Project title:	**Roses: Improving establishment in containerised bush roses.**
Project number:	**HNS 56b**
Project leader:	**C M Burgess** **HRI Efford** **Lymington** **Hampshire SO41 0LZ**
Report:	**Final Report (December 1999)**
Previous reports:	**None**
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Key words:	**Rose, rootstock, undercutting, module, containerisation, establishment**

PRACTICAL SECTION FOR GROWERS

Summary

The overall aim of this project was to investigate methods of improving the root systems of field grown roses prior to lifting, in order to minimise the severe root pruning that is typically required at potting, and thus improve their establishment and performance in the container. Specific objectives of HNS 56b were to:

1 Further examine the potential for a shallow undercutting field treatment to *Rosa* Laxa rootstocks at the end of the budding year to improve root systems for containerising bush roses.

2 Observe whether irrigation in the maiden bush production year alleviated the check to top growth that undercutting can induce.

3 Observe the potential for using module raised rootstocks to improve the root structure for containerised roses.

4 Monitor field treatment effects on plant establishment in the container, and quality of final flowering product, from autumn and winter potting dates.

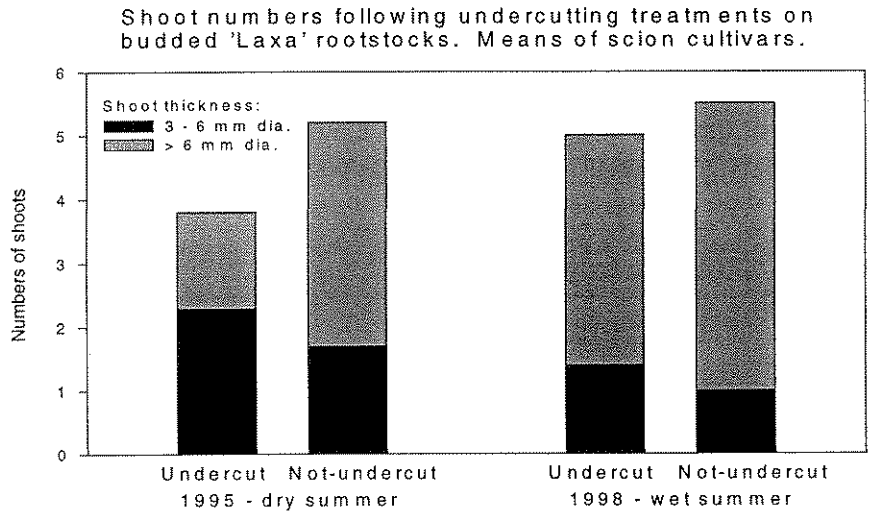
This project follows on from a previous project HNS 56. This showed that *Rosa* Inermis rootstocks formed a more finely branched root system than *Rosa dumetorum* Laxa, and required less severe root pruning at potting. However *Rosa* Inermis is little used as a rootstock for most garden roses in the UK, mainly because it produces too many suckers. *Rosa* Laxa produces relatively few suckers, which is an important labour saving consideration for the producers as well as gardeners, and is the preferred rootstock for the majority of rose types propagated by field budding in the UK. *Rosa* Laxa, can, however, produce a coarse root system, which in extreme cases has a predominant taproot, and relatively little lateral branching. Even with the deep 3.0 or 4.0 litre containers, which were specially developed for rose containerisation, this can result in very little fine root remaining after roots have been pruned for potting. Severe root pruning at potting was also thought to be an important factor responsible for plant losses overwinter or at least contributing to a check to growth and symptoms such as shoot dieback.

A shallow undercutting treatment to 150 mm depth in October of the *budding* year, using an angled bladed Egedal undercutter, was shown to encourage a finer branched root system in *R.* Laxa, with fewer thick deep roots, when bushes were lifted at the end of the following year. These required less root pruning, at potting. However, in HNS 56, the shallow undercut budded rootstocks produced less vigorous bushes with fewer thick shoots than the non-undercut rootstocks as a result of the dry spring in 1995, and no irrigation during the maiden bush year. As a containerised crop, establishment, growth and flowering in summer 1996 was equally good

from both the previously undercut and non-undercut field treatments, but the undercut treatment would have resulted in a poorer field grade-out if plants had been marketed as bare root or root wrapped plants.

A field trial was initiated under HNS 56b to verify these findings. In a replicated main trial, the cultivars Warm Wishes, Indian Summer, Kind Regards and Amber Queen received the same shallow undercutting treatment in their budding year of October 1997, compared with an untreated control. To investigate how far supplementary irrigation in the maiden bush year might alleviate the check to top growth that the undercutting treatment could induce, the main trial was regularly irrigated according to need. The main trial treatments were repeated on a smaller unreplicated plot, but which received no supplementary irrigation after undercutting, as an observational control.

Summer rainfall (April - September) was almost twice as great in the maiden year in 1998 (453 mm) as in the previous project in 1995 (232 mm). While shoots of undercut plants were still slightly thinner, on average, than non-undercut plants, the check to growth was much less marked in this project than in HNS 56 following the dry summer of 1995. Due to the wet summer in 1998, very little extra irrigation was required for the main trial, and results were therefore similar with the 'unirrigated' observation plot.



Differences in root growth between undercutting treatments were also less striking in 1998, although undercut plants nevertheless required 25% less weight of root pruned at potting. The wetter season undoubtedly stimulated stronger root and shoot growth, thus partly mitigating the effects of undercutting. However, in this project, the non-undercut plants did not show the poorly branched, predominantly taproot, root structure sometimes reported by growers. It is possible that this was influenced by the amount of fibrous root present on the seedling rootstocks at planting, and the soil's structure and organic matter content.

Most plants were lifted from the field and potted in late October / early November 1998. Deep 4.0 litre pots were used. Plants were held under a vent sided polythene tunnel until early April 1999, when they were grown on to marketing stage on outdoor beds. To test establishment under reputedly less favourable conditions, an additional batch of plants from the main undercutting trial was lifted and potted in mid January 1999, and stood directly on the outdoor beds.

Overall, establishment in the container and final quality at marketing stage was good, and the few plant losses that occurred did not appear to be directly related to experimental treatments. Following a mild and not excessively wet period after standing out, the January potted plants broadly performed as well or better than those potted in October and had fewer plant losses. Adequate wetting up of the growing media immediately following the autumn potting was demonstrated, in order to avoid undue stress which could affect growth the following spring.

There was some evidence that shallow undercut plants showed slightly stronger early root development and more vigorous and healthy shoot growth following containerisation, but results were not consistent across all cultivars or sub-trials. Kind Regards showed the most consistent positive response to undercutting. Some dieback of old shoots occurred in this cultivar, but this was less evident on undercut plants. With undercutting, the improved vigour was reflected in taller plants plus up to 30% more flowers present at marketing stage. In Amber Queen, Indian Summer and Warm Wishes, differences in final plant quality between undercutting treatments were small and of little commercial significance. Nevertheless, there were indications that undercut plants were better 'conditioned' to cope with stresses following lifting and potting, which might make them more robust under poorer cultural conditions.

Project HNS 56a showed that *Rosa* Laxa rootstocks could be successfully raised from seed in small modules. Limited quantities of these were available for comparison with conventional bare root seedling rootstocks in an unreplicated observation, to examine their potential for producing a finer root system in the field. These were planted out, by hand, alongside the main trial and budded with Pretty Polly, Rosy Future, Fellowship, Freedom, and Margaret Merril.

Module raised rootstocks produced a large number of roots which radiated from a shallow zone corresponding to the original module. On average 33% less root pruning was required at potting compared to plants on conventional rootstocks. Modules appeared to advance early root and shoot development somewhat after containerisation, particularly for Pretty Polly, which was reflected in improved flowering at the final assessment in this cultivar. However the other cultivars showed negligible differences, and final quality was similar from plants on both types of rootstock. Module raised rootstocks are likely to be more expensive than traditional stocks, but nevertheless are of sufficient interest for the Dutch nursery consortium, Rosaco, to be currently undertaking trials with them.

10% of plants on conventional rootstocks had an excessively long 'neck' (>100 mm), which required more severe root pruning in order to bury it at potting. Although no correlation could be

found with poorer establishment from these plants in this trial, this potential difficulty was eliminated with module raised stocks which all had short necks. A little more care was required when budding the module rootstocks, but bud take was as good as with conventional stocks.

Action Points

- A shallow undercut operation to a depth of 150 mm in the early autumn of the budding year has been shown to increase the amount of fine root present when plants are lifted at the end of the maiden year, and reduce the amount of root pruning required at potting.

- Undercutting is most likely to give worthwhile benefits on sites where root systems often tend to be very coarse with little lateral branching. Such plants are more likely to show poor establishment in the container as a result of severe root pruning.

- With shallow undercutting, irrigation should be used if dry the following spring / summer, to avoid a check to growth of the maiden bushes. This will be particularly important where a proportion of bushes are destined for sale as dormant plants. However, a slight reduction in shoot numbers or shoot thickness following undercutting did not reduce final quality where plants were containerised for sale in flower.

- In trials where the survival, growth and final quality of containerised plants was generally good, significant benefits have not been proven from the use of undercut plants. However, undercut plants did show some subtle improvements in early root and shoot development, the potential benefits of which were, to some extent, masked by the good performance of non-undercut controls.

- Module raised rootstocks (produced under project HNS 56a) formed plants with consistently short 'necks' and a root system that was easier to containerise with less severe pruning. Again, this did not result in significant improvements in the final quality of containerised plants in this project. However, they may still be worth considering for containerising high value standard roses for example, where it is important to pot centrally and upright. It may also be possible to improve crop uniformity from machine planted module stocks, however this was beyond the scope of this project.

Practical and financial benefits

On nursery sites where root systems of bush roses already appear sufficiently well branched at lifting, and where it is not suspected that severe root pruning prior to potting is adversely affecting establishment, the extra cost of a shallow undercutting treatment is unlikely to give any worthwhile benefit. The shallow undercutting treatment or use of module rootstocks may be worth consideration by growers, however, if their field sites produce coarse root systems, and it is thought that heavy root pruning is contributing to plant losses following potting. Field irrigation should be available where shallow undercutting is used.

SCIENCE SECTION

INTRODUCTION

Background

A previous project, HNS 56, established that shallow undercutting rootstocks to 150 mm depth in October of the year of budding, could not only reduce the length of the root, but also markedly improve the fibrousness of the root system when finished bushes were lifted in the autumn of the following year. This reduced the severity of the root pruning required at potting, particularly with Laxa rootstocks, which can sometimes produce a predominant tap root with few branches.

The bush production year in 1995 (following budding and undercutting) was particularly dry in the spring, and this caused a marked decrease in the vigour and weight of the undercut bushes in the absence of irrigation. Nevertheless, as a containerised crop, establishment, growth and flowering in summer 1996 were as good from both the previously undercut and non-undercut treatments.

Another season's experience was required to verify these findings. This follow-on project HNS 56b included the main undercutting treatment comparison, but also looked at other factors that might influence root growth and shoot grade-out from the field and subsequent performance in the container.

Water stress on the undercut plants was clearly a major factor affecting their field growth in the first project. Therefore, a well irrigated growing regime was used as the standard treatment in HNS 56b, with an additional area which received no irrigation in the bush production year as an unreplicated observation for comparison.

Two lifting and potting dates were also compared. Commercially, potting typically continues over a long season from early October onwards. This includes the less than ideal cold and wet winter months of December and January, when plants may remain dormant outside after potting for several months, with little or no new root production until temperatures warm up in spring.

Finally, some Laxa rootstocks raised in modules under project HNS 56a, were grown on in the field and budded alongside conventional bare root stocks. Module raised stocks could have the potential for improving the fibrousness of a Laxa root system when grown on in the field, and offer an alternative to shallow undercutting.

Objectives

1 Further examine the potential for a shallow undercutting field treatment to *Rosa* Laxa rootstocks at the end of the budding year to improve root systems for containerising bush roses.

2 Observe whether irrigation in the maiden bush production year will alleviate the check to top growth that undercutting can induce.

3 Observe the potential for using module raised rootstocks to improve the root structure for containerised roses.

4 Monitor field treatment effects on plant establishment in the container, and quality of final flowering product, from autumn and winter potting dates.

MATERIALS AND METHODS

This project had two distinct phases, the field growing stage, during which treatments to improve root structure were imposed, and the containerisation and growing on stage, in which establishment, growth and quality in the container was evaluated. Appendix I gives details of the trial layout for the field stage, and Appendix II for the container stage.

Treatments

Main trial - undercutting

Shallow Undercutting	Undercut (Egedal machine) to 150 mm depth (October 1997) Not undercut
Cultivars	Warm Wishes Indian Summer Kind Regards Amber Queen
Lifting / potting dates	October 1998 January 1999
Irrigation observation	Main area irrigated as required in bush production year Unreplicated non-irrigated area with above treatments (October lifting and potting only).

Module vs. Bare root rootstocks observation

Rootstock type	Module raised Laxa seedlings (Cells treated with Spin Out) Module raised Laxa seedlings (Untreated) Bare root Laxa seedlings (Blundell Rootstocks Ltd)
Cultivars	Pretty Polly Rosy Future Fellowship Freedom Margaret Merril

This observation was lifted and potted in October 1998.

Trial design (Appendix I and II for layout)

Field growing stage

For the irrigated main trial area, a split-plot design with four replicates was used with undercutting treatments as main plots and cultivars as the sub-plots. Plot size was nominally 40 - 45 plants per plot in a double row. The sub-plots were further split at lifting, with the plants

from the west row used for the October lift, and the east row for the January lift. For the unirrigated observation, unreplicated plots of nominally 50 plants in a single row were used. This area was located in the same field but about 50 m away from the main trial.

The modules vs. bare root rootstock observation had unreplicated plots of each treatment. Numbers of plants per plot varied according to cultivar, but ranged from about 25 to 50 plants per plot except for cv. Freedom where only 12 plants were available for some plots.

Container evaluation stage

Ten plants per plot were recorded and potted up from the main trial, on each of the potting dates. For the unreplicated observation plots, 30 plants per plot were lifted and split into three replicates of 10 (labelled with suffix A, B and C) for the growing on assessments.

The containers from the autumn potting were held pot-thick on beds under a vent sided polythene tunnel over winter in plot order as lifted from the field. Likewise those potted in January were held pot thick on outdoor beds until they were rearranged in early April at their final spacings for growing on. Within each sub-trial, plants of the same cultivar were grouped together and laid out as small randomised block experiments for the undercutting or module vs. bare root treatments. This was to avoid problems of differential shading that would otherwise occur between adjacent small plots of different cultivars. Plot numbering as used for the field plots was retained.

