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ANALYSIS AND EVALUATION OF PLANTS OF GENUS SYRINGA L. IN PODILLIA

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Abstract:

It is established that *Syringa L.* plants are very perspective both from the utilitarian and ornamental point of view. The species of this genus are typically used as a supplement to shrubs in urban parks and gardens and more rarely in the open areas in combination with other shrubs and very rarely by groups in the lawns or alleys.

Ecological and biological features of *Syringa L.* species in the territory of Podillia Botanical Garden have been studied. The rhythms of growth and development of *Syringa L.* species, in particular, *Syringa vulgaris* and its 8 varieties ('Buffon', 'Jeanne d'Arc', 'Montblanc', 'President Grevy', 'Ruhm von, Horstenstein', 'Furst Billov', 'Taras Bulba', 'Madame Lemoine') and *Syringa chinensis* are studied.

Leaf surface area has been measured and it has been found that leaf surface area in *Syringa chinensis* is smaller than leaf surface area in *Syringa vulgaris*, however, it varies in both species depending on the bush layer placement.

Due to phenological studies and processing of data on the dynamics of phenological phases of *Syringa L.*, the results on phenophases have been obtained, which enables to use research materials to create plantations of *Syringa L.* with the highest ornamental effect.

Having examined the shape of the flower, it has been found that double-flowered forms are open longer than common ones. Common white-coloured varieties have the shortest blooming period. Young plants bloom during a shorter period of time than old ones. The inflorescence is a panicle, it differs in length and width.

It has been established that the development of species of genus *Syringa L.* is highly dependent on the sum of effective and active temperatures. The amount of effective temperatures (above + 5 °C) required for swelling and budding and the sum of active temperatures (above + 10 °C) required for mass blooming and its completion as well as setting and maturation of fruits has been studied.

The most promising taxons have been selected for the practical use in accordance with studies on the biological, phenological and ecological features of plant development. The list of the most ecologically plastic recommended varieties has been compiled according to the color of flowers in order to create the most vivid and spectacular compositions.

Keywords: variety, introduction, flower, species, ornamental, shape.

Introduction. Nowadays, the issues of landscaping are of great urgency in conditions of urbanization of settlements. The requirements for the assortment of flowers and woody shrubs used for landscape gardening are constantly increasing. There is not much data on the active use of *Syringa L.* in Ukraine's landscaping, but this plant is extremely promising, both from a utilitarian and ornamental point of view [1].

In addition to general methodological guidelines on the possibility of using plants of the genus *Syringa L.* in various compositions, there are scientific works devoted to the study of *Syringa L.* biology and morphology, and a small part of them are the catalogs of species and varieties cultivated in a particular botanical garden or natural climatic zones. However, it is not insufficient for wide introduction of species of the genus *Syringa L.* as a valuable culture for greening [2].

The examinations of numerous urban areas indicate that these species are mainly used as a supplement to shrubs in urban parks and gardens and more rarely in the open areas in combination with other shrubs and very rarely by groups on the lawns or alleys. In many establishments, species of the genus *Syringa L.* are planted in dense rows in a group of tall trees, which of-

ten suppress these shrubs. This is explained by the neglect of the basic methods of creating compositions using species and varieties of this genus [3].

In Vinnytsia region there is no explicit limiting factor for *Syringa L.* The main problems that are dealt with during the cultivation of these species are dense planting or close proximity to other woody plants, poor edaphic conditions as a result of insufficient agricultural technology and acidic or moist soil [1].

The syringarium of Podillia Botanical Garden is one of the most ornamental collection and exposition sites of the garden, which has long become its so-called visiting card.

Overview of recent research and publications. Seeds of «Turkish viburnum» brought to Vienna in 1563 by an Austrian envoy from Constantinople were described by K. Linney as a *Syringa vulgaris L.* By 1770, two varieties of *Syringa L.* had been registered. In 50 years a white-flowered form was observed in European gardens and in 120 years a purple-colored form with larger flowers and inflorescences [4].

