AP532
Development of national rootstock source area - stage 2

R Green
SA Pome Fruit Improvement Committee

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Final Report

HRDC PROJECT - AP532

DEVELOPMENT OF NATIONAL ROOTSTOCK SOURCE AREA STAGE 2

1 July 1995 - 30 June 1996

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Photo 1. Experimental mechanical harvesting of established Layer beds

Photo 2. Hand harvesting young Ottawa 3 layer bed
SUMMARY

1.1 INDUSTRY SUMMARY

Changes in the Australian and International market places, particularly with the introduction of new varieties has put considerable pressure on Australian apple orchardists. To meet these changing market requirements and remain economically viable most orchardists have had to redevelop their orchards.

Redeveloping old or establishing new orchards is an expensive capital investment and long term proposition. It is also the best opportunity orchardists have to introduce new technology and ideas to improve orchard productivity and profitability. In conjunction with the up front costs of redevelopment there is the need to minimise the ongoing production, management and labour costs associated with maintaining these orchards.

To achieve this, individual orchardists and the Australian apple industry collectively need to plan carefully and develop (redevelop) their orchards using modern orchard design and production systems.

Worldwide trends in research and orchard development show that high density orchards using dwarfing rootstocks is the preferred way to develop new orchards. In Australia the commercial availability of these dwarfing rootstocks is extremely limited.

The Australian apple industry has recently undertaken an extensive review of itself and its abilities to remain internationally competitive. This review highlighted the significance of the rootstock problem and its potential effect on the future of the industry. The South Australian Pome Fruit Improvement Committee Inc (SAPFIC) in conjunction with the Australian Apple and Pear Growers Association have begun the development of an Apple Rootstock Source Area at Monash in South Australia. This report covers stage 2 of that development.

This area was selected for a number of reasons that include:

* Previous SAPFIC work at the site
* Excellent growing conditions - light, friable, well drained soils, ample water, long growing season
* Experienced workforce
* Industry (not government) ownership of the land
* Co involvement with other national crop improvement programs (shared resources and equipment)
* Isolation

Because of the critical shortage of rootstocks and the long lead times needed to establish productive stool and layer beds this rootstock source area has been given a high priority by industry allowing development to begin in advance of other aspects of the "Australian Pome Fruit Improvement Program".
Initially one hectare of land was leased from the South Australian Vine Improvement Committee Inc, the industry group owning Monash. During this stage a further hectare has been leased to enable a planned and efficient development of the area to meet industry requirements.

The total 2 hectare area has been fenced for wind and kangaroo protection. A comprehensive development plan was devised as part of stage 1. The continued expansion of the block in this stage has been undertaken in accordance with this plan. Future development strategies will become dependant on the directions set by the “Australian Pome Fruit Improvement Program” (APFIP).

A total of 6673 rootstocks have been planted this year, of these 2770 were M.26, 2085 Ottawa.3, 250 MM.106, (plus 680 rootpieces) and small quantities of M.9 and M.793. Only the best available sources of high health status rootstocks have been used. This has restricted the number of rootstocks available but has been done in the future interests of the Industry.

All of the M.26 and Ottawa.3 have been planted in permanent stool/layer beds each approximately 45m long. A range of planting techniques have been used to establish these stool/layer beds to utilise the available planting material in the most effective ways possible. As a result a method of nursery/stool bed establishment has been developed to establish stool beds using tissue cultured and other small rootstock planting material. Rootstocks produced from these initial stool and layer beds will be used to assist in the expansion of the source area. Additional rootstocks will be planted into permanent stool/layer beds (per the development plan) as part of stage 3.

A range of cultural practices are being evaluated to improve the establishment and productivity of the stool and layer beds.

Due to the location of the Monash Horticultural Crop Improvement Centre relative to the Adelaide Hills apple growing area an efficient management and supervision strategy is being developed in conjunction with the Monash staff and South Australian Vine Improvement Committee.

Further development of the rootstock source area will be undertaken in additional stages of the project.

An experiment to evaluate the potential of establishing M.9 stool/layer beds using root pieces was started but has had to be terminated due to concerns on the trueness to type of the planting material used. To eliminate any future problems all of the rootstocks used in this trial have been dug up and disposed of. This unfortunate (but unfortunately not unusual problem for the Australian apple industry) has had a significant impact on the rate at which M.9 stool/layer beds can be enlarged.
1.2 TECHNICAL SUMMARY

Following on from the experience gained from several trial plantings undertaken at the Monash Horticultural Crop Improvement Centre by the South Australian Pome Fruit Improvement Committee Inc and the stage 1 project a total of 37 additional permanent stool/layer beds were planted in this stage to enlarge on the 19 established in stage 1. Of these, 15 beds are of M.26 and 13 of Ottawa.3, 5 of MM.106 and 1 M.9 (initially 4). Each bed is approximately 45 metres long with 2 beds per 100 metres. Each bed initially requires approximately 150 rootstocks.

