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**SPECIFIC FEATURES OF
INTRODUCTION AND PROSPECTS
OF THE GENUS ROBINIA L. USE IN
LANDSCAPING OF VINNYTSA**

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*After analyzing data from the literature sources, it was found that *R. viscosa*, which ranks second after *R. pseudoacacia* in terms of the introduction process involvement, is characterized by less winter hardiness. According to Kachalov A.A. [10], *R. viscosa* proved its winter-hardiness in conditions of the east, northern and middle parts of Ukraine and Transcarpathia. In Vinnytsia conditions, it withstands frosts up to -30°C . In Moldova (Chisinau *R. pseudoacacia* tolerates winter well and bears fruit. As a result of the research, it was established that winter hardiness of the genus *Robinia L.* species in conditions of introduction was 1-2 (3) points. The introduced genus *Robinia L.* species and forms, which were objects of the research, in conditions of Vinnytsia were able to withstand negative temperatures (up to -32°C) without significant damage. According to the obtained data, it was established that the genus *Robinia L.* representatives belong to the drought-resistant species and are able to withstand a long period of dry and rainless weather. The level of drought resistance of the studied species and forms according to the Pyatnytskyi S.S. scale equals to 4-5 points.*

*According to the Pyatnytskyi S.S. light-demanding scale, *R. pseudoacacia* belongs to the most photophilous tree species – heliophytes. It was also defined that such species as *R. pseudoacacia*, *R. holdtii*, *R. ambigua* are fully acclimatized, *R. viscosa*, *R. luxurians* are well acclimatized. Their acclimatization numbers are: *R. pseudoacacia* = 100, *R. viscosa* = 86, *R. luxurians* = 86, *R. holdtii* = 95, *R. ambigua* = 94. Having analyzed the studied species in terms of their decorative characteristics, it was found that the time of decorativeness in the genus *Robinia L.* species is divided into two periods: the first is the flowering one, and the second – the time of leaf pigmentation change. According to our observations, the studied representatives received 5 points of decorativeness according to the Kalinichenko O.A. method in the following time periods: 1) from 05.15.2022 to 06.15.2022 – the time of flowering; 2) from 18.08.2022 to 20.09.2022 – leaf colour change.*

Key words: introduction, decorativeness, landscaping, perspective, urbanized area, *Robinia L.*

Table 4. Fig. 5. Lit. 13.

Problem statement. One of the urgent issues faced by mankind is the effective use and preservation of plant resources of the Earth's natural dendroflora in conditions of global degradation and changes in the natural environment due to the influence of anthropogenic activity. One of the ways to solve such a problem in Ukraine is introduction and acclimatization of plants, which contribute to their spread in new territories and improve ecological conditions of Ukrainian landscapes.

Robinia L. species do not grow in the natural dendroflora of Ukraine. In conditions of Vinnytsia city, only the *R. pseudoacacia* species is quite common. *R. viscosa* and several forms of *R. pseudoacacia* can be found in some arboretum collections, botanical gardens, and landscaping objects. Wider distribution is hindered by the ignorance of specialists about the species and form diversity of the genus, lack of sufficient knowledge about biological and ecological properties, the study of

biological and ecological characteristics and adaptation possibilities of the genus *Robinia* L. species in conditions of introduction seems to be quite relevant [6-7].

Analysis of recent publications. A number of domestic and foreign scientists dealt with the issue of expanding the species composition through introduction of the genus *Robinia* L. new species and their use in landscaping. A significant contribution to the study of this species was made by Mazurenko V.D. [4-6], whose scientific works highlighted the peculiarities of systematization, morphology, seed productivity, methods of reproduction of the genus *Robinia* L. species. In the scientific papers of Dirr M., Hryniewicz-Sudnik J., Huntley J.C. [11-13], the issue of effective reproduction and the use of the genus *Robinia* L. representatives in landscaping has been revealed.

Methods of research. Seasonal development of the genus *Robinia* L. species was investigated with the help of the observation method and reference data from the previous years. The sum of active temperatures, necessary for the passage of all phases of development of the genus *Robinia* L. species, was calculated from the moment when the air temperature reached +10°C [10].

