REFERENCES

Nowak T. J., W. Gawryś, and **J. Marcinkowski.** 2000. Index plantarum of outdoors cultivated herbaceous plants in Poland. Prace Ogrodu Botanicznego Uniwersytetu Wrocławskiego, 6:5-399.

Refining Root Propagation Techniques©

Paul Howling

Howard Nurseries Ltd, Wortham, Diss, Norfolk IP22 1PX

INTRODUCTION

As a leading producer of herbaceous perennials in the U.K., Howard Nurseries Ltd. (formerly Howard and Kooij's Nurseries) has always used root cuttings as one of the principle means of propagation. Many herbaceous genera lend themselves to propagation from roots. Commercially, root cuttings are a low-tech solution, capable of giving speedy increases in numbers with much less hassle than many propagators assume. Even highly skilled propagators who visit our nursery appear to regard propagation from roots with an air of muck and mysticism. In fact it is a very simple and effective technique if managed properly.

Recent years have seen many changes to propagation systems. Open-ground and low-tunnel systems have given way to glasshouses; mist and bottom heat have been joined by tissue culture; modular trays have replaced seed flats and boxes. At Howard Nurseries Ltd., techniques for production from root cuttings have been adapted in accordance with these trends. This paper reviews some of these developments both in general terms and applied to specific crops. Improvements in handling and preparation of land will also be shown to improve the final product. Equally an ability to examine old ideas, such as storage of cuttings, and to fit them into the modern system has been crucial to the nursery's present success with this means of propagation.

BENEFITS OF PROPAGATING FROM ROOT CUTTINGS

For the earliest horticulturists, the potential of some roots as propagation material must have soon been apparent. If a gardener tries to transplant subjects such as *Papaver* and *Phlox*, broken roots frequently regenerate into plants on the old site. Other genera such as *Macleaya* and *Anemone* already have visible buds on their roots. Many plants on commercial herbaceous production nurseries are candidates for propagation from roots. The following is at list of those genera for which the technique is currently used at Howard Nurseries: *Acanthus, Catananche, Echinops, Phlox, Anchusa, Centaurea, Eryngium, Physalis, Anemone, Cichorium, Geranium, Pulmonaria, Bergenia, Crambe, Macleaya, Stokesia, Brunnera, Cynoglossum, Papaver,* and *Verbascum.*

Commercially there are several justifications:

- It is a form of vegetative propagation so named cultivars can be maintained true to type. There are some exceptions, for example if the cultivar is variegated.
- The technique utilises the capacity of some genera to regenerate shoots from roots, either from existing buds or from callused wounds. Typically these roots are 'fleshy' rather than 'wiry'.

- It can be a cheap, low-tech solution.
- Unskilled labour can be easily trained to perform the task effectively.
- Propagation work can be scheduled for periods of the year when the nursery is less busy. Propagation facilities are more effectively utilised in winter. It can be a bad-weather task. Labour is then available for making tip, stem, and heel cuttings or carrying out other nursery tasks in busy periods during spring and early summer.
- Young plants may be rooted and weaned earlier in the year than from spring shoot cuttings.
- The techniques can readily be adapted to batch production.
- Yield and take rates can be high giving rapid multiplication.
- Certain pests and diseases can be eliminated, such as stem nematodes in *Phlox*.

ROOT CUTTINGS IN COMMERCIAL PRACTICE

When root propagation is mentioned in textbooks it can be hard to relate the advice given to commercially appropriate practice. For example, methods which consist of chopping up roots and scattering them horizontally across the surface of a seed tray would yield many shoots but the result could well be a tangled mess, with shoots of uneven size and the risk of considerable damage when separating the cuttings.

Polarity of Root Cuttings. Always retain the polarity of the root, storing and inserting the cuttings vertically whenever possible. The root has a "memory", probably based on hormonal gradients, of what was its proximal end (nearest the base of the plant) and what was its distal (furthest) end. Shoots will emerge from the proximal end even if cuttings are inserted upside down. However on very small cuttings the gradient may be lost and shoots arise from either end. Textbooks will advise a straight cut at the proximal end and a slanting cut at the distal end. This wastes time and material. Howard Nurseries uses a handling system whereby the cutting is either stored upright in its correct orientation or laying on its side with the top adjacent to the side of the box or tray.

