African Journal of Biotechnology Vol. 10(63), pp. 13789-13796, 17 October, 2011
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB11.942
ISSN 1684–5315 © 2011 Academic Journals

Full Length Research Paper

A sample for biodiversity in Turkey: Common bean (*Phaseolus vulgaris* L.) landraces from Artvin

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Accepted 12 August, 2011

Artvin province located in north-east region of Turkey is small province but has rich plant diversity due to its different geographical and ecological formation. Significant part of this province has been flooded by the dams which have been built. The common bean is a very important crop for Artvin's farmers. This study was carried out with the aim of determining and preserving the characteristics of domestic bean varieties grown in Artvin. Common bean seeds were collected from 279 locations in 74 villages in seven districts of the province. These seeds were allocated to 400 sample groups according to their shapes and colors. Eleven monocolored and 21 dicolored or polycolored seed groups were determined. Majority of the seed were subcompressus type seeds. The samples in the 1st group were ranked first in terms of size index. Considering the 100 seed weight, 64.68% of the population was found between 25 to 40 g; 30.69% of the population was higher than 40 g. By the advantage of having big variation of all characters, landraces of bean varieties grown in Artvin Province have a rich genetic source that can be used in breeding programs.

Key words: Common bean, landraces, seed shape, seed color, Turkey.

INTRODUCTION

Wild plant forms and local village cultivars in any country are indispensable gene stores for improving the traits of present cultivated plants or to develop new cultivars. These genetics sources have disappeared or are disappearing due to environmental problems, soil erosion, urban development, and technological advances in the last century. Sustainability in plant production will be supported by the preservation of these materials. For this reason, preservation of these sources in Turkey which has rich genetic diversity is vital for sustainable agriculture and life.

Turkey has an important place in terms of plant gene sources due to its geographical structure and ecological conditions. It is one of the rare countries located on 2 gene centers (Near East and Mediterranean) in the world (Şehirali and Özgen, 1987).

There are 163 plant families, 1255 plant genera and 9000 plant species in Turkey. 3% of these are endemic (Ozgen, 2000). Turkey grows a lot of agricultural products which are important in world commerce; including many leguminous plants. Of these, common bean (*Phaseolus vulgaris* L.) was introduced to Turkey in recent times but has become a product with broad usage. Dishes made with beans are considered national Turkish meals. Although it can be raised in all of the regions of Turkey, it is well adapted to the Black Sea region which is found in the north of Turkey and which has a large diversity of landraces. The improvement of bean cultivars that are appropriate for consumer demands, high yielding, resistant against diseases pests and stress conditions, and have rich nutritional content especially for more healthy nutrition is the most important factor for the maintenance of its agriculture. It follows that conservation and protection of natural resources is one of the priority issues for sustainability of life in Turkey and in the world.

Artvin province of Turkey is an important growing area with substantial plant diversity because of its traditional agriculture practices, geography and ecological diversity. Beans which are an important product in this province

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have not been replaced by newly developed cultivars. A major concern is that an important section of the province (45 villages) will be under water in future because of the seven dams which will be built on the Çoruh River (Anon., 2005). This situation encouraged the authors to carry out this study. The aim was to collect bean samples mainly in the areas which will be evacuated because of the dams and in main producing areas of the province, and to determine and conserve of these populations in this project.

The common bean (*P. vulgaris* L.) introduced in Turkey in the 17th century is an important agricultural crop which is cultivated for fresh pod and dry seed in Turkey. Bean is a well-adapted crop and it shows a large variation through the Black Sea region (Bozoglu and Sozen, 2007). Seed color and seed shape of bean are the most prominent indicators of genetic variability and consumer habits but seed size varies with region of domestication in common bean (Sexton et al., 1997). Escribano et al. (1997) informed that estimates of heritabilities of length/width and width/thickness ratio of dry seed were high on germplam of Northwestern Spain. Large-seeded cultivars are predominantly of Andean origin, while small-seeded cultivars are from Mexico and Central America, termed the Mesoamerican Center (Singh et al., 1991a).

In a research, a total of 173 samples of domestic germplasm of common beans and 118 selection lines and cultivars were tested. Spherical and elliptic shapes were most common in domestic germplasm. In the working collections, 97% of the selection lines and cultivars were elliptic in shape. It was established that the distribution of Andean and meso-American gene pools depends on seed shape (Tomlekova et al., 1999).

