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Effect of growth substances on the rooting of cuttings of rhododendron species

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ABSTRACT

Cuttings of the following rhododendron species were rooted: the evergreen *R. catawbiense* Michx. 'Grandiflorum', *R.* 'Cunningham's White', *R. brachycarpum* D. Don ex G. Don, *R. pachytrichum* Franch. (with green and red shoots), *R. yakushimanum* Nakai as well as the deciduous *R. atlanticum* (Ashe) Rhed., *R. calendulaceum* (Michx.) Torr., and *R. viscosum* (L.) Torr. The cuttings were treated with IBA (0.5, 1, 2, and 4%) in talcum powder with or without the fungicide Captan (2 : 1), or else with Seradix B2 (containing 0.4% IBA) and B3 (containing 0.8% IBA). The rooting level depended strongly on species. The highest percentage of rooted cuttings was recorded for *R. catawbiense* 'Grandiflorum', *R.* 'Cunningham's White', *R. atlanticum*, and *R. viscosum*, irrespective of the applied growth substance. *R. brachycarpum* cuttings rooted the best when 2% IBA had been applied with or without Captan. Rooting of *R. pachytrichum* strongly depended on the form: with red or green shoots. Cuttings

of red shoots rooted much better than those of green shoots, irrespective of the applied growth substance. Cuttings of *R. yakushimanum* rooted the best after application of 4% or 2% IBA with or without Captan, while *R. calendulaceum* after 1% IBA with 1% Captan. Application of Captan alone and Seradix B3 did not give positive effects.

INTRODUCTION

The majority of cultivated azaleas and evergreen rhododendrons are interspecific or intervarietal hybrids. The basic methods of their propagation include: grafting, cuttings, layers, and division of mother plants (Craig 1975, Czekalski 1991, Nawrocka-Grześkowiak 2001 b). Propagation by division and layers is rarely applied, mainly by amateurs, while in nurseries mainly cuttings and grafts are used. Many interesting species that have not yet been popularized are grown mainly from seeds. They have beautiful flowers and are resistant to low temperatures and unfavourable seasonal distribution of precipitation. These features enable their cultivation troughout Poland (Bugała 2000). The objective of this study was to develop effective methods of rooting of these valuable species.

MATERIAL AND METHODS

Mainly the species that are resistant to low temperatures (Heft 1966, Scheiber et al. 1999, Muras and Lukosek 2000) and unfavourable climatic conditions were used in this study: the evergreen *Rhododendron catawbiense* Michx. 'Grandiflorum', *R.* 'Cunningham's White' (hybrid between *R. caucasicum* and *R. ponticum* 'Album'), *R. yakushimanum* Nakai, and the less popular *R. brachycarpum* D. Don ex G. Don, *R. pachytrichum* Franch., as well as the deciduous *R. atlanticum* (Ashe) Rhed., *R. calendulaceum* (Michx.) Torr., and *R. viscosum* (L.) Torr. Some of those rhododendrons are characterized by a great potential to regenerate adventitious roots. These include *R. catawbiense* Michx. 'Grandiflorum' and *R.* 'Cunningham's White', which were used here for comparison with the rooting level of less popular species.

Cuttings were collected from old shrubs growing in the Kórnik Arboretum: from current-year shoots of evergreen rhododendrons in mid-October and from one-year-old shoots of the deciduous azaleas in mid-June. The cuttings were apical parts (10-12 cm long) of the shoots, cut off just below a node. In evergreen rhododendrons, a narrow strip (about 1 cm) of bark was removed at the base. Removal of a narrow strip of bark at the base of cuttings resulted in increasing the

percentage of rooted cuttings and size of the formed root systems (Ylätao 1979, Wells 1981).

Rooting was stimulated by treatment with an auxin (indolebutyric acid, IBA) at concentrations 0.5%, 1%, 2%, and 4% in talcum powder with or without the fungicide Captan (2 : 1). In other variants of the experiment, commercial rooting promoters were used: Seradix B2 (containing 0.4% IBA) and Seradix B3 (containing 0.8% IBA).

