Journal of Ecological Engineering

ISSN 2299-8993

JEE Journal of Ecological Engineering
ISSN 2299-8993

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Journal of Ecological Engineering 2024, 25(4), 238–248
https://doi.org/10.12911/22998993/184690
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Received: 2024.01.29
Accepted: 2024.02.20
Published: 2024.03.01

Influence of the Type of Root on the Rooting of *Viburnum opulus*

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ABSTRACT

The purpose of the study was to establish the optimal type of cuttings for the technology of root propagation of *Viburnum opulus*. The cuttings were harvested from native *Viburnum opulus* mother plants under the conditions of the nebulizing installation of the winter garden of the Podillia botanical garden of the Vinnytsia National Agrarian University. According to the research results, it was established that the rooting and further development of rooted green *Viburnum opulus* cuttings of the Velikoplidna variety depends on the type of cutting. Analyzing the influence of the type of cutting on the rooting of cuttings of the Velikoplidna variety in the investigated time of cutting, it should be noted the high rooting of cuttings in the variant with three nodes. A gradual decrease in the number of nodes led to a significant decrease in the rooting of green cuttings. Green cuttings of the Velikoplidna variety harvested during the period of mass flowering from the basal part of the shoot with three nodes were characterized by significantly higher rooting, number and length of the root system compared to cuttings harvested from the medial and apical parts. Green cuttings of the Velikoplidna variety harvested during the period of intensive growth of shoots from the medial part of the shoot with three nodes were characterized by significantly higher rooting, number and length of the root system compared to cuttings harvested from the basal and apical parts. Green cuttings of the Velikoplidna variety harvested during the period of slow growth of shoots from the apical part of the shoot with three nodes were characterized by significantly higher rooting, number and length of the root system compared to cuttings harvested from the basal and medial parts.

Keywords: *Viburnum opulus*, variety, green cuttings, type of cuttings, rooting, adventitious root system.

INTRODUCTION

In the plant world of Ukraine there are many useful types of plants that are little or not used at all (Didur, 2019; Pantsyreva, 2020; Petrichenko, 2019; Bakhmat, 2023). The forms of these plants are very diverse, many of them can be directly introduced into culture, and some can be turned into excellent cultivated plants through selection (Petrychenko, 2018; Bulgakov, 2023). Common *viburnum* belongs to them – it is valuable as a food, medicinal, soil-protecting and decorative plant. The genus *Viburnum* (*Viburnum* L.) includes about 220 species of plants distributed in Eurasia, North America and North Africa. These are mostly evergreen and deciduous shrubs or small trees. *Viburnum* life expectancy is 50–60 years. All types of viburnum are very decorative, have a large number of cultivars. Can be used in all types of plantations. Viburnum, in addition to decorative properties, has other useful properties: it is a good honey plant, a medicinal and food plant (Maier, 2019; Pohrishchuk, 2023). In addition, a new direction – medicinal horticulture – has developed in the world (Snitynskyi, 2023; Puyu, 2021). Its tasks include breeding such crops, the fruits of which can prevent or cure various diseases (Mazur, 2020). About 40% of the total number of medicinal products are herbal preparations. Raw materials for the production of almost half of them are wild plants, which include *Viburnum opulus* (Desurmont, 2020; Khaietska, 2023).

During the cultivation of planting material, the seed method of *viburnum* propagation is used to create an understory, secure ravines, and beams. However, with the use of seed propagation during

