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EFFECT OF LEAF SPRAY TREATMENTS ON ROOTING AND QUALITY OF *Prunus mahaleb* (L.) CUTTINGS

Veronika Szabó, Lajos Magyar, Károly Hrotkó
Corvinus University of Budapest, Hungary

Abstract. Cuttings are exposed to several stress factors during rooting. Leaf nutrient sprays may compensate the stress. Six treatments of leaf fertilizers and biostimulators and BA were applied on rooting two cultivars of *Prunus mahaleb* cuttings. Cuttings were taken from untreated stockplants in late May. Each cutting was 20 cm long with three leaves each cut in half. On all cuttings' base, except for untreated ones, 0.2% IBA were applied by dipping in 50% ethanol solution, than inserted into perlite and rooted under intermittent mist. The following leaf spray treatments were applied weekly on rooting cuttings from the first to fourth week: Kelpak® 0.2%, Wuxal® Ascofol 0.2%, Pentakeep®-V 0.05%, Yeald Plus® 0.15%, early BA 0.2%. The later BA treatment started on the 4th week of rooting. Control was sprayed with tap water. Yeald Plus® and Pentakeep®-V show some improving tendency in rooting rate compared to IBA treated and control (8.9 and 4.0%) on 'Bogdány' in average of three years. On 'Magyar' cuttings, which can be characterized with low rooting potential, foliar sprays of Kelpak®, Wuxal® Ascofol, Pentakeep®-V and Yeald Plus® significantly increased the rooting rate and the fresh weight increment during the rooting, while Pentakeep®-V and Yeald Plus® significantly increased the total dry weight of rooted cuttings.

Key words: biostimulators, leaf fertilizers, fresh weight, dry weight, rooting rate

INTRODUCTION

Cuttings during the rooting are exposed to several stress factors (water stress, nutrient supply deficiency, altered hormonal balance) due to the missing root system. This results in most common symptoms like leaf shading, leaf rot and stem rot [Leakey 2004]. Researchers hoped to compensate the stress by stockplant pretreatment and

Corresponding author: Veronika Szabó, Corvinus University of Budapest, Faculty of Horticultural Science, Department of Floriculture and Dendrology, H-1518, Budapest, Pf.:53, e-mail: veronika.szabo@uni-corvinus.hu

application of leaf nutrient sprays [Przeradzki and Mac Cárthaigh 1987, Leakey and Storeton-West 1992, Wiesman and Lavee 1995, Hartmann et al. 1997]. Recently biostimulators or combined sprays are applied to alleviate stress effects and improve rooting and cuttings' quality [Górnik et al. 2008, Nita and Iancu 2009, Jacygrad and Pacholczak 2010, Szabó et al. 2011, 2013, 2014].

Biostimulators may increase several physiological activities in plants [Hotta et al. 1998, Basak 2008a, Xu et al. 2011], first of all protein synthesis and they can help plants surviving stress. They are used to increase the yield of several crops [Hotta et al. 1997, Bingshan et al. 1998, North and Wooldridge 2003, Xu et al. 2011], and to mitigate environmental stress [Beckett and van Staden 1989, Hotta et al. 1998, Watanabe et al. 2000, Nishihara et al. 2002, Arthur et al. 2003, Babik et al. 2008, Kositorna and Smolinski 2008]. Although, softwood cuttings are exposed to severe stress during the rooting, there is little information about how biostimulator application can affect the propagation of *Prunus mahaleb* by cuttings.

Mahaleb clonal rootstocks, such as 'Bogdány' and 'Magyar', improve cumulative yield of sweet cherry while moderate tree vigour [Gyeviki et al. 2008, Hrotkó et al. 2009]. The cutting propagation of *Prunus mahaleb* 'Bogdány' rootstock [Hrotkó 1982, Hrotkó and Magyar 2004] showed variable responses. In order to diminish the stress symptoms some leaf fertilizer and biostimulators seemed promising based on abovementioned literature data and our previous trials [Szabó et al. 2011, 2013, 2014].

Substances of Kelpak® (made of brown kelp, *Ecklonia maxima*) are auxin, cytokinin, gibberellin and natural compounds such as vitamins, amino-acids and alginates [Kelpak Guide, Basak 2008b]. Auxin is dominant in Kelpak® which improves indication of adventitious root formation [Hartmann et al. 1997].

