CONSERVING LOCAL DIVERSITY OF COMMON BEAN (*PHASEOLUS VULGARIS* L.) *IN SITU* / ON FARM

T. Stoilova*, P. Chavdarov, N. Velcheva

Institute of Plant Genetic Resources, 2 Drugba str., Sadovo 4122, Bulgaria

Abstract

Dry bean is considered as one of the major legume crop with big number of landraces grown in Bulgaria. Local forms of Phaseolus spp. are conserved on farm in different geographical regions and show a wide morphological diversity.

The aim of our study was to collect, conserve and characterize local populations of Phaseolus vulgaris L. and Phaseolus coccineus L. typically grown in Smilyan, Troyan and Velingrad regions. The most popular local forms were characterized using different approaches. In this paper we will present results from morphological characterization and phythopathological evaluation. Qualitative and quantitative traits were assessed on 50 accessions of Phaseolus spp. during vegetation cycle. All information was documented in European electronic catalog "EURISCO" and is available on line (http://eurisco.ecpgr.org)

Key words: *diversity, common bean, landraces, conservation*

1. INTRODUCTION

The grain legumes are important source of protein against to hunger and malnutrition in the world [1]. They supply 18-20% of total fund of plant protein. The seeds are 2 to 5 richest of proteins comparing with cereals, and most of them consist between 20-35% crude proteins [2]. Traditional food for Bulgarians is field beans (*Phaseolus spp*.). The common bean (*Ph. vulgaris* L.) is more popular in the country, while runner bean (*Ph. coccineus* L.) is adapted and well grown in the mountain regions. Landraces of these two species contain a much larger gene pool that is being used to enrich crop diversity in breeding programs of this crop. Landraces include local populations and old varieties results of long evolution during more than hundred years [3]. Following the definition [4] "A landraces is a dynamic population(s) of a cultivated plant that has historical origin, distinct identity and lacs formal crop improvement, as well as often being genetically diverse, locally adapted and associated with traditional farming systems'[4]. Landraces are still maintaining in farmer's field in many regions and micro regions across all the country, because of their excellent organoleptic taste, culture and traditions, and very good adaptation to local agro climatic and soil conditions. Landraces are presented *on-farm* or *in-garden* and show a wide morphological and genetic diversity of plants, flowers, pods and seeds [5].

The Phaseolus collection preserved at the national genebank located at the IPGR consists at about 2000 accessions with different geographical origin and is one of the biggest among all crop collections [6]. More than 550 accessions are local and were collected with support of several national and international projects. Numbers of trips were organized to collect local plant material from different geographical locations of Bulgaria during the last decade.

The current objectives of this study were to collect and morphologically characterize Phaseolus germplasm with Bulgarian origin. To assess resistance to economically important diseases, namely *Pseudomonas syringae pv. phaseolicola* and *Xanthomonas campestris pv. Phaseoli.* The accessions will be grouped according to their traits' similarity to provide valuable information for researchers, breeders and farmers.

2. MATERIAL AND METHODS

2.1 Materials

The plant materials were collected together with passport information followed the methodology of Bioversity Int. and the International *Phaseolus* descriptor [7]. The study was carried out on 50 accessions of dry bean (Ph. vulgaris L.) with local origin.

Plants were observed for symptoms of natural infection caused by *Ps. Syringae pv. Phaseolicola* and *X. campestris pv. Phaseoli* twice at flowering and podding stages during vegetation cycle [8].

2.2 Methods

The field experiment was carried out on 50 samples with Bulgarian origin during 2019 and 2020 at the Institute of Plant Genetic Resources (IPGR), Sadovo. Each accession was sown in two rows with 5 m length and 0.7 m interrow in two replications. The entries were sown in a 2 or 4 rows, depends of the seed quantity available with two replications. Basic phenological and morphological parameters were recorded during vegetation cycle. The agronomic characters were taken after harvesting the matured plants. From each accession 10 plants per replication were measured for different morphological traits for biometrical measurements. Observations of 13 quantitative and two qualitative characters related to vegetative and reproductive organs were measured (Table 1). Number of days to flowering and number of days to maturity were also recorded.

Table 1. Observations on 14 characters of *Ph. vulgaris* (L.).