the cultivation of seedlings, due to high heterozygosity, shape characteristics are not preserved. That is why for viburnum, as a fruit, medicinal, food and decorative species, it is important to use such breeding methods that would ensure the production of genetically homogeneous seedlings that retain their form and do not differ from the mother individuals in terms of their economic and valuable characteristics. This condition is met by the vegetative method of reproduction, in particular, vegetative reproduction (Konstantinov, 2018; Bulgakov, 2023). Methods of green and woody cuttings fruit and berry plants have been quite successfully used in many types of nurseries in recent years. This method makes it possible to intensify the process of growing *viburnum* planting material. In production and biological aspects, this method is quite promising, gives it is possible to grow genetically homogeneous *viburnum* planting material in mass quantities. With, greater opportunities for the mechanization of many production processes appeared. Thanks to the creation of production equipment for the artificial creation of fog, the use of polyethylene films and synthetic growth regulators, grafting has become one of the leading methods of reproduction of the researched species in decorative horticulture of Ukraine (Maier, 2019; Ivanyshyn, 2021; Kaletnik, 2020). Growing seedlings from green cuttings is a long-known method of vegetative propagation, but it has not yet gained sufficient popularity due to the sharply different properties of cuttings to form roots not only of different breeds, but also of varieties. Therefore, in the practice of horticulture, seedlings are mostly grown in this way only selectively, taking into account the properties known in advance before rooting (Desurmont, 2014; Kaletnik, 2023). For types of fruit crops that are easily propagated by cuttings, this method has advantages. Yes, new numerous plants can be obtained in a small area from only a few mother plants (Desurmont, 2019; Okrushko, 2022, Pantsyreva, 2022; Bakhmat, 2023). Grafting is an inexpensive, fast method compared to grafting and does not require special techniques that are used in grafting by grafting or budding, since there is no incompatibility with the rootstock or poor growth of grafted components (Desurmont, 2020; Zagorulk, 2023). In order to increase the efficiency of growing *viburnum* seedlings from green cuttings, it is also important to identify the optimal type of cuttings. Many researchers point to the dependence of the processes of adventitious rhizogenesis in green cuttings on the type of cutting (Honcharuk, 2022; Pantsyreva, 2020; Mazur, 2020; Mazur, 2019). In the practice of green cuttings, it is customary to reduce the area of the leaf and the number of nodes on the cuttings in order to reduce the area of evaporation, but in this case the supply of the cuttings with the products of photosynthesis is impaired. Therefore, a differentiated approach to determining the optimal type of cuttings is necessary in order to provide physiologically active and plastic substances for the processes of regeneration of lost organs with green cuttings (Titarenko, 2022; Mazur, 2021; Hnatiuk, 2019; Kaletnik, 2020; Mazur, 2023; Pryshliak, 2023). The technology of green grafting provides accelerated and production-efficient reproduction of many fruit and berry cultures, is indispensable for the reproduction of forms and varieties, with a small amount of starting material. Green grafting ensures the production of native plants, which are characterized by genetic homogeneity, physiological and anatomical integrity (Lutkovska, 2020). The purpose of the study was to establish the optimal type of cuttings for the technology of root propagation of *Viburnum opulus*.

MATERIALS AND METHODS

The cuttings were harvested from native *viburnum* mother plants under the conditions of the nebulizing installation of the winter garden of the «Podillia» botanical garden of the Vinnytsia National Agrarian University. Shoots were selected in the phases of flowering, intensive growth of shoots, slowing down of growth of shoots (Lutkovska, 2020; Monarkh, 2019). The lower section was performed in the middle of the internode, the upper one – directly above the node (Balabak, 2003). The repetition of experiments is four times, in each repetition of experiments 48 cuttings. The study of the influence of the type of cutting (number of nodes) on the rooting and growth of green *viburnum* cuttings of the Velikoplidna variety, depending on the metamerism of the shoot, was carried out according to the scheme shown in Fig. 1.

RESULTS

Analyzing the effect of different types of cuttings during the period of mass flowering on rooting, it should be noted that rooting increases

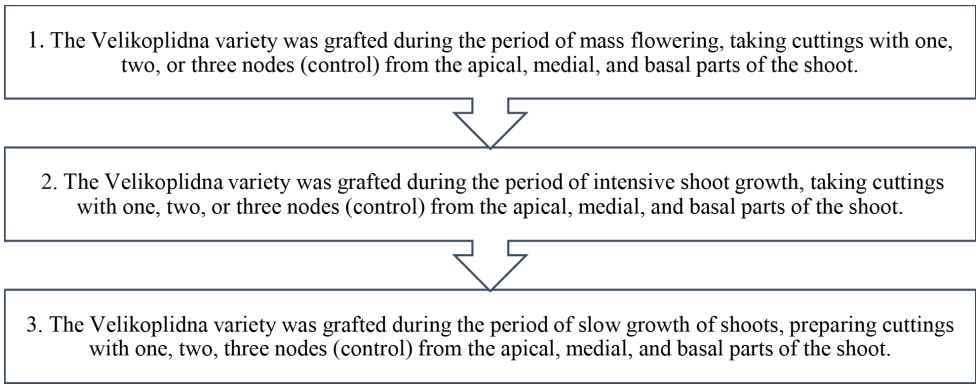

Fig. 1. Influence of the type of cutting (number of nodes) on the rooting and growth of green viburnum

with an increase in the number of nodes on the planted cuttings (Table 1).

The rooting rate of single-node cuttings harvested from the apical part of the shoot averaged 32.4% over three years, medial – 41.7%, basal – 54.1%. Among single-node cuttings, cuttings harvested from the basal part had better rooting – 1.7 times more than apical and 1.3 times more than medial cuttings. Rooting of two-node cuttings from the apical part, during the period of research, was 49.7%, which is 9.2% less than the rooting of similar cuttings from the medial part of the shoot, and 22% less than two-node basal cuttings. Three-node cuttings had a significant advantage in rooting, regardless of the part of the shoot from which they were harvested. It should be noted that the rooting rate of three-noded cuttings from the apical part of the shoot averaged 65.1% during the research period, which is 15.4% more than two-noded and 32.7% more than similar one-noded ones. Rooting of three-node cuttings prepared from the medial parts is also significantly higher than two-node and one-node medial cuttings, by 13.4% and 30.6%, respectively. The rooting percentage of three-node basal cuttings was 82.9%, two-node 71.7%, and one-node only 54.1%. Common *viburnum* cuttings, which take root better, later form a more developed root system than cuttings in which root formation occurred later (Table 2).