In the middle of the XIX there were introduced only 9 species of *Syringa L.* from 30 currently known, and later along with the introduction of *Syringa L.* there

was carried out the selection and reproduction of spontaneously emerged ornamental forms in previously introduced species. As a result, by the middle of XX century 25 of its forms were already known [1, 4, 5].

A new stage in the development of *Syringa L.* began in 1876, when the first *Syringa L.* breeder Frenchman Victor Lemoine brought out two ornamental varieties of *Syringa vulgaris*. The first double-flowered form of white-flowered *Syringa L.* was described in 1823, and in 1846 the first double-flowered form of colour-flowered *Syringa L.* was described [6].

In September 1974, the XIX International Congress of Gardeners in Warsaw entrusted the Royal Botanical Gardens of Hamilton (Canada) to compile and publish a checklist of all known names of the genus *Syringa L.* The register includes 1,359 names of varieties and 53 names of natural species and varieties [4].

Both cultivated and wild species, many of which were first described by botanists and travelers (A.A. Bunge, N.S. Turchaninov, F.I. Ruprekht, R.N. Potanin, V.L. Komarov) and then introduced to Europe through the botanical gardens of St. Petersburg and Moscow, are important in ornamental horticulture [5].

When breeding new varieties of *Syringa L.* the breeders apply interspecific hybridization. In 1919 at the Central Experimental Station in Ottawa (Canada), Isabella Preston produced the first hybrids due to the crossing of *Syringa reflexa* with *Syringa villosa*. In total, 76 hybrids were bred at an experimental station in Ottawa, 22 of which were recommended for further breeding [6].

The first domestic *Syringa L.* varieties were bred by I.M. Michurin. He first obtained a dwarf variety suitable for the cultivation indoor conditions (the height of bushes of this variety does not exceed 35 cm).

Since 1916 selection and breeding of new *Syringa L.* varieties was performed by the prominent originator L.A. Kolesnikov. For nearly three decades, he has bred more than 100 varieties of *Syringa L.*, and 52 of them have been included into the International Register. L.A. Kolesnikov was awarded the Golden Syringa Branch of the International Union for his achievements in the field of selection and breeding of *Syringa L.* [4].

In Ukraine, the works on the introduction, hybridization, selection and breeding of new *Syringa L.* varieties is concentrated in botanical gardens. A significant contribution to the introduction or selection of *Syringa L.* has been compiled by Lavrov, N.A. Kostetsky, L.A. Kolesnikov, P.D. Vekhov, L.I. Rubtsov, N.A. Lypunov, V.F. Bibikova, Burova, L.K. Kravchenko, A.F. Miroshnik, I.I. Shtanko, I.I. Mikhailov, E.A. Sharenkova.

The purpose and objectives of the research. The research aimed to study the ecological and biological characteristics of species of the genus *Syringa L.* in order to restore and reconstruct the syringarium in the territory of Podillia Botanical Garden. To achieve this goal, the following objectives were set: to study the ecological and biological features of *Syringa L.* species

in the territory of Podillia Botanical Garden; to select the most promising taxons for the practical use.

The object of the research was the species of *Syringa L.* genus in conditions of the syringarium of Podillia Botanical Garden.

Materials and methods. For our studies, two *Syringa L.* species were selected: *Syringa vulgaris* and its 8 varieties ('Buffon', 'Jeanne d'Arc', 'Montblanc', 'President Grevy', 'Ruhm von Horstenstein', 'Furst Bilow', 'Taras Bulba', 'Madame Lemoine') and *Syringa chinensis*.

Syringa vulgaris is a small tree or shrub. It is up to 5-8 m high, and has dark gray crust. The shoots are grayish-brown or greenish. The buds are 6-12 mm long, reddish or greenish. The leaves are 5-12 cm long, dense, dark green on the top. Petiole is up to 3 cm, bare. Flowers are of different colors (from white to violet) [7].

