

Freight to London Airport and the supplier always treats complaints sympathetically. There is duty to be paid which is between $\frac{1}{5}$ and $\frac{1}{6}$ of the quoted price, and there is delivery and dispersement from the airport to you. I always collect at the airport, however, as I then know there is a minimum delay before the plants are obtained.

PROPAGATION OF CONIFERS BY CUTTINGS AND GRAFTING

ANTON THOMSEN

Thomsens Planteskole
9200 Aalborg SV
Denmark

PROPAGATION BY CUTTINGS

Propagation of conifers by cuttings is the most common method used, but there are usually several different ways of treating cuttings of the same cultivar. More than once I have seen another nursery propagating a cultivar which we find difficult; they tell me how they do it, I go home and do exactly what they told me using the same peat, same hormones, at the same time and everything, but still I don't achieve the results as they do.

We have almost all our cuttings in our propagating glasshouse which is 20×61 m and made of aluminum. All the cuttings are inserted in plastic flats 30×60 cm with holes in the bottom so the compost can be in direct contact with the sand on the floor of the glasshouse. That way the capillary system can work so the compost does not get too wet. This also means that the flats are the furthest practical distance from the mistlines so the mist can cover the cuttings with the required minimum of water, in just a few seconds.

Almost all cuttings are inserted in a layer of sand with a low pH, about $1\frac{1}{2}$ cm thick, upon a layer of peat mixed with a little sand in order to make it easier to separate the cuttings when they are lifted. A few years ago we used pure peat much more, but we feel that our results justify the greater effort of putting 2 separate media in the same flat; now we only use pure peat for a few cultivars.

We have plastic pipes 25 cm underground and 50 cm apart to heat the soil to 22°C in the summer and down to 12°C in the winter. During the winter we try to keep the temperature of the air at about 5°C . We have automatic shading controlled by a

photocell which also turns the shades on at night which saves energy.

Almost all cuttings are dipped in a rooting hormone, usually Floramon C which contains 0.4% naptacid and 10% captan in a 50:50 ratio. If the same plant is propagated both summer and winter, we use only 1/2 strength hormone in the summer. Quite a few of the cuttings also root well under a plastic tent with bottom heat. This is, of course, a cheaper set-up and by working with cuttings for several years we seem to have found out which cultivars do best under mist, which do best under plastic tunnels, and those which root well in either one. We also get good results with plastic tunnels in the open.

Once a week all the cuttings are sprayed with benomyl or Euparen, the latter especially at low temperatures.

We have tried taking cuttings in November, keeping them in coldstore at -4°C and inserting them in the flats in March. One year the results were as good as those obtained with fresh cuttings; another year the results were not so good, though this might be accounted for by the fact that the temperature rose to $+4^{\circ}\text{C}$ for about 14 days on account of poor inspection.

I consider it of great importance to have top quality stock plants; and we have almost 2 hectare of different stockplants. These must be carefully selected for that purpose, must be regularly replaced, especially as some grow poorly after being cut back every year; they must be in a good healthy condition and well fed.

After rooting has begun, the cuttings are watered every week with liquid fertilizer, usually with the Hornum mixture which contains both major and minor nutrients, at a strength of 1/2 ppm.

Below are a few comments on the timing and the media we use for the different species:

Chamaecyparis: Cuttings are made in August and September, although good results can be obtained at almost any time of the year. Sand is the medium we use for all of them and all are treated with Floramon rooting hormone.

Juniperus: These are propagated from July until November, starting with *Juniperus horizontalis* cultivars which we do not treat with hormone, then *Juniperus chinensis*, *Juniperus virginiana*, and finally *Juniperus communis* cultivars. All are treated with Floramon and inserted in sand, except *Juniperus scopolorum* "Blue Pyramid" for which we use peat.

Picea: *Picea glauca* 'Conica' and *Picea abies* 'Nidiformis' are taken in early July and inserted in sand in plastic tunnels outside, without being treated with hormones.

Taxus: These cuttings are made from September to December and we now use only peat with a layer of sand for almost all of them, but peat and perlite, which we formerly used, also gave very fine results. This year we tried some of the rockwool Grodan blocks and the results have been pretty good though not better than in sand. Maybe they will grow faster after being potted; that remains to be seen.

