as the parent material is tested and constantly monitored. A green-graft union knits better than with dormant grafting because the cambium layers are joined together while actively growing. The resultant plant has a significantly stronger graft union which is often difficult to detect with the eye after one years growth.

CONCLUSION

There are several advantages to the green-graft system. Firstly, due to the efficiency of the technique only a small number of stock mother vines are required and, therefore, have to be tested for disease. Pathogen-free clones can be preserved in vitro. In vitro culture results in high multiplication rates. During production, infection of graftlings by virus or bacteria can be excluded. Production can take place 12 months of the year, significantly increasing the number of plants produced. Finally, green grafting offers propagators a viable alternative to quickly multiply clean clonal planting material and keep up with the constant cultivar changes.

Improving Grafting Techniques for Apples

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This paper examines minor systems changes to the grafting techniques of old aimed at obtaining better grafting results with a variety of types of grafts on apples. Specific reference will be given to the use of open-ended, humidified plastic caps over the grafts to protect the graft, and to increase the humidity within the graft environment to prevent the graft scions from dying due to dehydration.

INTRODUCTION

The basic grafting techniques, such as, "T" budding, cleft grafting, chip budding, patch budding, whip and tongue, peg grafting and most of the methods used today were in effect the best of the techniques used by the original experimental grafters. Most of the literature available on budding and grafting techniques repeat this early information, e.g., R. J. Garner's *Grafters Handbook*, and add slightly to the systems used within the grafting techniques. Only a few books discuss the merits of the use of open-ended plastic coverings over apple grafts to increase humidity, and very few papers discuss specific effects.

METHODS

Field trials were conducted over a period of 3 years at various locations in Melbourne, Australia, but primarily in the apple orchard of the National Trust property Rippon Lea. Grafting took place at different times of the year to test the seasonal effect. Selection of budding and grafting wood at different times of the year was made and traditional grafting techniques employed. These included early and late scion grafting, summer and late summer budding, and chip budding at various times of the year.

Innovative techniques using green grafting, fully leafed scion grafts, leaf-bud budding (chip and "T" bud), different sized scions, old-wood scions, old-spur scions, and multi-sectional grafts were used. Whole tree multi-budding and multi-grafting will be discussed. At all times an open ended, humidified, protective, narrow plastic bag which was sealed at one end, was placed over the graft area and allowed to remain in place until the graft had "taken". The following is a description of the type of graft or budding method used, the various treatments, if any, used, and the observed results.

Normal Sized Scions. The first trials were done in early spring, using normal sized scions of about 100 mm containing three to five buds. Later experiments in early winter and mid summer using stored scion wood were also trialed.

The scion wood was collected in early June and the longer laterals cut into 300 mm lengths, tied in bundles, moistened, then wrapped in black plastic before storage. Using whip and tongue and side whip and tongue grafts, scions with three to five buds, were attached to new (1 year) and old (3 to 5 years) growths on the stock trees.

The open ended plastic bag which was sealed at one end, had some drops of water added to the inside of the tube, then the excess poured out. The tube was placed over the scion and extended below the graft area. The plastic covers were pinned into place using an ordinary pin, or a plug of grafting wax, leaving the open end of the tube open to allow air circulation. The plastic bags placed on the experimental grafts were removed at various times, starting from when the grafted scions begin to grow shoots.

A few of the scions that were grafted onto the trees were allowed to flower. Some of these actually produced mature fruit by the following mid-summer period. Although late grafts in December did not produce accompanying lateral growth, early spring grafts did produce fruit and substantial lateral growth. Some of the plastic covers were left on until the plastic tube was filled with new leaf growth before being removed.

The results showed that scion grafting can be done very early in winter (June-July), in spring (Aug-Sept), and mid summer (Dec-Jan) using winter-collected scion wood that had been stored in the crisper section of a refrigerator. An observation was made that late-grafted scions in the December period tended to form flower bud spurs on the scion instead of vegetative lateral growths. Indications are that the plastic bag can be left on the grafts in the initial stages of growth, with little adverse effect except during heat-wave conditions (above 40C) when the leaves inside the plastic may be slightly burnt. The degree of leaf burn was directly correlated to the amount of leaf coverage and subsequent shading supplied by the tree onto which the grafts were placed.

