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The influence of indolebutyric acid, sampling-dates and juvenility on the rooting of filbert (*Corylus* sp.) cuttings

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Abstract

Propagation of filberts (= hazelnuts) by cuttings taken from long shoots (adult cuttings) and offshoots (juvenile cuttings) was attempted. The influence of sampling-dates, source of cuttings and of application of indolebutyric acid (IBA) was investigated. The best results were obtained when cuttings were taken in June and treated with IBA (50 mg/l^{-1} for 18 h). Juvenile cuttings, obtained from offshoots rooted better than those from long shoots of the crown. The rootability of cuttings varied in the investigated filbert cultivars. The results suggest the possibility of propagating filbert by cuttings.

INTRODUCTION

Filbert (*Corylus avellana* L. var. *pontica*) is propagated for production purposes only vegetatively (Goc, 1957; Maurer, 1938; Zagaja and Suski, 1975; Zaliwski, 1979). Multiplication from seeds is practiced within the genus *Corylus* only for breeding purposes (Zagaja and Suski, 1975) or for obtaining appropriate rootstock (Maurer, 1975). Vegetative propagation of filbert is done usually by stooling and simple or trench layering. The methods of air layering (Fontanazza, 1973) or grafting of noble varieties on *Corylus colurna* L. rootstock are much frequently applied (Manzo, 1972; Maurer, 1975). Propagation by way of layering is unfailing but labour-consuming and the yield is low. Therefore, attempts have been undertaken to propagate filbert from cuttings. Komissarov (quoted after Retovsky, 1953) succeeded, by the application of indoleacetic acid in a 100 mg/l^{-1} concentration, in inducing rooting of the cuttings in 22 per cent. The use of a mixture of growth regulators and bottom heat increased the rooting of lignified cuttings to 40 per cent (Roversi, 1972). Christensen (1977) was, however, the first to obtain satisfactory results with green cuttings from shoots. Cuttings of the variety 'Halle

Giant' treated with indolebutyric acid (IBA) rooted in 97 per cent. The first Polish studies on rooting of filbert cuttings (Piskornik and Piskornik, 1980) and purple-leaved filbert (Piskornik, 1980) also gave promising results.

The present investigations were undertaken to ascertain the influence of IBA, the date of taking cuttings and the kind of organ from which they were collected on the rooting of cuttings of several filbert varieties and two varieties of purple-leaved hazel.

MATERIAL AND METHODS

The plant material was derived from the collection of the Filbert Breeding Station in Cracow. The following species and varieties were used:

Corylus avellana L. var. *pontica*, crop varieties: 'Halle Giant', 'Catalan' and the new varieties: 'Frango-II', 'Justowski Późny', 'Nowowiejski', 'Krakowski' and 'Starowolski';

Corylus avellana L. var. *fuscorubra* – red-leaved wild hazel;

Corylus maxima Mill. var. *purpurea* – 'Lambert's red-leaved.

The cuttings were taken from offshoots and long shoots from the crown. From the offshoots which had grown in the current year, "current-season" cuttings were taken, whereas the offshoots which had grown in the previous season yielded "past-year" cuttings. The latter comprised the middle and upper part of the past year's shoots with foliated fragments of branchings.

Cuttings about 15 cm long were prepared with 2 or 3 healthy leaves left, and in the case of past-year cuttings 3 or 4 leaves. The lower ends of the cuttings were immersed in a 50 mg/l^{-1} IBA solution for 18 h at room temperature. This concentration was used after preliminary experiments performed in previous years. Control cuttings were immersed in tap water. For rooting a mixture of high peat and perlite (1:2) was used in a cold bed and a greenhouse. The care of the cuttings in the cold bed consisted barely in their spraying, shading on sunny days and ventilation of the bed after 4 weeks duration of the experiment. Propagation was conducted under mist in the greenhouse.

After 7-8 weeks the cuttings were taken out of the substrate and the per cent of rooted ones, those with callus and the mean number and length of roots were counted. In one experiment the influence of the degree of lignification of the shoot on the formation of adventitious roots was also determined. For this purpose the cuttings were taken from the apical, central and basal part of long shoots or offshoots. The influence of the date of setting the cuttings on the formation of adventitious roots was tested on the variety 'Catalan'. The experiments were performed during two vegetation seasons in five replications with 15 cuttings in each. The results were subjected to statistical elaboration with the use of analysis of variance and Duncan's multiple range test at $p \leq 0.05$. For statistical calculation the data expressed in per cents were converted to angular values with the use of Bliss tables (Elandt, 1964).