Wuxal® Ascofol is a leaf fertilizer with nutrients and seaweed (*Ascophyllum nodosum*) extract, containing NPK and micronutrients. Kelpak® and Wuxal® Ascofol was used effectively on apple to improve the shoot growth and root quality, as well as to enlarge the weight of root and shoot on woody plant seedlings [Magyar et al. 2008a, b].

The main substance of Yeald Plus® leaf fertilizer is zinc ammonium acetate, recommended for improved rooting after transplanting of young plants [Kwizda Agro 2009]. Yeald Plus® improved root branching on nursery trees [Magyar et al. 2008b].

The main substance of Pentakeep®-V is 5-aminolevulic-acid (ALA) which is a precursor of chlorophyll-synthesis in plants, in low level of concentration (10mM), which then improves photosynthesis and moderates the salt stress [Hotta et al. 1997, Watanabe et al. 2000, Nishihara et al. 2002, Xu et al. 2011]. The Pentakeep®-V besides 0.3% ALA (5-aminolevulic-acid) contains the nutrients 9.5% N, 5.7% Mg, 0.3% Mn, 0.45% B, further on DTPA-Fe, $ZnSO_4$, $CuSO_4$, and dinatrium-molibdenat.

BA (benzyladenine) spray successfully improved the sylleptic shoot formation on intact *Prunus avium* nursery trees [Hrotkó et al. 1999, Magyar and Hrotkó 2005] and shoot production on croton [Nahed 2007]. Spraying rooted cuttings with BA-solution may improve the cuttings' quality due to secondary shoot growth. However, the BA application on cuttings can decrease the rooting noticed by Eriksen [1974].

Based on literature data we supposed that these substances may diminish the leaf senescence, stimulate the rooting and shoot growth, improve rooting, root growth and finally cuttings' quality.

MATERIALS AND METHODS

Our trial was carried out at the Experimental Farm of Corvinus University of Budapest in year of 2011, 2012 and 2014. The farm is located in Central Hungary, the yearly average temperature is 11.3°C, sunshine hours around 2000, precipitation 550 mm in a year. The treatments were applied on *Prunus mahaleb* L. 'Bogdány' and 'Magyar' which cultivars root of variable results [Hrotkó 1982, Hrotkó and Magyar 2004].

Cuttings were taken from outdoor raised stockplants in late May, as the shoot length reached 40–50 cm and the basal diameter of shoots was larger than 3 mm. Each cutting was 20 cm long with three remaining leaves each cut in half. The basal part of cuttings – except for untreated ones – was treated with 0.2% IBA in 50% ethanol as recommended by Hrotkó [1982], than inserted into perlite and rooted under intermittent mist until 8 weeks. In each block, there were 80 cuttings (8 cuttings/per plot repeated 10 times).

The following leaf spray treatments were applied weekly on rooting cuttings from the first to fourth week: Kelpak® 0.2%, Wuxal® Ascofol 0.2%, Pentakeep®-V 0.05%, Yeald Plus® 0.15%, early BA 0.2%. The later BA treatment started on the 4th week of rooting. IBA treated cuttings received only IBA on cutting's base. Control cuttings and IBA treated ones were sprayed with only tap water onto the leaves. Treatment of IBA on softwood cuttings is wide-spread, so this was considered as the control for leaf sprays in these trials.

Before the trial starting fresh and dry weight of cuttings were measured. Eight weeks after the first treatment the following data were collected: the number of rooted cuttings per treatment, total fresh and dry weight of rooted cuttings, fresh weight of separated root, fresh and dry weight increments. Based on earlier results, in 2014 early BA treatment was cancelled. In that case average based on two years, in all other case average was counted based on three years. All data were statistically analysed by analysis of variance (ANOVA) using the statistical program IBM SPSS Statistics 20. Means were separated by Duncan-test at level $p = 0.05$.

RESULTS

After eight weeks, when cuttings were under intermittent mist, the statistically analysed data show different responses to treatments on cultivars by years.