No	Character	No	Character
1	Height of plant (HP)	8	Width of pod (W/pod)
2	Height of the first pod (H1stpod)	9	Number of seeds /pod (NS/pod)
3	Leaf length (LL)	10	Seed length (SL)
4	Leaf width (LW)	11	Seed width (SW)
5	Number of pods per plant (NP/pl.)	12	Weight of seeds/plant (WS/pl.)
6	Weight of pods per plant (WP/pl.)	13	Number of days to 50% flowering (DF)
7	Length of pod (L/pod)	14	Number of days to 95% maturity (DM)

The phytopathological observations were scored using scale from 1 to 9 according to the descriptor of [8]. The reactions are coded on a 1-9 scale, where: 1 – tolerant, 3- low sensitive; 5-medium sensitive; 7 – high sensitive.

The collected data were analyzed by the SPSS 19 programme.

3. RESULTS

The bean collection consists at about 2000 accessions, as one third is with local origin. As a result of the organized several expeditions during the last decade a rich collection of 455 specimens of common beans *(Ph. vulgaris* L. and *Ph. coccineus* L.) were gathered from different region of the country (Table 2). The sources of the collected materials were used private farms, home gardens and local markets. Each accession possessed information of the donor name; donor identification number (number assigned by the donor); scientific name (genus, species, botanical variety), local/ vernacular name, location with geographical information (latitude, longitude and altitude), photograph of the samples, name of the institute, collector's name, data of the collecting and other notes of the collector.

Table 2. Collecting missions and collected plant materials from 2010 to 2019.

Year	Project/ acronym	Visited regions	No of collected accessions
2010	GCDT*	Veliko Tarnovo, v.Arbanasi, Gabrovo, Dimitrovgrad, Lubimets, Dryanovo, Sadovo	33
	BGR-SVN	v. Sheinovo, Vratsa, Kazanlak	9
	BGR-SVN	Kavarna	4
Sub-total number			**46**
2011	BGR-CHN	Velingrad, v. Kostandovo, v. Rozovo, Bratsigovo, Pazardghik	47
	BGR-SVN	v. Krumovo, Pazardghik, Sliven, Burgas, Dobrich, Tsarevo, v. Kondolovo, v. Bratanitsa, v. Vetren Dol	35
	GCDT	Dimitrovgrad, Simeonovgrad, Velingrad, v. Kostandovo	22
	ERA 168	Pazardghik, Plovdiv, v. Kochovo	2
	MON	v. Pesnopoi	1
Sub-total number			**107**
2012	ERA 168	Bachkovo, Plovdiv, Koprivshtitsa	19
	BGR-MKD	Karlovo, Stara Zagora, Blagoevgrad, Razlog, Pazardghik, Smolyan	14
	GCDT	Chepelare, Sadovo	10
	BGR-CHN	Krichim	5
Sub-total number			**48**
2013	BGR-MKD	Stara Zagora, Pazardhik	4
Sub-total number			**4**
2014	P 150 (Agricultural Academy)	v. S. Gelezare, v. Malak Chardak, Sadovo, v. Katunitsa, v. Cheshnegirovo	14
Sub-total number			**14**
2015	BGR-CHN	Dobrich	2
Sub-total number			**2**
2016	DNTS/China 01/11	Blagoevgrad, Aitos, Burgas, Nessebar, Pomorie, Lovech, Vratsa, Kneja, Pazardghik, Strumyani	93
	P 150 (Agricultural Academy)	v. Kuklen	2
Sub-total number			**95**
2017	DNTS/China 01/11	Ivailovgrad	1
	P 172 (Agricultural Academy)	v. Kuklen	1
Sub-total number			**2**
2019	IPK Gatersleben	Repatriated germplasm	119
	NNP Food/ MON	v. Petkovo, v. Arda, Sozopol, v. Ognyanovo, v. Sinitovo	16
	P 172 (Agricultural Academy)	Elena, v. Cheshnegirovo	2
Sub-total number			**137**
TOTAL NUMBER			**455**

*GCDT-Global Crop Diversity Trust; BGR-Bulgaria; SVN-Slovenia; CHN-China; MKD-Republic of North Macedonia; MON-Ministry of Science; NNP Food- National programme for healthy food and strong bio economy;

All passport information is published in the European electronic catalog for plant genetic resources (EURISCO) and data are available and accessible on line through the website *http://eurisco.ecpgr.org* [9]. The landraces of beans in Bulgaria are distinguished by their great diversity, and therefore required a continuation of collection and research.

