



ISSN 2707-5826 DOI: 10.37128/2707-5826-2024-2

ВІННИЦЬКИЙ НАЦІОНАЛЬНИЙ
АГРАРНИЙ УНІВЕРСИТЕТ

Сільське господарство та лісівництво

Agriculture and Forestry



№ 2 (33), 2024 р.

**МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
ВІННИЦЬКИЙ НАЦІОНАЛЬНИЙ АГРАРНИЙ УНІВЕРСИТЕТ**

**Сільське господарство
та лісівництво
№ 2 (33)**

**Вінниця
2024**



Науковий збірник виробничого та
навчального спрямування
«СІЛЬСЬКЕ ГОСПОДАРСТВО ТА ЛІСІВНИЦТВО»
«AGRICULTURE AND FORESTRY»

Заснований у 1995 році під назвою
«Вісник Вінницького державного
сільськогосподарського інституту»

У 2010–2014 роках виходив під назвою «Збірник наукових
праць Вінницького національного аграрного університету».

З 2015 року «Сільське господарство та лісівництво»
Ідентифікатор медіа R30-05174 (рішення Національної
ради України з питань телебачення та радіомовлення
від 25.04.2024 р. №1337)

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ст. наук. співробітник

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ISSN 2707-5826

DOI: 10.37128/2707-5826

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«СІЛЬСЬКЕ ГОСПОДАРСТВО ТА ЛІСІВНИЦТВО»**«AGRICULTURE AND FORESTRY»****Журнал науково-виробничого та навчального спрямування 05'2024 (33)****ЗМІСТ***РОСЛИННИЦТВО, СУЧАСНИЙ СТАН ТА ПЕРСПЕКТИВИ РОЗВИТКУ*

ЦИЦЮРА Я.Г. РОЛЬ ГІДРОТЕРМІЧНОГО РЕЖИМУ ВЕГЕТАЦІЇ У ФОРМУВАННІ ЯКІСНИХ ПОКАЗНИКІВ БІОМАСИ РЕДЬКИ ОЛІЙНОЇ У СИСТЕМІ БАГАТОПРОФІЛЬНОГО ЇЇ ВИКОРИСТАННЯ 5

ГУЦОЛ Г.В., ОБЧАРУК І.І. ВПЛИВ СТРОКІВ СІВБИ НА ОСІННІЙ РІСТ І РОЗВИТОК ПШЕНИЦІ ОЗИМОЇ 23

OLHA MATSERA THE IMPACT OF PHOSPHORUS FERTILIZERS ON WINTER RAPESEED GROWTH AND YIELD 32

ЦИГАНСЬКИЙ В.І., МИКУЦЬКИЙ Ю.В. ФОРМУВАННЯ ВІТАЛІТЕТНИХ ТАКТИК КУКУРУДЗИ ЗА РІЗНОЇ ГУСТОТИ СТОЯННЯ ГІБРИДІВ РІЗНИХ ГРУП СТИГЛОСТІ 42

ГЕТМАН Н.Я. ФОРМУВАННЯ ВРОЖАЮ КУКУРУДЗИ ЗАЛЕЖНО ВІД ГУСТОТИ СТОЯННЯ РОСЛИН ЗА МІНЕРАЛЬНОГО ФОНУ ЖИВЛЕННЯ 55

ДІДУР І.М. БІОЛОГІЗАЦІЯ ТЕХНОЛОГІЇ ВИРОЩУВАННЯ СОЇ В УМОВАХ ЛІСОСТЕПУ ПРАВОБЕРЕЖНОГО 66

ЦИГАНСЬКИЙ В.І., МИХАЙЛЮК О.С. ДИНАМІЧНІ ЗАКОНОМІРНОСТІ ФОРМУВАННЯ НАДЗЕМНОЇ БІОМАСИ РОСЛИН ГІБРИДІВ КУКУРУДЗИ РІЗНОЇ ГРУПИ СТИГЛОСТІ З ПОЗИЦІЇ СИСТЕМИ ПОЗАКОРЕНЕВОГО ЖИВЛЕННЯ 76

