N. CLAYTON: Do you use wax when you bind with rubber ties?

P. BRADLEY: No, we just bury grafts in peat.

BENCH GRAFTING METHODS AT CROWDER'S NURSERIES

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GRAFTING FACILITIES

We have four grafting benches, each 45 ft long and 6 ft wide and having 9 in high wooden sides. These benches are supported by small 2 ft 9 in high walls, made of concrete blocks. The floor of the benches consists of corrugated zinc sheets covered by a layer of polystyrene for insulation. On top of the polystyrene there is a layer of sand in which we have soil warming cables embedded. Only three benches have bottom heat.

Each bench is covered by a 3 ft high polythene tent with lift up sides. These benches are housed in a double span greenhouse, two benches each side.

Across the roof and partly down the sides of the greenhouse we have a movable Netlon type shading. This shading was stitched by a sheet maker and is made to measure fit. It is held in place by wire and can be easily slid to the sides when not in use.

Also three tunnel houses are available, measuring 50 ft by 14 ft. These are used by the propagators in summer and have soil warming cables in them if we need them.

ROOTSTOCKS

We use mostly pot-grown rootstocks and have two methods of obtaining them.

First method: One year seedlings are graded in February or March from our own seed beds, or they are bought-in transplants for machine planting. These are cold-stored then potted when time allows. They are ready for grafting the following spring. Examples of genera whose rootstocks are handled this way are *Fagus*, *Prunus*, *Robinia*, *Picea*, and *Chamaecyparis*. For *Picea* and *Chamaecyparis* we would probably use two-year-old seedlings, or 1+1.

Second method: These rootstocks are bought in ready for grafting. They have been grown from seedlings propagated in seed trays and then pricked out into pots. Examples are *Betula*

spp., *Cupressus macrocarpa*, and *Syringa vulgaris*. We bare-root graft *Hibiscus* and sometimes *Prunus* and *Robinia* species. The pot size we use is usually either 3-in (7.5 cm) plastic or 4 in (10 cm) plastic long toms.

TREATMENT PRIOR TO GRAFTING

About six weeks before grafting the rootstocks are brought indoors to dry out. This helps to prevent flooding of the union in plants such as *Betula*. The greenhouse is washed out with a power wash and then disinfected.

GRAFTING TIMES

We graft from mid-January to the end of March. *Fagus* plants are the first to be grafted, then the *Betula* and the conifer plants. After this we try to graft the cultivars that come into leaf early.

GENERAL HYGIENE

All grafting operations have to be carried out in clean conditions. The pots and any parts of the rootstock which are to be cut are rubbed with a clean cloth if they are dirty. As a disease precaution and to keep knives clean, especially when grafting conifers, they are dipped in methylated spirits.

ROOTSTOCK AND SCION SELECTION

For good results we need healthy, strong rootstocks with a good root system. The scion material should be last season's growth, disease-free, and selected from the best plants. It should be firm and plump, not weak and straggly.

Scion material from such evergreens as *Picea* is taken, if possible, only from the terminal shoots. These grow better and retain the truer shape of the parent than would scions taken from lateral shoots.

TYPES OF GRAFT USED

We use two types of graft. One is what many people now call the modified whip graft, where the rootstock is cut down to about 2 or 3 in (5 to 8 cm) from the soil. We then make a cut about 1½ to 2 in (3.5 to 5 cm) long down the side of the rootstock. This cut can be longer if the scion and rootstock are quite thick. At the bottom of this cut we make a nick. On the scion we make one long cut on one side (behind a bud) and a short cut on the other side at the bottom to fit into the nick of the rootstock.

Like other types of grafting, it is necessary that the cambium layers on the scion and rootstock match each other when

tied. This may mean putting the scion on one side only if the rootstock is thick and the scion thin.

When the graft is tied a small portion of the cut on the scion should project up above the rootstock top. This portion then heals together with the rootstock top helping to make a strong union and preventing dieback of the rootstock top. Do not leave too much of this cut showing through as it may weaken the graft at this point. Some people call this cut the "church window" because that is what it looks like.

The second type of graft is the side-veneer graft; it is used on conifers but can also be used on deciduous plants. With this graft remove only a third of the rootstock to start with, then clear the bottom branches. A cut about 2 in (5 cm) long is then made as near to the bottom as possible. At the bottom of this cut a small nick is made. It is easier to make the small cut (the nick) first. The scion has one long cut on one side and a small cut at the bottom on the other side.

After about five weeks half of the remaining rootstock above the graft is removed. Around five weeks later the rootstock can be cut down to the graft union. This last piece of rootstock can remain for longer if the union is not that strong or if the scion has not made much growth.

TYING MATERIAL

We use ½ in (13 mm) wide polythene grafting tape; 1 in (26 mm) wide tape is sometimes used for thick stocks and scions. We use Arbrex to protect exposed cut surfaces on the rootstock and scion. We hope in the future to try rubber strips and paraffin wax. Polythene tape seems good for conifer and *Fagus* grafts but rubber strips may be better for *Betula* because the callus can expand easier and make a stronger union.

SUBSEQUENT TREATMENT

After grafting, the plants are stood out in the benches and labelled. The air temperature in the glasshouse is set at 40° to 50°F (5° to 10°C) depending on the species. Soil warming cables are set at 50° to 55°F (10° to 13°C). Each morning the polythene sides of the tent are lifted up for 2 or 3 hours to dry off the condensation. Sometimes the sides are left up longer if we want the plants to grow slower. On warm days the greenhouse is ventilated and shaded. The benches are sprayed over with cool water, especially the ones containing conifers.

WATERING

To start with the grafts are kept fairly dry, with only spot watering of the odd pot that dries out. We test how moist the

grafts are by lifting them out of their pots from time to time. This way we can make sure they do not dry out too much.

PEST CONTROL

As a precaution against diseases like *Botrytis*, we spray the grafts every 10 to 14 days with a fungicide. Usually we alternate with Benlate (benomyl) and Rovral (containing Iprodine). Both of these are applied at 1 gram in 1 litre of water. Each bench is sprayed from both sides so that the spray makes contact all around the graft. We spray with Malathion to eradicate greenfly, whitefly, etc. If we are troubled with caterpillars we use Fenitrothion. Slugs, which seem to appear every year, are destroyed with Draza G micropellets (containing Methiocarb).

TIE REMOVAL

The ties are removed either when they are just starting to cut in as the rootstock and scion swell, or when the grafts have made quite a bit of growth and they have callused well.

N. DUNN: Does Arbrex inhibit callusing?

R. THURLOW: We only paint the cut surfaces to protect from fungus. We get a 90% take.

B. HUMPHREY: The fungicide in Arbrex inhibits callus. Hilliers use Bituproof 3, which appears to be quite satisfactory.

C. LANE: Arbrex dries from the outside inwards and this can mean a mess seeping around the union. We use hot wax that dries immediately on contact.

P. GAUT: Has anyone used Mildothane canker paint?

B. HUMPHREY: We used it in the past but it is more expensive than some others.

J. GAGGINI: We use petroleum jelly and have no problems. We wipe it on with the finger and it is perfectly adequate in reducing transpiration from cut surfaces.

P. BINGHAM: Do you have any tips on keeping the knife clean?

D. HATCH: I use surgical spirit on a cloth to wipe the knife, and then wipe the knife on a piece of wood to avoid contamination.

B. HUMPHREY: We use methylated spirits and have no problems, although we don't wipe it off.

J. EDGEBY: An observation, at Writtle we use wallpaper paste with IBA to paint cuts and add a fungicide such as Mildothane.