Bulletin of the *Transilvania* University of Braşov
Series VI: Medical Sciences • Vol. 4 (53) No. 2 - 2011

STATUS OF THE NATIONAL CHICKPEA COLLECTION IN BULGARIA

S. PETROVA [1] S. ANGELOVA[1]

Abstract: *The National Gene Bank at the Institute of Plant Genetic Resources, Sadovo maintains 310 accessions of chickpea, 203 of which - under the long-term storage and the other 107 - as a working collection. Some of them are introduced from Hungary, Russia, Turkey and the U.S., but significant numbers are received from International Center for Agricultural Research in the Dry Areas (ICARDA), Syria and from Plant Production Institute"V. Ja. Jurjev"UAAS, Ukraine. The indigenous accessions (Bulgarian origin) constitute a small part of the collection - 50 accessions. They are represented by old populations, newly selected varieties and lines. For Bulgaria chickpea is not a particularly important crop and the breeding is quite limited. One of the major features of the chickpea collection is the high phenotypic variation. Usually accessions dominate with uni-imparipinnate leaves compared to those with simple and mutipinnate leaves. The colour of the flowers also varies widely: white, pink, red, purple and blue. There are accessions in the collection with fawn, cream and black colour of the seed, with variable shapes and sizes. The biggest part of the collection are the early ripen accessions (95%) which fully realize their biological potential under the climate conditions of Southern Bulgaria.*
The correlation coefficient presented showed that number of seeds per plant, total number of branches were positively and highly significant (P< 0.01) with weight of seeds per plant. However, weight of 100 seeds were negatively correlated with plant height, plant height, total number of branches, number of seeds per plant, number of seeds per pod and weight of seeds per plan.
Several chickpea breeding lines (36), sown in November, were field tested for cold resistance. Some of them seemed to possess this trait. The same accessions were tested in frost chamber of temperature -5˚C and -10˚C for 24 hour. At -5˚C only two accessions (A800602 and A800606) expressed this trait. At -10˚C all tested materials died.

Key words: *Cicer arietinum L., evaluation , phenotypic variation.*

1. Introduction

Chickpea is an old traditional crop in Bulgaria with various uses. Chickpea (*Cicer arietinum* L.) and other pulse crops are staple foods in many countries and play an enhanced role in the diets of vegetarians around the world. Pulses are a primary source of nourishment and, when combined with cereals, provide a nutritionally balanced amino acid composition with a ratio nearing the ideal for humans [13]. Frequent consumption of pulses is now recommended by most

[1] Centre "Advanced Research on Mechatronics", *Transilvania* University of Braşov.

health organi- zations [9]. Chickpea is a good source of energy, protein, minerals, vitamins, fibre, and also contains potentially health-beneficial phyto-chemicals. Among the food legumes, chickpea is the most hypocholesteremic agent; germinated chickpea was reported to be effective in controlling cholesterol level in rats [7]. "Medicinal applications include use for aphrodisiac, bronchitis, catarrh, cutamenia, cholera, constipation, diarrhea, dyspepsia, flatulence, snakebite, sunstroke, and warts. Acids are supposed to lower the blood cholesterol levels. Seeds are considered antibilious" [6].

Compared to other legumes the breeding improvement was initiated later in a very limited scale [11]. An increased interest is observed after 1994 with the introduction of a wide range of varieties connected with the production of varied and healthy products [10], [12].

Similar to other spring legumes as lentils, bean, mung bean etc. the chickpea breeding must be oriented towards creation of early and middle-early maturing varieties; with short vegetation period and a relatively good resistance to low temperatures in the early spring. To obtain a normal yield from these crops it is also very important the time of sowing, performed as early as possible and conformable to the climatic factors [11]. Usually the early and the middle-early maturing varieties fulfill their biological potential completely [3]. Most of the evaluated legumes accessions at the National Gene Bank at IPGR have been grouped on the ground of their characters, which are important for the breeding process as early ripening, winter resistance, productivity, content of raw protein, etc. [15], [1-2], [4]. The same procedure is supposed to be performed with the existing chickpea collection.

The economically most significant disease on chickpea is *Ascochyta blight* caused by the phytopathogenic fungus *Ascochyta rabiei.* Under conditions that are favorable for the development of this pathogen, the disease causes significant damages by reducing the yield up to 100% [7]. The best means of fighting with this disease is the creation of more resistant varieties.

