FINAL REPORT

ROSES: MODULE PRODUCTION OF ROOTSTOCKS - A FEASIBILITY STUDY

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1997

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AUTHENTICATION

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

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Signature

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PRACTICAL SECTION FOR GROWERS

Scope of project and objectives

This was a small scale technical feasibility study to determine whether rose rootstocks could successfully be raised in modules from seed. These rootstocks have been planted out in the field for comparison with bare root stocks under project HNS 56b, which has the overall objective of improving the root structure of roses for containerisation. Specific objectives in this project included assessing germination, management considerations and grade-out of stocks at the end of the season. Two sizes of modules were compared and also the effect of Spin Out root growth regulator.

Summary of results

Previously stratified seed of *Rosa* Laxa was sown in early May 1996 into a peat based medium containing a low rate of controlled release fertiliser (Osmocote Mini 2-3 months). Three seeds per cell were sown at about 18 mm (3/4") depth to encourage the formation of a 'neck' for budding. They were germinated under white polythene outside on a sand bed. Seedlings emerged over a 3 week period in late May and early June. Some thinning and gapping up was required to achieve a full stand of one plant per cell, but as a guideline, sowing three to four seeds per cell appears about right. Rapid growth was encouraged by growing stocks in a simple flood and drain irrigation system, and supplying them with additional liquid feeding during the summer.

Two module sizes, the QP96D (96 cells / tray, 75 cc cell volume) and QP150D (150 cells / tray, 37 cc cell volume) were compared, and by the end of the year over 75% of the QP96D cells had yielded plants of a 5 - 8 mm grade root collar diameter or thicker; twice the proportion produced by the QP150D trays. Taking the 3 - 5 mm grades and above, usable rootstocks were produced from a mean of 89% of cells of the QP96D trays and 75% in the QP150D trays.

Half of the trays used were also coated with Spin Out, a copper based root growth regulator which inhibits root growth on contact and encourages fibrous root within the module, while preventing an accumulation of roots on the plug surface. Spin Out clearly showed large effects on the amount of root visible, but no significant differences in grade-out were achieved over untreated cells. Some copper induced iron deficiency, causing premature yellowing of leaves, was evident at the end of the growing season, but applications of Fe EDTA sprays had some curative effect. Later observations under HNS 56b will determine whether the Spin Out treatments showed any advantages in root formation after two years growth in the field.

Practical and financial benefits from the study

Production of rose rootstocks in modules is clearly technically feasible, and may offer worthwhile advantages where there are problems containerising roses on conventional bare root stocks from the field. Results from ongoing work under HNS 56b will help indicate what degree of improvement in root structure can be expected from field planting module raised over bare root stocks.

The cost of module raised rootstocks will be more expensive than bare root stocks, but could offer advantages if a more fibrous root system were eventually produced for containerisation. The higher value of containerised roses might support an increase in the cost of start material if benefits such as easier potting and improved establishment and quality were sufficiently worthwhile. With a high value standard stem crop with a large three year old root system, for example, it can be particularly difficult to containerise the stem centrally and vertically in a pot without very drastic root pruning. Production of module raised rootstocks is likely to fit in with facilities available to specialist propagators currently propagating other tree, nursery stock or even vegetable crops in modules. Finally, there may be other benefits in uniformity and quality of the rose crop which may result from the use of machine planted module raised stocks, but which is beyond the scope of this project or HNS 56b.

EXPERIMENTAL SECTION

INTRODUCTION

Background

Project HNS 56 aimed to manipulate root systems of field grown bush roses to aid subsequent containerisation. The object was to increase the proportion of fine and fibrous root, minimise the development of thick 'tap roots' often found with *Rosa* Laxa stocks, and reduce the severity of root pruning required at potting. It was found that shallow undercutting a budded crop of rootstocks to about 150 mm depth in mid October did significantly increase the fibrousness of the root system by the time plants were lifted a year or so later (see Interim and Final reports for HNS 56). Some treatments from this project are being tested further in Project HNS 56b, but, in addition, the potential for using rootstocks propagated in modules or cells as a means of encouraging a fibrous root system in the field, is being explored.

This project, HNS 56a, was a small scale feasibility study to determine firstly whether rootstocks could be successfully raised from seed in modules, and secondly to provide some material for planting out and growing on under project HNS 56b.

