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PROPAGATION OF HARDY RHODODENDRONS

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ABSTRACT. Factors influencing the rooting of hardy rhododendron cuttings are described. Although rooting will be delayed where cuttings are propagated with a base temperature of 15°C, the extent of rooting will differ little as compared with a regime where temperatures are held at 21°C. Basal rotting will increase where temperatures are kept above 25°C and this may be the result of a detrimental interaction between high temperature, low light and high moisture levels in the compost. The use of growth regulators stimulates root production and this is demonstrated in experiments where a range of concentrations of indolebutyric acid (IBA) are applied to cuttings. Wounding the bases of cuttings also improves the incidence and quality of rooting. Excess wounding pre-disposes the cutting to basal rot whilst the removal of a light sliver from the basal 3cm of stem results in the emergence of roots along the length of the wound.

INTRODUCTION

The procedures of grafting and layering, though tedious, have nevertheless been very successful as methods of propagation of hardy rhododendrons. However, with the advantages of modern aids and a greater understanding of the physiology of these plants, attention has been focused on alternative propagation techniques which are faster and more productive. Thus, the rooting of cuttings has received much attention over the last thirty years, and recently the technique of micro-propagation has opened up new possibilities for the nurseryman in mastering rapid production methods and making more effective use of scarce propagation material.

This paper will consider the principal factors connected with rhododendron propagation from cuttings, as this method has superceded other systems, at least in the commercial sense. Although many highly refined operations have been described such as the use of low level radiation for improving rooting in order to dispense with the operation of stem wounding, factors such as timing, wounding, use of growth regulants, and base temperature during propagation are generally regarded as those with the greatest influence on rooting.

FACTORS INFLUENCING ROOTING

TIMING

It is more usual to propagate hardy rhododendron cuttings from material which is ripe. The cuttings are in this condition from October onwards and the best rooting results have been obtained during November and December (Van Elk, 1973). Although much success has also been reported for September cuttings, the influence of differing seasons on stem ripeness will be more evident in this month than later on.

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Cuttings of hardy rhododendrons generally fail to root from softwood cuttings, especially in improperly controlled mist systems (Wada, 1974). When such soft material is used, it must always be kept turgid from the time of removal from the mother plant, to the rooting stage. To assist in the reduction of evapo-transpiration, cutting away half of the larger leaves is an aid.

Cuttings of *R.* 'Pink Pearl', 'Purple Splendour', 'Lady Chamberlain' and 'Lady Roseberry' were taken at the end of July (Kelly, 1981). They were wounded, treated with 0.8% indolebutyric acid (IBA) power and propagated with a base temperature of 20°C in both the mist and warm bench with a covering of light polythene. The cuttings of 'Pink Pearl' failed to root and those of 'Purple Splendour' reached 30% in both systems. A notable feature was the high mortality under mist of 'Lady Roseberry' cuttings (85%) whilst under the warm bench and plastic, rooting reached 63%. Rooting was also higher in the latter system with cuttings of 'Lady Chamberlain' (80% vs 50%).

The rooting of large-flowered hardy hybrids from softwood cuttings requires exacting conditions whereas the use of well lignified cutting material in autumn or early winter is less prone to inadvertent neglect in the collection and handling stages. In addition, winter propagated material will root by early spring to coincide with the commencement of the growing season. Conversely for those softwood cuttings which root in September, the commercial grower must hold the plantlet in good condition during its six months dormancy, unless he is prepared to aid its growth by the use of heat and light.

In contrast many hardy dwarf rhododendrons root better from semi-ripe cuttings (July) than from hardwood cuttings in February (Kelly, 1978a). All cuttings were taken at a node, treated with 0.8% IBA powder and rooted under warm bench and plastic where the base temperature was held at 20°C. The hardwood cuttings were lifted 3 to 4 months after insertion and the July cuttings checked for rooting after 5 months. Table 1 shows the rooting percentages.

TABLE 1
Rooting percentages of cuttings of dwarf rhododendrons on two dates

Name	8 February	13 July
R. 'Blue Tit'	83	62
R. cilpinense	10	92
R. concatenans	8	32
R. glomerulatum	6	0
R. hippophaeoides	38	50
R. impeditum	26	43
R. leucaspis	50	100
R. macrostemmon	53	100
R. moupinense	15	76
R. mucronatum	0	41
R. tebotan	72	100
R. tschonoskii	43	32

Many hardy dwarf rhododendrons will root well from February cuttings but the majority of subjects tested in this trial have a clear advantage from July propagation. The February cuttings, however, will attain a greater size than July cuttings within the first growing season and will subsequently reach saleable size up to one year earlier.

