TECHNICAL SESSIONS

Tuesday Morning, November 28, 1978

The twenty-eighth annual meeting of the Eastern Region of the International Plant Propagators' Society convened at 8:30 a.m. in the Ballroom of the Royal York Hotel, Toronto, Ontario, Canada.

PRESIDENT McGUIRE: Welcome to the twenty-eighth annual meeting of the Eastern Region of the International Plant Propagators' Society. The weather notwithstanding we have a good crowd this morning. I wish to welcome those members from the Western Region, the Southern Region, the Great Britain and Ireland Region, and the Australian Region who are with us. At this time I would also like to introduce Ray Halward, who is the program chairman for this meeting. Also with us is Mr. Ken Lance, the Deputy Minister of Agriculture and Food.

KEN LANCE: Thank you, President McGuire. It is a real pleasure for me to welcome you to Canada and the city of Toronto. From the looks of your program I am sure you will have a most successful meeting.

PRESIDENT McGUIRE: Thank you Mr. Lance. We have one minor change this morning. Ralph Shugert will be the moderator of the morning program.

RALPH SHUGERT: I am pinch hitting for Jim Wells and I am pleased to report that he is not as ill as last year. He has a leg in a cast which makes getting around difficult. Jim assures us that he will be with us next year.

PROPAGATION BY GRAFTING UNDER GLASS AT HILLIERS NURSERY

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Approximately 60,000 plants are grafted under glass each year at our nursery. The species involved cover 126 genera and to achieve compatible stock-scion combinations, approximately 140 different species of rootstock must be established in pots before grafting can commence. The number of plants used in a species varies from as few as 15 to several hundred. This production cycle involves a degree of administrative organisation which may be of interest.

ORGANISATION AND PLANNING

As rootstocks are potted for 6 to 12 months before grafting, any significant increase in production levels must be considered in the season before grafting is to take place. Where this is not possible, bare-root bench grafting must be the technique used.

At Hilliers all plants grown are coded and listed in a master stock book. The code consists of the letter S, C, C.G., R.C.G., or B according to the method of propagation (seed, cutting, cutting graft, root cutting graft, or bud) followed by a number 1 to 52, which represents the week of the year in which propagation is to take place. All species with the same letter prefix and number code are printed out by our computer for the relevant week.

Within each week the plants are arranged in batches according to the understock required or, as in the case of cuttings, particular conditions preferred. Batches may also comprise only types which are produced in large quantities or, conversely, those which are required only in small numbers.

Production requirements are filled in on the blank sheets by the Marketing Division. Where grafting is involved, the number of available rootstocks is checked against the number of grafts required. Finally, the information is fed back into the computer which then prints out Production Target Sheets for the Propagating Units.

As results are known, completed Target Sheets are returned from the Units and filled in on a Master Print-Out for the year. This provides information for Management concerning stock availability, potential shortages or excesses, etc. No close monitoring of progress for grafting is undertaken, although weekly progress sheets are completed by the foreman responsible for a given batch.

Compatibility. Little is understood about compatibility, particularly for the long term, in many genera. Many years of trial and error have provided us with some information on compatibility and information on those combinations which will or will not make a successful union, at least in the short term.

Rootstocks. We generally prefer to use rootstocks which are well established in a pot. The normal size used for broadleaved species is a 4½ inch diameter pot. Its cubic capacity is approximately 1 litre. Conifer rootstocks and a few broadleaved plants (e.g. *Daphne*) may be grown in a smaller pot with a 3 inch diameter.

We prefer to use clay pots if time, handling and general costs would permit but generally the clay pot is now replaced

by a rigid plastic type. After potting in early spring, the pots are placed on sand or gravel beds. Clay pots need to be plunged to the rim in sand or weathered boiler ash.

One or two-year old seedlings are generally selected for potting as they usually provide the required pencil thickness at the collar. Some rootstocks are used for top working; these obviously need to be much larger and are either balled from the field and placed under glass for grafting or potted into much larger containers for subsequent working.

Time of Grafting. Normally grafting occurs either during the winter months or during summer up to early autumn (Table 1). The reasons for the times selected are often rather obscure. Experience is said to have shown the best time for a given species but these conclusions are often drawn from only a single or very few observations and are sometimes colored by prejudice. These comments are by no means aimed only at the Hillier methods. Provided the necessary physiological and environmental conditions are available, it can be said that most species would succeed well during either period.

