

Biological resources of the *Hyssopus* L on the south of European Russia and prospects of its introduction

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Abstract

Background and Objective: The south of European Russia (geographically - the southern part of the Central Russian Upland) has large biological and plant genetic resources. There is a concept considering the region as the second anthropogenic microgen center of formation of economically valuable plants. In the south of the Central Russian Upland, the genus *Hyssopus* L. is represented by two species: *Hyssopus cretaceus* Dubjan. and *Hyssopus officinalis* L. We accomplished the study of biological resources of species of the genus *Hyssopus* L. *in vivo* and *in vitro*. Several geobotanical expeditions were carried out to identify local, stable in space and time, self-renewal cenopopulations of the species *Hyssopus* L. which have a number of economically useful traits. **Methods:** There were revealed vast populations of the species *H. Cretaceous* Dubjan in Belgorod region, particularly in Alexeyevsky district. The frequency of occurrence of the species amounts 26.7%, and on the, especially, protected natural territory of the tract Varvarovka it can reach 75.0%. The species *H. cretaceous* Dubjan. is also distributed on chalky slopes of the river basins Quiet Pine (Tichaya Sosna), Black Kalitva (Chernaya Kalitva), Aidar, and Demina. With the aim of introducing, and reintroducing, as well as the industrial production of raw materials there was created a collection of valuable ecotypes of *H. cretaceous* Dubjan. *in vitro*. **Results:** The vast population of *H. officinalis* L. was found on the slopes of the Oskol River near the villages Lower and Upper Lubyanka of Volokonovsky district of Belgorod region. The starting material of the wild population formed the basis for the creation of a new hybrid of *H. officinalis* L. – Volokonovsky. The hybrid is suitable for commercial seed growing. Seed productivity of the hybrid Volokonovsky is more than 350 kg/ha. **Conclusion:** As a result of the completed research, there was created a new hybrid of *H. officinalis* L. - Volokonovsky. The hybrid has high-seed productivity, potential melliferous capacity, and good decorative properties. It is suitable for using as a plant for the green building, as well as for commercial seed growing.

Key words: Biological resources, hybrid Volokonovsky, *Hyssopus* L, introduction, medicinal cultures, secondary (anthropogenic) microgen center, seed growing, selection, spice and aromatic crops

INTRODUCTION

Due to their diverse useful qualities, the representatives of the genus *Hyssopus* L. are well-known and widely used by a man since ancient times. The homeland of the genus *Hyssopus* L. is considered the Mediterranean region and Central Asia. Today, there is no consensus among the researchers on the taxonomy of the genus. There are up to 15 species distributed in the southern Europe, Minor, and Central Asia, the Caucasus and

in North Africa. As a wild plant, hyssop is identified in all southern regions of Russia, as well as in the Caucasus.^[1-5]

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Hyssopus officinalis L. is widespread around the world. First, *H. officinalis* L. is an important vegetable spice and aromatic crop.^[6]

Second, *H. officinalis* L. has valuable medicinal properties, and it is recommended for use in the treatment of a wide range of diseases of the respiratory and nervous system, hospital infections, as well as an antioxidant and a radio protectant.^[7] The content of essential oils in the above-ground mass of hyssop amounts 0.3-1.5% in the leaves, and 0.9-2.0 2.5-3.0% in the inflorescences. There were identified pinene, b-pinene, pinokamfon, cineole, camphene, pinokamfeol and its ethyl acetate, alcohols, sesquiterpenes, tannin and bitter substances, flavonoids, vitamins B2, B1, organic acids, isospin pigment, microelements, and others. The level of ascorbic acid reaches 800 mg%, carotenoids - up to 47 mg/g of crude material.^[7-9]

Third, *H. officinalis* L. is a fairly cheap source of raw material for the pharmaceutical industry. Complex processing technology of *H. officinalis* for herbal remedies was developed with the aim of using the obtained herbal drugs in the composition of cosmetic products. The composition of hyssop includes triterpenoids, structurally, and genetically similar to steroids and particularly, pentacyclic triterpene acids - ursolic and oleanolic possessing hepatoprotective, antiviral, and antitumor activity.^[9-11]

Four, hyssop is a valuable melliferous plant, giving 120-330 kg/ha of honey of high-quality and attract bees and other pollinating insects.^[5-12]

Five, *H. officinalis* is a shrub with high decorative qualities and good resistance to shearing. This allows us to consider it as a promising species in green building and gardening of settlements. It is used to create mixed borders on sunny open spaces and for the formation of low hedges. However, there is no method of estimation of its decorative qualities, making it difficult to breeding, and selection of its promising varieties for horticulture and green building.