The aim of this study is to carry out evaluation of the national chickpea collection based on morphological, biological and economic traits; to create a data base and to differentiate the existing chickpea genotypes according to their use.

2. Material and Method

The evaluation of 97 chickpea accessions was carried out at the experimental field of the IPGR-Sadovo on cinnamon-forest soil with a wheat predecessor. The experi-mental plot area per accession was 5 m^2. Plant to plant and row to row distance was maintained at 10 cm and 50 cm, respectively. The seeds were treated with a fungicide before sowing. The beginning of flowering stage was calculated from the date of germination up to the date when 20% of the plants were in flower whereas the end of flowering stage was up to the date when 80% of the plants were in flower. Days to maturity were calculated from the date of germination up to the date when 90% of the plants were ready for harvest.

All accessions of chickpea *(Cicer arietinum L.)* have been characterized for their morphological traits - plant habit, anthocyanin coloration and intensity of green color of the plant, leaf type, flower and seed color and shape. The structural elements of the yield were established through a biometric analysis of 10 plants per accession. The means of all the quantitative characters were subjected to statistical analysis [16]. The genotypes were classified into different groups according to the values of various traits.

Some of the accessions were evaluated for their cold resistance at field experiment. Also the field resistance against some fungal diseases *(Ascochyta rabiei and Fusarium oxysporum)* was assess under natural infectious background. Some of the accessions were tested for cold resistance in field conditions as well as in growing chamber at -5°C and -10°C for 24 hour.

The accessions were described by certain indicators in accordance with the international descriptors (UPOV, 2005 and IBPGR/ICRISAT/ICARDA, 1993). The information was divided into two main groups: *passport information, which included data about the origin, the botanical category, the pedigree of the varieties (for the Bulgarian materials), the availability of seeds; and *evaluation information, which included data concerning the phenotype, biological, morphological and economic characteristics [2].

3. Results

Status and distribution of the collection

All chickpea accessions, existing in the National genes bank collection, IPGR belong to species *Cicer arietinum*, subssp. o*rientale G. Pop.*, *asiaticum G. Pop* and *mediterraneum G. Pop.*

The existing in the National genes bank *Cicer* sp. collection comprises 310 chickpea accessions, 203 at long-term storage and 107–at medium-term (Table 1).

Status of the chickpea collection Table 1

Total number of accession in genebank	Bulgarian origin	Foreign origin	**Lines**		**Varieties**		Local population
			Bulgarian origin	Foreign origin	Bulgarian origin	Foreign origin	
310	50	260	19	239	11	21	20

Some of them were introduced from Hungary, Russia, Turkey and the U.S., but significant numbers were received from International Center for Agricultural Research in the Dry Areas (ICARDA), Syria and from Plant Production Institute "V. Ja. Jurjev" UAAS, Ukraine.

Depending on the breeding level, they were divided into old and new varieties, breeding lines, landraces and a wild perennial chickpea *Cicer montbretii*, the only wild *Cicer* sp. native to Bulgaria. Over the last few years a lot of natural locations of the latter were discovered during collecting expeditions.

C. montbretii populations were found along the river Veleka, in the Southern Black Sea region and in the Balkan Mountain, near the village of Kosti and the village of Gramatikovo. In the latter this *Cicer sp.* was placed under in situ protection because it is considered to be rare for our country [8]. The number of accessions of Bulgarian origin was not large (50), including several old landraces, populations, newly-selected varieties and breeding lines. The accessions with foreign origin (260) comprised varieties and breeding lines used only as starting breeding materials or as direct entries into the Official Variety List of Bulgaria.

The origin of the older materials at the National genes bank was generally fromTurkey, Russia, Hungary, Poland and Romania. The collection has been extended recently with accessions coming mainly from Syria and Ukraine. Producers are especially interested in two accessions (№17 and №27), introduced from Israel in 1990, because of their high productivity and

relatively good resistance to *Ascochyta blight*.

The available plant genetic resources are annually extended by adding new accessions found during expeditions around the country and by receiving from other countries through non-currency exchange. *Evaluation information*

The biggest part of the collection (95%) comprises the early-maturing chickpea accessions which fully realize their biological potential under the climate conditions of Southern Bulgaria.

The remaining part of the collection includes the middle-early maturing accessions. They are also very important in the variety structure [8].

