Relationships between Stockplant Management and Rooting Environments for Difficult-to-Propagate Cuttings

Brian H. Howard[1] **and Richard Harrison-Murray**
Horticulture Research International, East Malling, Kent ME19 6BJ, UK

Syringa vulgaris **'Madame Lemoine' is difficult to root from leafy softwood cuttings and, at best, can be propagated during a brief period in early summer just before the end of rapid shoot growth. Stockplants must be pruned severely during the previous late winter, and growing shoots in the dark for 2 weeks after budburst improves subsequent rooting compared to normal light-grown cuttings, by reducing stem thickness without reducing leaf area. This treatment appears to increase the carbohydrates available for rooting by reducing the amount needed for stem respiration. The environmental requirements for rooting these cuttings, which are of the same cultivar but differ in their rooting potential, were investigated by setting up gradients of light and wetting perpendicular to one another to give 16 combinations. Dark-preconditioned cuttings in high light had the highest survival rate when wetting was sufficiently generous to prevent wilting. In heavy shade they rotted in greater numbers, and more extensively, than other cuttings. Survival rates determined rooting, with the highest rooting levels produced by dark-preconditioned cuttings in the high light/high wetting zones, and least rooting when they were propagated at the lowest light level. Normal, light-grown cuttings failed to exploit the high light conditions as well as the dark-preconditioned ones, but they survived and rooted relatively better in the low light conditions. There is a general benefit from selecting relatively thin-stemmed cuttings of difficult-to-propagate taxa from any source and rooting them in 20% to 25% available light with generous wetting.**

INTRODUCTION

There are commercially important ornamental shrubs for which there are no reliable methods of summer propagation by leafy softwood cuttings. For example, the double, white-flowered, French-hybrid lilac cultivar *Syringa vulgaris* 'Madame Lemoine' is grafted normally onto rootstocks of the common lilac. This combination produces numerous suckers from its roots which can eventually out-grow the cultivar. These suckers must be removed regularly to prevent the bush reverting to the common type, a problem that would be avoided if the selected cultivar could be rooted by cuttings and grown on its own roots.

Plants such as 'Madame Lemoine' are used as models in a combined physiological, biochemical, and molecular biology programme at HRI-East Malling aimed at understanding the processes which control adventitious rooting in difficult-to-propagate plants. This paper describes the importance of correct stockplant management for producing ready-rooting cuttings of *S. vulgaris* 'Madame Lemoine', and how the optimal balance of light and leaf wetting in the propagation environment is determined by the way cuttings were produced on the stockplant.

[1] Retired 31 Jan. 1997.

MATERIALS AND METHODS

Experiments took place between 1989 and 1995. General conditions are described here, with any changes required in particular experiments described with the relevant results.

Stockplants and Dark-preconditioning Treatments. Well-established hedges of *S. vulgaris* 'Madame Lemoine' were pruned during early March of each year to leave approximately 10 cm of the previous annual growth. As shoots began to grow in early May, they were either left to develop normally (light-grown) or the stockplants were covered with ventilated structures of opaque black polyethylene supported on metal frames (dark-preconditioned). After approximately 2 weeks strips of the black polyethylene cover were removed so that chlorophyll developed in the shoots. As a guide, no more than 50% of the roof area was removed in particularly sunny weather so as to avoid scorching. For further details see Howard and Ridout (1992).

Collection and Preparation of Cuttings. Shoots were collected in early June at about 8:00 AM, taken to a cool humid room, and sprayed with water at intervals during cutting preparation. Distal cuttings were prepared to a mean length of 20 cm with leaves removed from the proximal node, and with at least one pair of fully expanded leaves above. The stem base was treated with 1.25 g liter^{-1} indolylbutyric acid (1250 ppm IBA) dissolved in 50% (v/v) aqueous acetone for 5 sec to a depth of 8 mm and the distal leafy part was dipped in an aqueous suspension of 2 g liter^{-1} benomyl.

Rooting Environment. Cuttings were inserted to a depth of approximately 7 cm in a rooting medium consisting of sphagnum peat and finely granulated pine-bark (1 : 1, v/v), held in square plastic pots set down on a bed of fine sand to facilitate rapid drainage.