Rooting rate of cuttings. Rooting rates of 'Bogdány' cuttings in year 2011 varied between 9.7 and 90.3% (tab. 1). Pentakeep®-V and Yeald Plus® treatments resulted in rooting rate the highest value (90.3 and 80.6%), what differed significantly from untreated cuttings and from those that received basal IBA treatment only. In second year, 2012, Yeald Plus® treatment and IBA treatment values were over 90%, so there was not any significantly difference except to untreated cuttings' value (tab. 1). In year 2014, all rooting rates of 'Bogdány' were over 80%. Untreated cuttings' and Pentakeep®-V treated cuttings value was significantly lower than Kelpak®, Wuxal® Ascofol, Yeald Plus® and IBA treated cuttings value. In average of three years, rooting rate of untreated cuttings was 44.9%, which could be increased by basal IBA treatment to 82.4%. Although the highest rooting rate in average of three years produced the Yeald Plus®, none of the leaf spray treatment differed significantly, except for Kelpak® (lower than IBA). Early BA treated cuttings' showed lower value than untreated ones (tab. 1).

Table 1. Effect of leaf spray treatments on rooting rate (%) of *Prunus mahaleb* 'Bogdány' and 'Magyar' cuttings

	Treatments	2011	2012	2014	average
'Bogdány'	untreated	15.3a*	37.5a	81.9a	44.9b
	IBA	56.9b	93.1e	97.2d	82.4de
	IBA + Kelpak	52.8b	66.7bc	95.1cd	71.5c
	IBA + Wuxal Ascofol	68.1bc	75.0cd	93.1c	78.7cd
	IBA + Pentakeep-V	90.3d	81.9de	84.7a	85.7de
	IBA + Yeald Plus	80.6cd	90.3de	98.6d	89.8e
	IBA + early BA	9.7a	55.6b	–	32.7a
	IBA + later BA	65.0bc	88.9de	86.8b	80.8de
'Magyar'	untreated	25.0ab	8.3a	25.7a	19.7a
	IBA	29.2ab	80.6e	71.5b	60.4c
	IBA + Kelpak	77.8c	61.1cd	93.1cd	77.3d
	IBA + Wuxal Ascofol	72.2c	77.8e	79.9bc	76.6d
	IBA + Pentakeep-V	43.1b	44.4b	95.8d	61.1c
	IBA + Yeald Plus	80.6c	75.0de	80.6bc	78.7d
	IBA + early BA	8.3a	16.7a	–	12.5a
	IBA + later BA	23.6ab	45.8bc	81.9bc	50.5b

* – means are separated by Duncan-test, different letters in the same column indicate significant differences at p = 0.05. If there are two letters in one cell, there are not any significant differences

Rooting of 'Magyar' cuttings in 2011 varied between 8.3 and 80.6% (tab. 1). Kelpak®, Wuxal® Ascofol and Yeald Plus® treated cuttings' value was significantly higher than BA treatments, IBA or untreated cuttings' value. In 2012, IBA treated cuttings' rooting rate was the highest (80.6%), similar high rooting rate was found on cuttings treated by Wuxal® Ascofol and Yeald Plus®. In the third year, 2014, Kelpak® and Pentakeep®-V treated cuttings' value differed only significantly from IBA or untreated cuttings' value (tab. 1). Average rooting rates of untreated 'Magyar' cuttings over the three years was 19.7%, while the common IBA treatment resulted significant higher percentage (60.4%). Cuttings treated with leaf spray of Kelpak®, Wuxal® Ascofol and Yeald Plus® produced even higher rooting rate compared to IBA. Rooting rate of untreated cuttings and early BA treated cuttings was the lowest, so there was significant difference from all other treatments.

Performance of fresh weight of cuttings. In the year 2011, the Pentakeep®-V treated 'Bogdány' cuttings' total fresh weight (FW) had got significantly higher value than control (tab. 2). The other treatments did not show any considerable differences. In 2012, the fresh weight of treatments' did not differ. However Kelpak® treated cuttings had got the highest total fresh weight in year 2014, there was not any significant difference among the leaf spray treatments (tab. 2). The untreated cuttings produced average total fresh weight of rooted cuttings 3.33 g, while significant higher FW was measured, when cuttings were treated with Pentakeep®-V leaf spray. Early BA treated cuttings had got the lowest value (3.26 g), the other leaf spray treatments did not result significant differences.

Rooted cuttings of 'Magyar' in 2011 produced significant higher FW in comparison to control and IBA when treated with Yeald Plus® leaf spray. In 2012, Kelpak®, Wuxal® Ascofol, Pentakeep®-V, Yeald Plus® and later BA treated cuttings' had got significant higher total fresh weight than untreated ones. In 2014, 'Magyar' rooted cuttings showed significant higher total fresh weight when treated with Pentakeep®-V and Yeald Plus® leaf sprays, compared to control and IBA treatment (tab. 2). However, the IBA treated cuttings which were sprayed with Kelpak®, Pentakeep®-V and Yeald Plus®, had got significantly higher total fresh weight in average than control and early BA treated cuttings, only Yeald Plus® treated ones differed significantly from IBA treatment as the control for leaf sprays.

