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STUDY ON PROPAGATION OF SHRUB AND PILLAR ROSES BY HARDWOOD CUTTINGS WITH AUXINS PREPARATIONS

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Abstract. All rose cultivars are propagated by asexual methods and the one of them is hardwood cuttings rooting. The aim of the study was to verify the possibility of effective propagation of shrub and pillar roses of different origin by hardwood cuttings. The shoots were collected in autumn. The cuttings were prepared and planted in spring. The rooting were conducted in open field and greenhouse. There were used commercial rooting powders containing IBA or NAA: Ukorzeniacz AB_{aqua}, Ukorzeniacz B_{aqua}, Rhizopon AA 020 XX, Chryzotek beige 004 XX, Ukorzeniacz – korzonek D DS. Of the ten cultivars chosen for the present experiment, only two took root effectively, with good quality rooted cuttings: 'Excelsa' (31.2% in open field, 56.5% in greenhouse) and 'New Dawn' (18.7% in open field, 14.3% in greenhouse). Using commercial rooting stimulants did not guarantee an increase in the number or in the parameters of growth of the rooted cuttings. The most effective preparation was Chryzotek beige 004 XX for 'Poppius' (38.0%) rooted in the open field, and for 'Kew Rambler' (23.5%) in the greenhouse.

Key words: historical roses, IBA, NAA, rhizogenesis, cuttings

INTRODUCTION

The rose cultivars can be propagated by vegetative techniques: cuttings, layers, budding, grafting and micropropagation. In cultivars of species and old roses, due to phenological discrepancies and physiological incompatibility between the rootstock and the cultivar, using shield budding brings in practice various results [Krüssmann 1978, Schultheis 1998]. The winter hardiness of the most of shrub and climber roses, especial-

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ly historical, is sufficiently high to grow on own roots successfully [Monder 2007]. A possibility of propagating shrub and pillar roses by hardwood cuttings is described in many professional sources [Mulford 1916, Krüssmann 1978] and popular science [Schultheis 1998]. There are, however, few scientific papers on the possibility of using this method for roses. The multi-bud hardwood cuttings would offer a chance of obtaining shrubs of good quality in a short time, which has been the aim of studies in this field so far [Mahmoud 1964, Davies 1985, Hambrick et al. 1991, Ercişli and Güleryüz 1999, Ercişli et al. 2005]. Propagating roses from cuttings shortens the time of production and limits costs in relation to shield budding, and producing shrubs from hardwood cuttings allows to use workforce in late autumn and winter months and does not require specialist technological methods.

The rooting of rose cuttings is influenced by many external and internal factors e.g. growth conditions [Loach and Whalley 1978], type of cutting and number of node [Moroz 2006], term of cut and rooting [Davies 1985, Kazankaya et al. 2005], phenological phase of shoots [Monder et al. 2014], growth regulators [Ercişli et al. 2005, Kazankaya et al. 2005] and plant origin preparations supporting rhizogenesis [Monder et al. 2014]. The propagation of dog rose (*Rosa canina* L.) by softwood cuttings with the use of indole-3-butyric acid (IBA) did not bring the expected results. The highest rooting percentage (30.6%) occurred in cuttings treated with 25 ppm IBA for 20 min. [Hoşafçı et al. 2005]. However, Wiśniewska-Grzeszkiewicz and Podwyszyńska [2001] used the softwood cuttings for ground cover roses with the rooting range from 92–100% (Alba Meidiland, Ferdy, Red Fairy, Sommermorgen, 'The Fairy'). Growth regulators encouraged early callusing, root initiation [Mahmoud 1964] and number of young roots [Hartmann et al. 2011]. The advantageous influence especially of IBA on rhizogenesis of hardwood cutting of roses were proved many times [Mahmoud 1964, Davies et al. 1985, Ercişli and Güleryüz 1999, Ercişli et al. 2005, Kazankaya et al. 2005]. Based on the research made so far it may be stated that there is no versatile rooting hormone; each species, or even cultivar, depending on the kind of cuttings, responds specifically to preparations [Hartmann et al. 2011]. Also the time of taking cuttings for rooting influences their later reaction to various concentrations of the same preparation [Kazankaya et al. 2005].

The aim of this study was to verify the possibility of effective propagation of ornamental historical shrub and pillar roses of various origins by hardwood cuttings taken in autumn and planted in spring into the soil in the open field and in a cool greenhouse, with the use of standard powder rooting hormones used in nursery production and designed for roses.