Thuja: Cuttings of *Thuja occidentalis* cultivars are almost all made in the spring, though good results have been obtained from all except *Thuja occidentalis* 'Pyramidalis' taken in July and August. Floramon is applied and sand and peat layers are the medium used.

PROPAGATION BY GRAFTING

I am supposed to be a specialist on grafting, and I have had quite a number of years of practice, but it seems to be more and more difficult to decide which is the best method of grafting for the different cultivars of plants. I must admit that I was much better at it 30 years ago.

We only graft plants that we are not able to propagate satisfactorily any other way as this is the most expensive type of propagation. In some cases we graft cultivars which, although they take easily enough from cuttings, do not grow fast enough. For instance, *Chamaecyparis obtusa* 'Nana Gracilis' from cuttings grows very slowly and seems to continue to do so for the rest of its life and, for this reason, is usually grafted.

It is very important, when you graft, that all the factors under your control are right; the understock must be carefully selected and potted or heeled in at the right time; the scion must be in fine condition when taken and not allowed to dry out at any moment; the grafter must keep his knife sharp and clean; the temperature during aftercare must be correct, etc. . . . I have found that even if the grafter is not too careful about the way he fits and ties the scion to the understock, the results may be fine given the correct aftercare. For instance, when grafting *Chamaecyparis*, *Juniperus* and *Betula* there is little difference between the results of different grafters; however, *Picea* cultivars are exceptions where a skilled grafter is needed.

As skilled nurserymen become more and more scarce and the working hours get shorter and shorter, it becomes increasingly necessary to let automatic gadgets take over the job of supervising. Our results improved considerably after we had automatic shading, ventilation, basal and air heating installed. Some of the things we know little about is what the influence of weather conditions during the summer and winter before have on the scionwood. I have heard that one should only take

the scions when the temperature is above 0°C, but, if this were the case, we would be unable to do any grafting some years as we do all our grafting between December and March and in some years we have below freezing temperatures for maybe 2 months, yet these years we can still get fine results. Other years, such as the winter of 1977-78, where we had fairly warm weather until late February, we had poor results on some of the cultivars we consider easy, even though all the factors seemed to be perfect, yet we had good results on one of our most difficult plants, the Thomsen Blue Spruce. We graft during the winter for at this time we have available the necessary skilled labour, whereas we are always short during the summer.

We use a rubber band specially made for grafting by MEYER in Germany for tying and we use a bow-type knot that comes undone easily when you pull one end.

Aftercare of the grafts is of utmost importance, and particularly so during the first 6 weeks. We keep the grafts either under a plastic tent heeled in sphagnum peat with the union uncovered. This must be done carefully, for if any part with needles is covered, and this applies especially to *Picea*, the scion usually dies. After about 5 to 8 weeks we start to cut the understock back, usually in 2 stages about 4 weeks apart. On all grafts the rootstock top is completely removed one month before we pot them on into one or one-and-a-half litre plastic pots after the new shoots have matured, although on all *Picea* we leave a small part of the understock with a few branches, which are to be cut off the following spring. This seems to give better results. After being heeled-in all the grafts are sprayed with Benlate once a week and, a few weeks after grafting, the plants are also given liquid fertilizer once a week at ½ ppm.

I cannot say that we always have fine results. I am ashamed to say that it often seems when I talk to colleagues from other nurseries, that they always have results of at least 90% each time, while I am satisfied with 60-90% saleable plants; that is a percentage taken 6 months after grafting. A result of less than 50% is unsatisfactory.

There are many ways you can graft a certain cultivar depending on where you live, the way the business is run, time and labour managed, whether you have greenhouse or outdoor facilities, etc. . . .

I shall briefly describe below how we graft the different genera.

Abies: We graft quite a range of *Abies* and consider it an easy plant to graft and usually get fine results. We use *Abies alba* as understock, 3-year-olds for *Abies koreana* and other dwarf cultivars, and 4-year-olds for plants with thicker scions,

e.g. *Abies lasiocarpa* 'Argentea'. In November we heel the bare-rooted rootstocks in peat under glass keeping the soil temperature between 10° and 12°C, raising it to 14°C in January. We graft the plants in January-February when the new white roots are visible. The grafts are heeled-in in peat with the wounds uncovered under a plastic tent and the soil temperature is raised to 16°C in February.

