Hardy Woody Plant Propagation at the Royal Botanic Gardens, Kew

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INTRODUCTION

Hardy woody plants are propagated at the Royal Botanic Gardens, Kew, in the Temperate and Arboretum Nursery. In total there are four nurseries on the site at Kew, and a further nursery at Kew's satellite garden at Wakehurst Place, Sussex. Each nursery specialises in a particular range of plants:

- Alpine and herbaceous.
- Tropical nonwoody.
- Micropropagation (concentrating mainly on endangered plant species including orchids.
- Temperate and arboretum (a merging of two nurseries in effect on one site, where mainly woody plants from sub-alpine to tropical rainforest habitats are propagated and grown).

This paper will concentrate only on the Arboretum Nursery and the propagation and cultivation of hardy woody plant species.

The nursery covers an area of 6078 m^2 of which 889 m^2 is glass, 2975 m^2 open ground area, 175 m^2 polytunnels, and 198 m^2 sandbeds.

There are three full-time members of staff: a nursery manager, responsible for the general overall running of the nursery; a senior botanical horticulturalist, specialising in the propagation and cultivation of hardy woody subjects; and a higher botanical horticulturist, responsible for propagation and cultivation of nonhardy plants in support of the Palm House and Temperate House, with assistance from the nursery manager.

PROPAGATION FACILITIES

The closed mist propagation unit is computer controlled using a sun mist programme. A light meter measures the sun's radiance. When a certain threshold is reached a mist burst is given. It is a good system, but needs regular monitoring, and does not differentiate between bright humid days and bright dry days. This system is used for a wide range of soft and semi-ripe cuttings.

Closed case is used to propagate grey foliage plants, or dry-loving Mediterranean-type species that do not like the rooting environment too moist. Subjects that do well in closed case are *Teucrium orientale* var. *puberulens*, *Artemisia*, and *Genista tinctoria*. The closed case is set up on benches in a glasshouse.

PROPAGATION AND GROWING MEDIA

Propagation medium consists of approximately one-third fine bark, one-third coir, and one-third perlite. No nutrient is added. The general compost mix for potting and pricking out seedlings consists of loam, coir, and grit (1 : 2.5 : 1, by volume). To this mix is added Osmocote Plus 15N:9P_2O_5:11K_2O + 2 Mg + traces at 1.5 kg m^{-3}.

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RATIONALE FOR PROPAGATION

Propagation is carried out in response to requests for material from the managers of the relevant parts of the Living Collections to propagate from existing plants in the collections or to produce plants from newly obtained propagation material, for example from collections made abroad. In either case, the number of plants requested is generally small.

Propagation from existing plants in the collections is usually by cuttings or grafting. Seed for propagation is rarely collected from the Gardens as so many species of trees and shrubs freely hybridise in the confines of a botanic garden. Every plant batch at Kew has a unique accession number which allows access to the history of every individual plant for curation and scientific and botanical research. It also means the propagator can locate a particular individual for propagation if requested.

About 20% of all propagation carried out in the Arboretum Nursery is in response to requests for material from existing plants in the collection. The remaining 80% is propagation to raise new material for the collection from natural-source, wild-collected seed from hardy temperate zones.

Collaborative seed collections and exchanges with overseas organisations have been increased in recent years. Wide-scale environmental degradation has resulted in greater urgency to collect seed from plants and regions not yet represented within Kew's collections, so that their scientific, economic, and amenity qualities can be evaluated.

The main criteria for seed selection are:

- Is the species required, is it already represented in the collection?
- Is it of natural source known origin?
- Is it likely that it can be collected again in the future?
- Does it have particular conservation, scientific, or economic value?

SEED PROPAGATION

Seed arrives at the nursery from exchanges with other botanic gardens or from expeditions involving Kew staff. Expeditions during the last 5 years have included Sichuan in China, Taiwan, Sakhalin Island off the coast of Russia, north-east Turkey, and Tibet.

Expeditions usually take place in September and October, which is generally the best time to collect ripened seed. Seed arrives on the nursery in November and is priority sorted according to whether it is berried or dry seeded; ripe or unripe; recalcitrant (short-lived seeds that lose their viability quickly) or orthodox (seed which can be stored before germination); sowing time (autumn or late winter, or February).

Seed cleaning is an involved and time-consuming task as many of the seeds may not yet be fully ripe and so time must be given to allow further ripening prior to cleaning. Genera which generally need further ripening are: *Ilex* (which ripen well even when harvested green), *Berberis*, *Rhamnus*, *Actinidia*, *Sorbus*, and *Viburnum*.

PRE-TREATMENTS AND SOWING.