All cuttings were rooted in a mixture of peat, pine bark compost, and sawdust of various tree species (1 : 1 : 1). They were kept in a greenhouse on a windowsill, under a polyethylene cover. During rooting the cuttings were sprayed preventively with 0.2% Captan or 0.2% Benlate (alternately) every 14 days.

During transplantation in spring, i.e. after 8 months in the case of evergreen rhododendrons and 9 months that of azaleas, numbers of dead, diseased, healthy rootless and healthy rooted cuttings were recorded, and root system size was assessed. At the end of each experiment, the percentage of rooted cuttings was assessed and root system size was classified on a scale of 0 to 6: 0 = non-rooted cuttings producing callus, 1 = few small roots, 2 = root-ball volume: 1-8 cm^3, 3 = root-ball volume: 8.1-27 cm^3, 4 = root-ball volume: 27.1-64 cm^3, 5 = root-ball volume: 64.1-180 cm^3, 6 = root-ball volume: >180.1 cm^3. Diseased and rotten cuttings were regarded as dead.

The experiment was established in a randomized block design with three replicates. Each combination was represented by 24 cuttings (8 cuttings per replicate). The results were subjected to an analysis of variance. The significance of differences between individual combinations was assessed by Tukey's multiple range test for threshold values 5%.

RESULTS

Root system size and the percentage of rooted cuttings depended on the applied growth substance as well as on species. The highest rooting level (100%) was recorded for *R.* 'Cunningham's White' under the influence of 4% IBA and Seradix B2 (Table 1). Control cuttings, as well as those treated with the auxin at other concentrations and in combination with Captan or treated with Seradix B3, also gave very good results: over 90% of them rooted and developed large root balls (Table 2). In the case of *R. catawbiense* 'Grandiflorum', the highest percentage of cuttings rooted after treatment with 4% IBA with Captan (100%), 1% IBA (91.6%) or Seradix B2 (87.5%). Interesting results were recorded for *R. brachycarpum*, where the largest root systems (up to about 250 cm^3 for single cuttings) and the highest percentage of rooted cuttings (54.1%) were observed after treatment with 2% IBA with Captan. Good results for this species were noted also after application of 2% and 4% IBA, or 4% IBA with Captan (from 41.6 to 45.8%)

(Table 1). In *R. pachytrichum*, cuttings of the form with red shoots rooted much better than those of the form with green shoots (after treating IBA 1% and IBA 1% with Captan), as the latter gave worse results than all the other species. For the form with red shoots, the best rooting stimulant was 2% IBA with Captan or 4% IBA (33.3% of rooted cuttings). The green form rooted the best under the effect of 2% IBA (25%) and 4% IBA (16.6%). The last species, *R. yakushimanum*, had the highest percentage of rooted cuttings after application of 4% IBA with Captan (41.7%) and 2% IBA with Captan (33.3%).

Table 1. Effect of growth substances and Captan (a fungicide) on the rooting of cuttings of selected evergreen rhododendron species

Treatment	Rooted cuttings (%)					
	R. 'Cunningham's White'	*R. catawbiense* 'Grandiflorum'	*R. yakushimanum*	*R. pachytrichum*		*R. brachycarpum*
				green-shoot form	red-shoot form	
Control	95.8 c	58.3 d	4.1 b	8.3 c	12.5 a	12.5 b
IBA 1%	95.8 c	91.6 h	12.5 c	0.0 a	25.0 b	20.8 d
IBA 1% + Captan	91.6 b	54.1 c	20.8 e	0.0 a	29.1 c	16.6 c
IBA 2%	91.6 b	66.6 e	20.8 e	25.0 f	25.0 b	45.8 f
IBA 2% + Captan	95.8 c	58.3 d	33.3 g	8.3 c	33.1 d	54.1 g
IBA 4%	100.0 d	45.8 b	29.1 f	16.6 e	33.3 d	41.6 e
IBA 4% + Captan	87.5 a	100.0 i	41.7 h	4.1 b	12.5 a	41.6 e
Captan	95.8 c	75.0 f	0.0 a	16.6 e	12.5 a	8.3 a
Seradix B2	100.0 d	87.5 g	12.5 cd	12.5 d	33.3 d	20.8 d
Seradix B3	95.8 c	37.5 a	12.5 cd	8.3 c	41.6 e	12.5 b