Yugoslavian researchers (Zdravkovic et al., 2003) selected 10 local genotypes from the breeding program of the Centre for Vegetables in Yugoslavia. Significant differences were observed among the bean genotypes examined. The length:width ratios varied between 1.41 to 2.40 mm. The thickness:width ratio varied between 0.62 and 0.85 mm.

According to the other researchers (Bascur and Tay, 2005), with the purpose of collecting and preserving the genetic diversity present in the Chilean ecotypes of common bean, a germplasm collection was made, from Arica to Chiloe, visiting 207 locations in 28 expeditions and collecting 1239 accessions. Their purpose was to collect and to preserve the genetic diversity present in Chilean ecotypes of common bean. Analysis of frequency distribution indicated the presence of great variability: from growth habit I to IV with different shapes, sizes and other characters. Seeds varied from small to large, with round or oval shape and a large variation in the primary color and its combinations.

Stoilova et al. (2005) investigated 30 Portuguese and Bulgarian landraces grown in Sadovo, Bulgaria. The seeds were mostly white, but brown, red and brownish seeds, and seeds with white and red around the hilum were also observed. The seeds were kidney-shaped and cuboid except for two genotypes, which had oval seeds.

The study mainly focuses on the bio-variation of common bean in small province of Turkey. The common bean genotypes, just like the other plant species, have been threatened by waterlogged due to dams being constructed on River Çoruh. Therefore, it needs to be controlled if they could be used for cultivar improvement program and other breeding programs for both fresh and dry seed consumption of bean.

MATERIALS AND METHODS

Artvin province is in the east of the Black Sea region. It is a neighbor to Georgia and is also a gateway for the east region provinces to the Black Sea region. This province has an extremely steep and fractured landscape due to the deep valleys formed by the Çoruh River and its branches, and the Kaçkar mountain chains. The province has a total land area of 7513 km^2 and 310 villages.

There are many variations in the geographical and topographical structure of Artvin province. Artvin province has characteristics of both typical Black Sea climate and transition climate. Warm and rainy weather conditions prevail in the coastal areas of the region. However, in the inner parts of the province, long and snowy weather conditions are widespread in winter and cool weather conditions in summer. However, the climate in the base of the Çoruh valley is characterized by low rainfall and warm winter conditions.

Local genotypes have been preserved without disturbance due to the fact that (i) the geographical structure of the province is mountainous, (ii) there are no broad farmlands, (iii) farming is carried out with traditional methods and (iv) foreign varieties are not grown. Locations were material were collected was identified according to technical staff, records and master plan of Artvin provincial directorate of agriculture. Land that will be under dams that have been constructed or will be constructed, along with the province's sections that cultivate dry beans; was at the forefront as the target area for collection. Collection sites were selected according to the stratified sampling method by considering districts that cultivate beans, and the number of villages they have. 74 villages in seven different districts were visited and seed material was collected from 279 points.

During the collection period, the passport information (determined by the national gene bank) of each collected material was obtained and also the altitudes of the villages from which the samples were taken were determined by using a GPS instrument. The altitudes of the sample collection points ranged from 200 to 2100 m. The latitudes and longitudes of the locations where genetic material were collected from were in the lines of 40°35'01"and 41°32'19"N, 41°07'15" and 42°26'39" E.

In order to determine the variability, samples from each sampling location were grouped according to their seed types, seed shapes and seed colors, and 400 sample and 1034 sub-samples were formed. Seed colors and widths, lengths and thicknesses of the original collected material were categorized regarding color scale table. However, other characters were investigated on the seeds that were obtained from the crops grown in Samsun ecological conditions. The widths, lengths and thicknesses of at least 10 seeds (Gepts and Bliss, 1986) from each sampling location point were measured (Figure 2). Additionally, 100 seeds weight of samples were figured out regarding the method of Voysest (1983). Kjeldal method was also used to analyze crude protein of seeds. Seed size index can be determined by multiplying seed width, seed length and seed thickness values. There are three different groups (1st group: >0.6; 2nd group: 0.5 to 0.6; 3rd group: <0.5) (Akçin, 1988; Şehirali, 1988).