Table 2. Effects of leaf spray treatments on total fresh weight (g) of rooted *Prunus mahaleb* 'Bogdány' and 'Magyar' cuttings

	Treatments	2011	2012	2014	average
'Bogdány'	untreated	2.72a*	3.43a	3.82a	3.33ab
	BA	3.07ab	3.53a	4.12ab	3.57a
	IBA + Kelpak	2.93ab	3.56a	4.77b	3.75bc
	BA + Wuxal Ascofol	3.44ab	3.24a	4.01ab	3.56ab
	IBA + Pentakeep-V	3.69b	3.28a	4.54ab	3.84c
	IBA + Yeald Plus	3.22ab	3.28a	4.27ab	3.59ab
	IBA + early BA	3.24ab	3.28a	–	3.26a
	IBA + later BA	3.38ab	2.98a	3.81a	3.39ab
'Magyar'	untreated	2.47a	2.28a	2.83a	2.53a
	IBA	2.40a	2.82ab	3.22ab	2.81ab
	IBA + Kelpak	3.07b	3.31b	3.32ab	3.24bc
	IBA + Wuxal Ascofol	2.63a	3.26b	3.13a	3.01ab
	IBA + Pentakeep-V	2.47a	3.54b	3.90c	3.30bc
	IBA + Yeald Plus	3.50b	3.42b	3.92c	3.61c
	IBA + early BA	2.33a	2.84ab	–	2.59a
	IBA + later BA	2.45a	3.33b	3.69c	3.15bc

* – means are separated by Duncan-test, different letters in the same column indicate significant differences at p = 0.05. If there are two letters in one cell, there are not any significant differences

The root fresh weight (RFW) of 'Bogdány' cuttings in 2011 showed no significant difference among treatments. In year 2012, untreated cuttings had got the highest RFW, followed by the Kelpak® treatment. In year 2014, untreated, Wuxal® Ascofol, Pentakeep®-V and IBA treated cuttings gave significant higher RFW, compared to Yeald Plus® and later BA treatments, too (tab. 3). In average of years of 'Bogdány' cuttings' the early BA treatment decreased the RFW, all other treatments do not differ significantly from each other (tab. 3).

The RFW of leaf sprays treated 'Magyar' cuttings do not show any significant difference compared to IBA treated cuttings, except for early BA spray (tab. 3). Significant difference cannot be found in 2012 and 2014 among the leaf sprays compared to IBA treated cuttings. In average of years the leaf spray treated 'Magyar' cuttings did not show different RFW. Only early BA treated cuttings had got significantly less root mass (tab. 3).

The FW increment of rooted 'Bogdány' cuttings compared to untreated ones was significant in 2011 when cuttings were treated with Pentakeep®-V foliar spray (tab. 4). In 2012, there was not any significant difference among treatments. In 2014, the Kelpak® treated cuttings' compared to untreated ones showed higher FW increment, while the other treatments did not differ significantly from untreated cuttings (tab. 4). Compared to IBA treatment foliar spray treatments did not show significant difference.

Table 3. Effects of leaf spray treatments on root fresh weight (g) of rooted *Prunus mahaleb* 'Bogdány' and 'Magyar' cuttings

	Treatments	2011	2012	2014	average
'Bogdány'	untreated	0.38a*	0.83d	0.78b	0.67b
	A	0.67a	0.65bc	0.70b	0.67b
	IBA + Kelpak	0.53a	0.74cd	0.63ab	0.63b
	IBA + Wuxal Ascofol	0.68a	0.35a	0.69b	0.57b
	IBA + Pentakeep-V	0.58a	0.53ab	0.85b	0.64b
	IBA + Yeald Plus	0.68a	0.41a	0.54a	0.54b
	BA + early BA	0.34a	0.41a	–	0.37a
	BA + later BA	0.59a	0.43a	0.57a	0.53b
'Magyar'	untreated	0.12ab	0.39ab	0.53a	0.35b
	IBA	0.22bc	0.36ab	0.39a	0.32b
	IBA + Kelpak	0.26bc	0.49ab	0.39a	0.38b
	IBA + Wuxal Ascofol	0.34c	0.38ab	0.51a	0.41b
	IBA + Pentakeep-V	0.17ab	0.50ab	0.41a	0.36b
	IBA + Yeald Plus	0.23bc	0.51b	0.49a	0.41b
	IBA + early BA	0.03a	0.29a	–	0.16a
	IBA + later BA	0.14ab	0.29a	0.52a	0.32b

