Management of Hardy Nursery Stock Plants to Achieve High Yields of Quality Cuttings

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Efford Experimental Horticulture Station is part of the Agricultural Development and Advisory Service (ADAS) in the United Kingdom with responsibility for development trials with container-grown nursery stock and propagation from cuttings as one of its work sectors. This program has seen rapid expansion since 1973 and recently has been extended to include propagation in sun tunnels for field and container enterprises. Such programs require uniform batches of cuttings to reduce trial variability, and this becomes particularly important if, as often happens in larger-scale development work, complete replication is not possible.

Uniform material proved quite difficult to obtain from commercial sources, and there were relatively few U.K. nurseries in the early 1970s with a separate stock plant area. Three options were available in deciding to take our own cuttings. The option of taking cuttings from the growing crop was not feasible for trial work, although it is a common commercial practice. This practice is successful for crops requiring stopping (e.g., azalea), but can conflict with market requirements of plant size and shape at the point of sale. The alternative of taking cuttings from scattered specimen garden and park plants was not successful due to variability in rooting and/or shoots being mature or floral. Consequently, the third option of developing a stock area was adopted. The area was planned in 1972, prepared in 1973, and finally planted in 1974. Experimental work in the stock plant area has been extremely limited, since its main function is to supply uniform batches of cuttings for trials. However, a considerable amount of information has been accumulated on stock plant management during the past 12 years, which this paper reviews.

Advantages of a separate stock plant area are several. a) Plant health status is known. b) Ease of management. The propagator is in control of the plants in respect to nutrition, weed control, pruning, pest and disease control, and all aspects of plant manipulation, enabling cuttings to be taken at the correct time. c) Uniformity of plant growth. Uniformity ensures that evenly graded batches of cutting material are available at any one time and, hence, root more evenly.

The uniformity of plant growth was enhanced further by making the stock area clonal in nature, each cultivar propagated from a single parent source selected as being true to type. These stock plants take an extra year to produce, but the striking uniformity obtained proved not only ideal for trial work, where successive experiments were guaranteed the same parentage, but also in commercial nurseries. When cloning, however, it is important to ensure the parent plant is correctly named, of good form, and has reasonable rooting potential.

Since the stock area was set up at Efford, the UK Clonal Selection Scheme for hardy ornamental nursery stock was started. Now coordinated at the Institute of Horticultural Research, East Malling, this program is devoted to collecting named cultivars of a range of species from commercial sources; identifying the best correctly named source, and then multiplying and distributing this to the industry under an EM (East Malling) prefix [LA (Long Ashton) pre 1983]. The scheme is just gaining momentum, and as selections become available, they are included automatically in the stock area at Efford. d) Manipulation of growth. Stock plant growth can be influenced to produce the desired type of material required when and as needed.

PREPARATION OF THE STOCK AREA

Plant preparation

Plants destined for stock are container-grown for a year in a quarantine area to ensure that they are free from major diseases. This procedure is particularly important if plants are obtained from outside sources.

Land preparation

This must begin at least a season before stock is planted. The following procedures refer specifically to the Efford site where soil type is a fine sandy loam (pH 5.9) overlying gravel at 50-75 mm. This soil type gives reasonable drainage, but surface structure is poor, easily becoming muddy or crusty, and in need of amendment with organic matter. As a consequence, cultivation has been kept to a minimum to prevent excessive structural damage.

Site

Efford is a windy site [an area with an average of 269 hr/yr of wind speeds >33 knots (Force 7-8); 50% of the year has hourly mean wind speeds 7>5 m s-1 (Force 3-4)] and stock areas require shelter, either from natural copses, hedges, or artificial windbreaks. X Cupressocyparis leylandii [(A. B. Jacks. & Dallim.) Dallim. & A. B. Jacks.] and Escallonia spp. are used extensively as hedging on the Efford site.

Pre-planting preparation

The sites used were in grass leys (fallow) and, after subsoiling, were plowed and cultivated. A single application of a contact herbicide (paraquat) was sufficient to clear the postcultivation weed sward, (since there were no perennial weed problems) and was followed by an application of 60 t ha-1 farmyard manure, which was incorporated into the soil with a rotovator.

Table 1. Recommendation for base and top dressings for field-grown nursery stock.

