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THE PROPAGATION OF TWO RED AND BLACK CURRANT VARIETIES BY HARDWOOD CUTTINGS COMBINING SUBSTRATE AND ROOTING STIMULATORS

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Abstract

The planting material production is a particularly attractive segment of fruit growing field, both through the possibility of maximizing profits on small lands and because of the increased interest manifested by growers in the horticultural sector, especially in berries. The currant is specie that manages to propagate more easily than other berry shrubs, but rooting capacity vary from species to species and depending on different climatic and technological factors. The present paper supports the nursery activity by developing a complex experimental module that identifies the best solutions for black and red currant cuttings as a way of vegetative propagation. The thickness of the cuttings, rooting substrates and rooting hormonal stimulants (obtained in laboratory and commercial products) are taken into account. Two varieties of currants were used: 'Tinker' cultivar for black currant and 'Elite' cultivar for red currant. The rooting percentage of cuttings was very similar for the black and currant varieties (around 77%). For both currants, the thinner cuttings gave the best results in terms of rooted cuttings percentage. Perlite + sand substrate achieved the highest rooting percentage of the cuttings but with the lowest vegetative growths. Among the stimulators used for rooting, the IBA hormone (regardless of the concentration used) achieved the best percentages of cuttings rooted in both currant varieties. IBA 1000 ppm gave the best results on the length of the shoots on both currant varieties. Peat + sand positively influenced the root volume in the red currant and perlite + peat mixture for black currant. The volume of the root system in the red currant was approximately 2 times larger than the black currant. IBA 1000 and IBA 1500 conducted to the most extensive radicular system to both currant varieties.

Key words*: rooting hormons, cuttings thickness, 'Elite','Tinker', root system volume.*

INTRODUCTION

In horticulture, vegetative propagation is widely used to multiply elite plants obtained in breeding or selected from natural populations (Hartman et al., 1990). Propagation of currant's varieties is still one of the most cost-effective methods for vegetative regeneration as any other woody species (Koyuncu and Senel, 2003; De Klerk et al., 1999). It reclaims cuttings from the previous season's growth (minimum one year old) harvested during the dormant stage from the mother plant (Sandor, 2007).

Induction of roots is a process regulated by timing (Szecsko et al., 2002), environmental and endogenous factors including hormones. Auxin is one of the major endogenous hormones involved in the adventitious rooting process (Wiesman et al, 1988; Pop et al., 2011).

Well known sources of growth hormones for rooting of cuttings are the IBA (indole-3-butyric acid), IAA (indole-3-acetic acid) and NAA (α-naphthalene acetic acid) in different concentrations (Khudhur et al., 2015; Uniyal et al., 1993), together with a lot of commercial products nowadays used as root promoters (solutions or powders).

In a previous research, Pandey et al. (2011) concluded that IBA treatment had shown not only an improvement of the percent rooting at *Ginkgo biloba* L. but also a positive effect on the subsequent growth and survival rate of the plantlets.

IBA has recorded the highest recognition among all auxins used for rooting.

Treatments of the currants hardwood cuttings with furostanol glycosides (Caulet et al., 2012), for one hour, leaded to an increasing of roots number and contributed to obtain more

qualitative black currant cuttings of Deea, Abanos and Ronix varieties in comparison with Radistim 2% (commercial rooting stimulator product).
Combined and softwood cuttings have been experienced for several currant varieties by Siksnianas and Sasnauskas (2006) using IAA, NAA and ascorbic acid as rooting growth stimulators. Substrate used was 2 parts of peat and 1 part of sand and artificial mist was provided. Results showed that for cultivars of black currant, rooting of combined cuttings was higher and the NAA 25 g/l-1 offered the highest quality of rooting.
There is always a need for improvement and in this regard, the current study was conducted to determine the most suitable way to propagate two of the most cultivated varieties of black and red currant by hardwood cuttings. Thickness of the cuttings, rooting substrate and stimulator concentrations influence has been took into consideration.