The most distributed bean landraces in Bulgaria possess white color of the seeds. The majority of reported accessions in this study have white flowers and white color of seeds, respectively (Table 3). The rest 16 accessions have different flowers' color, like light or dark lilac and produced colored seeds, as brown, beige, spotted or striped with different colors. The most frequent seed shape among all studied accessions are cuboid (22), followed by kidney (15), oval (8), round (4) and one accession with truncate seed shape.

Table 3. Qualitative seed traits of 50 common bean accessions.

Cat. No	flower	Seed color	Seed shape	Cat. No	Flower	Seed color	Seed shape
Eleksir (St. 1)	white	white	cuboid	A9E0182	lilac	Beige /brown stripped	cuboid
A7E0269	white	white	kidney	A9E0150	white	white	kidney
A7E0270		White with black	oval	A9E0155	white	white	kidney
A7E0292	white	white	kidney	A9E0139	white	white	oval
A8E0634	white	white	cuboid	A9E0934	white	white	cuboid
A8E0594	lilac	beige	cuboid	A9E1104	lilac	brown	kidney
A8E0498	lilac	Light beige	round	A9E1106	lilac	brown	kidney
A80439	lilac	White with black	cuboid	A9E1121	white	white	cuboid
A8E0437	white	white	cuboid	A9E1101	lilac	Light brown	kidney
A9E0708	white	white	oval	A9E1100	white	white	cuboid
A9E0783	white	white	cuboid	A9E1054	lilac	Beige/green stripped	kidney
A9E01085	white	white	oval	A9E1008	lilac	brownish	kidney
A9E01150	white	white	kidney	A4E0001	white	white	cuboid
A9E0658	lilac	Beige/purple stripped	oval	A7E0643	lilac	black	cuboid
A9E0430	white	white	oval	A7E0668	white	white	cuboid
A9E0449	white	white	cuboid	A9E0460	lilac	Light beige	cuboid
A9E0311	white	white	cuboid	A7E0137	white	white	kidney
A9E0608	white	white	cuboid	A9E1008	lilac	brown	cuboid
A9E0607	white	white	truncate	A8E0139	lilac	Beige / brown stripped	cuboid
A9E0588	white	white	cuboid	B7E0212	lilac	beige	kidney
A9E0587	white	white	kidney	B9E0001	white	white	round
A9E0543	white	white	kidney	B0E0054	white	white	oval
B0E0048	white	white	cuboid	Blyan	white	white	cuboid
B1E0485	white	white	round	Skitya	white	white	kidney
B1E0483	white	white	oval	B(E0002	white	white	round

Mean, minimum and maximum values with coefficient of variation (CV%) of 12 quantitative morphological characters and two phenological observations are presented in Table 4.

Table 4. Descriptive statistics of the 50 common bean landraces.

No in row	Characters	Mean	Minimum	Maximum	CV (%)	SD (%)
1	Height of plant (cm)	59,9	25,4	132,2	38,4	23,0
2	Height of the 1st pod (cm)	23,6	14,4	42,0	20,4	4,8
3	Leaf Length (cm)	8,3	6,0	10,9	13,7	1,1
4	Leaf width (cm)	6,2	4,2	8,3	15,9	1,0
5	Number of pods/ plant	8,2	3,2	16,6	40,1	3,3
6	Weight of pods/ plant (g)	10,8	3,1	31,8	54,7	5,9
7	Length of pod (cm)	10,3	2,0	14,7	19,6	2,0
8	Width of pod (cm)	1,2	0,9	2,5	22,6	0,3
9	Number of seeds per pod	2,9	1,6	4,6	24,5	0,7
10	Seed length (cm)	1,2	0,8	1,5	12,7	0,2
11	Seed width (cm)	0,7	0,5	1,7	23,9	0,2
12	Weight of seeds/ plant (g)	7,1	1,9	21,8	60,3	4,3
13	Number of days to 50% flowering	34,9	26,0	53,0	14,3	5,0
14	Number of days to 95% maturity	81,9	68,0	94,0	11,9	9,8