RESULTS

For testing the effect of the date of setting the cuttings on their rooting, the cuttings were prepared from long shoots of the crown and offshoots of the variety 'Catalan' in June, July, August and November. The most suitable time for filbert setting proved to be June (Table 1). IBA stimulated formation of adventitious roots. Cuttings from offshoots rooted more readily than those from crown long shoots.

Table 1

Rooting of filbert cv. 'Catalan' cuttings at various times of the growing season

Time of rooting	% of rooted cuttings			
	long shoots		offshoots	
	C[1]	IBA	C	IBA
June 15, 1978	22.5 e[2]	83.3 ab	48.8 c	93.8 a
July 15, 1978	8.8 g	53.8 c	18.8 efg	77.5 b
August 24, 1978	0	18.0 efg	10.0 fg	35.0 d
November 25, 1978	0	0	0	20.0 ef

[1]C – control cuttings. [2]The means followed by the same letter(s) are not significantly different at P = 0.05 level.

The influence of IBA on the rooting of cuttings from several varieties of green-leaved and two species of red-leaved hazel cut from long shoots of the crown is shown in Table 2. Cuttings of the green-leaved varieties and red-leaved wild hazel rooted in 74-80 per cent, whereas adventitious roots formed much less readily on cuttings of 'Lambert's Red-leaved' hazel. Treatment with IBA not only increased the number of rooted cuttings, but also the number and length of the roots. Control cuttings not treated with IBA produced more readily callus tissue. The red-leaved varieties rooted exclusively after application of IBA, forming an abundant system of adventitious roots.

The rooting of cuttings from current-year offshoots of green-leaved varieties is shown in Table 3. They exhibited a higher ability to adventitious roots formation than the cuttings from crown long shoots. Cuttings of two varieties 'Justowski Późny' and 'Krakowski' when treated with IBA rooted in 100 per cent. An interesting exception was the new variety 'Starowolski' the cuttings of which after IBA application rooted only in 50 per cent. Significant changes between varieties in rooting were noted both in control cuttings and those treated with IBA. Treatment with IBA markedly stimulated rooting and improved the quality of the root system in cuttings from current-year offshoots as it did in those from long shoots.

Table 2

Effect of IBA on rooting of softwood filbert cuttings taken from long shoots in June

Species and cultivar	% of rooting		Mean number of roots per cutting		Mean length of roots in cm		% of cuttings with callus	
	C[1]	IBA	C	IBA	C	IBA	C	IBA
Corylus avellana L.								
cvs. 'Catalan'	20.8 d[2]	78.5 a	3.3	11.7	3.8	4.9	36.1	8.1
'Halle Giant'	24.7 d	80.4 a	5.4	37.0	2.4	4.1	36.9	2.5
'Frango – II'	23.7 d	80.0 a	8.3	37.5	5.0	7.7	21.5	1.5
'Justowski Późny'	38.4 c	78.9 a	5.0	22.1	3.8	4.6	21.3	7.5
Corylus avellana L. var. *fuscorubra* (red)	0	74.1 a	0	39.2	0	5.4	67.3	0
Corylus maxima Mill. var. *purpurea*, cv. 'Lambert's Red'	0	60.1 b	0	41.0	0	4.0	20.9	0

[1]C – control cuttings. [2]The means followed by the same letter are not significantly different at P = 0.05 level.

Table 3

Effect of IBA on rooting of softwood filbert cuttings taken from current-year offshoots in June

Cultivar	% of rooting		Mean number of roots per cutting		Mean length of roots in cm		% of cuttings with callus	
	C[1]	IBA	C	IBA	C	IBA	C	IBA
'Catalan'	32.7 f[2]	79.7 bc	7.1	25.5	4.6	5.2	24.7	1.2
'Frango – II'	61.2 bcde	91.9 b	4.9	25.1	2.5	3.2	15.6	0
'Justowski Późny'	68.4 bcd	100.0 a	7.5	50.8	4.7	3.0	12.8	0
'Nowowiejski'	44.7 ef	97.4 a	3.3	58.2	3.2	4.0	42.1	0
'Krakowski'	50.5 cdef	100.0 a	8.0	42.2	4.5	3.4	10.0	0
'Starowolski'	14.3 g	50.0 def	4.5	29.0	3.5	3.8	71.4	7.1

[1]C – control cuttings. [2]The means followed by the same letter(s) are not significantly different at P = 0.05 level.