Project Objectives

i) Assess the technical feasibility of propagating a crop of rose rootstocks in module trays. This included recording seed germination, management considerations, the grade-out of stocks at the end of the season, and observing how the development of a 'neck' suitable for subsequent budding once field planted might be affected.

ii) Look at the effect of two sizes of modules on the growth and grade-out of the rootstock seedlings. Also observe the effect of Spin Out root growth regulator which could be of further benefit in promoting fibrous root development.

iii) Provide module raised rootstocks for field trialling against conventional bare root stocks in Project HNS 56b.

MATERIALS AND METHODS

Treatments

Module trays:	QP96D	(96 cells per tray, 75 cc volume, 75 mm deep, 577 cells per m^2)
	QP150D	(150 cells per tray, 37 cc volume, 65 mm deep, 901 cells per m^2)
Root growth regulator:	Coated with Spin Out®	
	Untreated	

2 tray types x 2 coating treatments = 4 treatments. One tray per treatment.

Culture

The cells in the module trays to receive the root growth regulator treatment were painted by hand with a single coat of Spin Out®, an emulsion paint formulation containing 7.1% copper hydroxide.

Rosa Laxa seed, which had received acid and stratification pre-treatment to break its dormancy, was obtained from Blundell Rose Stocks Ltd, Spalding. On receipt on 23 April 1996, it was held for a further period in a cold store running at 0 - 1 °C as virtually no seeds were showing signs of splitting and germination, and it appeared that further cold treatment was required. There was little change in the appearance of the seed by 8 May, so it was given a 24 hour soak in cold water and then sorted into split and non-split seed.

Less than 1% of seed had split or chitted; sufficient to sow only six or seven cells in each of the four module trays with one chitted seed per cell. The remaining cells in each tray were sown with three non-split seeds per cell (Photo 1, p. 15). After the trays had been filled with propagation medium, settled, topped up and watered, the seeds were carefully inserted to a depth of about 18 mm (3/4"). This was to help encourage the development of a suitable length of hypocotyl which would eventually become the root collar or 'neck' for budding.

The following propagation medium was used:

100%	Medium Irish Shamrock Peat
0.75 kg/m^3	Osmocote Mini 2-3 months 18+6+12 controlled release fertiliser
2.2 kg/m^3	Magnesian limestone
400 g/m^3	Fritted trace elements FTE WM255
200 g/m^3	Furalaxyl as Fongarid 25 WP as a damping off precaution
100 ml in 40 litres / m^3	Fonofos as Cudgel as a precaution against vine weevil

After sowing on 9 May, trays were kept outside on a sand bed. Seed was encouraged to germinate under cool conditions, rather than being given any supplementary heat under protection which might have induced a secondary dormancy.

Trays were covered with 20 µm white propagation polythene until about 10% of seedlings had emerged. At the same time the trays were also covered by a netting enclosure in an attempt to deter birds and mice from damaging the seedlings, although despite this precaution, mice did gain access to the trays and caused some damage. Mouse traps were used at the first sign of attack and appeared to reduce, but did not eliminate, further damage.

By 18 June, when it was clear that no further seedlings were likely to emerge, cells with surplus seedlings were thinned, and others gapped up to produce complete trays with one healthy seedling per cell. The rootstocks were then moved and grown on using outdoor flood and drain beds, as used at Efford for the production of seedling trees in cells. This method was chosen to ensure even and thorough irrigation and rapid growth of the rootstocks from small volume cells. The beds were constructed on top of level sand beds with raised sides and lined with polythene to contain a shallow depth of water during irrigation cycles. Water and feed was then drained off and pumped back to holding tank for re-use. The trays were initially stood on a galvanised mesh support to provide a 75 mm air pruning gap underneath the trays to prevent root development out of the base of the modules. Later in the season, trays were stood directly on top of a layer of Spin Out treated ground cover fabric over the polythene liner to achieve the same effect. This had proved successful in trials with other subjects and clearly reduces construction and running costs for the system.