Old Wood Scions. Most grafting books do not recommend the use of this type of material because of the high failure rate and the supposed difficulty of old wood to form callous tissue to initiate union formation. Scions of wood of 2- to 3-year-old growth were chosen and used for grafting in early spring. The old scion wood chosen had few visible buds, the bark was aged and tightly adhered to the wood. Most of the grafts used were whip and tongue or a variation—side whip and tongue and scions were about 100 to 150 mm long.

The grafts were tied with budding tape or covered in Kendon™ grafting wax, then a tube of plastic, sealed at the top end and containing a few droplets of water, was

inserted over the graft area and held in place with a pin stuck into the bark of the tree below the graft. Although only few of these grafts were trialed, excellent results were achieved and the scions grew spur systems or both spurs and lateral growth during the following growth season.

Long Scions. Traditionally, grafting scions from 1-year-old wood are usually cut to contain only 3 to 5 buds. Long scions were too prone to dehydration before the graft knitted and thus the scion often dehydrated and died. Because of the field trial success with short scion growths using the humidified plastic tube covering, it was decided to try extra long scions attached with a normal graft (whip and tongue). Long scions of up to 300 mm were tried and covered with an extra long plastic tube. These scions also grafted well and showed no signs of stress.

Very Short Scions. Encouraged by the success of normal sized scions and long scions, short scions containing only one bud were trialed. These were treated in the same way as other grafts and worked well. The plastic covering preventing the dehydration of the tiny graft piece.

Chip Bud and Leaf. A variation of chip budding was trialed in mid summer. The chip buds were taken from current growth and inserted with the whole of the leaf on the chip bud still attached. The bud was tied with budding tape leaving the actual bud and leaf still exposed. The lateral to which the bud was attached was shortened to a bud just above the graft point, shortening the lateral to enable the insertion of a humidified plastic bag over the graft area. These chip buds grafted successfully.

Shield Bud and Leaf. "T" budding using a shield bud with the whole leaf still attached were trialed in late summer. The lateral was cut back to just above the inserted bud and the budded area was covered with a humidified plastic bag. These shield buds and attached leaf buds were successful.

Scion and Leaves. During late summer (February) 1995, some 150 mm fully leafed scions were collected from trees and whip and tongue grafted to new lateral shoots. The grafts were covered with the plastic bags. Although extreme heat wave conditions followed the grafting operation and the leaves eventually burnt and died off, the grafts seem to have taken.

Green Graft. During the November-early December period, grafts using young, sappy, new, active-growth scions were trialed. The scions chosen were about 20 to 25 mm long with all leaves except the top two and the growing tip removed. A simple "V" graft was made, cutting the rootstock piece down the centre and sharpening the scion piece to a "V" point. The graft was tied with 3-mm strips of grafting tape, cut for the occasion, and the whole graft covered with the humidified plastic cover. These green grafts were also successful, although some scions died back at the tip. Other scions were trialed using a scion section with the growing tip removed, these were more successful and the tip did not die back.

Chip Bud into Old Wood. Chip buds from 1-year-old scions were placed into old wood of apple limbs 5 to 7 year old. The chip buds grafted, but often remained dormant until the branch was cut back to the chip bud insertion point. In some cases, the injury caused by the cutting of the bark to insert the chip bud activated dormant buds on the tree branch.

Whole-Spur Grafts. Whole-spur systems, containing 3 to 5 spur buds were grafted onto 2- 3-year-old branch stubs using a whip and tongue or side whip and tongue method. The whole system and the graft were covered with a humidified plastic bag. These scions grafted and produced good fat flower buds on the spur system by the end of the following summer period.

Small Spurs. Small, one-spur systems were cut from the donor plant with a shield-shaped base. Some of these were placed into "T" cuts in the bark (as with budding), others were treated as a chip bud. They were tied to allow the actual spur to be uncovered and a plastic sleeve inserted over the graft area. Some grafts were also done without using the plastic bag coverings. Most of the one-spur grafts that were tried grafted very well.

