THE INFLUENCE OF BENZYLADENINE
AND NAPHTHALENE-1-ACETIC ACID ON ROOTING
AND GROWTH OF *Fuchsia hybrida* CUTTINGS

Katarzyna Wróblewska

Wrocław University of Environmental and Life Sciences

Abstract. Interaction of auxins and cytokinins affects many aspects of plant development. In root and shoot apical meristems these hormones act antagonistically in order to maintain the balance between the formation of new cells and their differentiation. The aim of the experiment was to determine the effect of benzyladenine and its cooperation with 1-naphthaleneacetic acid on rooting and development of aerial parts of *Fuchsia hybrida* cuttings and their subsequent growth. Anatomical analysis of rooting process was also undertaken. Cuttings were treated with BA, NAA or BA and NAA together. BA applied by quick-dip method, delayed root initiation and development and negatively affected the number of primordia. Under the influence of BA cell organization took place in meristem of smaller size. Independently on the year of research and way of treatment BA inhibited adventitious root development, even with the use of NAA. BA, regardless of the presence of NAA, stimulated lateral shoot formation on *Fuchsia* cuttings, applied by spraying, stimulated also shoot elongation. This effect diminished during subsequent development of plants.

Key words: auxins, cytokinins, anatomy, adventitious roots, axillary buds

INTRODUCTION

Commercial production of numerous plant taxa is based on vegetative propagation. In this process the development of adventitious roots, including wound roots, initiated as a response to injury, plays a crucial role. The excision of the cutting has two consequences: injury and isolation from physiological integrity of mature plant [Ahkami et al. 2009]. Endogenous auxins play a key role in the latter mechanism of root initiation. Natural IAA is synthesized in apical shoot meristem and transported to plant roots. Shoot detachment, as a result of cutting collection, prevents polar transport of auxins which begin to accumulate at a cutting base, where they stimulate rooting. The differ-

Corresponding author – Adres do korespondencji: Katarzyna Wróblewska, Department of Horticulture, Wrocław University of Environmental and Life Sciences, pl. Grunwaldzki 24 A, 50-363 Wrocław, Poland, e-mail: katarzyna.wroblewska@up.wroc.pl

ences in auxin synthesis, transport and accumulation establish the basis of rooting for both easy-to root and difficult-to-root plants [Ford et al. 2002]. Natural auxin concentration changes in different stages of rooting, namely it increases during the first stages and then decreases because of conjugation or enzymatic oxidation. Due to that fact the changes in peroxidase isoform pattern and peroxidase activity are regarded as biochemical markers of rooting phases [Syros et al. 2004].

This observation, apart from histological and molecular analysis, allowed to distinguish successive, but interdependent phases of rooting, with different hormone requirements [De Klerk et al. 1995, Li et al. 2009]: initiation, in which shoot tissues feature high concentration of endogenous auxins and are also susceptible to exogenous auxins, as well as to expression, when auxin concentration decreases and exogenous auxins applied at that stage do not affect rhizogenesis [Mohammed 1980, Li et al. 2009], or even they can inhibit it [De Klerk et al. 1999]. The first stage of rooting, completed with the first cell divisions, covers dedifferentiation of cells and induction of molecular and biochemical changes [Li et al. 2009]. That stage begins with activation of sequential genes, including the ones dependent on auxins [Pop et al. 2011]. In the first 24 hours of rooting, when dedifferentiation takes place and before tissues become sensitive to auxins, there reveals the role of wounding-related compounds, like ethylene, jasmonic acid, cellulases and pectinases degrading cell structures or phytoalexins secreted after excision of cutting [De Klerk 1999, Ahkami et al. 2009]. The stage of expression characterizes cell division, organizing root meristem and root elongation until a root occurs on a shoot surface.

Apart from concentration of natural auxins, it has been increasingly stronger emphasized that tissues sensitivity to hormonal signals, including exogenous auxins and cytokinins, is of a significant meaning. Long-distance transport and ratio of auxins to cytokinins control the major developmental processes in plants such as root development and apical dominance [Nördstrom et al. 2004]. Significance of such interaction is also based on regulation of meristem activity, which initiates the occurrence of adult plant structures [Gaspar et al. 2003]. In both, root and shoot apical meristems these hormones act antagonistically in order to maintain the balance between the formation of new cells and their differentiation [Dello Ioio et al. 2007, Moubayidin et al. 2009].