Syringa chinensis is a natural hybrid between Persian *Syringa* and *Syringa vulgaris*. The height of the bush in the *Syringa L.* alley of the botanical garden is 3.5 m. Although it can reach up to 6 m high. The leaves are not big, narrow-ovate up to 6 cm long. The inflorescence is large, 18-30 cm long and 16-26 cm wide [8].

During 2018-2019 we studied the seasonal development of species through phenological observations using the methodology of the Botanical Gardens Council [1980, 1995]. Phenological observations of the development of seedlings were performed according to the methodology developed by L.S. Plotnikova [1970]. The degree of winter hardiness of *Syringa L.* species was evaluated using 8-point scale by S.Y. Sokolova [1957]. The sum of effective and active temperatures required for swelling and budding, blooming, setting and maturation of fruits was determined by the method developed by H.K. Koval [1973], A.P. Losev [1988]. Ornamentality of *Syringa L.* species by the seasons was evaluated according to the method by N.V. Kotelova, O.N. Vynogradova [2004], and ornamentality in the blooming and fruiting phases was estimated by the scale of ornamentality by H.E. Mysnyk [1994]. The growth of shoots was measured by the method of studying the growth of woody plants by A.A. Molchanov, V.V. Smirnov [1967]. The growth was studied on the basis of linear measurement of the growth of one-year shoots. Flowering intensity and abundance of fruiting was determined using the method by M.S. Nesterov (2004). Leaf surface area was measured by Meyer's method using a pallet [2, 3, 9, 10].

Results and Discussion. To conduct our research on the development of project solutions for the restoration and reconstruction of the syringarium of the botanical garden, it was decided to evaluate the rhythms of growth and development of *Syringa vulgaris* and *Syringa chinensis*. Based on the phenological studies and processing of materials on the dynamics of phenological phases of *Syringa L.*, we obtained the results by phenophases, which allowed us to use research materials to create *Syringa L.* plantations having the most ornamental effect (Fig. 1).



Fig. 1 Syringarium of Podillia Botanical Garden

Due to the warmer winters of 2018-2019, the growing season began two weeks earlier. An increase in the bud size was observed in the third decade of March 2018, and on March 15-18, 2019. In 12 days, the first leaves were formed on the bush, and in 3 other weeks a full leafing took place [4].

The linear growth of leaves lasted 40-45 days and ended in June. It has been found that the leaves have

different surface area depending on their placement on the bush. Measurements of leaf surface area using Meyer's method have showed that leaf surface area of *Syringa chinensis* (row 2) is smaller than that one of *Syringa vulgaris* (row 1), but leaf surface area changes in both species depending on the bush layer placement, as shown in Figure 2.