MATERIAL AND METHODS

This studies were conducted in Polish Academy of Sciences Botanical Garden Center for Biological Diversity Conservation in Powsin (52.11°N, 21.10°E), Warsaw, in 2010–2011 years. The material were hardwood shoots of roses, that were cut in National Collection of Roses Polish Academy of Science Botanical Garden – Center for Biological Diversity Conservation in Powsin. There were chosen ten cultivars:

'Excelsa' (Wichurana Rambler, M.H. Walsh 1908), 'Harison's Yellow' (Hybrid Foetida, G.F. Harison 1824), 'Kew Rambler' (Rambler, Kew 1912), 'Mme Plantier' (*R.* × *damascena* Mill. × *R. moschata* Herrm., Plantier 1835), 'Maxima' (Alba, old rose, origin unknown), 'New Dawn' (Wichurana Climber, Somerset Rose Nursery 1930), 'Nevada' (Hybrid Moyesii, P. Dot 1927), 'Polstjårnan' (*R. beggeriana* Rambler, Wasastjerna 1937), 'Poppius' (Hybrid Spinosissima, C. Stenberg 1872), 'Tuscany Superb' (Hybrid Gallica, T. Rivers & Son 1837). The standard commercial rooting powders containing indolebutyric acid (IBA) and naphthaleneacetic acid (NAA) were used in the research, in following:

a) control (without rooting stimulators);

b) Ukorzeniacz AB_{aqua} (Himal, Poland) (NAA 0.2%, IBA 0.1%, amid NAA 0.1%);

c) Ukorzeniacz B_{aqua} (Himal, Poland) (NAA 0.2%);

d) Rhizopon AA 020 XX (Rhizopon BV, Netherlands) (IBA 2%);

e) Chryzotek beige 004 XX (Rhizopon BV, Netherlands) (IBA 0.4%);

f) Ukorzeniacz – korzonek D DS (ArtGarden, Poland) (IBA 0.4%; N-(trichlorometylosulfanylo)-cykloheks-4-eno-1,2-dikarboksyimide 0.5%).

Because of the climate conditions in Poland and high frequency of sub-zero temperatures in winter, it was decided to plant the cuttings in spring, which is recommended by many authors e.g. Krüssmann [1978]. Cuttings were taken in December, before the beginning of frost (1–15 Dec). Then, 20–22 cm long segments were tied in bunches of 50 and put in a sand pit until planting time. They were additionally covered with a 10–15 cm layer of sand and then of conifer branches for the winter. In spring the shoots were planted – only the healthy ones, with no signs of damage – after cutting only the top part. The cuttings were protected against shoot fungal diseases with Previcur Energy 840 SL (propamocarb 47.28%, fosetyl 27.65%) fungicide. Before rooting the 1.0 cm basal ends of the cutting were dipped in rooting preparation. The cuttings were rooted in two different conditions and places, as follow:

I. The first trial was conducted on experimental field, on good cultivated and mulched sandy loam soil. The black polyethylene film mulch blocked growth of weeds and water loss. The cuttings were planted on 1–10 Apr at a spacing 0.1 × 0.6 m. The rooted cuttings were dig at the first days of October. The averages monthly air temperatures [Ukorzeniacz – korzonek D DS C] and total precipitations [mm] in Botanical Garten in the 2010–2011 years are presented in the Figure 1.

II. The second place was established in cool greenhouse. The cuttings were planted in two terms: 9–12 Feb and 29–31 Mar, in cubic pots, about 24 cm width, in mixture of peat (Karaska, Poland) and sand (Vistula river) 1:1, pH 6.0–6.5. The pots before planting were sprayed with Bravo 500-SC 0.5% (chlorothalonil 500 $g \cdot dm^{-3}$) and Topsin M 500 SC 0.7% (thiophanate-methyl 41.91%). The experiment were conducted to 15 of July. The temperature a day approximately amounted to 8°C in February-March, 14–15°C in April and >22°C in May – July.

Current standard nursery practices were followed throughout the study period. The cuttings were irrigated by hand, properly to conditions. Weeds were removed by hand. Chemical agents were used for disease and pest control. The cuttings were spayed against fungal diseases alternately every 10–14 days with Previcur Energy 840 SL, Amistar® 250 SC (azoxystrobin 250 $g \cdot dm^{-3}$), Score 250SC (difenoconazole 250 $g \cdot dm^{-3}$),

Topsin M 500 SC. In the season the cuttings were fertilized with Ekolist 0.01% (Ekoplon S.A., Poland) double application: in open field 20 June and 10 July; in greenhouse 20 May and 20 June.

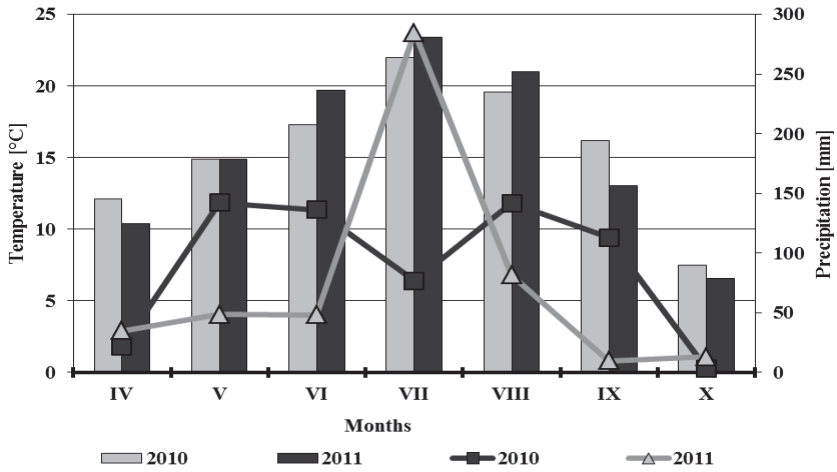

Fig. 1. The average monthly air temperature (ºC) and total monthly precipitation (mm) in the years 2010–2011 in the period of rose rooting, in PAS Botanical Garden CBDC in Powsin

The rooted cuttings were dug and the soil were washed from their roots. There were determined in cuttings rooted in:

– in open space: rooting percentage (%), degree of rooting (valuation scale), mass of cuttings (g), number and length of roots and shoots;

– greenhouse: rooting percentage (%), degree of rooting (valuation scale), mass of cuttings (g), number and length of roots and shoots, number of leaf on shoots.