Culture

The field trial was grown on a fine sandy silt loam soil of the Efford soil series in field S11 (north). A soil analysis from November 1996 gave the following results:

	mg/litre	ADAS index
pH	6.7	
P	70	high 4
K	238	3
Mg	486	6

The site, which had been previously down to grass, was sprayed with Roundup in mid March 1997. A liberal dressing of well-rotted stable manure was incorporated in early April but no further inorganic base dressing was required. The bare root *Rosa* Laxa rootstocks (5-8 mm grade from Blundell Rose Stock Ltd, Spalding, Lincs) were planted from 8 April 1997, followed on 10 April by the module raised rootstocks from the previous HDC Project HNS 56a. The bare root rootstocks were planted with a Super-Prefer planting machine; however this machine was not suitable for gripping the module stocks, which were planted by hand. Stocks were ridged up after planting prior to application of the residual herbicide. All were budded with the flowering cultivars in mid July 1997.

The shallow undercutting treatment was applied to treated plots mid October 1997 using an Egedal machine with the blade set to a nominal depth of 150 mm (Plate 1). This machine (as used in the previous Project HNS 56), employs a fixed blade set at an angle of 60° to the direction of travel. It is ideally suited to very light soils, and is mainly used for undercutting beds of tree seedlings. For this trial on Efford's soil, extra weights on the toolbar were required to prevent the blade from lifting. Travelling speed was slower than normal, and care was needed to ensure roots cut cleanly and stocks weren't dragged along the row. However, once the machine was set up correctly, it performed well.

Most of the trial was headed back in late February / early March 1998 and grown on as a conventional bush crop. However, rootstock tops on cv. Top Marks from the module vs bare root rootstock observation plots, were headed back early in mid August 1997 and plants lifted in early November as 'started eyes'. These were potted and held over winter under glass. Unfortunately, a significant number of these plants from both bare root and module rootstock sources suffered shoot dieback over winter and died, and so were eliminated from the trial.

Irrigation was applied as required in the rootstock year, but after heading back in 1998, no further artificial irrigation was applied to the 'non-irrigated' observation area. Due to sufficient rainfall in 1998, irrigations were only required for the main trial area twice, in May and in August.

A conventional spray programme for pests and diseases was used throughout the project. Three applications of simazine + metazachlor (Butisan S) residual herbicide were applied; after rootstock planting, budding and just prior to heading back. A wet spring in 1998 was probably responsible for a reduced period of activity from the final herbicide application, and a lot of hand weeding was required during the summer and autumn prior to lifting.

All plants (including those destined for the January lifting) were deep undercut with a J-blade Damcon undercutter in mid October 1998. Plants for autumn potting were lifted, and in most cases held in a cold store under polythene sheeting for a few days prior to potting. Before potting, shoots were trimmed to about 130 mm (as measured from the union), and roots, during the recording procedure, were trimmed using a rectangular wire frame template 150 mm x 200 mm depth. These dimensions approximated to the deep 4 litre pots used (i.e. Optipot 17 RX - 170 mm top diameter and max. 220 mm depth). Plants from the main trial and non-irrigated observation were containerised by the end of October, and the modules vs. bare root observation was lifted and potted by early November. Plants were placed in an unheated, vent sided, polythene tunnel until early April 1999 when they were spaced onto outdoor growing-on beds at 290 mm x 270 mm centres. A further set of plants were lifted from the main (irrigated) trial in mid January, and placed directly on the outside beds after potting. A pot drip system was used for irrigating the trial during the spring and summer 1998. A potting mix of 100% Premium grade Shamrock peat containing 3.0 kg/m^3 of Ficote 140 TE controlled release fertiliser and 2.4 kg/m^3 magnesian limestone was used throughout.

Records and statistical analyses

Budtake

Rootstocks present with live (growing) scion buds were recorded on 13 May 1998.

Mid-season field top growth assessment

Overall plant height, and the number of main shoots present (i.e. those > 5 mm dia and about 100 mm high), was recorded on 23 - 25 June 1998. Following experience in the previous project HNS 56, when effects of the undercutting treatment showed up particularly clearly as a check to growth early in the season, it was decided to include an interim growth record prior to the usual end of season grade-out. For the main replicated trial, 15 plants per plot were assessed (from the west row only) for this record, but all plants per plot in the remaining observation trials were recorded.

Final field top growth assessment

This was carried out 5 - 8 October 1998. The height of the longest shoot, and the number of 'thick' (≥ 6 mm dia.) and 'thin' (3 - 6 mm dia.) basal shoots were recorded. For the patio cultivars Pretty Polly and Rosy Future, 5 mm was chosen to divide thickness categories. Shoots thinner than 3 mm dia. or < 150 mm long were ignored. Basal shoots were defined as those arising from within 25 mm of the bud union.

Root and shoot assessments of lifted plants pre-potting

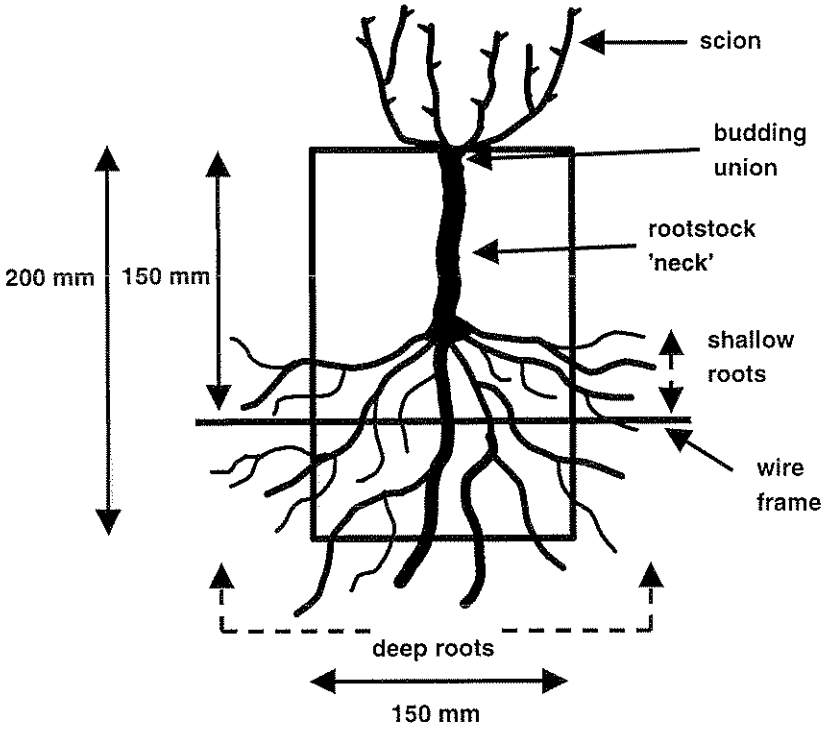
A sample of 10 plants per plot were lifted, assessed and containerised (see *Trial design* p.7). Lifting and assessing the main replicated trial commenced on 20 October 1998, the non-irrigated observation area on 27 October, and the module vs. bare root observation on 2 November.

The basal shoot record described above was repeated for the sample for potting. This was a check in case some of these plants were not representative of the plot as a whole, and enabled any subsequent establishment and growth effects to be traced back to the individual plant quality at potting. The presence or otherwise of a 'long neck' was recorded, (i.e. if there was a portion of stem from shoots to roots ≥ 100 mm). This was considered important as plants were potted with the bud union level with the top of the growing medium. Plants with a long neck therefore required a more severe root pruning in order to accommodate them in the pot.

Using a wire frame template with its top level with the bud union, the number of 'thick' (> 5 mm) and 'thin' (3 - 5 mm) roots were counted. They were classified as 'shallow' if they emerged from the wire frame boundary 0 - 150 mm from the top, or 'deep' if they emerged > 150 mm from the top (Fig 1).

Plants from the main trial potted in January, were lifted and recorded 14 - 15 January 1999. As roots had already been recorded from plot samples the previous October, this record was not repeated.

Figure 1 Wire frame for recording root system, and as a guide for pruning roots at potting



A clear polythene bag was used to line the containers for three plants per plot during the potting operation, in order to facilitate later examination of the potball for early root development without them disintegrating. Drainage holes were made in the polythene bags corresponding to those in the container.

Early assessment of stage of growth, health and root growth of containerised plants (Plates 5 - 7)

Assessments were made on the October / November potted plants on 11-12 March 1999. The January potting, on the outdoor beds, was assessed later on 14 April 1999.

There was some evidence of some leaf scorch and shoot dieback on some of the autumn potted plants by early March 1999, while they were still under the polythene tunnel. Also a few plants developed some abnormally small, yellow and twisted leaves at first. This leaf distortion, which we referred to as 'leaf feathering', was temporary and most plants grew away from it.

These effects were recorded along with a general vigour / stage of development score and early root assessment using the following scoring system:

Development stage / vigour

0 Dead or only very slight activity
1 Bud burst but before first expanded leaf ('flat leaf')
3 At least 2 shoots present at flat leaf stage
5 Good overall leafing out
7 Shoot extension in addition to leafing out

Root development

0 None
1 Some new root just visible
3 Medium amount
5 Most root

Leaf scorch

0 Not present
1 Present

'Feathered' leaves

0 Not present
1 Present

Shoot dieback

This related to dieback of the 'old' shoots present at potting rather than new shoots produced subsequently.

0 None or < 20 mm present on only one shoot
1 More than 20 mm present on one shoot or more than one shoot affected

Second vigour / health assessment of containerised plants

The evidence of leaf scorch, 'feathered' leaves or shoot dieback present at the early growth assessment was only temporary for most plants, but a few failed to recover or were still showing symptoms of poor growth by May. A second assessment for general vigour / health, and any evidence of leaf 'feathering' was therefore done on 4 - 5 May 1999.

Vigour / health

0 Dead / nearly dead

1 Severe dieback or plant very small

2 Less than average growth

3 Average growth

4 Better than average growth

5 Best growth for this cultivar

Feathered leaves

0 None

1 Slight evidence

2 Moderate

3 Severe

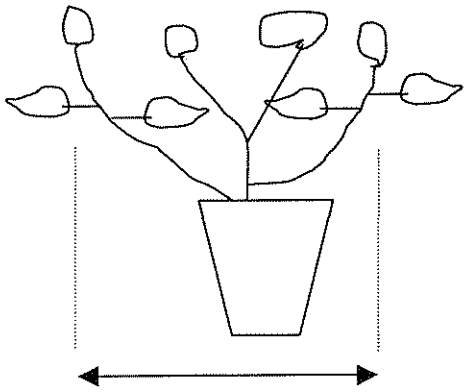
Final growth and quality assessments at marketing stage

The final assessments were carried out for each cultivar when they had reached the optimum development stage for marketing - i.e. when the flower buds were beginning to develop colour. Typically the flower bud count was recorded first, before the plants developed any further, and the subsequent measurements completed within a week. Timings varied according to cultivar, but assessments started on 26 May 1999 with the earliest cultivars to mature (e.g. Indian Summer), and continued until about 24 June with the later cultivars such as Warm Wishes and Fellowship.

The final assessment comprised:

Height (cm)- of the longest shoot measured to the base of the terminal flower bud.
Width (cm) - measured stem to stem at the widest point (Fig. 2), and at right angles to this.

Figure 2 Width measurement 'stem to stem' at widest point



Number of flowers - number of flower buds showing colour (or more advanced)
- number of green flower buds

Health score - overall health of plant taking into account any dieback or poor leaf colour on a scale of 0 = dead to 5 = best.

Statistical analyses of records

Where appropriate, data was subjected to analysis of variance (ANOVA). For the results of the field assessments and shoot and root records at lifting, ANOVAs were only possible for the replicated main (irrigated) trial. ANOVAs were feasible for data from records taken after potting for all the sub-trials, but formal comparisons could only be made between undercutting treatments for the main trial, and module vs. bare root rootstock treatments for this observation. Effects due to cultivars, and comparisons of the irrigated and non-irrigated plants and the two lifting / potting dates could only be made informally. Also, some results were clear cut enough not to require formal analysis.

RESULTS

Field growth results

Rainfall and irrigation

A weekly rainfall chart for the maiden bush growing year, 1998, is shown in Appendix III. The weather in summer 1998 was much wetter than for the maiden bush year 1995 in the previous project HNS 56, with particularly heavy rain in April and early May. Summer rainfall for April - September totalled 450 mm in 1998 compared to 230 mm in 1995.

A total of only 30 mm of irrigation was applied to the main trial area in 1998 split between two applications in late May and mid August.

Budtake

Table 1 Mean budtake (% of stocks present) for cultivars in each sub-trial

	Cultivar					
	Amber Queen	**Indian Summer**	**Kind Regards**	**Warm Wishes**	*SED (18df)*	*Signif. P*
Main trial	88.1	85.0	86.0	95.4	*2.77*	*<0.01*
Non-irrigated observation	86.0	86.5	91.5	97.0	-	-

	Pretty Polly	**Fellowship**	**Rosy Future**	**M. Merril**	**Freedom**
Rootstock type obsn.	89	91	91	94	84

In the main trial and non-irrigated observation, budtake was slightly better for Warm Wishes than the other cultivars. There was no significant effect of the undercutting treatment on budtake.

For the modules vs. bare root rootstock observation, budtake was acceptably good across the range of cultivars. In 1997, the budding operation on module raised stocks was slightly slower than for conventional stocks where a longer neck was present, however there was little difference in percentage budtake between the module raised or bare root stocks.

Mid-season field top growth assessment

By June, there was some indication that the undercutting treatment had reduced growth slightly, however this was not nearly as marked as in the previous project, HNS 56, in the dry summer of 1995. Table 2 shows that, on average, the undercut plants were 82% of the height of the non-undercut plants ($P<0.001$). Warm Wishes was also taller than the other cultivars at this stage ($P<0.001$).

The trend and magnitude of the plant height reduction was similar on the non-irrigated observation plot (data not shown). There was little difference in height due to rootstock type with the module vs. bare root stock observation.

Table 2 Mean height (cm) from 15 plants / plot from main (irrigated) trial - June 1998

	Cultivar				
	Amber Queen	**Indian Summer**	**Kind Regards**	**Warm Wishes**	***Mean***
Undercut	38.6	38.6	42.4	57.9	*44.4*
Not undercut	46.3	47.3	48.9	73.2	*53.9*
Mean	*42.4*	*43.0*	*45.6*	*65.5*	

SED (3 df) for vertical comparison of undercut treatment means:	*0.75*	*P<0.001*
SED (18 df) for horizontal comparisons of cultivar treatment means:	*1.47*	*P<0.001*
SED (18df) for vertical comparison of means within table body:	*1.95*	*P<0.05*

The difference in mean shoot numbers per plant between the undercut and non-undercut plants in the main trial was small and not statistically significant (2.2 and 2.3 shoots per plant respectively). Likewise for the non-irrigated observation, undercut plants averaged 2.0 shoots per plant and non-undercut 2.2 shoots per plant. There was some indication of slightly fewer shoot numbers with the module raised rootstocks compared to bare root stocks for three of the five cultivars.

