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Adaptability and prospects for the use of introduced representatives of the genus *Weigela* in different climatic conditions

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The use of highly decorative and beautifully flowering shrubs in urban green spaces, especially in sharply continental climatic conditions, is extremely important. In this regard, representatives of the genus *Weigela a*re highly valued in the in different climatic conditions. The main indicators of eco-physiological adaptability of plants, such as intensity of transpiration and photosynthetic productivity, water deficiency and the total water content, quantity of the plastids, have been studied for the representatives of highly ornamental shrubs of the genus *Weigela* Thumb. The object of the research was the following representatives of the genus *Weigela*: *W. praecox*, *W. coraeensis*, *W. floribunda*, *W. florida* and *W. florida* "Variegata", which were introduced into different climatic conditions in order to climate train and replenish the dendro-collections. Physiological research was conducted, during the vigorous vegetative period (May–June months). All the measurements were carried out within the 11:00–13:00 time period, in 9 repetitions (7–10 shoots were chosen for each sample). The nature of ecological adaptability of the studied species, along with the perspective of their application in the landscaping practices in different climatic zones was revealed. At the same time it was revealed that the studied species can be used not only as solitary plants (especially on the background of green lawns) but also in groups in long blooming gardens (with flowers with different colours and blooming phases) and in decorating rock gardens.

Keywords: ornamentals; total water content; photosynthetic productivity; transpiration; plastids; chlorophyll; carotenoids content.

Introduction

The protection of woody plants and their communities in nature and the preservation of habitats to ensure their optimal development and renewal are the most reliable and effective ways to conserve dendro resources. However, due to increasing anthropogenic pressure, protecting the gene pool of dendroflora solely in natural conditions may not ensure its safety. Anthropogenic impacts disrupt natural habitats and lead to the reduction and potential extinction of many plant species. Therefore, in addition to protecting plants in their natural habitats (in situ), developing effective methods for their introduction and conservation under controlled conditions (*ex situ*) is crucial. The introduction of plants, especially woody ones, is a significant challenge in botanical science, addressed in botanical gardens, which play a vital role in conserving and sustainably using plant resources. Botanical gardens and arboreta are essential for enriching local and cultural flora with new valuable plant species which are of great scientific and practical importance. The primary task for botanical garden and arboretum staff is to introduce new species, study their bio-ecological characteristics in different habitats, and develop sustainable methods for their seed and vegetative propagation.

Due to the extremely diverse soil-climatic conditions of the Armenian Highlands there has been a practice of introduction and growth of representatives from almost all ecological-geographical zones of world (except tropical ones) and different plant groups in Ancient Armenia.

Many years of investigations have allowed us to find that ecological flexibility and adaptability of woody plants is much lower than for herbaceous plants, which is conditioned by evolution of life forms: trees – shrubs – subshrubs – dwarf shrubs – perennial herbaceous plants – annual herbaceous plants – ephemeral plants. Their adaptation ability towards the environment's negative factors grow in the same order. Photoperiodism and the coincidence of rhythms of development of the introduced plants and the climatic rhythms of the new habitat play an important role in introduction of trees and shrubs. Discussing the botanical-geographical regions (Eurosiberia, the Caucasus, Eastern Asia and Northern America) from the point of view of estimation of their dendrofloras as sources of woody plants for introduction in the botanical gardens of Armenia, it was found that the Chinese–Japanese floristic region is one of the main centers providing plants for introduction. Tens of years of experiments show that 370 tree and shrub species from continental and rather temperate provinces as well as representatives of high mountain regions of subtropical provinces are the most promising ones for introduction, particularly, the representatives of the Pinaceae, Celastraceae, Betulaceae, Rosaceae, Salicaceae, Aceraceae, Fabaceae, Caprifoliaceae, Tiliaceae families (Vardanyan, 2012).

Botanical living collections within botanical gardens are a crucial global asset for plant diversity. Special attention should be directed towards dendrological collections due to their significant contribution to biodiversity conservation, support for scientific inquiry, enhancement of educational initiatives, and engagement of the public. Introducing plants, particularly woody species, poses a significant challenge in botanical science, one that is addressed through botanical gardens and arboretums. The establishment and development of dendrological collections in botanical gardens provide a means to comprehensively represent diverse plant species from various biogeographical regions and continents (Vardanyan et al., 2024).