<table>
<thead>
<tr>
<th>Soil index</th>
<th>P (kg·ha−1)</th>
<th>K (kg·ha−1)</th>
<th>Mg (kg·ha−1)</th>
<th>P (kg·ha−1)</th>
<th>K (kg·ha−1)</th>
<th>Mg (kg·ha−1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>43.7</td>
<td>166</td>
<td>75</td>
<td>21.9</td>
<td>83</td>
<td>25</td>
</tr>
<tr>
<td>1</td>
<td>32.8</td>
<td>124.5</td>
<td>50</td>
<td>10.9</td>
<td>41.5</td>
<td>Nil</td>
</tr>
<tr>
<td>2</td>
<td>21.9</td>
<td>83</td>
<td>25</td>
<td>Nil</td>
<td>20.8</td>
<td>Nil</td>
</tr>
<tr>
<td>3</td>
<td>10.9</td>
<td>41.5</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
</tr>
</tbody>
</table>

*Nitrogen: Before planting, 50-150 kg·ha−1 [calcifuge area: 50 kg·ha−1 in the form of Nitram (ammonium nitrate)]. Annual dressing: 50-150 kg·ha−1 [rates varied according to vigor or species. Calcifuge area limited to 50 kg·ha−1 N].

*Dolomitic limestone for calciole area, kieserite (MgSO4) for calcifuge and conifer area.
Base dressing (soil amendments)

These dressings, applied prior to planting, depended on whether calcifuge (acid-loving), calciocole (lime-tolerant), or coniferous species were being grown on the site, each receiving a different base (and subsequent top dressings) to help maintain appropriate pH levels. To help maintain low pHs in the calcifuge area, Kieserite (MgSO₄) replaced dolomitic limestone and ammonium nitrate as the source of nitrogen in place of nitrochalk. Guidelines used for determining base and top dressings were from the MAFF publication Fertilizer Recommendations for Field Grown Nursery Stock (10). The main points are outlined in Table 1.

Planting

The number of plants required for a given cutting production after a specified number of years was unknown, and little information was available on this or how long stock plants should be maintained before replanting. Initially, it was planned to keep stock plants for 10 years but to replant after 7 years to ensure there was no break in continuity of cutting supply. It would also provide an opportunity for comparing effects of age of stock on rooting performance. It turned out that some species (e.g., heathers) required replacement every 3 to 5 years, while constant rejuvenation from routine pruning has enabled other species to continue after 10 years (e.g., Berberis, Viburnum, and Ilex). More detailed work on the effects of stock age on rooting is required, and such comparisons with some of the species have begun at Efford. Planting of stock was successional as material became available and old plantings aided establishment of new plantings by acting as windbreaks.

The stock areas at Efford have only limited irrigation facilities; therefore, material was watered-in at planting and further irrigation was minimal. Despite several years of relatively severe summer droughts (1975, 1976, and 1984) when plants were under severe stress, they established and grew successfully.

Use of mulches

Since 1980, all stock plantings have been set through black polyethylene mulches. This practice has aided early establishment and growth, partly by moisture conservation and preventing early weed competition.

A special mulch area has been used for heathers, since they are extremely susceptible to poor drainage and Rhizoctonia infection from soil splashes. Here, a permeable black polypropylene material [Mypex (Propex)] was laid over soil that was amended with peat and grit and hilled into ridges with potato ridging equipment. Heather species were planted on top of the ridges through holes cut or burnt into the Mypex with a branding iron. Mypex suppressed weed growth while still allowing water to percolate through, and prevented soil splashing up onto the foliage. An irrigation line of seep hose was also placed under the Mypex on the top of the ridge. This system has proved successful as, since Mypex has an estimated useful life of 5 years, it will be replaced with each successive batch of heather stock. Mypex is more expensive than polyethylene, but stock areas represent high-value investment, and healthy active stock growth is essential.

Spacing

Most planting has been in rows with spacing depending on plant vigor. The spacings detailed in Table 2 have provided good access to plants for management and cutting collection. Close spacing of slow-growing species improved early cutting production, and alternate plants could be removed as growth increased (i.e., Rhododendron).

