

УДК: 712.27:582.916.16 (477.44)
DOI: 10.37128/2707-5826-2020-1-12

**FEATURES OF GROWTH AND
DEVELOPMENT OF THE
GENUS FORSYTHIA VAHL. IN
CONDITIONS OF THE
VINNYTSIA NATIONAL
AGRARIAN UNIVERSITY
BIOSTATIONARY**

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The analysis of the results of phenological observations on 7 phases, which reflect the main moments of seasonal development of plants, was carried out: 1 – the beginning of vegetation, which is characterized by budding and appearance of a cone of leaves; 2 – from the end of the growing season until the phase of massive leaf fall; 3 – the beginning of shooting; 4 – the end of shoot formation; 5 – the beginning of flowering; 6 – flowering completion; 7 – massive ripening of fruits. To compare the rhythm of introducers' development in the new conditions, the European Forsythia, as the most adapted to our conditions variety, was chosen. It was established that under our conditions the vegetation period of Forsythias begins at the late March – early April, when the average daily temperature does not exceed +4 °C, that is, at the general period of vegetation beginning of woody plants. Most of the varieties under study start their vegetation by April, 3, when, according to the long-term average data, the growing season usually begins. The sum of positive temperatures above 0 °C during this period ranges from 3.2 to 17 °C. Forsythia Ovata begins to vegetate a bit later.

As a result of the research, we have determined that at Forsythias under study the shoot formation began in the third decade of April – the first decade of May. This corresponds to the 11.5-18.7 °C average air temperature, with a 25.6-29.8 °C sum of active temperatures above zero. According to duration of the period of shooting and its completion, we have attributed the studied Forsythias to the group with a short (up to 115 days) growth period. According to our observations, in Vinnytsia the flowering periods of Forsythia lasts averagely for 13-15 days. The shortest flowering period – 13 days – was observed at the Forsythia Ovata. The period of fruit formation in the studied Forsythia varieties is rather short (from 18 to 32 days) and depends on the sum of temperatures, terms of the variety flowering, its geographical origin and systematic position.

As a result of the conducted observations, 30% of the annual shoots tips of the Forsythia Suspensa (up to 10-15 cm) were found damaged, but this did not cause a loss of decorativeness, since this species has a high growth rate (50-90 cm), thus there is no reason to claim its complete winter intolerance and low perspectives for its growing. Forsythia Ovata was not bitten by the frost, annual shoots of Forsythia Europaea was slightly frostbitten during the frosts at the end of March 2019 at the level of 15% (5-6 cm).

Study of the given species showed that all the Forsythia plants introduced in the territory of the VNAU biostationary show regular growth of shoots, satisfactory level of winter hardiness, formation of seeds capable of germination in Vinnytsia conditions (F. Sus. var. Sieboldii, F. Sus. var. Fortunei).

Key words: biostationary, botanical garden, forsythia, tolerance, vegetation period, acclimatization, winter hardiness, drought resistance.

Tabl. 7. Fig. 3. Lit. 8.

Problem statement. Decorative landscaping of settlements is a set of actions, which has, first of all, aesthetic and sanitary-hygienic purposes. Landscaping of cities with their large clusters of buildings, has certain problems in creating young and healthy ornamental plantations due to the specific conditions that are formed in the urban area.

With each passing year, the density of urban areas has been increasing, and this becomes a major factor affecting the landscaping features of the territories. Accordingly, the task is to develop new outlines for the placement of ornamental plantations and to form their tolerance to the current conditions of the territory. It is necessary to take into account durability of the species chosen and their decorative characteristics [3].

Ornamental plantations in urban territories affect the climate, as well as the sanitary and hygienic conditions of the city, slow down wind speed, trap dust and various types of sprays, absorb different impurities from the air, reduce noise pollution. Due to the deterioration of the atmospheric air, soil cover and aquatic environment of the city and suburban area, it is important to take into account the biological endurance of the forms used, the demand for such indicators as the degree of contamination of the air basin, soil condition and soil water composition. Today, shrubs are increasingly used for green building as they have both beautiful flowers and decorative foliage. They provide maximum decorative effect during the growing season or at certain periods of the year.