Soluble 'straight' fertilisers as potassium nitrate, ammonium nitrate and mono-ammonium phosphate were added to the irrigation supply tank as required during the season to maintain feed concentrations of about 200 mg/l N + 60 mg/l P_2O_5 and 200 mg/l K_2O. It was felt that the growing season should be extended as long as possible to help achieve a good final grade-out of seedlings. Therefore this feed formula was maintained and not changed to a lower N ratio 'hardening off' feed later in the season, as is normally done for tree seedling production in modules, because the seedlings still appeared to be growing vigorously during August.

Regular fungicide sprays were applied as part of the programme used for nearby flowering container grown roses. These included carbendazim as Bavistin at 0.5 g / litre plus dodemorph as F238 at 1.25 mls / litre, myclobutanil as Systhane Flo at 1.0 mls / litre, and bupirimate + triforine as Nimrod T at 3.2 mls / litre. This kept plants largely free from rose rust and black spot, although powdery mildew infection was less well controlled from September / October when conditions were more favourable for disease, but regular spraying was hampered poor weather. Insect pests were not a significant problem during the trial but an occasional spray for aphids with pirimicarb as Pirimor at 0.5 g / litre or dimethoate as Dimethoate 60 at 0.85 mls / litre was applied when required.

After leaves had fallen by late November, plants were removed from the trays, graded, measured, and held in polythene sacks in a cold store overwinter. These module rootstocks were then field planted in spring 1997 in a comparison with bare root stocks as part of project HNS 56b.

Records

Seedling emergence

Trays were observed three times per week during the period over which seedlings emerged, and the date (as day number) recorded for each new seedling present. These were mapped onto a grid of squares representing the cells in each tray. A cocktail stick was inserted into each cell whenever a seedling was recorded, so that the presence of newly emerged seedlings could be detected more easily by visually scanning the trays and comparing the number of sticks and plants in a cell.

Grade-out of rootstocks at the end of the season

On 15 November, the height (to nearest cm) and root collar diameter (to nearest 0.1 mm) of seedlings were recorded, keeping the edge line of plants in each tray separate from those inside.

Other observations

Photographs were taken at several stages of growth during the year (see Appendix p. 14).

RESULTS

Seedling emergence

Seedlings started appearing on 20 May, 11 days after sowing and continued to emerge over a three week period up to 10 June, although well over 75% of seedlings had emerged within the first 10 days. Mice caused a significant amount of damage over a few successive nights by either nipping off cotyledons of emerged seedlings or, in many cases, disturbing the growing medium in the cells before any signs of emergence making it difficult to determine how many germinating seedlings had been lost. It was thus difficult to obtain an accurate emergence record, but by recording the presence of disturbed cells, it was possible to make approximate estimates.

Table 1 Estimated seedling emergence and proportions of empty cells in module trays

Treatment	% emergence of all seeds sown[1]	% empty cells - no mouse damage	% empty cells - mouse damage[2]	% empty cells in total
QP96D Spin Out	42	15	14	28
QP96D Untreated	32	29	15	44
QP150D Spin Out	42	17	15	33
QP150D Untreated	37	22	12	34

[1] % emergence based on multiseeded cells, not the % of cells with seedlings present. This is a conservative estimate; seedlings severed by mice after emergence are included, but not the unaccounted for losses where cells were disturbed and one or more viable seedlings may have been lost.

[2] Includes cells with disturbed compost where it is reasonable to assume viable seedlings were removed.

Of all the seeds sown, 32% - 42% emerged and were counted, but this did not include others that germinated and were removed completely by mice before being recorded. 15% - 29% of cells remained empty with no evidence of losses due to mice. There were sufficient spare seedlings available during the thinning and gapping up operation to ensure that, when completed, all cells were filled with one per cell.

Growth observations during the season

By early July, seedlings were growing rapidly and good root development enabled plugs to be withdrawn intact from the module trays (Photo 2 & 3, pp. 15 - 16). The effects of Spin Out on root development soon became apparent, with a dense covering of root on the outside of the plug on untreated cells whereas roots grew vigorously within the plug volume but were prevented from developing on the outside surface where Spin Out was used (Photo 4, p. 17).

An unexpected side effect of Spin Out, however, was a yellowing of leaves which became quite marked late in the season from the end of September, and was symptomatic of iron deficiency (Photo 5, p. 17). Foliar sprays of chelated iron as Librel FeLo at 0.1% plus Libsorb wetter at 0.1 mls / litre were applied to five rows of each Spin Out treated tray on 2 October and 8 October, and the treatment was effective in 'greening up' these plants.