Table 3 Mean shoot numbers for module vs. bare root stock observation - June 1998

	Cultivar					
	P. Polly	**Fellowship**	**Rosy Future**	**M. Merril**	**Freedom**	***Mean***
Module + S/O*	2.5	2.2	1.8	1.7	1.9	*2.0*
Module nil S/O*	2.7	2.0	2.0	1.8	1.8	*2.0*
Bare root	2.5	2.3	2.2	2.1	2.5	*2.3*

*Spin Out treatment of module cells during propagation

Final field top growth assessment

By early October, there was still some evidence that the shallow undercutting treatment the year before had reduced shoot numbers and plant height. However, while some of these effects were statistically significant on the main trial, they were small. There was no significant treatment interaction between cultivar and undercutting treatments, and so the main treatment effects are presented in Table 4. Characteristic of the cultivars, Warm Wishes was the tallest, followed by Amber Queen and Indian Summer, and Kind Regards the shortest. Warm Wishes had fewest shoots on average, and Indian Summer the most. Averaged across cultivars, the undercut plants were 87% the height of the non-undercut ones, had 80% of the number of thick shoots and 90% of the total number of shoots.

The non-irrigated observation had received only about 30 mm less water in total than the main trial area, so it was not surprising that mean numbers of shoots and plant heights were very similar, or only marginally less.

With the module vs. bare root rootstock observation, there were negligible treatment effects on plant height. As in June, mean shoot numbers were slightly lower for the module raised stocks. No effects were apparent from the + or - Spin Out treatment applied to the module trays during propagation, so this is averaged in Table 5.

Table 4 Main treatment effects on numbers of shoots and plant height by October 1998.

Treatment	Number of shoots Thin 3-6 mm	Thick > 6 mm	Total	Height / cm
		Main irrigated trial		
Amber Queen	1.4	4.1	5.5	65.3
Indian Summer	1.1	5.0	6.1	64.0
Kind Regards	1.8	3.1	5.0	59.4
Warm Wishes	0.3	4.1	4.4	88.7
SED (18 df)	*0.15*	*0.23*	*0.15*	*1.71*
Significance, P	*<0.001*	*<0.001*	*<0.001*	*<0.001*
Undercut	1.4	3.6	5.0	64.6
Not Undercut	1.0	4.5	5.5	74.2
SED (3 df)	*0.18*	*0.12*	*0.20*	*0.16*
Significance, P	*NS*	*<0.01*	*0.084*	*<0.001*
		Non-irrigated observation		
Amber Queen	1.4	4.1	5.5	62.6
Indian Summer	0.9	4.9	5.8	62.5
Kind Regards	2.1	3.1	5.2	59.4
Warm Wishes	0.6	3.7	4.2	81.0
Undercut	1.5	3.4	4.9	60.5
Not Undercut	1.0	4.5	5.4	72.3

Table 5 Mean total shoot numbers for module v.s. bare root stock observation by Oct 1998

	Cultivar					
	P. Polly	**Fellowship**	**Rosy Future**	**M. Merril**	**Freedom**	***Mean***
Modules (mean)	4.0	5.1	4.2	3.4	5.4	*4.4*
Bare root	4.0	5.9	4.8	4.1	5.5	*4.9*

Root and shoot assessments of lifted plants pre-potting

First impressions on examining the roots of lifted plants in late October, was that the shallow undercutting treatment had not made as large a difference to the root architecture as had been the case in the previous project HNS 56 in 1995. On closer inspection, there were some indications that the undercut plants had a greater number of fine roots, and fewer deep roots, but this was not always consistent. The non-undercut plants frequently had a large and well branched root system, and did not exhibit the coarse 'tap root' type problem that is frequently associated with *Rosa* Laxa stocks (see Plates 3 & 4). The data for the counts of shallow / deep and thin / thick roots which protruded outside the wire template, and which were pruned off during potting, did not show any significant differences due to undercutting. The dry weight of root prunings were, however, slightly less from the undercut plants. Table 6 includes the main treatment effect (averaged over cultivars) for the main irrigated trial area, but there was a similar trend on the non-irrigated observation.

Data for the module vs. bare root stock observation indicated some clearer treatment differences, with the module stocks having more shallow roots and fewer deeper roots. The Spin Out treated modules also appeared to accentuate this trend. However, these results should be treated with caution as they could not be statistically analysed.

Table 6 Mean number of roots per plant outside of wire frame requiring pruning at potting, and dry weight (g / 10 plants) of root prunings, late October 1998.

	Number of shallow roots			**Number of deep roots**			
Treatment	**Thick > 5 mm**	**Thin 3 - 5 mm**	**Total**	**Thick > 5 mm**	**Thin 3 - 5 mm**	**Total**	**Dry wt. g / 10 pl.**
			Main irrigated trial				
Undercut	1.3	3.1	4.4	1.0	3.4	4.3	95
Not undercut	1.2	3.2	4.4	0.9	3.9	4.8	127
SED (3df)	*0.25*	*0.31*	*0.56*	*0.13*	*0.67*	*0.75*	*10.8*
Signif. P	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*0.059*
			Module vs. bare root stock observation				
Mod. + S/O	1.1	3.6	4.7	0.5	2.4	2.9	79
Mod. nil S/O	1.0	3.1	4.1	0.9	3.0	3.9	79
Bare root	1.2	2.6	3.8	0.9	3.8	4.7	119

None of the plants on module raised rootstocks had 'long necks', whereas, in this sample, 'long necks' were present on 12% of those raised on conventional bare root rootstocks (Plate 4).

Shoot numbers of the plant samples potted in late October (Table 7) were broadly similar to numbers on those assessed a few weeks earlier in the field (Table 4). There were similar significant differences between cultivars ($P<0.001$) as in the field assessment, but only the main effects of undercutting are shown in Table 7. Again, for the main irrigated trial, the undercut plants had 82% the number of thick shoots and 90% the number of total shoots as the non-undercut treatment. For the non-irrigated observation samples, the mean shoot number data indicates rather smaller differences between the undercutting treatments, but this cannot be tested statistically. Shoot counts for the potted samples from the module vs. bare root stock observation (data not shown) were also similar to the earlier field assessment.

Some additional shoot growth / thickening of shoots occurred in the field in autumn following the October lifting so that in the main trial, by January 1999, there were fewer thinner shoots and more thick shoots. There was no difference in total shoot numbers between the two undercutting treatments at this stage. For the root systems, only dry weights of the root prunings were assessed in January. Some further root growth had occurred since October, and there was no significant difference between the undercutting treatments, dry weights of roots removed averaging 137 g/10 plants.

Table 7 Main undercutting treatment effect on numbers of shoots of potted sample of plants in October 1998.

	Number of shoots		
Treatment	**Thin 3-6 mm**	**Thick > 6 mm**	**Total**
	Main irrigated trial - October 1998 potting		
Undercut	1.6	3.7	5.2
Not Undercut	1.3	4.5	5.8
SED (3 df)	*0.03*	*0.11*	*0.09*
Significance, P	*<0.01*	*<0.01*	*<0.01*
	Non-irrigated observation - October 1998 potting		
Undercut	1.2	4.2	5.4
Not Undercut	1.0	4.6	5.6
	Main irrigated trial - January 1999 potting		
Undercut	1.3	4.6	5.9
Not Undercut	0.8	5.2	5.9
SED (3 df)	*0.14*	*0.10*	*0.11*
Significance, P	*<0.05*	*<0.01*	*NS*

Container growth results

Early March and late April assessments

Shoot development and early root growth (Plates 5 & 6)

When the October / November potted plants were observed in early March 1999, differences were apparent in the overall vigour and stage of development between the plants from the main (irrigated) trial, and those from the non-irrigated observation and the modules vs. bare root stock observations. The main trial was potted first and placed into the polythene tunnel followed by the remainder over the next 2 weeks. The main trial was less advanced, i.e. on average just past the 'flat leaf' stage (overall mean score 3.4), compared to the non-irrigated plants which had leafed out more fully (overall mean score 5.0). In both trials, Warm Wishes was slightly more advanced in leafing out than Kind Regards, followed by Amber Queen and Indian Summer. The undercutting treatment, however, did not have any significant effect on stage of development for the main irrigated trial. For the non-irrigated observation, while the non undercut plants of Indian Summer and Warm Wishes were, on average, slightly earlier to leaf out than the undercut plants, this was not the case for Amber Queen and Kind Regards, and overall differences were small.

Early root development showed a small but consistent trend across the four cultivars in the main irrigated trial being more advanced from the undercut treatment ($P<0.01$; mean scores, undercut 2.8, not u/cut 2.0). This was not apparent with plants from the non-irrigated observation, where differences were not statistically significant (overall mean 2.9).

With the modules vs. bare root observation by early March, cvs. Freedom, Margaret Merril, Rosy Future and Fellowship were well leafed out (mean score 5.0), whereas Pretty Polly was a little less advanced (score 3.8, early to late 'flat leaf'). The module raised plants were slightly more advanced by 1.0 - 1.5 units on the shoot development stage scoring scale for Pretty Polly and Freedom ($P<0.05$), but not the other cultivars. Mean scores for root development followed a similar pattern with these two cultivars, bare rootstock raised plants averaging a score of 0.8 and 1.7 respectively, compared to 2.2 and 4.0 for module raised plants. Because there were insufficient plants of Freedom (ie only 2 - 3 plants per plot) for inclusion in the replicated trial layout on the outdoor beds, it was decided to exclude this cultivar from further assessments.

The January potted plants from the main trial, because they had been placed directly outside, were later in leafing out. When assessments were done in mid April, Warm Wishes was slightly more advanced than the other cultivars. Undercut plants of Kind Regards were 1.0 unit more advanced on average than non-undercut, but differences were very small for the other cultivars. Root development at the time of assessment was more advanced for the January plants (overall mean 4.3) than had been the case for the October potting at the earlier assessment. Root development scores followed similar trends to those for top growth.

Leaf 'feathering' (Plate 7)

This phenomenon was restricted to relatively few plants in some cultivars, and did not seem to be related to undercutting treatments. Damage was restricted to several plants in only a few plots in two of the four replicates. It is possible, therefore, that a few plants may have been affected by some accidental contamination from glyphosate herbicide spot treatments for localised patches of perennial weeds in the field the previous year. Between 3% and 10% of plants of Amber Queen, Kind Regards and Warm Wishes in the main trial and non-irrigated observation showed some evidence of leaf 'feathering' at this stage. However, there were no affected plants from the modules vs. bare root observation, and only two Kind Regards plants from the January potting of the main trial were affected.

Leaf scorch (Plate 7)

This was restricted to cv. Kind Regards from the autumn potting, where half to three quarters of plants showed some evidence of leaf scorch. None of the January potted plants (which were not held under polythene in early spring) showed any problem. There was no influence of undercutting treatments. The cause of the scorch was not clear, but may have been related to some form of stress under protection. The symptoms were transitory and there was little sign of the problem by the next assessment in May.

Shoot dieback

This appeared to be mainly associated with some cultivars, although in some cases more non-undercut plants were affected. In most cases plants were not seriously affected by the dieback present, and sufficient healthy shoots developed to produce good quality plants eventually, but on others, symptoms were still evident by the next assessment in May, and a few seriously affected plants eventually died or were of unmarketable quality.

A third to half of the Amber Queen and Indian Summer plants in both the main trial and non-irrigated observation showed some dieback on one or more shoots from the October potting, but numbers were similar from both undercutting treatments. A third of the Kind Regards from the main trial were also affected and in this case mainly the non-undercut plants. From the January potted main trial Amber Queen and Kind Regards showed some dieback on about a third of the non-undercut plants, but Indian Summer were little affected. Very few of the more vigorous cv. Warm Wishes were affected throughout. With the modules observation trial about 15% of the Fellowship and Pretty Polly showed symptoms.

Early May assessment

Leaf 'feathering'

Overall, the numbers of plants affected were little changed or had reduced compared to the earlier assessment in March, except that a few of the October potted Amber Queen and Kind Regards in the main trial had developed moderate to severe symptoms by this stage. Again, there was no obvious correlation with undercutting treatments, and affected plants tended to be restricted to a few plots.

Vigour/health

In general, mean differences in vigour and health scores for undercutting treatment effects were small, though there were some statistically significant differences. With the main trial potted in both October and January, and the non-irrigated observation, undercut Kind Regards were better than the non-undercut plants. For Indian Summer, the opposite trend was shown, although differences were not significant. There were some dead or very poor plants of both Amber Queen and Kind Regards in the October potted main trial, and these were mainly related to those that showed severe dieback symptoms in the March assessment. With the modules observation, again, differences in vigour were small, but plants on module rootstocks were slightly better than those budded on bare root stocks ($P<0.01$).

Final assessment in June

Plant height and spread

In the undercutting trials, the cultivars were clearly of different heights, with Warm Wishes the tallest, followed by Kind Regards and Amber Queen with similar height, and Indian Summer the shortest. Kind Regards tended to have the greatest mean plant spread, though differences were usually small. While formal comparisons could not be made between the main trial and sub-trials containing the undercutting treatments, plants were not as tall (and with less spread) from the main irrigated trial when potted in October compared to the non-irrigated sub trial and the main trial potted in January (Table 8). Although these differences in height were small, and were not striking enough to be immediately noticeable or affect marketable quality, they are consistent with the general check to growth observed at the March assessment for the October potted main trial plants.

For most cultivars the undercutting treatment had little or no significant effect on height or spread of the containerised plants. However, for Kind Regards in the main trial potted in both October and in January, undercut plants were taller (Table 8) and had a greater spread than the non-undercut treatment ($P<0.05$). Differences in the non-irrigated observation were not statistically significant.

With the modules vs. bare root stock observation, there were no significant effects due to type of rootstock on height or spread. Consistent with the type of cultivar, Margaret Merril, Rosy Future

and Fellowship were taller (mean 50 cm, 51 cm and 47 cm respectively) than Pretty Polly (mean 30 cm). Rosy Future had a slightly greater spread (mean 37 cm) than the other cultivars (mean 31 cm).