The various forms of Forsythia, which have no worse decorative features than many commonly used in green building aboriginal and introduced plants, are among the promising species. Investigation of the prospects for the use of the genus *Forsythia Vahl.* varieties in urban landscaping based on their morphological, biological and ecological features combination made it possible to identify plants that have a rather high decorative effect in landscaping. Introducing them into the culture will contribute not only to the aesthetic decoration of urban and suburban plantations, but also to the improvement of sanitary and hygienic conditions and will allow to increase the range of ornamental plant species used in urban territories greening.

The genus Forsythia, which currently has about 9 species of different geographical origin, is represented in the decorative landscaping of the territory of the of Vinnytsia National Agrarian University (VNAU) biostationary by mainly three species – the European Forsythia (*Forsythia europaea* Degen & Bald), the Ovate

Forsythia (*Forsythia ovata* Nakai), the Dangling Forsythia (*Forsythia suspensa* (Thunb.) Vahl). The use of new types and forms of ornamental plants in greening urban territory requires scientific substantiation of the choice from the variety range, which is based on the study of their morphological, biological and ecological features, determining the degree of their adaptation and tolerance to the environmental conditions of the area of introduction, establishing the optimal growing conditions and effective ways of reproduction.

Analysis of recent publications. Comprehensive study of the biological and ecological characteristics of the different genus *Forsythia* species ensures their successful use in culture. Problems of introduction and propagation of *Forsythias* in culture have been investigated by such scholars as M.O. Kokhno, A.M. Kurdyuk, P.I. Lapin and others. Honcharenko B.V., Lypa A.L., Molchanov A.A., Kalinichenko O.A., Smirnova V.V. and others [3-4] devoted their works to the present stage of development of the sector of landscape gardening and to the expansion of the species diversity of the introduced beautifully flowering plants and their introduction into the culture.

Materials and methods of the research. The main observations and experimental work were carried out on *Forsythia* shrubs growing in the botanical garden and on the territory of the VNAU biostationary. The experiments were carried out according to conventional methods and were aimed at studying the phenology, features of seasonal development of shoots, abundance of fruiting, winter hardiness, drought resistance. On the base of the long-term testing of different species of the genus *Forsythia* in urban plantations experience, an assessment of the prospects for its further cultivation in Vinnytsia was made. The estimation has been made according to the method proposed by Lapin P.I. and Sidneva S.V. [4]. To estimate the abundance of flowering and fruiting the method of Kalinichenko O.A. [8] was used, where each of the six points (flowering and fruiting) corresponds to a certain percentage of flowers and fruits. The dynamics of annual growth of shoots were studied on the basis of the technique developed by Sergeev L.I., Sergeeva K.A., Melnikov V.K. [7] for three trees of each species. Winter hardiness was determined by the Vekhov's M.K. four-point scale of freezing [4].

Results and Discussion. Biological rhythm is inherent to all plants and is fixed hereditarily. However, introduced plants are gradually producing new rhythms that are genetically predetermined. The more the onset and the rates of phenophases are synchronized with the climatic rhythm of the area of introduction, the more successful is the adaptation of plants. During the period of our observations, the high positive temperatures were fixed in Vinnytsia in spring 2018. But in March and April 2019 negative temperatures were registered (Table 1). Naturally, different temperature conditions of spring influenced the onset and duration of phenological phases, as well as the duration of vegetation period of *Forsythias*. Analysis of the results of phenological observations was carried out in 7 phases, which reflect the main moments of seasonal development of plants: 1 – the beginning of vegetation,

Table 1

Air temperature in Vinnytsia in spring, °C

Year	Temperature	Months		
		March	April	May
2018	average	1,1	8,4	21,5
	minimal	-9,2	- 4,0	1,5
2019	average	2,8	11	13,2
	minimal	-11,0	-4,0	3,2

Source: based on own research

for which the phase of budding and the appearance of a cone of leaves is characteristic; 2 – from the end of the growing season to the phase of massive leaf fall; 3 – the beginning of shooting; 4 – the end of shooting; 5 – the beginning of flowering; 6 – the completion of flowering; 7 – mass ripening of fruits. Simultaneously, the sums of positive (above 0 °C) and effective (above 10 °C) temperatures (average data for the years 2018-2019) have been determined, which are presented in (Table 2).