<table>
<thead>
<tr>
<th>Species</th>
<th>Distance between plants (m)</th>
<th>Distance between rows (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow growing</td>
<td>0.6–0.9</td>
<td>0.9–1.2</td>
</tr>
<tr>
<td>Medium vigor (and hedges)</td>
<td>0.9–1.2</td>
<td>1.2–1.8</td>
</tr>
<tr>
<td>Fast growing</td>
<td>1.2–1.8</td>
<td>1.8–3.0</td>
</tr>
</tbody>
</table>

STOCK AREA MAINTENANCE

Nutrition

Annual top dressings are applied in late winter/early spring as detailed in Table 1. This program has produced excellent growth.

Weed control

Weed competition will reduce growth and should be avoided, especially during establishment (4). The soil type at Efford precludes pathway cultivation as a means of weed control. A herbicide program was preferred, but residual substances must be used with caution, as there have been reports that 6-chloro-N,N-diethyl-1,3,5-triazine-2,4-diamine (simazine) has adversely affected propagation of some species, e.g., Calluna (13), some Rhododendron cultivars (1, 9), Juniperus, and Ilex (9). On the other hand, other species appeared unaffected (1–3, 9, 12, 13). Damage appeared to be associated mainly with softwood cuttings taken from treated container plants, but reduced rooting of softwood cuttings of field-grown ‘Davies’ Rhododendron was reported in one instance following two successive annual applications of simazine + DCPE (1).

Thus, simazine has not been used until plants have been in the stock area for 3 years. Pathways have been kept clear for the first 3 years after plantings with a contact herbicide as necessary (e.g., paraquat) and thereafter with a simazine–paraquat mixture. However, as a safety precaution for trial work, the area around each plant is maintained weed-free by hoeing. Other residual herbicides that have been or will be tried on pathways only include diphenamid + propachlor, napropamide, and oryzalin (Surflan), since simazine-resistant groundsel (Senecio vulgaris L.) is becoming a problem. Weed control has been labor-intensive in the stock area and more research to gain information on safe (and effective) herbicide programs is needed.

Pruning

Annual pruning is an important aspect of stock plant management in relation to: a) maintenance of juvenility to improve rooting; b) plant shaping (ease of management and faster collection of cuttings); c) timing of flushes; d) increasing cutting production; and e) reducing floral shoots. Pruning normally is done in March–April of each year, but some species, especially conifers, require only removal of cuttings or topping. A limited amount of work has compared various types of pruning and systems found suitable for specific crops are detailed below.

Very hard pruning (“Stooling” without earthing-up). Plants are cut back almost to the ground each year and produce a strong flush of suitable cutting material (e.g., Hydrangea, Senecio). If not cut back hard, species of these genera tend to produce many floral shoots.

Hard pruning. Cutting back the plants by at least half each year has proved the best treatment with some species, but not to the severity of “stooling,” as otherwise unsuitable growth of excessively strong shoots occurs (Table 3). If left unpruned, the shrubs (e.g., Deutzia, Forsythia, Weigela) become floral rapidly. Heathers also receive a relatively hard prune each year to maintain maximum cutting production.

Moderate pruning. Plants are cut back by one-third to one-half each year (e.g., Viburnum × burkwoodii Burk. & Skipw., deciduous azalea). In these examples, secateurs (pruning shears) are used to cut to a bud, thus reducing shoot dieback.

Light pruning. Tipping back or removal of cuttings suffices (Ilex and conifers).

Hedging. Many species are ideal hedging subjects (e.g., Berberis, Pyracantha). With these two vigorously growing examples, overall plant size is reduced by at least half each year. Less vigorous
Table 3. Deutzia scabra Thunb.: Effects of pruning treatments on cutting production over two seasons.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>First season</th>
<th>Second season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hard (stooled)</td>
<td>Medium (cut back by half)</td>
</tr>
<tr>
<td>First year cuttings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usable material</td>
<td>11</td>
<td>40</td>
</tr>
<tr>
<td>Too vigorous</td>
<td>40</td>
<td>25</td>
</tr>
<tr>
<td>Spring shear</td>
<td>150</td>
<td>100</td>
</tr>
<tr>
<td>Cutting removal only</td>
<td>50</td>
<td>30</td>
</tr>
</tbody>
</table>

'Spring shear (cut back by half)' and 'Cutting removal only' are mentioned.

‘One-half of shoot length removed.'

Species receive a lighter trim (Elaeagnus, Cornus). The severity of cutting back often is determined by the ease with which cuttings can be collected from older plants.