The presented data prove that Yerevan is an overloaded city both in terms of population density and environmental problems. However, to reduce the environmental pollution in the city it is necessary to extend the green areas using plant species mostly adapted to dry conditions (Vardanyan et al., 2024). Throughout their extensive history, botanical gardens worldwide have been involved in importing highly ornamental plants from various phytogeographical regions of the world. They create exhibition collections, conduct climate adaptation studies, and address issues related to their application in landscaping (Vardanyan, 2012). Recently rational nature management of the urban flora in the sphere of the influence of anthropogenic factor on the life state of plants has become one of the urgent problems of the environmental protection (Dogadina & Botuz, 2019). Ornamental shrubs within the dendro-composition of green plantations play a major role in improving the microclimate and sanitary-hygienic conditions of the urban environment. The family of Honeysuckles (Caprifoliaceae), which is overly abundant with the highly ornamental and beautiful blooming shrubs, contains about 400 species. The genus *Weigela* Thunb. especially stands out among them. The diversity of its species and their extensive geographical prevalence makes it possible to introduce and consider it as a valuable perspective raw material for growing it in different climatic zones of Armenia.

The genus *Weigela* contains about 15 species naturally spread in Eastern and Southeastern regions of Asia, in the Far East. This genus is named after the German professor of chemistry, pharmacy and botany Christian Ehrenfried von Weigel. After appearing in Europe during the last two centuries the genus *Weigela* was under targeted research by plant breeders and numerous inter-species hybrid forms were created. These hybrids were named *Weigela hybrida* and they have different morphological and biological characteristics, such as the shape of the foliage, growth rate, colour of leaves and flowers. The last feature defines the appropriate climatic zone and the landscaping nursery for growing the specific species. Seeds of the genus *Weigela* (Caprifoliaceae) are described from the Early Miocene Hannuoba Formation of Weichang County, Hebei Province, China. They are flat, elliptic, with translucent membranous wings on three sides. Overall Weigelas are frost hardy and sun loving, however they can tolerate some shade. They are not demanding to soil, on the other hand, they prefer fluffy, nutrient-rich and humid soil conditions (Jacobs et al., 2009; LiHua et al., 2009; Benetka & Hyhlíková, 2010; Moiseeva & Kramareva, 2012; Liang et al., 2013; Pfarr, 2015; Qian et al., 2018; Khamraeva et al., 2021; Rosca et al., 2022).

The cultivars in the genus *Weigela* have up till now been classified within a few species or directly under the genus. The two main species are: *W. florida* and *W. praecox*. Species freely hybridize with each other. Because many cultivars show the influence of two or more species, there is a lot of confusion about the correct classification, and this system is no longer satisfactory. The classification is mainly based on size of the plant, leaf colour and colour of the flower. The new classification is based on growers' practice, while the old classification was based on genetic relationships. The definitions of the cultivar-groups are simple and clear; cultivars can be classified better and this system is easy to work with, even for non-specialists (Hoffman, 2008).

Taking into considerations the above-mentioned circumstances we have undertaken targeted eco-physiological research on the representatives of the genus *Weigela* introduced into the botanical gardens of Armenia.

Brief characteristics of the studied species are given below.

Weigela coraeensis Thumb. – Korean Weigela – up to 1.5 m high, (up to 5 m in nature), with bare shoots, is a deciduous shrub. It naturally grows in Japan. The leaves have wide elliptic form, are 8–15 cm long. The flowers are gathered in 2–8 bunches on the lateral shortened shoots making a semi-umbrella. The flower crown is bell-shaped, 2.5–2.6 cm long, approximately 2 cm wide, at first, they are light pink, later they become darker up to red colour. The calyx is glabrous, the seed is winged. It breeds with seeds, cuttings, and also with layering. It was introduced into Yerevan Botanical Garden from Batumi city, Georgia and has been growing here for 12 years. It is frost hardy, however, in extremely cold winter conditions freezes, however recovers quickly in spring and manages to bloom during the same vegetative season (albeit a little bit late).

Weigela praecox (Lemoine) Bailey – Early Weigela – 1.5–2.0 m height, has reddish shoots, and is a deciduous shrub. It naturally grows in China, in the north of the Korean peninsula, and in Japan. The leaves are egg shaped or elliptic, 6–12 cm long. The flowers are bell shaped, very abundant, in 1–3 bunches sitting on the lateral shortened shoots, hanging down, 3–4 cm long, pink coloured or dark pink, fluffy. It is propagated with seeds, cuttings, splitting of the shrub, with layering. It has been growing in the Yerevan Botanical Garden for 6 years, was introduced from Ufa city, Russia. It is already in its second year of entering the generative stage, blooms abundantly, and gives seeds with high germination rate.