Rooting took place in one of two facilities and was assessed after approximately 4 weeks. Normally, cuttings were propagated at 20C bottom heat in a polythene house with air temperature partially controlled by shading to give approximately 20% available light in conjunction with forced ventilation operated at 27.5C. A fan-distributed "wet fog" (Agritech) system in the polythene house was controlled by an evapostat with timer back-up. This wet-fog system also always operated during periods of forced ventilation to ensure that leaves were constantly wet and that the air was visibly foggy during daylight hours (fog house).

A controlled propagation environment (CPE) was constructed by erecting a transparent polyethylene (50 µm) enclosure supported on a metal framework in a temperature-controlled room. A row of high pressure sodium lights (Philips 400 W SON-T SGR 104-400) was installed above and along one edge of the structure, which, together with a vertical reflector of black/white sandwich polyethylene hung inside the structure, produced a light gradient across the propagation bed. A wetting gradient perpendicular to the light gradient was achieved by placing a pneumatic fogging nozzle (Type 052 Sonicore) at one end of the structure, with the frequency of fogging controlled by timer to give 25 sec on and 75 sec off during the 12-h light period.

For experimental purposes each gradient was subdivided into four levels, thereby creating different combinations of light and wetting. The mean levels of photosynthetic photon flux density along the light gradient at cutting level were 289, 154, 28, and 17 µmol m^{-2} s^{-1} during a 12-h photoperiod, and the mean water depositions along the wetting gradient were 209, 103, 39, and 13 µm h^{-1}. These conditions reflected well the range of light and wetting in the fog house, except that the lower light levels were more extreme than those measured during dull weather and reflected also conditions at dawn and dusk. Additional details are given by Howard and Harrison-Murray (1995) and further developments of the CPE concept to produce "environmental fingerprints" for cuttings are described by Dr. Harrison-Murray in the Region of Great Britain and Ireland section of this volume.

RESULTS

Stockplant Conditions.

Pruning Severity and Apex Removal. A reduction in the severity of annual winter pruning to leave approximately 30 cm, instead of 10 cm, of the previous year's growth reduced the highest level of rooting obtained during the following summer from 78% to 17%. Removal of the shoot apex, either 2 weeks before collecting the cuttings or at the time of cutting collection, had no significant effect on percentage rooting, but halved the numbers of roots produced per cutting from a mean of 6.9 to 3.4 (mean of apex removal on both occasions). Shoot apices begin to abort naturally during the later stages of propagation.

Shoot Condition and Season of Cutting Collection. High levels of rooting were confined to cuttings collected during early June, when up to 80% success was obtained just prior to the cessation of shoot extension. By July, cuttings had become heavily lignified and rooting fell to below 20%. This brief period of optimal rooting was determined by the condition of the stem tissue. Similar seasonal trends in rooting were obtained in the variable conditions of the fog and in stable CPE conditions. Delaying shoot growth by holding dormant container-grown plants in cold-store for a month at 2C produced a peak in rooting similar to that in cuttings from normal stockplants grown in the field, but delayed by 1 month. For further information see Howard (1996).

Effects of Dark-preconditioning on the Ratio of Cutting Leaf Area to Stem Weight, and Rooting. The main effect of growing shoots in the dark for 2 weeks before weaning into approximately 50% light for a further 2 weeks before cutting collection, was to increase significantly the ratio of leaf area : stem weight (or thickness) and rooting, compared to normal light-grown cuttings. The relationship between the leaf area : stem fresh weight ratio and rooting could be predicted from a log-linear model (Table 1).

Dark-preconditioning reduced the leaf area : stem weight ratio by causing a reduction in the dry matter content and the thickness of the stem without reducing leaf number or area. These cuttings photosynthesised at similar rates to normal light-grown ones (results not shown), but the respirational demands of the smaller stems of the dark-preconditioned cuttings were less; it was concluded that more carbohydrates were available to support rooting.

By separating cuttings into different size grades before rooting, it was shown that relatively small, thin-stemmed cuttings rooted best, irrespective of their source, and that the model had general application beyond the effects induced by dark-preconditioning.