A range of planting techniques have been used to establish these beds due to the wide physical size range of the available rootstocks. These different techniques have been used in an attempt to make maximum use of the available planting material. Large rootstocks approx 1m were used to establish layer beds and the smaller rootstocks have been used in stool beds. Where small rootstocks have been trialled for layer bed establishment the results have not been as successful as anticipated. Where large rootstocks have been used reducing the length of shoot at planting has improved the establishment percentage and subsequent shoot development in the first season. An additional benefit has also been a reduction in early sunburn damage due to better shoot growth to protect the stems of the layers.

Because of the small size of the tissue cultured rootstocks obtained in stage 1 a new planting technique has been developed. This stool/nursery technique has enabled these very small rootstocks to be managed as nursery rows whilst at the same time has allowed them to develop a root system insitu for a permanent stool bed. The rootstocks from these nursery rows were harvested and used for further bed development enabling 2 layer/stool beds to be established using the 1 plant.

All stool and layer beds have been established in trenches approximately 15cm deep, this allows the permanent root systems to be established well below normal ground level enabling mechanical harvesting in the future. Strategies have been devised and tested to minimise sunburn problems.

Shoot growth from stools and layers has been very good, however concerns have arisen in older SAPFIC plantings that this shoot growth can become too large. Several shoot development and management procedures are being evaluated on these older plantings for future use in the rootstock source area. These practices include pinching techniques (adapted from flower growers) that force the initial shoot to branch, if done at the right stage before mounding these treatments have significant effects on total shoot numbers/bed and in the resultant size/quality of the rootstocks.

Experience gained in this development stage clearly indicates the need for the future mechanisation of several cultural practices, in particular sawdust spreading, mounding, demounding and harvesting. These requirements will be addressed as part of the future development stages of this source area.

The stage 1 development provided invaluable information that has been of considerable benefit in improving the establishment of stool/layer beds (and their long term productivity) in this stage.

Further development will be continued in the stage 3 development which is currently underway.
Committee Inc and is 50 ha in size. In addition to the vine and apple plantings the centre also has key plantings associated with the National Citrus and Almond Improvement Programs.

SAPFIC's initial work at Monash clearly identified the Horticultural Centre's potential as the site for a national apple rootstock source area. In addition to the excellent growing conditions (long growing season, ample water, light well drained and friable soils) the centre also has an experienced workforce that have a good understanding and commitment to the requirements of a national propagation scheme. It is Industry (not government) owned and because of its involvement with several other National Plant Improvement Programs the sharing of mutually required resources and capital equipment is possible which reduces the individual costs to each program.

Photo 4. Shoot growth - late summer
2.2 **Objectives of this Project**

While aspects of a National Pome Fruit Improvement Scheme are still being negotiated by the Industry there has been strong national support for a rootstock program to progress as quickly as possible. With this in mind this project was started with the following objectives:

1. Commence the establishment of stool and layer beds of a range of dwarfing rootstocks for future use by the industry. These rootstocks are to be used in evaluation programs and by orchardists and nurseries.

2. Begin establishment of the source area to minimise any time delays in rootstock availability due to the lead times associated with obtaining full productivity from the stool and layer beds.

3. Begin the bulking up of scarce rootstock material to provide additional planting material to expand stool and layer beds.

4. Reduce the establishment time and costs associated with the development of a National Propagation Scheme.

5. Provide a base for a possible National Propagation Scheme to expand on.

6. Begin development of a national rootstock repository.

Photo 5. Trialing the use of disks to mound soil up around shoots
2.3 Materials and Methods

The South Australian Pomefruit Improvement Committee initially negotiated with the South Australian Vine Improvement Committee Inc a long term lease for a 1 Ha section of irrigated nursery land on the Monash Horticultural Crop Improvement Centre. During this stage it became apparent that additional land would be required. An additional 1 hectare of land has been leased to increase the capacity of the block. This lease is to be paid on an annual basis. Opportunity exists to restructure this arrangement when the national propagation scheme is in operation. This nursery block is fully serviced with water as part of the irrigation mains system of Monash.

