1992. These will be headed back and stems grown and budded in 1993 with appropriate floribunda, patio and miniature varieties suited to ½ and ¼ standard roses for the container market. These will be containerised both as 'dormant eyes' in autumn 1993, or as a finished product lifted in Autumn 1994. Once containerised, final assessments on subsequent growth and quality in the container will be made in 1994 and 1995 respectively.

c) Hardwood cuttings from stock plants are being taken in winter 1992/93 as conventional cuttings. Hopefully growth will be vigorous enough from the new varieties to grow stems capable of being budded with flowering scions in 1993, rather than having to allow a full 'rooting year' with stem production in 1994. 'Long' cuttings will also be taken from stock plants as finished stems for growing in containers and budding in summer 1993. Both techniques offer the potential of a shorter production cycle than using 'Laxa'

rootstocks, especially for the ¼ and ½ standard stems.

d) Further savings in time and material may be possible with a "dual height budding" technique whereby an otherwise wasted length of stem removed at heading back a standard stem crop, is rooted complete with a second set of scion buds already in place to create another ½ standard crop. A pilot observation of this technique started under HNS 6a in 1992, if promising, will be repeated and developed in 1993/94 using the stems in b) above.

e) Finally, softwood cuttings will also be taken in summer 1993 for raising stems the following year, for comparison with those grown from hardwood cuttings taken in winter 1993/94.

Chronological Summary of Work

1993

a) Production of heads of field and container grown stems budded with flowering varieties in 1992 under HNS 6a.

b) Production of stems on 'Laxa' stocks and budding with flowering varieties. Containerising a proportion in autumn/winter.

c) Growing on hardwood cuttings/stems in containers and budding with flowering varieties in summer.

d) Production and assessment of heads of 1992 dual budding observation and repeat dual budding for further assessment of technique.

e) Strike of softwood cuttings (summer) and hardwood cuttings (autumn/winter) of stems.

1994

a) Growing on and final assessment during spring marketing period of some containerised standards started under HNS 6a.

b) Production of heads of field from stems on 'Laxa' stocks and 'dormant eyes' in containers. Containerisation of remaining field grown plants in autumn.

c) Production of heads on stems from winter '92/'93 stock hardwood cuttings in containers.

d) Production of heads on stems from 1993's dual budding.

e) Production of stems and budding with flowering varieties from 1993 stock softwood and hardwood cuttings.

1995

b), c) and d) Growing on and final assessment of finished products for quality during spring marketing period.

e) Production of heads for final year of softwood/hardwood comparison.

Preparation of reports.

7. **COMMENCEMENT DATE AND DURATION**

Start date 01.04.93; duration 3 years.

8. **STAFF RESPONSIBILITIES**

Mr C M Burgess, HRI Efford.

9. **LOCATION**

HRI Efford.

Contract No: HNS54

TERMS AND CONDITIONS

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

Signed for the Contractor(s)

Signature.....

Position.....

Date.....

Signed for the Contractor(s)

Signature.....

Position.....

Date.....

Signed for the Council

Signature.....

Position.....

Date.....