From the point of view of plant producers, quick and abundant rooting is only one of the factors contributing to commercial success. After rooting, cuttings should also characterize intensive growth and satisfactory tillering, yet at that stage there can appear an inhibitory effect of auxins on shoot growth [De Klerk et al. 1999]. One of the trials to solve this problem can be introduction of exogenous cytokinins in the course of rooting. These compounds abolish apical domination stimulating the development of lateral buds and adventitious bud setting, hence they are commonly applied in *in vitro* cultures and flowerbed plants. Contrary to auxins, cytokinins are believed to inhibit the process of rooting [Bollmark and Eliasson1986, Koukourikou-Petridou and Bangerth 1997]. However, there have been known cases, when cytokinins had stimulating effect on adventitious root induction. The latter phenomenon involves cytokinins administered by foliar application and in low concentrations [Van Staden and Harty 1988, Rani Debi et al. 2005].

The aim of the research was to determine the effect of benzyladenine and its cooperation with 1-naphthaleneacetic acid on rooting and development of aerial parts of cuttings of *Fuchsia hybrida* 'Swingtime' in the course of rooting and further cultivation and, therefore, making an effort to find a formula allowing to obtain young plants of best quality. Anatomical analysis of changes taking place in cuttings was also undertaken to support the aim of the research.

MATERIAL AND METHODS

The experiment with propagating of *Fuchsia hybrida* 'Swingtime' by stem cuttings was carried out in the greenhouse of Wroclaw University of Environmental and Life Sciences, Poland. It was established in February 2009 and 2010. Apical stem cuttings, 4 cm in length wre taken from 4-month-old plants grown in a greenhouse. The cuttings were treated with benzyladenine (BA), 1-naphtaleneacetic acid or benzyladenine with 1-naphthaleneacetic acid (BA + NAA) in the following combinations (in g dm^{-3}):

BA: 0.1; 0.2; 0.5; 1.0 (respectively: 4.4×10^{-4}, 8.9×10^{-4}, 2.2×10^{-3}, 4.4×10^{-3} mol dm^{-3}),
NAA: 0.5; 1.0 (respectively: 2.7×10^{-3}, 5.4×10^{-3} mol dm^{-3}),
BA + NAA: 0.1 + 1.0; 0.2 + 0.5; 0.5 + 1.0; 1.0 + 0.5.

BA in 0.1 and 0.2 g dm^{-3} concentrations (in both combinations: alone and with NAA), were applied by spraying of the solution (0.5 cm^3 of the solution per cutting) on leaves after placing the cuttings in soil, BA in 0.5 and 1.0 g dm^{-3} as well as NAA in both concentrations were applied by quick-dip method: basal ends of the cuttings were dipped in solutions for 5 seconds before placing in soil. Control cuttings were treated with none of the growth regulators. The soil consisted of white peat, pine bark and perlit 3:1:1; V:V:V, pH 6.4. It was heated to the temperature of 21°C. Low plastic tunnels were installed over the cuttings. The experiment was established in a one factorial design in 6 replications, per 10 cuttings in each replication. The measurements, including percentage of rooting, number of roots per cutting, height of cuttings, as well as number and length of axillary shoots were taken after 4 weeks of rooting. The measurements were done for every cutting in 3 replications that survived, even if they did not develop roots. Then intact cuttings, not exposed to measurement, were planted into pots, in peat substrate of pH 6.47 containing (in mg dm^{-3}): N-NO$_3^-$ 145, P 119, K 263, Mg 90, Ca 1120 and placed in glasshouse heated to the temperature of 20°C. The experiment was established in 4 replications, per 5 plants in each. After 4 weeks of cultivation the height of plants as well as the number and length of axillary shoots were measured.

Data of the study were subjected to analysis of variance, and least significant differences between means were calculated by the Tukey test at p = 0.05. Data concerning the percentage of rooted cuttings were formerly transformed according to Bliss function.