MATERIALS AND METHODS

The experiment was established in the Vegetation House of the University of Agronomic Sciences and Veterinary Medicine of Bucharest and was carried out between February and June of 2016.
The biological material consists of two varieties of currant: 'Elite' (red currant) and 'Tinker' (black currant).
The cuttings were made using annual dormand branches harvested from mother plants located in the experimental field of the Faculty of Horticulture, Bucharest.
Two categories of cuttings have been executed (figure 1):
- for red currant: thin cuttings (0.26-0.35 mm) and thick cuttings (0.36-0.78 mm)
- for black currant: thin cuttings (0.3-0.48 mm) and thick cuttings (0.49-1.89 mm)
The length of the cuttings was of 15 cm with minimum 3 nodes.
Cuttings were afterwards treated with different rooting hormones and concentrations as follows:

- IBA 500 ppm (solution)
- IBA 1000 pm (solution)
- IBA 1500 ppm (solution)
- Razormin (solution of aminiacids, macroelements and microelelments)
- Rhizopon AA1% (powder, IAA 1%)

Figure 1. Cuttings of red (left) and black currant (right) made with different thickness

Except the control, all the cuttings were submerged in the hormonal solutions for 5 minutes with the basal part or covered with powder in the situation of Rhizopon product.
Rooting substrate was represented by equal share of the following parts (figure 2).

Figure 2. Rooting substrate variants:
top Peat + Perlite = 1:1
middle Peat + Sand = 1:1
bottom Perlite + Sand = 1:1

At the end, 720 cuttings resulted: 360 of red currant and 360 of black currant. Half of them (360 cuttings) were in the first thickness category and the other half in the second one. In every pot it were placed 10 cuttings of currant according to the experimental model A number of 72 pots with the capacity of 3 liter each were customized (figure 3).

Figure 3. Experimental module of currant cuttings grouped by substrate, thickness and hormonal treatment (4.04.2016)

On 7th of June, 2016, all the cuttings were removed from the pots and several determinations and observations were performed: rooting percentage, vegetative growth of the rooted cuttings, root system volume.

All data were processed by analyze of variance and Duncan's multiple range test at confidence level of 95% (P≤0.05) using XLSTAT software.

RESULTS AND DISCUSSIONS

Five months after the experiment start, the entire plot was disassembled, taking each variant one by one in careful observation and gathering data related to the rooting success and overall cuttings quality.

In this respect, we remarked very small differences concerning the rooting ratio of the two currant species. As an overall percentage, 'Elite' variety recorded 77.22% rooting percentage; very close to the black currants 'Tinker' ones of 77.36% (table 1).

Depending on the cuttings thickness, the rooting percentages were quite variable; significantly differences have been registered at red currant thinner cuttings for control and variants treated with Razormin.

At black currant, the cuttings thickness did not influence much the rooting percentage, only 10.84% difference was noticed between thicker and thinner cuttings.

Comparing the two species on this issue, only few rooting percentages (3.33%) more have been registered between thicker black currant cuttings than red currants cuttings.

Same observation was made in the case of thinner cuttings (3.61%) but in favour of red currants.

The rooting substrate played a very important role in the rooting percentage of the cuttings, at the end of the experiment, the highest values been revealed for the perlite with sand mixture (more than 80%).

We find a relatively close hierarchy between substrate types, the second place being peat + perlite which averaged 77.08%. Peat + sand had a slightly weaker effect, with lower black currant (62.92%) and almost 10% lower than 'Elite' red currant variety.

Table 1. Rooting percentage of currant cuttings depending on cultivar, thickness of cutting, substrate and hormones

Red currant	%	Hormone/Product						
Cutting type	Substrate	IBA 500	IBA 1000	IBA 1500	Razormin	Rhizopon	Control	Average
Thin	Peat + Perlite	100	90	60	0	80	80	**68.33a**
	Peat + Sand	100	60	60	60	60	0	**56.67a**
	Perlite + Sand	90	100	100	20	90	80	**80.00a**
	Average	**96.67a**	**83.33a**	**73.33ab**	**26.67b**	**76.67ab**	**53.33ab**	**68.33a**
Thick	Peat + Perlite	70	100	90	30	100	80	**78.33a**
	Peat + Sand	80	100	80	100	70	90	**86.67a**
	Perlite + Sand	100	90	100	80	90	100	**93.33a**
	Average	**83.33a**	**96.67a**	**90.00a**	**70.00a**	**86.67a**	**90.00a**	**86.11a**
Overall Average (%)		***90.00a***	***90.00a***	***81.67a***	***48.33a***	***81.67a***	***71.67a***	***77.22a***
Black currant	%	Hormone/Product						
Cutting type	Substrate	IBA 500	IBA 1000	IBA 1500	Razormin	Rhizopon	Control	Average
Thin	Peat + Perlite	80	80	100	80	60	20	**70.00ab**
	Peat + Sand	60	60	60	55	60	50	**57.50b**
	Perlite + Sand	100	100	90	60	80	100	**88.33a**
	Average	**80.00a**	**80.00a**	**83.33a**	**65.00a**	**66.67a**	**56.67a**	**71.94ab**
Thick	Peat + Perlite	80	90	100	90	90	100	**91.67a**
	Peat + Sand	90	90	60	10	70	90	**68.33b**
	Perlite + Sand	70	90	90	90	90	100	**88.33ab**
	Average	**80.00a**	**90.00a**	**83.33a**	**63.33a**	**83.33a**	**96.67a**	**82.78ab**
Overall Average (%)		***80.00a***	***85.00a***	***83.33a***	***64.17a***	***75.00a***	***76.67a***	***77.36a***

