Tuesday Morning, November 30, 1978

The Thursday morning session convened at 8:15 a.m. with Judith Shirley serving as moderator.

PROPAGATION BY CUTTINGS AT HILLIERS NURSERY

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At present some 1,200,000 cuttings are inserted annually but expansion is being planned which will significantly increase this figure. Preparation and insertion of cuttings occurs every month of the year. March and April are the least important for woody plants but at this time propagation space is utilized for the production of herbaceous perennials. Nearly every genus listed by Hillier Nurseries has at least one species which may be propagated by stem cuttings. Where possible, propagation by cuttings has replaced grafting.

Organization and Planning. In general, this follows the same pattern as for grafting. Output is monitored weekly with occasional daily checks. Weekly meetings are held between executive and departmental management to review progress and highlight special problems such as shortage of material, etc. Progress is monitored by the use of graphs for quick appraisal.

Stock Plants. For many years the Hillier Arboretum, supplemented by local sources and stock on the nursery, provided most of the material requested.

Recently, the increasing emphasis placed on the value of selected stock plants, stock plant manipulation and the convenience of collection has meant that the provision of stock plant areas has become imperative.

It seems very likely that new facts will shortly emerge which make pre-treatment of stock mother plants by etiolation or similar techniques a matter of routine for the more difficult species.

Propagation by Mist. The first mist system was installed at Hillier Nurseries in 1959 and quickly established itself as an aid to propagation which had never previously been equalled. From the start we installed MacPenny equipment and found it to be extremely reliable and very good quality.

Mist House Design. The new generation houses were still designed with benches but instead of the traditional mist pipe lay-out, pipes were suspended above the benches on adjustable 'T' irons. This gave an unimpeded working surface to the benches. The other major change in bench design was to construct some form of free-draining porous concrete surface beneath which was placed electrical heating cable. This concept worked well though burnt-out heating cables could not be replaced.

Later houses have been built without benches with mist lines suspended above head height. Porous, no fines concrete floors are used and, to avoid the problem of burnt out electric cable, bottom heat is provided by hot water (100°F mean) circulated through polythene water pipe.

The concrete floor is made from ½″ diameter aggregate with no-fine material included. ½″ diameter polythene water-pipes are spaced at 6″ centres and cast 4″ deep in the 6″ thick floor. The no-fines concrete requires skill to lay and must be pressed rather than trowelled to ensure the open, porous structure is maintained.

Drainage is so good in this floor that it has been necessary to cover the surface with an inch deep ⅛″ grit to maintain sufficient humidity in the house. The porosity of the floor is protected by covering it with an industrial fabric (I.C.I. Cambrelle) known as Terram before the 1″ deep layer of grit is placed.

The high level mist lines are designed to completely cover the floor area in mist.

The advantages of this system are:

1. Unimpeded floor space
2. Flexibility in use and layout
3. Minimum loss of propagating area, up to 100% of floor area can be used.
4. Possibility of using mechanical handling (fork-lifts, pallets, etc.) inside the house.

Mist versus Polythene. Recent work at the Glasshouse Crops Research Institute in England has indicated that during the winter months cuttings under polythene are likely to be more successful than those under mist.

At Hillier's it has been standard practice to line a number of mist houses with polythene. This has been found to be a particular advantage with certain genera including many of the evergreens normally propagated during the autumn and winter months.

It may well be that the combination of mist inside a polythene house or polythene lined mist house has many of the advantages of both systems.

Preparation of Cuttings. Large cuttings are preferred since it is cheaper to grow plant material on the mother plant than on the cutting. Where material is scarce, small cuttings or leaf-bud cuttings can be successful on a surprising range of species. In some cases (e.g. *Mahonia japonica*) it is our standard method of propagation.

Wounding. Most cuttings prepared by us are wounded for it has been shown to consistently enhance results. The reason for this is not understood and various theories have been put forward including better uptake of water and rooting hormone. In some species removal of the pericycle fibre or primary phloem fibres may remove an anatomical barrier to rooting. Anatomical investigation shows that a very shallow wound is preferable to a deep one, the latter mainly exposing tissues incapable of regenerating roots.

Rooting Hormones. The value of rooting hormones or growth substances is long established. The basic range of main chemicals has not change since the 1930's and 40's but it is to be hoped that new and more potent materials may be available in the reasonably near future. IBA is generally acknowledged to be the most satisfactory material. Where extra activity is required, the chemical is normally used in the quick-dip formulation. It is well known that different species respond differently to high and low concentrations. Those in the high response group may be given "super optimum" doses which produce a basal inhibition of rooting or scorch, the roots arising above this area. High concentrations may occasionally inhibit or distort root growth (fused double roots etc.) but this usually returns to normal later.

Fungicidal applications. For some years, the use of fungicides, mainly as basal dips, has been advocated as an aid to rooting. Work, particularly at the Boskoop Experimental Station, has shown the value of Captan mainly when used on cuttings inserted into rooting media which did not receive artificial bottom heat.

More recently, systemic fungicides, notably benomyl, have shown considerable advantages when applied to cuttings. Other fungicides, particularly systemic chemicals such as furalaxyl will further enhance rooting results.

Bottom Heat. The switch from electricity to oil to provide the energy for heating the rooting medium resulted in a cost saving. Further savings were achieved by fitting electronic sensors to replace the rod type thermostats for temperature control. New houses built in the future will incorporate floor insulation using polystyrene blocks on the edges of the house and polystyrene blocks or empty glass bottles laid under the no-fines concrete floor.

Some work in England has shown that continuous bottom heat may not be necessary for successful rooting of at least some species and the possibility of periodic heating offers further opportunities for cost saving.