KOLISNYK O.M., MATIUSHEV A.O. INFLUENCE OF FOLIAGE FEEDING IN PRODUCTIVITY FORMATION OF SUNFLOWER HYBRIDS 90

ПАЛАМАРЧУК В.Д., КРИЧКОВСЬКИЙ В.Ю., НЕЇЛИК М.М. ЯКІСНІ ПОКАЗНИКИ ЗЕРНА КУКУРУДЗИ ЗАЛЕЖНО ВІД ФРАКЦІЙНОГО СКЛАДУ ТА ГЛИБИНИ ЗАГОРТАННЯ 100

ЗАХИСТ РОСЛИН

ПЕЛЕХ Л.В., ДРОЗД О.В. ЗАХИСТ СОЇ ВІД ОСНОВНИХ ХВОРОБ 113

ОВОЧІВНИЦТВО ТА ГРИБНИЦТВО

ВДОВЕНКО С.А., НАХТМАН Є.В., ГНАТЮК О.П. ОСОБЛИВОСТІ ВИРОЩУВАННЯ МОРКВИ У ВІДКРИТОМУ ГРУНТІ ЛІСОСТЕПУ ПРАВОБЕРЕЖНОГО 127

ЕКОЛОГІЯ ТА ОХОРОНА НАВКОЛИШНЬОГО СЕРЕДОВИЩА

ТКАЧУК О.П., МІЗЕРІЙ А.Т. ПРОДУКТИВНІСТЬ ЯБЛУНЕВОГО САДУ ЗАЛЕЖНО ВІД УДОБРЕННЯ 140

ТКАЧУК О.П. БОНДАРУК Н.В. ОСОБЛИВОСТІ РОСТУ І РОЗВИТКУ СОНЯШНИКУ ПРИ ЗАСТОСУВАННІ У ЙОГО ПОСІВАХ БІОПРЕПАРАТІВ РІСТСТИМУЛЮЮЧОЇ ДІЇ 154

ЛІСОВЕ ТА САДОВО-ПАРКОВЕ ГОСПОДАРСТВО

ПАНЦИРЕВА Г.В., ЦИГАНСЬКА О.І., МАТУСЯК М.В., ОПЛАКАНСЬКА А.Б. ПЕРСПЕКТИВИ ОЗЕЛЕНЕННЯ ОБ'ЄКТІВ СПЕЦІАЛЬНОГО ПРИЗНАЧЕННЯ НА ПРИКЛАДІ ТЕРИТОРІЇ ХРАМУ ТРЬОХ СВЯТИТЕЛІВ ВНАУ 169

TSYHANSKA O.I. FEATURES OF VEGETATIVE REPRODUCTION OF SPECIES DIVERSITY OF THE GENUS *SPIRAEA L.* IN CLOSED GROUND HOT-HOUSE CONDITIONS IN THE TERRITORY OF THE BOTANICAL GARDEN «PODILLIA» OF VNAU 185

ДУМКА МОЛОДОГО ВЧЕНОГО

ТОМЧУК О.М. ВІТАЛІТЕТ АГРОЦЕНОЗУ РІПАКУ ОЗИМОГО ЗА РІЗНИХ ВАРІАНТІВ УДОБРЕННЯ В УМОВАХ ЛІСОСТЕПУ ПРАВОБЕРЕЖНОГО УКРАЇНИ 194

БОГОМАЗ С.О. ВИВЧЕННЯ ВПЛИВУ ГУСТОТИ РОСЛИН ТА УДОБРЕННЯ НА УРОЖАЙНІСТЬ ГІБРИДІВ КУКУРУДЗИ 209

Журнал внесено в оновлений перелік наукових фахових видань України Категорія Б з сільськогосподарських наук під назвою «Сільське господарство та лісівництво» (підстава: Наказ Міністерства освіти і науки України 17.03.2020 №409).

Адреса редакції: **21008, Вінниця, вул. Сонячна, 3, тел. 46-00-03**

Вінницький національний аграрний університет

Електронна адреса: *selection@vsau.vin.ua* адреса сайту: (*http://forestry.vsau.org/*).

Номер схвалено і рекомендовано до друку рішенням: Редакційної колегії журналу, протокол № 18 від 09.05.24 року; Вченої ради Вінницького національного аграрного університету, протокол № 11 від 31.05.2024 року.

