Propagation Problems or Have You Tried This?©

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INTRODUCTION

Many of us have had plants that have basically said "tough; we are not going to let you propagate us." I have a saying that I use quite a lot "There is no such thing as a plant being impossible to propagate; it is only that we have not yet worked out how to do it. It is only a matter of time and patience, where there is a will there is usually a way."

I have been fortunate that through the 1970s I was involved in some basic propagation research when employed as a technician with the former Ministry of Agriculture and Fisheries (MAF) at the now-closed Levin Horticultural Research Centre (LHRC).This was a time when tissue culture was a new but still quite expensive tool in research. For more than half the time that I worked there I was responsible for the day-to-day running of the nuclear-stock unit, a plant quarantine unit that housed the National High Health (mainly virus free) berry-fruit collection. This included strawberries (*Fragaria*); boysen and logan berries (*Rubus* subgenus *Eubatus*); raspberries (*R. idaeus*); gooseberries (*Ribes uva-crispa*); black, red and white currants (*R. nigrum, R. rubrum*, and *R. sylvestre*); blueberries (*Vaccinium corymbosum, V. ashei,* and *V. angustifolium*), and other edible *Vaccinium* species. Other National High Health plants included grape (*Vitis vinifera*) and rose (*Rosa*) rootstocks. There were other groups of crop plants that were being used in production trials, such as hazel nuts (*Corylus*), elderberries (*Sambucus*), *Stauntonia*, and others.

I also carried out graft transmission virus testing of strawberries using a method that I developed that overcame the problems encountered with the older leaf petiole grafting method that had been the standard for many years. This new method involved approach grafting of stolons. The bioassay techniques used today were at that time only just being developed for these and other groups of plants. Although all these plants have some standard propagation methods that can be used, there are always species within a genus and cultivars/selections within a species that do not oblige and can pose challenges for us as propagators. I will relate some projects that I was involved in, that to the best of my knowledge have never been published and have relevance to the introduction to this paper.

HARDWOOD CUTTINGS FOR THE PRODUCTION OF PLANTS FOR MECHANICALLY HARVESTED CROPS

The use of low-cost hardwood cuttings of deciduous woody plants had at that time gone out of popularity for many of these plants in favour of the more controlled environment of the propagation house and softwood cuttings. With many plants there is a ratio between minimum hardwood cutting length and diameter (size) and the percentage of successfully rooted cuttings and the speed at which they grow away and reach useable size (retail, planting out).

Currants and Gooseberries. In the berry-fruit industry there had been some problems with cutting survival rates for hardwood cuttings being grown to produce plants for the mechanical harvesting of all the currants and gooseberries. These cuttings were being made 15–30 cm long, with the bottom half to two-thirds of the buds being removed in a similar way to that being used for rose rootstocks, so that plants could be grown on a single stem to allow the pick up skirts of the harvesting machines to catch the harvested fruit with the minimum of loss. When berry-fruit growers who also propagated their own replacement plants were asked about the timing of taking hardwood deciduous cuttings the usual answer was that it was done whenever it could be fitted in, even right up to bud break. It soon became evident that the cuttings were being blamed for poor rooting instead of looking at the physiology of root production and bud movement in relation to propagation date.

The longer the time period the hardwood cutting has to produce callus and then roots before the water and nutritional demands of the spring bud break occur, the more chance the cutting has to produce enough roots to support the growth of the buds and the new plant. Hardwood cuttings longer than the standard 15–30 cm length have more stored food in them and as a result usually have the ability to produce more and stronger roots, leading to better and more rapid establishment. Gooseberries and all the currants can be grown from softwood cuttings, but need the protection of a propagation unit of some sort and don't produce the single-stemmed type of plant required for mechanical harvesting. All of these plants will grow very well from hardwood cuttings taken at 30%–50% leaf fall and stuck in almost unprotected beds outside without a mist unit in sight. These beds were 1 m wide by 300 mm deep and filled with fresh *Pinus radiata* sawdust.