To compare the rhythm of the introducers development in new conditions, we took *Forsythia Europaea* as the most adapted to our conditions variety. Plants at which vegetation or any other phase of development begins or ends simultaneously with the aboriginal species were attributed to the mid-term phenological group; plants that start vegetation earlier or later than the native species – accordingly to the early or late phenological group. By the dates of the growing season beginning, the studied *Forsythia* plants were distributed to the early phenological group, and by the terms of vegetation ending – to the group of middle and late completion of the growing season (see Table 2).

Table 2

Vegetation period duration of the European Forsythia in conditions of Vinnytsia

Variety	Budding, average dates /The sum of positive temperatures for the given period, °C	Massive leaf fall/ The sum of effective temperatures for the given period, °C	Vegetation period duration, days	Phenological groups
<i>Forsythia europaea</i> Degen & Bald	27.03-03.04 / 132	20.10-30.10 / 1980	216	EL
<i>Forsythia ovata</i> Nakai	25.03-6.04 / 108	12.10-28.10 / 1917	227	EL
<i>Forsythia suspensa</i> (Thunb.) Vahl	8.04-20.04 / 178	07.10-15.10 / 2100	187	MM

Source: based on own research

It was established that in our conditions the beginning of Forsythia vegetation takes place at the late March – early April, when the average daily temperature does not exceed $+4^{\circ}\text{C}$, that is, at the beginning of the general vegetation period of woody plants. Most of the species studied start vegetation earlier than April, 3, when according to the average long-term data, the growing season begins. The sum of positive temperatures above 0°C during this period ranges from 3.2 to 17°C . Forsythia Ovata begins to grow later (Fig. 1).

The sharp fluctuations in temperature, as a rule, do not affect the plants. However, in February 6-9, 2019, after the $+6 - +8^{\circ}\text{C}$ day temperature rise, the weather changed dramatically and the temperature dropped to -15°C . Frostbitten buds were observed on the plants of *Forsythia Suspensa*, and the tips of the shoots of *Forsythia Europaea* and *Ovata* grew brown.

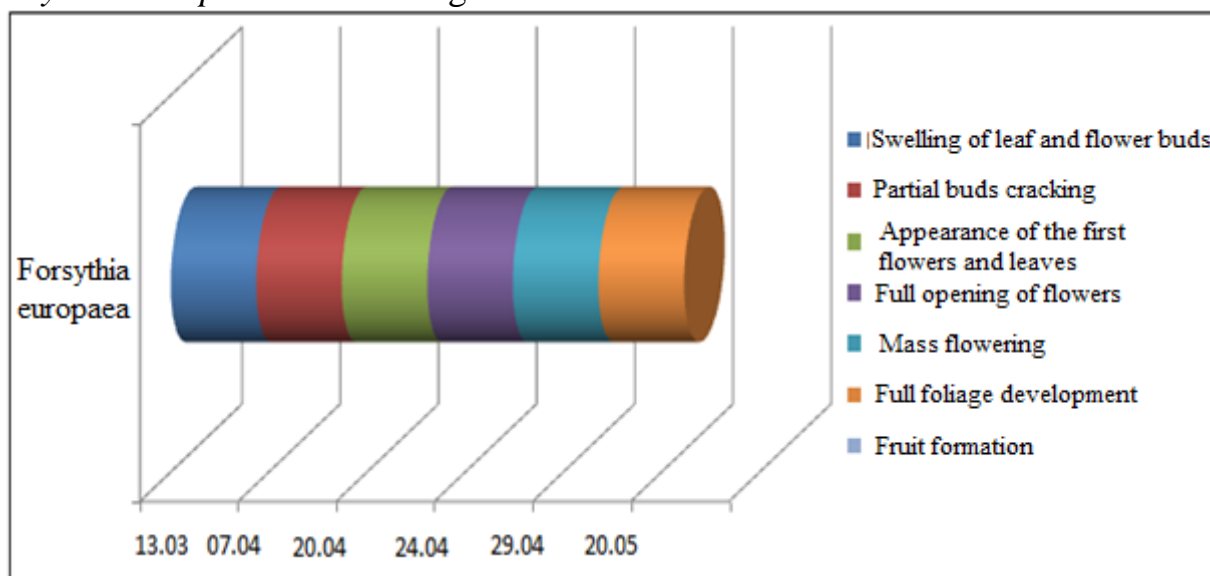


Fig. 1. Onset and passing of phenophases of the European Forsythia during 2018-2019 (biostationary of VNAU)

Source: based on own research

Full foliage development at most species occurs in the third decade of April – the first decade of May.