UDC 631.811.98:631.535:635.927

DOI:10.37128/2707-5826-2024-2-15

**FEATURES OF VEGETATIVE
REPRODUCTION OF SPECIES
DIVERSITY OF THE GENUS *SPIRAEA* L.
IN CLOSED GROUND HOT-HOUSE
CONDITIONS IN THE TERRITORY OF
THE BOTANICAL GARDEN "PODILLIA"
OF VNAU**

O.I. TSYHANSKA, candidate of
agricultural sciences, associate
professor
Vinnytsia National Agrarian
University

*The article examines the study of the features of cuttings for rooting and rooting of cuttings of the genus *Spiraea* L. as promising species and decorative forms for landscaping in the conditions of an urbanized environment, growing on the territory of the "Podillia" Botanical Garden of VNAU. In particular, *Spiraea japonica* "Golden Princess", *Spiraea japonica* 'Little Princess', *Spiraea betulifolia*, and *Spiraea nipponica* were studied. According to the results of vegetative reproduction on the territory of the botanical garden "Podillia" of the Vinnytsia National Agrarian University in 2021-2022, it was established that the use of growth stimulants during spirea cuttings contributed to their faster rooting and ensured better plant survival compared to the control.*

*Species of spirea that grow on the territory of the botanical garden "Podillia" of the Vinnytsia National Agrarian University belong to the following sections: Calospira, Glomerati, Chamaedryon, Spiraria. The largest number of plants is the Calospira section, which includes plants of the species *Spiraea japonica* (*Spiraea japonica* L.), *Spiraea bumalda* (*Spiraea bumalda* L.) and *Spiraea alba* (Miq.) Zab.*

*The results of the research indicate that the grafting ability of the cuttings is largely determined by the biological feature of the species and also the use of growth substances. The highest rooting in the control group was observed in *Spiraea japonica* "Golden Princess", and the lowest in *Spiraea nipponica*. The use of the growth stimulator "Kornevin" increased the level of rooting of cuttings for all researched species by 15% compared to the control group. The use of the drug "Heteroauxin" also contributed to the improvement of the rooting of spirea cuttings, the rooting rate of which is 90-100%, depending on the studied taxon. The use of growth stimulants in our experiment contributed to the formation of the largest length of main roots in spirea cuttings.*

Key words: cuttings, ornamental plants, rooting, callus tissue, growth stimulants.

Table. 4. Lit. 17.

Statement of the problem. Leafy tree-shrub plants are among the most widespread plants of the world flora [1, 3, 4, 6]. Leafy tree-shrub plants in the "Podillia" Botanical Garden of the Vinnytsia National Agrarian University are placed both in the main exposition and in the architectural-exposition area. In the arboretum, which is the heart of the botanical garden, a collection of many species of trees and shrubs is planted. The plants of these collections give seeds and cuttings, which are planted in greenhouses and winter gardens for further sale. The area of the botanical garden reaches 51.1 hectares, where about 20 forest associations, simulating the types of Podil forests, as well as a dendrological area with a nursery, a pathological department, a department of floriculture and medicinal plants grow successfully. In modern green construction, decorative forms of leafy plants are an important additional component, the use of which significantly increases the effect of garden and park compositions. Leafy plants enrich the air with oxygen, restrain strong gusts

of wind, soften the climate, absorb noise coming from the streets, clean the air from dust. Recently, in connection with the mass greening of settlements and industrial enterprises, there is a shortage of planting material of decorative leafy plants adapted to specific soil and climatic conditions. Therefore, specialists of nurseries face great challenges in terms of increasing the assortment and volume, improving the quality of the material produced for landscaping and reducing its cost price.