To identify the resistance of the genus *Robinia* L. species and forms to low temperatures in conditions of Central Ukraine in 2021-2022 winter period, observations by means of the Sokolov S.Ya. methodology were conducted [2]. Assessment of the prospects for the *Robinia* L. species introduction was carried out using the method of integral numerical assessment of the viability and prospects of introduction of tree species based on visual observations (Lapin P.I. and Sidneva S.V. 6-point scale) [3]. The most important indicators for the introduction were taken into account: the degree of shoots maturation, winter resistance, habitus preservation, shoot-forming ability, regularity of shoot growth, ability to generative development, methods of reproduction in culture. Table 1 presents methods for determining winter and drought resistance and decorativeness of the genus *Robinia* L. representatives [13].

Various computer programs were used to create models. Construction of graphs was carried out with the aid of the Microsoft Excel program.

Research results. In order to determine the level of introduction of this or that representative in conditions of a certain territory, it is necessary, first of all, to determine its relationship with the main environmental factors of the area. Thus, the features of the relationship of the genus *Robinia* L. representatives with the certain factors, namely: winter hardiness, light tolerance, drought resistance were investigated.

One of the main criteria for the success of introduction is the resistance of plants to a complex of adverse factors in the autumn-winter period, especially to the extremely low temperatures. This is confirmed by the works of many scientists. The ability of plants to withstand all those factors is called winter hardiness. Frost resistance is only part of a whole complex of them. Winter hardiness of many *Robinia* L. species and forms determines the perspective of their introduction in conditions of Central Ukraine.

Table 1

**Methods for determining winter hardiness, drought resistance and degree of
decorativeness**

Winter hardiness (according to the Sokolov S.Ya. method)	Drought resistance (according to the Pyatnytskyi S.S. method)	Decorativeness (according to the Kalinichenko O.A. method)
1 – the plant is completely winter-hardy; 2 – the tops of one-year shoots are frosted up; 3 – one-year shoots are frosted up along their entire length; 4 – two-year-old branches are frosted up; 5 – three-year-old branches are frosted up; 6 – the plant freezes to the level of the snow cover; 7 – the plant freezes to the root neck, but grows up; 8 – the plant dies during wintering	5 points – plants do not react to drought; 4 points – during drought only loss of turgor in leaves and shoots is observed: the edges of the leaves drop, the leaf plates shrivel, the petioles of leaves and tops of the shoots wither; 3 points – most leaves are partially damaged: leaf plates locally change color (turn yellow or brown); 2 points – most leaves dry completely, young shoots or tops – partially; 1 point – leaves fall, young shoots are damaged, skeletal branches and root system remain viable; 0 points – the plant dies.	1 point – the level decorativeness is negative (the appearance of plants significantly reduces not only their general attractiveness, but also the decorativeness of the surrounding plant composition); 2 points – the level of decorativeness is zero (the signs of attractiveness are imperceptible, which makes the specimen obscure on the background of a certain plant composition); 3 points – insignificant decorativeness (decorative characteristics are noticeable, but are indistinct, which does not contribute to the attractiveness of the plant group as a whole); 4 points – sufficient level of decorativeness (decorative characteristics are obvious, there observed a clear distinction of the plant among the decorative composition); 5 points – high level of decorativeness (the attractiveness of the object is undeniable and significantly increases the decorativeness of the entire plant composition).

Source: based on own research

The frosting of shoots reduces the decorative characteristics of plants, especially of the forms that have become now an integral element in landscaping of streets, gardens and parks [8].

R. viscosa, which ranks second in the introduction process after *R. pseudoacacia*, is characterized by less winter hardiness. According to Kachalov A.A. [10], *R. viscosa* showed its winter hardiness in culture in the east, northern and central parts of Ukraine and Transcarpathia. In conditions of Vinnytsia city, it withstands up to -30°C frosts. In Moldova (Chisinau), *R. pseudoacacia* is winter-hardy and bears fruit. In conditions of Latvia, sometimes occur very frosted up ones.

Regarding the introduction of *R. luxurians*, literary sources say, that the species is considered to be quite winter-hardy and capable of bearing fruit in conditions of Central Ukraine, Crimea, Central Asia (Tashkent) [6]. To identify the resistance of the genus *Robinia* L. species and forms to low temperatures in conditions of the Right Bank Forest-Steppe of Central Ukraine, *Robinia* L. plantations of various ages, which grow in arboretums, in the botanical garden “Podillia” of VNAU, on the streets and in the vicinity of Vinnytsia city were involved into the research. Indicators of winter hardiness of plants often depend on the weather conditions of the previous growing year [7].

