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ENRICHMENT OF THE LOCAL PLANT GENEFUND FOR PROVIDING A RESOURCE BASE FOR PRIORITY AGRO-FOOD SYSTEMS

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Abstract

Plant genetic resources are a link between environment, agriculture and food systems, so their conservation requires cooperation within the different sectors of bio-economy. The existing diversity in local genetic resources is an initial base in crop breeding corresponding with the new challenges such as climate change, plant health and food quality. As a result from the activities of the National Research Program "Healthy foods for a strong bio-economy and quality of life" 63 accessions from different regions of Southern Bulgaria were collected through several collecting missions. Each accession was described by passport data including: taxonomic description under the nomenclature of the GRIN system, date of registration in the collection, donor, ecological and geographical characteristics of the explored area, biological status, etc., according to the International descriptor of FAO/Bioversity. The greatest diversity of old varieties and local forms has been found in the legumes and vegetable crops. The seeds are usually inherited in families or passed between neighbours and they are intended for household or local market. The collected plant materials were evaluated by morphological and agro-biological characteristics. Evaluation data from accessions of bean showed high variability of morphological traits as height of plants, number of pods and seeds per plant. The results obtained from this study will be useful in breeding programs and interspecific crosses, for selection and introduction of desired traits through pre-breeding programs, for research and direct use of farmers.

Keywords: plant genetic resources, expeditions, documentation, evaluation, gene bank conservation.

INTRODUCTION

The climate changes create significant challenges to the global food safety. It is a power bank of emerging risks to food security, plant health and product quality. Long-term changes in temperature and precipitation, as well as the frequency of extreme weather events, have a negative impact on agricultural practices, production and nutritional qualities of the crops (Maggiore et al., 2020).

By preserving biological diversity and restoring some plant species forgotten for consumption and neglected in modern times, an access to unused food resources is provided. This, combined with the wealth of traditional knowledge about their use and time-proven good agricultural practices, makes a significant contribution to sustainable agriculture with a high social and cultural impact (Ulian et al., 2020).

Despite the documented great taxonomic diversity that provides food for the population, people are currently content with a surprisingly limited number of plants; for example, only three crops - rice, wheat and corn - make up over 50% of plant calories. The projected impacts of climate change on edible plants across the global spectrum endanger the sustainability of agri-food systems. The agricultural production needs to expand the range of species and varieties to diversify the

table, as well as to increase adaptability to changing conditions of the existing set of dominant useful plants. In the future, the main challenges facing agriculture will be the displacement of species, disruption of biotic interactions, the spread of invasive plants and new pests and pathogens. Timely and scientifically-based conservation and use of the local genefund is needed to mitigate and meet these negative impacts (Borrell et al., 2020).

Home gardens are usually seen as a complex, diverse type of farming system managed in a sustainable way for decades by a single family. In rural areas, these small farms are a kind of traditional biological exposures with their multi-layered plant structure. The main goals of home gardens are to provide for the family, as well as to generate income for the aging and poorer population. They should be seen as a model for sustainable agri-environmental systems, integrating both economic and social, cultural and environmental benefits. It is the maintained plant diversity in home gardens that is the basis for sustainable production (Knüpffer, 2002; Kehlenbeck et al., 2007).

The aim of the research is to analyze the created databases for accessions collected by expeditions, with a view to further use of their biological potential in crop breeding or for direct reintroduction of this local wealth in the agricultural practice.

MATERIALS AND METHODS

As part of the National Collection of Plant Genetic Resources, stored in the genebank of IPGR Sadovo, the local genefund occupies a quarter and is characterized by significant species diversity.

The objects of the present study are 36 local accessions collected during the period 2019-2020 from the regions of Southern Bulgaria (Table 1).

Three expeditions were organized according to an approved work program and pre-determined routes based on previous studies.

The passport database includes information on the taxonomic description of crops according to the nomenclature of the GRIN system (USDA Genetic Resources Information Network), date of registration in the collection, donor, ecological and geographical characteristics of the collection area, biological status of the accessions, etc. (FAO/Bioversity, 2017).