Fig. 1. *Weigela coraeensis* from the semidesert zone

Fig. 2. *Weigela praecox* from the semidesert zone

Weigela floribunda (Sieb. et Zucc) C.A. Mey. – Crimson *Weigela* – 3 m high, is a deciduous shrub. It naturally grows in Japan. The young shoots are hairy. The leaves are oval, or egg shaped, 7–10 cm long. The flowers are sessile, dark red, 2.5–3.0 cm long, hairy. It has been growing in Yerevan Botanical Garden for about 15 years. It is not frost hardy, which is why it is cultivated in the areas protected from cold and winds. The seedlings grown from seeds are highly frost hardy. It is demanding to humidity, light and soil (prefers acid soils).

Weigela florida (Bunge) A. DC. – Old Fashioned *Weigela* – 3 m high deciduous shrub. It naturally grows in Northern China, Korean Peninsula. The petiole is very short, the leaves are almost sessile. The leaves are oval or prolonged egg shaped, 5–10 cm long. The flowers are pink, gathered in 3–4 (1–6) inflorescences sitting on the lateral shortened shoots. It is propagated with seeds and cuttings.

Weigela florida is the most commonly produced species. It was collected by Robert Fortune from North China in 1845 and commonly known as old fashioned weigela. Weigelas are no longer old fashioned plants; they have regained popularity in the ornamental plant industry during the last 20 years. More than 180 weigela hybrids or cultivars with different foliar and flower colours, growth forms, and reblooming characteristics are available (Wang et al., 2017; Xiaming, 2017). *Weigela florida* is a dense, rounded, deciduous shrub commonly planted in landscapes. It is also used in Chinese medicine to treat sore throat, erysipelas, colds, and fever (Fan & Wang, 2011; Stawiarz & Wróblewska, 2016; Tian et al., 2021).

Weigela florida (Bunge) A. DC. "Variegata" – Old Fashioned *Weigela* "Variegata" – 3 m high deciduous shrub. The leaves are simple, 5–10 cm long, and the edges have a light yellowish shade. The flowers are gathered in 3–4 (1–6) flowerescences. It blooms in May–June months. It is frost hardy, loves light and moisture, and is demanding of soil. It reproduces vegetatively. Due to the variegated leaves it adds additional decoration to green plantings. In order to preserve the mottling of the leaves it is propagated with cuttings.

Fig. 3. *Weigela floribunda* from the semidesert zone

Fig. 4. *Weigela florida* from the mesophyll forest zone

Fig. 5. *Weigela florida* "Variegata" from the semidesert zone

Material and methods

The object of the research was the following representatives of the genus *Weigela*: *W. praecox*, *W. coraeensis*, *W. floribunda*, *W. florida* and *W. florida* "Variegata", which were introduced into the semidesert zone, mesophyll forest zone and high mountainous zone in order to climate train and replenish the dendro-collections. We conducted our research in 2021–2023 in the semidesert zone, 1200 m above sea level, high mountainous zone, 1950 m above sea level and mesophyll forest zone, 1450 m above sea level.

The climatic indicators, such as air temperature and relative humidity, soil humidity, were measured in May–September months. The elevation of the habitat above sea level was measured by GPS, soil humidity and acidity by a PH-Moisture Meter, air temperature, aid relative humidity, intensity of light were measured by an Environment meter PCE –EM 883 Instruments (Table 1).