According to the period of days to end of flowering chickpea accessions are separated into three groups and most of accessions are in second group (48-56 days) (Table 2).

Length of the vegetation period ranges from 83 to 92 days

The distribution of the evaluated genotypes according to their quantitative characters is presented at Table 2.

Frequency distribution of quantitative traits in chickpea germplasm Table 2

Character	Class interval	No. of accessions	Percentage
Days to beginning of flowering	> 42	14	14,4
	42-50	72	74,2
	<50	11	11,4
Days to end of flowering	> 48	18	18,5
	48-56	69	71,1
	<56	10	10,4
Period of vegetation (in days)	83-90	81	83,5
	<91	17	17
Plant height (cm)	28,9-38,3	16	16,5
	38,4-48,8	67	69,1
	>48,8	14	14,4
Height to upper pod (cm)	17,6-29,2	64	66
	29,3-30,8	9	9,3
	30,9-40,8	24	24,7
Total number of branches	4,4-7,6	83	85,6
	7,7-9,1	14	14,4
Number of seeds per plant	16,2-50,7	69	71,1
	50,8-65,7	24	24,7
	65,8-89,7	4	4,2
Number of seeds per pod	1-2	95	97,9
	2-3	2	2,2
Weight of seeds per plant (g)	7,5-15,5	52	53,6
	15,6-24,1	42	43,3
	24,2-30,5	3	3,1
Yield of 1m2 (g)	38,5-142,5	44	45,4
	142,6-244,6	26	26,8
	244,7-341,8	27	27,8
100-seed weight (g)	18,4-32,0	26	26,8
	32,1-42,3	29	30
	42,4-49,0	30	30,9
	49,1-68,8	12	12,4

Distribution of accessions by morphological characteristics Table 3

Growth habit			Anthocyanin coloration of the plant		Intensity of green color of the plant			Leaf type		
Erect	semi-erect	semi-spreading	absent	present	light	medium	dark	normal	simple	Multipinnate
48*/ 49.5	40*/ 41.2	9*/9.1	84*/ 86.6	13*/ 13.4	24*/ 24.7	30*/30.9	43*/ 44.4	69*/ 71.2	1*/1	27*/27.8

Flower color			Seed color				Seed shape		
dark pink	pink	white	cream	yellowish brown	reddish brown	black	round	round to angular	angular
13*/ 13.4	1*/1	83*/ 85.6	84*/ 86.6	5*/5.2	3*/3.1	5*/5.1	16*/ 16.5	72*/74.2	9/9.3

No. of accession*/Frequency %

Maximum number of genotypes for plant height, height to upper pod, total number of branches, number of seeds per plant, number of seeds per pod, weight of seeds per plant were presented in classes, 38.4 - 48.8 cm, 17.6 - 29.2 cm, 4.4 - 7.6, 16.2 - 50.7, 1 - 2, 7.5 - 15.5 g.

One of the major features of the chickpea collection is the high phenotypic variation. Usually accessions dominate with uni-imparipinnate leaves which are composed of many leaflets compared to those with simple and mutipinnate leavs. The colour of the flowers also varies widely: white, pink, red, purple and blue. There are accessions with fawn, cream and black flower colour of the seed, with variable shapes (round, round to angular and angular) and sizes. The variation for morphological traits revealed marked differences for plant habit, anthocyanin coloration and intensity of green color of the plant, leaf type, flower color, seed color and seed shape (Table 3).

Table 4

Minimum, maximum, mean, rang end standard deviation of eight traits in 97 chickpea genotypes with different origin