In the calculation per cutting, the total number of roots of the first and second order of branching in one-node cuttings from the apical part of the shoot was 168.9 pieces, while in two-node apical cuttings this indicator increased significantly and amounted to 223.8 pieces. The largest number of roots of the first and second order of branching

Table 1. Rooting of green cuttings harvested during the period of mass flowering of viburnum of the ordinary variety Velikoplidna, depending on the type of cutting, %

Type of cutting (number of nodes)	2019	2020	2021	Average for 3 years
Apical part				
1	34.2	33.1	30.1	32.4
2	50.1	49.6	49.7	49.7
3 (control)	64.2	65.8	65.3	65.1
Medial part				
1	40.2	43.4	41.6	41.7
2	58.3	61.1	57.5	58.9
3 (control)	70.3	74.1	72.6	72.3
Basal part				
1	54.1	55.2	53.2	54.1
2	72.1	72.5	70.5	71.7
3 (control)	80.2	84.7	83.8	82.9
LSD_{05}	4.4	6.2	5,6	

Table 2. The influence of the type of cutting on the number of roots in cuttings of the Velikoplidna variety harvested during the period of mass flowering, pcs

Type of cutting (number of nodes)	2019		2020		2021		Average for 3 years	
	Root branching order							
	1	2	1	2	1	2	1	2
Apical part								
1	13.6	100.2	15.0	101.4	15.5	142.4	14.7	114.6
2	19.2	154.6	19.5	175.4	22.1	182.6	20.2	170.8
3 (control)	26.7	230.2	23.2	209.7	28.0	248.0	25.9	229.3
Medial part								
1	14.4	131.2	17.2	140.7	21,2	190.7	17.6	154.2
2	19.5	200.4	23.3	200.2	26,8	210.2	26.5	203.6
3 (control)	24.7	244.5	29.7	260.8	34,7	276.7	29.7	261.6
Basal part								
1	20.1	200.2	23.4	214.3	27.1	219.6	23.5	211.3
2	30.9	273.4	29.6	241.7	32.2	271.5	30.9	262.2
3 (control)	38.9	310.2	35.3	318.7	38.7	331.0	37.5	319.9
LSD_{05}	3.1	7.1	2.3	10.1	4.4	13.2		

(255.2) was recorded in three-node cuttings. Analyzing the growth of the adventitious root system in different types of medial cuttings, it should be noted that in these cuttings three-node cuttings had a significant advantage in terms of this indicator. The total number of roots in this variant was 291.3 pieces, which is 61.2 pieces more than in two-knotted cuttings and 119.5 pieces more than in single-knotted cuttings. The total number of roots of three-noded cuttings harvested from the basal part of the shoot is 357.4 pieces per cutting, two-noded and one-noded basal cuttings, respectively, 293.1 pieces and 234.8 pieces. Depending on the type of scion, there was a difference in the length of the adventitious roots (Table 3).

The total length of the roots of the first and second order of branching of single-node cuttings from the apical part was 287.7 cm, from the medial part – 341.4 cm, from the basal part – 477.5 cm. In two-node cuttings, this indicator was, respectively, 451.4 cm, 469.3 cm, 641.2 cm.

Table 3. The influence of the type of cutting on the length of the roots of cuttings of the Velikoplidna variety, harvested during the period of mass flowering, cm

Type of cutting (number of nodes)	2019		2020		2021		Average for 3 years	
	Root branching order							
	1	2	1	2	1	2	1	2
Apical part								
1	126.4	157.9	134.4	150.2	142.2	152.2	134.3	153.4
2	192.6	255.3	200.6	255.4	210.1	240.6	201.1	250.4
3 (control)	286.1	358.2	260.1	330.1	276.8	370.8	274.3	353.1
Medial part								
1	120.2	150.2	162.4	200.2	182.6	210.1	155.1	186.3
2	175.6	250.7	215.4	255.4	220.4	290.4	203.8	365.5
3 (control)	241.1	326.1	310.7	303.2	326.1	390.8	292.6	340.1
Basal part								
1	220.1	260.1	210.6	260.2	230.1	251.7	220.2	257.3
2	310.2	340.3	275.5	340.2	280.2	377.9	288.6	352.6
3 (control)	372.6	437.4	340.2	414.6	355.1	450.9	355.9	434.3
LSD_{05}	10.3	17.2	7.6	8.4	9.9	7.1		

Three-node cuttings were characterized by the most extensive root system. Cuttings of this type harvested from the apical part of the shoot had a total root length of 632.7 cm, from the basal part – 790.2 cm. It should be noted that the growth of the aerial part of the three-node cuttings significantly exceeded the one-node ones (Table 4). Thus, in three-noded cuttings harvested from the apical part of the shoot, the growth was, on average, over three years of research, 5.8 cm, while in two- and one-noded ones – 3.3 and 0.3 cm. A significant advantage in length growth of three-node cuttings was also observed in cuttings harvested from the medial and basal part of the shoot.