In order to increase the volume and improve the quality of planting material, there are various methods of mass propagation with the aim of introducing it into wide production practice [2, 5]. In addition to seed reproduction, leafy plants are characterized by vegetative reproduction - reproduction from shoots, branches and roots. Tree-shrub breeds can be propagated vegetatively in the following ways: dividing bushes, cuttings from stumps, root and stem cuttings, and grafting. Seed reproduction is often complicated due to the low quality and long germination of seeds of some species, as well as the slow growth of seedlings. Decorative forms of plants during seed reproduction mostly do not transmit or only partially transmit the decorative features of the mother plant. In most ornamental forms, the seeds do not mature or form, or are dissimilar. Therefore, vegetative propagation of valuable forms and varieties is widespread in the practice of gardening, which ensures the identity of the propagated organisms. In addition, the period of growing planting material is shortened, since the growth of tree and shrub species occurs much faster during vegetative propagation than during seed propagation [6, 7].

The method of propagation of valuable forms and varieties of tree-shrub plants by green cuttings under a film cover in conditions of high humidity, which is supported by automatic installations, is widely used. At the same time, the correct preparation of cuttings and their care is of great importance. Rooting of cuttings depends on species, terms, methods and conditions of cuttings. Cuttings are carried out either in the spring before the beginning of growth, that is, in the bud swelling phase (it occurs in the forest-steppe zone at the end of April), or in the summer (in June) during the period of intensive growth. In this case, a significant part of the cuttings takes root in the same year. With later grafting, only callus tissue appears in the first year, and roots in the following year. The age of the mother plants from which the cuttings are taken is of great importance for the formation of roots in cuttings. The younger the plants, the faster and better the scion takes root. The age of the cuttings is also important. Two-year or three-year shoots take root better than one-year ones [10].

Research and publication analysis. Nowadays, the topic of increasing the comfort of the environment of human activity is becoming more and more relevant. The concept of the comfort of life in the city includes social comfort and the comfort of the environment (urban buildings, natural and landscape components) [8, 16].

One of the most important components of the natural landscape component is a well-chosen assortment of trees and shrubs for landscaping. In modern conditions of urbanization, greening in cities and settlements makes it possible to solve a whole set of problems: improving the microclimate and gaseous composition of the

atmosphere, reducing noise pollution, giving the city an aesthetic appearance [1, 2]. Therefore, creating stable and long-lasting plantations, expanding the assortment of plants used for landscaping is a rather important task [3, 5]. Some of the relevant species for urban landscaping are species of the genus *Spiraea*, such as: *S. japonica*, *S. chamaedrifolia*, *S. betulifolia*, *S. bumalda "Golden Flame"*, *S. salicifolia*, *S. media*, *S. bumalda "Anthony Waterer"*, *S. hipericifolia* [4, 6]. The genus *Spiraea* (*Spiraea* L.) in the modern concept includes shrubs and semi-shrubs from the family *Rosaceae* Juss., subfamily *Spiraeoideae* Agardh., tribe *Spiraeae* DC [7, 9].

The genus *Spiraea* L. (*Spiraea*) belongs to the Rose family (*Rosaceae* Juss), subfamily *Spiroideae* Agardh. It includes about 80-100 species of trees and shrubs found throughout the world, particularly in North America, Europe and Asia. The hybrids that spirea can produce are characterized by their resistance, as well as their ability to surpass, in terms of their decorative qualities, parental traits [4, 12]. The spirea genus (*Spiraea*) includes about 100 species. This is a decorative deciduous shrub of the family of roses (*Rosaceae*). Due to the high level of decorativeness and unpretentiousness in cultivation, they can be used in the most diverse elements of green construction.

Propagation of spirea is associated with the need to increase the number of seedlings of this culture for their use in landscaping cities and towns. Spireas reproduce quite easily by seeds, as well as vegetatively. You just need to remember that varieties, hybrids and decorative forms of spirea should be propagated exclusively vegetatively: by dividing the bush, layering, green and lignified cuttings. Vegetative propagation of woody plants using cuttings treated with growth stimulants has recently become widespread [11].

The process of root formation of cuttings depends on many factors, namely: the season and place of taking the source material, the method of harvesting and processing the cuttings, the composition of the substrate, the microclimate in which the rooting process takes place, the care of the planted cuttings, and the biological characteristics of the species that is propagated by cuttings [6, 17].

Material and methods of research. The research objects were the processes of growth and development of species and decorative forms of the genus *Spiraea* L.