Occasionally it is necessary to store unprepared roots for extended periods horizontally in boxes and you should then expect hormonal gradients to be lost and more variable shoot formation to result. The nursery has adapted its storage techniques accordingly, as described later.

MODERN SYSTEMS FOR ROOT CUTTINGS

Howard Nurseries has refined its root propagation techniques to take into account two major policy decisions affecting handling and land preparation.

The Original System. This was based on plastic boxes lined with newspaper and filled with a mix of sand with 10% to 15% perlite added. Cuttings were about pencil thick, 5 cm long, and stood up in rows, about 250 to 300 per box. The medium worked for most genera but some performed better with a proportion of peat added. The sand gave physical support to the cuttings but the nutrients came from within the cutting. Bottom heat was necessary for some genera but air temperatures were maintained on the cool side to obtain compact, hard, shoot growth.

The sand retained sufficient moisture but also drained freely so reducing losses due to rotting. For those subjects which were propagated in a part-peat medium the propagator had to be aware of the possibility of moisture collecting on the callused areas.

When potting or moving the plants on to the field, knocking out was quick and easy with little damage. But as the cuttings then effectively become bare-root transplants, they did not store well. Similarly, the time that cuttings could be held in the sand was limited so weather delays could be a big problem. *Papaver* and *Crambe* are examples of crops with poor shelf life. Propagation in boxes would typically be done under glass in January to March with weaning in polytunnels ready for planting or potting in April or May.

Phlox was one genus propagated using a more basic system. In this case the root cuttings were 5 cm long, pencil-lead thick, taken in December, and stood up in outdoor nursery beds, usually following methyl-bromide sterilisation of the soil. The plants grew in their nursery beds for a year and were then lifted and lined out in the field in February to March of the 2nd year. Again the problem was handling bare-root transplants that needed to be teased apart and handled without delay. However the result was excellent young plants after 2 years.

The Modified System. The change was made because the nursery had been shifting its seed, basal, and soft cuttings propagation into modular trays and wished to standardise handling on 150-unit trays. In practice some 104- or 77-unit trays are also used. The rooting medium is peat and perlite with Mini Osmocote and Intercept as necessary.

Using modular trays for root cuttings simplifies propagation management and results in the following advantages:

- Consistency of results.
- Ease of handling at potting or planting.
- Reduced transplant shock plus better shelf life in the tray and after the rooted cutting has been knocked out.
- Smaller cuttings can be used which means less material is required.
- Strong young plants drawing new root, especially if fed (liquid or controlled release fertiliser).

The transition to modules was very smooth for some genera, notably *Anchusa*. In *Crambe* the result was a valuable extension in "shelf-life" of the rooted cutting so transplant timing became less critical.

If using modular trays one thing to look out for is root coiling which can be a problem, for example on *Eryngium*, if plants have to be held in the modules for an excessive period.

At Howard Nurseries a foot-operated de-plugging machine is used to extract modules. Root cuttings are the most problematic to handle with this machine. Trays should be well watered before de-plugging, as well wetted plugs release easily and the plants have moisture to carry them through transplanting. However, some cuttings do not form the necessary fibrous root system and these may have to be extracted manually — and there is also the risk of these plugs falling apart. *Echinops* are a good example of this, performing so poorly in module trays that they are still propagated in sand boxes.

Cuttings are now smaller to fit the modules, about 2.5 cm long. This means that small size variations in the cuttings can affect the uniformity of the crop. In flat-growing genera such as *Verbascum* the first shoots up can swamp later cuttings.

The solution to obtaining a uniform take in modules for the more troublesome genera came more by accident than design. A very wet winter and problems with

the sterilised outdoor beds meant *Phlox* cuttings had to be stored in damp peat until conditions were suitable. It was noticed that these cuttings had callused uniformly. Most were still lined out but some went into modular trays. These proved good for potting on and when the modules were planted out, gave a saleable plant in just 1year. All *Phlox* are now grown via modules both for the field and as a promising 9-cm crop with no need for expensive or dangerous soil sterilisation.

Storage of Unrooted Cuttings. Storage of prepared cuttings in bundles in the sand and perlite mix has proved to be advantageous for several taxa. The cuttings callus in storage, which saves glasshouse space. In addition the callused cuttings can be graded as they are inserted into the modules to give even and high take trays. Material can be taken in succession from store to give batch production, especially useful for selling pots in flower or bud.