Table 2 Height, root collar diameter (RCD) and survival of rootstocks at end of season

Treatment	Mean height / cm		Mean RCD / mm		Mean survival / % live cells	
	Centre	Edge	Centre	Edge	Centre	Edge
QP96D Spin Out	38.2	31.3	6.27	5.76	88.3	88.9
QP96D Untreated	38.5	30.9	5.83	5.53	98.3	100.0
QP150D Spin Out	24.2	19.6	4.33	3.84	95.2	91.3
QP150D Untreated	25.4	18.4	4.76	3.62	85.6	95.7

The final stand of seedlings varied from 89% to almost 100%. Although a full stand of seedlings had been created by the thinning and gapping up operation, nevertheless there were a few subsequent losses. Mice or birds may have responsible, but it is more likely that some of those gapped up failed to generate new root and died, or suffered a significant check to growth and were 'shaded out' by stronger growing neighbours.

The rootstocks grown in the larger QP96D trays were clearly taller and had thicker root collar diameters than those in the smaller cell size QP150D trays. The centre plants in each tray were also taller and had thicker RCD's than those on the edge. In the QP96D trays, the edge row of plants made up 36 cells and the centre plants the remaining 60 cells. In the QP150D trays, the edge and centre plants made up 46 and 104 cells respectively. The Spin Out treatment appeared to have little or no effect on rootstock height or RCD.

Rootstocks are normally graded for sale by RCD, as heavier grade stocks at planting will normally make a sufficient thickness for budding earlier than lighter grade stocks, other things being equal. For the purposes of this study the grade-out of stocks was summarised by RCD in Fig. 1 using generally accepted commercial grades of 3 mm to <5 mm and 5 mm to <8 mm. Those <3 mm were regarded as waste and grouped with missing plants. There were only a few stocks with RCD's >8 mm diameter.

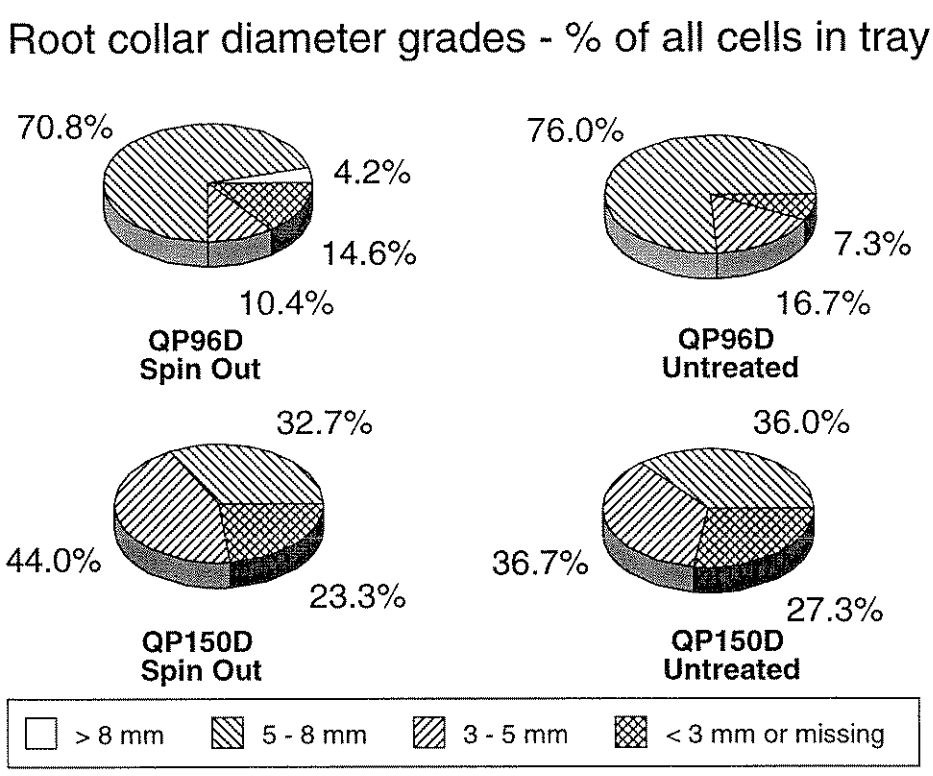

Figure 1 Grade-out of *Rosa* Laxa seedlings from modules

As a proportion of all the cells in a tray, the QP96D trays resulted in 76% of cells yielding 5 mm plus grade rootstocks, whereas the QP150D trays yielded only 33 – 36% at this grade. If, however, the 3 – 5 mm grade is included, the total yield of 'usable' grades varied from 85 – 93% for the larger celled QP96D trays and 73 – 77% for the QP150D trays. Although not statistically analysed, the Spin Out treatment appeared to have little effect on grade-out.