Carpentry of Grafting. With very few exceptions, the graft used is the side veneer graft in two forms, either (1) unmodified with a short lip at the base, or (2) an elongated lip or flap of rind retained on the rootstock. The latter method is used for species such as the conifers which have a flexible rind likely to survive displacement from the normal position. The advantage of the technique is that it gives an opportunity for more cambial contact between stock and scion than the conventional side veneer. As implied, the top of the stock is more or less completely retained with this graft.

Other grafts less frequently used are the simple splice or whip and an inlay type of graft which is in effect the conventional side veneer with the rootstock cut right back to the point of grafting. In both cases the easier species are chosen, the former method applicable where stock and scion are of similar diameter, the latter where there is some disparity in size between the two.

PHYSIOLOGY AND ENVIRONMENT

Essential points to bear in mind are as follows:

Rootstock. Usually the age of wood of the rootstock at the point of grafting is more than that of the scion wood by at least one year. Rootstock wood is therefore less responsive, slower to form callus, etc. The usual method to overcome this problem is to either graft in the summer when the rootstock is active, or to graft in winter or spring, to ensure the rootstock is in a more advanced stage of growth than the scion.

Table 1. Hillier Nurseries grafting calendar.

Time	Species	Comments
November-December	*Rhododendron* (also cutting-grafts) *Kalmia*	Early bud break of the scion is a danger and this is most delayed at this time of the year. Comparatively cool top conditions can be maintained despite supplying bottom heat. Tolerant of poor light conditions. These can also be done without artificial heat in April.
January-March	Main deciduous species: *Betula* *Fagus* *Juglans* *Fraxinus* Prunus *Sorbus*, etc.	Scions are leafless. Birch tend to take slightly longer to callus than most other species and are done early. Once growth starts after a successful union, light conditions are improving and top growth can proceed normally.
Febuary-March- April	Deciduous conifers: *Larix* *Taxodium* *Gingko*, etc.	
March-April	Evergreen conifers: *Picea* *Junipers*, etc.	Leafy scions.
June-July	Deciduous azalea *Rosa* spp. and some hybrids	The former species appears to do best at this time of the year. *Rosa* spp. break into growth rapidly when grafted in the spring and this can cause difficulties in management to avoid foliar disease.
July-August	*Acer* *Hamamelis* *Sinowilsonia* *Parrotiopsis* *Citrus*	Scions with leaves removed. Removal of leaves enhances survival of scion, reduces disease incidence in grafting cases.
August-September	*Carpinus*	Leaves retained. This particularly easy species responds to splice or inlay grafting with rootstock top removed.
August	Conifers	Usually the union is plunged in slightly moistened peat.
September-October	Quercus	Leaves removed. This slow callusing genus at this season remains dormant for a considerable time after grafting giving the union sufficient opportunity to form. Meristematic activity is higher than it would be in October - November.

Scions. Scions react physiologically in a very similar way to cuttings in the early stages of grafting. Leafy scions must be prevented from desiccation; leafless scions are much more capable of survival.

Sap flow and drowning of grafts and buds. A feature of grafting is that the rootstock is frequently grafted while it is relatively undisturbed and actively extracting moisture from the soil. Moisture in the form of sap passes up the rootstock until it

reaches the point of the union where only a small proportion is able to pass into the scion in the early stages after grafting has taken place. If there is a substantial sap flow the excess sap oozes out at the point of the union, sometimes with such force as to push its way through the protective coating of wax which may have been applied by the grafter. The presence of such quantities of sap at this point adversely affects callus formation and wound healing.

To avoid copious sap-flow it is essential in the operation of spring grafting under glass to dry the understock off before carrying out the grafting operation. This is normally best achieved by withholding water during the warm period under glass when bud activity is being encouraged by temperature.

In the case of summer grafting and budding where the top of the stock is normally retained, "drowning" is less of a problem since the presence of leaves ensures that the surplus sap is removed by transpiration.