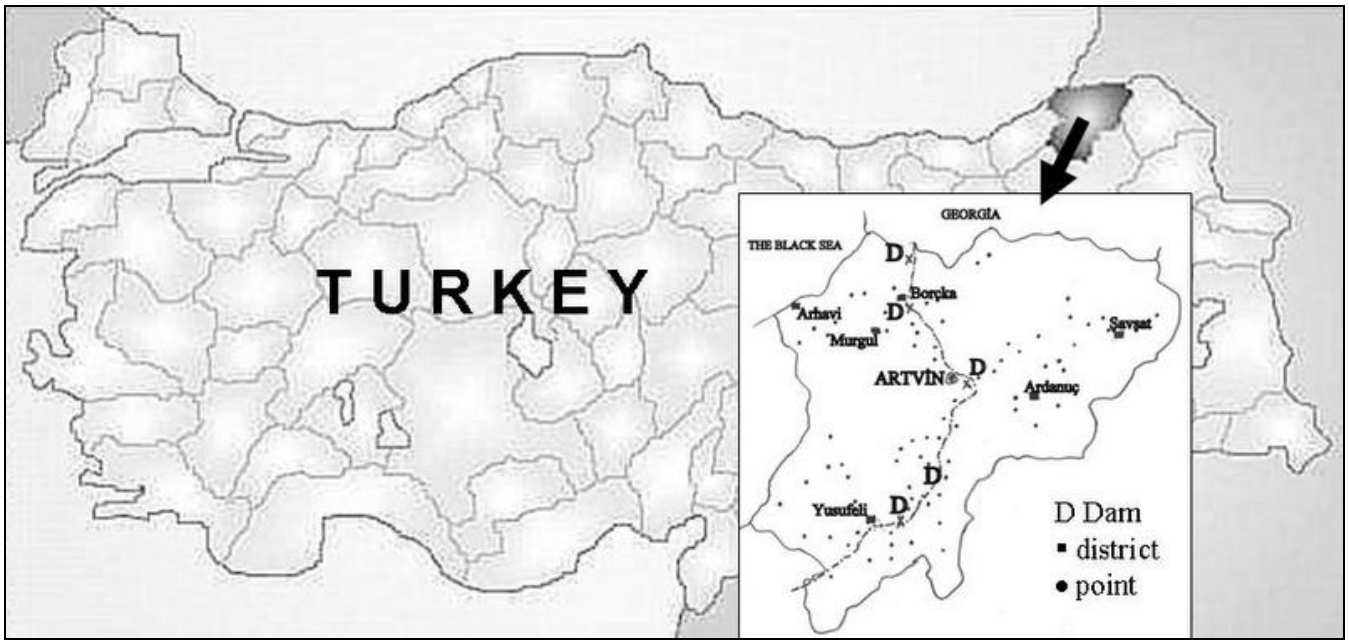

Figure 1. Map of Turkey and location of Artvin province (http://en.wikipedia.org/wiki/File:Artvin_Turkey_Provinces_locator.jpg).

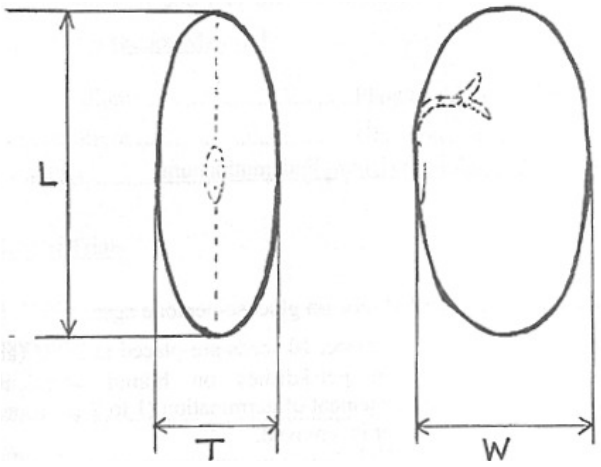

Figure 2. Dimensions (length, width, thickness) of bean seed. L, length; W, width; T, thickness (Anon., 2001).

RESULTS AND DISCUSSION

About 64 200 ha or 30% of Artvin total area, are considered arable. Forest and grassland areas are 57 and15% of total area, respectively. The sowing area of dry bean is only 650 ha. The average farm area is not more than 0.5 ha. There are a few farmers that have got more than one hectare. Agricultural methods are still primitive in Artvin province. Crops are cultivated for the purpose of meeting family needs or selling at local markets. But common bean is one of the four most important products (bean, wheat, corn, potato) in Artvin. The main sources of labor for these small farms are generally women and unpaid family members in Artvin. Emigration takes place and agricultural lands are being abandoned in the province because of socio-economic problems. The conservation and protection of natural resources and local varieties is one of the priority issues for sustainability of agriculture in Turkey and in the World.

In a previous study, to examine this invaluable material, some morphological characters of this material were observed. In the study, plant height, pods per plant, 100-seed weight, and seed yields showed a variation between 20 and 310 cm, 1 and 163 pods, 16.2 and 80 g, and 1 and 99 g, respectively (Bozoglu and Sozen, 2007).