Table 8 Height of containerised plants by final assessments in late May - late June 1999

Treatment	Plant height / cm Undercut	Not-undercut	Cultivar mean
	Main irrigated trial - October 1998 potting		
Amber Queen	34.5	33.9	*34.2*
Indian Summer	23.7	27.7	*25.7*
Kind Regards	40.3	35.6	*37.9*
Warm Wishes	55.3	55.6	*55.4*
SED (12 df) for u/cut vs. non-u/cut comparisons within cultivars		*1.88*	
Signif. P		*<0.05*	
	Non-irrigated observation - October 1998 potting		
Amber Queen	41.4	37.5	*39.5*
Indian Summer	29.1	31.4	*30.3*
Kind Regards	41.7	38.6	*40.2*
Warm Wishes	56.1	58.9	*57.5*
SED (8 df) for u/cut vs. non-u/cut comparisons within cultivars		*2.29*	
Signif. P		*NS*	
	Main irrigated trial – January 1999 potting		
Amber Queen	41.7	41.5	*41.6*
Indian Summer	32.5	33.4	*33.0*
Kind Regards	39.2	35.1	*37.2*
Warm Wishes	56.4	58.3	*57.4*
SED (12 df) for u/cut vs. non-u/cut comparisons within cultivars		*1.18*	
Signif. P		*<0.05*	

Health

This record, scored on a 0 (dead) to 5 (best) scale, was concerned with the extent of shoot dieback and poor leaf colour. There was little foliar disease such as powdery mildew, rust or black spot present. There was still some evidence of the poorer vigour and greater amount of dieback observed in March with the October potted main trial plants at this final assessment in June, compared to the other sub-trials. The overall mean health score was 3.5 compared to 3.8 for the non-irrigated observation and January potted main trial plants. There were also more dead plants from the October potted main trial - seven non-undercut Kind Regards and three non-undercut Amber Queen compared to three and one undercut plants respectively out of a total of 40 plants per treatment. Virtually no plants had died in the other two undercutting sub-trials. In

Fig. 5 Flower buds - main trial, January potting

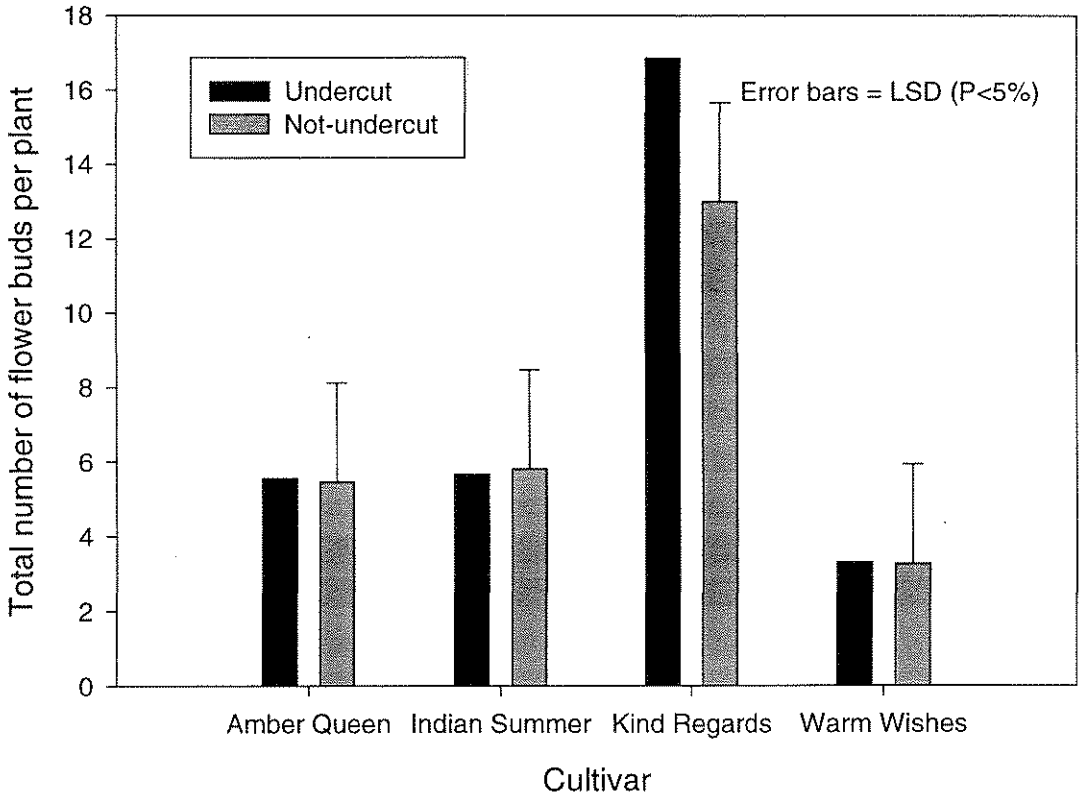
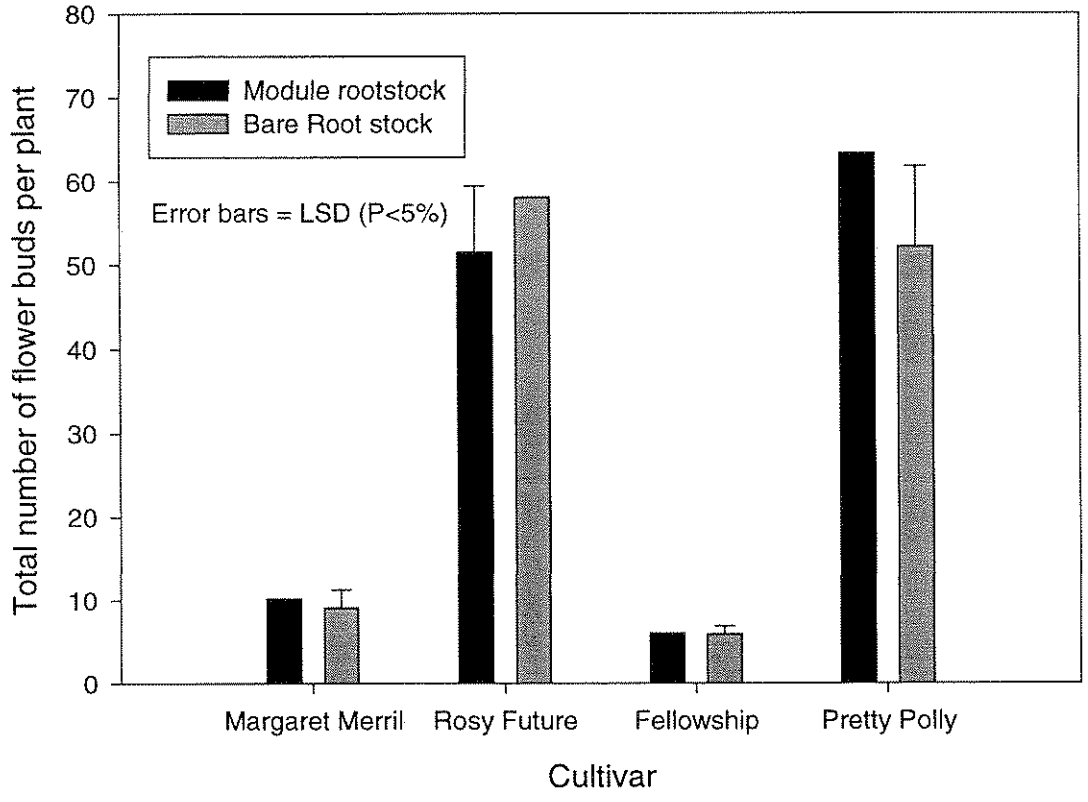


Fig. 6 Flower buds - modules vs bare root stock, October potting



It is not possible to formally compare the results of the different undercutting sub-trials. However, comparison of Figs. 3, 4 and 5 suggests that the January potted Amber Queen, Indian Summer and Warm Wishes had slightly fewer flowers per plant, on average, than those from the non-irrigated sub trial potted in October. This is despite there being little difference in mean height and spread between these two sub trials. Without records of other parameters (e.g. numbers of shoots carrying flowers), it is difficult to explain these differences in flower numbers, especially as no striking differences in quality between plants in the different sub-trial beds were apparent from informal observation of trial plots.

With the module observation, the small flowered patio cultivars Rosy Future and Pretty Polly carried, as to be expected, many more flowers per plant than the HT and floribunda cultivars Fellowship and Margaret Merril. Flower numbers for each cultivar were therefore analysed separately. There were no differences in flower numbers due to rootstock type for Margaret Merril and Fellowship. Rosy Future on module raised stocks had fewer flowers on average, although this was not quite significant at $P<0.05$, whereas module raised Pretty Polly did have significantly more flowers.

DISCUSSION

Field growth

Rainfall and irrigation on shoot growth

In HNS 56 in 1995, the shallow undercut treatment produced plants with less shoots overall and fewer 'thick' shoots (> 6 mm diameter) on average, compared with non-undercut plants at lifting. In this project, while undercutting still produced slightly 'lighter' bushes, the effect was much smaller, and for the second lifting in mid January 1999, differences in shoot thickness were even less marked, and total shoot numbers were the same. Because of the much higher rainfall in 1998, it was not possible to examine the interaction between shallow undercutting and applying irrigation the following maiden bush year, as had been hoped. However, comparing the response to undercutting in HNS 56 and 56b, it seems likely that the differences were largely due to rainfall levels. I.e. rainfall (or irrigation), particularly in early summer of the maiden bush year, can appreciably overcome the check to top growth that can occur following shallow undercutting budded rootstocks.

Root systems

The same method of assessing the root system of plants lifted from the field was used in this project as in HNS 56. Counts of thick and thin roots above and below a 150 mm depth in this latest project did not show the significant differences resulting from undercutting seen in the earlier project, although the photographs (Plates 3 & 4), nevertheless showed root systems were less coarse, with more fine roots on shallow undercut plants. The amount of root requiring pruning at potting was also 25% less for undercut plants.

However, non-undercut plants in this trial had a well-branched root system. The coarse 'predominantly taproot' structure that some growers have reported in the past with *Rosa* Laxa was not evident on many plants. This may have been partly influenced by the fine silty soil at Efford, and the incorporation of organic matter to improve soil structure. Also, the root system of seedling rootstocks used was quite fibrous, which was likely to have affected the subsequent root structure. It is possible that suppliers are now providing the industry with rootstocks with generally improved root systems than in the past, but this supposition could not be tested. Nevertheless, both soil structure and initial root system structure are likely to affect the final architecture of the root system, and should be considered in the extrapolation of these results to other situations.

Finally, the higher rainfall in 1998 compared to 1995 probably mitigated the effect of undercutting on root growth as well as shoot growth. The vigour of root and shoot growth are clearly linked, so plants with more thick and vigorous shoots will logically have stronger and thicker roots, as plants will tend to maintain some equilibrium between them.

Module grown rootstocks

Module raised stocks had a clearer effect on the formation of the root system than undercutting in this trial (Plate 4), although because there were insufficient plants available to carry out a replicated trial, field data could not be statistically analysed. There was no long 'neck' with these plants and the original fibrous root was concentrated in a small module. This resulted in the development of a large number of roots radiating from a shallow depth in the soil, and typically a greater proportion of root remaining after pruning for potting.

The Spin Out root growth regulator treatment used during propagation to increase fibrous root development, made a large difference to the distribution of roots within the module (see report HNS 56a). However, the establishment and development of a fine root system in the soil was not further enhanced with these treated modules.

There was an indication that shoot numbers were slightly poorer from plants on module raised compared to conventional rootstocks, but this could not be tested statistically and it did not apply to all the cultivars. It is not easy to explain what might have restricted shoot production. Growth of the module rootstocks after planting and subsequent bud-take was as good as conventional rootstocks.

Although the Super Prefer planting machine was unsuitable for planting the module rootstocks, it is likely that other machinery is currently available in the industry that would handle them. With the uniformity of length of neck and root system present at planting, it should be possible to achieve a very uniform crop of stocks in the field planted by machine. Larger scale commercial trials would be needed to ascertain whether the short necks on module raised stocks posed a significant problem for rose budders in the industry which, as well as cost, might affect their uptake. However, manipulation of 'neck' length may well be a possibility during the module phase and needs further investigation. At the time of writing, the Rosaco consortium of rootstock suppliers from the Netherlands is also carrying out trials with module raised stocks.

Performance of containerised plants

In HNS 56, there were big differences in shoot numbers and thickness of undercut vs. non-undercut plants at the time of containerisation, yet the quality of plants by the time they were in flower for marketing was similar. It is not surprising, therefore, that undercutting treatments did not make a large difference to the performance of containerised plants in this project. Nevertheless, small treatment effects were apparent that could improve our understanding of the factors influencing establishment and growth in the container.

Time of potting

Growers, to achieve the best establishment and performance of plants in containers, sometimes refer to an ideal 'potting window' during October and early November. Poorer establishment is sometimes attributed to potting plants in the middle of winter, i.e. late December and January, when they are fully dormant, and keeping them outside under cold wet conditions while there is little or no new root growth in the container. Nevertheless, many nurseries continue potting throughout the winter, and do not provide any subsequent rain protection. For this reason it was thought important to see whether a shallow undercut plant which received less severe root pruning at potting, would establish better under less than ideal conditions. In this project, January potting did not result in poorer survival from either undercut or non-undercut plants. On the contrary, they produced somewhat better growth at marketing than the October planting, which appeared to suffer some stress while being held under protection. Those potted in January and stood outside with no rain protection actually showed fewer losses than the October potted roses held under protection until early April, and the losses that did occur did not appear to be directly related to potting date. Experience in this and other projects shows that significant new root formation only occurs once new leaves and shoots develop. It can be a disadvantage for soft new growth to be induced by very early autumn potting, particularly if this growth is frosted or develops disease over winter. The winter of 1998 / 1999, was mild, and there was no very heavy and prolonged rain from mid January until spring growth commenced, that might have otherwise caused waterlogging problems in the late potted plants that were stood outside.

Against the background of generally good establishment in the container, it was not possible to adequately test the hypothesis that shallow undercutting could help plants to establish better when potted later than the ideal 'potting window'.

The main trial plants potted in the autumn appeared to suffer some check to growing away in early spring, compared to the non-irrigated observation and modules vs. bare root stock sub-trials potted at the same time. It seems unlikely this was related to the field treatments. Plants were given several waterings after potting, prior to being placed into the polythene tunnel. But inspection of the crop management records suggests initial watering of the earliest potted plants (i.e. the October lifted main trial) may have been insufficient to fully wet up the pot to depth until they were thoroughly watered again along with those potted later in October and early November. Although plants after potting had few leaves remaining, and were not actively growing, those from the main trial may have experienced some stress at this time, which resulted in a temporary check to growth the following spring. Fortunately, they appeared to catch up subsequently, and final commercial quality was little affected, but this highlighted the relative importance of good basic husbandry, and in particular minimising desiccation stress at all stages between lifting from the field and the development of new roots in the container.

Root pruning at potting

This project shows that, given strong and healthy bare root plants, and good conditions for growing on in the container, rose plants can tolerate the severe root pruning needed to fit them into a 4 litre deep pot, with little adverse affect on establishment and final quality (Plate 9). This confirms results obtained in project HNS 56. However, where plants have been weakened, for example by disease in the field or other adverse cultural factors, it is likely that severe root pruning at potting will be more detrimental, and may even be the critical factor responsible for plant losses in extreme cases. In this project, early root growth scores did show some small, but statistically significant, treatment differences for the October potted main trial plants, which may have suffered some water stress after potting. Here, the non-undercut plants, which had needed more root pruning at potting, had a lower rooting score. For the other undercutting sub-trials, which did not show signs of any check to early growth, there was no clear response from undercutting on early rooting.

Early root development in Pretty Polly and Freedom also responded positively for plants on module raised rootstocks. For these cultivars, the use of modules reduced the severity of root pruning required at potting, with pruning dry weights 50 - 65% that of plants from bare root stocks.

