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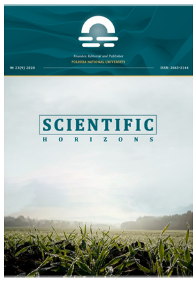

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Bacterial blight of viburnum (*Pseudomonas syringae* pv. *viburnum*): Biological features, causes, and consequences of manifestation, methods of control in the system of decorative and fruit gardening

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Abstract. Viburnum bacterial blight weakens the growth of Viburnum trees (bushes) and inhibits the physiological processes caused by the *Pseudomonas syringae* pv. *viburni* bacterium which survives in the affected stem tissue, plant remains, and soil. The purpose of the study was to examine the bioecological features of the manifestation of *Pseudomonas syringae* pv. *viburni* and development of measures to control bacterial leaf spotting in viburnum gardens. During the experiment, diagnostic methods were used to select plant leaves, identify, record, and analyse the affected leaves of viburnum plants by the *Pseudomonas syringae* pv. *viburni* bacterium. A method to avoid or reduce the risk of bacterial blights was developed. It was determined that various approaches can be used to prevent bacterial diseases in

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plants of the *Viburnum* L. genus, such as selecting more disease-resistant varieties, collecting and destroying fallen leaves and branches after pruning, and following agricultural techniques and gardening practices. For chemical control, copper-based bactericidal preparations, such as copper hydroxide or copper sulfate can be used, which are recommended for use in autumn and spring before budding. Performing these actions will help to prevent the manifestation of bacterial diseases in plants. It is proved that in the conditions of the Northern Forest-Steppe of Ukraine in the system of fruit gardening, it is advisable to grow high- and medium-resistant genotypes of Viburnum vulgaris of the Institute of Horticulture of the National Academy of Agrarian Sciences of Ukraine against bacterial leaf spotting. The practical value of the study lies in the fact that information about bacterial blight or bacterial spotting of viburnum leaves was expanded; it was proved that various species of the *Viburnum* L. genus differ in their susceptibility to *Pseudomonas syringae* pv. *viburni* bacterial damage; it is confirmed that the susceptibility of viburnum plants to this disease can be substantially reduced due to low-susceptible and resistant varieties and species of the *Viburnum* L. genus and timely technical and chemical measures

Keywords: species of the *Viburnum* L. genus; bacterial infection; features of the manifestation of bacterial disease; control measures

INTRODUCTION

Plant pathogens not only persist for centuries but also continue to appear on a global scale. S. Savary *et al.* (2017), state that direct crop growth losses due to biotic stress are about 20-40%. As noted by M.J. Landis *et al.* (2019), the representatives of multi-species *Viburnum* L. genus are no exception and substantially suffer from a number of diseases, including bacterial ones, which are among the most common and cause substantial damage to plants, causing vascular wilt (verticillosis), tissue necrosis, soft rot (mucosal bacteriosis), neoplasms or bacterial cancer, inhibit the processes of increasing viburnum gardens (Moskalets *et al.*, 2019; 2020), negatively affecting the growth, development, yield, decorativity, sometimes cause general weakening and death of plants.

One of the most dangerous bacterial diseases of Viburnum is bacterial blight, which is caused by phytopathogenic hemibiotrophic plant pathogenic rod-shaped *Pseudomonas syringae* Rod *Pseudomonas,* bacteria which, in addition, are part of a consortium of a broad evolutionary group of related species (Gomila *et al.*, 2017; Lalucat *et al.*, 2022) and lead to numerous diseases in other monocotyledonous, herbaceous dicotyledonous, and woody dicotyledonous plants worldwide (Xin *et al.*, 2018; Almeida *et al.*, 2022), causing brown mucus discharge, frostbite, fruit damage, and leaf and stem spotting (Fautt *et al.*, 2022). In particular, as noted by M. Lukas *et al.* (2020; 2022), *Pseudomonas syringae,* which was first isolated from common lilac (*Syringa vulgaris*) and described by Van Holl in 1902, produces active ice nucleation proteins (INA), which cause water to freeze in plant tissues at sufficiently low temperatures (-1.8 to -3.8°C or lower), in particular, in those that do not have antifreeze proteins, since the water in the plant can remain in a supercooled liquid state, which leads to damage to the epithelium and makes nutrients in nearby plant tissues available to bacteria.