Development of the site will take several years. To ensure that the source area can be developed effectively and efficiently a comprehensive development and planting plan was devised that divides the block into sections.

The two most significant environmental problems with the Monash site are wind and kangaroos. An external fence has been erected to isolate the site and exclude kangaroos. Internal fences/windbreaks will also be required to reduce wind damage and improve rootstock quality. To utilise the land more efficiently an initial internal fence 1.9 meters high and covered with shade cloth has been erected as an internal wind break. This has been successful and it is proposed to erect other internal windbreaks using this system. Using this approach there will be minimal loss of productive land area.

In stage 1 a comprehensive soil test was taken of the nursery site and any nutritional requirements determined. This report was used as the base for determining the preplanting fertiliser needs of the block. The site has excellent drainage and has not required any drainage infrastructure to be installed.

Careful consideration and evaluation of the layout of the stool/layer beds has been required. Factors such as ongoing management, mounding, harvesting, use of machinery, irrigation system design and minimising the risk of potential mixups have all had to be carefully assessed. As a final design the individual rows of stools and layers have been planted at 1.5m apart (to facilitate machinery use). Preliminary trial work at Monash conducted by the SAPFIC has shown that exceptional fibrous root growth can be achieved in one season by certain rootstock varieties. To minimise the potential for root invasion into adjoining stools/layers a gap between different rootstocks has been determined to be an essential requirement. The stool and layer beds in each section are each approximately 45m long separated by a 5m gap in the middle to allow for machinery access.

One of the most important decisions faced by SAPFIC in developing this source area has been what sources of planting material should be used. This is also one of the biggest problems facing the national industry. Ideally, to provide the industry with the best planting material, only virus tested planting material should be used. However after extensive investigation no "certifiable" sources of virus tested rootstock material could be found in Australia. Due to the reduction in governmental resources, the loss of the national FVF apple collection and lack of post entry virus indexing there is not a readily accessible source in Australia of rootstock material that has been regularly indexed for virus and certainly no material that has been recently indexed for all
appropriate viruses. For the future benefit of the national industry it is important that this issue be addressed, possibly as part of the national propagation scheme. Faced with this dilemma and the primary industry objective of obtaining dwarfing rootstocks it was decided to progress using the "best available" planting material which could then be virus indexed (part stage 3) and heat treated if necessary. To obtain "best available" planting material only material from Departments of Agriculture/Primary Industry or material sourced from them and produced with appropriate high health management techniques or tissue propagation techniques has been used. Commercial nurseries were not considered as principal source of planting material.

To date the planting material used for the initial development of the rootstock source area has only been obtained from 2 sources, the Tasmanian Department of Primary Industries and Fisheries (ex FVF rootstock stool beds) and the SAPFIC own stool/layer beds which have been developed using material obtained from the South Australian Department of Primary Industries or tissue cultured material obtained from Phytotech P/L originally sourced from the SA Department of Primary Industries.

SAPFIC members prepared the site, obtained the rootstocks, planted them, erected the protective fences and installed the irrigation systems. In total 6673 additional rootstocks have been planted in new stool/layer beds. Of these 2085 were Ottawa.3 and 1850 M.26 (obtained from SAPFIC and the stage 1 plantings). A further 920 tissue cultured M.26 obtained from Phytotech P/L were also planted. A total of 880 MM.106 rootstocks (250 rootstocks and 630 root pieces) obtained from the Tasmanian DPI & F and Monash stage 1 plantings were planted, as well as 230 M.9 rootstocks obtained from the Tasmanian Department of Primary Industries & Fisheries and stage 1. A total of 610 M.9 rootstock pieces were initially planted but these have subsequently been removed because of concerns regarding their trueness to type. In addition 8 other rootstock cultivars were planted in the repository area.

The SAPFIC has conducted a national survey of growers to ascertain what rootstocks the industry most wanted, from this survey it was concluded that M.9 was the most highly required followed by M.26 or rootstocks of similar vigour. Ottawa.3 is a relatively new rootstock to Australia and is still being evaluated, however current research being conducted by the SAPFIC and Primary Industries South Australia has shown it to be of equivalent vigour to a strong M.9 but has several advantages particularly on the strong growing varieties Pink Lady and Royal Gala.

**Planting techniques used**

A range of stooling and layering techniques have been used to establish the permanent stool and layer beds at Monash. The technique used depended on the rootstock cultivar, its source and its initial size.