Based on the growing season completion, the species under study are classified to the phenogroup with medium and late terms. The average calendar dates of massive leaf fall are October 7-15. Until this time, the sum of positive temperatures above 0°C makes up 17°C ; the sum of effective temperatures – from 10°C to 21°C .

The average calendar terms for the late vegetation completion groups are October, 20-30. The sum of positive temperatures above 0°C is 13°C ; the sum of effective temperatures – from 10°C to 19°C .

Thus, in terms of the beginning and the end of vegetation period Forsythias are classified into two phenological groups: MM – middle start and middle completion of

vegetation (*Forsythia Suspensa*), EL – early start and late completion of vegetation period (*Forsythia Europaea* and *Ovata*).

As a result of research, a relationship between the period of the beginning of Forsythias vegetation, the sum of temperatures above 0 °C and the latitude of the natural area was established: the farther north geographically is the natural area of the species, the earlier the period of vegetation begins in our conditions and the less is the sum of temperatures above 0 °C required for the beginning of vegetation [4].

The first from the state of rest comes *Forsythia Europaea*, later – *Forsythia Ovata* and *Forsythia Suspensa*. The European Forsythia has the same terms of vegetation completion, the end of the growing season is almost identical to that of the local varieties, or slightly beyond it, what sometimes can cause damage to the tips of their annual shoots at the end of winter. Despite this fact, the plants were flowering and fruiting. The average vegetation period duration of the species under study is about 210 days.

The beginning of shoots growth at the species under observation takes place in the third decade of April – the first decade of May. This corresponds to the average air temperature of 11.5-18.7 °C, with the 25.6-29.8 °C sum of active temperatures above zero. By the duration of the shooting period and the term of its completion, the studied Forsythia plants were attributed to the group with a short (up to 115 days) growth period.

A characteristic feature of *Forsythia Europaea* is the availability of two orders of shoots branching and two periods of growth. The first, most intensive period of growth, ends in the third decade of June, and the second – in the second decade of July. A valuable biological feature of Forsythia, for which they are used in landscaping, is their annual and abundant flowering [7]. *Forsythia Europaea* has golden flowers with short petals, gathered in axillary drooping tassels. The tassels are formed in the axils of the upper pair of leaves that have grown into a disk, and sometimes each whorl of six flowers has its own disk. Among all the types of Forsythias that were studied *Forsythia Ovata* breaks into blossom the latest (Fig. 2).



Fig. 2. Flowering of *Forsythia Ovata* on the territory of the VNAU biostationary

Source: based on own research

Our experiments have shown that, depending on the meteorological phenomena of each particular year, the dates of the onset of individual phenophases can be significantly shifted, but the sequence of their passing is maintained. The average flowering terms of the studied Forsythia varieties is given in (Table 3).

Table 3

Terms of Forsythias flowering in Vinnytsia

Variety	Average date of flowering		Average duration of the period of flowering, days	Grade of flowering
	beginning	end		
Forsythia europaea Degen & Bald	05.04	19.04	14	5
<i>Forsythia ovata</i> Nakai	07.04	20.04	13	4
<i>Forsythia suspensa</i> (Thunb.) Vahl	6.04	21.04	15	5

Source: based on own research

In Vinnytsia conditions, Forsythias bloom from 13 to 15 days on average. The shortest flowering period shows *Forsythia Ovata* – 13 days.

The next stage in the development of Forsythias is fruiting. Forsythias bear fruits annually. Individual fruits appear in 3-5 years after sowing the seeds. Since the 5-7th year of age the yield begins to increase gradually. Maximum yielding capacity Forsythia shrubs reach at the age of 8-9 years. The period of fruit formation of the investigated types of Forsythia varieties is rather short (from 18 to 32 days) and depends on the sum of temperatures, terms of flowering of the variety, its geographical origin and systematic position (Table 4).

Table 4

Terms of Forsythia fruits ripening in conditions of Vinnytsia

Variety	Average dates of fruits ripening		Number of days from the beginning to massive ripening of fruits
	beginning	massive	
Forsythia europaea Degen & Bald	20.04	15.06	25
<i>Forsythia ovata</i> Nakai	22.04	10.05	18
<i>Forsythia suspensa</i> (Thunb.) Vahl	24.04	26.05	32

Source: based on own research

In Vinnytsia conditions the fruits of *Forsythia Suspensa*, shown in Fig. 3, ripen later than all (the end of April – the end of May).