Environment During Grafting. For grafting under glass, particularly where leafy scions are used, the grafts are normally protected under double glass, a closed case or polythene tent (Table 2). In conditions of high humidity drying out of the unions is not a problem and it may be merely tied with waxed cotton or rubber strip. The unions of grafts which are placed on the open bench must be prevented from drying out by waxing or plunging them in a moistened medium such as peat or sawdust. Some species tolerant of low temperatures or subject to damping off are normally grafted on the open bench. The easiest species are grafted in the open field.

The majority of the more difficult species and most summer grafts are placed under close conditions where temperatures and humidity can be better controlled.

Practical aspects of environmental control.

a) *Close case/polythene conditions:*

1. Peat layer in base of case should be moist, not soaking.
2. Polythene sheet cover, if used, should be turned before water droplets get too large and drip back on grafts.
3. Grafts are not watered until extensive callus formation is visible and airing becomes necessary.
4. Height of polythene cover above grafts should be adjusted to ensure callus formation is healthy, not excessive or too 'soft'.
5. Heavy shading should be used to keep temperatures cool and prevent scions from being water stressed.

b) *Open bench:*

1. Dry understocks are normally plunged into moistened peat; watering is more critical.
2. Graft union must be protected by waxing or plunging.
3. Shading is very critical and must be liberally used as scion breaks into growth.

Table 2. Environmental conditions for grafts at Hillier Nurseries.

Field Grafting	Close Bench or Frame (Cold)	Open Bench (Heated)	Close case frame or Polythene tent (Heated)
Ailanthus	*Carpinus*	*Aralia*	*Aesculus*
Fraxinus	*Rhododendron*	*Magnolia*	*Acer* sp.
Laburnum	*Chamaecyparis*	*Gingko*	*Alnus*
Malus		*Larix*	*Amelanchier*
Prunus		*Taxodium*	*Aralia*
Pyrus		*Rhododendron*	*Betula*
Robinia			*Camellia*
			Castanea
			Catalpa
			Cornus
			Daphne
			Fagus
			Fraxinus
			Hamamelis
			Juglans
			Ligustrum
			Liquidambar
			Magnolia
			Prunus
			Quercus
			Rhododendron
			Rosa
			Sorbus
			Tilia
			Ulmus
			Vitis
			Wisteria
			Cedrus
			Chamaecyparis
			Cupressus
			Juniperus
			Picea
			Pinus
			Pseudotsuga
			Taxus
			Tsuga

After-care. Once the union has established, the grafts are gradually aired and hardened off. For side grafts the top of the rootstock above the union is reduced by more than half, this operation taking place five to eight weeks after grafting. "Snagging back" to the union occurs at some convenient handling stage afterwards, often the following spring or at bedding-out or potting-on stage.

Subsequent Handling. With slow-growing genera (*Quercus*,

etc.) it is important to bear in mind that the union may be a point of weakness for a considerable period and the graft should be handled carefully.

After the rigours of drying off and confinement in a pot, the young grafts may require high fertility and liberal water to promote vigorous growth. Some species, particularly the forest tree category should be checked for root curling which can cause, in the long term, poor health or death of the specimen. Severely curled roots should be unwound or, if this is impossible, cut off.

MICHAEL DIRR: Is there a universal understock for grafting the trifoliate maples?

BRIAN HUMPHREY: No. We use about six species of maple to cover the whole genera. *Acer triflorum*, *A. maximowiczianum* (syn.: *A. nikoense*), *A. griseum* and *A. mandshuricum* can only be grafted on their own rootstock.

LARRY CARVILLE: Brian, would you comment on the economics of grafting vs. rooting of deciduous azaleas.

BRIAN HUMPHREY: Well, it's not economical at all to graft. In fact, we don't graft them except for a few notable exceptions, such as *Rhododendron weyrichii*.

JOE CESARINI: Do you know if *Magnolia* × *soulangiana* is compatible with *M. grandiflora*?

BRIAN HUMPHREY: I would think so. For magnolia grafting we grow three species: *M.* × *soulangiana*, *M. kobus*, and one of the large leaf types. We do not graft any of the *M. grandiflora* group; that would be *M. virginiana*, *M. grandiflora* and *M. nitida*. All of those we root.

JOE CESARINI: Is wisteria compatible with *Albizia julibrissin*?