Late spring and cold, rainy summer sometimes mean that trees do not have time to finish their vegetative development by autumn. Summer drought often exhausts

plants and they also stay unprepared for the winter period. As the authors note, the high frost resistance of woody plants is ensured by the shoots maturation, which is associated with the process of the wood cell membranes lignification. This process is greatly facilitated by soil drought.

The *R. p.* «Decaisneana» decorative form demonstrated such winter hardiness, while *R. p.* «Umbraculifera», *R. p.* «Pyramidalis» and *R. ambigua* and *R. luxurians* species had lower one. Every year, significant damage to one-year shoots was noted in *R. viscosa* and insignificant – in *R. holdtii* and *R. p.* «Unifoliola». Examination of annual *R. pseudoacacia*, *R. p.* «Decaisneana», *R. p.* «Unifoliola», *R. viscosa*, *R. luxurians* plants indicated that winter hardiness of their shoots equaled 1-3 points. In the second year, plants of all the mentioned above taxa acquired higher resistance to low air temperatures [4].

Therefore, early autumn and late spring frosts are especially dangerous for the species and forms of the *Robinia* L. genus. Over the years of observation, their winter hardiness in the conditions of introduction was 1-2 (3) points. The introduced genus *Robinia* L. species and forms, which served us as objects of research, in conditions of Vinnytsia city withstood temperatures below -32°C without significant damage.

Thus, as a result of our observation, certain points were obtained in relation to the winter hardiness of individual representatives of the genus *Robinia* L., which are presented in Table 2. Determination of the winter hardiness score was performed according to the Sokolov S.Ya. method [2].

Table 2

Winter hardiness of *Robinia* L. species in conditions of Vinnytsia city (according to the Sokolov S.Ya. method), (2020-2022 years)

Species	Temperature regime, °C / winter hardiness point		Average
	-10...-15	-20...-25	
<i>R. pseudoacacia</i>	1	1	1
<i>R. viscosa</i>	3	1	2
<i>R. luxurians</i>	1	1	1
<i>R. ambigua</i>	2	2	2
<i>R. holdtii</i>	1	1	1

Notes:

1. Source: formed on the basis of own research

According to the obtained data, it can be stated that representatives of the genus *Robinia* L. have adapted quite well to the winter period conditions of the area of introduction.

Considering the issue of the relationship of the genus *Robinia* L. to moisture supply, it should be noted that in recent years the occurrence of very dry periods in the territory of Central Ukraine, including Vinnytsia region, were observed. Thus, in order to assess the perspective of introduction and active use of the studied representatives, it is necessary to determine their drought resistance [5].

As to the moisture need and the degree of drought tolerance, *R. pseudoacacia* belongs to mesophytes, hemixerophytes, however, most authors consider it to be one

of the most drought-resistant tree species – xerophytes. The fairly high adaptability of species of the genus *Robinia* L. to arid environmental conditions is characterized by the presence of xeromorphism features in them, namely: pubescence of leaves and shoots, reduction of stipules into spines, the ability to regulate the movement of the closing cells of the stomata, sharply reducing transpiration in drought conditions; the ability to change the position of the leaves in relation to the sun (they are turned with their edge, due to which the leaves rarely heat up above the air temperature, which reduces the danger of overheating); shedding part of the leaves in severe drought [4-5].

Among the biochemical mechanisms of protection against drought in *R. pseudoacacia*, the ability to split (proteolysis) high-molecular proteins into simple bypasses is distinguished. Due to the previous year reserves, cambium activity in *R. pseudoacacia* begins in early spring, what resulted in less sensitivity to hot, dry periods. In arid conditions, the extensive horizontal root system of *Robinia* with its numerous deep-lying anchor roots plays an especially important role. It is known that xerophytes have a much smaller number of stomata compared to moisture-loving species and are able to reduce their transpiration to a minimum in drought conditions. The study of the *R. pseudoacacia* stomata showed that they are small in size and placed rather sparsely. One of the ways of a certain species trees adaptation to transpiration reduce in dry periods is full or partial leaf fall. *R. pseudoacacia* can stop vegetation and shed leaves only in the driest periods caused by the absence of rain, especially in late summer. Using the Pyatnytskyi S.S. methodology, we determined the score of drought resistance of the genus *Robinia* L. representatives in conditions of Vinnytsia city (Table 3).