Shoot dieback and vigour

Causes of dieback of the 'old' shoots present at potting are still not well understood. Although several stem canker pathogens are responsible for some types of dieback (HNS 75), in cases where pathogens do not seem to be primary causes, dieback may be a physiological response to the accumulation of several stress factors throughout the process of field production through to establishment in a container. As with early root growth described above, severe root pruning at potting may be one of these factors that, in combination with others, predisposes plants to this disorder. There is also evidence that some cultivars are more susceptible. In this project, Kind Regards and Amber Queen were more affected overall by shoot dieback than Indian Summer and Warm Wishes. Non-undercut plants were worst affected by dieback and had poorer mean health/vigour scores in most cases for Kind Regards and to a lesser extent for Amber Queen.

Flowering and plant height

Containerised roses are not currently subject to the precise marketing specifications for numbers of flowers, height etc. that exist in some other lines of pot grown ornamentals. This would be impractical for roses with the wide cultivar variations in habit and flower form. It is therefore difficult to interpret whether the treatment differences for flower number and height observed have any commercial significance. However, it is interesting that for those treatments where undercut plants showed the largest positive effect on plant vigour and health early on, that this

was also reflected in numbers of flowers in the final assessment.

In HNS 56, where shallow undercutting produced significantly lighter plants, these plants had 10% fewer flowers at the marketing stage on average, although this difference was not statistically significant. In the current project, where shallow undercutting had less effect on the weight of plants for potting, mean flower numbers were, in most cases, as good or slightly better from undercut plants. There was a small, but significant, increase in flower numbers with the undercut Kind Regards and Amber Queen in the October potted main trial, and for undercut Kind Regards potted in January.

With the modules observation, Pretty Polly showed stronger initial root growth and more advanced shoot development at the March assessment from module raised plants, and this was reflected in a slightly higher flower count in June. For Rosy Future, Margaret Merril and Fellowship, however, growth and final quality in the container was broadly similar for both module and bare root plants. It is possible that any benefits to establishment in the container that modules conferred was cancelled out by the lower shoot numbers of module plants at potting for these three cultivars (Table 5).

CONCLUSIONS

The overall aim of this project was to investigate methods of improving the root systems of field grown roses prior to lifting, in order to minimise the severe root pruning that is typically required at potting, and thus improve their establishment and performance in the container.

- A shallow undercut treatment to *Rosa* Laxa rootstocks in the autumn of the budding year will increase the amount of fine root present when plants are lifted at the end of the maiden year, and will reduce the amount of root pruning required at potting. This is most likely to be worthwhile on sites where root systems tend to be coarse with little lateral branching.

- A check to top growth can occur in the maiden bush year following undercutting if the season is dry. This can be largely eliminated with sufficient rainfall or irrigation during the subsequent spring and summer. This is important where a proportion of the crop is destined for sale as dormant plants. A slight reduction in shoot numbers or shoot thickness following undercutting will not reduce quality where plants are being containerised for sale in flower.

- In both HNS 56 and this project, the control (non-undercut) treatments still had reasonably well formed root systems. Establishment of the control treatments in the container was also good from both autumn and winter potting dates. Against this background, the undercut plants, in most cases, did not show significant benefits to growth and flowering. There were some indications, however, that undercut plants were better 'conditioned' to cope with stresses following lifting and potting, which might make them more robust under poorer cultural conditions.

- Module raised rootstocks will produce a root system that is easier to containerise, although for the same reasons as with the undercut rootstocks, only small improvements in establishment and growth in the container over conventional plants were shown in this project. Modules may show benefits for containerising high value standard roses for example, where it is important to pot centrally and upright. It may also be possible to improve crop uniformity from machine planted module stocks, but this was beyond the scope of this project.

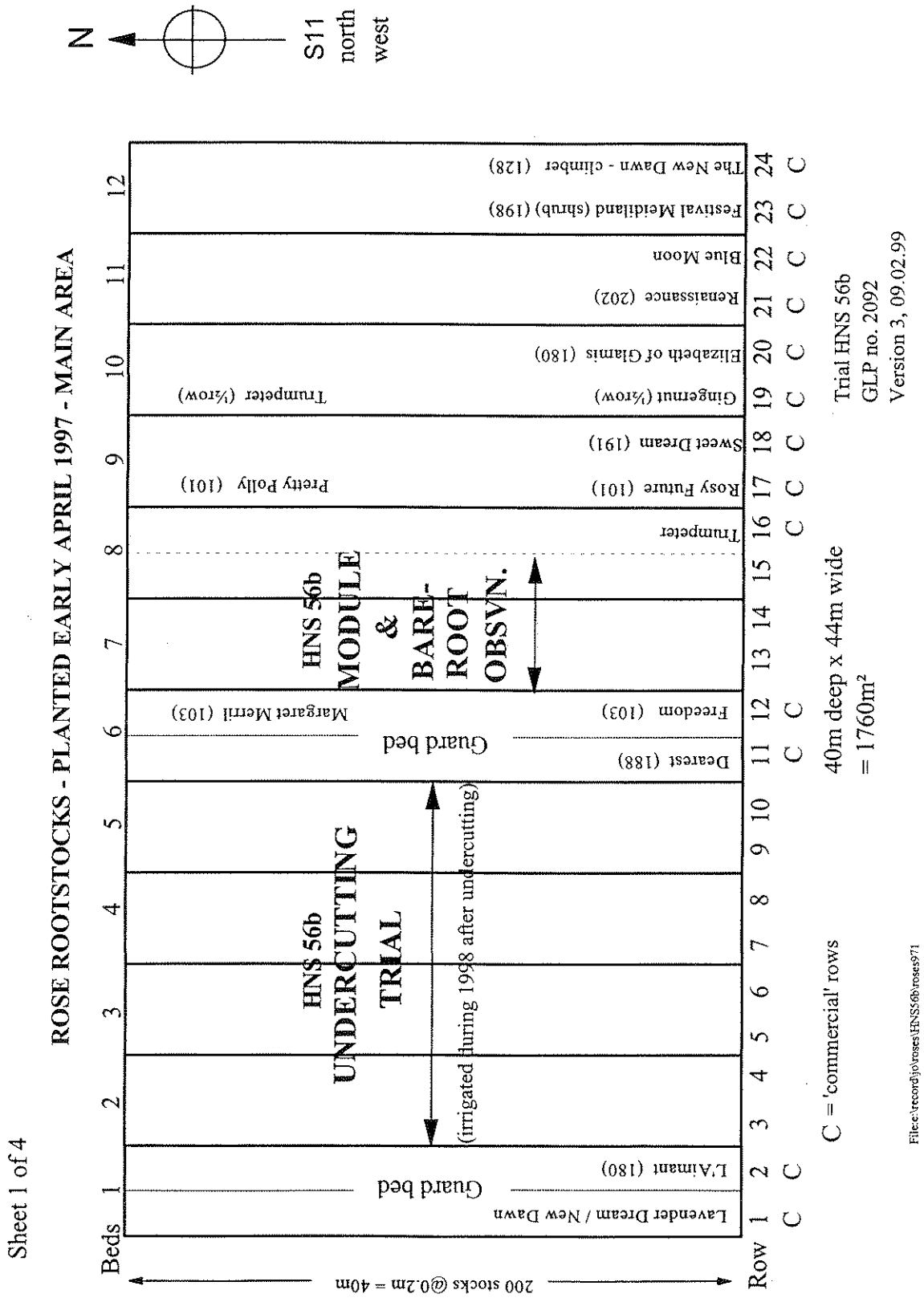
- The project has demonstrated that it is possible to achieve as good results from lifting and potting in January as in October / November, even where winter protection was not used. Time of lifting *per se* is therefore less important for establishment than, for example, the dormancy status and general health of plants when potted, how they are handled between lifting and containerisation, and whether or not they experience prolonged waterlogged or cold conditions between potting and the commencement of spring growth.

Acknowledgment

Thanks are offered to Mr Jamie Dewhurst of Greenhills Nurseries, Farnham, Surrey for the loan of the Egedal undercutter.

APPENDICES

APPENDIX I - Field Layout Plans

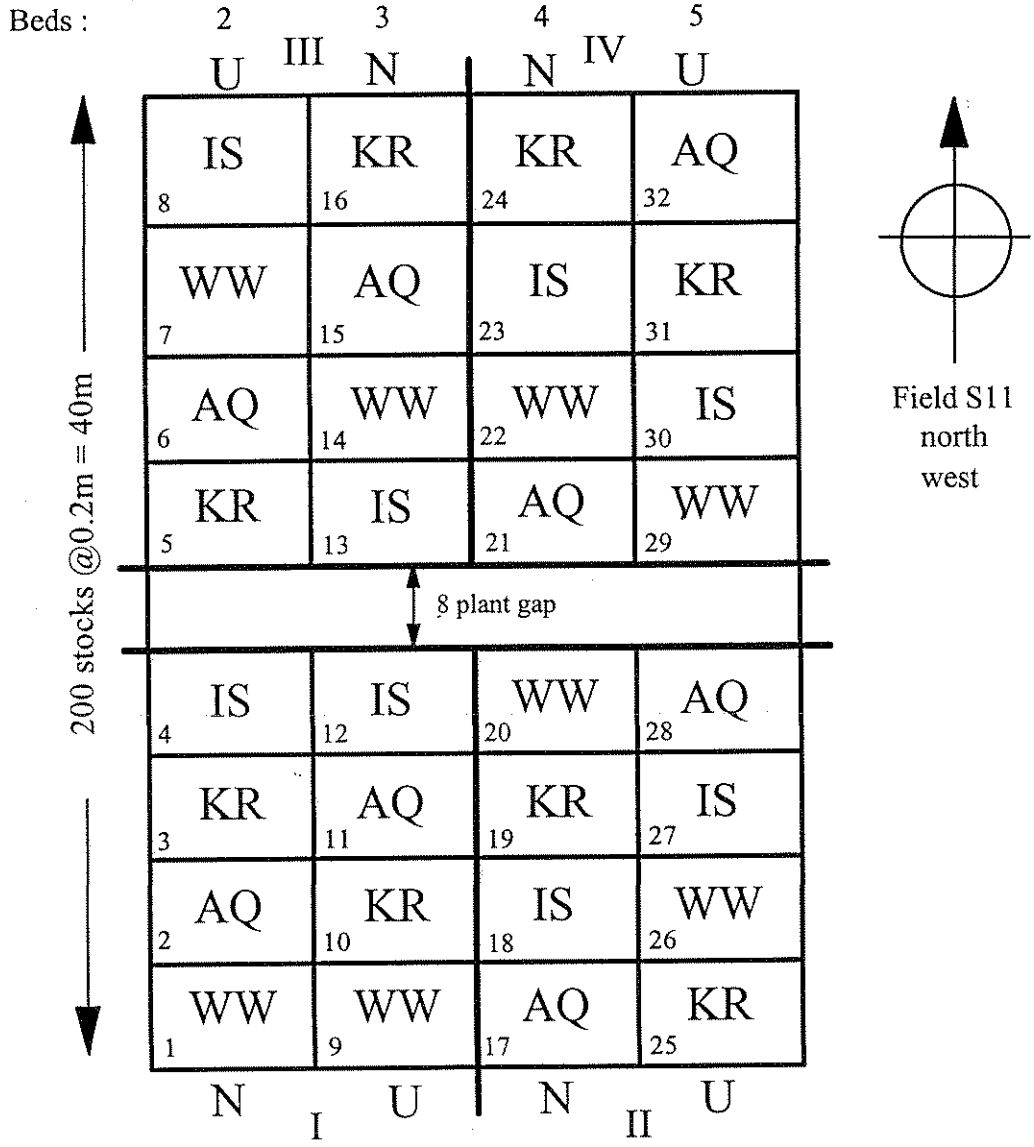


Sheet 2 of 4

Undercutting Trial 1997 HNS 56b

GLP no. 2092

(Main area irrigated during 1998 after undercutting)



AQ - Amber Queen

IS - Indian Summer

KR - Kind Regards

WW - Warm Wishes

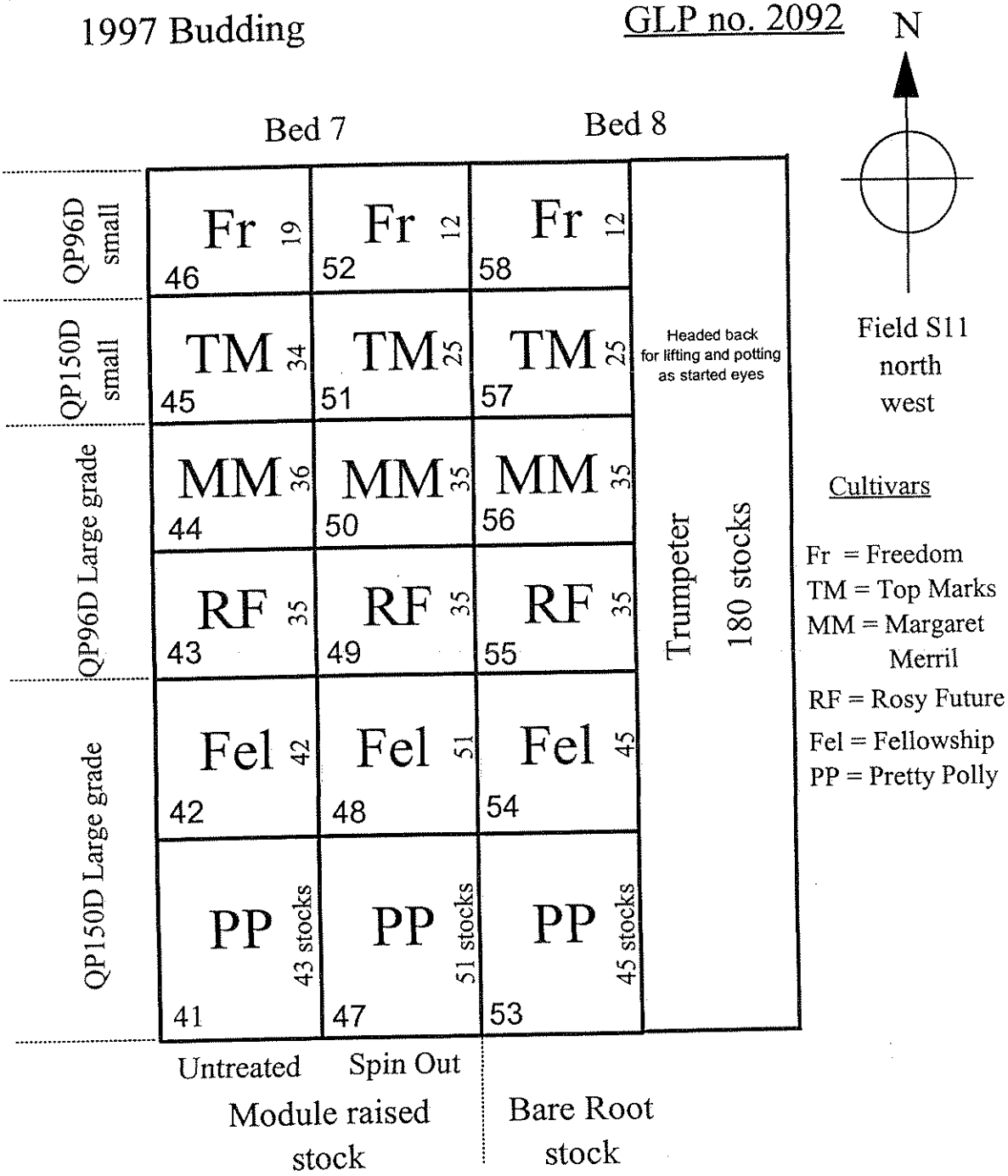
U = Shallow undercut (150mm) with Egedal undercutter October 1997

N = Not undercut

HNS 56b Rosa Laxa Modules vs. Bare Root Obsvn.