Double Graft. Two different cultivar scions were joined together with a whip and tongue graft. These joined scions were then placed onto the rootstock using a whip and tongue graft. A plastic humidity cover was placed over the scion and graft area. Both grafts were successful and produced a short-spur system containing two varieties of apples. This system could probably be used to graft several varieties at once.

Scion/Rootstock Cuttings. For this trial a scion piece and a cutting from an above ground sucker of a rootstock were grafted together using a whip and tongue graft in late spring. The rootstock cuttings were wounded by removing a 20-mm bark strip from the cutting base and then treated with plant rooting hormone powder to initiate roots. The grafted cuttings were placed into a well drained propagation mix and individual plastic humidity covers placed over them.

All of these joined cuttings grafted well, many initiated roots on the rootstock and the result was a fully grown, grafted apple tree in one season. Field trials on this system were very limited and proper care and watering of the material was not carried out so many of the cuttings failed. Results show, however, that this system does work and will be a very useful method of producing saleable trees in one season.

Multiple Budding. Access to many heritage apple varieties was available at the orchard where the trial grafting was carried out. One rootstock-initiated tree in the orchard was cut back in spring 1994 and all the new growth on the tree budded with about 100 different cultivars of apple in February 1995. Most of the buds have grafted well and will eventually produce a tree with apples ripening at different times from January to June. This particular tree will also be used for short-course demonstrations and to preserve the rare heritage apples at the National Trust Orchard at Rippon Lea, Victoria, Australia.

Multiple Grafting. One rootstock tree at Rippon Lea was grafted with other heritage apple varieties and in spring 1994 over 100 separate grafts were done on the tree. Most of the scions grafted well and the tree will be used for demonstration purposes. Eventually this tree will have 300 to 500 different apples cultivars grafted to it. The idea of multi-grafting a single tree is ideal for home gardeners as it gives them a wide-ranging apple season and negates the need for pollinator trees.

DISCUSSION

The results discussed in this paper were from limited field trials sometimes carried out under less than ideal conditions. However the positive results from so few

experimental grafts suggests that humidified plastic covers to aid grafting are useful in difficult conditions, especially with apples (*Malus*). The ease in which grafting can be carried out using humidified plastic tent covers should enable the popularisation of this craft with home gardeners.

More efficient and effective grafting increases the gardening and production capacities of home gardens and plant nurseries. This paper suggests that modern techniques, such as plastic caps, can enhance time-tested traditional techniques.

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Quality Management for Nurseries

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INTRODUCTION

Quality management systems are here to stay. Most production and manufacturing industries have been progressing down this path for some time with positive results in productivity, profitability, and customer satisfaction.

Horticulture and agriculture, being out of the manufacturing mainstream, have not been exposed to quality management systems thinking or activity until relatively recent times. The individual or combined powers of compulsion, competition, and self-interest are now quite active and many horticultural businesses have responded to the message.

There are a number of options available to the nursery industry to capitalise on this trend. These range from basic knowledge and skills training to high-powered programs tailored to a specific business enterprise. In the middle are a range of quality management systems which endeavour to cover the key activities of a business, through a step-wise process to more complex systems. The latter includes support activities which ensure that the system not only performs, but is self-improving.

It is up to individual businesses in the nursery industry to evaluate the merit of quality management systems, decide which option best suits their needs or aspirations, and then implement the preferred option.

What is Quality? There are three main reasons for implementing quality management systems: compulsion, competition, and self-interest.

Some consumers are requesting that their suppliers have certification to a recognised quality system standard. A number of horticultural businesses have been requested by their export customers to have certification to AS/NZS ISO 9002. Some governments are moving the same way. This is not strictly a compulsion, but is necessary to ensure continued business with that customer.

It is widely believed that it costs five times more to win a significant new customer than to retain an existing one and so quality assurance is the obvious choice to protect your customer base.