* – means are separated by Duncan-test, different letters in the same column indicate significant differences at p = 0.05. If there are two letters in one cell, there are not any significant differences

Table 4. Effects of leaf spray treatments on fresh weight increment (g) of *Prunus mahaleb* 'Bogdány' and 'Magyar' cuttings

	Treatments	2011	2012	2014	average
'Bogdány'	untreated	-0.09 a*	1.25 a	0.80 a	0.66 a
	IBA	0.26 ab	1.35 a	1.10 ab	0.90 ab
	IBA + Kelpak	0.12 ab	1.38 a	1.75 b	1.08 b
	IBA + Wuxal Ascofol	0.63 ab	1.06 a	0.99 ab	0.89 ab
	IBA + Pentakeep-V	0.88 b	1.10 a	1.52 ab	1.17 b
	IBA + Yeald Plus	0.41 ab	1.10 a	1.25 ab	0.92 ab
	IBA + early BA	0.43 ab	1.10 a	–	0.77 a
	IBA + later BA	0.57 ab	0.80 a	0.79 a	0.72 a
'Magyar'	untreated	-0.05 a	**-0.02** a	1.08 a	0.34 b
	IBA	-0.12 a	0.52 ab	1.47 ab	0.62 ab
	IBA + Kelpak	0.55 ab	1.01 b	1.57 ab	1.05 cd
	IBA + Wuxal Ascofol	0.11 a	0.96 b	1.38 a	0.82 c
	IBA + Pentakeep-V	-0.05 a	1.24 b	2.15 c	1.11 cd
	IBA + Yeald Plus	0.98 b	1.12 b	2.17 c	1.42 d
	IBA + early BA	-0.19 a	0.54 ab	–	0.17 a
	IBA + later BA	-0.07 a	1.03 b	1.94 bc	0.96 cd

* – means are separated by Duncan-test, different letters in the same column indicate significant differences at p = 0.05. If there are two letters in one cell, there are not any significant differences

'Magyar' cuttings in 2011 when treated with Yeald Plus® foliar spray showed significant difference in FW increment, compared to IBA treatment (tab. 4). In 2012, foliar spray treatments did not show significant difference compared to the common IBA treatment, while in 2014, Pentakeep®-V and Yeald Plus® treated cuttings' FW increment was significantly higher than IBA treated ones. In average, Kelpak®, Wuxal® Ascofol, Pentakeep®-V, Yeald Plus® and later BA foliar spray treatments improved significantly the FW increment on 'Magyar' cuttings compared to IBA treatment.

Dry weight of cuttings. However, the total dry weight (DW) of foliar spray treated 'Bogdány' cuttings in 2011 (except for Yeald Plus®) and in average of years on Kelpak®, Wuxal® Ascofol, Pentakeep®-V and Yeald Plus® treatments was higher than untreated control, none of the foliar spray treatments showed significant differences compared to IBA treatment (tab. 5). Similarly, none of the DW increment of foliar spray treatments in the three years and in average show significant difference compared to IBA treatment (tab. 6). Total DW of 'Magyar' untreated and IBA treated cuttings do not differ significantly in the investigated years, but in average the IBA treatment show higher DW (tab. 5). Compared to IBA treatment, the Yeald Plus® foliar spray in every year, early BA in 2011, Pentakeep®-V in 2014 showed higher values. In average of three years on cuttings after rooting we measured significant higher DW when treated with Pentakeep®-V and Yeald Plus®. The DW increment performed similarly (tab. 6), but in average the Yeald Plus® foliar spray resulted significant higher value.