Table 1
The profile of the microclimatic conditions of the habitat by the average data for the period of May–September 2021–2023

Zone and altitude	Air temperature, ^0C	Air relative humidity, %	Soil humidity, %	Soil acidity (pH)	Lighting, Lx
Semidesert zone, 1200 m	29.9	34.4	5.0	7.0	3483
Mesophyll forest zone, 1450 m	22.7	40.1	7.5	7.5	4510
High mountainous zone, 1950 m	20.8	56.2	8.5	6.9	5100

Eco-physiological features (total water content, water deficiency, intensity of transpiration and photosynthetic productivity, amount of the plastid pigments) of the above-mentioned species of the genus *Weigela* were studied based on the principal of the integrity of the plant organism. Research was implemented during the vigorous vegetative period (May–June months). All the measurements were carried out within the 11:00–13:00 time period, each measurement was done in three samples and three repetitions (7–10 shoots were chosen for each sample). Physiological research was conducted by well-known methods (Mezhunts & Navasardyan, 2010; Akopian et al., 2019, 2023; Ghukasyan et al., 2023). The presented data represent statistically processed average results of the analysis. Fresh samples were weighed immediately (KERN ABS 220–4N, China, 2021) and dried in a thermostat at (Binder BF–56) 105 °C, to determine the whole water content in the leaves.

The water deficit was determined based on the principle of leaf water saturation. One gram of the received circles was weighed and then placed in a petri dish filled with distilled water. After 2 hours, the circles were removed, dried with filter paper and weighed again. To ensure that the leaves were fully saturated with water, they were placed back in the petri dish for an additional 30 minutes, then removed again, dried and weighed. This process was continued until the weight of the sample no longer changed and the leaves were considered to be fully saturated. The last weighing data was used as the final result. After that, these leaf circles were dried in a thermostat at 105 °C for 5 hours, weighed, and then dried again up to stable weight.

The intensity of transpiration of the leaves was determined by rapid weighing with an analytical balance. The leaf material was cut with scisors and quickly weighed with an analytical balance, after 5 minutes the weighing was repeated.

The photosynthetic productivity was also measured during this research by the method of leaf halves saturation, the essence of which is the determination of the increase in the weight of the plant mass per unit area as a result of photosynthesis in a certain time. For this purpose, leaves were selected from the 4 sides of the middle part of the trees, the number of which should not be less than 20. Half of the leaves were cut along the length of the main vein and placed in a bowl filled with water for 0.5 hours to saturate the tissue with water. Then, 100 circles of leaves were removed, divided into an equal number of groups and dried in a thermostat for 4–6 hours at 105 °C. This determines the initial dry weight per unit leaf area (mg/dm^2). The other half of the leaf with the petiole remains on the plant for several hours (4–5 h), after which the dry weight of their surface (mg/dm^2) is determined as described above. The amount of dry material accumulated during photosynthesis is determined by the difference between the dry weight of the last and the first determinations, which, dividing by the time between the determinations, expresses the photosynthetic productivity in mg/dm^2, hour.

To determine the leaf surface area, the leaves are laid out on paper and their contours are outlined, cut out and weighed. A square of 100 sm^2 is cut out of the same paper and weighed.

The content of photosynthetic pigments (chlorophylls *a* and *b*, and carotenoids) was determined by a modified method based on the use of an organic solvent of dimethyl sulfoxide, which allows one to obtain stable extracts necessary for performing extralaboratory studies (Mezhunts & Navasardyan, 2010). For the determination of plastid pigments, we take 100–500 mg weight of a fresh leaf sample, place it in 25 mL graduated and ground-necked test vials, add 7–10 mL of Dimethyl sulfoxide (DMSO), close with a cork, wrap it with a black cloth and place it in a wooden box. In order to dissolve pigments in the laboratory, we put the test vials with the samples in a water bath (WB7 2) at a temperature of 65 °C until the leaf tissues are completely discoloured and the extract is obtained. The measurement was carried out on a spectrophotometer (UV-6300PC Double Beam Spectrophotometer, China, 2020), and the quantitative accounting of chlorophylls *a* and *b* and carotenoids was carried out according to the Shlyk's formulas (1971):

chlorophyll a = 12.7E663-2.69E645;

chlorophyll b = 22.9E645-4.68E663;

sum of carotenoids = 4.695E440.5-0.268 ($a + b$),

where the E is the spectrophotometer reading.

Results

The indicators of the water regime by the elevation of the habitat are as follows: the total water content in the leaves of *Weigela* florida is the highest in mesophyll forest zone, the lowest in mountainous-steppe zone, in the semi-desert zone we obtained average data (Table 2). This pattern indicates that the decrease of the total water content in the leaves of the plants growing on the 1950 m level, unlike the plants growing on the 1200 m, is a regular phenomenon and such a decrease is observed regardless of the species or ontogenetic progression of the studied plants.