*Duncan's multiple range test (P≤0.05)

Regarding the effect of rooting stimulants on the percentage of root formation, we noted a fairly good influence of the IBA hormone regardless of the concentration in which it was used. A negative response was also noticed at Razormin, which practically had an antagonistic effect, the rooting percentages being lower for both species but more evident in the red bark (48.33%). By stimulating with the IBA 500 and IBA 1000, the red currant has reached a very good rooting percentage, 90% of the cuttings have been rooted.

Observations and calculations were made on the type of the vegetative growths resulting from the evolution of the apical buds of the cutting. Thus, more shoots could be counted than leaf rosettes in the case of thicker cuttings; the thinner ones, even if they have recorded the best rooting percentage, have led to the formation of more rosettes of leaves (table 2).

The rooting hormones showed a more pronounced effect on the black currant related to the percentages of cutting's shoots, where the IBA 1500 and descending to the IBA 500 induced the occurrence of larger shoots. For red currant, the differences between the compounds used to stimulate the rooting of the cuttings were less evident; the control formed the highest number of shoots compared to the other cuttings.

Also, the highest number of rosettes was observed in the perlite + sand substrate (figure 4).

Table 2. Share of shoots and rosettes / currants cuttings (5 months from the begining)

Red currant	Substrate	Hormone/Product												Average	
		IBA 500		IBA 1000		IBA 1500		Razormin		Rhizopon		Control			
		S	R	S	R	S	R	S	R	S	R	S	R	S *	R*
		%	%	%	%	%	%	%	%	%	%	%	%	%	%
Thick cutting	Peat + Perlite	7	3	88.8	11.1	83.3	16.6			87.5	12.5	10		**85.94a**	**14.06a**
	Peat + Sand	7	3	83.3	16.6	66.6	33.3	5	5	83.3	16.6			**70.66a**	**29.34a**
	Perlite + Sand	77.7	22.2	9	1	7	3	10		77.7	22.2	10		**85.92a**	**14.08a**
	Average	***72.59***	***27.41***	***87.40***	***12.59a***	***73.33***	***26.66***	***75.00***	***25.00a***	***82.87***	***17.13a***	***100***	***0.00***	**80.84a**	**19.16a**
Thin cutting	Peat + Perlite	10		8	2	9	1	66.6	33.3	8	2	7	2	**81.94a**	**18.06b**
	Peat + Sand	7	2	7	3	5	5	9	1	57.1	42.8	66.6	33.3	**68.13ab**	**31.87b**
	Perlite + Sand	5	5	33.3	77.7	7	3	12.	87.	33.3	77.7	9	1	**44.49b**	**55.51a**
	Average	***75.00***	***25.00***	***57.41***	***42.59***	***70.00***	***30.00***	***56.39***	***43.61***	***53.12***	***46.88***	***77.22***	***22.78***	**64.86ab**	**35.14ab**
Overall mean		***73.80a***	***26.20a***	***72.41a***	***27.59a***	***71.67a***	***28.33a***	***65.69a***	***34.31a***	***67.99a***	***32.00a***	***88.61a***	***11.39a***	***72.85a***	***27.15a***
Black currant	Substrate	Hormone/Product												Average	
		IBA 500		IBA 1000		IBA 1500		Razormin		Rhizopon		Control			
		S	R	S	R	S	R	S	R	S	R	S	R	S *	R*
		%	%	%	%	%	%	%	%	%	%	%	%	%	%
Thick cutting	Peat + Perlite	75	25	75	25	90	10	62.5	37.5	83.33	16.66	50	50	**72.64b**	**27.36b**
	Peat + Sand	100	0	100	0	100	0	100	0	100	0	100	0	**100.00a**	**0.00c**
	Perlite + Sand	30	70	50	50	44.44	55.55	0	100	0	100	20	100	**24.07c**	**79.26a**
	Average	***68.33a***	***31.67a***	***75.00a***	***25.00a***	***78.15a***	***21.85a***	***54.17a***	***45.83a***	***61.11a***	***38.89a***	***56.67a***	***50.00a***	**65.57b**	**35.54b**
Thin cutting	Peat + Perlite	62.5	37.5	88.88	11.11	100	0	55.55	44.44	66.66	33.33	100	0	**78.93ab**	**21.06c**
	Peat + Sand	77.77	22.22	66.66	33.33	100	0	100	0	71.42	28.57	100	0	**85.98a**	**14.02c**
	Perlite + Sand	42.85	57.14	20	80	0	100	0	100	0	100	0	100	**10.48c**	**89.52a**
	Average	***61.04a***	***38.95a***	***58.51a***	***41.48a***	***66.67a***	***33.33a***	***51.85a***	***48.15a***	***46.03a***	***53.97a***	***66.67a***	***33.33a***	**58.46b**	**41.54b**
Overall mean		***64.69a***	***35.31a***	***66.76a***	***33.24a***	***72.41a***	***27.59a***	***53.01a***	***46.99a***	***53.57a***	***46.43a***	***61.67a***	***41.67a***	***62.02a***	***38.54a***