Anatomical analyses. For anatomical studies additional cuttings of *Fuchsia hybrida* 'Swingtime' were prepared. They were treated with the following formulations: BA 0.5, BA 1.0, NAA 0.5 and NAA 1.0 g dm^{-3} applied by quick-dip method. The fifth combination dealt with control cuttings. All the cuttings were rooted in the conditions described above. For analysis three cuttings were collected: every 24 hours during the first week of rooting and every 2 days during following 2 weeks. Transversal sections were made

from basal part of cuttings, 0.5–1 cm long. Stem segments were embedded in parafine, cut into 10 μm sections using microtome with disposable blades (Boeckeler MR2), stained with acid fuchsin and fast green and covered with canadian balm. Microscopic analyses were performed in optic microscope and photographed.

RESULTS AND DISCUSSION

Rooting of cuttings. Auxins stimulate the occurrence of adventitious roots in the majority of plant species, if they have at least some natural capacity to root. Root promoting properties of auxins provide for the fact that they are commonly used in vegetative propagation. Application of exogenous auxins increases concentration of natural auxins in cuttings [Tonon et al. 2001, Pop et al. 2011], which is expressed by the increase in the number and quality of roots. From a commercial point of view equally significant is also the fact that they positively affect uniformity of rooting [Blazich 1988]. Contrary to auxins it is believed that the range of exogenous cytokinin concentration which promote rooting, is fairly narrow [Van Staden and Harty 1988]. Relatively few reports on stimulating effect of exogenous cytokinins on adventitious or lateral rhizogenezis involve low or even very low concentrations, within the range of 10^{-10} to 10^{-4} mol dm^{-3}, depending on the compound and the form of its application. Recent researches have enabled the knowledge on cytokinin role in the process of rhizogenesis. It is usually connected with interaction between cytokinins and auxins [Pijut et al. 2011]. The mechanism of such interaction can be explained by the influence on polar transport and gradient of auxin as well as the coordination of cell-cycle progression [Pernisová et al. 2009]. According to Laplaze et al. [2007] cytokinin is responsible for creating auxin gradients required for organogenesis. The authors stress that species-specific details may occur in this phenomenon.

Cytokinins stimulate some aspects of root development, such as stimulation of proliferation and root outgrowth from the shoot, which is most often expressed by higher percentage of rooting and root length. In the experiment, there was reported advantageous effect of cytokinins on percentage of rooted fuchsia cuttings in the first year of research. In two combinations: BA 0.1 and BA 0.2 + NAA 0.5 g dm^{-3} percentage of rooting was the same as in cuttings treated solely with NAA (tab. 1). In the first year of experiment only for BA in the strongest concentration 1.0 g dm^{-3} cuttings after 4 weeks of rooting did not produce roots. In the second year of the experiment the same situation occurred in the case of almost all cuttings treated with benzyladenine – exclusively or in combination with NAA. Independently on the year of experiment only NAA 0.5 g dm^{-3} positively influenced number of rooted cuttings. These data found their reflection in the decreased number of roots. Cuttings treated with BA developed less roots than control. The strongest negative effect was observed after quick-dip application, even when it was applied together with NAA (tab. 1). Cuttings treated with BA in concentration 1.0 g dm^{-3} developed no roots in any of the experimental years, yet callus and the fact that cuttings survived, proved that the process of rooting was proceeding. This statement was confirmed by anatomical analysis of cuttings in the course of a rooting process and further stages of the experiment, when a considerable number of cuttings con-

tinued development. One of the solutions to the problem of inhibition of root initiation is delayed application of cytokinins [Rani Debi et al. 2005].

Table 1. The influence of BA and NAA application on rooting of cuttings of *Fuchsia hybrida* 'Swingtime'
Tabela 1. Wpływ traktowania BA i NAA na ukorzenianie sadzonek fuksji ogrodowej *Fuchsia hybrida* 'Swingtime'

Treatment Kombinacja	Concentration (g dm^{-3}) Stężenie (g dm^{-3})	rooting[*] (%) ukorzenianie[*] (%)			number of visible roots liczba widocznych korzeni		
		2009	2010	mean średnia	2009	2010	mean średnia
Control – Kontrola	---	61.9	77.7	69.8	5.1	5.9	5.5
BA	0.1[1]	90.0	57.8	73.9	5.9	2.8	4.4
	0.2[1]	75.0	53.1	64.1	6.7	1.7	4.2
	0.5[2]	66.6	52.8	59.7	1.2	0.0	0.6
	1.0[2]	72.8	59.2	66.0	0.0	0.0	0.0
BA + NAA	0.1[1] + 1.0[2]	70.1	75.0	72.6	2.7	0.9	1.8
	0.2[1] + 0.5[2]	90.0	61.2	75.6	3.7	0.0	1.9
	0.5[2] + 1.0[2]	72.3	54.8	63.6	1.0	1.0	1.0
	1.0[2] + 0.5[2]	77.7	57.8	67.8	1.5	0.0	0.8
NAA	0.5[2]	90.0	77.7	83.9	10.9	7.6	9.3
	1.0[2]	90.0	66.1	78.1	6.8	7.0	6.9
LSD for treatment – NIR dla kombinacji:							
for treatment × year			11.3			1.1	
dla kombinacji × rok			16.0			1.5	