‘Renewal pruning’: Some tall plants (such as Camellia and Viburnum bodnantense Aberc) do not produce suitable cutting material in the season following pruning, but, if unpruned, gradually produce fewer and fewer cuttings. A 3-year schedule has proved best for these. Third-year wood is removed (Viburnum) or cut back hard (Camellia) in the spring, promoting a new flush of strong growth unsuitable for cuttings. However, cutting this growth back by half in the second year produces a good flush of cutting material prior to its removal in the third season.

Double pruning. Spring pruning produces a flush of cuttings for summer softwoods or, if delayed, semi-mature autumn cuttings. A second trimming in June can shift the growth flush back to September–October in the case of Berberis or Viburnum × burkwoodii. This double pruning will increase cutting production, but growth is weaker than that on the first flush and can reduce rooting percentage.

Pest and disease control

Plants need routine inspection for pest and diseases and appropriate action taken, either as a routine preventive spray (i.e., some fungicides) or as problems occur, since it is vital that clean, healthy cutting material is taken into the propagation area. Major pest problems in the United Kingdom include aphid, tortrix moth larvae, Eriophid mites, red spider mite, white fly, and scale insects. Root rot and leaf diseases can occur in a stock area, but careful quarantine of plants destined for stock should reduce the incidence of major root problems, unless the soil already is contaminated. The incidence of Rhizoctonia in heathers has become a problem in the United Kingdom. Attention to good cultural practices combined with use of iprodione (Rostral) (8) and growing through Mypex mulches has successfully combated the problem. Powdery and downy mildews also can be troublesome on some species, requiring specific fungicide programs.

The main fungal problems encountered at Efford are leaf diseases of Pestalotiopsis funerea (DSM) Steyaert on Juniperus and a closely related organism on Camellia, Monochaetia karstenii (Sacc. and Syd) Sutton (11). These fungi can be a severe problem in propagation material and young liners, causing severe leaf drop and often death of unchecked. The fungi are wound pathogens, and readily infect stock plants where cuttings are continually removed, thus providing the source of inoculum for later infection. Prochloraz/ manganese complex (Octave) is applied to these two crops on a monthly basis during the growing season, with an application just before cuttings are taken.

CUTTING PRODUCTION

A limited amount of work has been done on cutting production as related to species vigor, which gives some guidelines as to the number of plants required for a given cutting harvest schedule. Data for a representative group of species are given in Table 4.

Manipulation of cutting production

Use of different types of protection can give greater flexibility in stock bed management.

a) Polyethylene covers. Short-term covering with clear or opaque polyethylene can be used to accelerate cutting development, with low tunnels in the case of Hydrangea or walk-in tunnel structures for deciduous Azalea, Magnolia, and Acer. b) Etiolation or partial blanch. Research (7) suggests that covering plants with black polyethylene (or permeable material) for limited periods early in the season to produce etiolated material could have advantages in the propagation of certain difficult-to-root species (i.e., M.9 apple rootstock). Development trials using Hardy ornamentals have given variable results depending on species and season. Rooting of Syringa was improved by etiolation only in one

Table 4. Annual cutting production as influenced by age of plant.

<table>
<thead>
<tr>
<th>Species</th>
<th>Average number of cuttings/plant</th>
<th>Year 7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 3</td>
<td>Year 4</td>
</tr>
<tr>
<td>Rhododendron</td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘Pink Pearl’</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Ilex aquifolium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘Silver Queen’</td>
<td>15</td>
<td>35</td>
</tr>
<tr>
<td>Chamaecyparis lawsoniana</td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘Ellwoods Gold’</td>
<td>20</td>
<td>45</td>
</tr>
<tr>
<td>Thuja occidentalis</td>
<td>15</td>
<td>60</td>
</tr>
</tbody>
</table>

*Plants held in container (quarantine) first year; planted out in stock field second year.

*Actual sizes in each category varied for each species. Ilex: large = 100 mm, medium = 75 mm, small = 50–60 mm; ‘Ellwoods Gold’: large = 90–100 mm, medium = 70–90 mm, small = 50–70 mm; Thuja occidentalis: large = > 200 mm; medium = 150–200 mm, small = 100–150 mm.
out of four seasons’ trials on a nursery site (5). A similar pattern was observed with deciduous Azalea at Efford (6). In the first year, rooting improved 42% with etiolated deciduous ‘Berrysore’ Azalea cuttings, but Botrytis under the etiolation cages caused abandonment of the trial in the second year. Black polyethylene was used in this work; further investigation on a development scale with black permeable materials is needed.