Table 3

**Drought resistance of the *Robinia* L. genus in conditions of Vinnytsia city
(according to the Pyatnytskyi S.S. method), (2020-2022)**

Species	Years of observation		Average
	2020	2022 (own research)	
<i>R. pseudoacacia</i>	5	5	5
<i>R. viscosa</i>	4	4	4
<i>R. luxurians</i>	5	5	5
<i>R. ambigua</i>	4	5	4,5 (5)
<i>R. holdtii</i>	4	4	4

Notes:

1. Source: formed on the basis of own research

According to the obtained data, we can state that representatives of the genus *Robinia* L. belong to the drought-resistant species and are able to withstand a long period of dry and rainless weather.

According to the Pyatnytskyi's S.S. light-demanding scale, *R. pseudoacacia* belongs to the most light-loving tree species – heliophytes. Scientific sources confirm that members of the genus *Robinia* L. belong to the light-demanding species, but some sources demonstrate different need for light intensity in *R. pseudoacacia* and *R. viscosa* [5].

In order to determine the light-demanding and shade-tolerant species of the genus *Robinia* L., a number of experiments were conducted, the results of which determined the effect of light intensity on the growth and development of one-year seedlings of the genus *Robinia* L. species.

Comparison of the critical illumination levels for *Robinia* L. and other tree species confirms that the studied *Robinia* L. species belong to the exceptionally light-demanding ones. Moreover, in *R. pseudoacacia*, the critical level occurs at a higher light intensity than in *R. luxurians* and *R. viscosa*.

Summarizing the obtained research results, we confirm that the introduced genus *Robinia* L. species belong to the group of heliophyte plants and differences as to this indicator between the representatives of the genus are insignificant.

In order to evaluate the prospects for the *Robinia* L. species introduction, the method of integral numerical assessment of the viability and prospects of introduction of tree species based on the Lapin P.I. and Sidneva S.V. visual observations was used. It takes into account the most important for introduction indicators, in particular, the degree of shoot maturation, level of winter hardiness, preservation of habitus, shoot-forming ability, regularity of shoot growth, ability to generative development, methods of reproduction in culture. The highest level of plant viability is estimated as 100 points. The sum of the average score is an integral numerical expression of the plant's viability in the given conditions. The higher is the sum of points, the higher will be the viability and perspective of the species introduction.

The results of our research on the main viability indicators of the introduced *Robinia* L. species, allow assessing the prospects of introduction in conditions of Vinnytsia city (Table 4). Table 4 shows that all the studied introduced *Robinia* L. species have high viability and are quite promising tree species for the use in culture in Central Ukraine [8].

Table 4

**Prospects of the certain genus *Robinia* L. species introduction
in conditions of Vinnytsia (2021-2022)**

Indicators	Species				
	<i>R. pseudoacacia</i>	<i>R. viscosa</i>	<i>R. luxurians</i>	<i>R. ambigua</i>	<i>R. holdtii</i>
Shoot maturation	20	15	15	20	20
Winter hardiness	25	15	20	20	25
Drought resistance	5	4	5	5	4
Growth in height	5	4	5	5	4
Ability to generative development	25	25	25	25	25
Methods of reproduction	10	8	9	10	8
Keeping of the growth form	10	10	7	10	8
The sum of viability indicators	100	86	86	95	94
Group of introduction perspectiveness **	I – QP	II – P	II – P	I – QP	I – QP

Notes:

1. Source: formed on the basis of own research;

** P – promising; QP – quite promising.

With the use of the Kohno M.A. acclimatization number method, the degree of acclimatization of the introduced *Robinia* L. species was determined. It is the sum of indicators of growth, generative development, winter hardiness and drought resistance of plants [2]. Indicators were evaluated on a 5-point scale and multiplied by the weight coefficient of this characteristic.

The sum of indicators gives an integral value – the acclimatization number A. Its largest value is A = 100, the smallest – A = 20. Thus, A = 100 means full acclimatization, A = 80 – good, A = 60 – satisfactory, A = 40 – poor, A = 20 – no acclimatization.