[1] applied by spraying – oprysk
[2] quick-dip application – metoda quick-dip
[*] Data modified according to Bliss' function – Dane zmodyfikowane wg funkcji Blissa

Anatomy of rooting. Adventitious root development follows the same pattern as lateral root formation, differing, in the place of root forming [Ermel et al. 2000]. Contrary to lateral roots, coming from pericycle, adventitious roots can be of a diverse origin. In plants that root easily adventitious roots derive from established plant cells, which can dedifferentiate and proliferate, such as cambium, phloem and, rarely, cortex. In difficult-to-root plants adventitious roots take origin from callus occurring after wounding of tissue. In such cases the place of root initiation are vascular tissues emerging in callus.

Adventitious roots in fuchsia develop as a response to injury [Strzelecka 2006]. Initiation of root primordia took place in a cambium ring, close to phloem parenchyma.
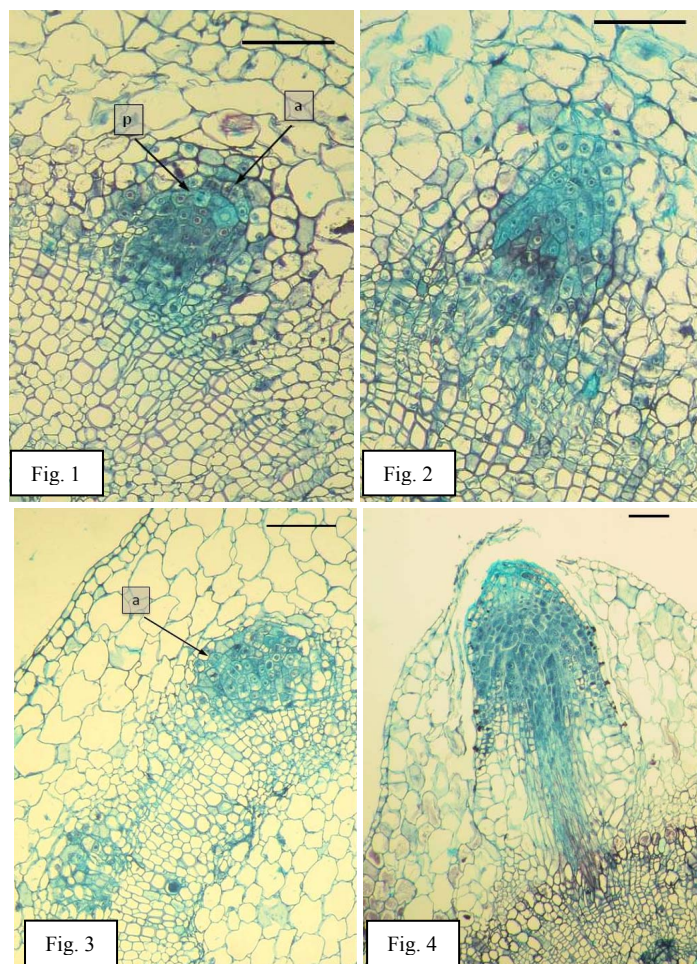
Fig. 1–4. Transversal sections of the shoot of *Fuchsia hybrida* 'Swingtime' cuttings after 11 days (fig. 1, 2, 4) and 7 days (fig. 3) of rooting: 1. treated with BA 0.5 g dm^{-3}, showing adventitious root primordium organizing in root apical meristem with anticlinal (a) and periclinal (p) cell divisions; 2. treated with BA 1.0 g dm^{-3} showing adventitious root apical meristem; 3. control showing adventitious root primordium with anticlinal (a) cell division in the outer tier being the first signs of root meristem organization; 4. treated with NAA 1.0 g dm^{-3} showing adventitious root developing through the outer tissues of the shoot. Bar equalls 100 µm