The results obtained show a big variation among morphological characters and phonological records of the studied genotypes. The average number of days to reach 50% flowering was registered with 34,9 days, with range from 26 to 53 days. The earliest flowering accessions were A9E0708 (26 days), A9E 1085 (27 days), B0E0048 (27 days) while the latest accessions were A8E0139 (46 days) and A9E0783 (53 days). According to the number of days to maturity stage, the average period is 81,9 days where four accessions reach this stage after 68 -70 days (A8E1085, A9E0608, A9E0658, A8E04390), while few accessions mature late after 90-94 days (A9E0934, A9E1106, A9E1104). The variation of number of days to flowering and maturity stages are comparatively low compare with morphological traits. The group of studied accessions show a big variation in terms of the height of plant and height of the 1st pod, with mean values 59,9 cm and 23,6 cm respectively. The variation of plant height was recorded with 38,4% (CV%). The most variable traits referred to number of pods/ plant (40,1 %) and weight of pods/ plant (54,7%), as well as weight of seeds per plant (60,3%). The length of leaf and length of seed varied the least among the recorded traits, 13,7% and 12,7 % respectively.

The dendrogram show low similarity among all accessions. The cluster analysis identified five groups consisting from 5 to 18 accessions (Fig. 1).

Results from field assessment didn't show tolerant and middle tolerant scores. The majority of accessions showed middle sensitive and few accessions sensitive reactions.

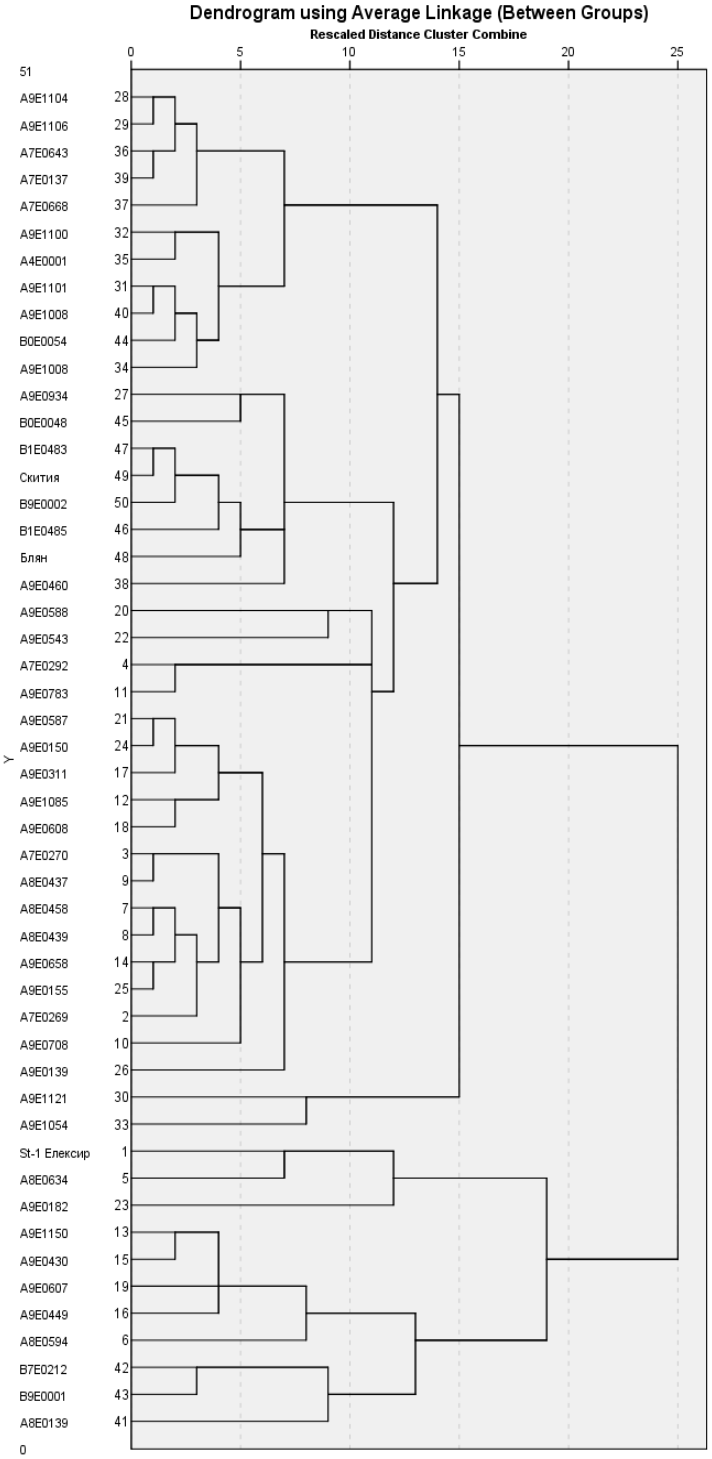
4. DISCUSSION

Common bean has an important role in the traditions of Bulgarian population for consumption as source of protein, as fodder for animal feeding and take special place in crop rotation with ability to improve soil fertility. There is a big diversity of common bean landraces in Bulgaria and different accessions are grown widely in almost every region of the country [5].