In this article, seed characters of this material were examined and summarized as follows:

Seed colors

Bean seeds were grouped according to their seed colors and shapes. Each sub-sample was considered as a different ecotype, because the ecotypes from which they were collected were different. Seed colors, which will be used as variability indicators for the collected material, were determined by one person using the method developed by Genchev and Kiryakov (2005). Seeds were grouped according to the main colors, regardless of their color tones, as their storage places and ages were different. Of the collected seeds, 445 are monocolored and 589 are dicolored and multicolored. The ratios of samples in each color group (within their own group and within the total sample) are given in Table 1.

The color of the material collected was 43.04% presenting only one color and the rest were discolored

Table 1. Seed color groups and their ratios to general ratio in bean samples collected from Artvin province of Turkey.

Mono color			Two and more than two color					
Color group	**1**	**2**	**Color group**	**3**	**2**	**Color group**	**3**	**2**
White	45.8	19.73	Pink-bordeaux	22.24	12.67	White-green	1.87	1.06
Yellow	2.47	1.06	Light pink-red	2.04	1.16	White-bordeaux	8.32	4.74
Black	10.11	4.35	Pink-black	3.90	2.22	White-dark yellow	1.87	1.06
Bordeaux	6.51	2.80	Pink-dark yellow	2.55	1.45	White-black	0.0085	0.0048
Cream	3.15	1.35	Cream-black	7.98	4.54	Green-black	1.19	0.0067
Grey	0.007	0.003	Cream-bordeaux	15.10	8.6	Green-bordeaux	1.19	0.0067
Pink	11.46	4.93	Cream-green	3.06	1.74	Black-gray	1.87	1.06
Dark yellow	3.59	1.55	Cream-brown	4.75	2.71	Black-lilac	1.02	0.0058
Green	8.09	3.48	Brown-green	8.66	4.93	Pink-lilac	0.0068	0.0039
Violet	1.57	0.007	Brown-bordeaux	2.21	1.26	White-lilac	0.0017	0.0010
Brown	6.50	2.80	Brown-black	8.49	4.83			

1, ratio of color groups ration in mono-color; 2, ratio of color groups ration in all samples; 3, ratio of color groups ration in two or policolor samples .

and multicolored samples. White colored samples formed the largest group with a 45.8% ratio within monocolored samples. Zeven et al. (1999) found that 15 seed color and color pattern were found and the most predominate were white, beige and cream mottled collected from Netherlands. In Turkey, white beans are generally preferred to be used as dry seed. There are 19 varieties registered for dry seed purpose. But, more varieties should be developed due to these facts; (i) beans are grown in different regions of Turkey, (ii) they have different usage types such as dry, fresh interior, fresh seed and pickled and (iii) people's requirements for high quality foods have increased. For this reason, determination and preservation of characteristics of this material is of importance from the point of guaranteeing the future of agriculture in Turkey.

Ten main groups except for white were formed within monocolored samples. The existence of all the colors between white and black indicates the extent of the variability. The seeds with two or more colors were collected in one group and dominant colors on the broadest area on the seed surface were taken into consideration. 21 main groups were formed. Pink-claret red colored types formed the largest group (22.24%). Samples can also be grouped according to their coloring forms. If doing so, variability can be enhanced. Castiñeiras et al. (1991) collected 328 bean accessions in the genetic resources in Cuba. Basic seed colors were black (53%), red (25%) and white (0.3%) in the study. Sing et al. (1991b) reported that landraces were obtained from *Phaseolu*s germplasm bank of the CIAT and that large variations in seed colors and their spotting, striping, and speckling patterns were found.

Seed shape and dimensions

One of the characteristics which were taken into consideration in classification of beans is seed shape (Akçin, 1988). Shape is a significant criterion in varying consumption preference among the regions. While sphaericus seeds are preferred in one region, compressus seeds can be preferred in another region in Turkey. All the grain shapes are consumed in various regions of our country. With the aim of determining the seed shapes of collected bean samples, the width, length, thickness measurements of each sub-sample were made and are given in Table 2.

Seed shape depends upon the length, height, and width of fully mature and dry seed. Seed shapes ranging from very big to very little small were observed in the 1034 subsamples. Frequency distributions of seed dimensions are given in Figures 3 to 5.