The general layering technique that has been utilised by SAPFIC is a modification of a layering technique described by Dr Jim Cummins, (Cornell University, USA). The rootstocks are planted approximately 15 cm below the normal ground level, allowed to settle in and then are pegged down. The shoots are allowed to grow and are mounded as normal. At the first harvest only large stocks are removed and as many shoots as possible are repegged down to increase the total number of potential shoots and root mass. The advantages of this technique are that all of the layerbed's
crucial root system is established below ground level (reducing mechanical harvesting damage) and it increases the early density of the layer bed subsequently reducing the development time to achieve maximum productivity from each bed.

Where stool beds have been established in preference to layer beds these also have been established by planting 15 cm below normal ground level. The larger stocks were headed at planting, the smaller stocks and tissue cultured stocks were not. Where small stocks were used the machine-dveled trenches were reshaped by hand to achieve the right depth and reduce rootstock losses due to sides of the trenches collapsing.

**Planting strategies**

**Ottawa.3**  
This rootstock is reported to be hard to root but this can be overcome by using tissue cultured planting material. The majority of the 2085 rootstocks planted were of a large size and were planted directly into a trench formed behind a delver. They were then tipped and layed down as layers.

**M.26**  
Large stocks obtained from SAPFIC were planted as layers using the same techniques as Ottawa.3. Smaller stocks (30 - 40 cm) obtained from the Tasmanian Department of Primary Industries and Fisheries were also layered.

**MM.106**  
The expansion of the block has enabled the initial layer bed of MM.106 planted in 1994 to be dug up and relocated to a more practical position. Several techniques were used to reestablish these layer stool beds including:
- **Layer beds**: the larger rootstocks (50) were established using the layering technique described previously
- **Stool beds**: 200 rootstocks were obtained from the Tasmanian DPI&F. These rootstocks were not large enough to layer so were established as stools spaced approximately 20 cm apart. The tops were recut after planting.
- **Root pieces**: As a trial all of the roots from the rootstocks in the initial layerbed were dug up, cut into 5 - 8 cm pieces and replanted in the new position. These root pieces were planted at a shallow depth (to encourage shoot development) in hand formed trenches 15 cm below normal ground depth.

**MM.793**  
As with the MM.106 the expansion of the block enabled the original layerbed of MM.793 to be dug up and replanted in a more appropriate position. The rootstocks were replanted using the same techniques as MM.106.

**M.9**  
As M.9 is proposed to be one of the major rootstocks to be planted at Monash the original M.9 bed was also dug up and relocated to a more practical position. The larger rootstocks were established as layerbeds and the roots were cut up (as per MM.106) and shallow planted in a trench 15 cm below normal ground level.

All beds have been labelled for correct identification and record keeping purposes.
2.4 Management of the Source Area

Monash is situated approximately 250 km (5 hours round trip) from Lenswood (in the Adelaide Hills) where most SAPFIC members are based. This distance creates a problem ensuring that the rootstocks are managed correctly on a day to day basis and that any cultural or management requirements are carried out when and how they should be.

This problem has been addressed by developing a close working relationship with the management and staff of the Monash Horticultural Crop Improvement Centre. A system has been developed where SAPFIC provides the strategic management and development strategies and the Monash staff provide the day to day management and labour requirements. One Monash staff member has been specifically assigned the responsibility for ensuring that all of the SAPFIC directions regarding irrigation, mounding, pest and weed control, and all other cultural requirements are carried out.

The Committee has adopted a strategy of holding two of its monthly meetings (November and May) at Monash to specifically monitor the development of the source area. The May meeting is used as a review meeting to critically analyse the season’s performance and plan for the future. In addition to this, rostered Committee members travel to Monash every 2-3 weeks to monitor the growth and management of the planting and provide the Monash staff with direction and instruction.

Photo 6. Reduction in rootstock size as a result of early spring “pinching”
2.5 RESULTS

In July 1996 (as part of the stage 3 development) the stool and layer beds were harvested and graded. The most suitable material has been used to establish further stool and layer beds as part of the program to increase the plantings on Monash as quickly as possible.

The following is a summary of the 1995/96 stool and layer bed production. Please note that each row was individually harvested and graded. This individual harvest and grading was undertaken for the following reasons:

Traceback - the rootstocks from every source used at Monash are planted in separate rows and an accurate record of their position maintained. This system is also used for any rootstocks produced at Monash. This procedure ensures that only material from the same source is used in any 1 individual row. This allows us to maintain an accurate record of material, enabling a tracing system to be used for any future purposes such as virus indexing etc.

Quality Management - recording the quality ie size and any specific problems associated with a row or rootstock cultivar provides valuable information that is used to modify the management practices used on that row or cultivar. It also provides valuable data on the success or failure of a specific establishment technique or management procedure under evaluation.