BRIAN HUMPHREY: I don't know.

JOE CESARINI: Did you say one grafter does 200 grafts per hour?

BRIAN HUMPHREY: Yes. In fact we have some who do 220 per hour.

MAT ZACK: Do you graft larch at lower or higher temperatures?

BRIAN HUMPHREY: Lower temperatures.

MAT ZACK: In poly tent or open bench?

BRIAN HUMPHREY: We only graft our larch in an open bench with a waxed graft union. Larch, like many of the deciduous conifers, does not grow well at high temperatures. If

you get a combination of high temperature and humidity they "damp-off" so we try to bring them along naturally in an open bench with a waxed union.

MAT ZACK: How about *Cornus* cultivars?

BRIAN HUMPHREY: We side graft *Cornus florida* in February and March under low temperatures in a poly tent.

MIKE LEE: For someone starting out new, would you recommend one year potted material or bare root?

BRIAN HUMPHREY: I would recommend one year potted stock.

MIKE LEE: Particularly, I am interested in *Fagus sylvatica* cultivars.

BRIAN HUMPHREY: Well, you are onto a good one there because *F. sylvatica* is very easy to graft. If you can get the stock dry and do a reasonably competent job with the knife I am sure you will get a high percentage take.

FRANK GOUIN: Have you done any grafting or budding of 'Bradford' pear?

BRIAN HUMPHREY: Yes, we used to grow it in England. We have stopped growing it because our climate is so mild in the autumn, and cool and moist in summer, that the plant gets frosted in winter. The selection 'Chanticleer' is proving to be a better plant. We bud on *Pyrus communis* seedlings but get 1 to 5% incompatibility.

FRANK GOUIN: At what age does the incompatibility appear?

BRIAN HUMPHREY: Immediately.

FRANK GOUIN: In some of the original plantings of 'Bradford' pear in Maryland we are noticing some incompatibility showing up after 20 years.

BRIAN HUMPHREY: I am not surprised to hear that. The Rosaceae, in general, have a very complex incompatibility structure.

CASE HOOGENDOORN: You don't have to graft or bud 'Bradford' pear, you can root cuttings.

BRIAN HUMPHREY: We like to get a 6 foot whip the first year. You won't get that with a cutting.

CASE HOOGENDOORN: No, not in one year.

JACK ALEXANDER: Do you ever cover your graft unions with peat and then poly?

BRIAN HUMPHREY: No, that is not necessary. Perhaps I did not explain it to you well enough. The real purpose of poly for dormant scions is that it simply maintains humidity around

the cut surface of the graft union until they can form callus. You could cover the union with wax or plunge the graft in moist peat moss, both of which require a lot of materials and handling. We like to cover the grafts with poly because it saves us that labor.

ED MEZITT: Is the dryness of the root as important with evergreen conifers as deciduous conifers? The reason I am asking this is because we have observed with blue spruce a quick death of many of the roots and are wondering if they are too wet.

BRIAN HUMPHREY: I cannot give you a precise answer. My suspicion is that it is as important. My advice is that for any plant you are grafting, try to keep the rootstock on the dry side.

VEGETATIVE PROPAGATION OF ELMS BY GREEN CUTTINGS

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Abstract. Semi-lignified green stem cuttings of several elm clones were successfully rooted in containers under specially prepared tented frames, without a misting system and chemical treatments. The cuttings were collected from vigorous sprouts produced on grafted stools. Clonal variation in rooting was observed.

In the early 1930's, when Dutch elm disease (*Ceratocystis ulmi* (Buism.) C. Mor.) was discovered in North America, programs were initiated to develop resistant elms for future use. American elm (*Ulmus americana* L.) was the most extensively planted species and tree selections of disease resistant individuals were made throughout North America. In Holland, where the disease appeared earlier, disease resistant hybrid elms were developed and released for planting and testing to several European countries as well as to North America. The vegetative propagation of these trees was necessary to raise stock for breeding arboreta, plantation trials and for resistance-testing.

Elms can be propagated by cuttings, but results vary. The propagation of dormant root cuttings can be satisfactory with some elm species (1,5). Experiments with rooting stem cuttings were carried out in different countries (2,3,4). The rooting of semi-lignified and softwood stem cuttings appeared to be more