H. Ehau-Taumaunu *et al.* (2022) claim that like other bacteria, *Pseudomonas syringae* compete for resources in a variety of environments using a range of antagonistic strategies, including the production and expression of narrow-spectrum antibacterial proteins called bacteriocins.

M. Ruinelli *et al.* (2019) quoting B. Schellenberg, note that strains of different *P. syringae* species produce phytotoxins that act as an irreversible proteasome inhibitor and promote bacterial colonisation in apoplexy by inhibiting leaf stomatal closure, and the synthesis of auxins, cytokinins, and coronatine, which can mimic plant hormones and therefore specifically interfere with the regulation of plant immune responses. According to J.S. Rufian *et al.* (2018), dynamic interactions between pathogenic, avirulent, and non-pathogenic strains occur in plants in a garden or field, and pathogenesis of *Pseudomonas syringae* depends on effector proteins that contribute to its manifestation, mainly due to inhibition of the protective properties of plants, which was well shown in the example of plant species *Arabidopsis thaliana*, *Nicotiana benthamiana*, and *Lycopersicon esculentum*. Therewith, bacterial plant pathogens compete with host plants and each develops strategies to overcome the other. Thus, because all organisms undergo phenotypic acclimatisation to various stimuli, they reverse the expression of genes and proteins to resist changes in the environment.

Phenotypic acclimatisation is evident in bacteria, during their colonisation of plants. M. Mulet *et al.* (2022) note that the phylogenetic group *Pseudomonas syringae* includes 15 recognised bacterial species and more than 60 pathovars, the largest of which are the following: *Pseudomonas syringae* pv. *aceris* (affects maple), *Pseudomonas syringae* pv. *aptata* (affects beetroot), *Pseudomonas syringae* pv. *atrofaciens* and *Pseudomonas syringae* pv. *lapsa* (affects wheat), *Pseudomonas syringae* pv. *dysoxylis* (affects kohekohe), *Pseudomonas syringae* pv. *fraxini* (causes ash cancer), *Pseudomonas syringae* pv. *quercus* (affects oak, sweet chestnut, and beech, causing the formation of Haloid outgrowths on the plants' trunks and the barks deformation (Orlovsky *et al.*, 2017), *Pseudomonas syringae* pv. *japonica* (affects barley), *Pseudomonas syringae* pv. *oleae* (causes the leaves of the olive to curl), *Pseudomonas syringae* pv. *panici* (affects millet), *Pseudomonas syringae* pv. *papulans* (affects apple trees), *Pseudomonas syringae* pv. *pisi* (affects peas), *Pseudomonas syringae* pv. *syringae* (affects lilacs, beans, and some species of viburnum), *Pseudomonas syringae* pv. *viburni* (affects viburnum, including *Viburnum sargentii*), etc.

C.E. Morris (2019) notes that the manifestation of *Pseudomonas syringae* pv. *viburni* has grown substantially in recent years, and this is the main threat to tree and bush species of plantings for agroforestry, decorative, and fruit gardening purposes. Therewith, as claimed by A.C. Velásquez (2018), global climate change substantially increases the potential for bacterial diseases, including: *P. syringae*, in gardens and crops. Therefore, to reduce the risks associated with the threat to global food and environmental security, rapid detection and characterisation of the epidemic and new pathogenic foci are relevant.

The purpose of the study was to examine the bioecological features of the manifestation of *Pseudomonas syringae* pv. *viburni* and develop measures to control bacterial leaf spotting in viburnum gardens.

MATERIALS AND METHODS

Accounting for damage to viburnum plants by bacterial leaf spotting was conducted at the experimental sites of the Institute of Horticulture of the National Academy of Agrarian Sciences of Ukraine (NAAS) and its research network during 2019-2021. Varieties/breeding forms of Viburnum (*Viburnum opulus* L.) of Ukrainian selection were involved in the investigation of the degree of plant damage: Ania, Uliana, Yaroslavna, Elina, Omriyana, Sonetta, Horikhova, Osinnia, Kralechka, Plododekorna (co-authors of which are T.Z. Moskalets, V.V. Moskalets *et al.*) and speciesof viburnum: Viburnum lantana; Viburnum carlcephalum; Viburnum rhytidophylloides (*Viburnum×rhytidophylloides*); Burkwood Viburnum; leatherleaf Viburnum (*Viburnum rhytidophyllum* Hemsl.); Viburnum Roseum (*Viburnum opulus* Roseum); Viburnum sargentii Onondaga (*Viburnum sargentii* Koehne Onondaga); common dwarf Viburnum (*Viburnum opulus* L.), Eskimo Viburnum (Fig. 1). Observations and records of plants were conducted during May-September (Methodology for examination of varieties..., 2016). Leaves of the examined varieties were collected twice during the growing season. During the growing season of Viburnum plants, 10-15 leaves were selected from 3 trees (bushes) of each variety/species (5 leaves x 3 repetitions).