Analyzing the rooting of cuttings harvested during the period of intensive growth and fading of shoot growth, it should be noted that the rooting of cuttings, as well as in the period of mass flowering, significantly increased with an increase in the number of nodes on the planted cuttings. The rooting rate of single-node cuttings harvested during the period of intensive shoot growth from different parts of the shoot was 47.6-60.1%. Among this type of cuttings, a significant advantage of the rooting of cuttings harvested from the medial part of the shoot should be noted.

A significant advantage of the rooting of two-node cuttings was recorded in cuttings harvested from the medial parts of the shoot in comparison with two-node apical and basal ones. As in the period of mass flowering, three-node cuttings had a significantly higher rooting rate, regardless of the part of the shoot from which they were prepared, on average during the research period 72.1–84.2% (Table 5).

Analyzing the rooting of different types of cuttings, selected during the period of slow growth of shoots, it should be noted a significant advantage, compared to other cuttings in this period, of three-noded cuttings – 45.9–53.5% depending on the shoot zone (Table 6). Three-node cuttings harvested from the apical part showed the best rooting – 53.5%, which is 11.4% more than two-node and 23.3% single-node cuttings, also harvested from the apical part of the shoot. Among the different types of cuttings harvested from the medial part, three-node cuttings were also noted for their better rooting – 48.9%, while single-node – 20.6% and two-node – 36.2%. The lowest percentage of rooted cuttings was observed in single-node cuttings harvested from the basal part of the shoot.

The total number of roots of the first and second orders of branching of three-noded cuttings harvested during the period of intensive shoot growth, depending on the shoot zone, was 190.4–235.9 pieces, while this indicator in two-noded cuttings was 130.4–215.1 pieces in single-noded ones 95.9–143.7 pieces. Among cuttings harvested from different parts of the shoot, in this period a significant advantage was recorded in medial cuttings. Three-node medial cuttings prevailed over similar apical cuttings by 54.6 pieces, basal – by 100.1 pieces. In two-noded medial cuttings, the total number of roots of the first and second order of branching was 215.1

Table 4. Growth of rooted cuttings of the Velikoplidna variety, harvested during the period of mass flowering, depending on the type of cutting, cm

Type of cutting (number of nodes)	2019	2020	2021	Average for 3 years
Apical part				
1	0.0	1.0	0.0	0.3
2	2.8	4.0	3.1	3.3
3 (control)	5.1	6.7	7.9	5.8
Medial part				
1	2.9	3.5	5.0	3.8
2	4.9	6.7	7.8	6.4
3 (control)	8.0	9.2	10.5	9.2
Basal part				
1	5.9	7.7	7.7	7.1
2	8.2	10.1	10.1	9.4
3 (control)	12.1	13.7	14.9	13.5
LSD_{05}	0.8	0.5	0.4	

Table 5. The influence of the type of cutting on rooting in green viburnum cuttings of the ordinary variety Velikoplidna, harvested from intensive growth of shoots, %

Type of cutting (number of nodes)	2019	2020	2021	Average for 3 years
Apical part				
1	58.1	53.6	51.1	54.2
2	69.5	67.2	63.3	66.6
3 (control)	80.3	78.8	79.0	79.3
Medial part				
1	58.6	59.6	62.2	60.1
2	70.2	70.1	74.1	71.4
3 (control)	84.4	83.3	85.1	84.2
Basal part				
1	47.2	50.3	45.3	47.6
2	59.1	61.2	57.1	59.1
3 (control)	70.6	73.0	72.6	72.1
LSD_{05}	5.5	6.6	7.2	

Table 6. Rooting of cuttings of the Velikoplidna variety harvested during the period of slow growth of shoots, depending on the type of cutting, %

Type of cutting (number of nodes)	2019	2020	2021	Average for 3 years
Apical part				
1	30.5	30.7	29.5	30.2
2	43.1	40.2	43.2	42.1
3 (control)	53.5	51.1	55.9	53.5
Medial part				
1	21.2	20.2	20.4	20.6
2	37.1	34.1	37.5	36.2
3 (control)	49.5	47.1	50.1	48.9
Basal part				
1	20.4	19.6	20.9	20.3
2	32.2	29.3	31.1	30.8
3 (control)	44.9	45.2	47.8	45.9
LSD_{05}	6.3	6.1	5.7	

pieces, in apical ones – 179.8 pieces, basal – 130.4 pieces (Table 7).

The length of roots in cuttings increased significantly with an increase in the number of nodes. The length of the roots of the first order per cutting was 132.1 cm from the apical part of the shoot, from the medial part – 160.8 cm, from the basal part – 109.8 cm. An increase in the number of nodes to two caused a significant increase in the length of the roots of the first order in apical ones up to 200.6 cm, in medial ones – 229.8 cm, in basal ones by 70.8 cm compared to single-node ones. Three-node cuttings had a significant advantage in terms of this indicator during the entire period of research, both in comparison with two-node and one-node cuttings (Table 8). The number of roots in the cuttings harvested from the apical part of the shoot during the period of slow growth of the shoots, regardless of the type of cutting, significantly outweighs the cuttings harvested from the medial and basal parts of the shoot (Table 9).

