

Features of acclimatization of *Ligustrum* L. in the Middle Urals

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Abstract. The article is devoted to the introduction and acclimatization of *Ligustrum vulgare* L. in the Middle Urals since the creation of the collection in 1960. At that time, the average annual temperature was only 1°C and *Ligustrum vulgare* L. froze, grew again and fruited in favorable years. It was possible to create an introduction population by families, but, nevertheless, in 1998 all plants died from the return of cold weather and frosts. The study of the growth and development of privet has been resumed since 2016. Several geographical samples of seedlings grown without irrigation were studied. It turned out that the sample from Barnaul turned out to be the best in all indicators, close values of growth and development of plants from seeds from Samara, and the worst indicators of plants from seeds obtained from Kazan. Average values were noted in *Ligustrum ibota* (Kaliningrad reproduction), while agrotechnical care (watering and weeding) revealed the maximum height in a sample from Penza.

1. Introduction

Privet *Ligustrum* L. is a shrub, less often a small tree from 2 to 5 m high, deciduous, semi-evergreen and evergreen. The leaves are simple, entire, leathery, green, purple-green in autumn. Flowers in pyramidal panicles, bisexual, cream or white, blooms from 10 to 35 days, in June-July. The fruits are black, berry-like, bears fruit from 6-8 years. Grows in floodplains, on open slopes, drought-resistant, shade-tolerant, gas-resistant, regenerates well. Distributed in the subtropical, tropical and temperate zones of the eastern hemisphere. Natural range - Europe, Western Ukraine, Caucasus, Crimea, North Africa, southern regions of East Asia. There are about 30 species in the genus [1]. Common privet (*Ligustrum vulgare*) is not found in the wild in Central Russia, but is often cultivated as an ornamental plant and often self-sows [2]. Naturalization and resettlement in the Saratov agglomeration and near children's institutions was noted, while the fruits similar to bird cherry, popularly called "wolfberry", are poisonous and pose a serious danger [3]. Many chemical compounds of privet are used in pharmacology and digestion. So, Chinese businessmen use the fruits in brewing [4] and preparing some types of dough [5]. Privet is

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used in ornamental horticulture, due to its long flowering and leathery dark green leaves, most often in border plantings. Methods for growing seedlings and planting material are covered in the works of employees of the Nizhny Novgorod Agricultural Academy [6]. Spring sowing with stratified seeds using heat treatment is the optimal time. Autumn sowing is not effective.

Features of the growth and development of seedlings of *Ligustrum vulgare* L. are presented in the works of Volgograd scientists [7]. The main development cycles consist of the following stages:

- Two years of intensive growth of shoots of the formation and branching of the first order.
- At the age of 6, the growth of shoot formation is completed, the formation of flower-bearing shoots and supplement shoots.
- At the age of 14, the branching shoots complete their growth, the supplement shoots die off, the height of the bush is 2.6 m with a crown diameter of 2.7 m.

Common privet has been growing in the Main Botanical Garden of the Russian Academy of Sciences since 1941. At the age of 10, the height of the shrub is 1.5 m, the crown diameter is 130 cm. The vegetation period is 174 days, it bears fruit from the age of 6, blooms for 26 days, winter hardiness II, is used in landscaping in Moscow [8]. In the CRBS of Minsk, privet reached a height of 2.7 m at the age of 30 [9].

2. Materials and methods

Used materials for the cultivation of common privet since 1959. Growth features were studied on plants of 6-7 years of age, plant height, projection area and crown volume, number of formation shoots and increments, leaf sizes are given. The purpose of the study is to study the growth and development and cold resistance of two species *Ligustrum vulgare* L. and *Ligustrum ibota* Siebold et Zucc. in the collection of the Botanical Garden of the Ural Branch of the Russian Academy of Sciences.

3. Results

In the Urals, for the first time in the city of Sverdlovsk, on a collection site, common privet was planted at the age of 10 years (Moscow reproduction) in 1936 at a height of 0.4 m, the growth in the first year was 24 cm, freezing of young shoots and fruiting was noted [10]. *Ligustrum vulgare* L. has been growing in the Botanical Garden of the Ural Branch of the Russian Academy of Sciences since 1960, the shoots froze up to 90 cm, almost to the level of the snow cover, but with an increase in the average annual temperature since 1990, the privet began to bloom and bear fruit [11]. But as a result of climate cyclicity and abnormal weather conditions, all privet plants died in 1998. New plantings appeared in 2016, grown from seeds obtained from the Botanical Garden of Penza. In 2022, at the age of 7 years, they began to bloom and bear fruit. Their height was 0.9 m; 1.4; 1.2; 1.3; 1.25; 1.2; 1.35; 1.40, mean height 1.25 ± 0.06 . These plants were periodically watered, freezing was not observed. The leaves are 4.25 x 1.55 dark green, they did not fall on November 7, 2022. 3 geographic samples of *Ligustrum vulgare* L. and *Ligustrum ibota* Siebold et Zucc., which were grown without irrigation, were studied in more detail - they did not bloom, although the amount of precipitation was sufficient, in May and June there were 25 and 22 days with precipitation (Table 1).

Plants grown from seeds obtained from the Botanical Garden of Samara in 2017, plant height was 0.62 m (Table 2). The number of formation shoots is 9 pieces, the growth length is 7.86 cm.

Table 1. Climatic conditions for the growing season 2022.

Month	Average temperature, °C	The amount of precipitation, mm	Number of days with precipitation
April	6	35	19
May	10.9	73	25
June	15.7	86	22
July	20.9	11	15
August	20.6	13	11
September	10.9	54	16

Table 2. Characterization of *Ligustrum* L. in the Botanical Garden of the Ural Branch of the Russian Academy of Sciences.