The information from the seed donors for traditional technologies of cultivation of crops is collected and analyzed, as well as specific characteristics such as early maturity, disease resistance, quality of production, productivity, where the accession was obtained, how long it is grown on the farm, the area loan, reasons for growing - traditional, cultural/religious, market demand, taste; direction of production - for domestic consumption, local market, ecotourism, for the country/abroad, direct market/through an intermediary; traditional recipes for using the accession, etc.

The accessions were evaluated by morphological and agro-biological qualities in the experimental field of IPGR Sadovo by ECPGR descriptors, which complement the passport characteristic.

The reproduced accessions were stored in the genebank.

The obtained results were processed using statistical package SPSS 19.0. for Windows (IBM SPSS Statistics 19 Product Version: 19.0.0). The genetic distance of the traits was determined using cluster analysis. The accessions were grouped according to the Euclidean distance.

RESULTS AND DISCUSSION

Expeditions were conducted in three municipalities of Southern Bulgaria with

different ecological-geographical characteristics and traditions in agriculture (Fig. 1).

As a result of the studied local plant diversity in the areas of cultivation and maintenance on farm, valuable local varieties and information on traditional agricultural practices have been collected (Picture. 1).

The territory of Smolyan Municipality is characterized by mountainous terrain and small farms. The altitude of the visited villages is over 1000 m. Three farms were visited, where traditional local forms of beans (*Ph. vulgaris* and *Ph. coccineus*) are still maintained. A local chickpea variety (*Cicer arietinum*) was collected from a home garden in the village of Arda. According to the farmers, these accessions have been grown for 100 years and have been passed down for generations. They are characterized by very good taste, extremely favorable for mountain climate, but do not resist drought and are not highly productive. Farmers apply only organic fertilizers and use almost no plant protection. The production is intended for the preparation of traditional dishes for the region in the household. In case of an excess production, part of it is offered for sale at the local market in the village or at a designated place by the roadside. The region of Pazardzhik has traditions in vegetable production. There are large farms with a high degree of intensification, which is one of the main reasons for limiting the diversity of local and traditional varieties, replacing them with high-yielding modern hybrids. The high urbanization in the area, the developed transport infrastructure and the ecological threats have put the local plant genefund at great risk. However, there are villages in the municipality where the old varieties are still grown.

Table 1. Passport information of collected local accessions

N	Cat. N	Taxonomy	Municipality	Location	Altitude (m)
1	B9E0004	*Phaseolus vulgaris L.*	Smolyan	Petkovo	1100
2	B9E0005	*Phaseolus vulgaris L.*	Smolyan	Petkovo	1100
3	B9E0006	*Phaseolus vulgaris L.*	Smolyan	Petkovo	1100
4	B9E0007	*Phaseolus coccineus L.*	Smolyan	Petkovo	1100
5	B9E0008	*Phaseolus vulgaris L.*	Smolyan	Petkovo	1100
6	B9E0009	*Phaseolus coccineus L.*	Smolyan	Petkovo	1100
7	B9E0010	*Phaseolus vulgaris L.*	Smolyan	Arda	1003
8	B9E0011	*Phaseolus vulgaris L.*	Smolyan	Arda	1003
9	B9E0012	*Phaseolus vulgaris L.*	Smolyan	Arda	1003
10	B9E0013	*Phaseolus vulgaris L*	Smolyan	Arda	1003
11	B9E0014	*Cicer arietinum L.*	Smolyan	Arda	1003
12	B9E0015	*Phaseolus coccineus L.*	Smolyan	Petkovo	1100
13	B9E0016	*Phaseolus vulgaris L.*	Pazardzhik	Ognyanovo	195
14	B9E0017	*Hibiscus esculentus L.*	Pazardzhik	Ognyanovo	195
15	B9E0018	*Capsicum annuum L.*	Pazardzhik	Ognyanovo	195
16	B9E0019	*Capsicum annuum L.*	Pazardzhik	Ognyanovo	195
17	B9E0020	*Cucurbita sp.*	Pazardzhik	Ognyanovo	195
18	B9E0021	*Solanum lycopersicum L.*	Pazardzhik	Ognyanovo	195
19	B9E0022	*Solanum lycopersicum L.*	Pazardzhik	Ognyanovo	195
20	B9E0023	*Solanum lycopersicum L.*	Pazardzhik	Ognyanovo	195
21	B9E0024	*Phaseolus vulgaris L.*	Pazardzhik	Sinitovo	199