Cold storage of module rootstocks and subsequent handling

The rootstocks were cold stored out of their module trays in black / white co-extruded polythene tree bags overwinter, at a temperature around 0 - 1 °C, until they were field planted alongside bare root rootstocks in early April 1997 under Project HNS 56b. Subsequent performance will be considered in more detail in reports under that project, but the plants stored well and established rapidly following planting. The module raised stocks leafed out noticeably earlier after planting than the bare root stocks. There was some concern at planting that the rootstock's necks might not have been long enough, but nevertheless they were adequate for budding in July 1997.

DISCUSSION

Seedling emergence

Pricking out and gapping up empty cells is labour intensive and there is also a chance that transplanted seedlings will suffer a check or may even fail to survive. However, with seed of *Rosa,* as with many other tree and shrub species which require dormancy breaking treatments, it is often difficult to achieve predictable and high germination rates and even emergence. Recent research into seed dormancy mechanisms and stratification techniques may yet offer some improvements, but it is unlikely that the uniform results currently possible with precision sown bedding plant or vegetable subjects in cells, for example, can be achieved with open pollinated 'semi-wild' species such as *Rosa* Laxa. Multiple sowing of cells is helpful, the object being to increase the chances of achieving at least one seedling per cell, while keeping the need for thinning and wastage of seed to a minimum. Better emergence than obtained in this preliminary study could probably be achieved on a large commercial scale where sub-sampling of seed lots and germination tests would typically be used to determine dormancy status and optimum sowing times more precisely. However, based on this study, and given freedom from vermin damage, it appears that a sowing rate of 3 - 4 seeds per cell is about right.

Subsequent growth and grade-out

For this production system to be viable, plants must grow rapidly, particularly as sowing dates cannot easily be advanced as seed needs sufficient time for stratification. To achieve this a good supply of feed and water, as provided by a flood and drain system, or a good quality overhead irrigation rig, will be essential.

It is too early to say whether or not the Spin Out coating on the module cells was an advantage. Although plugs appeared very 'root bound' when extracted from the untreated cells, preliminary results after planting out suggested they established equally well as those from the Spin Out treated trays. Records after lifting the crop in HNS 56b will determine whether any differences in root structure in the soil, such as improved fibrousness, were induced by this treatment. The iron deficiency exhibited by the Spin Out treatment was almost certainly induced by copper in the Spin Out. There was likely to be a low level of iron left in the growing medium at this stage, and because copper and iron compete for the same absorption sites at the root tip, insufficient iron could be taken up. While the effect of induced Fe deficiency due to Spin Out did not appear too serious in this trial, it should be borne in mind as a potential problem, and extra iron applications earlier in the season should be considered to prevent its occurrence.

Both the 5 - 8 mm and 3 - 5 mm grade module raised stocks were field planted out in comparison with 5 - 8 mm grade bare root stocks. The choice of rootstock grade used by growers is influenced by the expected growth rate and vigour applicable to their site, and when it is desired that stocks

should be budded. Observations to date with HNS 56b showed that the smaller grade module raised stocks planted in April were thick enough for budding by July. The Super Prefer planting machine used for the bare root stocks was unsuitable for the module raised stocks which were planted by hand. Given other machinery, however, there may be potential for precision machine planting of module raised stocks. A more uniform planting depth could lead to less variation in root formation and length of budding 'neck' than with bare root stocks. It was important to plant the module 'proud' of the soil surface before earthing up, as some of the budding neck was within the top centimetre of the module. Although necks were clearly shorter than with the bare root stocks, they were sufficient for budding. These plants should be easier to containerise neatly without having to bury the long neck frequently present on 'high worked' conventional stocks. There may be other benefits in crop uniformity and an overall improvement in quality arising from machine planted module raised stocks, but which is beyond the scope of this project or HNS 56b.