Cedrus atlantica 'Glauca' is grafted onto *Cedrus deodara* and treated in the same way as *Abies*, but here we still have a rather valuable plant even if the graft fails.

Chamaecyparis: the only cultivar we graft here is *Chamaecyparis obtusa* 'Nana Gracilis', as our climate is too harsh for the more sensitive cultivars. We propagate quite a few cultivars by cuttings that were previously always grafted, e.g. *Chamaecyparis lawsoniana* 'Hollandia', *Chamaecyparis lawsoniana* 'Lanei', *Chamaecyparis lawsoniana* 'Aurea Kelleriis', ('Kelleriis Lutea') the hardiest of the yellow types, *Chamaecyparis lawsoniana* 'Stewartii', etc. . . . *Chamaecyparis* can be grafted in December and are, therefore, the first to be grafted. We use a side-graft leaving a flap from the understock to cover the scion, and treat the grafts similar to *Abies*.

Juniperus: We do not graft many cultivars today as we can propagate almost all of them by cuttings. We only graft *Juniperus chinensis* 'Blaauw', as this method gives a saleable plant much quicker, and *Juniperus scopolorum* 'Blue Heaven' because our results from cuttings are too poor and we also get rather a nice plant within a few years. We use *Juniperus chinensis* 'Hetzii' as understock; they are potted up and can be grafted any time between December and April. We like to leave a small opening in the bottom of the flap of approx. ½ mm which will be filled with callus within a few days.

Picea: Most cultivars are grafted onto *Picea abies* and, if possible, we like to use 2 to 3 year old rootstocks, and we certainly do this with cultivars with very thin scions, like *Picea omorika* 'Nana'. But for plants with thicker scions we have to use 4-year-old understock. These are potted up during October and November in the greenhouse; they will have rooted and be ready for grafting in late January. We use a side-graft. The grafted plants are inserted in pure sand in an open bench in the glasshouse and the unions very carefully covered with sand.

We prefer to use 1-year-old scionwood for blue spruce but for the different dwarf types we have to use 2-year-old scionwood. Removing the needles from the scions of *Pinus* and *Picea* without harming the bark can be rather difficult. The method varies from one cultivar to another; some you can cut or scrape off with a knife, but for others you can pull or rub them off.

Formerly we used to wax spruces and quite a few other plants, placing them in open benches, but we find the method described here more successful. We have tried taking the scions in November-December and keeping them in plastic bags in coldstore at 4° Celsius and grafting them in March. Even if the scions looked a bit dry the results were just as good as with newly cut scions. The reason for this experiment was to avoid winter damage and also, in the case of prostrate evergreens, it can sometimes be hard to find cuttings and scions in winters where there is a lot of snow, although this has not been a problem in recent years.

Pinus: We use *Pinus mugo* as understock for all *Pinus*, including the five-needled types. The understocks are potted up in August and moved to the glasshouse in December to be ready for grafting in February. They are usually treated like *Picea* and inserted in sand, but inserting them in peat under a plastic tent with the unions uncovered has also been successful.

Pseudotsuga: These are treated exactly the same as *Pinus*.

Taxus: We graft *Taxus baccata* 'Fastigiata Aurea' and usually use *Taxus media* 'Hicksii' as the understock. They are treated in the same way as *Juniperus*, and they turn out fine when grafted in December. We also grow this cultivar by cuttings but the growth is then slower than when we graft.

IMPROVEMENT OF HARDY NURSERY STOCKS

J. B. SWEET, R. ANNE GOODALL and A. I. CAMPBELL

Long Ashton Research Station
Bristol, Somerset

Selection of plants with improved or new ornamental characters of horticultural value has been a feature of the nursery trade for many years. Nurserymen have been aware of the variation which occurs in plant material and have selected, propagated, named and sold improved cultivars and clones. However, the major attributes considered by propagators are ease of rooting and rapid growth, much less attention being paid to the eventual appearance of the plant. In consequence it is, e.g., the easiest rooting \times *Cupressocyparis leylandii* clone, or the more rapid growing *Cornus alba* 'Gouchaltii' cultivar, that is chosen rather than the cultivars with the best appearance when mature.

Recently a more scientific approach to the selection of nursery stocks, coupled with an investigation of their virus diseases, has been initiated in several countries. At Long Ashton propagating material of several common trees and shrubs has