For sowing, seed is divided into:

- Small-seeded species which do not have a dormancy requirement. For example, *Philadelphus, Rhododendron, Spiraea, Hypericum*, and *Deutzia* which are sown mid February to early March;

- Hard-seeded species that require a natural cold period to break dormancy. Hard-seeded species which require dormancy treatment are cleaned, sown, and placed into a cold seed frame outside, where they receive natural cold stratification through the winter. For many genera, including *Fraxinus, Acer, Cupressus, Picea, Betula*, and *Sorbus*, one winter of this treatment is sufficient to break dormancy followed by good germination between March and June. However, there are some species which require up to 3 years to trigger germination, species in genera such as *Tilia, Viburnum, Ilex*, and *Rhamnus* sometimes demonstrate this.

Recalcitrant genera, such as *Quercus*, do not require cold treatment and it is vital that they are sown immediately upon arrival, to prevent drying out or premature germination in transit, which may result in damage to the radicle.

Salix and *Populus* also need particular care. Experience has shown that the British native *Populus nigra* (black poplar) germinated within 12 h of being sown. The seed had been collected the previous day. For similar reasons, *Salix* seed are not usually collected on expeditions, however, a seed collecting trip to north-east Turkey, in September 1993, provided an opportunity to experiment by collecting seed from *Salix triandra* ssp. *triandra*. The seed was collected and kept in a paper envelope without being allowed to become too dry. A plastic seed bag would have caused premature germination. Regular monitoring of the seed for moisture content was essential. Seed was carried around in a rucksack for 3 weeks before arriving at Kew for sowing, and following that germination resulted just 1 week later.

This proved that with regular monitoring and good seed storage, the moisture balance could be more easily maintained. It is vitally important that collected seed is cleaned as required during the expedition to avoid loss of viability through desiccation, fermentation, or weevil damage.

Small-seeded genera, including *Rhododendron*, are cleaned, dried, packed in plastic seed bags, and cold stored at domestic fridge temperature (2 to 5C) until late winter, usually mid-February. They are then sown in 4-in. (10 cm eqv) dwarf pots and put into a glasshouse with a minimum temperature of approximately 10C and covered with a light gauge clear plastic, with bottom heat at approximately 20C. Germination takes place within 2 to 4 weeks for most of these small-seeded species.

Seed compost consists of loam, grit, and coir (1 : 1 : 2.5, by volume). Osmocote is added at 1.5 kg m^{-3} to which one part of fine grit (5-mm grade) is added to make it very free draining.

Post Emergence. When seedlings are big enough to handle they are pricked out into 3-in. (7.5 cm eqv) pots and grown on in a glasshouse with a minimum temperature of about 8C. Some genera which do not suit open-ground production, such as *Ceanothus, Cistus, Caragana, Colutea*, and *Decaisnea*, are potted on into 1-litre pots to be grown on outside or in a polythene tunnel, depending on shade requirement. The remainder are transplanted into an open-ground nursery frame, where they are grown on for 1 year. They are then moved on to the open-ground production area where they are grown for their final year, prior to being selected for planting out into the Arboretum.

To produce 10 plants of each species is the aim, in order to give choice, show natural variation, and as an insurance if any plants failed to establish in the first year of

planting. Surplus plants are gradually sent to other gardens and arboreta. This gives a wider representation of the species and performance can be measured against the specimens planted out at Kew.

PROPAGATION BY CUTTINGS

Propagation by cuttings is carried out between May and August with some hardwood cuttings in October-November or March. The majority of plants requested for propagation are in small numbers, usually about three to five plants of each, with the exception being Mediterranean plants such as *Cistus, Teucrium, Artemisia, Epilobium, Lavandula*, and *Brachyglottis*, which are propagated in batches of about 50 to 100 to give bold drifts in the area surrounding King William's Temple. These plants are stuck in May and June in a closed case within a glasshouse. A second crop is also propagated in July and August and direct stuck into a cuttings frame outside, covered with whitewashed Dutch lights. The cuttings root and are left in situ overwinter before potting in March. The early crop are potted into 3.5-in. (9 cm eqv.) pots in August and then into 1-litre pots in March and grown on for planting out by the end of May or beginning of June.

Rooting Hormone. Synergol liquid hormone (IBA and NAA) is used extensively on the Arboretum Nursery. For easy-to-root subjects a Synergol and water mixture [1 : 9, v/v (1000 ppm a.i.)] is used. For the more difficult-to-root subjects a Synergol and water mixture (1 : 3, v/v; 2500 ppm a.i.) or Synergol and water (1 : 1, v/v; 5000 ppm a.i.) are used, depending on the species in question.

GRAFTING

Grafting is only carried out on a small scale, where possible every effort is made to propagate plants on their own roots.