If the hardwood cuttings are taken at 30%–50% leaf fall, from well grown stock plants, it should be possible to make nonfeathered cuttings at least 40–50 cm long with the bottom half to one-third disbudded to reduce the chances of below ground suckering. As soon as possible after making the cuttings the remaining leaves should be cut off, leaving short stubs of petiole to drop off in their own time. If the leaves are stripped off there will usually be some bark stripping and other damage. Any such damage will use some of the stored water and food reserves in the cutting to produce callus and other repair tissue, which could reduce the ability of the cutting to produce enough roots before bud break. At the same time diseases could enter through the fresh wounds. The use of fresh *P. radiata* sawdust appears to assist many plants to produce good healthy callus and then roots. The chemicals that occur naturally in the wood of most pines appear to have a therapeutic effect and also have some disinfectant effect in preventing disease attacking the cutting preparation wounds and the developing callus.

As these types of cuttings are taken when there are still a number of leaves present it is important to prevent the remaining foliage from sucking all the water out of the cutting material. Like softwood cuttings this type of cutting material must be kept damp but not sodden and cool after removal from the stock plant. These cuttings were able to root at 90%–95% before spring bud movement and could be bagged up for sale or planted out. This was done as soon as green tip occurred. In some cases they were able to produce a small crop in the first year.

I also tried this technique of taking deciduous cuttings at early leaf fall with *Cotinus,* several maples (*Acer* species), and a number of other deciduous trees that were growing around the research centre. Although I left soon after this initial work was done, the results were encouraging enough to warrant further investigation. Results ranged from 20%–85% rooting as long as the cuttings were at least 8–10 mm in diameter at their bases and a minimum of 25–30 cm long. The use of bottom heat under outside beds is used by some propagators to help callus and root development.

Blueberries: *Vaccinium ashei, Vaccinium corymbosum*, and Hybrids. When I started working at LHRC in 1970, the standard way to propagate all blueberries was to use 5–15 cm hardwood cuttings, buried to their tips in the rooting medium. Rooting rates were from 5%–95% were very cultivar- and cutting-diameter dependent. At that time some nurserymen were using softwood cuttings with mixed results. Because we were doing fruit yield trials with all the cultivars that we had at that time and we did not have large numbers of plants to get cuttings from; any removal of softwood cuttings could have an effect on the next years crop yield. It was decided to continue with hardwood cuttings collected at pruning time and look at the selection and timing of cutting removal, cutting length, depth of sticking, and cold storage of cuttings to simulate winter chilling. From memory the best results were as follows.

1) Collect the cutting material at 50%–70% leaf fall. Use the least feathered current season's water-shoot type growths and the nonfruiting lower portions of growths that had just finished fruiting. Try to make the cuttings a minimum of 20–30 cm long with a base diameter of at least a pencil (7–10 mm) in thickness. Because the cuttings often have little taper, it is easy to lose the polarity of them. Although the buds are very small they each have a very small prickle on them that points to the tip of the cutting and can be just felt with your finger. Each cutting should have a shallow double wound about 1 cm long and dipped in Seradix 3™ (Bayer Crop Science) (4-indol-3-butyric acid). Deep wounds will rot the cutting base from the inside later in the year.
2) Wrap the cuttings (all with the correct polarity) in bundles in damp newspaper, put them in sealed plastic bags, and store standing right way up in a refrigerator (not a freezer) set as cold as possible (but no lower than 0.5–1.0 °C) for 4 weeks.
3) Use an outdoor propagation bed in a sheltered area under shade cloth with a mist system set to operate for 1 min every hour only during the day. Stick the cuttings no more than 10 cm deep. Straight *P. radiata* sawdust or sawdust and peat moss (1 : 1, v/v) worked equally well.
4) The cuttings will usually develop a good root system by the time bud break occurs. Sticking the cuttings into individual propagation tubes instead of community trays/pots means the cuttings can be potted on earlier without damaging the very fine root system that the cuttings initially form, they can then be potted on as soon as roots show at the bottom of the propagation tubes. Growth rates appear to be cultivar dependent, with some of the larger cuttings of stronger growing selections making enough growth to produce a small crop of fruit the following year.