The degree of rooting were determined in valuation scale (1–5):

– in open field: 1 – callus only; 2 – one or a few thin, unbranched lead roots; 3 – root system weak and shallow with a few longer roots; 4 – root system moderately developed, with several branched lead roots; 5 – root system well developed, with numerous branched lead roots bearing numerous secondary roots;

– greenhouse: 1 – callus only; 2 – at least one, short root 1–3 cm; 3 – 6–15 roots not longer than 10 cm; 4 – longer (> 10cm), developed roots; 5 – roots strong, branched, very well developed.

Statistical analysis. The research were conducted for two years: 2010 and 2011. The experiment in open field were designed in a randomized block. There are consisted of 6 treatments including 20 cuttings with five replicates, summarizing – 600 cuttings per cultivar. The experiment in greenhouse involved 6 treatments, each in 4 replicates containing 10 cuttings, which makes a total of 240 cuttings for each cultivar. The all results were analysed with the ANOVA (one-way or two-way analysis of variance) procedure with the use STATISTICA 10 software (Statsoft Polska, Kraków) used Tukey's test.

RESULTS AND DISCUSSION

Spring propagation by the hardwood cuttings in the open field is a method commonly applied for many species and cultivars of ornamental and fruit plants in nursery cultivation. According to literature [Mulford 1916, Schultheis 1998], this methods have a potential use for rose cultivars of different origin. Mulford [1916] advised propagation by hardwood cuttings for Rugosa, Carolina, Prairie, Wichurana and other Climbing. Hartmann et al. [2011] recommended this method to Polyanthas, Pillars, Climbers, Hybrid Perpetuals, some Hybrid Teas. The hardwood cuttings may be used to rootstocks propagation e.g. *R. multiflora* 'Brooks 56' [Hambrick et al. 1991], *R. rugosa* 'Hollandica', *R.* 'Manetti', *R. multiflora* [Krüssmann 1978].

Table 1. Percentage of rooted cuttings of pillar and shrub roses in open field (%)

Cultivar		Treatment						
	year	control	Ukorzeniacz AB_{aqua}	Ukorzeniacz B_{aqua}	Rhizopon AA 020 XX	Chryzotek beige 004 XX	Ukorzeniacz – korzonek D DS	mean
Excelsa	2010	66.0 e*	24.0 b	0.0 a	0.0 a	58.0 de	20.0 b	28.0 a
	2011	73.0 e	45.0 cd	0.0 a	0.0 a	62.0 de	27.0 c	34.5 b
	mean	69.5 C	34.5 B	0.0 A	0.0 A	60.0 C	23.5 B	31.2 C
Harison's Yellow	2010	8.0 b	3.0 a	0.0 a	0.0 a	8.0 b	6.0 b	4.2 b
	2011	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
	mean	4.0 A	1.5 A	0.0 A	0.0 A	4.0 A	3.0 A	2.1 A
Kew Rambler	2010	18.0 cd	6.0 a	0.0 a	0.0 a	26.0 d	15.0 bc	10.8 a
	2011	22.0 cd	7.0 a	0.0 a	8.0 a	24.0 d	11.0 b	12.0 a
	mean	20.0 C	6.5 A	0.0 A	4.0 A	25.0 C	13.0 B	11.4 AB
Mme Plantier	2010	26.0 d	16.0 bc	0.0 a	0.0 a	28.0 d	20.0 cd	15.0 b
	2011	10.0 ab	5.0 a	0.0 a	0.0 a	11.0 bc	15.0 bc	6.83 a
	mean	18.0 B	10.5 B	0.0 A	0.0 A	19.5 B	17.5 B	10.9 AB
New Dawn	2010	26.0 c-e	24.0 c-e	0.0 a	2.0 a	12.0 ab	19.0 bc	13.8 a
	2011	42.0 e	36.0 de	0.0 a	26.0 c-e	18.0 bc	20.0 bc	23.7 b
	mean	34.0 C	30.0 C	0.0 A	14.0 B	15.0 B	19.5 B	18.7 B
Poppius	2010	20.0 b	28.0 bc	0.0 a	0.0 a	38.0 c	0.0 a	14.3 a
	2011	16.0 b	14.0 ab	0.0 a	4.0 a	38.0 c	16.0 b	14.7 a
	mean	18.0 B	21.0 B	0.0 A	2.0 A	38.0 C	8.0 A	14.5 AB
Polstjårnan	2010	4.0 a	0.0 a	0.0 a	0.0 a	6.0 a	0.0 a	1.7 a
	2011	2.0 a	0.0 a	0.0 a	2.0 a	0.0 a	2.0 a	1.0 a
	mean	3.0 A	0.0 A	0.0 A	1.0 A	3.0 A	1.0 A	1.3 A