Seeds with width ranging from 8.259 to 9.892 mm formed the largest group (63.94%) (Figure 3). Seed lengths ranged from 1.183 to 25.958 mm. The most crowded group was formed by two groups (13.703 to 16.832 and 16.832 to 19.963 mm). These groups formed 92.15% of the general total. This group was followed by the group having values that ranged from 19.963 to 23.092 mm (31.51%) (Figure 4). These data reveal that the large seed types were preferred by consumers in this region.

Seed thicknesses were between 0.709 and 9.957 mm (Table 2). The largest groups were those having thicknesses of 7.309 to 8.628 and 5.989 to 7.308 mm. These two groups had a ratio of 92.68% in the general total (Figure 5).

Seed shapes, nomanclature and the inclusion rates of collected material into these groups are given in Table 3. Voysest (1983) reported that the three dimensions are considered jointly; seed shape can be round, oval, rhombohedric, kidney, or cylindrical. Community Plant variety office classifies circular, circular to eliptic, eliptic, kidney-shaped according to shape of median longitudinal section (Anon., 2001). There are five seed shapes

Table 2. Some statistical values related to seed shapes of bean samples collected in Artvin province of Turkey.

Seed dimension	Range (mm)	Mean (mm)	Standard error (Sx)	Coefficient of variation (CV%)
Width	5.783-15.350	8.50	0.026	9.85
Length	1.183-23.090	13.49	0.059	14.10
Thickness	0.709-9.957	6.68	0.027	13.44
100 seed weight	16.49-76.99	37.00	0.508	23.44
Crude protein	16.77-34.71	26.85	0.196	10.92

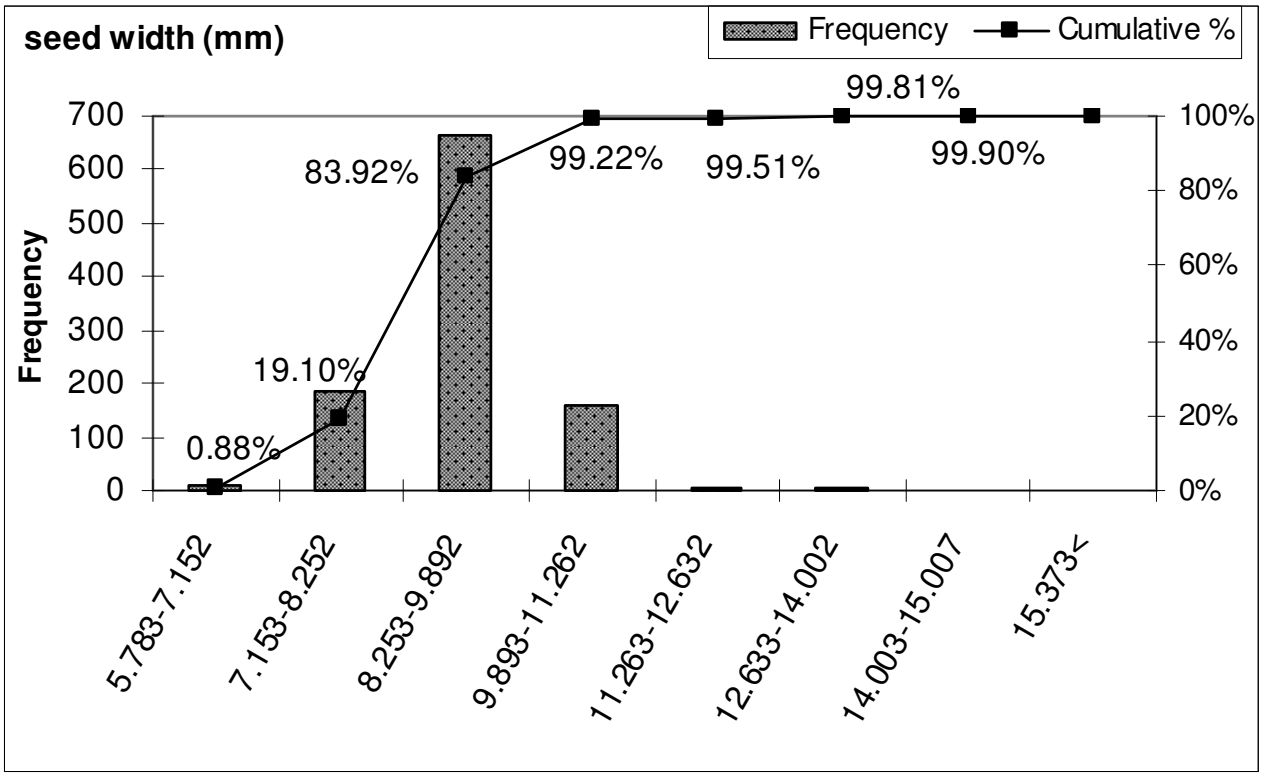

Figure 3. Frequency distributions related to seed widths of beans collected from Artvin.