Ryc. 1–4. Ryciny 1-4. Przekrój poprzeczny pędu sadzonki *Fuchsia hybrida* 'Swingtime' po 11 dniach (ryc. 1, 2, 4) i 7 dniach (ryc. 3) ukorzeniania: 1. traktowanego BA 0,5 g dm^{-3}, ukazujący zawiązek korzenia przybyszowego z podziałami antyklinalnymi (a) i peryklinalnymi, organizujący się w merystem wierzchołkowy korzenia (p); 2. traktowanego BA 1,0 g dm^{-3}, ukazujący merystem wierzchołkowy korzenia przybyszowego; 3. kontrolnego, ukazujący podziały antyklinalne (a) w zewnętrznej warstwie komórek zawiązek korzenia przybyszowego, będące pierwszą oznaką organizowania się merystemu wierzchołkowego korzenia; 4. traktowanego NAA 1,0 g dm^{-3}, ukazujący korzeń przybyszowy rozwijający się przez zewnętrzne tkanki pędu. Podziałka wynosi 100 µm

A number of research works confirm the fact that duration of the first stage of rooting, covering dedifferentaiation and induction of primordia and finishing with the first cell divisions does not depend on application of exogenous auxins. In our experiment the first cell divisions were observed after 72 hours in control cuttings and those treated with NAA, the same time as in apple microcuttings [De Klerk et al. 1995] and cuttings of *Petunia hybrida* [Ahkami et al. 2009]. Anatomical analysis of cutting shoot cross-sections proved a considerable delay of rhizogenesis under the influence of benzy-ladenine. In cuttings treated with BA, regardless its concentration, the first cell divisions were visible after 96 hours. The first primordia, in the form of disorganized cell clusters of a spherical shape, were observed after 11 days of rooting. In that time some primordia showed the beginning of an organized system expressed as anticlinal divisions of an external cell layer leading to formation of dermatogen/calyptrogen initial tier [Rost and Bryant 1996]. Under BA influence these first steps of cell organization took place when primordia reached relatively smaller size of 170×200 μm and on their cross-section there were visible about 30–40 cells (fig. 1). Evident meristem organization, with selected axis and tiers, took place when primordia reached the size about 370×230 μm (fig. 2). In control cuttings and the ones treated with auxin the beginning of primordium organization became visible when reaching the size of 320–330 μm. That stage occurred after 4 days in cuttings treated with NAA and after 7 days in control cuttings (fig. 3). Meristem axis was apparently noticeable after 7 and 9 days, respectively.

Similar responses in decreased length and cell number of root meristem under cytokinin influence were observed in *Arabidopsis* [Beemster and Baskin 2000]. Research conducted with *Arabidopsis* mutants overexpressing genes of cytokinin oxidase, involved in cytokinin degradation, confirms that cytokinin application causes reduced number of proliferating cells [Werner et al. 2001, 2003]. In more details cytokinins suppress root meristem size by mediation of meristematic cell differentiation at the transition zone [Dello Ioio 2007].

In subsequent rooting stages delay was more apparent. Cortex perforation took place 21 and 19 days after BA application, in 0.5 and 1.0 g dm^{-3} concentration, respectively and 7 days after introduction of NAA (fig. 4). In control cuttings the first adventitious roots appeared on the shoot surface after 13 days. Apart from delayed development of adventitious roots, BA negatively affected the number of root primordia. Under the influence of this cytokinin in the shoots of cuttings there occurred up to 2 primordia, in comparison to 3 in control cuttings and 5 in cuttings treated with NAA.

Lateral shoot formation. Shoot apical meristem activity requires high level of cytokinins. Exogenous cytokinin application stimulates the growth of lateral buds [Li and Bangerth 2003]. Contrary to root meristems, where cytokinins promote cell differentiation, in shoot apical meristems they are responsible for maintenance of their proliferative activity [Werner et al. 2001, 2003, Doerner 2007, Kyozuka 2007]. Antagonistic interaction of auxin and cytokinins also affects this aspect of plant development. Auxins, produced in apical shoot meristem and transported basipetaly in the shoot, suppress axillary bud outgrowth. A number of works do confirm that auxin does not act directly on axillary shoot outgrowth. One of the arguments speaking for this hypothesis is the fact that it does not penetrate buds [Hall and Hillman 1975]. Further research indicates that the mechanism of auxin-induced inhibition of lateral shoot outgrowth is connected