Fig. 3. Fruiting of *Forsythia Ovata* (VNAU biostationary)
Source: based on own research

Characteristic of the reproductive capacity of the studied Forsythias in Vinnytsia conditions are shown in Table 5.

Table 5

**The age of reproductive ability onset in the studied
Forsythia varieties in Vinnytsia conditions**

Variety	Age of entry into the generative phase, years	Stage (after Kalinichenko O.A.), grades	
		flowering	fruiting
<i>Forsythia europaea</i> Degen & Bald	4	5	4
<i>Forsythia ovata</i> Nakai	5	5	3
<i>Forsythia suspensa</i> (Thunb.) Vahl	5	5	3

Source: based on own research

From the age of 15, biological capabilities for fruiting begin to decline. *Forsythia* is not a durable species, it can't be grown in one and the same place for more than 10-15 years.

All types of the studied *Forsythias* can flower and bear fruits in conditions of Vinnytsia. Good level of fruit bearing (4 points) demonstrated *Forsythia Europaea*. *Forsythia Ovata* and *Suspensa* fruit slightly worse (3 points). All kinds of *Forsythias* displayed abundant blooming every year (5 points).

The main limiting factors for the species studied in Vinnytsia are low temperatures and frosts, as well as the whole system of external climatic effects that plants have to experience during winter period.

The actual winter hardiness was established on the 5-point Vekhov's scale of frost injury [4]. As a result of the conducted observations (Table 6), 30 % of the tops of annual shoots of *Forsythia Suspensa* (up to 10-15 cm) were found to be damaged, but this did not cause a loss of decorative effect, since this species demonstrates a strong growth (50-90 cm), thus there is no reason to claim its complete lack of frost resistance and small prospects for introduction. *Forsythia Ovata* was not bitten by the frost, *Forsythia Europaea* had slight frost injuries of annual shoots during the frosts at the end of March, 2019 at the level of 15 % (5-6 cm). Due to the active growth of shoots *Forsythia* formed a well-developed crown, which is characteristic of the species.

Table 6

Study of Forsythia varieties winter hardiness in Vinnytsia conditions by the field method (after Vekhov M.K.)

Variety	Points by the years		Average value
	2018	2019	
<i>Forsythia europaea</i> Degen & Bald	3	3	3
<i>Forsythia ovata</i> Nakai	4	4	4
<i>Forsythia suspensa</i> (Thunb.) Vahl	3	3	3

Source: based on own research

Having analyzed the results of the research we concluded that the highest actual winter hardiness in Vinnytsia conditions showed *Forsythia Ovata*.

Thus, according to the degree of frost resistance, we divided Forsythias into the following groups:

- high frost resistant (up to 15 % of tissues damaged) – *Forsythia Europaea* and *Ovata*;

- medium frost resistant (15 to 25 % of the tissues are damaged) – *Forsythia Suspensa*.

The proposed division is rather nominal, since the climatic conditions, plant growth location and its age will also have an impact on winter and frost resistance. According to the observations, in severe winters the annual shoots of Forsythias become frostbitten as their growth lasts until the late autumn, and they do not have time to become fully lignified. But next spring *Forsythia*'s shootings quickly grow back. It should be noted that flower buds are only occasionally damaged by the frost.

Therefore, the results of the actual winter hardiness of *Forsythia* varieties study indicate their high winter resistance in conditions of Vinnytsia. However, *Forsythia Suspensa* in some cold winters may be damaged by the frost, but due to the strong

annual growth, it restores the shape which is characteristic of the species.

To assess the drought resistance of Forsythias, water content of the leaves and the intensity of their transpiration were determined twice during the growing season. The withering method was also used, which determines the deficiency of water, relative turgor and water-holding capacity of the leaves just removed from the plants and after 1.5 hours of wilting in a thermostat at a 35 °C temperature.

Measurements were made twice (in 2018 and 2019) at the end of the growing season (the third decade of August). More distinct differences between varieties were noted in 2018. It was due to the arid 2018 summer in Vinnytsia compared to the 2019 summer: in the first case, from June to August inclusive, the average rainfall made up only 65 % of its average long-term values, and in the second – 90 %.