* – mean values marked with the same letters do not differ significantly at $\alpha = 0.05$

In the experiment made in the open field, among the ten cultivars, seven rooted. The highest average percent of rooted cuttings after two vegetative seasons was noted for 'Excelsa' (31.2%). Also the cuttings of 'New Dawn' (18.7%), 'Poppius' (14.5%), 'Mme Plantier' (12.3%), 'Kew Rambler' (11.7%), 'Harison's Yellow' (2.1%), 'Polstjårnan' (1.3%) rooted. The rooting percentage differed in the case of two years of the research (tab. 1). The cuttings of 'Maxima', 'Nevada' and 'Tuscany Superb' did not root and died within several weeks.

In the glasshouse experiment, only cuttings planted in the second term (29–31 March) rooted in five cultivars. The most average rooting percentage were noted for 'Excelsa' – 56.5%, and the lowest – 'Harison's Yellow' (0.4%) and 'Mme Plantier' (1.4%) (tab. 2).

Table 2. Percentage of rooted cuttings of pillar and shrub roses in greenhouse (%)

Cultivar	Year	Treatment						
		Control	Ukorzeniacz AB_{aqua}	Ukorze-niacz B_{aqua}	Rhizopon AA 020 XX	Chryzotek beige 004 XX	Ukorzeniacz – korzonek D DS	Mean
Excelsa	2010	65.0 ef*	32.5 a	40.0 ab	55.0 b-d	57.0 c-e	85.0 g	55.7 a
	2011	60.0 ef	37.0 ab	48.0 a-c	50.0 a-c	67.0 f	82.0 g	57.3 a
	mean	62.5 B	34.8 A	44.0 A	52.5 AB	62.0 B	83.5 C	56.5 C
Harison's Yellow	2010	0.0 a	0.0 a	0.0 a	2.5 a	2.5 a	0.0 a	0.8 a
	2011	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
	mean	0.0 A	0.0 A	0.0 A	1.2 A	1.2 A	0.0 A	0.4 A
Kew Rambler	2010	12.5 bc	10.0 b	2.5 a	0.0 a	20.0 d	2.5 a	7.9 a
	2011	15.0 c	17.0 cd	5.0 a	0.0 a	27.0 e	4.0 a	11.3 a
	mean	13.7 B	13.5 B	3.7 A	0.0 A	23.5 C	3.3 A	9.6 B
Mme Plantier	2010	1.0 a	0.0 a	5.0 a	0.0 a	1.0 a	0.0 a	1.2 a
	2011	5.0 a	0.0 a	3.0 a	0.0 a	2.0 a	0.0 a	1.7 a
	mean	3.0 A	0.0 A	4.0 A	0.0 A	1.5 A	0.0 A	1.4 A
New Dawn	2010	22.5 b	7.5 a	7.5 a	0.0 a	17.5 b	10.0 ab	10.8 a
	2011	39.0 c	15.0 b	19.0 b	0.0 a	22.0 b	12.0 b	17.8 b
	mean	30.7 C	11.2 B	13.2 B	0.0 A	19.7 B	11.0 B	14.3 B

* – mean values marked with the same letters do not differ significantly at $\alpha = 0.05$

After analysing the results of both experiments it can be noticed that the applied rooting commercial rooting powders had a different influence on the process of rooting and none of the five preparations guaranteed an improvement in the percentage of rooted cuttings (tab. 1). Studies conducted so far, however, showed a highly beneficial impact of using plant hormones on the effectiveness and growth parameters of the rooted cuttings. Early root initiation may be beneficial under glasshouse conditions where cuttings can quickly develop foliage before the cuttings root. This is believed to seriously deplete the starch reserves necessary for root initiation [Mahmoud 1964] especially for IBA using as water solution [Mahmoud 1964, Davies 1985, Ercişli and Güleryüz 1999, Ercişli et al. 2005, Kazankaya et al. 2005]. The significant impact of IBA were noticed in the research of Ercişli et al. [2005] , in that hardwood shoots cut in November of *R. dumalis* Bechst. were rooted in heated greenhouse. This cuttings rooted in 0–7.5% in control, whereas the use of IBA increased the percentage of rooted cuttings. The results presented significant increase when bazal part of cutting were dipped in water solution of IBA in concentration of 1500 ppm (37.5–40.0% rooted cuttings), 3500 ppm (47.5–70.0% rooted cuttings) and 5000 ppm (40.0–62.5% rooted cuttings). The IBA had a positive influence in rooting of hardwood cuttings of others wild roses [Ercişli and Güleryüz 1999, Kazankaya et al. 2005]. It has been showed, that the use of auxins and other rooting pretreatments are of little benefit in the commercial propagation rootstock 'Broocks'56' of *R. multiflora* Thunb. [Davies 1985].