Table 2.   The influence of BA and NAA application on shoot development on cuttings of *Fuchsia hybrida* 'Swingtime'
Tabela 2. Wpływ traktowania BA i NAA na rozwój pędów na sadzonkach fuksji ogrodowej *Fuchsia hybrida* 'Swingtime'

Treatment Kombinacja	Concentration (g dm⁻³) Stężenie (g dm⁻³)	Feature – Cecha								
		height of cuttings (mm) wysokość sadzonek (mm)			number of lateral shoots liczba pędów bocznych			sum of lateral shoot length (mm) suma długości pędów bocznych (mm)		
		2009	2010	mean średnia	2009	2010	mean średnia	2009	2010	mean średnia
Control – Kontrola	---	35.6	61.3	48.5	6.0	1.6	3.8	12.8	4.9	8.9
BA	0.1^1	19.6	44.9	32.3	7.8	2.8	5.3	31.7	3.7	17.7
	0.2^1	18.3	37.2	27.8	7.5	2.7	5.1	29.7	3.1	16.4
	0.5^2	27.0	42.5	34.8	5.2	3.2	4.2	17.6	2.3	10.0
	1.0^2	20.0	45.8	32.9	7.2	3.6	5.4	27.7	6.2	17.0
BA + NAA	$0.1^1 + 1.0^2$	34.9	48.7	41.8	6.0	4.3	5.2	25.0	18.1	21.6
	$0.2^1 + 0.5^2$	15.1	41.6	28.4	6.9	2.8	4.9	32.3	8.7	20.5
	$0.5^2 + 1.0^2$	26.2	55.7	41.0	7.8	1.8	4.8	13.5	12.5	13.0
	$1.0^2 + 0.5^2$	33.3	57.9	45.6	7.7	2.8	5.3	20.8	16.2	18.5
NAA	0.5^2	40.0	72.5	56.3	8.6	2.6	5.6	21.5	6.9	14.2
	1.0^2	40.7	58.3	49.5	5.6	2.4	4.0	24.9	6.6	15.8
LSD for treatment – NIR dla kombinacji:										
for treatment × year			8.1			0.7			4.3	
dla kombinacji × rok			11.5			1.1			6.1	

[1,2] see Table 1 – patrz tabela 1

Table 3.   The influence of BA and NAA application on cuttings on subsequent growth of young plants of *Fuchsia hybrida* 'Swingtime'
Tabela 3.   Wpływ traktowania BA i NAA w czasie ukorzeniania sadzonek na wzrost następczy młodych roślin fuksji ogrodowej *Fuchsia hybrida* 'Swingtime'

Treatment Kombinacja	Concentration (g dm⁻³) Stężenie (g dm⁻³)	Feature – Cecha								
		lenght of main shoot (mm) długość pędu głównego (mm)			number of lateral shoots liczba pędów bocznych			sum of lateral shoot length (cm) suma długości pędów bocznych (cm)		
		2009	2010	mean średnia	2009	2010	mean średnia	2009	2010	mean średnia
Control – Kontrola	---	99.9	97.8	98.9	12.1	7.9	10.0	56.9	58.1	57.5
BA	0.1^1	84.5	51.9	68.2	8.6	7.6	8.1	7.0	105.3	56.2
	0.2^1	71.1	45.9	58.5	11.7	11.7	11.7	17.4	69.7	43.6
	0.5^2	61.3	36.3	48.8	8.2	4.0	6.1	21.3	15.2	18.3
	1.0^2	52.1	37.0	44.6	5.6	2.0	3.8	7.4	8.8	8.1
BA + NAA	$0.1^1 + 1.0^2$	55.0	74.5	64.8	9.9	8.7	9.3	34.0	90.0	62.0
	$0.2^1 + 0.5^2$	67.6	56.3	62.0	10.0	6.8	8.4	10.6	83.4	47.0
	$0.5^2 + 1.0^2$	63.6	59.7	61.7	8.1	5.8	7.0	17.6	36.8	27.2
	$1.0^2 + 0.5^2$	61.1	32.4	46.8	13.1	3.1	8.1	27.7	25.8	26.8
NAA	0.5^2	106.1	103.9	105.0	12.7	7.1	9.9	35.0	53.9	44.5
	1.0^2	97.7	90.5	94.1	13.2	5.7	9.5	55.9	40.0	48.0
LSD for treatment – NIR dla kombinacji:										
for treatment × year			14.0			1.4			8.9	
dla kombinacji × rok			19.8			2.0			12.6	