The grading system used separated the rootstocks into the following general categories

1. Large - large rootstocks considered unsuitable for bench/field grafting
2. Medium - medium sized rootstocks considered suitable for field/bench grafting
3. Small - small caliper rootstocks considered too small for field/bench grafting but suitable for nursery liners

Problem Rootstocks

4. Runts - too small for any commercial or nursery use
5. No roots - too few or insufficient roots to be of commercial or nursery use
6. Bent - stems not straight enough for commercial sale (may be suitable for layer/stool bed establishment)
7. Other - pest/disease damage etc (no commercial value)

Please note that this system was devised for current management purposes within the Monash block. For the future distribution of rootstocks from this block a grading system with specific categories and specifications will need to be developed as a high priority.

The harvesting strategy in previous years has focussed on increasing bed density, so only stocks that were considered large enough, too strong to reped down, or in areas already dense enough were harvested. This year all rootstocks were harvested and graded.
Table 1 1996 M.26 Rootstock Harvest Results (all layer/stool beds)

<table>
<thead>
<tr>
<th>Grades</th>
<th>Total</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>large</td>
<td>664</td>
<td>11.2</td>
</tr>
<tr>
<td>medium</td>
<td>2055</td>
<td>34.6</td>
</tr>
<tr>
<td>small</td>
<td>513</td>
<td>8.6</td>
</tr>
<tr>
<td>runts</td>
<td>393</td>
<td>6.7</td>
</tr>
<tr>
<td>no roots</td>
<td>1097</td>
<td>18.5</td>
</tr>
<tr>
<td>bent</td>
<td>1211</td>
<td>20.4</td>
</tr>
<tr>
<td>total</td>
<td>5933*</td>
<td>100</td>
</tr>
</tbody>
</table>

* an additional 363 rootstocks were also harvested, these were not graded but used to extend the beds.

From the figures above only 43.2% (medium and small) of the stocks were considered commercially acceptable under the strict grading system tried this year. Of the remaining 56.8% some valuable information has been gained. The percentage in each category has been looked at relative to management practices and changes to those practices will be introduced.

The lessons learnt include

Large (11.2%)

The rootstocks in this category were considered too large for bench or field grafting. Successful grafting may possibly be achieved with chip grafting. However these rootstocks were extremely strong growing, often had relatively small root systems indicating that they were being well supported by the original layer/stool root system and were invariably the only shoot from that particular rootstock stub.

Further early season management practices (such as pinching) must concentrate on forcing more shoots from each potential growth point and wherever possible check the growth of the more dominant shoots which tend to be the first to emerge each spring.

Whilst these shoots may not be very suitable for nursery or orchard use they are particularly useful for the establishment of new layerbeds.

Runts (6.7%)

The majority of the runts were produced from sections of the mounded layer beds that had been mounded too early, too high or too heavily. In many cases they were late developing shoots that continued to develop even though they had been completely buried.

In an effort to improve the efficiency of mounding and reduce the large labour costs associated with this crucial activity the SAPFIC experimented (in 1995/96) with mechanically mounding the layer/stool beds. From this experiment we will modify the system to concentrate on only moving the sand/sawdust mixture close to the beds so that hand mounding can then be done much easier and quicker. Total mechanical mounding will only be used for the third and final mounding. Whilst undertaking the first and second mounding attention will be given to modifying the height of
mounding according to the height of the rootstocks, avoiding the complete covering of shoots wherever possible.

No roots (18.5%) 

In every layer/stool bed there will always be a percentage of rootstocks that do not produce roots, the more dwarfing the rootstock the higher the percentage. Our management strategy aims to minimise this percentage.

In addition to the physiological reluctance to root the three main physical problems identified at Monash have been; 
1. excessive shoot strength 
2. too dry rootzone 
3. incorrect mounding strategies

To minimise these problems the management strategies will be adjusted to increase shoot density per layer and stool and reduce the vigour of early shoots as outlined above for strong shoots. The sawdust used for the mounding medium will continue to be broadcast and incorporated into the soil prior to its use for mounding to avoid the previously experienced problems of dry spots in the mounds due to unwettable sawdust. All shoots will be manually mounded according to their development and height in the early part of the season.

Bent Shoots (20.4%) 

Our experience at Monash has shown that while Ottawa.3 and MM.106 generally produce a straight shoot other rootstocks such as M.26 tend to be more bent and branched. Several scientific articles confirm this observation.