Our studies of the dynamics of the total water content in the leaves showed that at *Forsythia Europaea* the amount of total water until the end of the growing season remains virtually unchanged, at *Forsythia Suspensa* and *Ovata* it decreases by 3-10 % (Table 7).

Table 7

Total water content in leaves of Forsythia, % per dry weight

Variety	III decade of May	III decade of August
Forsythia europaea Degen & Bald	65,5 ± 0,6	63,2 ± 0,34
<i>Forsythia ovata</i> Nakai	64,6 ± 0,35	54,1 ± 0,32
<i>Forsythia suspensa</i> (Thunb.) Vahl	74,5 ± 0,54	71,2 ± 0,36

Source: based on own research

A significant decrease in the amount of total water at the end of August in the leaves of *Forhsythia Ovata* (by 15.6 %) is explained by the beginning of the necrotic processes in them. Literary evidence indicates that less drought-tolerant plants in conditions of the reduced moisture supply have a more sharp decrease in the total water content of the leaves.

Conclusions. It was established that in Vinnytsia conditions Forsythia's vegetation begins at the end of March – early April, when the average daily temperature exceeds a +4 °C temperature mark; at most Forsythias cultivated in the city and suburban areas of Vinnytsia flowering season is completed by April, 3.

It was found that by the duration of the shoot growth period and the terms of its completion, the studied Forsythias belong to the group with a short (up to 115 days) growing period. Duration of flowering period of different varieties of Forsythia varies from 13 to 15 days, and the period of fruit formation – from 18 to 32 days. This makes it possible to obtain fit seeds resulted from breeding or hybridization in a short time.

3. In the course of the winter hardiness study of *Forsythia* varieties it was established that *Forsythia Europaea* and *Ovata* are best adapted to the negative climatic conditions. They withstand low temperatures up to -20°C , with a 15-25 % proportion of damaged tissues. *Forsythia Suspensa* shows the worst adaptation to low temperatures, what is manifested in the injury of annual shoots by the frost. However, this does not cause a loss of decorativeness, since the species has a strong growing capacity.

4. *Forsythia Europaea* is most commonly cultivated in Vinnytsia's parks, as it has a steadier intensive growth, blooms and bears fruit annually, what proves its successful introduction and a high degree of acclimatization to the conditions of the given growing environment.

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АНОТАЦІЯ

ОСОБЛИВОСТІ РОСТУ ТА РОЗВИТКУ ВИДІВ РОДУ FORSYTHIA VANH. В УМОВАХ БІОСТАЦІОНАРУ ВНАУ

Аналіз результатів фенологічних спостережень проводився по 7 фазам, які відображають основні моменти сезонного розвитку рослин: 1 – початок вегетації, за який прийнята фаза розтріскування бруньки і поява конусу листя; 2 – закінчення вегетації – фаза масового листопаду; 3 – початок росту пагонів; 4 – закінчення росту пагонів; 5 – початок цвітіння; 6 – закінчення цвітіння; 7 – масове дозрівання плодів. Для порівняння ритму розвитку інтродуцентів в нових умовах ми взяли форзицію європейську, як найбільш пристосовану до наших умов. Ми встановили, що в наших умовах початок вегетації форзиції розпочинається в кінці березня – на початку квітня, коли середньодобова температура не перейшла через відмітку +4 °C, тобто на початку загального вегетаційного періоду деревних рослин. Більшість досліджуваних видів починають вегетацію до 3.04, коли за середньо-багаторічними даними починається період вегетації. Сума позитивних температур вище 0 °C в цей період становить від 32 до 17 °C. Пізніше цього строку розпочинає вегетацію форзиція яйцевидна.