The aim of the study was to determine the characteristics of cuttings for rooting and rooting of cuttings of the genus *Spiraea* L. as promising species and decorative forms for landscaping in the conditions of an urbanized environment, growing on the territory of the "Podillia" Botanical Garden of VNA. The research was conducted in the period 2021-2022. The object of the research was the species and decorative forms of the genus *Spiraea* L. The ability of vegetative reproduction was determined by rooting the cuttings according to the appropriate methods.

Research on the effect of growth stimulants "Kornevin" and "Heteroauxin" was carried out according to the methodology of R. H. Turetska. The cuttings took 60 pieces of each species, 20 pieces. treated with heteroauxin, 20 pcs. root vegetable and 20 pcs. was isolated as a control sample (plants were kept in distilled water). Cuttings were processed in accordance with the recommendations of manufacturers of growth

stimulants. Cuttings were processed at a temperature of +18...+22 °C. The cuttings were rooted in the greenhouse, and soil from a mixture of sand, sawdust and garden soil was used as a substrate for rooting. Before planting the cuttings, the surface of the substrate was leveled and moistened. During the entire period of rooting of the cuttings, the necessary microclimate was ensured by fine-dispersed irrigation: temperature regime and humidity of the substrate and air. The number and percentage of surviving plants, the number and quality of rooted plants, the average number of roots per plant and the average length of roots were determined during the records. The measurement was carried out using a ruler. During the experiments, 2 species and 2 decorative forms of the genus *Spiraea L.* were studied.

Research results and their discussion. According to the results of the vegetative reproduction on the territory of the botanical garden "Podillia" of the Vinnytsia National Agrarian University in 2021-2022, it was established that the use of growth stimulants during spirea cuttings contributed to their faster rooting and ensured better plant survival compared to the control (Table 1).

Table 1

The proportion of rooted cuttings of the studied species depending on the type of growth stimulator, %

№	The name of the species and the variety	The method of pre-planting cuttings preparation		
		The control	Kornevin	Heteroauxin
1	<i>Spiraea japonica</i> "Golden Princess"	80	95	100
2	<i>Spiraea japonica</i> 'Little Princess'	75	90	95
3	<i>Spiraea betulifolia</i>	75	90	90
4	<i>Spiraea nipponica</i>	70	85	95

Source: made by author based on own research

The research results showed that the survival of cuttings is largely determined by the biological feature of the species and the use of growth substances. The highest rooting in the control group was observed in *Spiraea japonica* "Golden Princess", and the lowest in *Spiraea nipponica*. Accordingly, the share of rooted cuttings on the control variant was at the level of 70% in *Spiraea nipponica*. The maximum rate of rooting in the control was recorded in *Spiraea japonica* "Golden Princess" and it was 80%. *Spiraea japonica* 'Little Princess' and *Spiraea betulifolia* showed average values of rooting of cuttings in this version of the experiment (75%).

The use of the growth stimulator "Kornevin" increased the level of rooting of cuttings for all researched species by 15% compared to the control group. Thus, the rate of rooting ranged from 85% to 95% depending on the species. The use of the drug "Heteroauxin" also contributed to the improvement of the rooting of spirea cuttings, the rooting rate of which is 90-100%, depending on the studied taxon. The maximum rate of rooting of cuttings was noted in the taxon *Spiraea japonica* "Golden Princess", which is evidenced by the rooting of all cuttings in this version of the experiment. The number of roots was determined in the cuttings that took root during the research. This indicator is important for understanding the adaptation and speed of rooting of new plants (Table 2).

Table 2

The average number of roots on one cutting in the studied species, pcs

№	The name of the species and the variety	The method of pre-planting cuttings preparation		
		The control	Kornevin	Heteroauxin
1	<i>Spiraea japonica</i> "Golden Princess"	7,2±1,5	15,1±2,7	16,4±2,6
2	<i>Spiraea japonica</i> 'Little Princess'	6,4±0,8	12,3±2,1	13,1±1,9
3	<i>Spiraea betulifolia</i>	5,9±1,7	13,4±1,9	12,3±2,1
4	<i>Spiraea nipponica</i>	7,3±2,4	13,8±2,3	14,7±2,5