	Origin	Plant height (cm)	Total number of branching	No. of pods / plant	No. of seeds per plant	No. of seeds per pod	Weight of seeds per plant (g)	Yield of $1m^2$ (g)	Mass of 100 seeds (g)
min	Bulgaria	43,4	5,0	26,9	25,6	1,0	8,4	169,6	21,3
	Ukraine	32,7	5,3	30,8	34,0	1,0	13,0	174,3	18,4
	Syria	37,6	4,7	27,9	29,2	1,0	10,0	66,5	30,7
max	Bulgaria	60,1	9,1	55,6	80,2	2,0	18,9	300,2	48,8
	Ukraine	56,9	8,0	57,7	88,4	2,0	22,6	349,0	53,6
	Syria	45,4	9,0	85,1	89,7	3,4	27,5	173,0	59,0
$\bar{x}$	Bulgaria	48,9	6,9	40,2	50,9	1,6	13,0	258,8	29,4
	Ukraine	43,8	6,3	41,3	48,6	1,3	17,8	275,6	37,0
	Syria	40,8	6,6	44,1	47,2	1,3	18,7	132,0	44,2
Range	Bulgaria	16,7	4,1	28,7	54,6	1,0	10,5	130,6	27,5
	Ukraine	24,2	2,7	26,9	54,4	1,0	9,6	174,8	35,2
	Syria	7,8	4,3	57,2	60,5	2,4	17,5	106,5	28,3
Std. Deviatio	Bulgaria	4,7	1,2	8,2	13,2	0,3	3,0	32,8	6,0
	Ukraine	6,8	0,7	7,0	14,6	0,3	2,6	44,3	9,8
	Syria	2,1	1,4	14,4	15,3	0,6	4,9	26,8	6,5

The tallest plants among the accessions were of Bulgarian origin. The biggest number of pods, the highest mass of 100 seeds and the highest weight of the seeds per one plant were registered in the breeding lines of Syrian origin.

The maximum yield of seeds from 1 m^2 area was obtained from the accessions introduced from Ukraine.

In relation to the mechanized harvesting of the crops, the height of the plant is of great importance. This character varied widely among the tested varieties, lines and populations – from 32.7 to 60.1. It is genetically determined but can also be influenced by the conditions of the environment.

The accessions with a longer vegetation period had a bigger average height of the plant.

The number of seeds per plant is directly related to the number of pods and is very important when choosing plants for breeding purposes.

The average values of this trait varied between 41.1 and 44.3.

The evaluated accessions showed significant variation in mentioned above traits probably due to the different weather conditions during years of experiment. Usually accessions with larger seeds formed fewer seeds in a pod compared to those with smaller seeds.

The weight of 100 seeds was a trait which influences the yield of chickpea. The largest number of accessions fall within the range from 37,9 to 44,3 g. Usually the influence of weather conditions on this trait is weaker because it is considered variety determined.

Grain yield is a complex character that is outcome of interaction between many plant traits, influenced by the genetic background and surrounding environment. Therefore, the direct evaluation and improvement of grain yield itself may be misleading due to involvement of environmental component. It is very important to analyze the data for relative contribution of various components to yield performance. The simple correlation analysis is an important tool for this purpose. Correlation coefficients of yield and its components estimated in this study indicated that most of the traits studied in this experiment were positively and significantly correlated with yield.

The correlation coefficient presented showed that number of seeds per plant, total number of branches were positively and highly significant ($P<0.01$) with weight of seeds per plant (Table 5).

Correlation coefficients among seven traits in 97 chickpea genotypes Table 5

Character	Plant height (cm)	Height to upper pod (cm)	Total No. of branches	No. of seeds per plant	No. of seeds per pod	Weight of seeds per plant (g)	Weight of 100 seeds (g)
Plant height (cm)		0,806**	0,258*	0,218*	0,243*	-0,064	-0,345**
Plant height (cm)			0,401**	0,158	0,272**	-0,16	-0,314**
Total No. of branches				0,620**	0,285**	0,332**	-0,405**
No. of seeds per plant					0,460**	0,436**	-0,657**
No. of seeds per pod						0,019	-0,496**
Weight of seeds per plant (g)							-0,236*

*,**, Significant at $P<0.05$ and 0.01, respectively

Most of the chickpea accessions seemed to be tolerant or highly tolerant to *Fusarium oxysporum f.sp. ciceri* during the field assessment of the collection. Two of them (BGR 23148 and BGR 1942) showed no visible symptoms of the attack. Regarding the viral diseases at the natural infectious background, a lot of the accessions did not express visible symptoms.

The climate conditions during the period of study of the chickpea collection were unfavorable for the development of *Ascochyta blight*. The months, critical for this diseases development, were characterized with low rainfalls, which suppressed the progress of that disease. For this reason the field assessment of chickpea accessions was not carried out. Same accessions (28 local accessions, 2 introduced varieties) were inoculated with spore suspension of 10 day cultures of *Ascochyta rabiei* of artificial condition. Reporting is done 14 days after inoculation in 9-point scale. Resistance reaction of the three isolates (B10, VD-7 and 1018 M2) showed accession BGR 21227 and Balkan variety. Progress variety and BGR 1915 accession showed resistance to 1018 M2 and VD-7 isolates and to B-10 isolate was the same average resistance [5].