1997 Budding

GLP no. 2092



Field S11
north
west

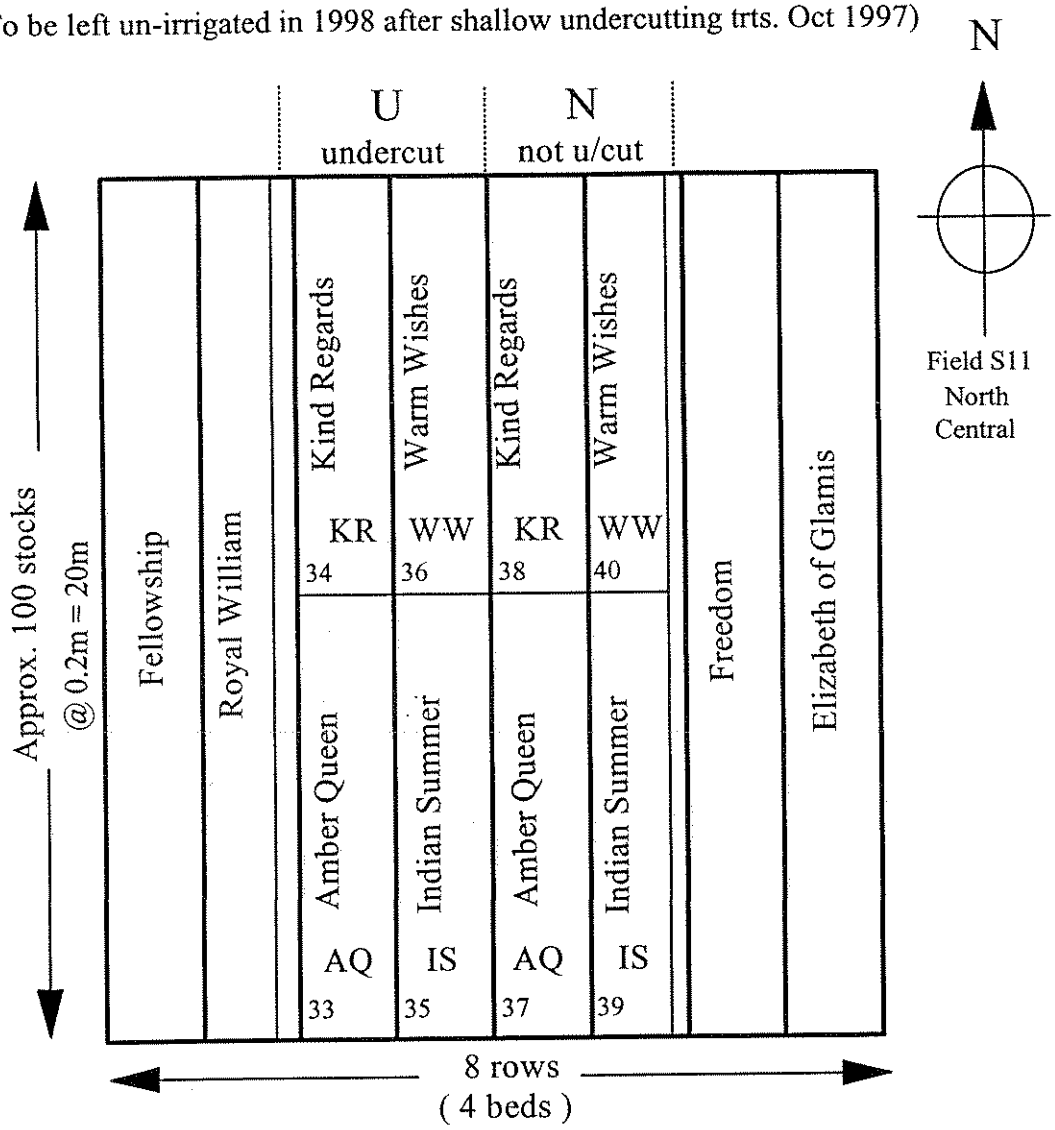
Cultivars

Fr = Freedom
TM = Top Marks
MM = Margaret Merril
RF = Rosy Future
Fel = Fellowship
PP = Pretty Polly

HNS 56 b Trial Area - Large plot = 8 beds = 1.83 x 16 rows x 40m² = 1171m²
Small plot = 4 x ½beds = 1.83 x 8 rows x 20m² = 293m²

Undercutting Trial Small Area

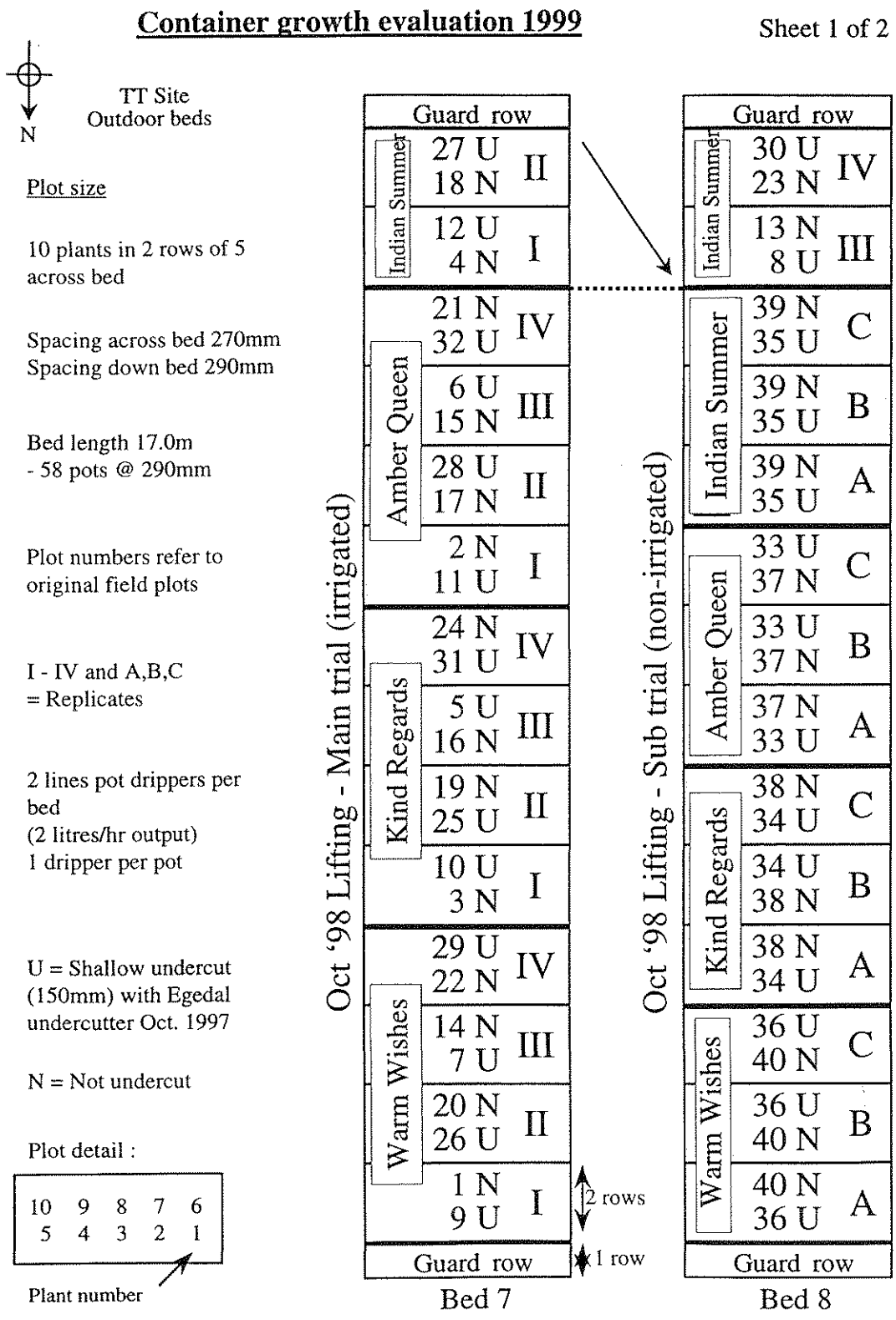
(To be left un-irrigated in 1998 after shallow undercutting trts. Oct 1997)

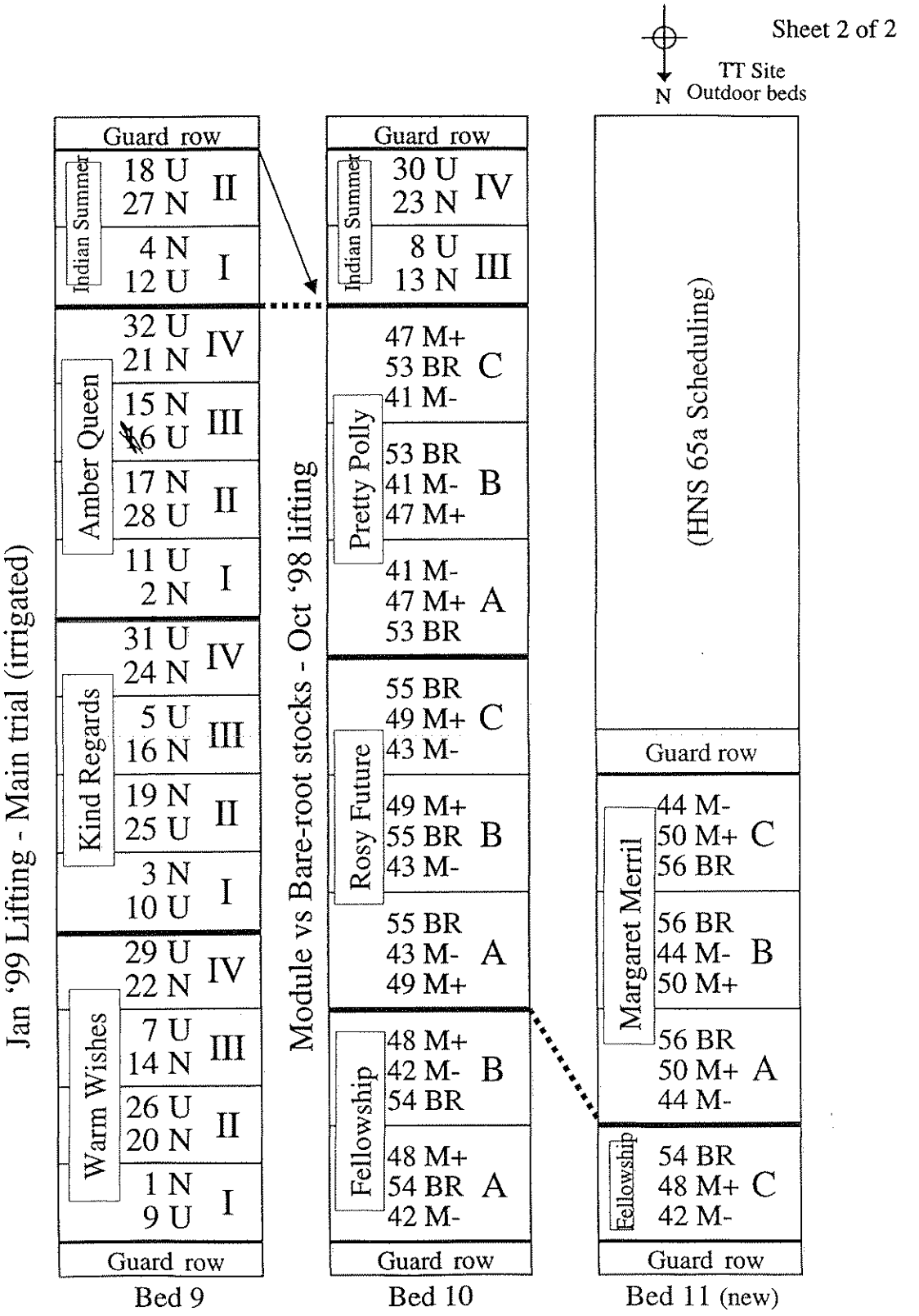


Undercutting Trial

Yellow	Amber Queen	20m deep x 15 m wide
Blue	Indian Summer	= 300m²
Red	Kind Regards	
Green	Warm Wishes	

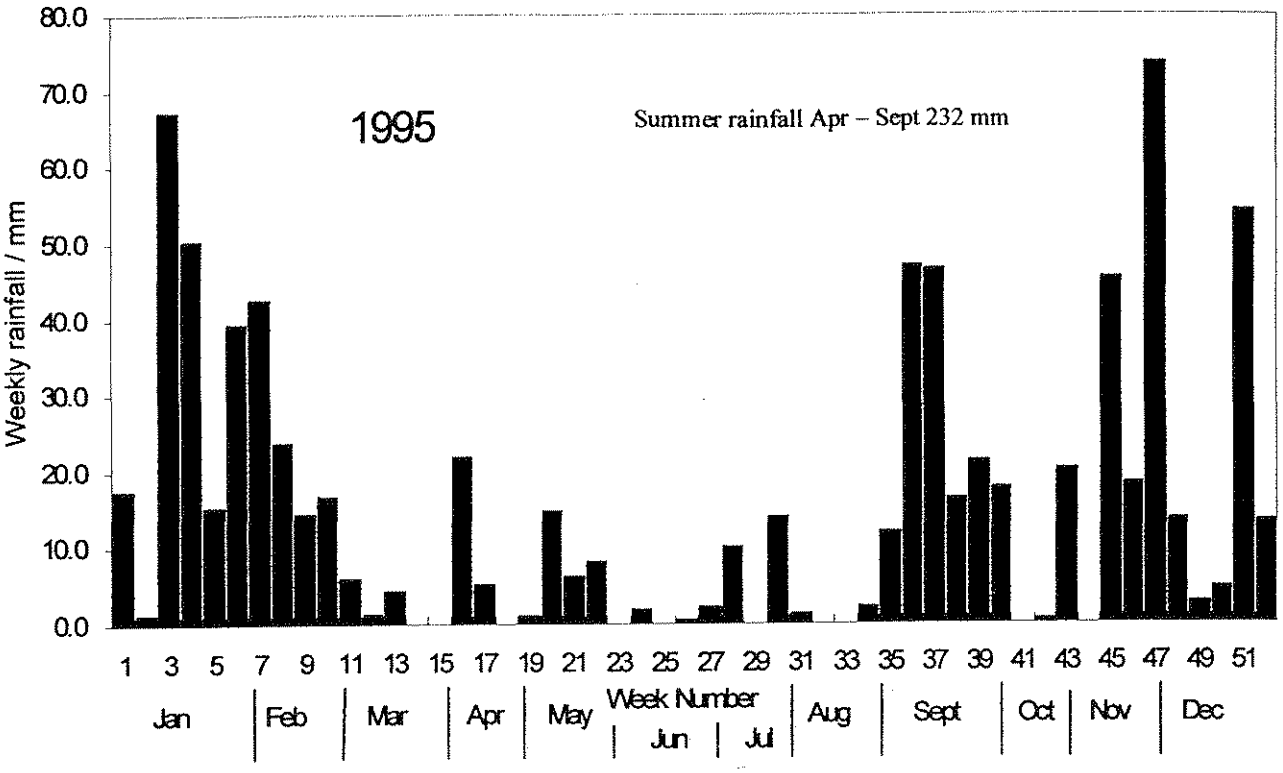
APPENDIX II - Container bed layout plans