All above-mentioned makes the genus of *Hyssopus* L., especially the species *H. officinalis* L., a promising purpose for introduction in different regions of Russia and worldwide. In the climate conditions of Tyumen region, *H. officinalis* showed a 100% survival rate and collection of plant materials in average of six years reached 14.2 t/ha, seeds - 0.2 t/ha. There are from 8.5 to 29.2 t/ha of raw mass and seeds to 0.3-0.5 t/ha in Volga region. In the conditions of Moscow region, the species *Hyssopus seravschanicus* (Dub.) Pazij has been successfully introduced. An active research of properties of hyssop *Angustifolia* (*Helianthus angustifolius*) is carrying out in North Ossetia. Simultaneously, some farming techniques of cultivation of hyssop are adopted.^[12-14]

The south of Central Russian Upland is of great interest from the botanical point of view.^[1,4,13,15] There is a concept that considers the region as the secondary anthropogenic

microgen center for formation of economically valuable forms, which are characterized by multiform genetic and phytocenotic fund as a result of divergent evolution.^[16,17]

In this regard, the aim of the research is studying the ecological and biological characteristics of species of the genus *Hyssopus* L., growing on the calcareous soils of the southern part of Central Russian Upland to identify the forms valuable for environmental selection and introduction.

METHODS

Methodological basis of the research is the doctrine of the centers of origin and diversity of cultivated plants.^[18] Species of the genus *Hyssopus* L. in natural communities of the southern part of Central Russian Upland were studied in the process of itinerary studies (2013-2016 years).^[12,13,16,17,19,20] *In vitro* studies were carried out at the plant breeding nursery of Joint-Stock Company "Krasnojaruzhsky grain campaign." The soil of the pilot area was the typical black soil; its humus content is 5.8. Observations, surveys, and statistical data processing were carried out according to standard procedures adopted in geobotanical and biogeocenological studies.^[2,17]

RESULTS

At present, the State register of breeding achievements of Russia only includes 13 varieties of *H. officinalis* L. In Belgorod region of the Russian Federation, the plant breeding work is being done for the creation of varieties of hyssop with high potential of melliferous capacity, resistance to the climate conditions of the region, and the suitability for seed industry. Plant breeding selection is founded on such basis as shape, height, diameter and bush density, length of peduncle and inflorescence, the duration of the blooming period, the yield of green mass and seeds, resistance to winter, to early spring and autumn frosts, to a drought and diseases.

The basis for successful ecological breeding is creation a raw material based on the wide use of local and wild forms subjected to natural selection under the influence of ectopic conditions and adapted to the specific area of growing. In this regard, the selective work with the genus *Hyssopus* was started in the region with the study of local forms, growing in natural conditions of ravines complex.

In the southern part of Central Russian Upland, the genus *Hyssopus* is represented by two species: *Hyssopus cretaceus* Dubjan. and *H. officinalis* L.^[2,12]

After carrying out a series of geobotanical expeditions in the region, there were identified local, stable in space and time, self-renewing cenopopulations of both species *Hyssopus*, having a number of economically useful traits.

H. cretaceus Dubjan. is a relic, preserved since the tertiary period. In addition to Belgorod region, it can be found in chalky and limestone hills in Samara, Saratov, Voronezh, and Volgograd regions. The species is listed in the Red Book of Russia and Belgorod region (category of rarity status VI - a particularly valuable species).

Plant communities where *H. cretaceus* Dubjan. are dominated were named isospin. Isospins are pioneers of chalky outcrops because they can grow on the slopes devoid of any other vegetation. It is shown that under influence, including the root system of *H. cretaceus* Dubjan. There is an accelerated destruction of parent rock and soil formation [Figure 1].

H. cretaceus Dubjan. is a xerophytes, its life form is a half-shrub with height from 20 to 45-60 cm. It has quadrangular round stems slightly pubescent on its top and narrowly linear leaves of gray-green with almost imperceptible middle vein. *H. cretaceus* Dubjan. blossoms in the Belgorod region from May to September, it has bilabiate blue flowers of irregular shape and a distinctive fragrant aroma. Its fruit is nut ripening in August and September.

The vast populations of *H. cretaceus* Dubjan. are revealed in Alexeyevsky district of Belgorod region - the frequency of occurrence of the species is 26.7%, while on the territory of the protected area "Varvarovsky" it reaches 75.0%. *H. cretaceus* Dubjan. is also distributed on chalky slopes of the river basins Quiet Pine (Tichaya Sosna), Black Kalitva (Chernaya Kalitva), Aidar, Demina.

The spatial pattern of cenopopulations *H. cretaceus* Dubjan. and *H. officinalis* L. at the stationary points in the gully landscapes of the Belgorod region is presented in Table 1.