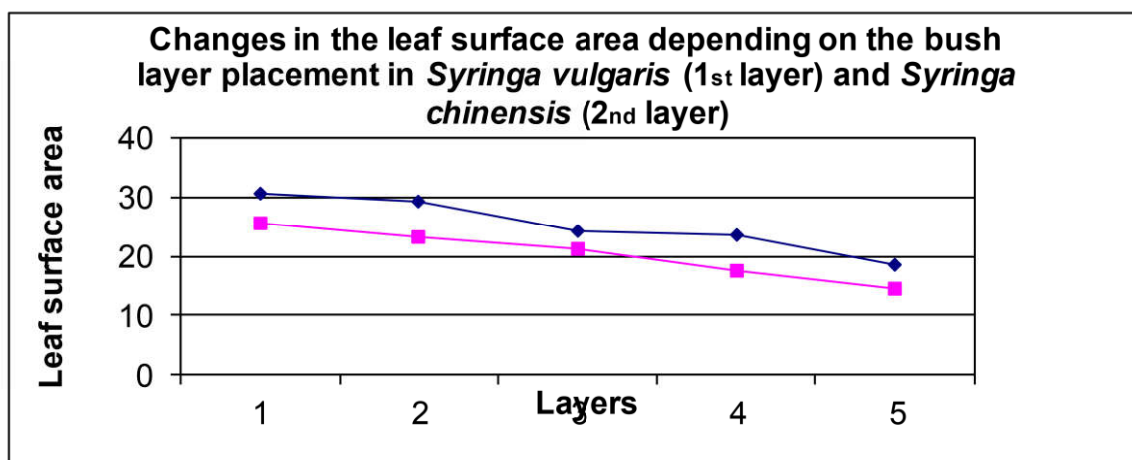


Fig. 2 Changes in the leaf surface area depending on the bush layer placement

The shoots began to grow simultaneously with the leaves. The most intense growth of shoots was observed in May. In June the energy of shoot growth decreased, and in August it stopped altogether. According to our observations, the biology of blooming of the species studied is almost similar. The only significant difference is different blooming periods.

The blooming was observed, as a rule, in the first decade of May when the average daily air temperature rose to 12-15 °C. When high temperature was kept

every day during spring warming, the blooming was accelerated and took 12-18 days. When it was getting colder during blooming period and the average daily temperature dropped below 10 °C, the blooming period increased to 20-28 days.

The inflorescences appeared simultaneously with the leaf opening, in addition, the dormant state of generative buds finished earlier and they bloomed faster than the vegetative ones [5].



Fig. 3 *Syringa L.* (*Syringa L.*)

The onset of phenophases of *Syringa L.* was largely determined by weather conditions and varied substantially over the years. Thus, as a result of the warm winter and early spring of 2018, the growing season of *Syringa L.* began almost three weeks earlier. Due to the humid and warm autumn of 2018, the mass November leaf falling began almost two weeks later. Biological zero, i.e. the air temperature below which the growth and development of plants ceases, is +6 °C for the phases of coming out and budding, +9 °C for the development, + 13 °C for blooming, but the temperature in these phases may be higher. High temperature

of the third decade of May, which sometimes reached 32-35 °C, caused rapid completion of blooming.

Syringa L. started to bloom nearly in a month after the beginning of the growing season, but during our observations it began in 1.5 months or 46 days due to the abnormally warm winter and spring weather of 20018. According to our studies, the bush of *Syringa L.* got entirely bloomed in 9-10 days; one panicle was blooming during 13-18 days, a separate flower was blooming during 9-12 days. Phenological phases of *Syringa L.* development in the botanical garden are shown in Table 1.

Table 1

Phenological phases of *Syringa vulgaris L.* and *Syringa chinensis L.* development (in the conditions of the botanical garden according to the data of 2018-2019)

Mean date (in 2018-2019)	Development phase	Number of days from the beginning of the growing season
March 18	Bud swelling.	0
March 30	Formation of the first leaflets, beginning of leaf formation	12
April 7	Separation of shoots, emergence of flower buds, beginning of budding	21
April 16	Completion of leaf setting, full leafing	30
May 11	Mass blooming	55
May 28	Completion of blooming, dying of the apical bud of one-year shoots	72
June 5	The end of growth of one-year shoots	80
September 20	Mass maturation of fruits	188
November 5	Beginning of mass leaf falling	234

Having investigated the flower shape, we have found that the double-flowered forms are open longer than common ones. The shortest blooming period is observed in common white varieties. Young plants are blooming during a shorter time period than the old ones. Inflorescence is a panicle, and it has different length and width.

The elements of inflorescences of some *Syringa L.* varieties by the average observation data of 2018-2019 are shown in Table 2.

It is the longest inflorescence that has a branched shape in 'Ruhm von Horstenstein' and 'President

Grevy' varieties. 'Taras Bulba' and 'Jeanne d'Arc' have large but compact inflorescences. According to our calculations, the number of flowers in the parcel varies from 106 to 319. Flower diameter ranges from 0.8 cm to 2.5 cm. The flowers have a long-lasting pleasant fragrance varying from gentle to tart. 'Buffon', 'Montblanc', 'Ruhm von Horstenstein', 'Furst Billow' have common corolla, while 'Jeanne d'Arc', 'President Grevy', 'Taras Bulba', 'Madame Lemoine' are double-flowered.