У результаті наших досліджень ми визначили, що початок росту пагонів у досліджуваних форзицій спостерігається у третій декаді квітня – першій декаді травня. Цьому відповідає середня температура повітря 11,5-18,7 °C, при сумі активних температур вище нуля 25,6-29,8 °C. За тривалістю періоду росту пагонів і строками його закінчення досліджувані форзиції ми віднесли до

групи з коротким (до 115 днів) періодом росту. За нашими спостереженнями в умовах м. Вінниці цвітіння форзицій в середньому триває від 13 до 15 днів. Найменший період цвітіння виявлено у форзиції яйцевидної – 13 днів. Період формування плодів у досліджуваних видів форзиції досить короткий (від 18 до 32 днів) і залежить від суми температур, строків цвітіння виду, його географічного походження та систематичного положення. В результаті проведених спостережень виявлено пошкодження 30 % верхівок однорічних пагонів форзиції повислої (до 10-15 см), що однак не стало причиною втрати декоративності, оскільки даний вид має сильний приріст (50-90 см), тому немає підстави стверджувати про цілковиту незимостійкість та малу перспективність даного виду. Форзиція яйцевидна обмерзання не мала, форзиція європейська мала незначне обмерзання однорічних пагонів під час заморозків у кінці березня 2019 року на рівні 15 % (5-6 см).

Дослідження даних видів свідчать про те, що всі інтродуковані на території біостаціонару рослини форзицій мають регулярний приріст пагонів, задовільну зимостійкість, деякі з них (*F. sus. var. sieboldii*, *F. sus. var. fortunei*) в умовах Вінниці утворюють схоже насіння.

Ключові слова: біостаціонар, ботанічний сад, форзиції, толерантність, вегетаційний період, акліматизація, зимостійкість, посухостійкість.

Tabl. 7. Fig. 3. Lit. 8.

АННОТАЦИЯ

ОСОБЕННОСТИ РОСТА И РАЗВИТИЯ ВИДОВ РОДА *FORSYTHIA* VANL. В УСЛОВИЯХ БИОСТАЦИОНАРА ВНАУ

Анализ результатов фенологических наблюдений проводился по 7 фазам, которые отражают основные моменты сезонного развития растений: 1 – начало вегетации, за который принято фаза растрескивания почки и появление конуса листьев; 2 – окончание вегетации – фаза массового опадания листьев; 3 – начало роста побегов; 4 – окончание роста побегов; 5 – начало цветения; 6 – окончания цветения; 7 – массовое созревание плодов. Для сравнения ритма развития интродуцентов в новых условиях мы приняли форзицию европейскую, как наиболее приспособленную к нашим условиям.

Мы установили, что в наших условиях начало вегетации форзиции начинается в конце марта – начале апреля, когда среднесуточная температура не перешла через отметку +4 °С, то есть в начале общего вегетационного периода древесных растений. Большинство исследуемых видов начинают вегетацию до 3.04, когда по средне-многолетним данным начинается период вегетации. Сумма положительных температур выше 0 °С в этот период составляет от 32 до 17 °С. Позже этого срока начинает вегетацию форзиция яйцевидная. В результате наших исследований мы определили, что начало роста побегов в исследуемых форзициях наблюдается в третьей декаде апреля – первой декаде мая. Этому соответствует средняя температура воздуха 11,5-18,7 °С, при сумме активных

температур выше нуля 25,6-29,8 °С. По продолжительности периода роста побегов и сроками его окончания исследуемые форзиции мы отнесли к группе с коротким (до 115 дней) периодом роста. По нашим наблюдениям в условиях г. Винница цветения форзиций в среднем длится от 13 до 15 дней. Наименьший период цветения обнаружено в форзиции яйцевидной – 13 дней. Период формирования плодов в исследуемых видов форзиции достаточно короткий (от 18 до 32 дней) и зависит от суммы температур, сроков цветения вида, его географического происхождения и систематического положения.

В результате проведенных наблюдений выявлено повреждение 30 % верхушек однолетних побегов форзиции повисшей (до 10-15 см), что однако не стало причиной потери декоративности, поскольку данный вид имеет сильный прирост (50-90 см), поэтому нет основания утверждать о полной незимостийкости и малой перспективности данного вида. Форзиция яйцевидная обледенения не имела, форзиция европейская имела незначительное обледенения однолетних побегов во время заморозков в конце марта 2019 на уровне 15% (5-6 см). Исследование данных видов свидетельствуют о том, что все интродуцированные на территории биостационара растения форзиций имеют регулярный прирост побегов, удовлетворительную зимостойкость, некоторые из них (*F. sus. Var. Sieboldii*, *F. sus. Var. Fortunei*) в условиях Винницы образуют схожие семена.

Ключевые слова: биостационар, ботанический сад, форзиции, толерантность, вегетационный период, акклиматизация, зимостойкость, засухоустойчивость.

Tabl. 7. Fig. 3. Lit. 8.

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