Table 3. Means of growth parameters of cuttings in open field research in the years 2010–2011

Cultivar	Treatment	Rooting degree[1]	Mass of cuttings (g)	Number of roots	Lenght of roots (cm)	Number of shoots	Length of longer shoot (cm)
Excelsa	control	4.67 b[2]	23.70 ab	12.67 a	19.58 ab	2.55 ab	18.26 a
	Ukorzeniacz AB_{aqua}	3.83 a	18.92 a	15.08 ab	12.44 a	3.33 b	23.69 b
	Ukorzeniacz B_{aqua}	–	–	–	–	–	–
	Rhizopon AA 020 XX	–	–	–	–	–	–
	Chryzotek beige 004 XX	4.72 b	26.66 b	16.59 b	24.59 b	2.03 a	26.60 b
	Ukorzeniacz – korzonek D DS	4.55 b	27.21 b	14.01 ab	15.65 ab	2.00 a	20.02 a
	mean	4.44 C	24.12 C	14.58 C	18.06 B	2.48 B	22.14 C
Harison's Yellow	control	1.75 a	8.25 b	3.25 a	2.50 a	1.50 a	2.54 a
	Ukorzeniacz AB_{aqua}	3.00 b	6.00 a	5.00 b	10.50 b	1.00 a	10.52 b
	Ukorzeniacz B_{aqua}	–	–	–	–	–	–
	Rhizopon AA 020 XX	–	–	–	–	–	–
	Chryzotek beige 004 XX	2.50 b	6.00 a	2.50 a	8.25 b	1.00 a	8.25 b
	Ukorzeniacz – korzonek D DS	2.32 ab	6.27 a	3.52 a	7.92 b	1.00 a	8.34 b
	mean	2.39 A	6.63 A	3.57 A	7.29 A	1.12 A	7.41 A
Kew Rambler	control	2.67 a	15.44 b	6.44 a	7.09 a	1.89 b	13.65 ab
	Ukorzeniacz AB_{aqua}	3.33 b	10.67 a	9.00 b	9.80 c	2.33 bc	12.00 a
	Ukorzeniacz B_{aqua}	–	–	–	–	–	–
	Rhizopon AA 020 XX	3.33 b	14.25 b	8.72 b	7.70 a	1.12 a	16.93 b
	Chryzotek beige 004 XX	3.33 b	12.50 ab	9.75 b	10.33 c	2.83 c	22.56 c
	Ukorzeniacz – korzonek D DS	2.75 a	13.10 ab	7.80 ab	8.95 b	2.45 bc	14.97 ab
	mean	3.02 B	12.93 B	8.25 B	9.04 A	2.37 B	15.80 B
Mme Plantier	control	2.08 a	13.54 b	4.31 a	5.31 a	1.38 a	10.39 a
	Ukorzeniacz AB_{aqua}	4.00 b	15.75 b	5.50 b	13.13 b	1.63 a	10.42 a
	Ukorzeniacz B_{aqua}	–	–	–	–	–	–
	Rhizopon AA 020 XX	–	–	–	–	–	–
	Chryzotek beige 004 XX	3.14 b	9.5 a	6.29 c	6.93 a	1.29 a	9.94 a
	Ukorzeniacz – korzonek D DS	–	–	–	–	–	–
	mean	3.07 B	12.93 B	5.37AB	8.46 A	1.43 A	10.25 AB
New Dawn	control	3.52 a	8.76 a	4.95 a	18.24 a	1.38 ab	21.00 a
	Ukorzeniacz AB_{aqua}	4.05 b	23.44 c	6.39 ab	26.00 b	1.94 c	36.89 cd
	Ukorzeniacz B_{aqua}	–	–	–	–		–
	Rhizopon AA 020 XX	4.54 bc	20.69 c	7.69 b	32.15 c	1.54 b	43.92 d
	Chryzotek beige 004 XX	4.78 c	12.44 b	10.67 c	22.44 b	1.22 a	29.78 bc
	Ukorzeniacz – korzonek D DS	4.40 bc	14.00 b	11.40 c	25.6 b	1.10 a	28.40 b
	mean	4.26 C	15.87 BC	8.22 B	24.89 C	1.44 A	32.00 D
Poppius	control	2.50 c	4.13 ab	2.00 b	5.13 b	1.00 a	6.13 d
	Ukorzeniacz AB_{aqua}	1.86 ab	4.00 a	1.43 ab	5.29 b	1.00 a	4.71 c
	Ukorzeniacz B_{aqua}	–	–	–	–	–	–
	Rhizopon AA 020 XX	1.50 a	4.00 a	1.00 a	3.50 a	1.00 a	3.00 b
	Chryzotek beige 004 XX	1.50 a	4.00 a	1.33 a	4.00 a	1.33 b	2.17 a
	Ukorzeniacz – korzonek D DS	2.13 b	4.25 b	2.38 b	6.75 c	1.13 a	5.94 d
	mean	1.90 A	4.07 A	1.63 A	4.93 A	1.09 A	4.39 A
Polstjårnan	control	5.00 b	14.00 a	2.00 a	44.00 b	1.00 a	35.00 b
	Ukorzeniacz AB_{aqua}	–	–	–	–	–	–
	Ukorzeniacz B_{aqua}	–	–	–	–	–	–
	Rhizopon AA 020 XX	5.00 b	32.00 b	4.0 b	43.00 b	3.00 b	80.00 c
	Chryzotek beige 004 XX	–	–	–	–	–	–
	Ukorzeniacz – korzonek D DS	4.00 a	12.00 a	2.00 a	23.00 a	1.00 a	18.00 a
	mean	4.67 C	19.33 C	2.67 A	36.67 D	1.67 A	44.33 E