22	B9E0025	*Cucurbita sp.*	Pazardzhik	Sinitovo	199
23	B9E0026	*Capsicum annuum L.*	Pazardzhik	Sinitovo	199
24	B9E0027	*Solanum lycopersicum L.*	Pazardzhik	Sinitovo	199
25	B9E0028	*Capsicum annuum L.*	Pazardzhik	Sinitovo	199
26	B9E0029	*Solanum lycopersicum L.*	Pazardzhik	Sinitovo	199
27	B9E0030	*Cucurbita moschata Duch.*	Pazardzhik	Sinitovo	199
28	B9E0031	*Cucumis melo L.*	Pazardzhik	Sinitovo	199
29	B9E0032	*Capsicum annuum L.*	Pazardzhik	Sinitovo	199
30	B9E0033	*Capsicum annuum L.*	Pazardzhik	Sinitovo	199
31	B9E0034	*Capsicum annuum L.*	Pazardzhik	Sinitovo	199
32	B9E0035	*Capsicum annuum L.*	Pazardzhik	Sinitovo	199
33	B9E0036	*Solanum lycopersicum L.*	Pazardzhik	Sinitovo	199
34	B9E0037	*Solanum lycopersicum L.*	Pazardzhik	Sinitovo	199
35	B9E0038	*Solanum lycopersicum L.*	Pazardzhik	Sinitovo	199
36	B9E0039	*Solanum lycopersicum L.*	Pazardzhik	Sinitovo	199
37	B9E0040	*Solanum lycopersicum L.*	Pazardzhik	Sinitovo	199
38	B9E0041	*Solanum lycopersicum L.*	Pazardzhik	Sinitovo	199
39	B9E0042	*Capsicum annuum L.*	Pazardzhik	Sinitovo	199
40	B9E0043	*Cucurbita sp.*	Pazardzhik	Sinitovo	199
41	B9E0044	*Vicia faba L.*	Pazardzhik	Sinitovo	199
42	B9E0045	*Zea mays L.*	Pazardzhik	Sinitovo	199
43	B9E0047	*Solanum lycopersicum L.*	Sozopol	Indje Voivoda	274
44	B9E0048	*Solanum lycopersicum L.*	Sozopol	Indje Voivoda	274
45	B9E0049	*Allium sativum L.*	Sozopol	Indje Voivoda	274
46	B9E0050	*Solanum lycopersicum L.*	Sozopol	Indje Voivoda	274
47	B9E0051	*Capsicum annuum L.*	Sozopol	Indje Voivoda	274
48	B9E0052	*Trigonella sp.*	Sozopol	Indje Voivoda	274
49	B9E0053	*Phaseolus vulgaris L.*	Sozopol	Indje Voivoda	274
50	B9E0054	*Cucurbita maxima Duch.*	Sozopol	Indje Voivoda	274
51	B9E0055	*Cucurbita moschata Duch.*	Sozopol	Indje Voivoda	274
52	B9E0056	*Phaseolus vulgaris L.*	Sozopol	Indje Voivoda	274
53	B9E0057	*Cucurbita maxima Duch.*	Sozopol	Indje Voivoda	274
54	B9E0058	*Cucurbita pepo L.*	Sozopol	Indje Voivoda	274
55	B9E0059	*Phaseolus vulgaris L.*	Sozopol	Indje Voivoda	274
56	B9E0060	*Cucumis melo L.*	Sozopol	Indje Voivoda	274
57	B9E0061	*Ocimum basilicum L.*	Sozopol	Indje Voivoda	274
58	B9E0062	*Anethum graveolens L.*	Sozopol	Indje Voivoda	274
59	B9E0063	*Capsicum annuum L.*	Sozopol	Indje Voivoda	297
60	B9E0064	*Capsicum annuum L.*	Sozopol	Indje Voivoda	297
61	B9E0065	*Capsicum annuum L.*	Sozopol	Indje Voivoda	297
62	B9E0066	*Solanum melongena L.*	Sozopol	Indje Voivoda	297
63	B9E0067	*Cucurbita moschata Duch.*	Sozopol	Indje Voivoda	297