WOUNDING

The rooting of many hardy rhododendrons can be improved by wounding the base of the cutting. Personal observation and the experiences of plant propagators (Wells, 1962, 1966) strengthen the view that wounding improves both the incidence and quality of rooting. The particular type of wounding has been investigated (Kelly, 1978b). Six hardy hybrid cultivars, 'Pink Pearl', 'Britannia', 'Prof. Zaayer', 'Cynthia', 'Gomer Waterer', and 'Purple Splendour' were tested for rooting after being given (a) a single heavy wound, (b) a double heavy wound and (c) a chip wound. The latter type is an uncompleted single wound in which a small stub is left on the base of the cutting. The heavy wound entails the removal of a sliver of wood from the basal 3cm of stem. The highest number of deaths occurred where cuttings were treated with a double wound. There was no significant difference between wound types in numbers rooted. The chip wound takes slightly longer to execute and thus for a commercial operation the single wound is recommended.

According to other findings (Van Elk, 1973), several hardy hybrid cultivars propagated on three different dates and given either single light or heavy wounds showed higher rooting percentages where the light wound was applied.

Despite rooting percentage increases in some cultivars of dwarf rhododendrons where wounding was used the majority of subjects responded adversely to the treatment (Kelly, 1974). Basal rot was notable in cuttings inserted in February under warm bench and plastic after treatment with 0.8% IBA powder and wounding of *R. repens* 'Gertrude Schale', *R. williamsianum* 'Bountiful', *R.* 'Hummingbird' and *R.* 'Blue Tit'. In this test the cuttings were heavily wounded, and this is the treatment which is detrimental to subjects with such a small diameter stem. A very light scrape wound may result in less basal rot.

GROWTH REGULATORS

The treatment of the base of the cutting with a growth regulant in order to promote faster and more comprehensive rooting has long been practised. The three most commonly used acids are indolebutyric (IBA), naphthaleneacetic (NAA) and indoleacetic (IAA) acids. Several other compounds in both powder and liquid form have been employed (Gray, 1978). Working with cuttings of *R.* 'Nova Zembla', taken in November, it was reported that prewounded cuttings were soaked in a sodium hydroxide solution at pH 10·5 for $\frac{1}{2}$ hour. The cuttings were then washed in tap water (pH 6·5) and treated with IBA either in talc or in isopropyl alcohol (2-propanol). Best rooting (100%) came from IBA at 5000 ppm in alcohol.

A proprietary rooting powder containing 0.8% IBA powder was

TABLE 2
Rooting percentages of *R.* 'Britannia' cuttings after treatment with four levels of IBA (means of four replicates)

Treatments	% Rooting
0.8% IBA + 5% Captan	17
2·0% IBA + 5% Captan	12
10% IBA + 5% Captan	25
4000 ppm IBA in alcohol	42
Control	5

compared with powder of 0·6% IBA plus 20% Captan dust on a range of hardy hybrid cultivars (Kelly, 1976). Both treatments gave significantly better rooting than where hormone treatment was absent and did not differ from each other except with 'Purple Splendour' (75% vs 44%).

Although many species and cultivars of hardy rhododendrons show a rooting response to normal doses of growth regulant powders, those regarded as more difficult to root often respond to growth regulants prepared in alcohol solutions (Kelly, 1969). 'Britannia', a shy rooting cultivar was used in a test in which 0·8%, 2% and 10% IBA powder plus 5% Captan dust were compared with a treatment of 4000ppm IBA in alcohol. The cuttings were inserted on 28 October, and propagated under mist with a base temperature of 20°C. The cuttings were lifted on 8 January. Untreated cuttings showed poor rooting (5%) as did those which received the powder treatments (15%). A higher percentage (42%) of cuttings rooted when the concentrated dip treatment of 4000ppm IBA was given (Table 2).

Trials in USA (Wells, 1963) indicate that the addition of Captan powder (10% strength) to IBA powder (2%) improved the quality and the percentages of rooting. It was also noted that there was a mild inhibitory effect on the top growth of the cuttings after rooting. There would thus be an advantage for commercial growers who take cuttings in sequence over some months and who wish to maintain some uniformity in growth pattern.

The investigation of the use of proprietary hormone powder (IBA 0·8%) and benomyl (5%) or thiabendazole (10%) (Hoitink & Schmitthenner, 1970) resulted in improved rooting of *R.* 'H. C. Dresselhuys' and 'Roseum Elegans'. Benomyl (Benlate 50% w.p.) was mixed with 0·8% IBA in talc at rates of 1, 2, 2·5, 5, 10 and 15% benomyl. Thiabendazole (TZB 60% wettable powder) was mixed with 0·8% IBA in talc to give 2·5, 5, 10 and 15% thiabendazole. Rooting percentages were notably higher in all these treatments than where mixtures of 0·8% IBA powder and thiram or Captan were used (90% vs 60% mean rooting).