(round, oval, cuboid, kidney shaped and truncate fastigiate) according to IBPGR (1982). Some of the bean samples were included in three seed types when the values calculated from length/width ratio were taken into consideration. Materials in elipticus and sphaericus groups formed 70.8% of the collected samples. Subcompressus type beans (called “Selanik” in Turkey), which are the most preferred types in Turkey, are generally used dry. Beans were divided into five subspecies when the length /width and width/thickness x length values were taken into consideration and nine subgroups formed when the crossbreds of these were included (Akçin, 1988). In this study, 16.4% of samples were included in these groups.

The ratio of subsamples included in large seed group in terms of seed size index was 71.76%. This ratio indicates that Turkish people prefer large bean seeds. Farmers have produced village types according to their preferences by selecting their own seeds.

Seed weight

100 weight is a quality that has a positive and significant effect on yield and its heredity degree is high (Bozoğlu and Gülümser, 1999). Turkish people generally prefer large seeds in dry bean and in all of the grain legumes. 100 seed weight of samples in this study varied between 16.49 to 76.99 g. Variation coefficient of this character was the highest (23.44%) in the investigated characters. Voysest (1983) found that the seed weight of common bean could vary from < 15 to > 90 g/ 100 seeds. It could be grouped into small (<25 g), medium (25 to 40 g), and large-seeded (>40 g/ 100 seeds). The seed weight of

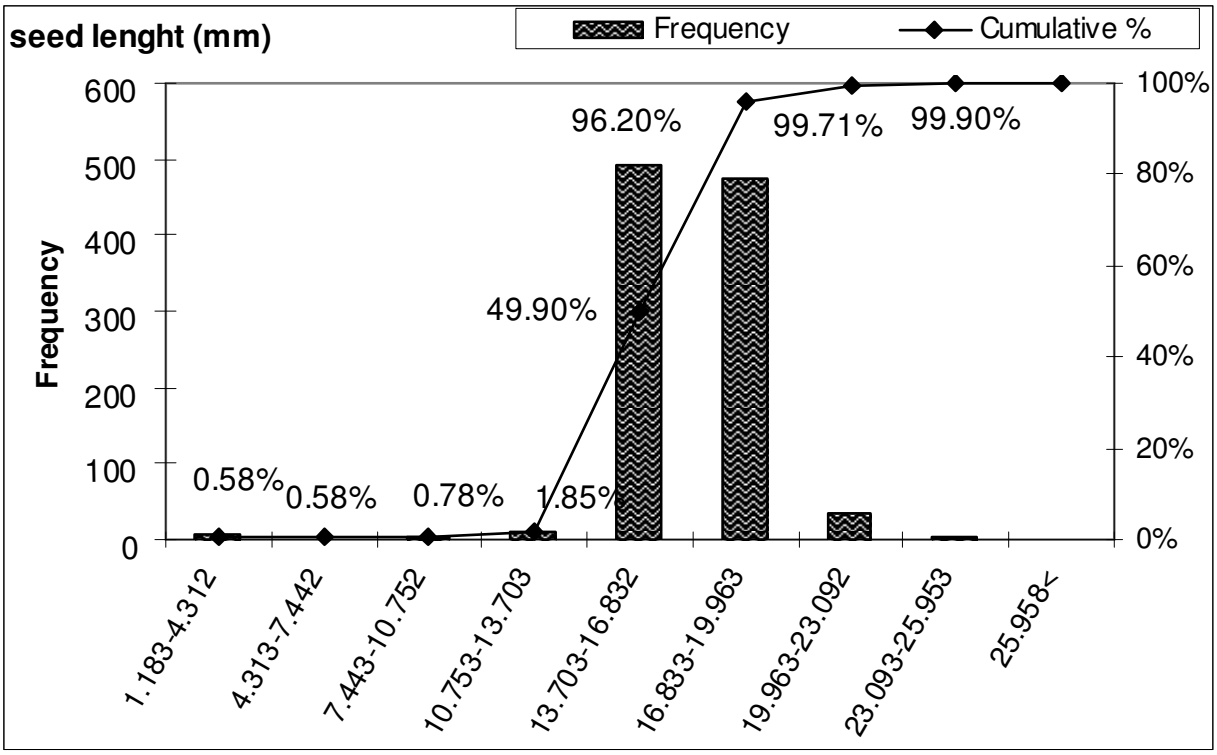

Figure 4. Frequency distributions related to seed lengths of beans collected from Artvin.