The acclimatization numbers of *Robinia* L. species introduced in Vinnytsia are as follows: *R. pseudoacacia* = 100, *R. viscosa* = 86, *R. luxurians* = 86, *R. holdtii* = 95, *R. ambigua* = 94.

It should be noted that such indicator as acclimatization number is one of the main elements that allows determining the perspective of introduction of a particular species in a certain territory.

As for the genus *Robinia* L. representatives, it should be said that according to the data determined, they have excellent prospects for the introduction in the territory of Central Ukraine.

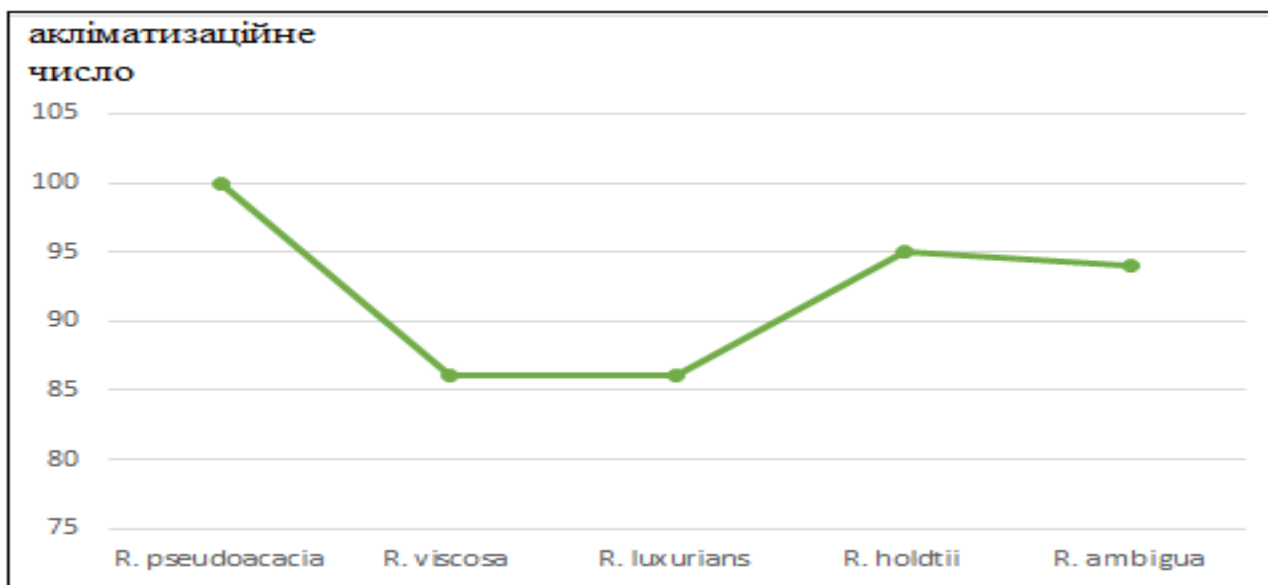


Fig. 1. Acclimatization number of the studied *Robinia* L. species (2021-2022)

Source: based on own research

As can be seen, *R. pseudoacacia*, *R. holdtii*, *R. ambigua* are completely acclimatized, *R. viscosa*, *R. luxurians* are well acclimatized. Therefore, the indicators of viability and the value of acclimatization numbers for the introduced *Robinia* L. species confirm the prospects of their introduction and success in acclimatization in Central Ukraine. Defining and establishing all possible indicators for one or another representative makes it possible to assess the level and perspective of its use in the landscaping system of an urbanized area. Thus, we also faced this problem. It was

necessary to determine the peculiarity of the genus *Robinia* L. representatives use in landscaping the territory of Vinnytsia city. The first thing we considered was determination of the plant's decorativeness level in comparison with the other ones. To determine this indicator, we used the Kalinichenko O.A. method [1].

It should be noted that the period of the *Robinia* L. decorativeness is divided into two periods of time: the first one is flowering, and the second – leaves pigmentation change. As our observations showed, the species under study received within 3 to 5 points of decorativeness according to the Kalinichenko O.A. method in the following periods: 1) from 05.15.2022 to 06.15.2022 – the time of flowering; 2) from 18.08.2022 to 20.09.2022 – changes in leaves colour.