Source: made by author based on own research

On variants without the use of rooting stimulants, the average number of roots on one cutting was in the range of 5.9±1.7 - 7.3±2.4 pcs. At the same time, the lowest indicator was recorded in *Spiraea betulifolia*, and the highest in *Spiraea nipponica*. On average, the use of the drug "Kornevin" increased the number of roots on one rooted cutting by 5.5-7.9 pcs. At the same time, the taxon *Spiraea japonica* "Golden Princess" reacted best to the application of the rooting agent. The average number of roots on one cutting was within 15.1±2.7 pcs. At the same time, the use of the growth stimulator "Heteroauxin" contributed to the formation of 6.4-9.2 pcs. more roots compared to the control. The highest average number of roots in a cutting was noted in *Spiraea japonica* "Golden Princess" when using the drug heteroauxin and was 16.4±2.6 pcs.

In the course of the study, a positive effect of treatment of spirea cuttings with growth stimulants on the biometric indicators of plants was established, namely, the average length of roots in rooted cuttings was determined in different variants of the experiment (Table 3).

Table 3

The average length of the roots depending on the treatment with stimulating drugs in the studied species, cm

№	The name of the species and the variety	The method of pre-planting cuttings preparation		
		The control	Kornevin	Heteroauxin
1	<i>Spiraea japonica</i> "Golden Princess"	0,7±0,2	2,7±0,4	3,0±0,4
2	<i>Spiraea japonica</i> "Little Princess"	1,5±0,4	2,3±0,2	3,4±0,7
3	<i>Spiraea betulifolia</i>	0,8±0,1	2,1±0,2	2,2±0,5
4	<i>Spiraea nipponica</i>	1,0±0,2	2,4±0,6	2,7±0,4

Source: made by author based on own research

On the control variants without the use of stimulants, the average root length was in the range of 0.7±0.2 - 1.5±0.4 cm. At the same time, *Spiraea japonica* "Golden Princess" had the lowest value. The use of growth stimulants in our experiment contributed to the formation of the largest length of main roots in spirea cuttings. In the variants of the experiment with the use of Kornevin for the processing of cuttings, the average length of the roots was within the range of 2.1±0.2 - 2.7±0.4 cm. The maximum indicator was recorded in the taxon *Spiraea japonica* "Golden Princess", which indicates the active effect of treatment with growth stimulants and the corresponding reaction in the growth of the roots of this

particular species. Table 3 also shows that the maximum average length of the main roots was noted in *Spiraea japonica* "Little Princess" when using the drug "Heteroauxin" - 3.4 cm. The difference with the control was 1.9 cm. The minimum average root length when using Heteroauxin was recorded in *Spiraea betulifolia* at the level of 2.2 ± 0.5 cm.

Also, the research program provided for determining the growth of rooted cuttings. After all, the further dynamics of growth and development of the cuttings testifies to the success of their rooting and the success of adaptation to the growing conditions. The increase in the length of the rooted cuttings of the investigated spirea species is presented in Table 4.

Table 4

The increase in the length of rooted cuttings of the studied spirea species, cm

№	The name of the species and the variety	The method of pre-planting cuttings preparation	The method of pre-planting cuttings preparation	
		The control	Kornevin	Heteroauxin
1	<i>Spiraea japonica</i> "Golden Princess"	$1,8 \pm 0,9$	$2,8 \pm 1,5$	$3,2 \pm 1,9$
2	<i>Spiraea japonica</i> "Little Princess"	$1,5 \pm 0,5$	$1,9 \pm 1,3$	$2,5 \pm 1,3$
3	<i>Spiraea betulifolia</i>	$2,1 \pm 0,7$	$3,1 \pm 0,7$	$2,7 \pm 1,2$
4	<i>Spiraea nipponica</i>	$1,3 \pm 0,8$	$2,3 \pm 0,7$	$2,2 \pm 0,7$

Source: made by author based on own research

According to the results of the study, spirea cuttings took root better under the influence of "Heteroauxin", their growth on average for all studied species ranged from 1.2 to 5.1 cm. Cuttings treated with "Kornevin" showed a slightly worse result, the length of the cuttings increased in on average by species by 0.6-4.3 cm. Cuttings of the control group took root the worst, their growth on average was from 0.5 to 2.8 cm. In general, on the basis of the conducted research, a high tolerance of the studied spirea species to the use of growth stimulants was revealed. Their use for processing cuttings before planting had a positive effect on the speed of rooting and the formation of the underground and above-ground parts of spirea cuttings.