The decrease in the number of nodes led to a significant decrease in the number of roots in two-node and one-node cuttings. Thus, in two-noded apical cuttings, the number of roots of the first and second order of branching was 111.4 pieces, in medial ones – 66.4 pieces, basal – 57.8 pieces. In

Table 7. The influence of the type of cutting on the number of roots in cuttings of the Velikoplidna variety harvested during the period of intensive growth of shoots, cm

Type of cutting (number of nodes)	2019		2020		2021		Average for 3 years	
	Root branching order							
	1	2	1	2	1	2	1	2
Apical part								
1	14.7	131.7	19.1	95.7	15.5	102.6	16.4	110.0
2	19.6	175.6	25.1	131.7	21.1	166.4	21.9	157.9
3 (control)	24.2	206.5	31.2	203.5	27.2	215.2	27.5	208.4
Medial part								
1	16.5	120.4	21.1	133.6	16.1	123.6	17.9	125.8
2	22.1	181.7	27.1	200.1	23.1	191.2	24.1	191.0
3 (control)	27.0	222.5	34.6	294.5	30.0	265.0	30.5	260.6
Basal part								
1	10.9	75.7	14.9	92.6	12.2	81.7	12.6	83.3
2	15.1	100.7	20.4	127.6	18.1	110.4	17.5	112.9
3 (control)	18.7	150.5	26.2	180.7	24.2	170.7	23.1	167.3
LSD_{05}	2.3	9.6	3.3	9.5	2.4	11.5		

Table 8. The influence of the type of cutting on the length of the roots in cuttings of the Velikoplidna variety harvested during the period of intensive growth of shoots, cm

Type of cutting (number of nodes)	2019		2020		2021		Average for 3 years	
	Root branching order							
	1	2	1	2	1	2	1	2
Apical part								
1	120.4	192.7	155.6	192.6	120.2	172.4	132.1	185.9
2	192.6	265.6	228.7	277.2	175.7	255.3	200.6	266.1
3 (control)	260.6	321.6	321.9	343.8	264.6	312.1	282.3	325.8
Medial part								
1	155.2	175.5	200.5	215.6	126.9	192.4	160.8	194.5
2	210.5	260.1	277.4	301.7	201.5	281.4	229.8	281.1
3 (control)	280.8	359.9	366.1	386,2	290.7	373.7	302.5	373.2
Basal part								
1	95.6	100.1	111.7	175.2	112.3	121.7	109.8	132.3
2	120.7	170.2	192.6	243.6	201.7	210.2	171.6	208.0
3 (control)	195.8	260.4	273.8	325.2	295.7	295.1	254.9	302.8
LSD_{05}	9.8	8.5	8.3	8.1	7.2	7.5		

single-node cuttings, the largest number of roots was recorded in the apical ones – 59.7 pieces, the smallest in the basal ones – 37.6 pieces. Apical cuttings significantly prevailed in the length of adventitious roots (Table 10).

The total length of the roots of the first and second orders of branching in two-node cuttings harvested from the apical part of the shoot was 164.6 cm, the least branched among this type of cuttings was the adventitious root system of basal cuttings – 63.8 cm. The root system of two-node cuttings was more developed compared to single-node ones apical cuttings – 275.4 cm, which is 81.1 cm more than medial and 115.3 cm more than basal cuttings. In three-node apical cuttings, the total length of the roots was 425.4 cm, in medial – 316.8 cm, basal – 262.9 cm.

Among the different types of cuttings, selected during the period of intensive growth of shoots, the growth of three-noded medial cuttings had

Table 9. The influence of the type of cutting on the number of roots in cuttings of the Velikoplidna variety harvested during the period of slow growth of shoots, pcs

Type of cutting (number of nodes)	2019		2020		2021		Average for 3 years	
	Root branching order							
	1	2	1	2	1	2	1	2
Apical part								
1	13.3	47.1	13.1	49.2	11.3	45.5	12.5	47.2
2	17.1	95.5	18.2	91.1	17.2	95.1	42.1	93.9
3 (control)	21.7	139.5	21.2	125.7	23.7	136.7	53.5	133.9
Medial part								
1	8.4	40.2	8.8	30.2	8.2	32.2	8.4	34.2
2	12.1	60.1	13.8	50.1	12.1	51.4	12.6	53.8
3 (control)	16.7	88.5	19.4	79.7	18.2	89.7	18.7	85.9
Basal part								
1	7.1	29.1	7.0	24.8	9.5	38.1	7.0	30.6
2	11.0	50.9	10.1	41.4	10.7	50,1	10.4	47.4
3 (control)	15.2	71.2	16.2	70.7	15.5	72.5	15.6	71.4
LSD_{05}	3.2	6.1	4.1	5.2	3.7	8.1		

Table 10. The influence of the type of cutting on the total length of the roots in cuttings of the Velikoplidna variety harvested during the period of slow growth of shoots, cm