Figure 1. *Photos of Viburnum samplesinvolvedin the study: 1 – Viburnum opulus L. Yaroslavna; 2 – Viburnum opulus Roseum; 3 – Viburnum opulus L. Eskimo; 4 – Viburnum rhytidophyllum Hemsl.; 5 – Viburnum × carlcephalum; 6 – Viburnum lantana; 7 – Viburnum lantana var. variegatum; 8 – Viburnum × rhytidophylloides; 9 – Viburnum × burkwoodii; 10 – Viburnum sargentii Koehne*

Source*: photographed by the authors*

The material was collected in parchment bags. A label indicating the sample number, place and time of collection was added to each sample of a specific variety/type of viburnum plant. Visual examinations were performed in the basal part and on the periphery along the entire vertical of the plant crown. Assessment to determine the resistance of viburnum plants was performed in three terms: the first – 10 days after the detection of the first diseased plants in the experiment, the second – 2-3 weeks after the first, that is, during the period of the greatest development of the disease, the third – at the end of harvesting.

The degree of damage by bacterial blight of viburnum leaves was determined on a scale in points: 1 – there are no symptoms of the lesion; 3 – single spots less than 1/5 of the leaf on individual leaves; 5 – spots occupy 1/4 of the leaf surface; 7 – occupy 1/2 of the leaf surface; 9 – 2/3 of the leaf surface. Using the obtained data, the percentage of disease development (*R*) was calculated by the formula:

$$P = \frac{a}{b \times 9} \quad (1)$$

where: *a* – sum of points of the degree of damage to all plants in repetition; *b* – number of accounting plants in repetition; *9* – maximum lesion score.

The lower the degree of damage, the higher the resistance of plants of the variety (Table 1).

Table 1. *Methods for assessing the resistance of viburnum plants to diseases caused by Pseudomonas syringae pv. viburni*

Degree of damage, score	Degree of stability	Score
1	Highly resistant	9
3	Resistant	7
5	Medium-resistant	5
7	Susceptible	3
9	Very susceptible	1

Source: *(Methodology for examination of varieties..., 2016)*

A corresponding calendar on phytopathological records was designed to facilitate the study on accounting for deciduous diseases on viburnum plants (Methodology of qualification examination..., 2016), part of which is presented in the methodological part of the study (Table 2).

Table 2. *Calendar of Phytopathological records of Viburnum plants*

Time of accounting	Name of the disease	Nature of the lesion, damage	Parameter of accounting
For a noticeable detection	bacterial blight	The leaves fade, dry out, and the bark of shoots and branches dries up, ulcers or depressions form on them. When the blight rings a branch or trunk, the leaves wither, dry out but do not fall off for a long time.	Percentage of affected plants and shoots (visually), %

Source: *(Methodology for examination of varieties..., 2016)*

In parallel with the diagnosis of Viburnum plants, two experiments were conducted. The scheme of the first experiment provided for 4 options: 1 – without pruning; 2 – pruning branches in autumn; 3 – pruning branches in early spring; 4 – pruning branches in summer. The second experiment involved investigating the effect of copper preparations on the manifestation of bacterial infection. The scheme of which included two options: without processing and with 2-3 treatment sessions of plants with copper sulfate. Among the experimental plants, plants of leatherleaf Viburnum, Viburnum opulus Roseum/Buldonezh, Viburnum sargentii Onondaga, and Viburnum dwarf Eskimo variety were taken. The repetition of the above-mentioned experiments is threefold. A 2% solution of copper sulfate was used, while 2 litres of solution were prepared for young plants, 3 litres – for 4-year-olds, 4 litres of the mixture were required for 6-year-olds, and 6 litres – for older ones. Bordeaux liquid was also used to control bacterial infection in viburnum plants, which was prepared by mixing copper sulfate with slaked lime. Statistical data processing was performed using the Statistica-6.0 computer programme.