Considerable rooting benefits from the use of 0·8% IBA powder were shown (Kelly, 1971) where the mist system of propagation was compared with that of warm bench and plastic covering (Table 3).

TABLE 3
Rooting percentages of hardy hybrid rhododendrons after treatment with 0.8% IBA in different propagation systems

	Propagation system			
	Mist		Warm bench & polythene	
Cultivar	0.8% IBA	NOH*	0.8%	NOH*
'Britannia'	12	2	10	4
'Purple Splendour'	78	18	46	6
'Pink Pearl'	56	36	72	60

*No hormone.

BASAL TEMPERATURE

Hardy rhododendrons are prone to basal rot especially when propagated during the lower light periods of the year with high base temperatures. In a propagation experiment (Whalley & Loach, 1977) on *R.* 'Pink Pearl', 'Fastuosum Flore Pleno' and 'Mrs. R. S. Holford' base temperatures of 15, 20, 25°C were used on cuttings which were inserted in November. Basal rot of the cuttings was more frequent in the three cultivars at the highest temperature, but of those cuttings which did not rot, rooting was correspondingly better at the higher temperatures. The numbers of survivors were highest at the lower temperatures. When expressed as an overall percentage of the original numbers of cuttings inserted, rooting for all three cultivars was highest at 15°C and lowest at 25°C. In other tests (Kelly, 1975) single-wounded cuttings of several cultivars of hybrid rhododendron, immersed in a Captan solution and then treated with 0·8% IBA powder were propagated under warm bench and plastic in two basal heat regimes, i.e. 15°C and 21°C in mid-November. Cuttings at the lower temperature were left one month longer in the bench and lifted four months after insertion. This test was notable for the low numbers of plants with basal rot. Table 4 shows the rooting results, from which it is seen that no distinct overall advantage lay with either temperature regime.

TABLE 4
Rooting percentages of hybrid rhododendrons in two propagating temperature regimes. (Mean of three replicates)

	Basal temperature	
Cultivar	15°C	21°C
'Cynthia'	75	100
'Doncaster'	86	77
'Pink Pearl'	55	71
'Hugo Koster'	92	87
'Gomer Waterer'	83	71
'Purple Splendour'	75	75

MICRO-PROPAGATION

The use of this modern technique, which involves the culturing of shoot tips in a nutrient solution, is suitable for propagating clones of rhododendrons which are difficult to root by conventional methods. It is estimated (Anderson, 1975) that 10 years are required to develop sufficient stock of a new clone for large volume sales but that this technique, which allows rapid production in the initial stages, could shorten development by several years.

In Anderson's experiments, shoot tips of the plants to be propagated were surface sterilized, rinsed several times and then placed on the nutrient medium. Cultures were kept in a room with temperatures from 19–23°C. Lighting was by cool white fluorescent lamps with an intensity of c.1000 lux on the cultures and with a daylength of 16 hours. The essential compounds required for shoot development in the basal medium were 80 mg/l of adenine sulphate dihydrate, 15 mg/l of Zip (N^6-(Δ^2-isopentenyl)adenine) and 4 mg/l of indoleacetic acid. This combination of compounds resulted in an average increase of 6·2 shoots per culture in 3 weeks. Further work (Anderson, 1978) was directed at rooting the shoots produced in culture. A soil mix composed of 72% peat, 18% perlite and 9% sand with 1 kg of 18-6-12 Osmocote per $1m^3$ compost improved the general health and survival of the plantlets compared with a control where no fertilizer was added to the soil mix. According to Kyte & Briggs (1979) shoots for rooting can be transferred to a sterile root-inducing agar or removed from sterile culture and placed in a growing mix in a covered container. In either case, roots will appear in two months. In the succeeding six to twelve months the plantlets will produce normal size foliage and can then be containerized in preparation for final sale.

The commercial production of hardy rhododendrons from micro-propagation is relatively new. Although many refinements have been tried on media to optimize proliferation and rooting procedures, experiments must take account of the acclimitization of plantlets to less favoured conditions than those in tissue culture laboratories (Strode, Travers & Oglesby, 1979). At this stage the young leaves, with their thin cuticle layer and less than the usual amounts of pigments, will require the protection of a humidity tent during the first few days of this period. Frequently, the early high level of branching, in these early stages of growth as a rooted plant, may be due to the high levels of growth regulants used in the culture solutions.