Values marked with the same letter do not differ significantly

Table 2. Effect of growth substances and Captan (a fungicide) on the root system size of cuttings of selected evergreen rhododendron species

Treatment	Root system size (scale 0-6)					
	R. 'Cunningham's White'	*R. catawbiense* 'Grandiflorum'	*R. yakushimanum*	*R. pachytrichum*		*R. brachycarpum*
				green-shoot form	red-shoot form	
Control	4.28 ab	3.22 ab	0.30 ab	0.30 ab	0.33 a	0.33 a
IBA 1%	4.18 ab	4.06 abc	0.40 abc	0.00 a	1.41 ab	1.74 a-d
IBA 1% + Captan	3.56 a	2.91 ab	1.13 a-d	0.00 a	1.16 ab	1.31 abc
IBA 2%	4.02 ab	3.58 abc	1.56 b-e	1.40 bc	1.16 ab	2.88 bcd
IBA 2% + Captan	4.23 ab	2.56 ab	1.95 de	0.34 ab	1.12 a	2.84 bcd
IBA 4%	4.39 ab	2.41 ab	2.04 de	2.10 d	2.31 ab	2.21 a-d
IBA 4% + Captan	3.50 a	3.99 abc	3.13 f	0.16 ab	0.95 a	1.14 abc
Captan	3.44 a	3.77 abc	0.00 a	0.66 ab	0.68 a	0.42 a
Seradix B2	5.19 ab	5.19 abc	0.67 abc	0.63 ab	0.66 a	1.00 ab
Seradix B3	4.50 ab	2.23 a	1.02 a-d	0.77 abc	1.11 a	0.97 ab

Root system size = number of rooted cuttings in a given class number x class number/number of cuttings per replicate

Among azaleas, the best results (83.3% of rooted cuttings) were obtained for *R. atlanticum* when 1% IBA with Captan had been applied (Table 3). A high percentage of *R. viscosum* cuttings rooted under the effect of 0.5% IBA with Captan (79.2%). They developed also large root balls (Table 4). For *R. calendulaceum*, the best rooting stimulant was 1% IBA with Captan (54.1%) and 0.5% IBA with Captan (45.8%). It can be concluded that at that developmental stage, Captan has not only a passive function, protecting cuttings against pathogens, but also stimulates the process of rooting.

Table 3. Effect of growth substances and Captan (a fungicide) on the rooting of cuttings of selected azalea species

Treatment	Rooted cuttings (%)		
	R. atlanticum	*R. calendulaceum*	*R. viscosum*
Control	20.8 b	8.3 a	16.6 a
IBA 0.5%	29.1 c	16.6 b	33.3 b
IBA 0.5% + Captan	66.6 f	45.8 d	79.2 d
IBA 1%	37.5 d	20.8 c	33.3 b
IBA 1% + Captan	83.3 g	54.1 e	58.3 c
Captan	12.5 a	8.3 a	20.8 ab
Seradix B2	41.7 e	20.8 c	25.0 ab
Seradix B3	29.1 c	16.6 b	20.8 ab

Values marked with the same letter do not differ significantly

Table 4. Effect of growth substances and Captan (a fungicide) on the root system size of cuttings of selected azalea species