Table 5. Effects of leaf spray treatments on total dry weight (g) of rooted *Prunus mahaleb* 'Bogdány' and 'Magyar' cuttings

	Treatments	2011	2012	2014	average
'Bogdány'	untreated	0.983 a*	1.384 a	1.418 a	1.262 a
	IBA	1.223 ab	1.401 a	1.537 a	1.387 ab
	IBA + Kelpak	1.269 b	1.417 a	1.727 a	1.471 b
	IBA + Wuxal Ascofol	1.383 b	1.415 a	1.452 a	1.417 b
	IBA + Pentakeep-V	1.488 b	1.305 a	1.650 a	1.481 b
	IBA + Yeald Plus	1.215 ab	1.440 a	1.637 a	1.431 b
	IBA + early BA	1.340 b	1.380 a	–	1.360 ab
	IBA + later BA	1.350 b	1.253 a	1.399 a	1.334 ab
'Magyar'	untreated	0.981 ab	0.934 a	1.018 a	0.947 a
	IBA	0.962 ab	1.047 ab	1.211 ab	1.130 b
	IBA + Kelpak	1.278 bcd	1.264 bc	1.261 bc	1.258 ab
	IBA + Wuxal Ascofol	1.026 abc	1.134 abc	1.149 ab	1.175 b
	IBA + Pentakeep-V	1.012 abc	1.194 bc	1.483 c	1.351 c
	IBA + Yeald Plus	1.388 d	1.322 c	1.450 c	1.343 c
	IBA + early BA	1.334 cd	1.248 bc	–	1.206 b
	IBA + later BA	0.919 a	1.114 abc	1.341 bc	1.255 bc

* – means are separated by Duncan-test, different letters in the same column indicate significant differences at $p = 0.05$. If there are two letters in one cell, there are not any significant differences

Table 6. Effects of leaf spray treatments on dry weight increment of *Prunus mahaleb* 'Bogdány' and 'Magyar' cuttings

	Treatments	2011	2012	2014	average
'Bogdány'	untreated	0.039 a*	0.641 a	0.554 a	0.411 a
	IBA	0.279 ab	0.658 a	0.673 a	0.537 b
	IBA + Kelpak	0.325 b	0.674 a	0.863 a	0.621 b
	IBA + Wuxal Ascofol	0.439 b	0.672 a	0.588 a	0.566 b
	IBA + Pentakeep-V	0.544 bc	0.562 a	0.786 a	0.631 b
	IBA + Yeald Plus	0.271 ab	0.697 a	0.773 a	0.581 b
	IBA + early BA	0.396 b	0.637 a	–	0.516 b
	IBA + later BA	0.406 b	0.510 a	0.535 a	0.483 ab
'Magyar'	untreated	0.198 ab	0.135 a	0.162 a	0.165 a
	IBA	0.179 ab	0.379 ab	0.356 ab	0.305 ab
	IBA + Kelpak	0.495 bcd	0.495 b	0.406 b	0.465 bc
	IBA + Wuxal Ascofol	0.243 abc	0.489 b	0.294 ab	0.342 b
	IBA + Pentakeep-V	0.229 abc	0.623 b	0.628 c	0.493 bc
	IBA + Yeald Plus	0.605 d	0.502 b	0.595 c	0.568 c
	IBA + early BA	0.551 cd	0.409 b	–	0.480 bc
	IBA + later BA	0.136 a	0.556 b	0.486 bc	0.392 b

* – means are separated by Duncan-test, different letters in the same column indicate significant differences at p = 0.05. If there are two letters in one cell, there are not any significant differences

DISCUSSION

The rooting rate of untreated cuttings of 'Magyar' was low (19.7%), while 'Bogdány' rooted in much higher rate (44.9%) without any treatment, so our results confirm Hrotkó [1982] and Hrotkó and Magyar [2004]. In agreement with Szabó et al. [2011, 2014] we can state that the efficiency of additional foliar spray treatments is higher on cultivar with lower rooting potential. On 'Bogdány' cuttings none of the additional foliar sprays increased significantly the rooting rate in average of three years, although Yeald Plus® and Pentakeep®-V show some improving tendency (additionally 8.9 and 4.0% higher rooting rate). In contrary, on 'Magyar' cuttings in average of three years the Yeald Plus®, Kelpak® and Wuxal® Ascofol foliar sprays significantly increased the rooting rate (by 30.3, 28 and 26.8%, respectively) compared to the common IBA treatment.