Rooting of past-year offshoot cuttings is presented in Table 4. The results are similar to those described above. IBA significantly stimulated rooting and varietal differences also appeared in the ability of forming adventitious roots. The cuttings of most of the tested varieties rooted when treated with IBA almost in 100 per cent. The variety 'Starowolski' was here an exception as well, rooting poorly.

Table 4

Effect of IBA on rooting of filbert cuttings taken from past-year offshoots in June

Cultivar	% of rooting		Mean number of roots per cutting		Mean length of roots in cm		% of cuttings with callus	
	C[1]	IBA	C	IBA	C	IBA	C	IBA
'Catalan'	45.3 d[2]	86.0 b	3.0	18.7	2.0	2.9	18.0	10.0
'Frango – II'	43.3 c	100.0 a	4.1	25.7	4.2	4.7	0	0
'Justowski Późny'	74.3 b	98.8 a	8.5	39.5	5.5	3.8	12.0	0
'Nowowiejski'	24.3 d	98.1 a	3.2	36.1	2.0	3.4	58.3	0
'Krakowski'	47.7 c	96.9 a	7.5	40.8	5.1	3.8	22.0	0
'Starowolski'	5.9 e	38.9 cd	3.0	26.7	5.0	4.3	58.8	22.2

[1]C – control cuttings. [2]The means followed by the same letter(s) are not significantly different at P = 0.05 level.

Cuttings from the apical, central and basal part of the long shoot or offshoot, thus differing in their degree of lignification, rooted in a similar degree (Table 5). Only in the 'Catalan' variety cuttings from the basal part of offshoots showed a lower root-forming ability. Cuttings from long shoots of the crown exhibited significant differences in their ability of rooting in dependence on the degree of lignification. Cuttings from the upper part of the long shoot (deprived, however, of the several-centimetre segment comprising the growth apex) rooted much faster and formed a larger number of adventitious roots than did those from the lower part of the current year increment.

DISCUSSION

The developmental phase of the organ from which cuttings were prepared was important for their rooting. Cuttings taken in June with a low degree of lignification (green cuttings) showed the highest ability of adventitious roots formation (Table 1). More lignified cuttings taken at later dates of the vegetation season had a lower rooting ability. These seasonal differences in adventitious roots formation in cuttings of various kinds of plants have been stressed by numerous authors (Bojarczuk, 1978; Douglas, 1966; Hartmann and Kester, 1968; Jankiewicz, 1979; Smith and Chiu, 1980; Tombesi, 1967). It seems that the first unsuccessful trials of rooting filbert cuttings (Komissarov, quoted after Retovsky, 1953) were due to the collection of cuttings at unsuitable dates. Cuttings from the lower parts of long shoots, lignified to a higher degree, also exhibited a much poorer rooting ability (Table 5). Similar results were obtained by Bojarczuk (1978) when testing the rooting of lilac

Table 5

Rooting of softwood filbert cuttings taken from different parts of the current-year offshoots and long shoots

Species and cultivar	Part of the offshoot or long shoot	% of rooting		Mean number of roots per cutting		Mean length of roots in cm		% of cuttings with callus	
		C[1]	IBA	C	IBA	C	IBA	C	IBA
Current-year offshoots									
C. avellana L.	apical	61.5 f[2]	91.4 ab	5.3	30.4	2.2	2.7	23.8	0
cv. 'Frango – II'	middle	65.2 ef	95.0	3.7	20.4	2.5	2.4	12.5	0
	basal	56.8 fg	89.2 abc	5.8	19.0	2.8	4.6	23.1	0
	apical	40.7 h	75.0 d	10.4	27.1	3.9	4.9	37.0	3.7
cv. 'Catalan'	middle	36.8 h	82.0 cd	6.3	24.6	4.1	4.9	28.0	0
	basal	22.7 i	34.8 h	5.0	24.0	5.8	5.7	9.1	0
Long shoots									
C. avellana L.	apical	19.1 ij	73.6 de	3.2	13.7	2.4	3.5	14.3	0
cv. 'Catalan'	basal	1.3 l	12.0 jk	1.0	6.1	2.5	3.4	0	0
C. maxima Mill. var.	apical	0	52.6 g	0	28.5	0	3.2	4.2	10.5
purpurea	basal	0	40.5 h	0	22.2	0	3.6	0	4.5
C. avellana L. var.	apical	0	85.7 bc	0	41.8	0	6.4	68.2	0
fuscorubra	basal	0	8.7 kl	0	9.0	0	0.4	73.7	0