Having analyzed Fig. 2, we determined that the decorativeness of the genus *Robinia* L. species ranges from 3 (*R. pseudoacacia*) to 5 (*R. luxurians*) points. The average decorativeness score is 4 points.

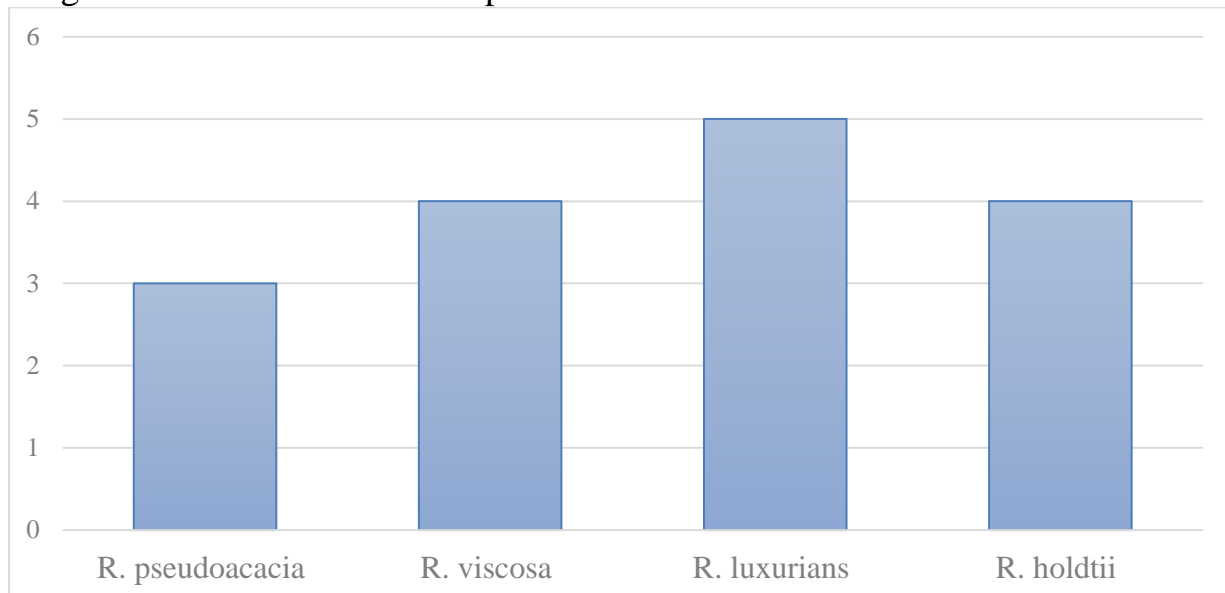


Fig. 2. Decorativeness indicator of the studied *Robinia* L. species (2020-2021)
Source: based on own research

Therefore, it can be said that the genus *Robinia* L. representatives, unlike many other introducers, have a fairly good indicator of decorativeness. Thus, taking into account the high rate of introduction according to the acclimatization number and decorativeness score, we can state that these species should be actively introduced into the gardening system of urban areas [1].

This issue requires special attention in the sphere of forest economy. As it is known, on the territory of Vinnytsia region, individual representatives of the *Robinia* L. genus can be met in almost all forest stands. They have adapted quite well to the forest conditions of our territory and have taken root in the most diverse forest associations.

A large number of *R. pseudoacacia* trees are found largely in the forest plantations, especially on the forests edges. This species becomes a real ornamentation in the first period of its decorativeness (Fig. 3).



Fig. 3. *R. pseudoacacia* at the edge of the forest
(Vinnytsia region, Zhmerynka district) (25 May 2022)

Source: based on own research

It is worth noting that during the period of its introduction, *R. pseudoacacia* demonstrated quite good indicators just in the system of forest plantations. Basically, this representative reproduces by self-sowing, young seedlings quickly grow and fill the surrounding area. As to the urbanized territories, the species can be found in the most diverse places: park zones, botanical gardens (Fig. 4), alleys, in the gardens of the private homeownership.