RESULTS AND DISCUSSION

Bacterial diseases caused by *Pseudomonas syringae* pv. *viburnum* progress in wet, cool weather – the optimal temperature of their manifestation is up to 25°C. Pathogenic bacteria *Pseudomonas syringae* pv. *viburnum* introduce protein and toxin molecules into plant cells and thus affect the host plant's immunity, they overwinter on infected plant tissues, including areas of necrosis, or on healthy plant tissues. In spring, due to precipitation, bacteria enter the leaves/flowers, where they reproduce and spread in the epiphytic phase of the life cycle without causing the manifestation of the disease. As soon as the bacteria enter the plant through leaf stomata or necrotic spots on leaves or stems, the pathogen begins to progress, developing in the intercellular space, causing numerous spots on the leaves and various ulcers in diameter – the bacterial blight of Viburnum. Schematically, the spread of bacterial blight of Viburnum can be depicted as follows (Fig. 2).The symptoms of this bacterial disease are as follows. Initially, the affected areas on the leaves become glossy and covered with condensation (Fig. 3).

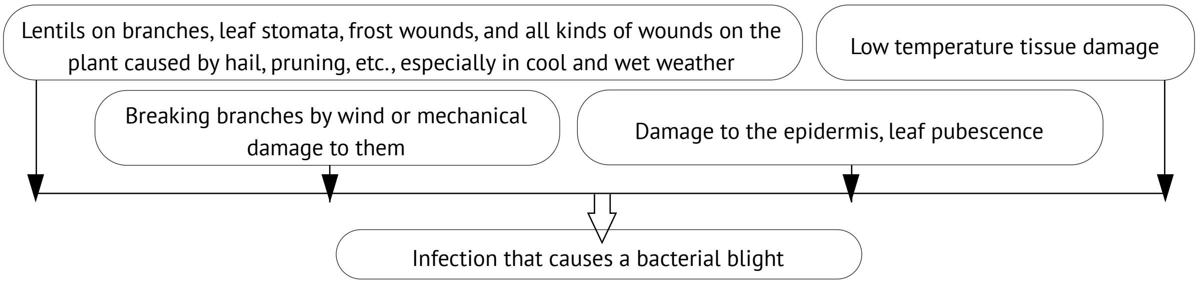

Figure 2. *Ports of entry and spread of bacterial infection in the plant body*

Source*: compiled by the authors*

A B

Figure 3. *Manifestation of the causative agent of bacterial blight at the initial stage of the Pseudomonas syringae pv. viburni lesion on the leaves of Viburnum vulgaris dwarf (Viburnum opulus L.) Eskimo (A) and Viburnum Roseum (Viburnum opulus Roseum) (B)*

Source*: photographed by the authors*

The manifestation of bacterial blight of Viburnum is accompanied by the appearance of watery spots, which eventually turn brown, and bacterial exudate often forms along the edges. A substantial manifestation of bacterial infection can lead to the death of shoots. In connection with the above mechanisms of pathogenicity *Pseudomonas syringae* pv. *viburnum* can be divided into several categories: the ability to penetrate the plant, the ability to overcome the resistance of the host plant, the formation of biofilms, and the production of proteins with the properties of ice nucleation. In plantings of different species of Viburnum, symptoms on leaves and stems were noted that differ from common diseases. The lesions were characterised as round areas soaked in water, which after 5 days turned into irregular, wrinkled brown spots up to 3 mm in diameter. The central part of the lesions on the leaves looked barely transparent. Then, in the third week, the leaves completely dried up.

On the surface of the leaves, a layer of bacterial secretions, which makes the leaves shiny, can be observed. If a bacterial blight occurs at the beginning of the growing season, the leaves may be distorted. In severe cases, the shoots may die off (Fig. 4).

Figure 4. *Manifestation of the causative agent of bacterial blight at the initial stage of the Pseudomonas syringae pv. viburni lesion on the leaves of twigs of Viburnum sargentii Onondaga variety (Viburnum sargentiiii Koehne Onondaga)*

Source*: photographed by the authors*

The greatest manifestation of bacterial blight was noted on plants of the *Viburnum rhytidophylloides* Surin species, which manifested itself in browning and premature leaf fall. Brown spots appeared on the upper, lower, or both surfaces of the leaves. In particular, the spots on the leaves were pointy or rounded, slightly raised or recessed, and had smooth or fringed edges. Therewith, the colours of the spots varied from yellow to yellow-green, orange-red to light brown, dark brown, or black with a halo of yellow tissue around each spot (Fig. 5).