[1] – valuation scale of rooting degree (1–5) in open field: 1 – callus only; 2 – one or a few thin, unbranched lead roots; 3 – root system weak and shallow with a few longer roots; 4 – root system moderately developed, with several branched lead roots; 5 – root system well developed, with numerous branched lead roots bearing numerous secondary roots;

[2] – mean values marked with the same letters do not differ significantly at $\alpha = 0.05$

Table 4. Means of growth parameters of cuttings in glasshouse research in the years 2010–2011

Cultivar	Treatment	Rooting degree[1]	Mass of cuttings (g)	Number of roots	Lenght of roots (cm)	Number of shoots	Lenght of longer shoot (cm)	Leaf number on shoots
Excelsa	control	3.50 a[2]	14.50 a	7.29 b	10.30 a	1.73 ab	12.07 ab	7.85 a
	Ukorzeniacz AB_{aqua}	3.69 a	18.65 b	10.83 d	12.91bc	2.06 b	13.95 b	8.95 a
	Ukorzeniacz B_{aqua}	3.44 a	15.73 a	6.36 a	13.73 c	1.31 a	13.86 b	9.27 a
	Rhizopon AA 020 XX	3.73 a	19.00 b	7.59 b	12.63 b	1.98 b	10.95 a	8.39 a
	Chryzotek beige 004 XX	3.78 a	18.45 b	9.87 c	14.76 c	1.43 a	14.06 b	9.72 a
	Ukorzeniacz – korzonek D DS	3.32 a	18.98 b	7.40 b	11.33 a	1.44 a	11.94 a	8.36 a
	mean	3.58 C	17.55 C	8.22 C	12.61 AB	1.66 C	12.80 C	8.76 B
Harison's Yellow	control	–	–	–	–	–	–	–
	Ukorzeniacz AB_{aqua}	–	–	–	–	–	–	–
	Ukorzeniacz B_{aqua}	–	–	–	–	–	–	–
	Rhizopon AA 020 XX	2.00 a	4.00 a	1.00 a	8.00 a	0.00 a	0.00 a	0.00 a
	Chryzotek beige 004 XX	2.00 a	8.00 b	5.00 b	9.00 a	1.00 a	2.00 a	4.00 b
	Ukorzeniacz – korzonek D DS	–	–	–	–	–	–	–
	mean	2.00 A	6.00 A	3.00 A	8.50 AB	0.50 A	1.00 A	2.00 A
Kew Rambler	control	3.75 b	12.50 a	8.50 c	28.00 c	1.75 b	5.50 ab	7.75 bc
	Ukorzeniacz AB_{aqua}	3.25 b	14.08 b	6.25 b	12.50 b	1.00 a	2.50 a	3.75 a
	Ukorzeniacz B_{aqua}	5.00 c	15.40 c	7.00 bc	15.00 b	1.00 a	12.00 c	10.00 c
	Rhizopon AA 020 XX	–	–	–	–	–	–	–
	Chryzotek beige 004 XX	3.00 b	16.20 d	7.00 bc	12.53 b	1.50 b	7.25 b	6.50 b
	Ukorzeniacz – korzonek D DS	2.00 a	17.80 e	3.00 a	2.00 a	1.00 a	4.00 a	2.00 a
	mean	3.40 C	15.20 C	6.35 BC	14.01 B	1.25 BC	6.25 B	6.00 B
Mme Plantier	control	2.00 a	5.00 a	1.00 a	1.00 a	1.00 a	1.50 a	1.50 a
	Ukorzeniacz AB_{aqua}	–	–	–	–	–	–	–
	Ukorzeniacz B_{aqua}	3.50 b	8.00 b	7.50 b	16.00 b	1.00 a	6.50 b	5.50 b
	Rhizopon AA 020 XX	–	–	–	–	–	–	–
	Chryzotek beige 004 XX	2.00 a	8.00 b	1.00 a	1.00 a	1.00 a	1.00 a	1.00 a
	Ukorzeniacz – korzonek D DS	–	–	–	–	–	–	–
	mean	2.75 B	7.00 AB	3.17 A	6.00 A	1.00 B	3.00 AB	2.67 A
New Dawn	control	4.11 c	8.25 a	6.00 c	15.11 c	1.00 b	6.67 b	1.00 b
	Ukorzeniacz AB_{aqua}	2.50 a	7.50 a	4.75 ab	9.40 b	1.00 b	4.50 a	1.00 b
	Ukorzeniacz B_{aqua}	3.25 b	8.90 a	5.50 bc	5.75 a	1.00 b	9.25 c	1.00 b
	Rhizopon AA 020 XX	–	–	–	–	–	–	–
	Chryzotek beige 004 XX	3.71 b	13.20 c	3.68 a	6.07 ab	0.43 a	3.02 a	0.43 a
	Ukorzeniacz – korzonek D DS	3.75 b	10.60 b	6.25 c	18.75 c	1.00 b	10.00 c	1.00 b
	mean	3.46 C	9.69 B	5.24AB	11.02AB	0.89AB	6.69 B	0.89 A