The number of bent shoots harvested during 1996 was exacerbated due to the experimental mechanical mounding. The forward motion of the soil during this process tended to bend shoots forward and if not corrected they remained bent. Adjustments in the forward speed and manual positioning of shoots whilst mounding will be implemented for any future mechanical mounding operations.

Of the rootstocks produced at Monash a total of 1605 were used to establish new layer/stool beds (including new trial beds). A further significant (but unrecorded number) were used to increase the bed density and fill any gaps in the existing stool and layer beds.

Ottawa.3 

Table 2 1996 Ottawa.3 Harvest Results

<table>
<thead>
<tr>
<th>Grade</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>large</td>
<td>177</td>
</tr>
<tr>
<td>med</td>
<td>940</td>
</tr>
<tr>
<td>small</td>
<td>190</td>
</tr>
<tr>
<td>runt</td>
<td>40</td>
</tr>
<tr>
<td>no roots</td>
<td>538</td>
</tr>
<tr>
<td>bent</td>
<td>360</td>
</tr>
<tr>
<td>other</td>
<td>2245</td>
</tr>
</tbody>
</table>

Of total | % of total |
100 | 7.9  |
41.9 | 8.5  |
1.8  | 24    |
16    | 100   |
Overall the performance of Ottawa.3 was better than M.26, the main area of concern being the higher percentage of no or poor rooted shoots. This is a recognised problem of this particular rootstock. At Monash we have noticed that any strong early season shoots of this cultivar tend to be poor rooting. Adjustments in management will be undertaken.

While the number of poor or non-rooted shoots is of concern, it is significantly better than the results obtained in stage.1 of the project where 55% of the shoots produced failed to root adequately enough to enable them to be harvested and replanted.

**MM.106**

This rootstock has been included in Monash as a general purpose rootstock which can be used to assist in the rapid buildup of other rootstocks in short supply (ie root grafts etc) and as a comparative rootstock in national evaluation trials.

No grading of the MM.106 rootstocks produced and harvested was undertaken as they were immediately replanted to extend the total number of MM.106 layer/stool beds.

In 1995 a large number of 50-100 mm long root pieces were planted out in 3 trenches similar to all the other stool and layer beds as an experiment. This experimental technique proved to be 100% successful with the root pieces establishing well and also producing enough rooted shoots to enable another complete bed to be established from each original bed.

**M.9**

Obtaining significant quantities of suitable quality M.9 rootstock planting material continues to be a major problem facing the potential of Monash to build up commercial numbers of this rootstock quickly. From the original 58 rootstocks planted in 1995, a total of 64 rooted shoots were harvested. These were immediately replanted as were an additional 150 obtained from Tasmania.

In an experiment to rapidly increase the numbers of M.9 available an established stool bed of tissue cultured “M.9” rootstocks was dug up and as many root pieces as possible were harvested and planted. Whilst initially considered promising the growth of these rootstocks aroused concern, the experiment was terminated and the beds subsequently removed because of concerns regarding their trueness to type.

**M.793**

M.793 was originally planted at Monash because of its potential for use in some of the less vigorous regions ie Stanthorpe, Harcourt. Because of the increase in land available the initial stool bed of M.793 planted in 1994 was dug up and repositioned. A total of 36 rooted shoots and several root pieces were planted in 1995, from this 59 shoots were produced and replanted to extend the layerbed.
2.6 Discussion

Stool Beds or Layer Beds?

Stools or layer beds - which system do we use? Answering this question is involving considerable thought, investigation and discussion. No conclusive answer has been obtained although a range of techniques has been tried. Each technique so far tested has taken into consideration, the quality of the initial planting material, the need for good initial plant establishment, SAPFIC experience with the climatic and soil characteristics of Monash and the future use and productivity of the stool and layer beds.

There have been mixed results from the techniques. These results have been evaluated and we have also discussed the techniques used with co-operative commercial nurseries. As a result of this review and consultation process planting techniques for stage 2 were modified where necessary. The preliminary assessment of these adjustments has been very encouraging but have shown that there is still the opportunity for better performance.

Our discussions with commercial nurseries have been beneficial but have also shown that the limitations on rootstock availability (hence the need for this program) are due in part to the propagation practices currently being used by many commercial nurseries. The scale of stool/layer beds at Monash, the long term need for productivity and labour efficiency and the management practices associated with the climatic conditions at Monash have necessitated that we look very critically at how we undertake the establishment of Monash. In several cases the establishment and management practices adopted by SAPFIC appear to be more effective than those of commercial nurseries.

