

of planting out of season. These are better soil conditions, instant impact, better establishment, ease of handling, and no failures

## CONCLUSION

The market for semi-mature trees is well established but people still associate tree planting with the dormant season. There is a lot of work to be done to market the concept of year round planting but I believe that over the next few years more trees will be planted "out of season".

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# Ten Years' Experience of Grafting Using the Hot-Pipe Callusing Technique®

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## INTRODUCTION

During the past 10 years hot-pipe callusing has been used and developed as an integral part of the production system at Coilóg Nurseries. The details outlined in this paper are the principles of propagation using the system as we have experienced it during that time.

The system is not the answer to your entire bench-grafting problems. However it has helped us to streamline and organise production. It has also reduced the number of failures in the grafting programme.

## MAXIMISING THE BENEFITS FROM HOT-PIPE CALLUSING

The technique provides each new graft with the environmental conditions most favourable to callus formation. The objective is to direct heat to the point of union, while maintaining a cold atmosphere at the root and at the remainder of the scion. The system needs to be viewed in the context of overall production and it is important to ensure all the preceding and following production procedures are undertaken according to best practice:

- Selection of compatible rootstock and scion.
- Selection of correct strength of rootstock.
- Treatment and preparation of rootstock.
- Timing of the grafting process.
- Selection of good quality scion wood.
- Preparation of the scion wood.
- Use of fungicides in the grafting process where necessary.
- Use of a high-quality wax and perfectionism in the waxing process leaving no exposed surfaces, no pinholes at the graft union and all tips covered in wax.
- Employment of skilled staff who are capable of using a grafting knife with competence, accurately matching cambium layers, tying effectively and carrying out the work to a high standard at an economical speed.

- A well thought out handling system for preparation, bench work, waxing, and heeling in.

Hot-pipe callusing is not worth perusing unless you attend to these points.

## ADVANTAGES AND DISADVANTAGES OF HOT-PIPE CALLUSING

### Advantages:

- Easier production with standardisation leading to potential of improved scheduling.
- Increases the speed of callusing.
- Increases percentage of takes especially with more difficult species.
- Grafting of species out of season, e.g., *Carpinus*, *Acer palmatum* cultivars, etc. during less busy periods.
- Eliminates the need to pre-pot rootstocks.
- Increases rate of onward growth because of the strong-callused union formed.

### Disadvantages:

- Capital outlay to establish the system.
- Increases heating cost during production and requires maintenance.
- Requires more handling, therefore increases labour costs.
- Requires dedicated space and although permanently set-up is only used for a small part of the year.
- Accurate temperature control required and continuous monitoring of the system needed.
- Specialist staff training will be needed.

## PREPARATION AND GRAFTING

**Rootstock Preparation.** The pre-graft handling of the rootstock is one of the most influential factors in the success of the new plant and its importance should not be underestimated.

It is essential that rootstocks be dried down under controlled conditions to prevent drying out. When using bought-in rootstocks they should be heeled into well-drained sand as soon as they arrive at the nursery. They are then moved into a controlled environment — we use peat beds in a polythene tunnel — where they remain for 3 weeks. The object is to reduce the level of available surplus moisture. This is important because in the hot-pipe technique the local application of heat to the point of union attracts moisture.

Trimming away excess roots stimulates new root activity and efficient growing on. It also makes potting easier. We grade all the rootstocks we use to 6-10 mm girth at the point of union.

**Scion Preparation.** Scion wood should only be sourced from virus-free stock. Ensure the varieties are true to name and from vigorous mother stock.

Take precautions to prevent scion material from drying out or over heating. Cold storage helps maintain scion wood in good condition. Scions should be stored in sealed bags at 1 to 2 °C after treatment with a protective fungicide.

**Grafting.** At Coilóg Nursery, we begin grafting in early January and continue to the first week in April. Most of our grafting is by a simple whip graft made with a

cut 25 to 50 mm long. Depending on the species, the scion is prepared using 3 or 4 buds, dipped in a fungicide and allowed to dry off for 1 or 2 min and then joined to the rootstock, leaving a "church window" between the scion and rootstock. The graft is tied using 3-mm tying bands 75 mm long.

In cases where the scion is considerably lighter than the rootstock we use a side graft. The usual principles of matching cambium layers, selecting similar sized rootstock and scion apply. Tying with sufficient pressure is necessary to ensure cell differentiation.

When waxing, the graft is immersed into the wax to a depth of 25 mm below the union. The seal is checked for pinholes at the point of union and at the tip. The scion is then dipped into cold water to seal the wax. The wax, which contains a fungicide and growth hormone, is kept liquid at 70 °C. Between three and five scions can be dipped at one time. The wax breaks down quickly, avoiding the unsightly appearance of the resin type sealants.

After waxing, the grafts are placed in the hot-pipe apparatus for 18 to 21 days. The new plants are stored in crates before potting up, after callusing.

It is important to handle the new grafts carefully, as the union is very fragile and callus formation begins as soon as the cambium layers of rootstock and scion have been brought together. Any damage to the new graft at this stage, for example disturbing the line of the cambium layers before or during tying, cannot be rectified.

Heat at the point of union stimulates callus formation, while keeping them cold prevents growth of roots or shoots. There is a danger that the heat generated by the pipe will "leak" and cause premature growth of the buds and the scion. To overcome this we use longer scion wood and remove the lower buds, so putting distance between the buds of the new plant and the source of heat to reduce the risk of premature bud break. The air temperature is kept low and the roots are plunged into dry peat, to avoid drying out.

## APPARATUS

Harry B. Lagarstadt of the National Clonal Germplasm Repository, Oregon, originally developed hot-pipe callusing. His system used soil-warming cable strapped to a small diameter pipe, running inside a larger pipe. Heat from the cable warms the air in the large pipe. Slots in the large pipe accommodate the graft unions.

We use a modified version of the system. Our outer pipe is a 50-mm diameter PVC duct, laid horizontally and with the top third of the circumference removed. Inside the duct is a 10-mm PVC pipe, which carries heated water, which heats the air in the outer duct to 20 °C. The outer duct is insulated. The grafted plant is laid on the duct so that the graft union only is exposed to the heat. Hot water is circulated continually from January to April.

The system is established indoors. This reduces the risk of cold damage to the exposed parts of the new plant and allows greater control over moisture levels. It also means a more comfortable working environment for staff.