Conclusions and prospects for further research. The soil and climatic conditions of the studied territory of the botanical garden "Podillia" of VNAU are generally favorable for the cultivation of most species of the genus *Spiraea* L., including for their creation and use in various types of garden and park compositions. According to the results of vegetative propagation on the territory of the botanical garden "Podillia" of the Vinnytsia National Agrarian University, it was established that the use of growth stimulants during spirea cuttings contributed to their faster rooting and ensured better plant survival compared to the control.

In addition, during the study, a positive effect of treatment of spirea cuttings with growth stimulants on their biometric indicators was established. The use of growth stimulants in our experiment contributed to the formation of the largest length of main roots in spirea cuttings. The obtained research results determine the relevance of conducting research in the future, studying the prospects of vegetative eproduction of decorative species using stimulating drugs in closed ground conditions.

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АНОТАЦІЯ

ОСОБЛИВОСТІ ВЕГЕТАТИВНОГО РОЗМНОЖЕННЯ ВИДОВОГО РІЗНОМАНІТТЯ РОДУ SPIRAEA L. В УМОВАХ ЗАКРИТОГО ГРУНТУ НА ТЕРИТОРІЇ БОТАНІЧНОГО САДУ «ПОДІЛЛЯ» ВНАУ

У статті розглядається дослідження особливостей живцювання на вкорінення та приживання живців роду *Spiraea* L. як перспективних видів і декоративних форм для озеленення в умовах урбанізованого середовища, що зростають на території Ботанічного саду «Поділля» ВНАУ. Зокрема, вивчали *Spiraea japonica* «Golden Princess», *Spiraea japonica* «Little Princess», *Spiraea betulifolia*, *Spiraea nipponica*. За результатами проведення вегетативного розмноження на території ботанічного саду «Поділля» Вінницького національного аграрного університету у 2021–2022 рр. встановлено, що використання стимуляторів росту під час живцювання спіреї сприяло більш швидкому їхньому укоріненню та забезпечувало кращу приживлюваність рослин, порівнюючи з контролем.

Види спіреї, котрі зростають на території ботанічного саду «Поділля» Вінницького національного аграрного університету належать до таких секцій: *Calospira*, *Glomerati*, *Chamaedryon*, *Spiraria*. Найчисельнішою за кількістю рослин є секція *Calospira*, до складу якої належать рослини виду Спірея японська (*Spiraea japonica* L.), Спірея Бумальда (*Spiraea bumalda* L.) і Спірея біла (*Spiraea alba* (Miq.) Zab.).

Результати досліджень свідчать про те, що приживлюваність живців значно визначається біологічною особливістю виду, а також використанням ростових речовин. Найвища укорінюваність у групі контролю прослідковувалася у *Spiraea japonica* «Golden Princess», а найнижча – *Spiraea nipponica*. Використання стимулятора росту «Корневін» збільшило рівень укорінюваності живців у всіх досліджувальних видів на 15 %, порівнюючи з контрольною групою. Застосування препарату «Гетероауксин» також сприяло покращенню вкорінення живців спіреї, частка укорінюваності яких складає 90–100 %, залежно від досліджуваного таксону. Використання стимуляторів росту в нашому досліді сприяло формуванню найбільшої довжини основних корінців у живців спіреї.

Ключові слова: живцювання, декоративні рослини, укорінення, калюсна тканина, стимулятори росту.

Табл. 4. Літ. 17.

Інформація про авторів

Циганська Олена Іванівна – кандидат сільськогосподарських наук, доцент кафедри лісового та садово-паркового господарства Вінницького національного аграрного університету (21008, м. Вінниця, вул. Сонячна, 3; e-mail: lenkatsiganskaya@gmail.com).

Tsyhanska Olena – candidate of agricultural sciences, associate professor of the department of forestry and horticulture of Vinnytsia National Agrarian University (21008, Vinnytsia, Soniachna Str. 3; e-mail: lenkatsiganskaya@gmail.com).