Several chickpea breeding lines (36), sown in November, were field tested for cold resistance. Some of them seemed to possess this trait (A8000624, A8000622, A8000627, A8000602, A8000 610, A8000609, A8000604, A8000606). They produced a few seeds but fall in line (in respect with phases of development) with accessions that were sown in early spring. The same accessions were tested in frost chamber of temperature -5˚C and -10˚C for 24 hour. At -5˚C only two accessions (A800602 and A800606) expressed this trait. At -10˚C all tested materials died.

4. Conclusion

The evaluation description of the plant genetic resources of chickpea provides useful information concerning their utilization in various directions: as initial material in breeding process, recovery in the gene bank, international exchange, technological assessment and direct implementation in production.

The selection of valuable donors allows us to create core collections of chickpea.

References

1. Angelova, S., Georgieva, T.: *Characterization of some species from the genus Vicia L. of Bulgarian origin.* 41st Croatian Symposium on Agriculture. Univ. of J.J. Strossmayer, Faclty of Agriculture, Osijek (2006), p. 13-17.
2. Angelova, S., Guteva, Y.: *Study on the productive potential of some Vicia L. species.* A periodical of scientific research on field and vegetable crops. Institute of field and vegetable crops, Novi Sad, Serbia May 30-June 1, 2007, p. 97-103.
3. Angelova, S.: *Status of grain legume collections in Bulgaria.* Report of a Working Group on Grain Legumes, ECP/GR, Lisbon, Portugal, 2007.
4. Angelova, S, Sabeva, M.: *Chemical characterization of pea in Bulgarian collection.* EUCARPIA – meeting by plant genetic resources Slovenia, Ljubljana – 26-29 May 2009, p 25.
5. Chavdarov, P. and Petrova, S.: *Study of the resistance of local and introduced accessions of chickpea to caused of askohitoza - Ascochyta rabiei.* International Scientific Conference 23 June 2011 (in press; Scientific Researches of the Union of Scientists in Bulgaria-Plovdiv).

6. Duke, J.A.: *Handbook of legumes of world economic importance.* Plenum Press, New York (1981) p. 52-57.
7. Geervani, P.: *Utilization of chickpea in India and scope for novel and alternative uses.* In: Uses of Tropical Grain Legumes: Proceedings of Consultants (1991) p. 47-54.
8. Koeva, R., Angelova, S., Guteva, Y.: *Plant genetic resources and their biological potential integrated to the agricultural and ecological systems.* BIO Technology and Technological EQ, (2002), Vol. 2 p. 26-35.
9. Leterme, P.: *Recommendations by health organizations for pulse consumption.* British Journal of Nutrition 88 (2002), p. 239–242.
10. Mehandziev, A., Goranova, K., Mihov, M., Genchev D.: *Success of breading of grain legumes in Bulgaria.* Space, nature, man., Scientific conference (2002), p. 41-54.
11. Mihov, M., Mehandziev, A., Stoyanova M.: *Achievement in the breeding of cool grain legume crops.* Anniversary Scientific Session. Breeding and farming equipment for field crops (2001) Vol.1, p. 283-286.
12. *Cicer arietinum L.* Available at: http://www.hort.purdure.edu/newcrop/cropfactsheets/chickpea.html.
13. *"Chickpea Breeding and Management",* Edited by S.S. Yadav, R.J. Redden, W. Chen, B. Sharma, CABI, (2007) p.101
14. Nakayama, H., Afzal, M.and Okuno, K.: *Intraspecific differenciation and geographical distribution of wx allele for low amylose content in endosperm of foxtail millet (Setaria indica L.).* Euphytica 102 (1998) p. 289-293.
15. Petrova, S., Ivanova, I., Angelova, S.: *Characterization of local and introduced samples from the collection of chickpea /Cicer arietinum/.* Scientific Researches of the Union of Scientists in Bulgaria – Plovdiv (2011) Vol. VIII, p. 218-221.
16. Steel, R. G. D. and. Torrie, J. S.: *Principals and procedures of statistics.* McGraw Hill Book Co. Inc., New York, 1966.