Work at the Glasshouse Crops Research Institute indicates that, with rhododendron, the advantages of a high bottom heat temperature of 77°F may be offset by a greater incidence of disease. Although rooting is less pronounced at 59°F, more cuttings survived at this temperature and the overall percentage of rooted cuttings was higher than at 68°F or 77°F.

There can be no doubt that, properly used, stimulation of the cutting by controlled basal temperatures is a very potent aid to rooting. This is particularly evident in the comparatively unresponsive hardwood cutting where some species (e.g. *Platanus* or *Malus*) can only be guaranteed to root well if subjected to a pre-conditioning treatment of heat applied in conjunction with rooting hormones to the base of the cutting. In common with many other growers, we have at Hillier's a set of Garner Bins constructed in a cool shed for the pre-treatment of hardwood cuttings. This provides the ideal conditions of warm base and cold tops, with adequate moisture control.

Sun-Frame Cuttings. The original system was based on the old hand-sprayed frame normally placed in full sun and unshaded to build up high temperatures. The "boy" in the propagation department was responsible for keeping the cuttings sprayed over as much as was necessary to keep them turgid. With the advent of mist and polythene the old system, which had fallen into disuse, was revitalized and many nurserymen in Europe and America (notably Templeton with the Phytotektor at Winchester, Tennessee) transformed the old system by using a polythene tunnel equipped with a mist system. We took this up ourselves in the early 1960's and have used it with good success ever since.

A few years ago concern was expressed at the considerable labour content involved in moving and re-building the polythene tunnels and installing the mist lines. It was decided to attempt to build a mobile 'walk-in' polythene tunnel, 20 feet wide by 120 feet long with a maximum height of approximately 10 feet, into which was permanently installed mist propagation water lines and jets. Each tunnel was piped into a solenoid valve controlled water supply. This system has proved very successful enabling the polythene propagation tunnel to be moved from one site to another by a single tractor in a matter of 30 minutes.

Weaning and Over-wintering. The MacPenny weaning unit which is used to provide reduced misting cycles of 1 in 3, 1 in 6 or 1 in 12 has generally been found unnecessary to ensure successful weaning. Well rooted cuttings are normally taken directly from the mist and placed in humid, shady conditions, such as polythene tunnel, glasshouse with closed ventilators, or a cold frame. Under these conditions, we have rarely experienced significant loss at this stage. For over-wintering we like to provide sufficient heat to maintain 40°F but in Southern England many species will overwinter successfully in unheated glasshouses or polythene tunnels.

We do not generally pot off rooted cuttings of deciduous species until the spring after they have been rooted. This simple rule avoids the heavy losses of deciduous plants which, after rooting in mid-summer, are potted off in late summer or early autumn. These often die during the winter unless they can be induced to produce a new flush of growth after potting.

Special techniques, including provision of supplementary light and CO_2 enrichment, are being used by some growers to induce a flush of growth after potting. So far we have not needed to use these techniques. We are interested in the use of growth stimulants, such as gibberellin, to induce secondary growth.

One problem with overwintering cuttings in the rooting boxes is that the more vigorous species are liable to root through the box into the medium below. This results in considerable root damage and consequent loss of vigour when the plants are handled the following spring. At Efford Experimental Station trials are in progress with Gloquat applied to the surface of the standing down medium (normally sand). This chemical kills the root tip and consequently prevents rooting through.

VOICE: With the *Mahonia* cuttings, was that a compound leaf with a piece of stem?

BRIAN HUMPHREY: Yes, with *Mahonia* cuttings, we simply make leaf-bud cuttings with a wound on the back side of the stem. The cuttings are stuck so that the bud and stem are below the surface of the medium. Seradex 2 or 3 is used as the rooting hormone.

VOICE: Why do you object to a solid concrete floor with some water on it?

BRIAN HUMPHREY: Because I believe we need to set up a water tension in the rooting medium to suck air into it. You can only do that with a deep column of water moving through. A solid floor would inhibit this free drainage and put a thin film of capillary water on the bottom of the cutting.

VOICE: Do you have an algae problem in the porous concrete?

BRIAN HUMPHREY: No.

VOICE: How do you root apple rootstock cuttings?

BRIAN HUMPHREY: We only root apple rootstock from hardwood cuttings. We can root MM.111 and MM.106 reasonably well but M.7 is very difficult.

VOICE: Can *Acer griseum* hardwood cuttings be rooted?

BRIAN HUMPHREY: *A. griseum* is extremely difficult, if not impossible, to root from any type of cutting.

CARMINE RAGONESE: Have you run into any problems with an excessive amount of callus on rhododendrons.

BRIAN HUMPHREY: The sure sign of too much callus on any cutting is either that you have an extremely difficult plant to root or that you have used too weak an auxin.

TISSUE CULTURE OF FRUIT TREES AND OTHER FRUIT PLANTS

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The uses of tissue culture in plant propagation have been amply reviewed in the IPPS Proceedings of the past several years. In the Fruit Laboratory, we are interested in (a) rapid propagation of new selections from our breeding programs, (b) rapid increase of plants that have been indexed for freedom from known viruses, (c) preservation of germplasm, and, in the future, (d) production of haploids for plant breeding. The crops with which we are working are apple (*Malus sylvestris* Mill.), thornless blackberry (*Rubus* sp.), strawberry (*Fragaria* × *ananassa* Duch.) and blueberry (*Vaccinium* sp.). We also have four peach (*Prunus* sp.) understocks in culture but in the future Dr. Hammerschlag of the Cell Culture and Nitrogen Fixation Laboratory will be doing most of the work on peaches at Beltsville.

Tissue culture of fruit crops is underway at numerous locations around the world. In the United States, most such work is in state or federal research stations although several nurseries are now beginning to join in. In Europe, and possibly elsewhere, both commercial laboratories and nurseries are using