Geographic patterns	Plant height, cm	Crown projection area, m²	Crown volume, m³	Number of formation shoots, pcs.	Number of increments, pcs.	Growth length, cm
<i>Ligustrum vulgaris</i>						
Samara	0.62±0.07	0.16±0.09	0.36±0.02	9	99	7.86±0.95
Kazan	0.33±0.01	0.23±0.18	0.02±0.01	3	29	7.98±1.78
Barnaul	0.70±0.02	0.14±0.02	0.03±0.01	4	102.8	9.89±1.26
<i>Ligustrum ibota</i>						
Kaliningrad	0.57±0.04	0.12±0.02	0.03±0.01	3	170.25	5.71±0.69

Plants grown from seeds of the Kazan Botanical Garden, height 0.33 m, number of formation shoots - 3, growth length 7.98.

Seeds obtained from the Botanical Garden of Barnaul, height 0.70 m, number of formation shoots - 3 and growth length 9.89.

Ligustrum ibota. Seeds are received from BS of Kaliningrad. In 2019, the plants are 4 years old, height 0.57, number of formation shoots - 3, growth length 5.71. During the cultivation of this species, the average temperature and rainfall were more favorable compared to previous years (Table 3). The average temperature during the privet growing period was 3.9°C, and the average rainfall reached 472 mm.

Table 3. Average temperature and rainfall for 2016 -2021.

Of the year	Average temperature, °C	The amount of precipitation, mm
2016	3.7	403
2017	3.6	486
2018	2.6	473
2019	4	583
2020	5.4	443
2021	4.1	446

Correlation analysis showed that the higher the plants, the greater the number of increments ($r = -0.63, p < 0.05$) and the smaller the crown area of privet ($r = -0.94, p < 0.05$). With an increase in the number of increments, their length decreases ($r = -0.52, p < 0.05$).

4. Discussion

T.N. Vstovskaya [12] summed up the cultivation of *Ligustrum vulgare* L. in the botanical gardens of Western Siberia:

- In the city of Barnaul, privet grows as a shrub 1-1.4 m tall, the shoots freeze to the snow line, but bear fruit.
- Omsk - semi-shrub, at 11 years old - 0.7 m, freezes slightly, but bears fruit.
- Novosibirsk, at the age of 6 - 0.6-0.9 m, did not bloom, froze to the level of snow cover.
- Leninogorsk - winters under the snow.
- Tomsk, 1953, does not bloom, annual shoots freeze slightly.
- Petrozavodsk - blooms, but freezes.

In Yekaterinburg, the average height of plants at 7 years of age when irrigated was 1.25; without irrigation from Samara - 0.62, from Kazan - 0.33; from Barnaul - 0.70.

In Yekaterinburg, young plants freeze and even freeze out. So, in 2021, 50 seedlings were planted at the age of 3 years of the Orenburg reproduction, in 2022 only 13 pcs. - 33%.

When relatively heat-loving *Ligustrum* L. plants are introduced into culture outside their range, they adapt to changed environmental conditions and thereby acclimatize. This species has not yet reached the full stage of acclimatization. As a result of climate warming, they bloom and give seeds for the continuation of offspring, but, nevertheless, they freeze slightly. Abnormal years are especially destructive, when plants die as a result of short-term frosts. Therefore, the use of *Ligustrum* L. in border plantations makes them stable and safe, since they do not form seeds or very few. Differences in the growth and development of geographical samples of seedlings without irrigation were obtained. The best indicators turned out to be in Barnaul and Samara plants, the height is almost 2 times lower in Kazan ones. The height of *Ligustrum vulgare* L. at the age of seven when irrigated was 1.25 m, fruiting was noted for the first time. The height of seedlings without watering, also seven years old, is 0.6-0.7 m and they did not bloom.

5. Conclusion

Differences in the growth and development of seedlings in geographical samples were revealed, the best were the Barnaul and Samara plants, the worst Kazan ones. Young plants of *Ligustrum vulgare* are more sensitive to cold snaps, so in 2022, 67% of 3-year-old seedlings died. Thus, based on the intraspecific variability of plants, it is possible by selection to identify more resistant and decorative individuals.

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References

1. S.G. Saakov, Trees and shrubs USSR, **5**, 462-474, (1960)
2. P.F. Mayevsky, Flora of the middle zone of the European part of Russia (Association of scientific publications KMK, Moscow, 2006)
3. A.S. Potapova, Trends in the development of science and education, **49**, **12**, 47-49, (2019)
4. H. Zheng, Invasive Plants of Asian Origin Established in the United States and Their Natural Enemies, **1**, 93, (2004)

5. J. Chunli, *Cereal Chemistry*, **89**, **3**, 166-167, (2012)
6. N.V. Martynova, N.N. Besschetnova, Prospects for the development of agricultural production, 118-121 (2015)
7. A.V. Solonkin, *Journal of Agronomy*, **2**, **109**, 35-41, (2020)
8. Woody plants of the Main Botanical Garden. N. Tsitsina of the Russian Academy of Sciences. 60 years of introduction (Nauka, Moscow, 2005)
9. Woody Plants of the Central Botanical Garden of the Academy of Sciences of the BSSR (Science and Technology, Minsk, 1982)
10. M. Stelmakhovich, Guide to the collection site of ornamental vegetation U.O.S.Z.S. (AKH, Sverdlovsk, 1940)
11. L.A. Semkina, *IOP Conf. Ser.: Earth Environ. sci.*, **1010**, 012066 (2022)
12. T.N. Vstovskaya, Woody plants – introduced species of Siberia (Abelia – Ligustrum) (Nauka, Novosibirsk, 1985)