

The use of morphobiological characteristics in the selection of *Phacelia Tanacetifolia* Benth

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Abstract

Aim: The aim of the work is to create new adapted varieties resistant to the complex of biotic and abiotic factors on the basis of the use of *Phacelia tanacetifolia* Benth. morphological and biological characteristics. **Material and Method:** For the first time in the conditions of Cretaceous South of the Central Russian Upland, morphological and biological features of wild *P. tanacetifolia* Benth. cenopopulations were studied. Morphological and biological features of *P. tanacetifolia* Benth. and the expansion of run wild forms were examined in route studies in various districts of Belgorod region (2002–2008). Selection analysis of the obtained material in 2009–2016 was carried out on the basis of the Botanical garden of NRU “BelSU.” Method of selection is individual family selection. The standard in the experiment was the released Ryazanskaya variety. Field experiments on competitive variety testing in 2014–2016 were laid by the method of split plots. It was repeated 6 times. The area of registration plots of the 1st order (a record harvest of green mass) was 50 m². The area of registration plots of the 2nd order (taking into account the crop for green mass and seeds) was 25 m². Observations, records, and statistical processing of the obtained data were carried out according to standard methods. **Result and Discussion:** It is found that quite a wide variation is observed between individuals, which may indicate the possibility of getting forms with the necessary characters by breeding methods. The original forms of different sprawling bush identified in Volokonovsky area have the green coloration of the stem and blue or a light blue corolla. Variety populations of Alekseyevsky, Chernyansky, and Krasnogvardeysky have semi-closed form of a bush, anthocyanin-colored stems, and light purple or lilac-colored corolla. A wide range of variation is classified for other parameters: Plant height (Cv = of 34.8–46.7%), diameter of the bush (Cv = of 43.2–54.5%) and diameter of the stem (Cv = of 67.1–78.4%), and length of inflorescences (Cv = of 46.7–55.2%) and 1.000 seed weight (Cv = of 25.4 mm to 37.4%). By the method of individual-family selection from local wild populations, the source material that became the basis for obtaining new varieties *Milica* and variety population IOF 21/12 is derived. The productivity of green mass of *Milica* variety is 26.0% higher than the standard, seed yield - 43.1%. The productivity of variety population OSP 21/12 is higher at 49.5 and 3.6%, respectively. Thanks to the complex of valuable morphobiological features. **Conclusion:** New varieties of phacelia can be used as a phytoameliorant and to create a forage base of beekeeping on highly eroded lands in the Steppe and Forest-Steppe zone. The new variety *Militsa* and variety population OSP 21/12 have high seed productivity and are suitable for commercial seed production.

Key words: Biological resources, calcareous soil, ecological selection, morphobiological characteristics, *Phacelia tanacetifolia* Benth., tolerance to drought, variety *Milica*

INTRODUCTION

A peculiarity of the Cretaceous South of the Central Russian Upland, in addition to unstable wetness, periodic droughts, and active erosion processes, is the high calcareousness content of soils and the reduction of the average power of the humus horizon.^[1,2]

The Cretaceous South of the Central Russian Upland is considered as a secondary anthropogenic

microgeneration center for the formation of a number of synanthropic plant species.^[3-7]

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Stable cenopopulations of wild conspecific of cultivated plants, possessing xeromorphic structure, drought resistance, resistance to carbonate chlorosis, and iron deficiency are revealed in gully-beam complexes of the region.^[8-10]

Their studying as biological resources and starting material for ecological selection is of undoubted scientific interest. Promising for the region is research unconventional synanthropic species introduced plants such as *Phacelia tanacetifolia* Benth.

The expansion of the cultivation regions, as well as the prospects for the use of phacelia, requires the creation of new adapted varieties resistant to a complex of biotic and abiotic factors.^[11-20]

P. tanacetifolia Benth. is the only species of the family waterleaf (*Hydrophyllaceae*) cultivated in the European part of Russia and the Ciscaucasia.^[21-24]

P. tanacetifolia Benth. is widely used as break crops. Phacelia is a good phytomeliorant capable in field, fodder, and special crop rotations to increase soil fertility and to strengthen fodder base of animal husbandry and beekeeping.^[23,25]

Methods for improving drought resistance of *P. tanacetifolia* Benth. are under study.^[17]

P. tanacetifolia Benth. is a promising forage crop: Green mass contains protein at 17.97 – 21.84%, fat at 2.18 – 2.88%, and soluble carbohydrates at 39.85–42.54%. The yield of green mass is from 160.3 to 341.0 dt/ha, dry matter is from 34.48 to 42.19 dt/ha. The preparation technology of haylage and pelleted feed of phacelia is developed.^[6,26]

The peculiarities of mineral nutrition and chemical composition of green mass of phacelia^[27-29] and ways to improve seed production^[2,17] are under study.

P. tanacetifolia Benth. is a valuable nectarous crop. The flower allocates at an average 1.62 mg of nectar with a sugar content at 42–57%. Depending on the region and conditions of cultivation, the melliferous capacity of the crop varies from 250 to 500 kg/ha with a high level of profitability.^[8,23-25,30-33]

The aim of the work is to create new adapted varieties resistant to the complex of biotic and abiotic factors on the basis of using morphological and biological characteristics of *P. tanacetifolia* Benth.

