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INTRODUCTION OF *HOSTA MINOR* (J. BAKER) NAKAI IN THE FOREST-STEPPE ZONE OF THE BASHKIR PRE-URAL

Research article

Abstract

The article reports the results of introduction studies of the species *Hosta minor* (J. Baker) Nakai in the forest-steppe area conditions of Bashkir Pre-Ural which were conducted at South-Ural Botanical Garden-Institute of Ufa Federal Research Centre of Russian Academy of Sciences (the city Ufa). The data on phenology and dynamics of foliage growth, anthecology, pollen viability and seed germinating ability are considered. The introduction success and economically valuable characteristics are estimated.

Keywords: *Hosta minor*, introduction, dynamics of foliage growth, anthecology, Republic of Bashkortostan.

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ИНТРОДУКЦИЯ *HOSTA MINOR* (J. BAKER) NAKAI В УСЛОВИЯХ ЛЕСОСТЕПНОЙ ЗОНЫ БАШКИРСКОГО ПРЕДУРАЛЬЯ

Научная статья

Аннотация

В статье представлены результаты интродукционного изучения вида *Hosta minor* (J. Baker) Nakai в условиях лесостепной зоны Башкирского Предуралья, проведенных в Южно-Уральском ботаническом саду-институте Уфимского федерального исследовательского центра Российской академии наук (г. Уфа). Рассмотрены данные по фенологии и динамике роста листьев, антэкологии, жизнеспособности пыльцы и всхожести семян. Оцениваются успешность интродукции и хозяйственно-ценные качества.

Ключевые слова: *Hosta minor*, интродукция, динамика роста листьев, антэкология, Республика Башкортостан.

1. Introduction

It has been long since Hosta gained their due recognition as an ever-present participant of artistic landscapes. The three words summarizing the garden value of Hosta – its foliage, practical value and reliability – can easily explain this fact [10]. The genus name honors Austrian doctor and botanist Nicholas Host [2], the author of numerous works on plants, “Flora Austriaca” among them. The plant has its second name in honor of German pharmacist H.G. Funk [14]. In the wild Hosta grows in a variety of habitats – rocks, river and spring banks, often very close to water, on mountain sides, forest edges, sometimes on sand dunes and waterlogged patches. They can grow in any zone, with the exception of tropical and extremely cold ones. The culture may be found in moderately warm zones of East Asia (China, Japan, and Korean peninsula), far south-west of Far East, also in Sakhalin and Kuril islands. The genus *Hosta* Tratt. has about 40 species (including cultural taxa), also there are many garden forms and hybrids known [1]. Being tolerant to saline and post flooding soils, Hosta turn to be particularly useful in designing problematic locations in gardens [8], [10], [13].

It has been the aim of the research to study of biological peculiarities of *H. minor* (J. Baker) Nakai introduction at the South-Ural Botanical Garden-Institute of Ufa Federal Research Centre of Russian Academy of Sciences. In this connection the

following tasks have been set: to establish seasonal rhythm features and to study dynamics of foliage growth of *H. minor*; to investigate the biology of its florescence; to study the viability of *H. minor* pollen grains; to measure the germinating ability of seeds; to estimate introduction success, decorative and economic characteristics of *H. minor*.

2. Methods

Introduction researches were performed at the South-Ural Botanical Garden-Institute of Ufa Federal Research Centre of Russian Academy of Sciences in 2000–2019, laboratory experiments – in 2015–2018.Climatically, the research area (Ufa, Bashkir Pre-Ural) is characterized by a great amplitude of year temperatures with a fast change from a severe winter to a hot summer, and frosts in late spring and early autumn [9]. Average annual temperature is 2,6ºC. Average winter air temperature is minus 12,0ºC to minus 16,6ºC, an absolute minimum being minus 42ºC. Summers are hot and dry, with average air temperature 17,1ºC to 19,4ºC, an absolute maximum 37ºC [12]. Average precipitation in summer is 54–69 mm, average annual precipitation is 580 mm. Average non-freezing period is 144 days. The soils are mainly grey and dark grey forest ones [12].