Our research revealed that the water regime reorganization varies in the different species of *Weigela* introduced in different climatic conditions of Armenia. This is a reaction to the influence of external conditions and is directed towards their adaptability and survival. According to the results of our research the indicators of water deficiency vary as follows: the highest rate was recorded in mesophyll forest zone. In the high mountainous zone we observed an opposite picture – with the increase in habitat level transpiration rate and decrease in photosynthetic productivity. Analyzing the photosynthetic productivity indicators in different ecological conditions, we revealed changes in elevation at the same rate. The highest indicator was recorded in mesophyll forest zone, in the high mountainous zone the rate was lower. Consequently, it can be concluded that the changes in the rate of the photosynthetic productivity are influenced by heredity and structural features.

Table 2
The average values of the eco-physiological indicators of *Weigela* introduced into the botanical gardens in 2021–2023
(mean ± standard deviation, n = 9: in 2021, 2022 and 2023 with 3 plants studied for each ecosystem)

Zone and altitude	Species	Total water, % from wet weight	Water deficiency, % from wet weight	Intensity of transpiration mg/g on wet weight, hour	Photosynthetic productivity mg/dm^2, hour
Semidesert zone, 1200 m	*W. coraensis*	72.22 ± 0.67^{c}	16.46 ± 0.22^{d}	582.3 ± 7.6^{d}	3.286 ± 0.036^{cd}
Semidesert zone, 1200 m	*W. praecox*	75.67 ± 0.87^{d}	14.56 ± 0.12^{b}	476.3 ± 4.6^{b}	3.331 ± 0.022^{d}
Semidesert zone, 1200 m	*W. floribunda*	75.78 ± 1.79^{cd}	17.27 ± 0.07^{e}	501.6 ± 16.8^{c}	3.249 ± 0.018^{c}
Semidesert zone, 1200 m	*W. florida*	69.89 ± 0.78^{b}	11.69 ± 0.17^{a}	594.3 ± 6.8^{d}	3.274 ± 0.017^{c}
Semidesert zone, 1200 m	*W. florida* " variegata"	77.00 ± 0.87^{d}	17.46 ± 0.12^{e}	468.0 ± 5.3^{b}	3.143 ± 0.016^{b}
Mesophyll forest zone, 1450 m	*W. florida*	82.56 ± 1.33^{e}	27.64 ± 0.85^{f}	632.8 ± 5.9^{e}	3.434 ± 0.033^{e}
High mountainous zone, 1950 m	*W. florida*	63.89 ± 0.78^{a}	15.67 ± 0.48^{c}	371.2 ± 11.8^{a}	2.667 ± 0.042^{a}

Note: within each column different letters indicate samplings which significantly differ from one another according to the results of the Tukey test ($P < 0.05$).

We also studied the content of the plastid pigments. The elevation of the habitat and accordingly the increase in the intensity of illumination results in a decrease in the chlorophyll content, which is explained by the relationship between the types of chlorophyll *a* and *b* and light: the total chlorophyll content (*a/b* ratio) decreases with the increase in elevation (Table 3). This can be attributed to the biological property: the plants' reaction to light intensity. The variation in green pigments content inversely correlates with the functional activity. The results of our experiments confirm that with the increase in the elevation of the habitat the chlorophyll content decreases. The highest carotenoid content was recorded in the species *Weigela florida* "Variegata" which is caused by the spotting of the leaves.

Table 3
The average values of the plastid pigment content in the *Weigela* introduced in botanical gardens of the RA
(mean ± standard deviation, n = 9: in 2021, 2022 and 2023 3 plants per ecosystem studied)