[1]C – control cuttings. [2]The means followed by the same letter(s) are not significantly different at P = 0.05 level.

cuttings from shoots with various degrees of lignification. The foregoing results indicate that the ability of rooting of filbert cuttings seems to be also dependent on the physiological state of the growth apex of the long shoot or offshoot.

IBA proved to be an efficient stimulator of rooting of filbert cuttings. It would seem that its efficiency was partly dependent on the degree of lignification of the shoot (Table 1). The lower this degree the more pronounced was the influence of IBA, particularly in the number of adventitious roots formed. This suggests an interaction between IBA and internal rooting factors. In the case of hazel this phenomenon does not confirm the view that the reaction of the cuttings to exogenous auxin is usually higher in periods unfavourable for rooting (Jankiewicz, 1979).

The tested varieties differed in the rooting ability of the cuttings, notwithstanding whether they were taken from long shoots or offshoots. Varietal differences in the ability of forming adventitious roots have also been noted in poinsettia (Beck and Sink, 1974), dahlias (Biran and Halevy, 1973) and in lilacs (Bojarczuk, 1978).

Rapid formation of wound callus tissue favourably affected the survival of the cuttings in the early period after their detachment from the parent plant. Adventitious roots in filbert cuttings did not form from callus but grew out above the wound. It was observed that the cuttings forming excessively abundant callus rooted worse.

The results of the present studies indicate that there is a possibility of applying the method of vegetative cuttings for propagation of filbert for commercial purposes. A condition for success is the taking of cuttings at a suitable developmental phase of the shoots, that is in our climatic zone in June as well as the application of IBA as stimulator of formation of adventitious roots.

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Wpływ kwasu indolilomasłowego, terminu cięcia i juwenilności na zakorzenianie sadzonek leszczyny (Corylus sp.)

Streszczenie

Badano wpływ IBA, terminu cięcia i juwenilności pędu na zakorzenianie się sadzonek leszczyny wielkoowocowej (*Corylus avellana* L. var. *pontica*), leszczyny czerwonolistnej leśnej (*Corylus avellana* L. var. *fuscorubra*) oraz czerwonolistnej Lamberta (*Corylus maxima* Mill. var. *purpurea*). Sadzonki zakorzeniano w mieszaninie torfu wysokiego i perlitu (1:2, v/v). Najwyższy procent zakorzenionych sadzonek i dobrą jakość systemu korzeniowego uzyskano, wówczas gdy sadzonkowanie przeprowadzono w czerwcu, natomiast najgorsze wyniki uzyskano gdy sadzonki cięto pod koniec listopada. Sadzonki pozyskiwane z odrostów (forma juwenilna) odznaczały się wyższą zdolnością do formowania korzeni przybyszowych niż sadzonki z długopędów korony (forma dojrzała). Podwierzchołkowe fragmenty długopędu zakorzeniały się łatwiej niż fragmenty dolne. Stwierdzono różnice odmianowe w zdolności sadzonek do zakorzeniania się. Sadzonki cięte z długopędów zakorzeniały się pod wpływem traktowania IBA (50 mg/l^{-1} — przez 18 godz) w 60-80%, natomiast kontrolne w 0-38%. Zakorzenianie się sadzonek ciętych z odrostów 1-rocznych wynosiło, przy zastosowaniu IBA, 50-100%, a z odrostów 2-letnich, 39-100%; w zależności od odmiany. Obiekty kontrolne zakorzeniały się odpowiednio w 14-68% i w 6-74%. Wyniki wskazują na możliwość zastosowania metody sadzonkowania do rozmnażania wegetatywnego leszczyny na skalę produkcyjną.