Another system that we looked at was the production of much larger rooted plants that could be field planted direct from a stool bed. This stool bed was prepared in the following way:

> Well established potted rooted cuttings were planted 50 cm apart along the centre of an 80-cm-wide, rotary-hoed strip of previously weed-sprayed ground. The crown of each plant set so that it was about 5 cm deep in the bottom of a shallow hole, and left to start growing normally.
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> When the plants and shoots averaged 30 cm tall, 15 cm × 2.5 cm (6 inch × 1 inch) boards were then set up on their edges with a supporting wooden peg every metre (not nailed) on either side of the row of plants to form a bed 60 cm wide. Then a supplementary dressing of blood and bone fertiliser and superphosphate was spread along and between the rows of plants. This bed was then filled with fresh *P. radiata* sawdust to the top of the boards, the sawdust was also worked into and through the plants, it was then given a good watering to settle the sawdust in and around the shoots, more sawdust was applied and watered until the sawdust was level with top of the boards. This would need a further top up due to settling after about 1 month and then left until leaf fall was nearly finished. In this first year most of the shoots would produce some roots from the sections of the stems with light excluded by the sawdust.
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> At leaf fall the boards and pegs were removed. A well sharpened chainsaw with an 80-cm blade was used to make a cut along the surface of the soil to cut all the shoots off the plants. There was some damage to the base of the shoots/canes from this method of removal, if this was a problem a good heavy duty pair of loppers was used although it was slower.
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> The shoots were then carefully teased apart while shaking off any loose sawdust. This is to avoid doing too much damage to the fine roots that have developed on the shoot/cane bases. The roots must not be allowed to dry out before the rooted stool shoots/canes are planted out. In the second and subsequent year the rooted shoots/canes produced by the stools will often be strong enough to produce flowers and give a light crop of fruit in their first year after being planted out. The success of this method is cultivar dependent and is possibly due to the ability of the sawdust covered shoot bases to develop roots when light deprived by being covered by the sawdust. Any sawdust left in the rows was simply raked out to form a mulch about 10 cm thick over the recently cut stools. Once the stools have resprouted to about 20 cm the board edging to the bed is re-erected, fresh sawdust was then reapplied as for Year 1. Before the fresh sawdust is put on to reform the stool bed some more fertiliser must be applied.

An interesting observation made at that time was that in the process of some early tissue culture of blueberries a batch of *V. ashei* cultures were left in culture too long and started shedding basal leaves. In the culture flasks these plantlets produced leaves that were heavily lobed around their margins, when they fell on the agar they behaved like *Kalanchoe* (syn. *Bryophyllum*) leaves in that plantlets formed in each of the lobe notches, these could be excised and grown on like normal culture plantlets.

STRAWBERRIES AND SERPENTINE LAYERING

There was a requirement for strawberry plants being grown in quarantine for virus testing to have any runner plantlet production isolated from the parent plant. To do this the parent plant was grown in a pot on a bench in the glasshouse. There were metal racks that would hold a number of small pots about 30 cm above the potted parent plant. As runners were produced they were threaded up through the drainage holes in the bottom of the pots and left there until the plantlets started to form; at that stage the pots were filled with potting mix and the runner pulled back down so that the new plantlets were touching the surface of the mix in the pots. Here the plantlets would root into the small pots and could be cut off the parent plants at the bottom of the pots after a couple of weeks. The important thing here was that the plantlets could be established in pots above the parent plants and reduce the risk of any splash contamination of fungal diseases from the parent plants.

This was in fact a form of serpentine layering, a technique that is sometimes practised with *Clematis* and other climbers that can be notoriously difficult to root from cuttings. Here the growths are usually pegged down at their nodes to form roots, the system I used avoided the use of pegs and almost eliminated the risk of snapping the stems when they are being pegged down. I tried this method with *C. paniculata* and *Stauntonia heterophylla* where the growing point of a shoot was simply threaded up through the bottom of the pots in succession. As the nodes developed leaves they were pulled back down into the pots, which were then filled with potting mix. It worked very well and gave me plants that established in small pots quite rapidly. Once the plants were well rooted they could be cut apart and potted on without much root disturbance. I think this method could be tried for any climber that is difficult to root from cuttings since the racks of pots do not need to be in a glasshouse and could be set up where the stock plant is growing.

HAZEL NUTS AND WITCH HAZEL

A number of *Corylus* cultivars were imported from Europe and arrived as just sprouted hardwood cuttings (due to delivery delays) at the end of March (early autumn), which created a few problems since they had to be grown in quarantine for at least two growing seasons. Because they had sprouted, I could not put them into normal cold storage. After the standard insecticide/fungicide dip, they were put into a refrigerator set at 2–4 °C with a light in it that was on all the time; this was an attempt to get some chlorophyll development under way because the sprouting had started in the packaging they arrived in and the shoots were very chlorotic. So I had to come up with some way of propagating them before they died.