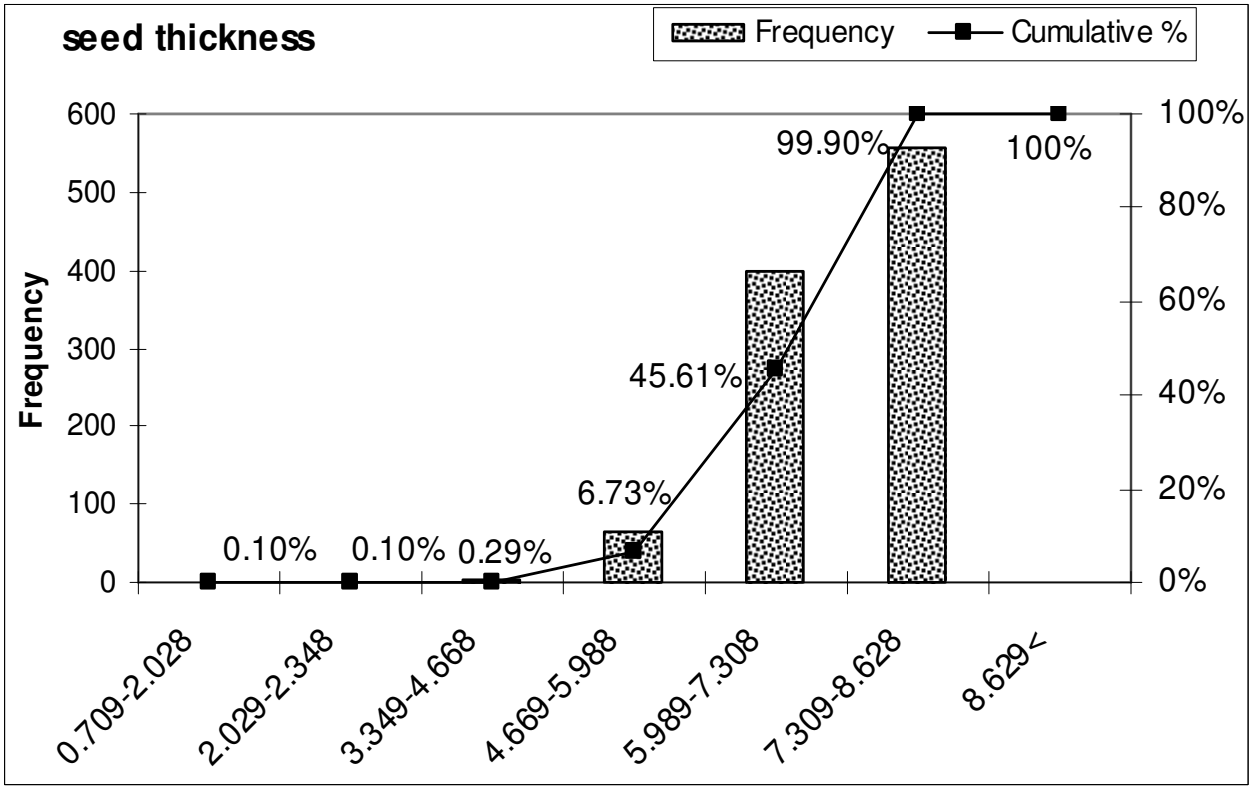

Figure 5. Frequency distributions related to seed thicknesses of beans collected from Artvin.

Table 3. Distribution of the bean samples collected in Artvin province of Turkey according to the seed shapes.

Seed shape	Length/width ratio	Percent of collected sample (%)
Sphaericus Mart.	1.20-1.49	34.8
Elipticus Mart.	1.51-1.71	36.0
Oblangus Savi.	1.85-2.31	12.8
	Width/thickness × length	
Subcompressus Al.	1.29-2.08	83.0
Compressus DC.	2.17-3.15	8.1
	Seed size index	
Groups	***Length × width × thickness***	
1st group	0.600<	71.76
2nd group	0.500-0.600	22.39
3rd group	< 0.500	5.84