[1] – valuation scale of rooting degree (1–5) in greenhouse: 1 – callus only; 2 – at least one, short root 1–3 cm; 3 – 6–15 roots not longer than 10 cm; 4 – longer (> 10cm), developed roots; 5 – roots strong, branched, very well developed;

[2] – mean values marked with the same letters do not differ significantly at $\alpha = 0.05$

In the present study the effectiveness of using commercial standard powder preparations containing auxins, IBA included, was not so significant. The impact of the preparations was different, and the rooting percentage of cuttings, both in the open field and in the greenhouse, was changeable and depended on the cultivar. The reason of rooting failure here might be the way of applying the preparations, a matter which requires verification. However, it is noticeable that a high rooting percentage was noted in the control combination. Moreover, the rooting percentage in the open field was improved for 'Mme Plantier' (28.0%) and 'Poppius' (38.0%) by the use Chryzotek beige 004 XX, and in the greenhouse experiment – for 'Excelsa' (83.5%) by Korzonek D DS and for 'Kew Rambler' (23.5%) – Chryzotek beige 004 XX. With Ukorzeniacz B_{aqua} (NAA 0.2%) applied, cuttings in the open field did not root. Three cultivars rooted with its use in the greenhouse, but the studied percent was lowered in relation to the control group: 'Kew Rambler' (3.7 to 13.7%), 'New Dawn' (13.2 to 30.7%), and 'Excelsa' (44.0 to 62.5%). However, in the research of Khosh-Khui et al. [1979] rooting of *Rosa damascena* Mill. was significantly enhanced by auxin pretreatment (IBA and NAA), and NAA was superior in increasing root length and root fresh weight. In this research negative results were also obtained for Rhizopon AA 020 XX. When applied, cuttings in the open field did not root ('Excelsa', 'Harison's Yellow', 'Mme Plantier'), or rooted in a much lower percent than the control group: 'Kew Rambler' (4.0 to 20.0%), 'New Dawn' (14.0 to 34.0%) and 'Poppius' (2.0 to 18.0%) (tab. 1). In the case of the cuttings in the greenhouse, the 'New Dawn', 'Kew Rambler' and 'Mme Plantier' did not root. The 'Excelsa' rooted in 52.5%, similarly to the control (62.5%) (tab. 2). The cause of the negative influence of Rhizopon AA 020 XX may be the high concentration of IBA (2%). However, Ercişli et al. [2005] obtained a high percent of rooted cuttings using the highest concentration of IBA in his study (5000 ppm), but this result was lower than that when solution with the concentration of 3500 ppm was used.

In the conducted experiment the growth parameters of the rose cuttings planted in the open field and glasshouse were different, depending on the cultivar (tabs 3 and 4). Cuttings with the high quality root system and aboveground part were obtained in open field for 'Excelsa', 'New Dawn' and 'Polstjårnan'. Cuttings of other cultivars had lower parameters of rooting degree and aboveground part, and the least worthy ones were obtained for 'Harison's Yellow' and 'Poppius'. The use of rooting stimulants for cuttings in the open field brought just a small improvement in the quality of the root system ('Harison's Yellow', 'Kew Rambler', 'Mme Plantier', 'New Dawn') and the aboveground part ('Excelsa', 'Harison's Yellow', 'Kew Rambler', 'Polstjårnan'), and the impact of particular preparations was different within cultivars. However, the using of rooting stimulants for 'New Dawn' caused significant improvement of growth parameters (tab. 3). In this study in glasshouse, the high means of rooting degree were noticed for 'Excelsa', 'Kew Rambler' and 'New Dawn', and the lowest mean was for 'Harison's Yellow' (tab. 4). Ercişli et al. [2005] obtained opposite results, where the quality of *R. dumalis* Bechst. clearly improved after using IBA solutions, and the higher concentration, the bigger the number and length of roots were.

CONCLUSIONS

The results of studies for ten cultivars of roses presented above showed that the effectiveness of this method of propagation was fallible and the decision to apply it requires checking it for the each cultivar. Among ten cultivars mentioned above just two ('Excelsa' and 'New Dawn') had moderate percentage and good growth parameters. The commercial rooting powders for the ten studied rose cultivars do not guarantee an increasing in the effectiveness of rooting and the quality of the rooted cuttings. The Chryzotek beige 004 XX was the most effective, but only in the case of 'Poppius' rooted in open field and 'Kew Rambler' in greenhouse.