A period of storage can be of benefit to unprepared material, too. For example, *Verbascum* and *Papaver* both suffer less from bleeding after a period of storage. So now, depending on the genera, we choose from the following strategies (see Fig 1):

- Obtain, prepare, and insert directly.
- Obtain, store, prepare, and insert.
- Obtain, store, prepare, store as bundle of cuttings, and insert when callused.

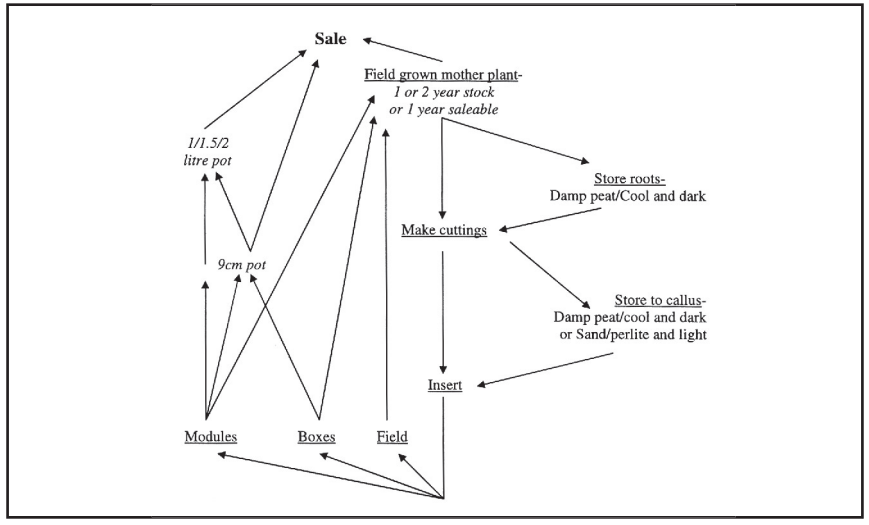

Figure 1. Options in the growing cycle.

Soil management. Originally ex-cereal land at Howard Nurseries was prepared for planting by sub-soiling, mucking, and ploughing over winter. To enable machine planting in spring, soil was broken down using spring-tines and a power harrow. However, the power harrow was damaging the soil structure and causing a tendency to pan in the root zone which in turn led to roots following the remaining weak points in the soil — often the shear line — giving some unbalanced root systems. The initial cure was to replace the power harrow with a rotarer on a bed system. The nursery has also acquired a shakerator (a vibrating subsoiler) and built a bed maker for use in damper conditions.

Ex-cereal land is now prepared using the shakerator in the autumn at right angles to the bed line. This is followed by muck spreading, ploughing over winter, use of the shakerator again in the spring to form the beds and, finally, finishing the soil with the rotarer or the bed maker.

The current treatment results in a better-structured soil, balanced and straight roots, improved drainage, and quicker restarts to planting after irrigation or rain. It is noticeably easier to dig plants by hand, one person being able to handle a large *Crambe* without risk of breaking the crown, rather than the two people previously needed.

FUTURE DEVELOPMENTS AND OPPORTUNITIES

The current techniques, as described, result in some excellent crops of herbaceous perennials from root cuttings but developments are on-going. Improvements must be monitored by collecting data on take rates and establishment percentages. At Howard Nurseries harsh measurements are used: to qualify as a rooted cutting material must have fully developed shoots and roots and be able to withstand transplanting by machine. Establishment is measured in terms of the number of saleable plants produced.

Simple observations contribute to success. The results of rabbit damage revealed that trimming back flowers can be beneficial in forming crowns on *Anchusa* and *Cichorium* so these crops are now mown or trimmed using a tractor-mounted rotary cutter.

Modules have created new markets. For example it is now possible to batch-crop for a succession of plants in flower. There is also new business in selling on the rooted cuttings to other producers. Module-raised rooted cuttings also have potential for sale to landscapers undertaking “prairie plantings”.

The nursery makes increasing use of root cuttings out of the normal December to March season. Many of the field- grown plants are containerised in 2-litre or larger sizes or may be sold to other producers as stock material or even to landscapers for planting directly in landscaping schemes.

ADDITIONAL READING

Crosland, P. 1988. Propagation of *Papaver* by root cuttings. Comb. Proc. Intl. Plant Prop. Soc. 38:300-301.

Howling, P. 1995. Using the opportunities for *Geranium* propagation. Comb. Proc. Intl. Plant Prop. Soc. Vol 45:172-176.