Treatment	Root system size (scale 0-6)		
	R. atlanticum	*R. calendulaceum*	*R. viscosum*
Control	0.40 a	0.40 a	0.58 a
IBA 0.5%	1.25 ab	1.25 ab	1.53 bc
IBA 0.5% + Captan	2.50 c	2.50 c	3.12 d
IBA 1%	1.02 ab	1.35 ab	1.76 bc
IBA 1% + Captan	2.47 c	3.19 c	3.19 d
Captan	0.34 a	0.55 ab	0.45 a
Seradix B2	1.26 ab	1.41 ab	1.28 abc
Seradix B3	0.68 ab	0.76 ab	0.74 ab

Values marked with the same letter do not differ significantly.
Root system size = number of rooted cuttings in a given class number x class number/number of cuttings per replicate

While rooting evergreen rhododendrons and azaleas, a strong relationship between species and rooting level was observed (Tables 1 and 3). Irrespective of the applied growth substance, the highest percentage of cuttings rooted in *R.* 'Cunningham's White', *R. catawbiense* 'Grandiflorum', and *R. atlanticum*. However, in some investigated species, worse results were obtained when cuttings were treated with Captan alone or Seradix B3.

DISCUSSION

Research on the rooting of selected species of azaleas and evergreen rhododendrons helps to determine if they can be grown only from seeds or also from cuttings. Results of the present study indicate that good rooting depends mainly on the application of an appropriate substance stimulating this process. Many authors (Lewis and Sizemore 1978, Sanders 1978, Goreau 1980, Hieke 1981, Czekalski 1996, Nawrocka-Grześkowiak 1996) suggest that the best rooting stimulant for azaleas and evergreen rhododendrons is IBA, at various concentrations depending on species and cultivar. Treatment with IBA increased the percentage of rooted cuttings and the size of their root systems. The most effective combinations were: 2% IBA or 2% IBA with Captan for evergreen rhododendrons, and 0.5% IBA with Captan or 1% with Captan for azaleas. Thus we recommend these combinations for application in practice.

There are many publications on rooting of *R.* 'Cunningham's White' and *R. catawbiense* 'Grandiflorum', but little information is available concerning the rooting of other species of this genus. Ylätalo (1979) rooted 100% cuttings of *R. brachycarpum* ssp. *tigerstedti* in January by applying 0.6% IBA. As shown by Bojarczuk and Kieliszewska-Rokicka (1996), *R. brachycarpum* cuttings in this period contain some natural stimulants, which facilitate their rooting. It is possible that also in the present study the high percentage of rooted cuttings is due to a suitable period of their collection. Good results were obtained in this study also when cuttings were collected in October, but only when higher concentrations of IBA were applied. Perhaps the date of collection was also important in those species where the percentage of rooted plants was lower (*R. pachytrichum* and *R. yakushimanum*). *R. yakushimanum* is grown mainly from seeds, because its cuttings are difficult to root (Czekalski 1990). Heft (1966) reports that after treatment with 1-3% IBA, 60% of cuttings of this rhododendron rooted, but often the cuttings produced only callus and no roots.

A significant role in the process of formation of adventitious roots is attributed to proper periods of collection of cuttings for rooting. Many authors (e.g. Sanders 1978, Goreau 1980) advise that cuttings of evergreen rhododendrons should be collected in October. Other authors recommend September for *R. catawbiense* 'Boursault' (Bojarczuk and Kieliszewska-Rokicka 1996), May for *R. catawbiense*

'Grandiflorum' (Czekalski 1981), and December for *R. maximum* (Czekalski 1996).

For azaleas, late June has proved to be the best time for the rooting of cuttings (Lewis and Sizemore 1978, Nawrocka-Grześkowiak and Grześkowiak 2003). However, Gambrill (1978) believes that azalea cuttings should be taken earlier (May), during the peak of their growth. As in evergreen rhododendrons, also in azaleas physiological properties of cuttings are important. The cuttings with lower levels of active inhibitors and higher levels of active stimulants, usually root well. Concentrations of those substances depend on the time of collection of cuttings (Lipecki 1973). Recent investigations (Nawrocka-Grześkowiak 2001 a) have shown that lignified cuttings contain active inhibitors that make rooting more difficult. The present study indicates that the selected period of collection of cuttings is suitable, because the percentage of rooted cuttings was generally high (especially in *R. atlanticum* and *R. viscosum*).