Table 2

**Structure of inflorescences of *Syringa vulgaris* L. varieties
(average for 2018-2019)**

Variety	Colour	Type of inflorescence	Size of panicle, cm		Number of flowers	Dimeter of flower, cm
			length	Width		
'Buffon'	mauve-pink	common	17.5	7.0	184	2.8
'Jeanne d'Arc'	white	double-flowered	18.9	9.3	200	2.5
'Montblanc'	white	common	22.6	10.8	244	2.5
'President Grevy'	mauve-blue	semi double-flowered	25.7	8.7	200	2.2
Ruhm von	violet-red	common	28.0	8.6	319	2.6
Horstenstein	white	common	20.2	8.2	177	2.5
'Furst Billow'	dark-violet	double-flowered	20.2	8.6	219	2.2
'Taras Bulba'	white	double-flowered	20.0	9.0	139	2.2
'Madame Lemoine'	mauve-pink	common	17.5	7.0	184	2.8

The blooming period of all varieties lasts at least 40 days and ends in late May-early June. The range of colors of the flowers is extremely wide: from pure white, white-cream, mauve-pink, mauve-blue to mauve-red, red-violet and dark violet.

There is an interesting fact that *Syringa* L. with pink and white flowers bloom mostly in the early terms, while those with purple and violet bloom in late terms and *Syringa* L. having mauve, *Syringa* L. and blue coloured flowers bloom in mid-terms. Blooming of early and late varieties lasts 17-25 days, mid varieties bloom a little bit longer – 20-30 days.

The features of blooming were largely dependent on the air temperature. The earlier *Syringa* L. starts blooming, the longer and more evenly it blooms. While the blooming of *Syringa* L. was restrained by cold weather, the blooming of early and mid-varieties occurs simultaneously with the late ones. High temperature of May 2018 during blooming contributed to the rapid "burning" of the flowers, with the edges of the petals getting brown and the inflorescences looked less ornamental. 'President Grevy' and 'Ruhm von Horstenstein' are the varieties that best withstood the heat of the third decade of May and looked good ornamentally.

Table 3

Phenospectrum of blooming of some *Syringa vulgaris* L. varieties

Variety	Date of blooming	Average duration, days	
		mass	total
'Buffon'	30.04	12	17
'Jeanne d'Arc'	11.05	10	15
'Montblanc'	10.05	14	17
'President Grevy'	7.05	12	17
Ruhm von	8.05	12	17
Horstenstein	12.05	13	15
Furst Billow	11.05	18	28
'Taras Bulba'	15.05	18	30
'Madame Lemoine'	14.05	13	25

Vegetative shoots stop growing when the bush finishes blooming. Thus, the duration of adult plant growth averages 50 days. Since mid-June, no visible alteration of the top part was observed, but during this time intensive internal differentiation of the vegetative and generative buds was conducted. Formation of vegetative buds had ended by July. Differentiation of generative buds requires more time and ends in winter only in areas with a long growing season, and in the middle zone it ends next spring.

Inflorescence differentiation began in late May and most intensively in early June, coinciding with the

end of shoot growth in thickness. According to our observations, all parts of the inflorescence had mostly formed by mid-August.

Mass maturation of fruits was observed at the end of September. The fruit of *Syringa* L. is an oblong double locule pod, and its size and shape vary depending on the variety, so that it is long-oval in varieties having white flowers, and it is shorter and wider in varieties having colorful flowers. There are usually two flat winged seeds in each locule. Double-flowered varieties often have four-locule pod. The weight of 1,000 seeds is 5-9 g and depends on the variety, thus the seed of double-flowered forms is smaller, while common forms have larger seeds and better germination.