Shade structures

Growing under permanent shade houses improves the quality of stock plants and could be economical for more valuable or shade-requiring species (e.g., Camellia, Rhododendron, Skimmia, Eu- chryphia, Magnolia, and Pieris). Improvement of Camellia is particularly striking under shade.

CONCLUSIONS

Benefits of a separate stock area, rather than taking cutting material from isolated specimens or salable plants, have been demonstrated clearly since the beds were planted. Not only has greater uniformity in the type of material available and ease of management been achieved, but there also has been a striking improvement in overall quality of plants in the subsequent experimental (research) plots.

A considerable amount of information has been gleaned on stock bed management from these observations; however, detailed work is required on herbicide programs and pruning to achieve maximum cutting potential of various species and timing of growth flushes as influenced by forcing technique. Greater understanding of cutting pretreatment techniques on stock plants (i.e., etiolation, growth regulators) is required to see whether cutting production and/or rooting can be improved for selected species. Rooting potential of cuttings from micropropagated plants as compared with conventionally propagated material also needs investigation, since there are indications that the former will root more easily.

The Efford stock collection is clonal in source to increase uniformity for experimental work. Its advantages make it a worthwhile consideration for the commercial situation. This can be done either by progeny selection of the best plant from an established area as replanting becomes due, or by taking up the clones as they are released to the trade from “Clonal Selection Schemes”.

In conclusion, the final quality of the plant produced is dependent on many factors, but it begins with the stock and type of cutting taken. The need for well-graded quality cuttings is an essential starting point in any propagation schedule. Attention to detail and the setting of high standards in the stock-plant area will ensure this good start in the production cycle, which will be reflected throughout the life of the crop.

Literature Cited


Effect of Carbon Dioxide Enrichment During Stock Plant Cultivation

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Carbon dioxide enrichment has become an important factor in ornamental plant production during the past few years. Nurseries, especially those producing cuttings or young plants, increasingly use CO₂ enrichment during stock plant cultivation and propagation. This development was brought about by new and inexpensive equipment for measuring and regulating greenhouse CO₂ concentrations. Although the positive effect of CO₂ enrichment on plant growth has been well established by previous investigations (3, 4, 6, 8, 9), optimum CO₂ concentrations have not been clearly defined. Only a few previous investigations have dealt with the influence of CO₂ enrichment on the growth and yield of stock plants and on successful propagation (1, 2, 5, 7, 10). Therefore, the aim of this study was to find optimum CO₂ concentrations for stock plant cultivation and for the propagation of different plant species. Results with only five cultivars and species are presented, although 15 different species were tested.

Cultivars of five different species [Pelargonium x zonale (L.) L'Hér. et Ait. ‘Empress’; Pelargonium x peltatum (L.) L'Hér. et Ait. ‘Lachskönigin’; Chrysanthemum x indicum (L.) ‘Trumpf’; Fuchsia x hybrida Hort. ex Vilm. ‘Hanna’; and Saintpaulia ionantha H. Wendl. ‘Typ 6’] were grown as stock plants in four greenhouse compartments with different CO₂ concentrations: ambient (350–450), 800, 1200, and 1600 µl·liter⁻¹. Carbon dioxide was applied daily as soon as the light intensity exceeded 200 1x and CO₂ application ceased when the light intensity dropped below 200 1x. To avoid effects of components other than CO₂, CO₂ was used only in the liquid form. The CO₂ concentration was measured by a Siemens CO₂ analyzer at short intervals and was regulated by Dansk Gartneriteknik AS (DGT) equipment. Trials were carried out during the winter (October–March), when the greenhouse vents were mostly closed.

Stock plant cultivation. Stock plants were grown in a standard fertilized peat–clay mixture (Einheitserde P) in plastic pots, containers, or plastic trays. Plant density was 37 plants/m² for the Pelargonium cultivars, 66.7 plants/m² for Chrysanthemums, 44.4 plants/m² for the Fuchsias, and 300 tufts/m² for the Saintpaulias.