Type of cutting (number of nodes)	2019		2020		2021		Average for 3 years	
	Root branching order							
	1	2	1	2	1	2	1	2
Apical part								
1	63.5	121.4	72.1	100.9	55.4	80.7	63.6	101.0
2	120.4	172.2	110.7	172.4	110.3	140.2	113.8	161.6
3 (control)	190.3	248.5	189.5	232.3	176.9	239.1	185.5	239.9
Medial part								
1	42.2	61.1	41.1	51.9	39.9	50.2	41.1	54.4
2	81.2	110.3	92.7	100.4	87.7	110.7	87.2	107.1
3 (control)	106.7	171.2	148.8	198.1	135.8	189.9	130.4	186.4
Basal part								
1	29.2	49.4	30.4	59.9	40.2	55.4	33.2	54.9
2	52.4	82.6	71.2	110.7	71.3	92.3	64.9	95.2
3 (control)	82.2	133.2	126.8	183.9	111.1	151.7	106.7	156.2
LSD_{05}	7.6	8.1	6.9	6.1	3.0	9.3		

a significant advantage. On average, over three years of research, the growth of three-node medial cuttings was 16.0 cm, which is 4.8 cm more than that of two-node medial cuttings by 7.7 cm – one-node. Three-node medial cuttings significantly prevailed over the same type of apical and basal cuttings during the entire period. Analyzing the growth of the above-ground part of rooted single-node and two-node cuttings, it should be noted a significant advantage over the period of studies of two-node cuttings (Table 11). In the cuttings harvested during the period of slow growth of the shoots, the largest increase in the three-node apical cuttings is 5.3 cm, which is 1.6 times more than in the medial ones, and 1.9 times more than in the basal ones. So, the optimal type for green *viburnum* cuttings is a three-node cutting. If there is a lack of material for grafting, it is possible to use double-knotted cuttings. In cuttings harvested during the period of slow growth of shoots, the

Table 11. The influence of the type of cutting on the growth of cuttings of the Velikoplidna variety harvested during the period of intensive growth of shoots, cm

Type of cutting (number of nodes)	2019	2020	2021	Average for 3 years
Apical part				
1	4.9	3.1	6.1	4.8
2	7.1	6.3	9.2	7.5
3 (control)	11.9	10.1	12.4	11.4
Medial part				
1	7.7	7.1	10.2	8.3
2	10.5	10.2	13.0	11.2
3 (control)	16.1	14.9	17.0	16,0
Basal part				
1	1.5	0.9	0.5	0.9
2	3.1	3.2	2.1	2.8
3 (control)	6.1	5.8	5.6	5.8
LSD_{05}	2.7	0.7	0.6	

Table 12. The influence of the type of cutting on the growth of cuttings of the Velikoplidna variety harvested during the period of slow growth of shoots, cm

Type of cutting (number of nodes)	2019	2020	2021	Average for 3 years
Apical part				
1	1.2	1.0	0.0	0.7
2	3.0	2.9	1.2	2.3
3 (control)	6.1	5.7	4.1	5.3
Medial part				
1	0.0	0.3	0.0	0.1
2	1.3	1.1	0.5	0.7
3 (control)	4.2	3.2	3.0	3.4
Basal part				
1	0.0	0.0	0.0	0.0
2	1.3	0.5	0.0	0.6
3 (control)	3.5	2.9	2.1	2.8
LSD_{05}	0.6	0.4	0.3	

growth of three-noded apical cuttings significantly exceeded those of the same type from the medial and basal parts of the shoot. It should be noted that there is no significant difference between the growth of rooted three-node medial and basal cuttings in 2020. During the period of research in single-node basal cuttings (Table 12).

There was no increase, only in 2020 a slight increase was recorded in medial ones, and the largest and significantly higher increase among this type of cuttings was in apical cuttings. So, the optimal type for *viburnum* cuttings is a three-node cutting. If there is a lack of material for grafting, it is possible to use double-knotted cuttings.

CONCLUSIONS

It has been established that the rooting and further development of rooted green cuttings of *viburnum* of the ordinary variety Velikoplidna depends on the type of cutting. Therefore, the optimal type of cuttings for the Velikoplidna variety is a three-node. The rooting and subsequent growth and development of rooted three-node cuttings of *viburnum* of the ordinary Velikoplidna variety significantly outweigh the similar indicators of two- and one-node cuttings. If production requires, it is possible to use two-node cuttings. For the Velikoplidna variety, a single-node scion

is insufficient for effective grafting. Three-node cuttings harvested from the apical part showed the best rooting – 53.5%, which is 11.4% more than two-node and 23.3% single-node cuttings, also harvested from the apical part of the shoot.