For the analysis of seasonal rhythms of plant development we used the method of phenological observations in botanic gardens [7]. The growth dynamics was found by measuring leaf lengths every 10 days. In studying the ecology of florescence and pollination we employed the method of A.N. Ponomarev [11]. Pollen viability was found according to I.N. Golubinski [5]. Seed production was calculated according to I.V. Vainaghia [4]. Germinating ability and mass of 1000 seeds was found according to M.K. Firsova and E.P. Popova [15]. The introduction results were analyzed with a 7 grade scale worked out at the Donetsk botanic garden [3]. Decorative and economically useful features of the genera were evaluated using a state variety testing standard method [6]. *H. minor* was brought to South-Ural Botanical Garden-Institute from Ekaterinburg Botanic Garden of RAS in 2000.

3. Results

The results obtained show that in the forest-steppe area of Bashkir Pre-Ural *H. minor* grows as high as 25 cm with 80 cm in diameter. The leaves are small, 8,0–8,5 cm long. The flowers are violet, funnel-campani-form, 4,0–4,5 cm long. Thin flimsy flower stems stand much higher than foliage; can be as high as 61 cm. The inflorescence size is 2,0–17,0 cm. Leaf tips which can be called “pushing out” are emerging on the ground surface in the first half of May in spring. The leaves remain lepidoid and short, leaf blades are not developed. They are attached lower than the other leaves and are called cataphylls or lower formation leaves. Subsequently, there unfold leaves with a leaf blade and a petiole, these are called lower formation leaves. The main task of such leaves is to supply the plant with photosynthesis products. [16]. *H. minor* is noticed to show the most intensive growth of these leaves (to 0,6 cm) in the phase of spring growth (I and III decade of May). The growth of middle leaves ceases at the start of bud formation phase (II and III decade of June). When preparing to blooming the shape of leaves changes again. These leaves are attached to a flower stalk and are called bracts or upper formation leaves. Their leafstalk is poorly developed; there is only a leaf blade. The leaves take part in the flower formation. In the middle of summer Hosta often undergoes a second growth wave: the plants send the underground bud meristems a signal that the days are becoming shorter thus encouraging the growth and opening of new leaves.

As for the flowering season, it begins in the first decade of July (12.07±17) and finished flowering in the third decade of July (30.07±11). The flowering period is shorter than 20 days, while the whole of vegetation period is 144–164 days.

Hosta flowers are bisexual and actinomorphous, the floral envelope is funnel-campani-form, the corolla is sympetalous. The flowers are declinate, are 4,0–4,5 cm long, the flower diameter is 2,8–3,5 cm. The six floral envelope leaves coalesce to a long tube with six stamens attaching to its walls. The ovary is formed by three carpels that have fused. As for the corolla, pollen bag and pistil color, the Hosta under study can be classified as belonging to a violet, yellow-orange and yellow group correspondingly (according to RHS Color Chart). The pollen bag having violet dotted spots is 0,33 long and 0,13 cm wide.

When performing research of anthecology we have found the following regularity: blooming flowers within the inflorescence come out in an acropetal order. One to three flowers can simultaneously unfurl on the same inflorescence. At the beginning of flowering about 6 o’clock in the morning a turned up pistil style is emerging from the bud. The petals of the first flowers start to unfurl around 7–8 o’clock in the morning at 18°C and 75% air humidity. The three upper leaves are the first to come out, with the three lowers ones following them. We could observe a non-simultaneous anther and stigma ripening in the same protheandry form flower: a stamen becomes functional first, with the following pollen split sometime later. The flower dusting lasts 6–7 hours, the pollen being able to get onto pistil stigma as early as the first hours of the flower life. Around 14–15 o’clock stigma blades get smoothed out and thin sticky secrete drops appear on them, which is the sign that the flower enters a stigma flowering phase. The flower longevity varies with the weather conditions: it may be a day in hot weather and more than a day in cold weather (10°C), and throughout the time they are actively visited by onthophilinae insects. While producing pollen the pistil style is more and more bent upward. The phenomenon of hercogamy has been noticed, that is, there is little difference in the length of stamen and pistil. The pistil (5,20±0,04 см) is 1,1 longer than the stamen. The availability of hercogamy encourages the process of cross pollination and makes self-pollination less likely.