From among the applied foliar sprays Pentakeep®-V on 'Bogdány' and Yeald Plus® on 'Magyar' significantly increased the total FW of rooted cuttings. Furthermore, in average of years on 'Magyar' cuttings foliar sprays of Kelpak®, Wuxal® Ascofol, Pentakeep®-V and Yeald Plus® significantly increased the FW increment during the rooting, although these treatments did not affect the RFW. On the cuttings of 'Magyar', which can be characterized with low rooting potential, the foliar sprays of Pentakeep®-V and Yeald Plus® significantly increased the total DW of rooted cuttings. The Yeald Plus® spray increased the DW increment, too. Our results confirm Przeradzki and Mac Cárthaigh [1987], Leakey and Storeton-West [1992], Wiesman and Lavee 1995, Górnik et al. [2008], Nita and Iancu [2009], Jacygrad and Pacholczak [2010], and Szabó et al. [2011, 2013, 2014] who reported that biostimulator and nutrient sprays alleviate stress effects and improve rooting and cuttings' quality.

Early BA treatments on both *Prunus mahaleb* (L.) cultivars decreased rooting rate, what is in agreement with results of Eriksen [1974]. Later BA treatment on 'Magyar' cuttings improved the fresh weight increment of rooted cuttings. It can explain with effect of cytokinins, what results new shoots under rooting period by amplifying of source process [Mothes et al. 1961, Mothes and Engelbrecht 1963, Werner et al. 2008]. Those cuttings can survive the deficiency of water, nutriment, had got faster mobilization potential of nutriments, so they can improve their fresh mass.

CONCLUSIONS

1. On 'Magyar' cuttings with low rooting potential, the Yeald Plus®, Kelpak® and Wuxal® Ascofol foliar sprays significantly increased the rooting rate compared to the common IBA treatment, while on easy to root 'Bogdány' these treatments were less efficient.

2. Foliar sprays of Kelpak®, Wuxal® Ascofol, Pentakeep®-V and Yeald Plus® on 'Magyar' cuttings significantly increased the fresh weight increment during the rooting, which suggests, that above-mentioned foliar sprays improve the quality of rooted cuttings.

3. Early BA treatments decreased rooting rate in general but later BA treatment on 'Magyar' cuttings improved the fresh weight increment of rooted cuttings.

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WPŁYW ZABIEGÓW OPRYSKIWANIA LIŚCI NA UKORZENIENIE I JAKOŚĆ SADZONEK *Prunus mahaleb* (L.)

Streszczenie. Podczas ukorzeniania sadzonki są wystawione na działanie kilku czynników stresu. Opryskiwanie liści substancjami odżywczymi może zrekompensować ten stres. Zastosowano sześć zabiegów nawożenia, biostymulatory i BA na liście dwóch odmian sadzonek *Prunus mahaleb*. Sadzonki pochodziły z podkładek z późnego maja. Każda sadzonka miała 20 cm długości i trzy liście, z których każdy był przecięty na pół. Na podstawie wszystkich sadzonek, z wyjątkiem sadzonek niepodanych zabiegowi, zastosowano 0.2% IBA poprzez wkroplenie 50% roztworu etanolu. Następnie sadzonki umieszczono w perlicie i tam ukorzeniały się pod ciągłą mgiełką. Na ukorzeniające się sadzonki, począwszy od pierwszego aż do czwartego tygodnia, stosowano co tydzień następujące zabiegi: Kelpak® 0.2%, Wuxal® Ascofol 0.2%, Pentakeep®-V 0.05%, Yeald Plus® 0.15%, początkowo BA 0.2%. Późniejszy zabieg BA rozpoczął się czwartego tygodnia ukorzeniania. Kontrolę spryskiwano wodą wodociągową. Yeald Plus® oraz Pentakeep®-V wykazują pewną rosnącą tendencję, jeśli chodzi o wskaźnik ukorzeniania w porównaniu z zabiegiem IBA i kontrolą (8.9 i 4.0%) w przypadku 'Bogdány' i średnich wartości trzyletnich. Na sadzonkach 'Magyar', które charakteryzują się niskim potencjałem ukorzeniania, dolistne spryskiwanie za pomocą Kelpak®, Wuxal® Ascofol, Pentakeep®-V i Yeald Plus® znacznie zwiększyło wskaźnik ukorzenienia oraz przyrost świeżej masy podczas ukorzenienia natomiast zastosowanie Pentakeep®-V i Yeald Plus® znacznie zwiększyło całkowitą suchą masę ukorzenionych sadzonek.

Słowa kluczowe: biostymulatory, nawozy dolistne, świeża masa, sucha masa, wskaźnik ukorzenienia

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