Table 4

The sum of effective and active temperatures required for the swelling and budding, blooming and setting of fruits of the genus *Syringa L.* in the botanical garden of VNAU

Variety	The of sum of effective temperatures (over +5°C) required for		The sum of active temperatures (over +10°C) required for			
	bud swelling	budding	mass bloom- ing	completion of blooming	fruit setting	fruit ma- tura- tion
'Buffon',	9.8	55.8	135.3	164.2	470.9	2260.8
'Jeanne d'Arc', 'Montblanc', 'President Grevy', Ruhm von Horstenstein	9.8	51.6	143.6	173.2	411.0	2355.7
'Furst Billow', 'Taras Bulba', 'Madame Lemoine'	38	154.8	225.4	242.1	583.7	2434.5

After leaf falling in the third decade of October, the plants experience the period of winter dormancy. Thus, the growing season of the studied *Syringa L.* varieties in 2018-2019 averaged to 234 days, which was 2-3 weeks longer compared to the average long-term indicators.

The period of winter dormancy depends on the variety and lasts only 1.5-2.5 months. It began in October and ended in early January. Then the plants start a period of forced dormancy, which lasts 65-80 days depending on the temperature. The budding phase was considered as the beginning of the vegetation of the seasonal rhythm of species development.

The development of species of genus *Syringa L.* greatly depends on the sum of effective and active temperatures. Table 4 shows the sum of effective temperatures (above +5 °C) required for swelling and budding and the sum of active temperatures (above + 10 °C) necessary for mass blooming and its completion as well as fruit setting and maturing.

Ecological features of the development of shrubs and peculiarities of blooming of *Syringa L.* genus are the basis for recommendations on the widespread use and establishment of the syringarium.

Having investigated biological, phenological and ecological features of the development of *Syringa L.* genus, we have compiled a list of recommended varieties that can be defined as the most environmentally plastic ones. We have selected them according to the colour of their flowers to create the most vivid and spectacular compositions.

White double- flowered varieties are as follows: [гатунки] 'Abel Chatenay', '[Jeanne d'Arc]', 'Miss Ellen Willmott', 'M-me Casimir Perier', 'M-me Lemoine', 'Obelisk', 'Princesse Clementine'.

Varieties having white common flowers are as follows: [гатунки] 'Gloire de Almeer', 'M-me Florant Stepman', 'Marie Legray', 'Montblanc', 'Vestale', 'Excelens'.

[гатунки] Varieties having blue, mauve-blue and mauve double-flowers are as follows: 'Abel Carriere', 'Alphonse Lavallie', 'Berryer', 'Due de Massa', 'Leon Simon', | 'Mathieu de Dombasle', 'Mister Edward Harding', 'Michel Buchner', 'Leon Gambetta', 'Monument Carnot', 'President Grevy'.

Varieties with blue, mauve-blue, mauve common flowers are as follows: '[Hugo de Vries]', '[вогнище]Hugo Koster', 'Ruhm von Horstenstein', '[бузковий]Sinaihell Lila'.

Varieties having [гатунки] mauve-pink and purple-pink double flowers are as follows: 'Belle de Nancy', 'Emile Lemoine', 'Lavoisier', 'Louis Henry', 'M-me Antoine Biichner', 'M-me Francisque Morel', '[Olivier de Serres]', 'President Poincare', 'William Robinson'.

Varieties with mauve-pink and purple-pink common flowers are as follows: 'Buffon', 'Capitaine Baltet', | 'Praecox Necker', 'Congo'.

Varieties with purple and dark violet flowers are as follows: 'Arthur Wiliiam Paul', 'Charles Joly', 'Frau Katherina Havemeyer', 'Maximowicz', 'Paul Thirion', 'President Loubet', 'Renuncule'.