MATERIALS AND METHODS

The methodological basis of selection research is developed by the authors with the concept of formation in the South Central Russian Upland secondary anthropogenic microgene center of forming individual synanthropic species of plants.^[4,20,21,24,31]

Morphological and biological features of *P. tanacetifolia* Benth. and the expansion of run wild forms were examined in route studies in various districts of Belgorod region (2002–2008). In the process of longstanding work of scientists breeders from Belgorod State National Research University (NRU “BelSU”), a working collection of phacelia forms, which have valuable morphological and biological characteristics, was created.

Selection analysis of the obtained material in 2009–2016 was carried out on the basis of the Botanical garden of NRU “BelSU.” Method of selection is individual family selection. The standard in the experiment was the released Ryazanskaya variety. Field experiments on competitive variety testing in 2014–2016 were laid by the method of split plots. It was repeated 6 times. The area of registration plots of the 1st order (a record harvest of green mass) was 50 m². The area of registration plots of the 2nd order (taking into account the crop for green mass and seeds) was 25 m². Observations, records, and statistical processing of the obtained data were carried out according to standard methods.^[9,34]

RESULTS AND DISCUSSION

P. tanacetifolia Benth. came under cultivation in the Belgorod region, runs wild, and forms coenopopulations in the natural conditions adapted to difficult soil and climatic conditions of the region. They get a complex of morphological and biological features of environmental resistance and adaptability.

In the process of route studies, the habitats of *P. tanacetifolia* Benth. on the territory of several districts of the Belgorod region were identified: The Alekseyevsky, Krasnogvardeysky, Volokonovsky, and Chernyansky. All habitats are concentrated near settlements, the former farms or beeyards, dumps of garbage, and roadsides.

The study of coenopopulations of *P. tanacetifolia* Benth. of various ecological origin allowed to reveal both certain features of similarity and differences between them on morphobiological characteristics. At the same time, quite a wide variation is observed between individuals, which may indicate the possibility of obtaining forms with the necessary characters of breeding methods.

The original forms identified in Volokonovsky area differ by sprawling bush form, green coloration of the stem, and blue or a light blue corolla. Variety populations of Alekseyevsky, Chernyansky, and Krasnogvardeysky regions have semiclosed form of a bush, anthocyanin-colored stems, and light purple or lilac-colored corolla. A wide range of variation is established for other parameters: Plant height (Cv = of 34.8–46.7%), diameter of the bush (Cv = of 43.2–54.5%) and diameter of the stem (Cv = of 67.1–78.4%), and length of inflorescences (Cv = of 46.7–55.2%) and 1.000 seed weight (Cv = of 25.4 mm to 37.4%).

The main morphological and biological features, by which there was breeding, were branching stem, inflorescence length, the number of cincinnuses in the inflorescence, time of beginning of plants flowering, the degree of stem downiness, and the degree of leaves downiness.

By the method of individual family selection in 2018, a new variety of phacelia - *Milica* was obtained. The variety has good drought resistance, high yield of fodder mass, and stable seed productivity. *Milica* variety is promising for use as green manure and fodder and nectareous culture. It is being tested a promising new variety population OSP 21/12, which will be transferred to the state competitive strain testing in 2018 [Tables 1 and 2].

Compared with the variety *Ryazanskaya*, the productivity of green mass of variety *Militsa* is higher by 26.0% and the yield of seeds by 43.1%. The new variety population OSP 21/12 is higher by 49.5 and 30.6%, respectively.

Individuals of variety *Milica* have the leaf coverage of 51.0% and OSP 21/12 of 56%, which is 7.2–7.9% higher than the standard. In height, they surpass variety *Ryazanskaya* by 9.1–9.8%. The duration of the flowering period exceeds the standard by 5–8 days, that allows to extend the period of nectar gathering and is an important indicator for beekeeping.

Drought resistance of variety *Milica* and variety population OSP 21/12 on average for 3 years of research was 4.6 points against 3.8 points in the standard.

Farm tests have shown that the new varieties are suitable for production technology of cultivation, mechanized harvesting, and processing. Higher and guaranteed seed productivity allows to reduce the self-cost of their cultivation by 22–24%.

Table 1: Seed yields of phacelia in the competitive strain testing, dt/ha

Variety	Years of research			Average
	2014	2015	2016	
Variety <i>Ryazanskaya</i> standard	3.05	2.56	2.88	2.83
Variety <i>Militsa</i>	3.90	3.45	4.80	4.05
OSP 21/12	3.78	3.87	5.03	4.23
LSD, 05	0.20	0.16	0.23	0.20

Table 2: Productivity of phacelia green mass in competitive strain testing, dt/ha

Variety	Years of research			Average
	2014	2015	2016	
Variety <i>Ryazanskaya</i> standard	186.0	193.0	230.0	203.0
Variety <i>Militsa</i>	226.0	256.0	285.0	255.7
OSP 21/12	230.0	264.0	298.0	265.0
LSD, 05	7.2	11.3	11.8	10.1

Due to the valuable morphological and biological qualities of the new varieties, it is recommended to use them for creating a forage base of beekeeping on strongly eroded lands in the Steppe and Forest-Steppe zone.

CONCLUSION

For the first time in the conditions of Cretaceous South of the Central Russian Upland, morphological and biological features of wild *P. tanacetifolia* Benth. cenopopulations were studied. The method of individual-family selection from local wild populations obtained the starting material, which became the basis for the production of new varieties. The new variety *Militsa* and variety population OSP 21/12 have high seed productivity and are suitable for commercial seed production. Thanks to the complex of valuable morphobiological characters, and they can be used as a phytomeliorant and to create a fodder base of beekeeping on strongly eroded lands in the Steppe and Forest-Steppe zone.

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