Source: National Register for Plant Genetic Resources, IPGR Sadovo

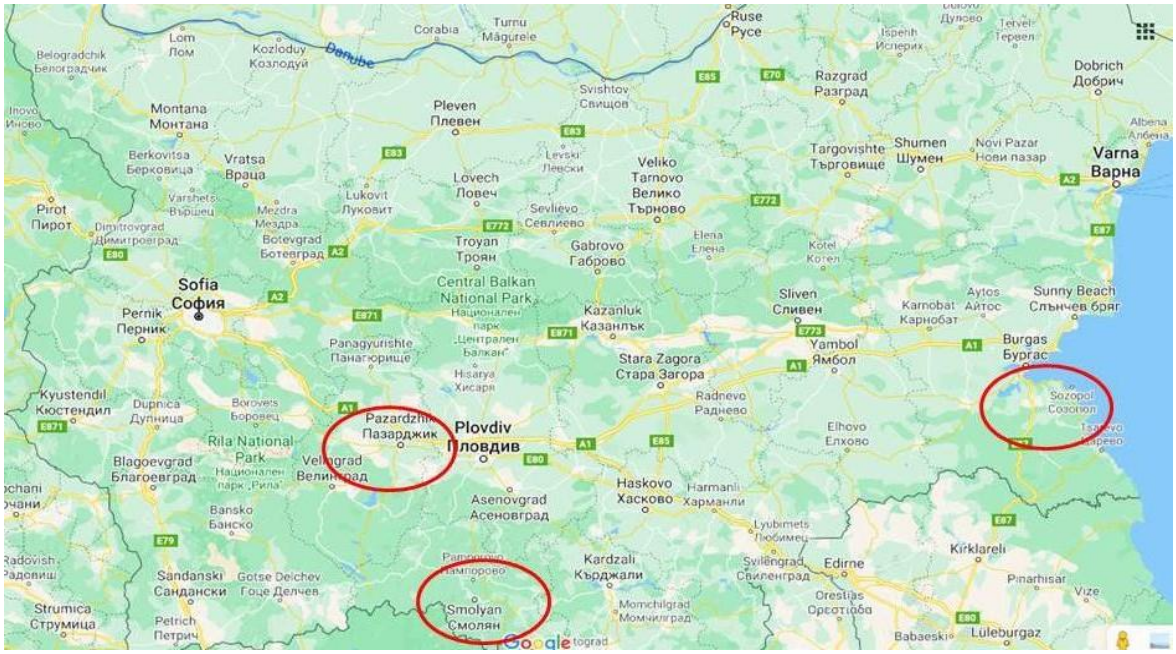

Fig. 1. Visited areas for collecting local accessions
Source: Google maps

The expeditions were aimed at investigating the home gardens of older farmers who still maintain a variety of traditional vegetables in small areas. The villages of Ognyanovo and Sinitovo as well as four farms were visited, in which old local varieties were grown. As a result, one variety of sweet corn, 2 accessions of bean (*Ph. vulgaris*), 1 acc. of broad beans, 11 acc. of tomatoes, 9 acc. of pepper, 1 acc. of okra, 4 acc. of pumpkin and 1 acc. of melon were collected.