Zone and altitude	Species	Chlorophyll *a* content per wet leaf, mg/g	Chlorophyll *b* content per wet leaf, mg/g	*a* +*b*, mg/g	*a/b*	Carotenoids content per wet leaf, mg/g
Semidesert zone, 1200 m	*W. coraensis*	12.081 ± 0.088^{d}	4.116 ± 0.127^{c}	16.200 ± 0.213^{d}	2.933 ± 0.072^{c}	7.112 ± 0.095^{c}
Semidesert zone, 1200 m	*W. praecox*	12.230 ± 0.038^{e}	4.143 ± 0.031^{c}	16.373 ± 0.066^{d}	2.947 ± 0.014^{c}	4.891 ± 0.054^{a}
Semidesert zone, 1200 m	*W. floribunda*	11.293 ± 0.036^{c}	3.800 ± 0.069^{b}	15.093 ± 0.059^{c}	2.968 ± 0.058^{c}	6.979 ± 0.059^{c}
Semidesert zone, 1200 m	*W. florida*	16.548 ± 0.052^{g}	5.910 ± 0.041^{e}	22.458 ± 0.091^{f}	2.797 ± 0.011^{b}	8.177 ± 0.032^{e}
Semidesert zone, 1200 m	*W. florida "Variegata"*	15.692 ± 0.063^{f}	5.591 ± 0.161^{d}	21.283 ± 0.221^{e}	2.804 ± 0.070^{bc}	9.798 ± 0.052^{f}
Mesophyll forest zone, 1450 m	*W. florida*	10.590 ± 0.067^{b}	3.681 ± 0.090^{b}	14.271 ± 0.111^{b}	2.873 ± 0.072^{c}	6.700 ± 0.045^{b}
High mountainous zone, 1950 m	*W. florida*	8.060 ± 0.050^{a}	3.417 ± 0.056^{a}	11.477 ± 0.058^{a}	2.354 ± 0.046^{a}	7.732 ± 0.044^{d}

Note: see Table 2.

Discussion

Researchers of eco-physiological characteristics of plants pay specific attention to the water regime of plants, which is explained by the indispensable role of water in the plant's life. Several studies have been carried out on the physiological adaptability of introduced shrubs into the botanical gardens of The Republic of Armenia at the different elevations above sea level (Kazaryan & Davtyan, 2011; Nie et al., 2011; Butnariu, 2015; Hovakimyan & Muradyan, 2019). The results of our study somewhat coincide with the indicators published by the above researchers.

We studied the issues of water regime, intensity of transpiration and photosynthetic productivity, of some species of *Weigela* growing in the botanical gardens of the Republic of Armenia situated at elevations ranging from 1200 to 1950 m above sea level. Our studies revealed that the soil-climatic conditions of the habitat have certain effect on the total water content in the leaves of plant species. Moreover differences are observed even in the different species within the same zone. Overall, during vegetation, the total water content is lower in plants growing in habitats with relatively high temperatures and low humidity, in high temperature and somehow shaded areas, as well as in mesophyll habitats with high humidity of soil and air.

Water deficiency and the intensity of transpiration, depending on external factors play a considerable role in complex changes of the water regime, because these indicators together with the water inlet and outlet define the water balance of the plants. The direct relationship between transpiration and water deficit is logical in conjunction with the increase of habitat level. Based on the latter it should be assumed that in the habitat at 1950 m the water regime is in a certain disbalanced condition, which is associated with the slowing down of the growing process along with the transition to the generative development of the plants.

Considering the indicators of physiological characteristics of adaptability of the introduced plants by the example of *W. florida*, it can be assumed that *W. florida* is ecologically flexible and can be widely used in greening of all of the studied ecological zones, especially in the mesophyll forest zone, where we recorded the highest indicators of transpiration and photosynthetic productivity and the water deficiency. The semidesert zone occupies an intermediate position by the physiological indicators.

Accordingly, the physiological indicators of the plants change with the soil-plant-air chain-link and according to the conditions of a specific habitat those variations have an adaptive nature. Based on the results of our research, we think that this is the main reason of increasing intensity of the physiological indicators in the line with reaching from 1200 to 1950 m, although the normal water exchange and life activity are ensured by adapting the internal structure and course of physiological processes of plants to the external conditions. Our studies reveal that despite the differences in the natural habitat and certain soil-climatic differences, the ornamental shrubs can be cultivated also in the high mountainous conditions, if normal care and irrigation are provided. In the mesophyll forest zone, where we recorded higher indicators as compared with semidesert zone, they can be widely cultivated.

Conclusion

Our investigation of the eco-physiological characteristics, and adaptability indicators of the four new species of the genus *Weigela* introduced by us and the introduction of one parasitic form, which are not widely used in greening, enables us not only to replenish the living collection, but also to ensure the decoration of the gardens with beautifully blooming shrubs. Based on our research results, it is advisable to widely use all the species of the genus *Weigela* in landscaping in different natural climatic conditions ensuring proper care and irrigation. They can be used both as solitary specimens (especially against the background of a green lawn), and in a group in long-blooming gardens (with different colours of flowers and different periods of flowering), and in the design of rock gardens.

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The authors consider that there is no conflict of interest.

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