Figure 5. *Manifestation of the causative agent of bacterial blight at the initial stage of the Pseudomonas syringae pv. viburni lesion on the leaves of Viburnum rhytidophylloides Surin*
Source*: photographed by the authors*

On the same plant, there may be spots on the leaves of different sizes. Notably, smaller spots on the leaves indicated the beginning of the development of the causative agent of bacterial blight, and large spots – a long period of infection. Shoots, buds, and flowers can also turn black and be damaged by bacterial spotting. Often, in the centre of large spots on the leaves, signs of fungal pathogens, in particular, peronosporosis (*Plasmopara viburni*) could be noted, which was observed on the example of plants of Viburnum Serzhenta (Fig. 6).

Figure 6. *Manifestation of the causative agent of bacterial blight on the leaves of Viburnum sargentii*
Source*: photographed by the authors*

It was determined that according to the degree of resistance, highly resistant to bacterial blight are varieties of Viburnum vulgaris: Yaroslavna, Ania; Burkwood viburnum (degree/score of damage – 1/9), resistant – varieties of Viburnum vulgaris: Elina, Uliana, breeding forms: Omriyana, Osinnia, Kralechka, Sonetta; viburnum lantana; viburnum carlcephalum (degree/score of damage – 3/7), medium-resistant – breeding form of Viburnum vulgaris: Plododekorna, Horikhova clone; Viburnum rhytidophylloides (*Viburnum×rhytidophylloides*) (degree/score of damage – 5/5).

Plants of leatherleaf Viburnum seemed unstable to bacterial spotting of leaves (shoots) (*Viburnum rhytidophyllum* Hemsl.), Viburnum Roseum (*Viburnum opulus* Roseum), Viburnum sargentii Onondaga (*Viburnum sargentiiii* Koehne Onondaga), common dwarf Viburnum (*Viburnum opulus* L.) Eskimo (miniature copy of Viburnum Roseum/Buldonezh, but with a denser spherical crown) (Table 3).

Table 3. *Results of the assessment of the resistance of Viburnum plants to bacterial disease caused by Pseudomonassyringaepv. viburni, average value for 2019-2021*

Name of the species/variety (breeding form)	Degree of damage, score	Degree of stability	Lession score
Viburnum vulgaris, varieties: Yaroslavna, Ania; Burkwood viburnum	1	Highly resistant	9
Viburnum vulgaris, varieties: Elina, Uliana, breeding forms: Omriyana, Osinnia, Kralechka, Sonetta; viburnum lantana; viburnum carlcephalum	3	Resistant	7
Viburnum vulgaris, breeding form: Plododekorna, Horikhova clone; Viburnum rhytidophylloides (*Viburnum × rhytidophylloides*)	5	Medium-resistant	5
Leatherleaf viburnum, viburnum vulgaris Roseum/Buldonezh, Viburnum sargentii Onondaga, Viburnum vulgaris dwarf Eskimo	7	Susceptible	3
-	9	Very susceptible	1

Source*: compiled by the authors*

An experiment was conducted on pruning experimental plants to reduce the manifestation of bacterial infection on those susceptible to exposure of *Pseudomonas syringae* pv. *viburni*, (leatherleaf Viburnum, Roseum/Buldonezh, Sargent Onondaga, Viburnum vulgaris dwarf Eskimo). The experiment provided for 4 options: 1 – without pruning; 2 – pruning branches in autumn; 3 – early spring; 4 – in summer.

It was determined that pruning in autumn and early winter also contributed to more serious damage to viburnum trees (bushes) from bacterial infections caused by *Pseudomonas syringae* pv. *viburni*. Pruning trees in early spring had partial results. Summer pruning in dry weather proved more effective since almost all Viburnum species (varieties) were noted as medium-resistant with an average lesion score of 5 (Table 4).