Sozopol Municipality is located in the eastern part of Burgas region. Its area includes coastal tourist villages, as well as a flat part, which gradually passes into the hills of Strandzha. The expedition was aimed at exploring the villages in the lowlands. There are no large farms in the area, which, combined with the relatively small population and the specific climatic conditions of the coastal area, supports the possibility of finding valuable accessions of traditional local cuisine. We visited the village of Indje Voivoda, where within several farms 21 local accessions were collected: bean (3 acc.), tomatoes (3 acc.), pepper (4 acc.), eggplant (1 acc.), melon (1 acc.), pumpkin (5 acc.), garlic (1 acc.), basil (1 acc.), dill (1 acc.) and fenugreek (1 acc.).

According to the information provided by the farmers, the local varieties are grown in the gardens in a completely environmentally friendly way, without the use of chemicals and fertilizers. Genotypes show high adaptability to soil and climatic conditions of cultivation and high tolerance to diseases. Only biological control of pests and manual cultural practices are applied in the cultivation of crops. The yields are good and the taste qualities are suitable for the specific cuisine of the Southeast Black Sea coast. The farm grows an average of 10 to 20 plants per sample, watered by gravity, unevenly, sparingly in order to save water resources. These varieties have been grown for many years on the farm, with the oldest member of the family preparing the seeds for the following year. The largest and well-ripened fruits are selected from the healthiest plants for seeds next year.

The clean natural environment

preserved as a result of socio-economic factors and the guaranteed market in the tourist settlements are excellent preconditions for restoring the traditional taste in practice. The area is extremely suitable for the development of organic and environmentally friendly agriculture.

The newly collected accessions of bean were studied by descriptor in the conditions of the town of Sadovo and a high variety of economic characteristics was reported. Based on the phenological assessment, 71.43% of the genotypes are characterized as early-flowering with a period from sowing to mass flowering of 30 to 40 days, and the rest - medium early-flowering (41 to 50 days). 54.29% of the genotypes *Ph. vulgaris* ripen for the period 50 to 70 days, and the other 42.85% - from 71 to 80 days. The results of the biometric measurements of plant height (cm), number of pods and seed weight per plant (g) are presented on Fig. 1, 2 and 3.

Picture. 1. Collection mission in village Indje Voivoda, Strandzha mountain, Bourgas region, conducted by National Research Programme "Healthy Foods for a Strong Bio-Economy and Quality of Life", 2019

The cluster analysis separates the *Ph. vulgaris* genotypes in four groups (Fig. 5). The first cluster unites two subgroups, which include 7 genotypes of a diverse geographical origin. The second cluster includes 3 genotypes from Smolyan Minicipality, which are characterized by plant height from 44.8 to 51.0 cm, a high number of pods per plant and seed weight. An independent cluster forms catalogue number B9E0056 from the village of Indje Voivoda, which has the lowest values of the traits. The genotypes B9E0005 and B9E0008 from the village of Petkovo are grouped into the fourth cluster. They are characterized by the highest values of all studied economic characteristics: plant height (62.0-73.5 cm), number of pods per plant (8.2-9.2) and seed weight (12.5 -13.2 g).