H. minor pollen viability was found by its germination in vitro on media with different concentrations of sucrose (2,5%, 5%, 7%) using the method of I.N. Golubinski [5]. The pollen used was freshly collected. The pollen grains were germinating during 30 minutes. 5% sucrose solution was found to be optimal for growing *H. minor* pollen seeds in laboratory. In this experiment the pollen viability value achieved 5%. When adding boric acid (0,003%) the value went up 4 times (20,0%). Thus, *Hosta minor* seed viability value in not high (less than 20%), which is one of the factors of low pollination outcome.

From the introduction investigations conducted it is inferred that the period from Hosta seeds setting to ripening lasts from the third decade of July to the first decade of October (63–73 days). The Hosta fruit is an elongated leathery three-celled boll opening along the walls. The boll is 1,83±0,04 cm high and 0,52±0,01 cm wide. Scarce big flat thin black winged seeds are

0,89±0,01 cm long and 0,33±0,01 cm wide. The mass of 1000 seeds is 2,75±0,05 g. Throughout the vegetation period 1–9 bolls form on one flower stem, with 60,8±2,4 average overall number of flower stems. *H. minor* shows a low (21%) percent of fruitification. In Pre-Ural conditions of Bashkortostan *Hosta minor* has the following seed productivity: the potential productivity is 55,2±1,1 number of seeds on a flower stem, while the practical productivity is 14,6±0,7 seeds on a flower stem. Judging from the productivity coefficient, the adaptive potential of *H. minor* (26%) in Pre-Ural Bashkortostan forest-steppe area is not fully realized. In order to find the depth of physiological dormancy the seeds were grown out in laboratory at different times. Germinating ability and productivity of seeds of self-reproduction were determined immediately after gathering and after 2, 4, 6, 8, 10, 12 months of storage. The seeds were grown out in Petri dishes on wet filter paper at room temperature on light. The first shoots appeared in the course of the third day. Quick-collected seeds showed maximum germinating ability (100 %) value which went down with time. The data obtained enables to make the conclusion that *H. minor* seeds do not have a dormancy period.

Our experience of growing *H. minor* on the introduction field at Ufa Botanic Garden indicates that the plants may be grown in the same location for 17 years and more. New shoots come out via the formation of reproduction buds wintering on the rootstock. No winterkilling or damping out was noted over the years of observation. The estimation of introduction success is 5 grades, that is, untroducents show regular large scale florescence and fruitification, are tolerant to local climatic conditions and do not require watering and covering. A number of factors including aesthetic perception of the plant determine the evaluation of Hosta use potential. It received 84 points in the 100 point scale of decorative quality evaluation. Maximum points were given for florescence abundance and foliage decorative quality. H. minor is defined as a plant of considerable promise. According to economically useful features *H. minor* had 32 points. Maximum points were given for flowering productivity which makes it a promising culture. Taking account of its commercially useful features and decorative qualities *H. minor* is recommended as a candidate into the zonal assortment of cultivated greenery in populated areas of Bashkortostan.

4. Conclusion

Introduction research of *H. minor* (J. Baker) Nakai in Bashkortostan Pre-Ural forest-steppe area resulted in the study of its foliage growth dynamics and phenology. It is concluded that the middle formation leaves have a maximum day growth increase (to 0,55 cm) in the phase of spring growth (I and III decades of May). Their growth ceases at the beginning of the bud formation phase (II and III decades of June). In terms of florescence time *H. minor* is referred to a mid-early group (flowering from II decade to III decade of July). The florescence period lasts less than 20 days while an overall vegetation period is 144–146 days.

The results of anthecology research showed an alternative ripening of anthers and stigmas in the same protherandry-form flower. Besides, hercogamy – a little difference in the length of a pistil and a stamen -was noticed. A 5% sucrose solution was found to be optimal for *H. minor* pollen grain germination in laboratory. In this experiment pollen viability indicators reached 5% which increased 4 times with the addition of boric acid (0,003%).

H. minor seed productivity has been studied. The plant is seen to have low indicators of potential and real seed productivity. According to the productivity coefficient value (26%), the potential of *Hosta minor* in the Bashkortostan pre-Ural forest-steppe area is not fully realized.

To find out seed germination conditions, they were grown out in laboratory at different periods. Quick collected seeds of self-reproduction germinated immediately upon gathering and showed maximum germination ability.

Taking into account successful introduction, high decorative and economically useful characteristics, *H. minor* is considered to be a promising plant for landscaping in Bashkortostan.

Conflict of Interest

None declared.

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