Close observation of the growth and flowering characteristics should be maintaned as aberrations are possible. So far, however, clones observed through the growth and bloom cycle have altered little from the parent plants.

DISCUSSION

Because of the more exact control of the environment now possible through modern aids and materials, most rhododendrons are being propagated by the conventional cutting or micro-propagation techniques. The manipulation of many factors allows propagators to form reliable routine systems for a genus which has many easy, medium and difficult to

root species. In addition to the factors discussed here there is evidence that a range of pre-treatments, such as the use of herbicides on stock beds (Ahrens, 1972) or the exposure of cutting bases to low level radiation (Vaughn, 1979), will affect the rooting potential of hardy rhododendrons. These and other treatments will influence rooting only marginally, while the primary factors, such as timing, base temperature, wounding and use of growth regulants, affect the success rate in a more substantial manner.

Adequate precautions must be taken should softwood cuttings be the chosen method of propagation. The maintenance of high humidity is essential as excess evapo-transpiration will cause severe damage to the young leaves. This is in contrast to the cuttings propagated in early winter when, rather than leaf rot, the principal source of damage is stem rot, brought about by the interaction of base temperature and light.

The benefits to rooting by the use of growth regulants are considerable and have been the most important factor in the advances made in propagating hardy rhododendrons from cuttings. Basal wounding of cuttings leads to more rapid and comprehensive rooting. This is important in considering the economics of rhododendron production. Micro-propagation, although yet not practised on a broad scale for rhododendrons, has the twin advantage of being an effective means of increasing plant numbers in species and cultivars which are difficult to root by conventional methods, and of allowing a speedy build up of stock of new clones and hybrids. To take advantage of the benefits of micro-propagation, new handling techniques must be perfected by commercial growers prior to reverting to good nursery husbandry for the growing-on procedures.

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QUESTIONS

K. Hulme: Has Mr Kelly carried out any treatments to compare wounding and non-wounding cuttings?

Kelly: Yes. In practically every case it has decided advantages, provided it was not a deep wound, which we usually associate with basal rot. This applies to hardy hybrids not Lapponicum hybrids.

A. C. Clark: Is the base temperature in any way tied up with the ambient temperature for successful rooting?

Kelly: We have had better rooting where the structure has been of plastic rather than a greenhouse which retains moisture less. It seems that an adequate base temperature can overcome a fairly low ambient temperature.

A. C. Clark: Has any work been done using a 24 hour soak?

Kelly: Yes. It is not an attractive proposition for the nursery trade. For some *Ilex* cultivars like 'Silver Queen' and 'Golden King' the powder has been shown to be more successful than the soak. The Dutch recommend soak techniques for quite a few species but we have not used it with rhododendrons.

E. H. King: You suggested that one could not wound dwarf rhododendrons because of damage. If you are light-handed you can successfully propagate the tiniest dwarf rhododendron.

Kelly: When a wound may be beneficial we often use a scrape wound holding the blade of the knife at right angles.

E. H. King: Have you tried a rooting medium called 'Roota'. It came on to the market as a liquid and it was on the label to be used on dwarf rhododendrons. When I tried it, it killed every one. I suggest that nobody tries 'Roota'.

R. Stevenson-Clark: A power cut lasting two whole days and nights finished a lot of my cuttings this year.

Kelly: I am surprised. Were they particularly tender?

R. Stevenson-Clark: No, there were some tender, some hybrids and some hardy species and I lost the lot.

Kelly: I doubt that such a cut at low temperature would cause such a loss. You are more likely to lose them through excess heat.

Unidentified Speaker: We all know that some hardy hybrids like 'Cunningham's White' are easy to root while others, like 'Brittania' are very difficult. Has any research been done to find the differences in the hormones present to find out why?
Kelly: Not by us. There have been some rather detailed studies on root functions and what predisposes the plant to root. There are subtle differences between the cytokinin and ozone content of the various rooting chemicals within cuttings. There are ozone barriers to rooting because of the bark constituents and epidermis. We speak about plants being easy or difficult. However, attention during the propagation and post-propagation period often determines whether you have successful or unsuccessful rooting. The impact of modern aids is only minor; they may make a difference of 10–15%, but basically careful gardeners were perfectly capable of rooting to an acceptable level before they were available.
G. A. Petterson: In N America there is quite a lot of excitement about the use of an extract of willow. Have you tried this?
Kelly: No.
W. Spethman: Have you used a solution of IBA in acetone? It has been very successful in other species.
Kelly: No, I have seen a number of references to its use in Germany. I have written for information but have not yet received a reply.