The present data indicate wide variability in vegetative and reproductive organs of the plants. The accessions differ in terms of vegetative plant habit, climbing, semi climbing and determinate. The variation of plant height explained the big difference among all accessions in the group. The accessions with climbing and semi climbing plant habit originated predominantly from mountain

regions and possess high yield potential and are associated with maximum T◦C during flowering and podding stages. The most important reproductive organs are pods and seeds. The majority of the accessions produced seeds with white color and kidney shape. The researches have been done in previous showed consumer preferences to white color and kidney shape of the seeds. The differences have been observed particularly in the mountain regions, where the most popular landrace was beige and stripped [10]. Based on the results from this study we may select the most promising accessions with high potential for yield and high quality of grains.

Fig. 1. Dendrogram using Average Linkage (Between Groups)



5. CONCLUSIONS

The evaluation of quantitative and qualitative traits gives the possibility to choose and include the most adapted accessions in future breeding activities or to conserve *ex situ* and *in situ*/ on farm and use them for typical production with high quality. The most important components of yield are: number of pods and seeds/ plant; weight of pods and seeds/ plant. The color shape and size of seeds are very important from the consumer's point of view. The results from our study provided information about the diversity of common bean landraces in terms of their morphological characteristics and phenological observations. The most promising accessions with early maturity of 72-74 days and total weight of seeds/ plant were A8E0594 (10,8 g/pl.); A9E0588 (13,1 g/ pl.); A9E0542 (21,8 g/pl.) and late maturity with 90-94 days to reach maturation and high yield potential were accessions with cat. No A9E1121 (20,8 g /pl.) and cat. No A9E1054 (15,4 g/ pl.). The scientific information obtained from this study is useful for others gene banks, breeding and research activities, and for direct use by farmers.

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REFERENCES

1. Singh, SP 1999, Improvement of small–seeded race Mesoameriaca cultivars. In: Singh, S.P. ed. Common bean improvement in the twenty–fi rst century. Kluwer Academic Publishers. Dordrecht. Boston, London. (1999), pp. 255-274.
2. Piergiovanni, AR, Cerbino, D., and Della Gatta 2000, Diversity in seed quality traits of common bean populations from Basilicata (Southern Italy)"., Plant Breeding, 119, pp. 513-516.
3. Negri, V. and Tosti N 2002, Phaseolus genetic diversity maintained on-farm in Central Italy. Genetic Resources and Crop Evolution 49, 511-520."
4. Gamacho Villa, T.C., Maxted, N. Scholten, M. and Ford-LIoyd B. 2005. Defining and identifying crop landraces. Plant Genetic Resources 3(03): 373-384.
5. Stoilova, T., Pereira G., Tavares-de-Sousa, M.M., Carnide, V 2005, Diversity in Common Bean Landraces (Phaseolus vulgaris L.) from Bulgaria and Portugal." Journal of Central European Agriculture, vol.6 (4), 443-448.
6. Stoilova, T 2007, "The collection of dry beans as initial material for breeding. International Research Conference-125 Years Agricultural Research in Sadovo, Plovdiv, June 13-14. Institute of Plant Genetic Resources, Sadovo, vol.1, 53-58."
7. International Board of Plant Genetic Resources (IBPGR), Descriptors for *Phaseolus vulgaris* Rome, Italy, 1982.
8. Genchev D. and Kiryiakov I 1994, "Common bean (*Phaseolus vulgaris* L.) breeding traits and their assessment". PSSA, p. 60.
9. Velcheva, N., H. Knüpffer, St. Weise (2017) Bulgarian National Inventory in International Plant Genetic Resources Databases. 135 years Agricultural Science in Sadovo and 40 years Institute of Plant Genetic Resources. 137-144.
10. Stoilova, T, Berova, M., Kouzmova, K. and Stamatov S 2014, "Study on diversity of Phaseolus spp. Landraces with reference to global climate change." Afr. J. Agr. Res. Vol. 9 (39): 2925-2935.