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REFERENCES

Davies, F.T. Jr. (1985). Adventitious root formation in *Rosa multiflora* 'Brooks 56' hardwood cuttings. J. Environ. Hort., 3, 55–57.

Ercişli, S., Eşitken, A., Anapali, O., Şahin, U. (2005). Effects of substrate and IBA-concentration on adventitious root formation on hardwood cuttings of *Rosa dumalis*. Acta Hortic., 751, 149–152.

Ercişli, S., Güleryüz, M. (1999). A study of the propagation of the hardwood cuttings of some rose hips. Turk. J. Agric. For., 23, 305–310.

Hambrick, C.E. III, Davies, F.T. Jr., Pemberton, H.B. (1991). Seasonal changes in carbohydrate/nitrogen levels during field rooting of *Rosa multiflora* 'Brooks 56' hardwood cuttings. Sci. Hort., 46, 137–146.

Hartmann, H.T. Kester, D.E., Davies, F.T. Geneve, R.L. (2011). Plant propagation, principles and practices. 7th ed. Prentice-Hall, Englewood Cliffs, N.J., USA.

Hoşafçı, H., Arslan, N., Sarıhan, E.O. (2005). Propagation of dogrose (*Rosa canina* L.) plants by softwood cuttings. Acta Hortic., 690, 149–152.

Kazankaya, A., Yörük, E., Doğan, A. (2005). Effect of IBA on rooting of *Rosa canina* hardwood cuttings from lake van region, Turkey. Acta Hortic., 690, 153–158.

Khosh-Khui, M., Tafazoli, E. (1979). Effect of acid base pretreatment on auxin response of Damask rose cuttings. Sci. Hortic., 10, 4, 395–399.

Krüssmann, G. (1978). Die Baumschule. Verlag Paul Parey. Berlin und Hamburg.

Loach, K., Whalley, D.N. (1978). Water and carbohydrate relationschips during the rooting of cuttings. Acta Hortic., 79, 161–168.

Mahmoud, E.A. (1964). Factors affecting the rooting of hardwood cuttings of *R. multiflora*. Master of Science Thesis. Department of Horticulture. The University of Arizona, USA.

Monder, M.J. (2007). Zasoby genowe i ocena wybranych odmian róż historycznych w kolekcji Ogrodu Botanicznego CZRB PAN. Zesz. Probl. Post. N. Roln., 517(2), 487–494.

Monder, M.J., Niedzielski, M., Woliński, K. (2014). Effect of rooting preparations on protein, chlorophyll and carotenoid content in leaves of *Rosa gallica* 'Duchesse d`Angoulême' cuttings. Dendrobiology, 72, 29–40.
Moroz, E.K. (2006). Korniesoobstwiennyje rozy w Nacionalnom Parkie 'Sofiewka'. NANU Centralnyj Botaniczeskij Sad, Umań, Ukraine.
Mulford, L.F. (1916). Roses for the home. Farmers' Bulletin. United States Department of Agriculture. Government Printing Office, 750, 27–28.
Schultheis, H. (1998). Rosen. Die besten Arten und Sorten für den Garten. Ulmer Eugen Verlag, Germany.
Wiśniewska-Grzeszkiewicz, H., Podwyszyńska, M. (2001). Propagation of ground cover roses by stem cuttings and tissue culture. Acta Hort., 547, 371–376.

UKORZENIANIE SADZONEK ZDREWNIAŁYCH RÓŻ PARKOWYCH I PNĄCYCH PRZY UŻYCIU PREPARATÓW ZAWIERAJĄCYCH AUKSYNY

Streszczenie. Wszystkie odmiany róż uprawnych rozmnażane są wegetatywnie i jednym ze sposobów jest ukorzenianie sadzonek zdrewniałych. Celem badań była weryfikacja możliwości efektywnego rozmnażania parkowych i pnących róż o różnym pochodzeniu przez sadzonki zdrewniałe. Sadzonki pobierano jesienią, przechowywano i sadzono wiosną. Ukorzenianie przeprowadzono na polu doświadczalnym i w szklarni. Użyto komercyjnych preparatów wspomagających ukorzenianie w postaci pudrowej zawierających IBA lub NAA: Ukorzeniacz AB_{aqua}, Ukorzeniacz B_{aqua}, Rhizopon AA 020 XX, Chryzotek beige 004 XX, Ukorzeniacz – korzonek D DS. Spośród 10 ukorzenianych odmian tylko dwie ukorzeniały się efektywnie, a ich sadzonki miały dobrą jakość: 'Excelsa' (31.2% w polu, 56.5% w szklarni) i 'New Dawn' (18.7% w polu, 14.3% w szklarni). Użycie preparatów komercyjnych wspomagających ukorzenianie nie gwarantowało zwiększenie liczby ukorzenionych sadzonek ani poprawy ich parametrów wzrostu. Najbardziej efektywnym okazał się Chryzotek beige 004 XX dla 'Poppius' (38.0%) ukorzenianej w polu i dla 'Kew Rambler' (23.5%) w szklarni.

Słowa kluczowe: róże historyczne, IBA, NAA, rizogeneza, sadzonki

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