Table 4. *Evaluation of Viburnum plants for resistance to bacterial disease caused by Pseudomonas syringae pv. viburni depending on the experiment variant, Northern fForest-Steppe, average value for 2020-2021*

No.	Species name	Plant damage option/score			
		without pruning	autumn pruning of branches	early spring pruning of branches	summer pruning of branches
1	Leatherleaf viburnum	3	3	4	5
2	Viburnum Roseum/Buldonezh	1	3	4	5
3	Viburnum sargentii (Onondaga variety)	1	3	3	5
4	Viburnum vulgaris dwarf (Eskimo variety)	3	4	3	5

Source*: compiled by the authors*

During 2020-2021, it was established that the application of copper sulfate in combination with slaked lime (Bordeaux mixture) 2-3 times is effective for reducing the damage of susceptible viburnum species by a bacterial infection caused by bacteria *Pseudomonas syringae* pv.*viburni*.

The study presents the results of examining various Viburnum species on susceptibility to *Pseudomonas syringae* pv. *viburni*. Bacterial viburnum burns can be a problem during the cool, humid spring in other parts of the country, including the Northwest and East. Bacterial infections can lead to shoot death and complete defoliation. The first reports in the 2000s about a serious manifestation of bacterial blight or bacterial spotting of Viburnum leaves are indicated in the studies of researchers from the UK (Stead *et al.*, 2006), Italy (Garibaldi *et al.*, 2005), and other countries that indicate that there is no 100% effective method of destruction *Pseudomonas syringae* pv. *viburnum*.

Information on the susceptibility of Viburnum species, in particular, *Viburnum rhytidophylloides* to bacterial blight was also obtained by researchers from the University of Oregon (USA), in particular, R. Rosetta (2019) identified that plants of the above-mentioned species were characterised as highly resistant, in contrast to leatherleaf viburnum. Phytopathologists N. Gauthier *et al.* (2022) also note that the manifestation of bacterial blight of Viburnum plants is the appearance of pointy, water-soaked spots on the leaves, which over time turn from light shades to brown or dark brown scales. A layer of bacterial cells and exudate on the surface of the leaves gives them shine. Further, the leaves are deformed, and the shoots mostly die off.

Many modern researchers on the above-described problem, including, J.W. Pscheidt (2018) note that bacterial infection in viburnum plants can also be successfully controlled by taking timely measures. The specified researcher also believes that the most common ways to combat the bacterial blight of Viburnum are the use of resistant species and varieties of Viburnum in decorative and fruit gardening, regulatory and sanitary pruning with disinfected garden tools, and the use of bactericides with compounds of copper or other metals, including iron, which can be appropriately combined with fungicides or other chemical preparations to control pests – carriers of pathogens. Combined treatment with biological and chemical preparations has been shown to be effective in controlling bacteriosis (Ni *et al.*, 2020). The aforementioned researcher also believes that chemical treatment with copper hydroxide and copper sulfate can stop the spread of *Pseudomonas syringae* pv. *viburni*, and it is best to prevent their manifestation by regularly conducting preventive measures.

E. Osdaghi (2020) claims that adding ammonium fertiliser to viburnum plants can cause metabolic changes in them, leading to resistance to *Pseudomonas syringae* bacteria. However, as noted by A.I. González-Hernández *et al.* (2019), this so-called ammonium syndrome causes an imbalance of nutrients in the plant and instead triggers a protective response against the pathogen.

Summarising the above, it can be stated that measures for early diagnosis of Viburnum plants for the appearance of bacteriosis, timely preventive measures, selection of immune varieties adapted to a specific territory, compliance with elements of agricultural cultivation techniques, control in seedling production, etc. will reduce the manifestation of *Pseudomonas syringae* pv. *viburni* in the gardens of the examined culture.

CONCLUSIONS

It was determined that the *Pseudomonas syringae* pv. *viburni* pathogen at the initial stages affects only a small percentage of the total leaf area of Viburnum plants and creates a slight stress that does not affect the normal growth and development processes of the examined plants. However, bacterial spotting of leaves (shoots) of Viburnum should be taken seriously, since the disease for 2-4 years leads to moderate or complete loss of leaves (branches) in susceptible to bacterial disease varieties/species, affecting the reduction of growth processes and increased susceptibility to pests and pathogens of other diseases.

Varieties of Viburnum vulgaris: Uliana, Yaroslavna, Elina, Ania, Omriyana, Sonetta, Plododekorna, etc., Burkwood viburnum, Viburnum lantana, in particular, the decorative form of this species with colourful leaves, viburnum×carlcephalum (*Viburnum×carlcephalum*), Viburnum rhytidophylloides (*Viburnum×rhytidophylloides* (*Viburnum lantana×Viburnum rhytidophyllum* Hemsl.)) are resistant to bacterial blights.