The presented results attest to the possibility of propagation of the studied species from cuttings. These valuable species are worthy of popularization in urban green areas because of their resistance to unfavourable weather conditions.

CONCLUSIONS

1. The largest percentage of rooted cuttings of evergreen rhododendrons species was obtained after treating them with preparations containing 2% IBA (indolebutyric acid) with Captan. The exceptions were *R. catawbiense* 'Grandiflorum' and green-shoot form of *R. pachytrichum*.
2. Satisfactory results of rooting deciduous cuttings (azalea cuttings) were obtained after treating them with 0.5% and 1% IBA with Captan.
3. Captan with talk (1 : 2) had not only a passive function but also stimulated the process of rooting. It did not affect positively only the rooting of *R. yakushimanum, R. brachycarpum,* and *R. calendulaceum.*

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WPŁYW SUBSTANCJI WZROSTOWYCH NA UKORZENIANIE SADZONEK WYBRANYCH GATUNKÓW RÓŻANECZNIKÓW

Streszczenie: Badaniami objęto głównie gatunki odporne na niską temperaturę i niesprzyjające warunki klimatyczne, a są to: różaneczniki o liściach zimozielonych (*R. catawbiense* ‘Grandiflorum’, *R.* ‘Cunningham’s White’, *R. brachycarpum*, *R. pachytrichum*, *R. yakushimanum*) oraz mało popularne gatunki o liściach opadających na zimę (azalie) (*R. atlanticum*, *R. calendulaceum* i *R. viscosum*). Sadzonki do ukorzeniania pozyskiwano ze starych krzewów rosnących w Arboretum Kórnickim, które ukorzeniano w połowie października (różaneczniki zimozielone) i w połowie czerwca (azalie). Podłożem do ukorzeniania była mieszanina torfu, kompostu korowego i trocin w stosunku 1 : 1 : 1. Sadzonki traktowano auksyną IBA o stężeniach 0,5%, 1%, 2% i 4% w preparacie proszkowym zawierającym sam talk lub talk z Kaptanem (2 : 1) oraz Seradix B2 (z substancja czynną IBA 0,4%) i Seradix B3 (z substancją czynną IBA 0,8%). Ukorzeniając zarówno różaneczniki zimozielone jak i azalie stwierdzono różny stopień ukorzeniania sadzonek w zależności od gatunku i zastosowanej substancji stymulującej. Stosowanie auksyny IBA zwiększało procent ukorzenionych sadzonek, jak również wielkość ich systemu korzeniowego. W wysokim procencie przy zastosowaniu substancji stymulujących, ukorzeniły się sadzonki *R. catawbiense* ‘Grandiflorum’, *R.* ‘Cunningham’ s White’, *R. atlanticum* i *R. viscosum*. Sadzonki *R. brachycarpum* ukorzeniły się w najwyższym procencie przy zastosowaniu IBA 2% oraz IBA 2% z Kaptanem. Ukorzeniając sadzonki *R. pachytrichum* wykazano różny stopień ukorzeniania w zależności od koloru pędów. Znacznie lepiej ukorzeniły się sadzonki tego gatunku o pędach czerwonych niezależnie od zastosowanego stymulatora. Sadzonki *R. yakushimanum* najlepiej ukorzeniły się po zastosowaniu IBA 4% oraz IBA 2% z Kaptanem. Dla azalii *R. calendulaceum* najbardziej efektywnym było stężenie IBA 1% z Kaptanem. Sam Kaptan i Seradix B3 nie zawsze działał pozytywnie na ukorzenienie sadzonek niektórych gatunków.

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