*S-shoot; R-rosette of leaves

*Duncan's multiple range test (P≤0.05)

Figure 4. The bigger share of rosettes formed by red currants cuttings in perlite + sand substrate (first two rows in the front) - 21.05.2016

The vigour of the rooted cuttings was highlighted by the length of the total growth of the cutting (figure 5).

The length of the shoots was influenced by all the experimental factors analysed and are presented in table 3 for each type of currant.

Regarding the type of cutting, we can say that this factor did not directly influence the length of the shoot/s, the differences being very small in the red currant and somewhat larger in the black currant (only 1.18 cm).

The same thing cannot be said about the type of substrate, which had a decisive role in plant height. Therefore, for the black currant, the

most effective was the peat + sand substrate, which achieved an average of 16.79 cm. At the opposite side, there is the perlite with sand, the substrate which generated the lowest length of the shoot, and the biggest share of the rosettes/cutting. For the red currant, the best substrate proved to be peat + perlite.

Table 3. The length of the shoots/cutting (cm)

Red currant	Substrate	IBA 500	IBA 1000	IBA 1500	Razormin	Rhizopon	Control	Average
Thick cutting	Peat + Perlite	11.07	12.50	14.20	0.00	20.14	12.00	**11.65a**
	Peat + Sand	13.40	9.40	11.00	8.33	13.00	0.00	**9.19a**
	Perlite + Sand	8.57	7.88	5.67	5.50	7.00	6.25	**6.81a**
	Average	**11.01a**	**9.93a**	**10.29a**	**4.61a**	**13.38a**	**6.08a**	**9.22a**
Thin cutting	Peat + Perlite	13.14	10.50	12.89	8.00	11.25	11.33	**11.19a**
	Peat + Sand	10.50	9.07	11.25	11.22	10.63	11.08	**10.63ab**
	Perlite + Sand	7.20	4.00	4.57	6.00	6.00	5.67	**5.57c**
	Average	**10.28a**	**7.86a**	**9.57a**	**8.41a**	**9.29a**	**9.36a**	**9.13b**
Overall mean		**10.65ab**	**8.89ab**	**9.93ab**	**6.51b**	**11.34a**	**7.72ab**	**9.17ab**
Black currant	Substrate	IBA 500	IBA 1000	IBA 1500	Razormin	Rhizopon	Control	Average
Thick cutting	Peat + Perlite	7.17	8.91	8.05	4.8	12.4	2	**7.22b**
	Peat + Sand	17	22.17	19.83	11.75	17.16	15.75	**17.28a**
	Perlite + Sand	1.75	2.7	2.5	0	0	2	**1.49c**
	Average	**8.64a**	**11.26a**	**10.13a**	**5.52a**	**9.85a**	**6.58a**	**8.66ab**
Thin cutting	Peat + Perlite	12.2	13.31	12.8	12.8	15	7.05	**12.19b**
	Peat + Sand	16.71	18.67	22	14	13.2	13.22	**16.30a**
	Perlite + Sand	3.67	2.5	0	0	0	0	**1.03c**
	Average	**10.86a**	**11.49a**	**11.60a**	**8.93a**	**9.40a**	**6.76**	**9.84b**
Overall mean		**9.75ab**	**11.38a**	**10.86a**	**7.23bc**	**9.63abc**	**6.67c**	**9.25abc**

*Duncan's multiple range test (P≤0.05)

Figure 5. The stimulating effect of IBA hormone upon the length of the thicker black currants cuttings rooted in the sand + perlite substrate (7.06.2016)

To illustrate the quality of the cuttings, we proceed to assess the root volume of the black and red currant cuttings.

As can be seen from table 4, the black currant developed a bigger root system, which also explains the length of the shoots on same substrates.