On the basis of these populations, there was created a collection of samples to study the possibility of creating of hybrid forms of *H. cretaceus* Dubjan., suitable for commercial seed growing with the aim of both introduction and reintroduction, and industrial production of raw materials.

H. officinalis L. is a branched shrub, its height is 40-70 cm and it has a woody root. Numerous erect stems are tetrahedral, slightly rounded, lignified at the base, and slightly tormentors at the top. The species has linear leaves with dotted glandules.

Calyx teeth are triangular, shorter than half of its length, flowers of irregular shape, bilabiate, and collected in the leaves axils into half-whorl, which are formed in the upper part of the stem into oblong spiky inflorescences. Its fruits are black-brown, oblong egg-shaped nuts, and lightly tormentors on the top [Figure 2].

In its first year, *H. officinalis* L. forms one unbranched stem that blossoms in July and gives seeds in late September. In its second and subsequent years, *H. officinalis* L. begins to grow in the first-to-third 10-day period of April, after establishing of stable positive average daily temperature. The average duration of blooming period of studied forms is 48-56 days,



Figure 1: *Hyssopus cretaceus* Dubjan. in Alexeyevsky district of Belgorod region



Figure 2: *Hyssopus officinalis* L. in Volokonovsky district of Belgorod region

Table 1: Spatial pattern of cenopopulations *H. cretaceus* Dubjan. the reference stationary points (2011-2015 years)

Stationary point	Area, m ²	Abs. number of species, units	Instance saturation (density), units/m ²
Village Vatutino, Valuysky district	700	246	0.35
Village Varvarovka, Alexeyevsky district	2780	2864	1.03
Cv, %	53.6	69.8	61.4

Cv: Variability ratio

Table 2: Spatial pattern of cenopopulations *H. cretaceus* Dubjan. the reference stationary points (2011-2015 years)

Stationary point	Area, m ²	Abs. number of species, units	Instance saturation (density), units/m ²
Farm Evdokimov, Volokonovsky district	500	26	0.052
Village Upper Lubyanka, Volokonovsky district	9000	12870	1.43
Cv, %	48.9	33.8	67.4

Cv: Variability ratio. *H. officinalis*: *Hyssopus officinalis*

the growing season - 143-150 days. Weight of 1000 seeds is on average 0.9-1.4 g.

In the process of itinerary studies, a large population of *H. officinalis* L. was found on the slopes of the Oskol River near the villages of Lower and Upper Lubyanka in Volokonovsky district of Belgorod region.

The spatial pattern of cenopopulations *H. officinalis* L. at the stationary points in the gully landscapes of the Belgorod region is presented in Table 2.

At present, there is created a hybrid form of *H. officinalis* L. on the basis of these populations. The hybrid has high-seed productivity, potential melliferous capacity, and good decorative properties. It is suitable for using as a plant in the green building, as well as for commercial seed growing. Nowadays, state selection trials are accomplished to test a new variety of *H. officinalis* L. It is reproducing in Belgorod region on the area of over than 18 hectares for getting seeds. During 3 years of tests an average seed productivity of the hybrid amounted more than 350 kg/ha. Beekeepers in different areas of Belgorod region actively use this new variety of *H. officinalis* L.

CONCLUSION

As a result of the completed research, there was created a new hybrid of *H. officinalis* L. – Volokonovsky. The hybrid has high seed productivity, potential melliferous capacity, and good decorative properties. It is suitable for using as a plant for the green building, as well as for commercial seed growing. In 2016, the new hybrid Volokonovsky successfully passed a State variety testing and from 2017 it is included in the register of breeding achievements recommended for using in Russian Federation. The new hybrid is reproducing in Belgorod region on the area of over than 18 hectares for getting seeds. An average seed productivity of the hybrid during 3 years of tests amounted more than 350 kg/ha. Beekeepers in different areas of Belgorod region are actively using this new hybrid Volokonovsky.

Findings

1. The south of European Russia (geographically - the southern part of the Central Russian Upland) is the

secondary anthropogenic microcenter of formation of economically valuable plants and possesses vast biological and plant genetic resources of the genus *Hyssopus cretaceus* Dubjan. and *Hyssopus officinalis* L.

2. With the aim of introduction and reintroduction and industrial production of raw materials there was created *in vivo* a collection of valuable samples of hybrid forms of *H. cretaceus* Dubjan.
3. The raw material of a wild population served as the basis for the creation of a cultural form – the new hybrid of *H. officinalis* L. - Volokonovsky. It is suitable for commercial seed growing. An average seed productivity of the hybrid amount more than 350 kg/ha.

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