At that time of year rootstocks would be starting to prepare for autumn leaf drop. By ringing around I was able to locate some seedling hazelnut liners that were still in growth. These liners had to brought into the quarantine facility where

I was going to try and do some form of grafting or budding. This meant that all the soil/potting mix had to be removed, the liners dipped in an insecticide/fungicide mix and then repotted in sterile potting mix. Once potted, any autumn effect already under way had to be reversed; the liners were put in a mist/high humidity tent with the bottom heat set to 26 °C and given 18 h of light each day. The sprouts were very fragile so I tried both tip and side (chip) grafts, tip grafting with the longest sprouts and chip budding with the shortest ones. Nearly all the grafts failed, but sufficient chip buds survived to give us at least two plants of each cultivar. The next challenge was to get the cultivars onto their own roots so that they could be stooled. I kept the plants growing in the propagation tent until they had made a minimum growth of three leaves and then reduced heat and light levels to allow them to go dormant. In the spring the grafted plants were put in a warm glasshouse. Most of the buds broke on all the cultivars and started to produce lateral shoots as well as terminal ones. I used all the lateral shoots and later the terminal ones once the plants reached 30–50 cm in height. Cuttings were made from shoots that had developed a minimum of four leaves and had a fully developed bud in the axil of the terminal leaf.

The lowest node and leaf of each shoot was left on the stock plant to encourage further shoot production. Cuttings were prepared by removing the lowest leaf and bud and reducing the remaining leaves by half, dipped in Seradix 2™ (Bayer Crop Science) (4-indol-3-ylbutyric acid) and stuck in fine pumice. They were placed in a mist/high humidity tent with 18-h light supplied by one red and two cool white fluorescent tubes. Rooting was quite rapid in most cases (this was the easy bit!), and I found that cuttings taken late in the season would root easily enough, but unless they developed at least a two-leaf extension growth with a mature terminal bud before going dormant they would not sprout the next spring. Cuttings made before the longest day had the greatest survival rate with a rapid fall off for any cuttings made after the end of January (mid-summer).

I was asked to have a quick look at the possibility of trying this cutting technique for *Hamamelis*, which worked quite well on the cultivars that were growing in the station grounds, but I found that the cuttings needed to have at least five leaves/nodes and with a mature terminal bud.

PROPAGATION OF NOTORIOUSLY DIFFICULT PLANTS WITH DENSELY HAIRY LEAVES AND STEMS

Leucadendron argenteum. This plant appeared to have a reputation for being difficult to grow from cuttings, so the only plants available or being sold were seedlings, which meant that one had to wait a number of years to see the flowering cones followed by the very decorative tassel-like seeds hanging from them. People who had tried to get cuttings to root would say that the cuttings would go black and die rapidly under mist and especially if the propagation house temperatures got above 25 °C. Even hardwood cuttings that were direct stuck in field beds had a very poor survival rate. I tried to emulate the existing routine for cutting production; this meant that the cuttings were put through a fungicide/insecticide dip before they were stuck. Doing this I too killed nearly all the cuttings. I then had a look at the dip and each ingredient, and found that the two pesticides combined, or each on their own and with no added wetting agent did not kill all the cuttings straight away. Commercial formulations often have some form of wetting agent already in them. I tried several different wetting agents individually and in each case killed every cutting in about 5 days from dipping. It appeared that the wetting agents destroyed the natural water repellence of the dense hairs/indumentum, which then becomes waterlogged and drowns the cuttings as the stomata cannot allow air exchange. To this end I query the need for dipping all cutting material if the regular spraying of stock plants is properly carried out. Also in nature most diseases usually only attack stressed plants, I think that this also has a lot to do with the natural microflora that live symbiotically on all plants and help to keep them healthy. I tried making cuttings of a number of other plants that are densely hairy and found that they also don't really need any insecticide/fungicide dipping to be rooted successfully.

SUMMARY

I feel that we should take another look at the following:

- The use of deciduous hardwood cuttings for a number of species, including when cuttings are taken and the length of cutting used. A preliminary check should be done first before large numbers of cuttings are made.
- Modified serpentine layering should be considered for difficult-to-root climbers.
- Stool bed production of species, such as blueberries, where low to medium numbers of large-grade liners are required.
- The importance of maturity of the terminal buds in rooted softwood cuttings of *Corylus* and *Hamamelis* going into autumn to enable survival the following spring.
- Try to avoid insecticide/fungicide dipping of cuttings of plants with a lot of indumentum to reduce cutting death by drowning.