Hot Pipe Callus. Two years ago hot pipe callus was seen at Hadlow College and was proving to be a good facility for grafting many species of deciduous trees and shrubs. This system has been set up on the nursery at Kew.

Kew's hot pipe callus system consists of a series of lengths of 1.5-in. (4 cm eqv) diameter pipes with perpendicular side slots at set distances and extending for just less than half the diameter of the pipe. The pipe is insulated with thick foam rubber and slit at the points over the slots. A small hot water pipe runs through the larger pipe and is thermostatically controlled to maintain the correct temperature.

It has worked successfully with *Fagus sylvatica, Acer* spp., *Prunus, Crataegus, Betula cylindrostachya*, and *Magnolia*.

For the grafting of evergreens and conifers, a closed tent is used with bottom heat.

The three main types of graft used are side graft, side veneer graft, and splice graft where scion and stock are the same diameter. Elastic strips are used for tying and the union is sealed with horticultural wax which melts at a low temperature. All grafting is carried out in January and February and chipbudding of *Prunus, Pyrus, Sorbus, Crataegus,* and *Malus* is carried out in August and September.

SPECIAL PROJECTS

Collections of some genera of horticultural importance have recently been redeveloped in the light of new taxonomic research and to create displays which show visitors the relationships between the various wild species and the garden cultivars.

This requires the propagation of all the species or cultivars obtainable within a particular genus. Examples of genera that have been propagated in their entirety are *Syringa, Philadelphus*, and *Berberis*.

Syringa. The *Syringa* species are propagated by softwood cuttings, nurse grafting, and chipbudding. Seven years ago it was decided that the old collection of *Syringa* taxa would be taken out and replaced by new plantings of not only the previous species and cultivars, but new and exciting species and cultivars from Canada, U.S.A., Poland, and Russia. As a result, Kew's *Syringa* collection is now one of the best in Britain.

Softwood cuttings were taken from the end of May to about the second week in June. *Syringa* has a narrow window of rootability and so timing is critical and can vary slightly from year to year depending on the season. All of the *Syringa* taxa were rooted under a closed mist facility. *Syringa* taxa from abroad came in as hardwood material.

When stocks were not available for nurse grafting the scionwood was chipbudded onto open-ground plants of *Syringa oblata* var. *alba* with good success. When new shoots had broken in spring, cuttings were removed and propagated.

From stock plants grown under glass, propagation was carried out from about mid April. Nurse grafting was used extensively using *Syringa vulgaris* as the stock. Mother stock plants were kept for as long as required until the cuttings were on their own roots.

Rooted cuttings remained in their pots until the following March when they were potted into 3.5-in. pots. They were potted into 1-litre pots in July and 3-litre pots the following year. Their final year, prior to planting out, was in the open ground. Many of the species and cultivars propagated have been sent to other gardens and arboreta to ensure their continuation in the future.

Philadelphus. *Philadelphus* taxa are another group of plants being propagated in their entirety. The collection has also been relocated within the gardens. This project has been in progress for 3 years and is still underway. Softwood cuttings are taken in July, potted on in March into 3.5-in. pots, and are then potted into 1-litre pots outside in June. The following year they are planted out into the open ground for 1 year prior to planting out into the Arboretum. All *Philadelphus* propagated are verified upon flowering to ensure correct naming.

Berberis. *Berberis* propagation has proved the most challenging project of all. Three years ago all the evergreen berberis were successfully propagated in a closed mist facility in January.

But propagation of some 30 different deciduous species proved much more difficult. After two attempts it was decided that a stock bed might be the answer. The plants in the collection in the Gardens (Berberis Dell) were old, diseased, had suffered from drought, and overcrowding over the years and as a result had been weakened. A bed was developed on the nursery for difficult-to-root plants and, in two stages, the *Berberis* species were dug up from the Dell and brought into the nursery. Cuttings taken in July, after pruning, feeding, and watering, resulted in a 90% take, compared with complete failure 2 years previously.

CONCLUSION

The arboretum nursery is a small but complex unit with many different environments for propagating and cultivating not only plants for the Gardens but also material for scientists in Kew's Jodrell Laboratory. The great challenge is that many of the plants come to Kew at a very vulnerable stage and must be closely monitored through this stage, to growing on into an established plant. It is vitally important that skills and knowledge are passed on to fellow members of staff, to Kew Diploma students, and to international trainees, so that the work within the Arboretum Nursery and within Kew can be carried on through all the horticultural industries from botanic gardens to commercial hardy nursery stock production. The author has experience in both botanic garden and commercial nurseries and although there are many differences the same fundamentals apply—propagators in both kinds of nursery could learn much from each other.