Considerable benefits for the program, nurseries and orchardists have arisen from this co-operative approach with the nurseries and we will continue to work with them.

Layer bed establishment practices

In establishing the layer beds the "Cummins" technique has been preferred. This technique has a 2 year establishment phase but ultimately develops a more productive layer bed quicker than conventional systems. The 2 year establishment phase involves initially planting the rootstocks as per conventional practises, but in preference to harvesting shoots at the end of the first year as many shoots as possible are left attached to the original shoot and then bent down. This results in a rapid increase in the layer bed density and subsequent shoot production.

The basic system utilised for this season involved preparing a trench approximately 30 cm deep and 45 cm wide into which the rootstocks were planted at an angle of approximately 45 degrees and spaced 40 cm apart. In the planting process the trenches were back filled with soil which resulted in the final trench depth of approx 15 cm below normal ground level.

Initially the rootstocks used for layering were relatively large (approx 1 - 1.3m in length) and had extensive root systems. Each stock had its top 10 - 15 cm of growth removed. All rootstocks were "watered in" as soon as practical after planting. However because of sunburn problems on the
shoots causing significant damage and restricted new shoot growth, the rootstocks are now cut back more severely at planting (approximately 1/2 length) and the tips are recut prior to layering. This adjustment has been very successful because there is less top for the disturbed root system to nourish, this has led to reduced establishment problems and the encouragement of rapid early shoot growth. This greater and more even new shoot growth provides early and extensive leaf cover to the original shoot thereby reducing sunburn problems. The recutting of the tip prior to layering has led to a reduction in apical shoot dominance allowing a better result to be obtained from the remaining shoots.

Because of the size of the Monash area and the need to minimise labour requirements a significant proportion of the layer beds were planted with tractor assistance in preference to hand planting. This approach was very successful.

**Stool bed establishment practices**

Similar land and trench preparation techniques as outlined for layer beds were used for the stool beds. Where small rootstocks were used the trenches were "squared off" (ie the edges of the trench were shaped) to prevent the trench side collapsing and smothering the rootstocks.

The rootstocks were planted in these trenches at 20 - 30 cm apart and headed approximately 5 cm above the bottom of the trench.

We have adopted the practice of planting the stools and layers in a trench in preference to soil level because we anticipate the use of mechanical harvesting in the future. By establishing all of the parent root systems below ground level and then allowing the stools to gradually increase in height any potential damage due to mechanical harvesting can be minimised. Additional benefits from the deeper establishment depth include easier plant management, greater irrigation flexibility, easier mounding and less sawdust required for mounding.

The below ground planting depth has shown both disadvantages and advantages in the hot Monash environment. On the plus side it has increased the total mound depth of each stool/layer bed increasing the rooting performance from these beds. Additionally there is less sawdust lost from around the base of the new shoots due to wind. On the negative side we have had to revise our pegging down procedure on the layer beds due to sunburn damage in the middle part of the laid down canes. In severe cases this has resulted in approximately a 1/3 reduction in shoot production.

**Modified stool/nursery system**

In developing Monash the extreme shortage of planting material for most rootstocks has necessitated that we use all the planting material we have available. In response, we have developed a modified stooling/nursery system for small and tissue cultured rootstocks. This system enables us to use small stocks to establish a new stool bed while managing the trees under nursery conditions.

The small rootstocks are planted in trenches as prepared for normal stool bed establishment. These trenches are approximately 15 cm deep, the stocks are planted at an appropriate spacing (approx 20 cm) and grown as nursery plants allowing only 1 shoot per plant to develop. In the initial stages of
mounding a mixture of soil and sawdust is used to fill in the trenches up to normal soil level (as per normal mounding). Once filled in the beds are not mounded any further but managed as relatively wide spaced nursery trees.

At harvest the soil/sawdust mixture is removed from the trench to expose the roots. The rootstock is harvested (with some roots) leaving the original rootstock root system insitu as part of a permanent stool bed. The harvested rootstock is then used to establish a new layer or stool bed.

Using this technique overcomes several problems including making the most efficient use of all available planting material, more rapid development of permanent stool beds, reduced need for a nursery area, and potential replant and contamination problems associated with the previous use of land for nursery purposes.

The use of this technique is greatly assisted by the soil drainage conditions at Monash, but may not be suitable for use in high rainfall and heavy soil conditions.