Fig. 4. *R. viscosa* on the territory of the «Podillia» botanical garden of VNAU,
Vinnytsia (27 May 2022)

Source: based on own research

Of course, special attention deserves the possibility of using representatives of the studied genus in various forms and associations, even in flower beds and exhibition formations. Moreover, creation of such formations is becoming widely

used. A specific feature is that the genus *Robinia* L. plants is suitable for the decorative formation, primarily of the crown. Planting Robinias in city alleys is quite promising. They can be placed along the paths paved with cobblestones, and flowers can be planted between them. In this way a decorative-exposition lane can be created (Fig. 5).



Fig. 5. Alley plantation of *R. ambigua* (Keletska st., Vinnytsia), (20 May 2022)
Source: based on own research

Representatives of the genus *Robinia* L., after their successful introduction and diversification of the species and form composition, are suitable for the planting in the park zones of the urbanized area as during the flowering period they become a real decoration of the territory.

Conclusions. Species and forms of the genus *Robinia* L. introduced in the Right Bank Forest-Steppe of Ukraine can be considered completely and relatively winter-hardy plants (winter hardiness – 1-2 (3) points). They are characterized by a high drought resistance (4.8-5.0 points) and belong to the xerophytes. The most drought-resistant one is *R. pseudoacacia*. All the introduced species of the genus *Robinia* L. belong to heliophytes in terms of light preference. Such introduced species of the genus *Robinia* L. as *R. pseudoacacia*, *R. holdtii*, *R. ambigua* are completely acclimatized, *R. viscosa*, *R. luxurians* – well acclimatized. Their acclimatization numbers are: *R. pseudoacacia* = 100, *R. viscosa* = 86, *R. luxurians* = 86, *R. holdtii* = 95, *R. ambigua* = 94. Species and forms of the genus *Robinia* L. are highly decorative tree breeds, the average decorativeness of which equals to 4 points.

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АНОТАЦІЯ

ОСОБЛИВОСТІ ІНТРОДУКЦІЇ ТА ПЕРСПЕКТИВИ ВИКОРИСТАННЯ В ОЗЕЛЕНЕННІ М. ВІННИЦІ РОДУ ROBINIA L.

Проаналізувавши літературні дані ми встановили, що *R. viscosa*, яка у залученні в інтродукційний процес займає друге місце після *R. pseudoacacia*, характеризується меншою зимостійкістю. За даними А. А. Качалова, *R. viscosa* зимостійка в культурі на сході, північній і середній частині України і в Закарпатті. В умовах Вінниці витримує морози до - 30 °С. У Молдові (Кишенев) *R. pseudoacacia* зимостійка, плодоносить.

В результаті проведених досліджень встановлено, що зимостійкість видів роду *Robinia L* в умовах інтродукції становила 1-2 (3) бали. Інтродуковані види і форми роду *Robinia L.*, які слугували нам об'єктами досліджень, в умовах Вінниччини можуть без значних пошкоджень витримувати температуру нижче -32 °С. Згідно отриманих даних ми встановили, що представники роду *Robinia L.* належать до посухостійких видів і здатні витримувати довгий період посушливу і бездощову погоду. Рівень посухостійкості досліджуваних видів і форм за шкалою С.С. П'ятницького становить 4-5 балів.

За шкалою світлолюбності С. С. П'ятницького *R. pseudoacacia* належить до найбільш світлолюбних деревних порід – геліофітів.

Встановлено, що цілком акліматизованими є такі види як *R. pseudoacacia*, *R. holdtii*, *R. ambigua*, добре акліматизованими – *R. viscosa*, *R. luxurians*. Їх акліматизаційні числа становлять: *R. pseudoacacia* = 100, *R. viscosa* = 86, *R. luxurians* = 86, *R. holdtii* = 95, *R. ambigua* = 94.

Проаналізувавши досліджувані види на предмет декоративності, ми встановили, що період декоративності у видів роду *Robinia L.* поділяється на два відрізки часу: перший – це період цвітіння, а другий – це період зміни пігментації листя.

Згідно проведених нами спостережень досліджувані представники отримали 5 балів декоративності за методикою Калініченка О. А. в наступні періоди часу: 1) з 15.05.2022 р. по 15.06.2022 р. – це період цвітіння представників; 2) з 18.08.2022 р. по 20.09.2022 р. – зміна забарвлення листя.

Ключові слова: інтродукція, декоративність, озеленення, перспективність, урбанізована територія, *Robinia L.*

Табл. 4. Рис. 5. Літ. 13.

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