Consideration was given to other ways of exploiting the module rootstocks for other specialist rose container crops. Thought was given to possible ways of bench budding or grafting flowering cultivars onto the stocks at the end of the production year. Being able to pot on, or even field plant, a pre-budded module raised stock sounds attractive. However, it did not seem likely that a reliable strong bud union or graft, capable of withstanding subsequent potting on or machine planting, could be achieved by working scions onto relatively thin necks during the dormant season. There has already been some success in the industry from side grafting certain miniature cultivars directly onto one year old bare root seedling stocks prior to potting them up, and module raised stocks are unlikely to offer any significant advantage here.

Economics

This preliminary study cannot be expected to answer many of the complex questions involved in a full economical evaluation of a radically different production system to the field production of rootstocks. Development of the technique further will depend on the results of HNS 56b, but it is likely that module rootstocks will be best suited for specific uses or markets which will maximise the benefits they may offer. Module rootstocks will be more costly than bare root stocks, but if they offer significant advantages for containerisation, they may be worthwhile for these higher value crops. Containerised standard stem roses, are an example. Potting standard roses centrally and vertically, even in large 10 litre containers, can be very difficult without severe root pruning.

The QP96D trays have 577 cells / m^2, and the QP150D trays have 901 cells / m^2. Of these, 80% of the large trays and 70% of the small trays might yield usable grade rootstocks. Allowing for about 40% lost production area for paths and headlands, these trays might be expected to yield about 270 - 380 saleable stocks / m^2 of nursery space. A field of rootstocks might be expected to yield some 50 - 100 stocks / m^2 after grading, but such straight yield comparisons with field production do not mean much economically without further data.

CONCLUSIONS

1 Production of rose rootstocks in modules is technically feasible, and may offer worthwhile advantages where there are problems containerising roses on conventional bare root stocks from the field. Project HNS 56b is including a comparison of module raised and bare root stocks in a field trial to see whether module raised stocks induce a more fibrous root system on the two year old lifted crop.

2 Both QP96D and QP150D module trays (i.e. 75 ml and 37 ml volume) are capable of producing saleable grade stocks, but the larger sized QP96D cells produced twice the proportion of 5 - 8 mm grade stocks. Conventional grading systems used for bare root stocks, however, may not be applicable for module raised stocks.

3 Spin Out did not make any significant differences to the grade-out of seedlings from the modules. Very little root was visible on the outside of the growing medium plug where Spin Out was used, whereas the untreated plants appeared quite 'root bound', however establishment in the field the following spring appeared as good from both treatments.

4 Spin Out can induce iron deficiency in this crop, which can be avoided by the addition of extra applications of Fe chelate during the growing season.