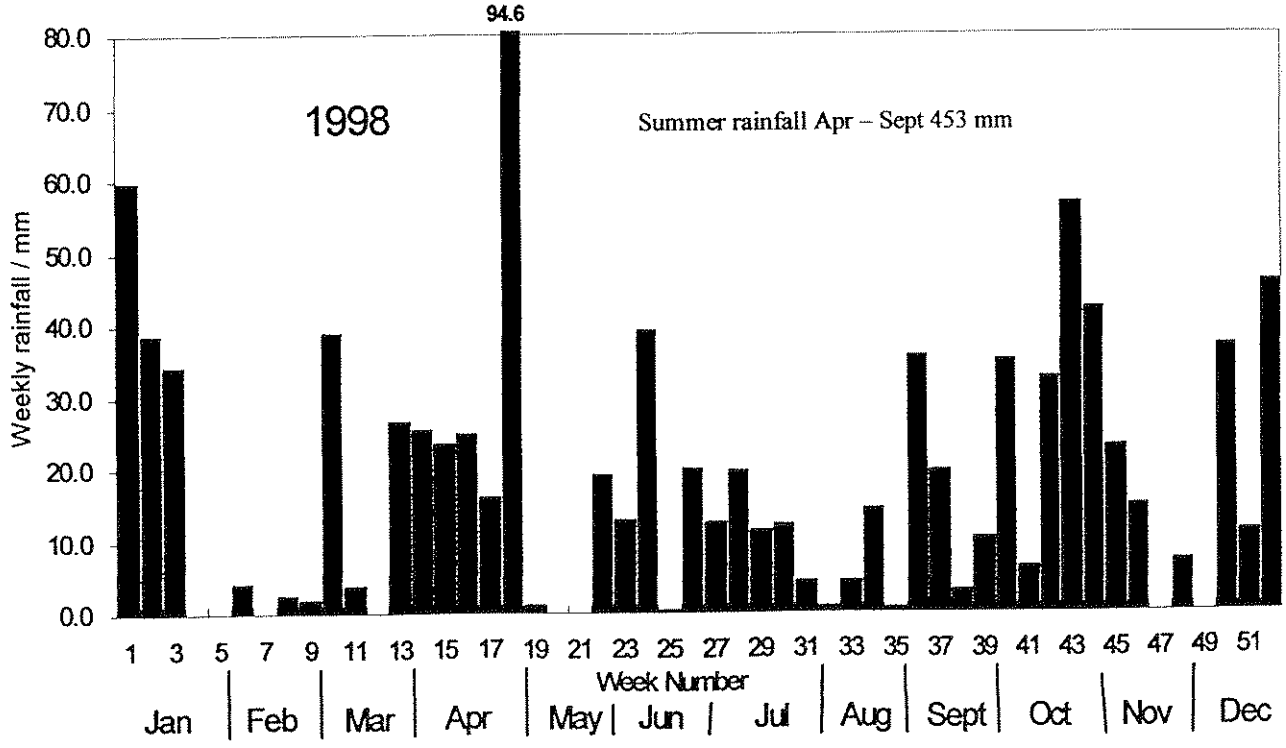




M+ = Module raised rootstock + SpinOut
M- = Module raised rootstock - SpinOut
BR = Bare Root rootstock

APPENDIX III - Weekly Rainfall at HRI Efford. Comparison of maiden bush production years in projects HNS 56 (1995) and HNS 56b (1998)





APPENDIX IV

Photographs

Plate 1

Edgedal undercutter for shallow undercutting rootstocks at end of budding year. Note angled blade.

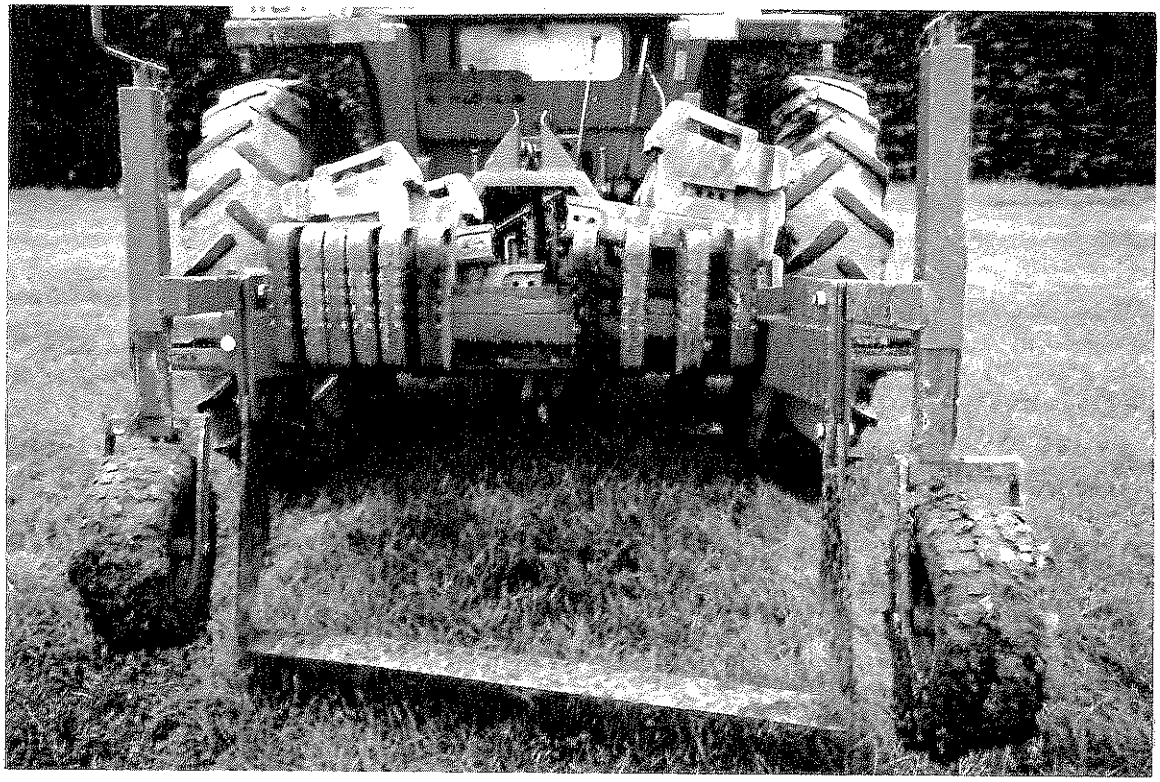
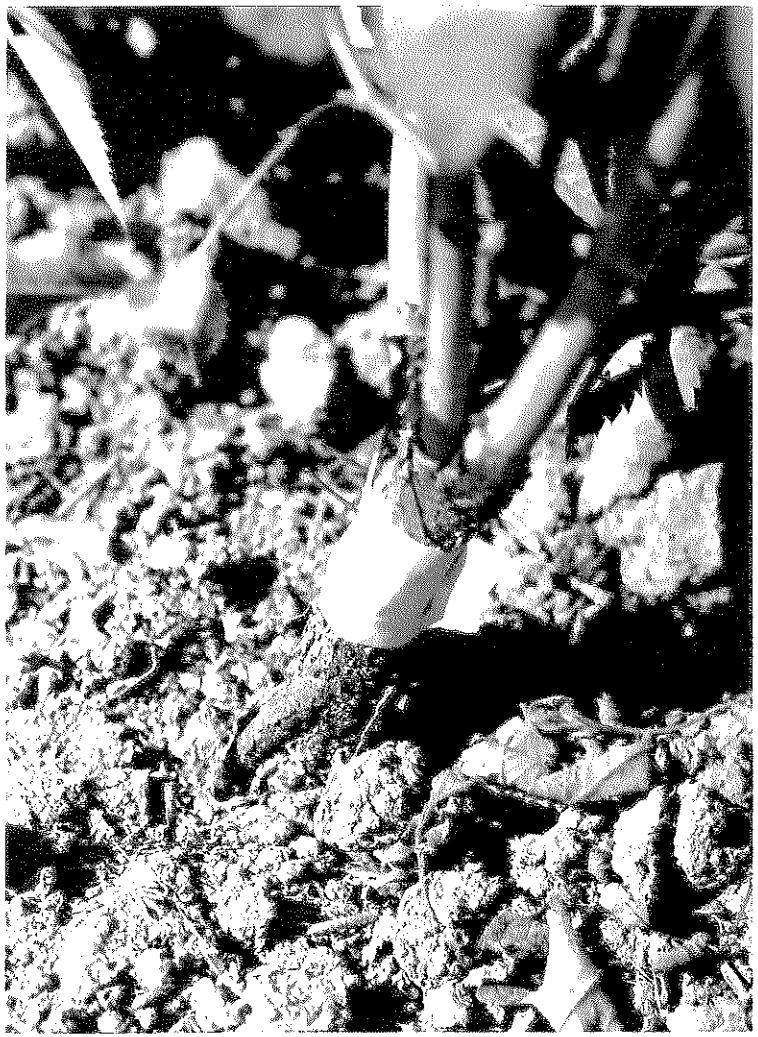


Plate 2

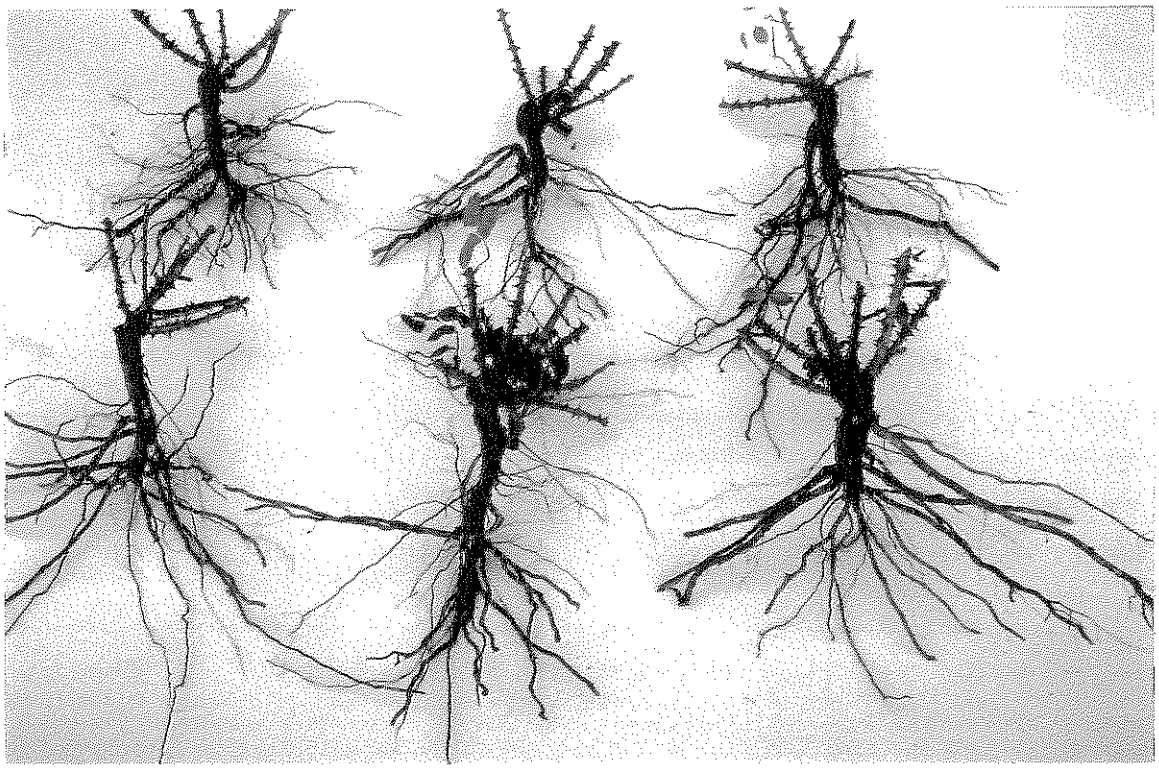
Rootstocks after budding, July 1997



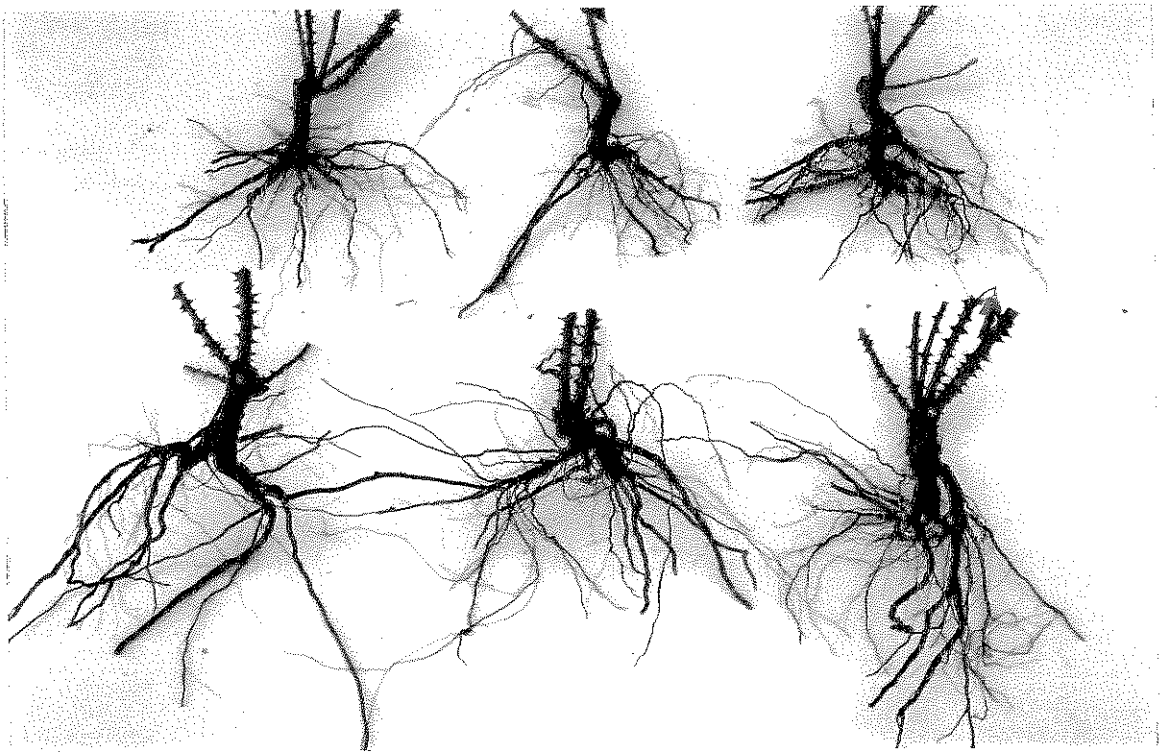
Conventional bare root stock.