Suscrptible to bacterial spotting of leaves (shoots) are plants of leatherleaf Viburnum (*Viburnum rhytidophyllum* Hemsl.), Viburnum Roseum (*Viburnum opulus* Roseum), Viburnum sargentii Onondaga (*Viburnum sargentii* Koehne Onondaga), common dwarf Viburnum (*Viburnum opulus* L.) Eskimo.

Measures to minimise bacterial blight of Viburnum plants include: exclusion, elimination, or reduction of the *Pseudomonas syringae* pv. *viburni* bacterial pathogen inoculum, the spread of genetic diversity in a certain area in the system of decorative or fruit gardening and inhibition of the mechanisms of virulence of bacterial pathogens in various ways (selection of species and varieties, compliance with the cultivation technology, including chemical protection systems, fertilisation, irrigation, tillage in the row spacing or in the trunk zone, etc.). The effectiveness of measures of pruning and 2-3 times treatment with a Bordeaux mixture of plants susceptible to bacterial blights of leatherleaf Viburnum, Viburnum Roseum/Buldonezh, Viburnum sargentii Onondaga, Viburnum vulgaris dwarf Eskimo is proved.

Due to the chemical protection of Viburnum stands against bacterial infections, it is advisable to treat plants with copper-based preparations in combination with fungicides. In the irrigation system of mother-cuttings nurseries, hybrid nurseries, if necessary, it is advisable to use only drip irrigation, avoid water getting on the leaves, and also avoid contact of the ground part with moist soil.

A promising area of further research is the involvement of immune or low-susceptible to bacterial blight species and varieties of the *Viburnum* L. genus in the breeding and production processes in the system of fruit and decorative gardening, which will correct the population characteristics or make it impossible for this disease to appear.

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CONFLICT OF INTEREST

None.

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Бактеріальний опік калини (*Pseudomonas syringae* pv. *viburnum*): біологічні особливості, причини і наслідки прояву, способи контролю в системі декоративного та плодового садівництва

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Анотація. Бактеріальний опік або бактеріальна плямистість листків (англ. Viburnum-BacterialBlight) послаблює ріст дерев (кущів) калини, гальмує фізіологічні процеси,зумовлені бактерією *Pseudomonas syringae* pv. *viburni*, яка виживає в ураженій тканині стебла, рослинних рештках і ґрунті. Мета досліджень передбачала вивчення біоекологічних особливостей прояву *Pseudomonas syringae* pv. *viburni* і розроблення заходів щодо контролю бактеріальної плямистості листків у садах калини. Під час експерименту були використаніметоди діагностики з відбору рослинних листків, виявлення, обліку, аналізу уражених листків рослин калини бактерією *Pseudomonas syringae* pv. *viburni*. Розроблено спосіб уникнення або зменшення ризиків появу бактеріального опіку. З'ясовано, що для запобігання бактеріальних хвороб у рослин роду *Viburnum* L. можна використовувати різні підходи, такі як підбір більш стійких до хвороб сортів, збір і знищення опалого листя та гілок після обрізки, дотримання агротехніки та садівницьких практик. Для хімічного контролю можна застосовувати бактерицидні препарати на основі міді, такі як гідроксид міді або мідний купорос, які рекомендується використовувати у восени і весною до розпускання бруньок. Виконання цих дій допоможе запобігти прояву бактеріальних хвороб у рослинах. Доведено, що в умовах Північного Лісостепу України в системі плодового садівництва доцільно вирощувати високо- і середньостійкі проти бактеріальної плямистості листків генотипи калини звичайної Інституту садівництва НААН України. Практична цінність роботи полягає в тому, що було розширено відомості про бактеріальний опік або бактеріальну плямистість листків калини; доведено, що різні види роду *Viburnum* L. різняться за сприйнятливістю до ураження бактерією *Pseudomonas syringae* pv. *viburni*; підтверджено, що сприйнятливість рослин калини до зазначеної хвороби можна істотно знижувати за рахунок малосприйнятливих і резистентних сортів і видів роду *Viburnum* L. та своєчасних технічних і хімічних заходів

Ключові слова: види роду *Viburnum* L.; бактеріальна інфекція; особливості прояву бактеріальної хвороби; заходи контролю