APPENDIX - PHOTOGRAPHS

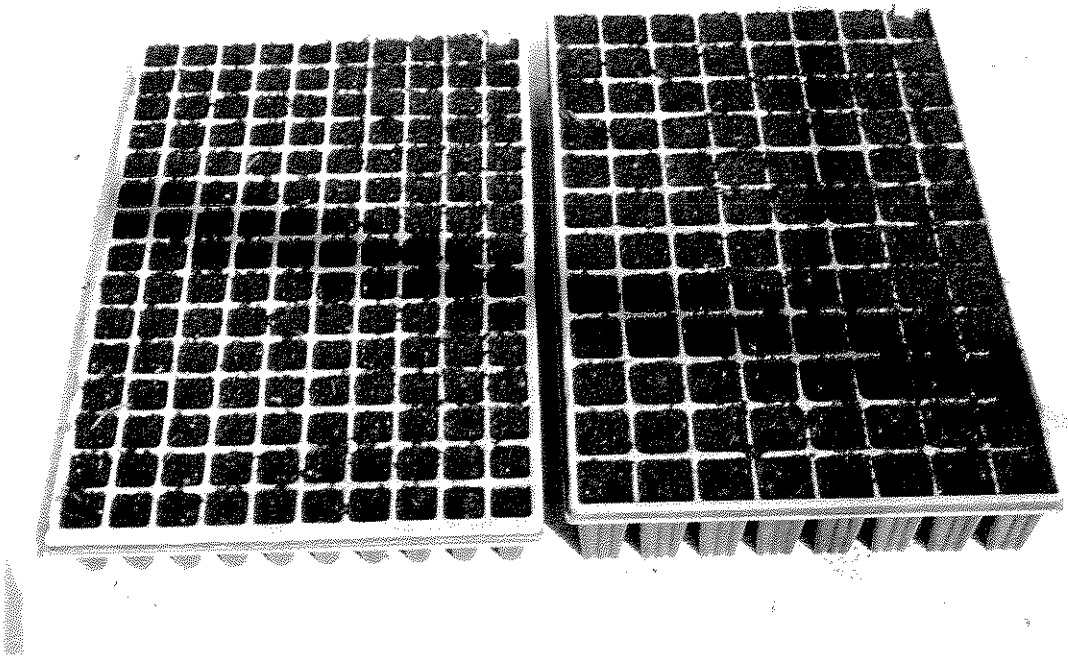

Photo 1 QP150D (left) and QP96D (right) module trays after sowing

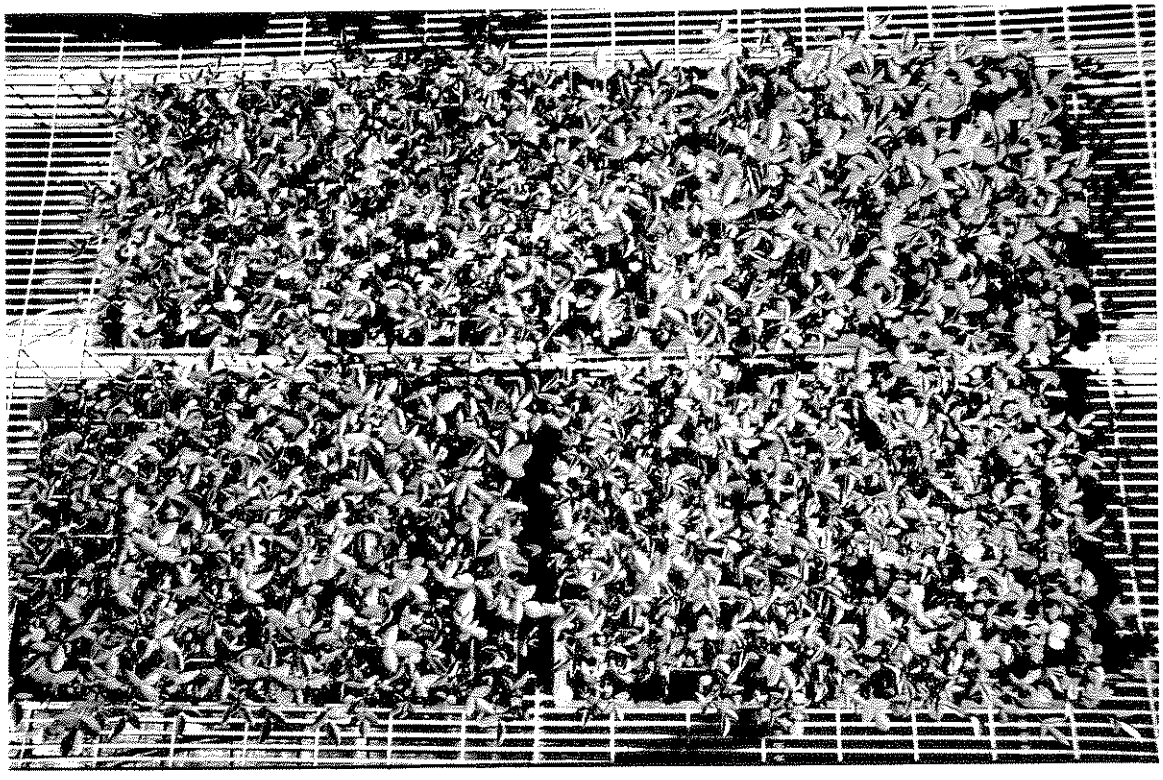

Photo 2 Growth of seedlings by 4 July 1996

Photo 3 **Growth of rootstock by 4 July 1996**

Photo 4 Spin Out Untreated Spin Out Untreated
QP150D QP96D

Photo 5 Growth by 14 November 1996 (QP96D trays). Yellow leaves in Spin Out treatment (right) is evidence of copper induced iron deficiency