REFERENCES

1. Balabak A.F. 2003. Root propagation of uncommon fruit and berry crops. Uman Operational polygraphy, 109.
2. Desurmont G.A., Weston P.A. 2014. Switched after birth: Performance of the *viburnum* leaf beetle *Pyrrhalta viburni* (Paykull) after transfer to a suboptimal host plant. Insects, 5(4), 805-817. deficiency system of fertilization. Bulletin of Uman National University of Horticulture, 1, 21–26. https://doi.org/10.3390/insects5040805
3. Desurmont G.A., Kerdellant E., Pfingstl T., Auger P. 2019. Mites associated with egg masses of the *viburnum* leaf beetle *Pyrrhaltaviburni* (Paykull) on *Viburnum tinus* L. Acarologia, 59(1), 57-72. https://doi.org/10.24349/ acarologia/20194311
4. Desurmont G.A., Morelon S., Benrey B. 2020. First insights into the chemical ecology of an invasive pest: Olfactory preferences of the *viburnum* leaf beetle (Coleoptera: Chrysomelidae). Environmental Entomology, 49(2), 364-369. https://doi.org/10.1093/ee/nvaa007
5. Konstantinov A.S., Prathapan K.D., Vencl F.V. 2018. Hiding in plain sight: Leaf beetles (C*hrysomelidae: Galerucinae*) use feeding damage as a masquerade decoy. Biological Journal of the Linnean Society, 123, 311-320. https://doi.org/10.1111/een.13096
6. Maier C.T. 2019. Range expansion of the *viburnum* leaf beetle, *Pyrrhalta viburni* (Paykull, 1799) (Coleoptera: Chrysomelidae), in Connecticut. Proceedings-Entomological Society of Washington, 121(1), 54-62. https://doi.org/10.4289/0013-8797.121.1.54
7. Bulgakov V., Rucins A., Holovach I., Adamchuk O., Aboltins A., Zabolotnyi H., Kolomyets L., Polishchuk S. 2023. Computer investigation of mineral fertiliser particle movement along centrifugal spreader disc inclined under angle to horizontal plane. Engineering for Rural Development, 22, 506-516.
8. Titarenko O., Ibatullin I., Nedashkivskyi V., Nedashkivska N., Stepanchenko V. 2022. Accumulation of zn and cu by cereal and leguminous vegetation under agrochemical improvement of natural fodder lands of the right bank forest steppe of Ukraine. International Journal of Ecosystems and Ecology Science, 12(4), 245-250.
9. Pantsyreva H. 2021. Morphological and ecological-biological evaluation of the decorative species of the genus *Lupinus* L. Ukrainian Journal of Ecology, 9(3), 74-77. https://doi.org/10.15421/2019_711
10. Petrichenko, V.F., Kobak, S.Y., Chorna, V.M. 2017. Influence of inoculation and morphology of the regulator on the peculiarities of soybean plant growth in the Forest-Steppe. Bulletin of Agricultural Science, 11, 29-34.
11. Didur I.M., Prokopchuk V.M., Pantsyreva H.V. 2019. Investigation of biomorphological and decorative characteristics of ornamental species of the genus *Lupinus* L. Ukrainian Journal of Ecology, 9(3), 287-290.
12. Monarkh V.V., Pantsyreva H.V. 2019. Stages of the environmental risk assessment. Ukrainian Journal of Ecology, 9(4), 484-492. https://doi.org/10.15421/2019779
13. Pantsyreva H.V., Myalkovsky R.O., Yasinetska I.A., Prokopchuk V.M. 2020. Productivity and economical appraisal of growing raspberry according to substrate for mulching under the conditions of Podilia area in Ukraine. Ukrainian Journal of Ecology, 10(1), 210-214. https://doi.org/10.15421/202033
14. Honcharuk I., Matusyak M., Pantsyreva H., Kupchuk I., Prokopchuk V., Telekalo N. 2022. Peculiarities of reproduction of pinus Nigra arn. in Ukraine. Bulletin of the Transilvania University of Braşov. Series II: Forestry, Wood Industry, Agricultural Food Engineering, 15(64), 1, 33-42
15. Bakhmat M., Padalko T., Krachan T., Tkach O., Pantsyreva H., Tkach L. 2023. Formation of the Yield of *Matricaria recutita* and Indicators of Food Value of Sychorium intybus by Technological Methods of Co-Cultivation in the Interrows of an Orchard. Journal of Ecological Engineering, 24(8), 250-259. https://doi.org/10.12911/22998993/166553
16. Petrychenko V.F., Kobak S.Ya., Chorna V.M., Kolisnyk S.I., Likhochvor V.V., Pyda S.V. 2018. Formation of the nitrogen-fixing potential and productivity of soybean varieties selected at the institute of feeds and agriculture of Podillia of NAAS. Mikrobiol. Z, 80(5), 63-75.
17. Puyu V., Bakhmat M., Pantsyreva H., Khmelianchyshyn Y., Stepanchenko V., Bakhmat O. 2021. Social-and-ecological aspects of forage production reform in ukraine in the early 21st century. European Journal of Sustainable Development, 10(1), 221-228.
18. Snitynskyi V., Razanov S., Hnativ P., Bakhmat O., Kutsenko M., Kolisnyk O. 2023. Phytoremediation of 137Cs contaminated sod-podzolic soil in Northern Polissia white sweet clover (Melilotus albus). International Journal of Environmental Studies. 80(5), 1-7. https://doi.org/10.1080/00207233.2023.2270305
19. Lutkovska S. 2020. Methodical approaches to

evaluation of the processes of modernization of the environmental sustainable system. Scientific Horizons, 2, 111-118