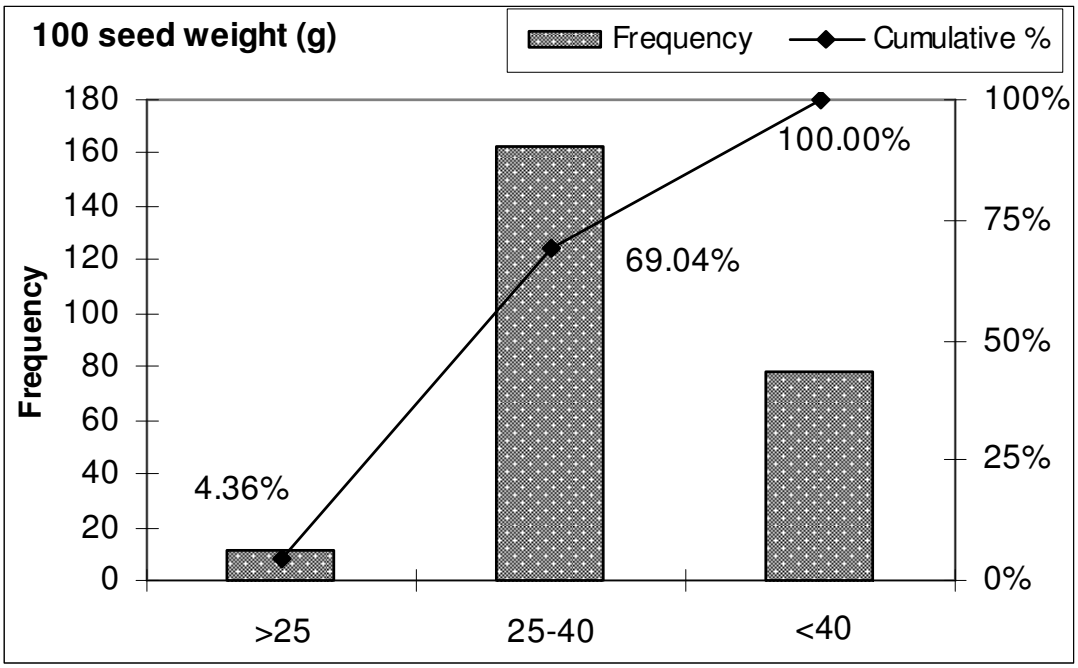

Figure 6. Frequency distributions related to 100 seed weight of beans collected from Artvin.

64.68% of the population was found between 25 and 40; while 30.69% of the population was higher than 40 g. On the other hand, only 4.36% was less than 25 g (Figure 6). Sing et al. (1991a) reported that small-seeded (<25 g/ 100 seed) landraces are from the Mesoamerican Center, and large seeded from Andean (Sing et al., 1991a; Sexton et al., 1997). Rodino et al. (2001) reported that Andean types include medium and large, white and pinto seeded cultivars. It could be said that most of these material might belong to Andian gene pool concerning seed weights, although Phaseolin seed protein pattern of bean was not able to be determined in this study.

Crude protein ration of seed

Common bean is one of the most important sources of protein and the most popular national meal for Turkish people. There is an expression in Turkey: Beans are the staple diet of poor people. The crude protein ratio varied

between 16.77 and 34.71%. 14 dry bean varieties were grown in four locations for two years. The crude protein ratio was found between 21.42 and 24.85% and heritability of crude protein ratio was found as 51% (Bozoğlu and Gülümser, 1999). Artvin bean germplasm is rich for this feature. It is not only sufficient to find out crude protein ratio, protein content should also be analyzed. Sing et al (1991a) reported that when landraces were classified based only on their phaseolin seed protein and allozyme patterns.

Conclusions

Although Artvin had an extremely low ratio of the total acreage of Turkey (0.0095% of total), it is a significant region due to its genetic richness. Artvin province contains “Important Plant Areas” determined by World Wildlife Fund (WWF), Turkey. Determination of local gene resources has a significant role in increasing the number of bean varieties. The current materials which are at the risk of disappearing were collected and supplied to the national gene bank. The existence of all grain shapes and lots of grain colors indicates the extent of genetic diversity. Using this material for improvement of new bean varieties can contribute to bean farming in our country.

It is recommended that these seeds be registered after determining molecular characteristics. These results give information about diversity and breeding value of Artvin bean germplasm that could be useful to widen the genetic base of national breeding material. This population is suitable to use on the breeding program for seed size in Turkey.

This study emphasizes again that collection and conservation of material is extremely important in certain areas that have a rich diversity of biological and local varieties before dams’ constructions. Otherwise, invaluable material could be lost because of waterlogged.

ACKNOWLEDGEMENT

This study was supported by The Scientific and Technological Research Council of Turkey (TUBITAK). The authors sincerely thank Gregory Thomas Sullivan from Foreign Language Teaching Centre of Ondokuz Mayıs University for his assistance in editing this manuscript.

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