Table 1. Experimentally observed rooting percentages and root numbers per rooted cutting compared to those predicted by a log-linear model incorporating area and numbers of leaves, and stem fresh weight (stem diameter gave virtually identical results)

	Light-grown		Dark-preconditioned	
	Observed	Predicted	Observed	Predicted
Rooting (%)	16	14	74	68
Root numbers per rooted cutting	5 3	7 9	26 1	18 5

Responses of Light-grown and Dark-preconditioned Cuttings to Light and Wetness Gradients During Propagation. On the 10th day, just prior to root emergence, measurements of the dry weight of the basal 35 mm of stem (rooting zone) were compared with those taken at the start of the experiment The largest gains in dry matter occurred in the dark-preconditioned cuttings in the high light/heavy wetting zones, with much smaller dry matter gains in the normal light-grown cuttings. Gains in dry matter were smaller in the high light/low wetting zones, where cuttings were stressed severely. All cuttings at the two lowest light levels, irrespective of wetness, lost dry matter during the first 10 days, and, at the lowest light level, this was more severe in the dark-preconditioned cuttings. Under the most favourable conditions the proximal 35 mm of stem in the dark-preconditioned cuttings showed an increase of approximately 40% in dry matter, while in the least favourable conditions they showed a loss of the same magnitude

Basal rotting was evident in some light-grown cuttings in most environments. Among the dark-preconditioned cuttings this was less serious or absent in high light, but was more frequent and more extensive in low light The combination of high light and low wetting caused both types of cuttings to wilt permanently, despite the rooting medium being watered directly

The extent to which cuttings survived in the different environments determined the frequency of rooting. Dark-preconditioned cuttings, which neither rotted nor wilted in the high light/heavy wetting zones, rooted in the largest numbers; no cuttings from either source rooted in the high light/low wetting zones where serious wilting occurred

The frequency of rooting decreased generally as light levels decreased, but light-grown cuttings performed slightly better than dark-preconditioned ones at the lowest light level, reflecting the high levels of rotting in the latter. No rooting occurred in cuttings from either source in the lowest light/heaviest wetting zone Rooting responses are shown in Figure 1.

DISCUSSION

The use of well-established, field-grown stockplants is particularly important in subjects where rooting occurs for only a brief period, because the numbers of cuttings which root readily can be maximised by severe winter pruning and, if desired, by