20. Mazur V.A., Myalkovsky R.O., Pantsyreva H.V., Didur I.M., Mazur K.V., Alekseev O.O. 2020. Photosynthetic productivity of potato plants depending on the location of rows placement in agrophytocenosis. Ecology, Environment and Conservation, 26(2), 536-545
21. Mazur V., Didur I., Tkachuk O., Pantsyreva H., Ovcharuk V. 2021. Agroecological stability of cultivars of sparsely distributed legumes in the context of climate change. Scientific Horizons, 24(1), 54-60. https://doi.org/10.48077/scihor
22. Mazur V.A., Pantsyreva H.V., Mazur K.V. and Didur I.M. 2019. Influence of the assimilation apparatus and productivity of white lupine plants. Agronomy Research 17, 206-219.
23. Mazur V., Pantsyreva H., Mazur K., Myalkovsky R., Alekseev O. 2020. Agroecological prospects of using corn hybrids for biogas production. Agronomy Research, 18, 205–219. https://doi.org/10.15159/ar.20.016
24. Mazur V., Alieksieieva O., Mazur K., Alieksieiev O. 2023. Ecologicai and economic aspects of the formation of hidhly productive soybean crops. Journal of Ecological Engineering, 24(12), 124-129. https://doi.org/10.12911/22998993/173008
25. Hnatiuk T.T., Zhitkevich N.V., Petrychenko V.F., Kalinichenko A.V., Patyka V.P. 2019. Soybean diseases caused by genus Pseudomonas *Phytopathenes* bacteria**.** Mikrobiol. Z, 81(3), 68-83. https://doi.org/10.15407/microbiolj81.03.068
26. Ivanyshyn O., Khomina V., Pantsyreva H. 2021. Influence of fertilization on the formation of grain productivity in different-maturing maize hybrids Ukrainian Journal of Ecology, 11(3), 262-269. https://doi.org/10.15421/2021_170
27. Kaletnik G., Lutkovska S. 2020. Strategic priorities of the system modernization environmental safety under sustainable development. Journal of Environmental Management and Tourism, 11, 5(45), 1124-1131.
28. Kaletnik, G., Honcharuk, I., Yemchyk, T., Okhota, Yu. 2020. the world experience in the regulation of the land circulation. European Journal of Sustainable Development, 9(2), 557-568
29. Mazur V., Alieksieieva O., Mazur K., Alieksieiev O. 2023. Ecological and economic aspects of the formation of highly productive soybean crops. Journal of Ecological Engineering. 24(12), 124-129.
30. Kaletnik H., Yaropud V. 2023. Research of pressure losses and justification of forms of side- evaporative heat exchangers channels in livestock premises. Przeglad Elektrotechniczny, 99(7), 247-252.
31. Pryshliak N., Dankevych V., Tokarchuk D., Shpykuliak O. 2023. The sowing and harvesting campaign in Ukraine in the context of hostilities: challenges to global energy and food security. Polityka Energetyczna, 26(1), 145-168.
32. Pohrishchuk B., Kolomiiets T., Chaliuk Y., Yaremko I., Hromadska N. 2023. Modeling the application of anti-crisis management business introduction for the engineering sector of the economy. International Journal of Safety and Security Engineering, 13(2), 187-194.
33. Khaietska O., Holovnia L., Pavlyuk T., Osipova L. 2023. Branch Structure of the national economy and directions of its optimization in the post-war period. Economics. Ecology. Socium, 7(3), 1-12.
34. Zagorulko A., Zahorulko A., Kasabova K., Chuiko L., Yakovets L., Pugach A., Barabolia O., Lavruk V. 2023. Improving the production technology of functional paste-like fruit-and-berry semi-finished products. Eastern-European Journal of Enterprise Technologies, 4(11), 43-52.
35. Okrushko S. 2022. Allelopathic effect of couch grass (*Elymus repens* L.) on germination of common wheat seeds. Zemdirbyste, 109(4), 323-328.
36. Pantsyreva H., Vovk V., Bronnicova L., Zabarna T. 2023. Efficiency of the use of lawn grasses for biology and soil conservation of agricultural systems under the conditions of the Ukraine's Podillia. Journal of Ecological Engineering, 2(11), 249-256. https://doi.org/10.12911/22998993/171649
37. Bakhmat M., Padalko T., Krachan T., Tkach O., Pantsyreva H., Tkach L. 2023. Formation of the yield of matricaria recutita and indicators of food value of sychorium intybus by technological methods of co-cultivation in the interrows of an orchard. Journal of Ecological Engineering, 24(8), 250-259.