Photo 7. One seasons shoot growth of MM.106 initially planted as rootpieces
Note: fibrous root development
Quality of Planting Material

Our experience demonstrates that the physical quality of the planting material and how it is actually utilised has a critical bearing on the success of stool/layer bed establishment. In the establishment of layer beds only material that has a length in excess of 50 cm, butt circumference greater than 1 cm and a reasonably developed root system should be used. Planting material shorter, thinner or with a small root system should be stooled in preference.

Layering improves the initial size and productivity of the bed enabling quicker rootstock production. If unsuitable material is used the plants have trouble establishing and producing new shoots. This can negate all of the benefits to be achieved from layering.

Stooling is also an efficient way to produce rootstocks, however it requires more planting material / metre of bed to establish than layering and their productivity is directly influenced by the initial planting density. They allow more flexibility in the quality of planting material that can be used but should not be established with material that is too small or weak. Small or weak material should be grown in a nursery row for another year to increase in size before use.

Sawdust

After investigations by SAPFIC and assessment of the site sawdust has been introduced as part of the rooting medium around the developing stool and layer shoots. It also has advantages in assisting with the prevention of surface crusting in the heavier soil conditions of the block. This has added to the operating and labour costs of the development but has significantly improved the development of roots on shoots. Rooting problems have occurred where there has been insufficient wetting and moisture retention in the sawdust. This problem is associated with the quality and degree of breakdown in the sawdust. To eliminate any further problems all sawdust applications are now mechanically incorporated into the surrounding soil before being mound up around the shoots.

This modification will reduce the total amount of sawdust needed, improve the soil/sawdust moisture retention capacities, improve the overall rooting medium and improve the efficiency of sawdust application.

Mounding

Mounding is one of the most critical aspects of rootstock production in stool and layer beds. The timing, particularly of the first and second mounding operations has a significant affect on the level of rooting in the stools and layers. If not mounded effectively the numbers of commercially useable rootstocks is reduced.

SAPFIC have undertaken several small trials to ascertain the appropriate and most efficient ways of mounding at Monash. It is clearly evident that as the number of the permanent stool[layer beds are increased that some mechanismisation of this operation will be essential. A 3 point linkage tipping scoop has been lent to us, it has reduced labour requirements significantly, highlighting the need for an appropriate sawdust spreading machine to be purchased or developed as the plantings are expanded.
During stage 2 further investigations of techniques and machinery to improve the efficiency, costs and timeliness of mounding were undertaken with variable results. Mechanisation reduced labour and time requirements, however this was achieved with a subsequent affect on rootstock quality. Further modification and trialling will be required to achieve an acceptable balance between mounding costs and rootstock quality.

Rootstock Shoot Growth.

One of the significant advantages of Monash as a site for the rootstock source area is its warm dry climate, particularly its long growing season. A potential disadvantage of this climate is that the rootstock growth (shoot length and thickness) achieved on the stool/layer beds can become too large if not managed properly. The largest rootstocks occur where not enough shoots are initiated per stool. SAPFIC have begun investigations using shoot pinching techniques commonly used in cut flower production. These investigations are investigating when to pinch, ie shoot height and development, early or late pinching, and also at cost effective techniques of conducting this pinching. Preliminary results have demonstrated a 40 - 80% increase in total shoot numbers per bed and corresponding reduction in shoot length to a suitable commercial quality. Further investigations will be undertaken in later stages of the source area development.

The production of large stocks has not been considered a problem as they are of an ideal size for the establishment of layer beds. However as the plantings become commercialised the number of these large rootstocks will have to be reduced dramatically.

Development of the site

During the stage 1 and 2 developments, expansion has been limited by the availability of dwarfing rootstocks. Plantings have been restricted to predominantly only 2 rootstocks Ottawa.3 and M.26. Smaller areas of other varieties have also been planted but the rate of increase in these beds (particularly M.9) is of concern.

Management problems with these small areas and the need for future production and management efficiency have highlighted the need for an overall development plan for the whole area. In the absence of an industry co-ordination committee, SAPFIC have developed an interim development strategy and planting plan for the site. To address the varied requirements of the industry an additional 1 hectare of land has been leased from the South Australian Vine Improvement Committee. This land has been fenced and it's development started in accordance with the development strategy.

As part of this development strategy the area has been split into sections with a specific planting plan for each section. At this stage 3 & 1/2 sections (approx 1.15 hectare) have been allocated to permanent stool/layer beds of dwarfing rootstocks, 1 section for stool/layer beds of other rootstocks of industry significance, 1/2 section for a rootstock repository and 1 section for nursery and future expansion. Fine tuning of this strategy will be undertaken in consultation with Ms Sandy Dickinson (national coordinator) and APFIP.
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