Varieties with purple and dark mauve common flowers are as follows: 'Andenken an Ludwig Spath', 'Charles X', 'Furst Billow', 'Monge', 'Rcaumur', 'Praecox Cotina'.

Along with the recommended varieties, some domestic varieties produced by L. Kolesnikov are considered to be indispensable in the collection, e.g. 'Mria', 'India', 'Kolesnikov's Olympiad', 'Moscow's Morning'.

Domestic varieties produced by the National Botanical Garden of NAS of Ukraine are the following: 'Vohni Donbasu', 'Bohdan Khmelnytskyi', 'Taras Bulba'.

Thus, most species of *Syringa L.* are undemanding, resistant to adverse environmental conditions, highly ornamental, so they are very suitable for landscaping of urban areas and establishment of the syringarium in the Podillia Botanical Garden.

Conclusions and prospects for further research. *Syringa L.* is light-demanders and grows well in full sunlight, although they can tolerate shading. Therefore, it is classified by the ecological criterion as optional heliophytes. *Syringa L.* also tolerates light shading of buildings and it is resistant to industrial pollution. In case of severe shade, especially under the crown of trees, it grows slowly and blossoms slightly [4-8].

At the same time, in case of severe heat, we have observed that the *Syringa* L. gives smaller inflorescences and blooms quickly. It is believed that the sun in the early afternoon is more useful for *Syringa* L. than the afternoon. Open areas or gentle slopes facing south should be selected for *Syringa* L. planting.

Syringa vulgaris and its varieties are absolutely winter-hardy in the middle zone and withstand the most severe frosts without any harm. Partial freezing is observed only in dry years, when the plants are dehydrated in summer and weakened in winter. We have noted that mostly the buds, which have come out of the state of dormancy in autumn, are damaged by frosts. The root system of grafted and rooted plants tolerate deep and prolonged freezing of soil in low-winter winters. Newly transplanted and poorly rooted seedlings are less resistant to low soil temperatures. Spring frosts can damage the trunks of plants in which sap ascent has already started. In addition, these frosts are harmful to young inflorescence with buds that develop. Flowers that have bloomed at the same time withstand the temperature drop to $-3-4$ °C.

Syringa L. is also characterized by extreme heat resistance, so that it can withstand high positive temperatures without any damage. According to the research by S.S. Lunova (1990), the latter is due to the fact that protein coagulation in its cells occurs only at $50-53$ °C.

Syringa L. is usually very drought resistant. However, sufficient moisture is required for the normal development of the plant species, especially seedlings. In very dry places, it grows poorly.

Excess moisture is also poorly tolerated. Stagnant groundwater has a negative effect on *Syringa vulgaris*. It develops well only on permeable soils. The constant groundwater level should be no higher than 1.5-2 m. If the melt water is stagnating annually in *Syringa* L. area for two- three days, it is doomed to die. Therefore, wetlands and lowlands cannot be used for its planting [7, 8].

All species have a superficial root system and need fertile, loose, fresh, but not wet soil, although *Syringa* L. can grow on different soils, including poor, sandy, and rocky ones. Only very heavy and acid soils are absolutely unsuitable. However, it achieves the best growth and abundant flowering on rich, moist and well permeable soils. According to our observations, in the middle zone the loamy soil enriched with humus, having a weakly acidic and neutral reaction is quite acceptable for *Syringa* L. If the soil is nearly neutral, *Syringa* L. varieties with delicate pink, mauve and blue flowers grow well. Under another soil reaction, their color becomes dull.

Thus, most species of *Syringa* L. are undemanding, tolerant to adverse environmental conditions, highly ornamental, so they are very suitable for the

landscaping of urban areas and creating the syringarium. Based on the previous studies, it is recommended not only to replenish *Syringa* L. collection in the syringarium of Podillia Botanical Garden with early varieties and the varieties having longer blooming periods, but also to use *Syringa* L. for the greening of populated areas. This will let the territories look more aesthetic and improve the environmental condition of the city.

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