^{1,2} see Table 1 – patrz tabela 1

mainly with reducing of local cytokinin biosynthesis and supply in the nodal stem [Nördstrom et al. 2004, Tanaka et al. 2006, Ongoro and Leyser 2008]. Removing of apical shoot meristem induces cytokinin accumulation from roots to axillary buds which releases them from their dormancy [Mader et al. 2003, Shimizu-Sato et al. 2009]. This cytokinin increase may be neutralized by apical treatment with exogenous auxins. In our experiment NAA was applied into a cutting base and it did evoke any negative effects on the development of lateral shoots (tab. 2). BA, applied alone or with NAA, did increase lateral shoot number on fuchsia cuttings compared to control. Similar effect was obtained by treating with low-concentrated NAA. Regardless of the year of the experiment, BA, applied as a foliar spray, stimulated shoot elongation as well. Combination of this form of cytokinin application with NAA proved to be even more advantageous. After cuttings had been transplanted into pots, beneficial effect of benzyladenine on cutting tillering diminished. Similar response to BA treatment of *Portulaca umbraticola* Kunth plants was observed [Wróblewska and Bąbelewski 2010]. The only combination positively affecting this property in *Fuchsia* plants was benzyladenine in 0.2 g dm^{-3} concentration (tab. 3), since advantageous effect of this compound became evident in both years of the experiment. The examined regulators did significantly influence the height of cuttings. Benzyladenine, applied exclusively and in combination with NAA, proved to be a strong inhibitor of main shoot growth in the course of the rooting process, as well as after cutting transplantation into pots (tab. 3).

CONCLUSIONS

1. BA, apart from concentration 0.2 g dm^{-3}, had advantageous effect on percentage of rooted *Fuchsia hybrida* 'Swingtime' cuttings in the first year of experiment. Independently on the year of BA negatively affected the number of adventitious roots.

2. BA delayed root initiation and development and decreased the number of primordia. Under the influence of BA the beginning of cell organization took place in meristem of relatively smaller size comparing to control or NAA treated cuttings.

3. BA, regardless its concentration, way of treatment and presence of NAA, increased lateral shoot number on *Fuchsia* cuttings. BA applied by spraying stimulated also shoot elongation. This effect diminished during subsequent development of cuttings.

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WPŁYW BENZYLOADENINY I KWASU NAFTYLO-1-OCTOWEGO NA UKORZENIANIE I WZROST SADZONEK FUKSJI MIESZAŃCOWEJ *Fuchsia hybrida*

Streszczenie. Interakcja auksyn i cytokinin wpływa na wiele aspektów rozwoju roślin. W merystemach korzeni i pędu auksyny i cytokininy działają antagonistycznie w celu utrzymania równowagi pomiędzy powstawaniem nowych komórek a ich różnicowaniem się. Celem doświadczenia było określenie wpływu benzyloadeniny i jej współdziałania z kwasem naftylooctowym na ukorzenianie i rozwój części nadziemnej sadzonek fuksji oraz ich wzrost następczy. Przeprowadzono także analizę anatomiczną procesu ukorze-

niania. Sadzonki traktowano BA, NAA oraz BA i NAA jednocześnie. BA aplikowana metodą quick-dip opóźniała inicjację i rozwój korzeni i hamowała tworzenie się primordiów. Pod wpływem BA organizacja komórek zachodziła, gdy merystemy osiągały mniejsze rozmiary. Niezależnie od roku doświadczenia i sposobu aplikacji BA hamowała powstawanie korzeni przybyszowych na sadzonkach nawet wtedy, gdy była podawana razem z NAA. Niezależnie od obecności NAA, BA stymulowała powstawanie pędów przybyszowych na sadzonkach fuksji, a podawana dolistnie stymulowała także ich wydłużanie. Efekt ten zanikał w późniejszym etapie uprawy.

Słowa kluczowe: auksyny, cytokininy, anatomia, korzenie przybyszowe, pędy boczne