In the red currant, both for the thicker and the thinner cuttings, the substrate that favoured the formation of a larger root volume was peat + sand (figure 6).

In the black currant, the differences were somewhat smaller, highlighting peat mixed with pearl or sand.

Table 4. The root volume of the currants cuttings (mm^3)

Red currant	Substrate	IBA 500	IBA 1000	IBA 1500	Razormin	Rhizopon	Control	Average
Thick cutting	Peat + Perlite	6.10	5.22	7.00	1.00	4.80	6.00	**5.02a**
	Peat + Sand	6.17	6.50	7.43	4.67	7.00	6.00	**6.29a**
	Perlite + Sand	3.89	4.80	3.40	7.00	4.67	3.75	**4.58a**
	Average	**5.39a**	**5.51a**	**5.94a**	**4.22a**	**5.49a**	**5.25a**	**5.30a**
Thin cutting	Peat + Perlite	4.29	2.50	3.56	2.67	3.90	4.20	**3.52bc**
	Peat + Sand	3.33	4.22	6.67	5.00	4.57	4.89	**4.78a**
	Perlite + Sand	3.14	2.60	2.60	2.44	2.60	2.80	**2.70c**
	Average	**3.59a**	**3.11a**	**4.27a**	**3.37a**	**3.69a**	**3.96a**	**3.67b**
Overall mean		**4.49a**	**4.31a**	**5.11a**	**3.80a**	**4.59a**	**4.61a**	**4.48a**
Black currant	Substrate	IBA 500	IBA 1000	IBA 1500	Razormin	Rhizopon	Control	Average
Thick cutting	Peat + Perlite	2.60	3.11	2.00	1.75	3.71	2.50	**2.61abc**
	Peat + Sand	2.80	4.33	3.25	3.50	2.25	2.57	**3.12a**
	Perlite + Sand	2.20	2.00	2.22	2.80	2.88	2.10	**2.37bc**
	Average	**2.53a**	**3.15a**	**2.49a**	**2.68a**	**2.95a**	**2.39a**	**2.70ab**
Thin cutting	Peat + Perlite	2.57	2.67	2.60	2.22	2.22	2.40	**2.45a**
	Peat + Sand	1.60	2.25	2.50	2.40	2.25	2.50	**2.25a**
	Perlite + Sand	2.22	1.80	1.33	1.56	1.67	0.80	**1.56c**
	Average	**2.13a**	**2.24a**	**2.14a**	**2.06a**	**2.05a**	**1.90a**	**2.09ac**
Overall mean		**2.33a**	**2.69a**	**2.32a**	**2.37a**	**2.50a**	**2.15a**	**2.39a**

*Duncan's multiple range test (P≤0.05)

IBA 1000 and IBA 1500 presented the highest efficiency in providing a broader radicular system, managing the highest values in both species of currant. But the differences were not significantly evident from the other variants.

Figure 6. Detail of the root system generated by red currants thick cuttings stimulated with IBA 1000 ppm in peat + sand substrate (left) versus perlite + sand (right)

Regardless of the variants analysed, we can emphasize the clear difference between the ability to form more roots / cutting in the case of the black currant compared to the red currant. Thus, about 65% of the total roots belong to the black currant cuttings while only 35% of the red currant.

CONCLUSIONS

The rooting percentage of cuttings was of 77.22% for the black currant variety 'Tinker' and 77.36% for the 'Elite' red currant variety.

For both varieties, the thinner cuttings, with a diameter between 0.3-0.48 mm (black currant) and 0.26-0.35 mm (red currant) gave the best results in terms of rooted cuttings percentage.

The perlite + sand substrate achieved the highest rooting percentage of the cuttings but with the lowest vegetative growths, also with higher share of rosettes vs shoots.

Among the stimulators used for rooting, the IBA hormone (regardless of the concentration used) achieved the best percentages of cuttings rooted in both currant varieties.

The mixture of perlite + peat for 'Tinker' variety, has contributed to the appearance of a larger number of shoots than the other tested substrates.

For the black currant, the sandy peat substrate favoured the development of the most vigorous shoots, its average length being 16.79 cm with a maximum of 22.17 cm.

The IBA 1000 ppm gave the best results on the length of the shoots on both currant varieties.

The root volume in the red currant was positively influenced by the peat + sand mixture regardless to the thickness of the cuttings.

For black currant, better results of root volume were recorded when the perlite + peat mixture was used as substrate for rooting.

The volume of the root system in the red currant was approximately 2 times larger than the black currant.

IBA 1000 and IBA 1500 gave the most extensive radicular system to both currant varieties.

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