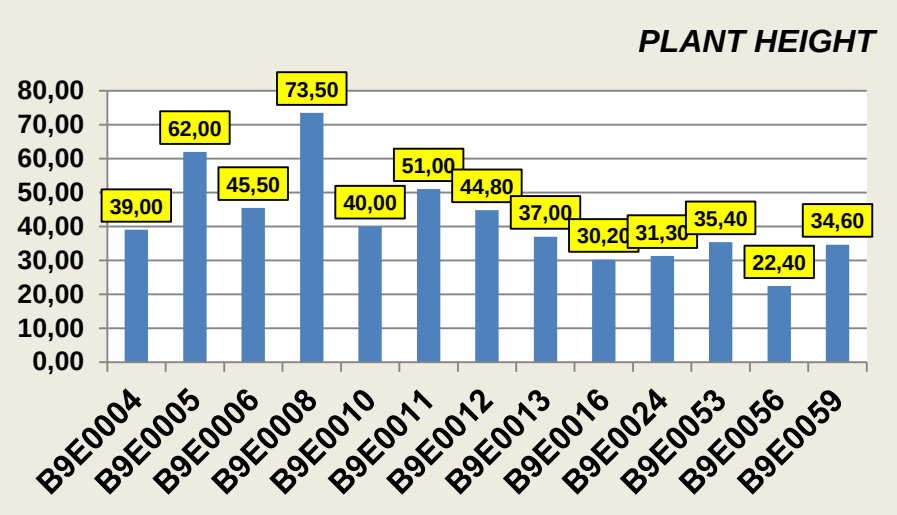

Fig. 2. Plant height of local *Ph. vulgaris* genotypes

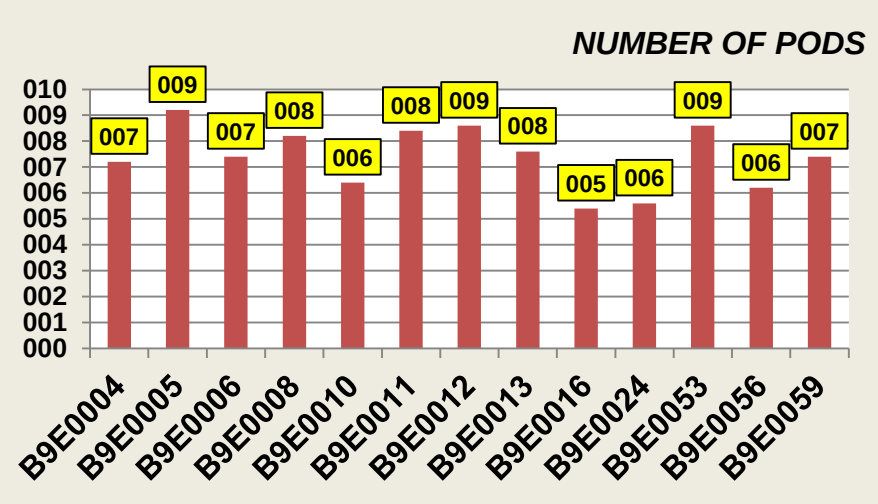

Fig. 3. Number of pods of local *Ph. vulgaris* genotypes

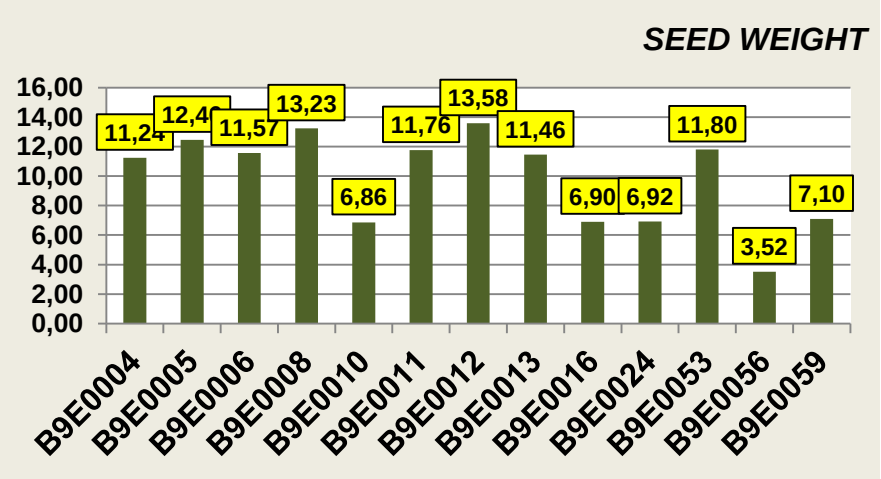

Fig. 4. Seed weight of local *Ph. vulgaris* genotypes

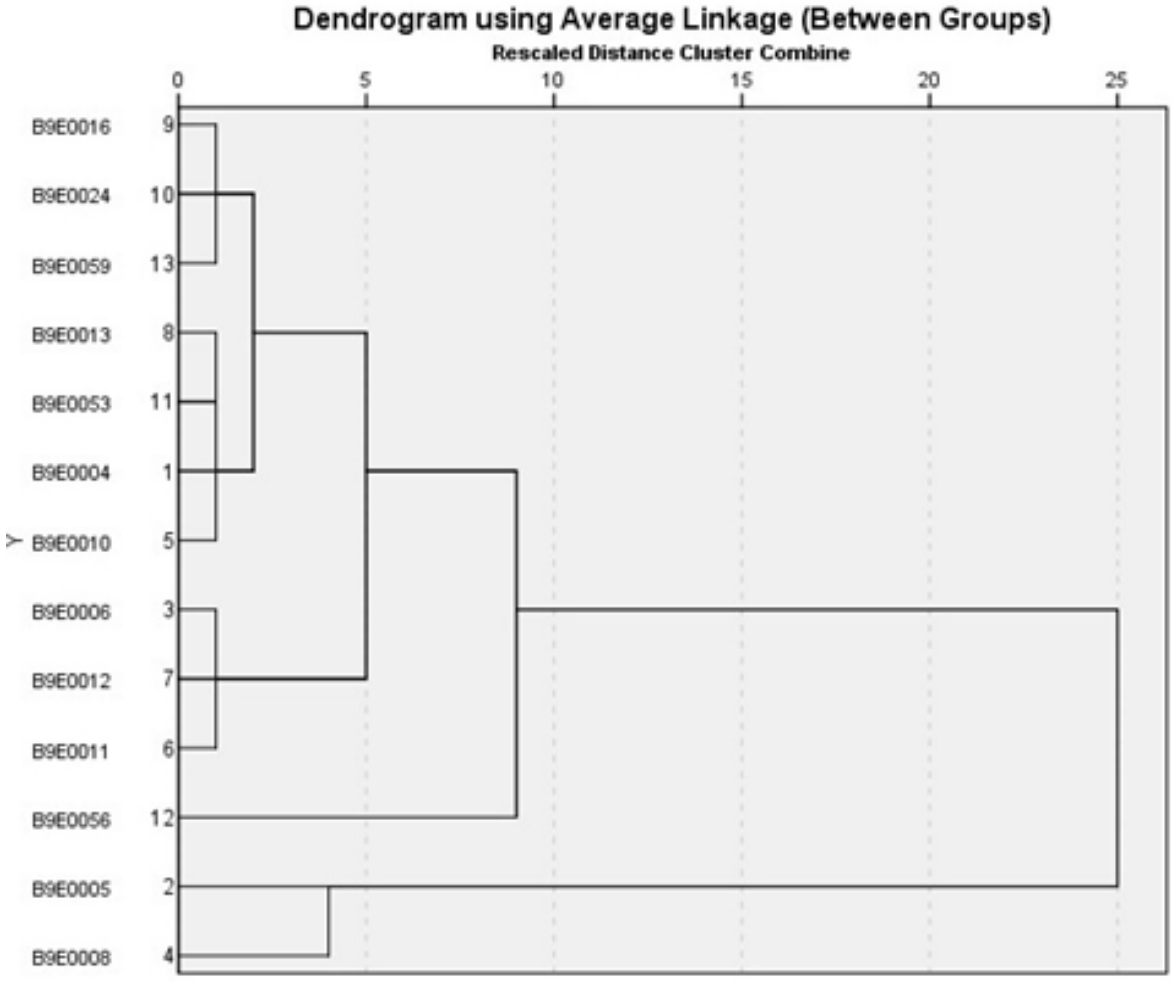

Fig. 5. Grouping of *Ph. vulgaris* genotypes

CONCLUSIONS

During the period 2019-2020 the National Collection is enriched with 63 accessions, characterized by a diverse ecological-geographical origin and biological status.

Through expeditions in the region of Strandzha a great variety of valuable local plant genetic resources was reported even within the boundaries of one settlement.

The collection of local genefund significantly contributes to the enrichment of *ex situ* collections, expands the possibilities of crop breeding and reintroduction of valuable traditional varieties in practice in connection with the climate change and food security.

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