Module raised rootstock

Plate 3 Rootstocks lifted from main trial, end October 1998



Indian Summer. Top, undercut; bottom, not undercut



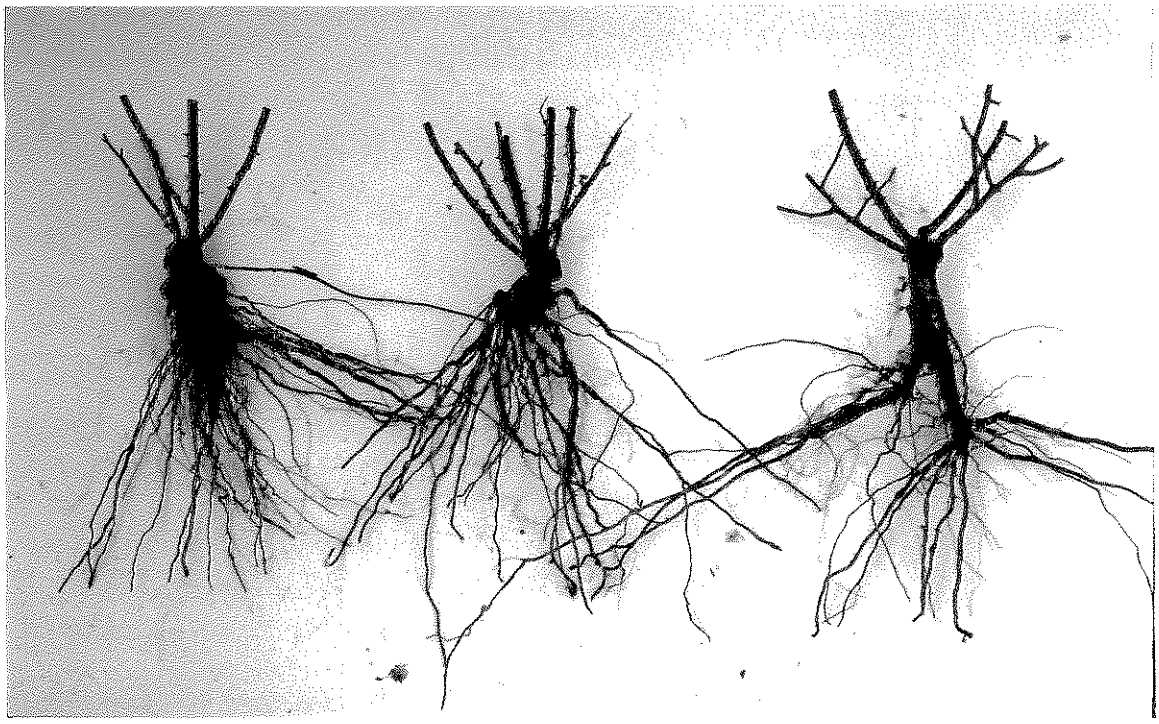
Warm Wishes. Top, undercut; bottom, not undercut

Plate 4

Amber Queen after roots pruned for potting

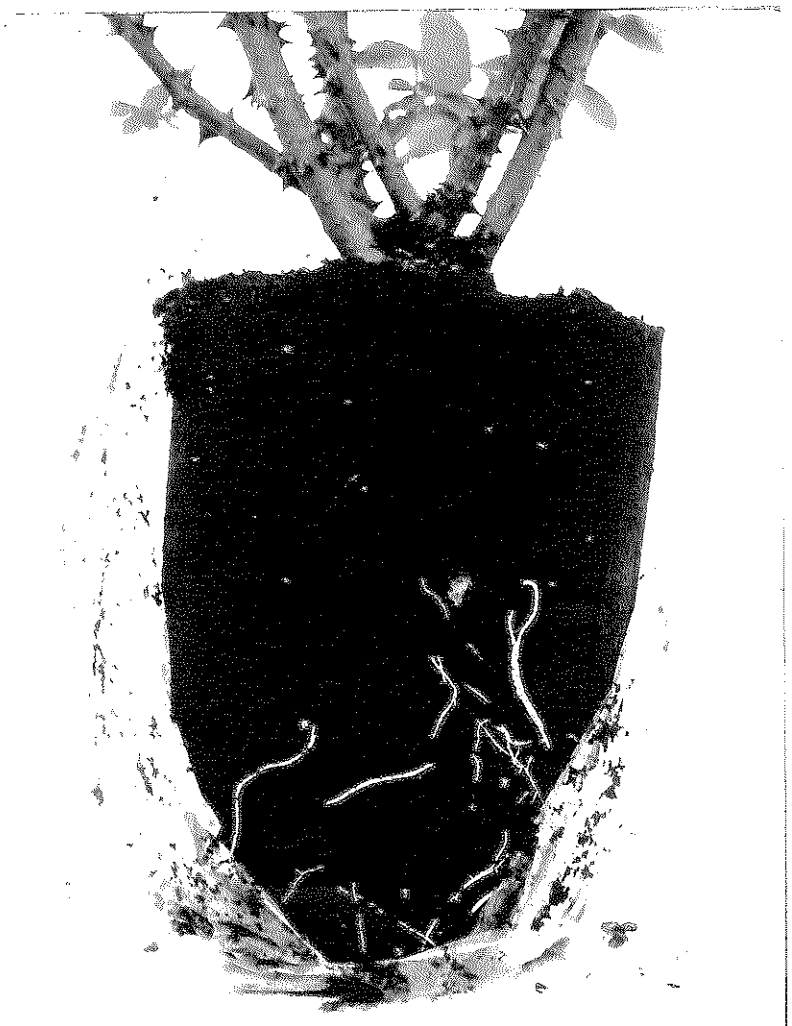
Top, undercut; bottom, not undercut

Rosy Future

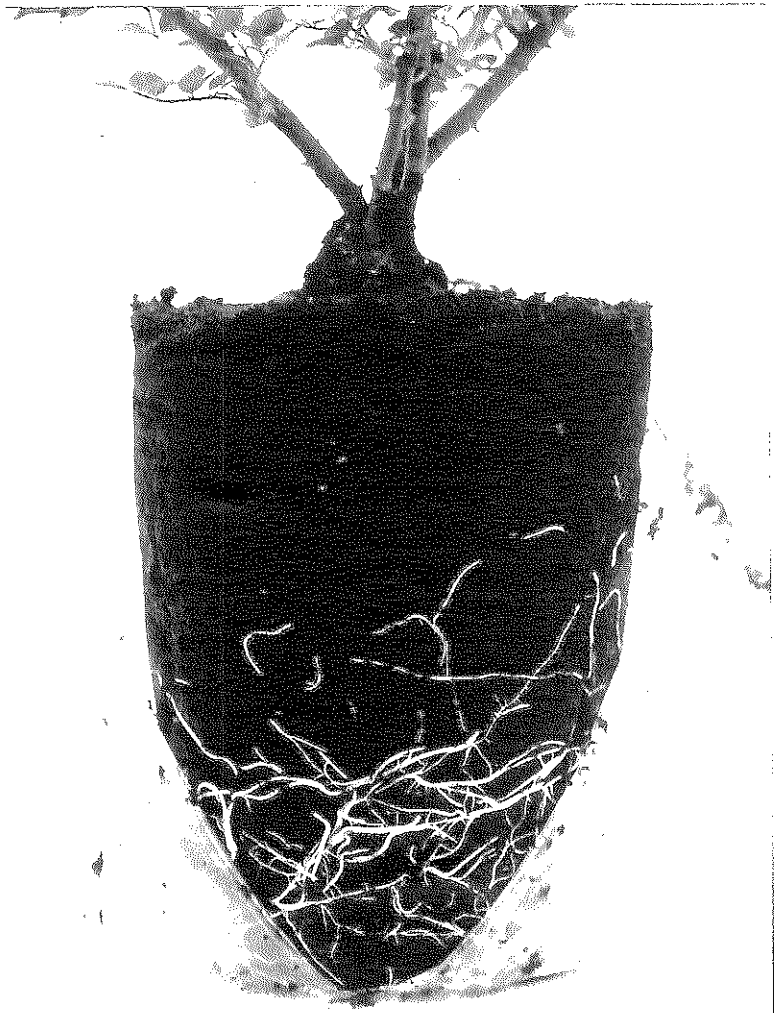


on module raised rootstocks **on conventional bare rootstock**

Plate 5 **Early root development mid March 1999 on October potted plants**



Score 3



Score 5

Plate 6 October potted plants under ventilated tunnel, mid March 1999

Stage of development assessment 11 March 1999

Score 1 Score 3 Score 5 Score 7

Plate 7 Early season leaf disorders on cv. Kind Regards

'Feathering'

Leaf scorch

Plate 8

Trial beds in flower mid June 1999

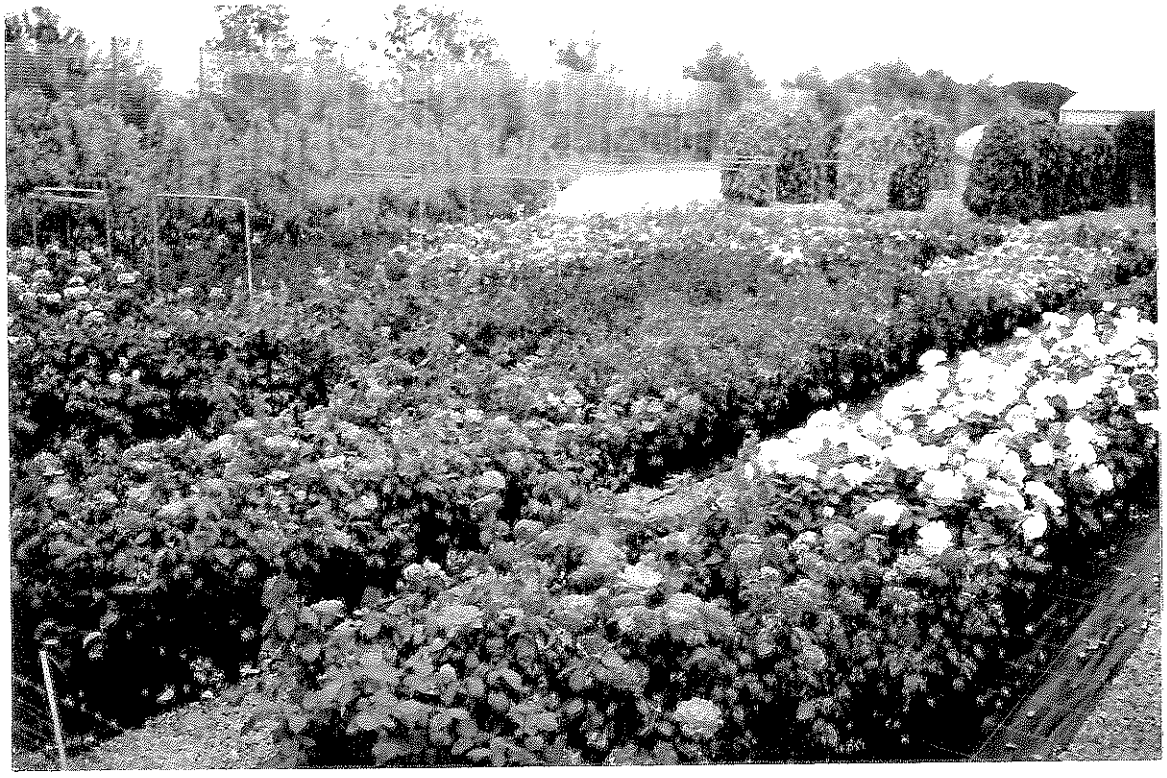
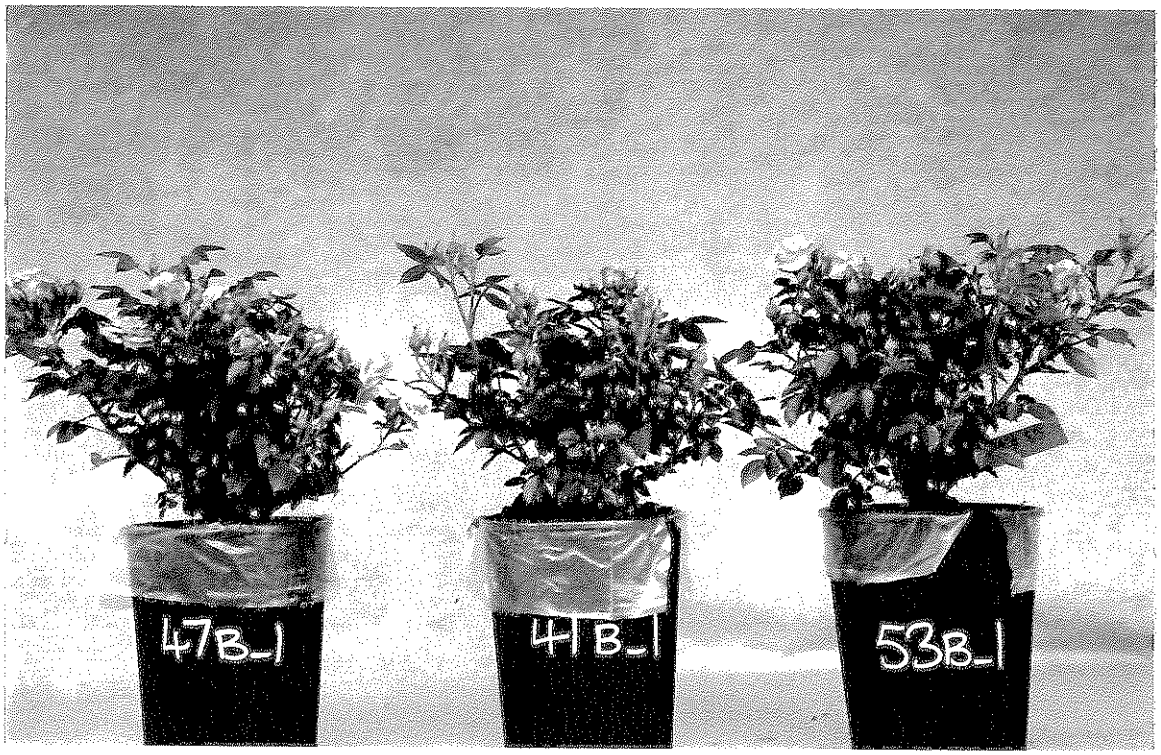


Plate 9 Final assessment early June 1999

Kind Regards, October potted main trial

Not undercut Undercut

Pretty Polly



On module raised rootstock On bare root stock