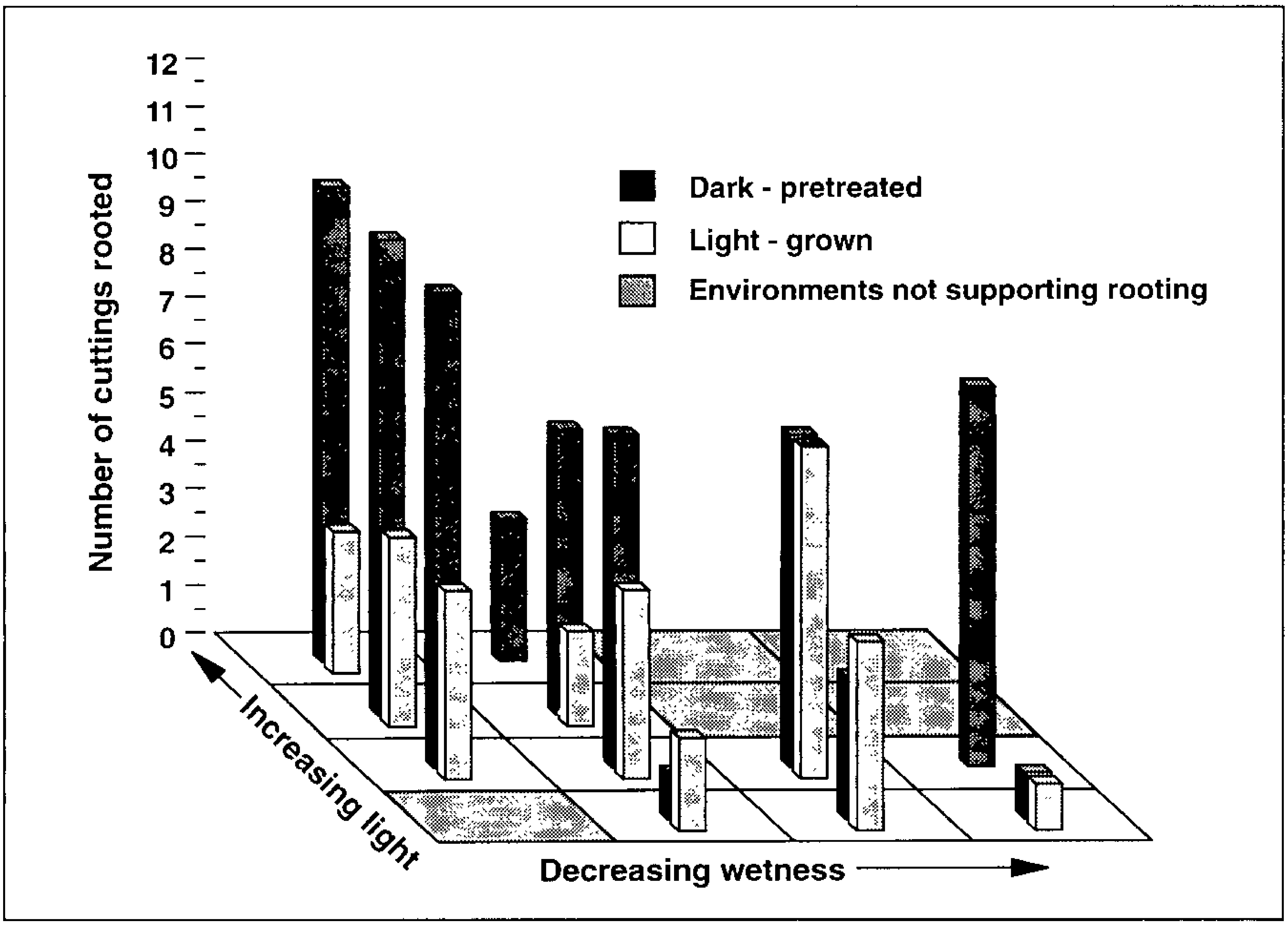

Figure 1. Numbers of rooted cuttings out of 12 from dark-preconditioned and light-grown sources when propagated in different combinations of light and wetness.

dark-preconditioning. Shoots from container-grown plants rooted equally well to those from the field, but cutting production per stockplant was much lower.

It is not necessary to retain the shoot apex which can, therefore, be pinched out to encourage lateral production. The timing of collecting cuttings is critical and they must be propagated during the later stages of rapid shoot extension. Delaying propagation beyond early June in south-east England, or preparing cuttings at a relatively old (proximal) node, will result in little or no rooting.

The advantage of dark preconditioning appears to be an increase in leaf area : stem mass ratio, effectively maintaining similar photosynthetic ability, but with reduced respirational demand, compared to thicker-stemmed light-grown cuttings. Under suitable environmental conditions dark-preconditioned cuttings accumulated more carbohydrate (measured as dry matter increase) in the rooting zone of the stem. This reduced the frequency and extent of rotting and increased rooting compared to normal light-grown cuttings. These experiments showed also that there is general advantage when propagating difficult-to-root subjects in selecting relatively thin-stemmed cuttings.

These difficult-to-root cuttings showed a remarkable ability to root over a wide range of rooting environments, as long as the balance of light and wetting was correct. At high light, wetting had to be heavy to avoid wilting and, at low light, wetting had to be minimal so as not to exacerbate rotting. These combinations are the opposite to those often found in commercial practice where high light is often accompanied by relatively dry conditions, and heavy shade with relatively wet conditions — circumstances which gave no rooting in these experiments.

Acknowledgements. This work was funded by the Ministry of Agriculture, Fisheries, and Food. Figure 1 is reprinted by permission of the Journal of Horticultural Science and Biotechnology.

LITERATURE CITED

Howard, B.H. 1996. Relationships between shoot growth and rooting of cuttings in three contrasting species of ornamental shrub. J. Hort. Sci. 71:591-605.

Howard, B.H. and **M.S. Ridout.** 1992. A mechanism to explain increased rooting in leafy cuttings of *Syringa vulgaris* 'Madame Lemoine' following dark treatment of the stockplant. J. Hort. Sci. 67:103-114.

Howard, B.H. and **R.S. Harrison-Murray.** 1995. Responses of dark-preconditioned and normal light-grown cuttings of *Syringa vulgaris* 'Madame Lemoine' to light and wetness gradients in the propagation environment. J. Hort. Sci. 70:989-1001.