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Some Agronomic Properties of the Local Population of Common Bean (*Phaseolus vulgaris* L.) of Artvin Province*

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Abstract: The objectives of this study were to determine the changes to some agronomic properties that significantly affect seed yield, and to conserve landraces of the common bean of Artvin province, especially in areas that will be flooded by dam projects, by collecting them before they are lost. Landraces of common bean were collected from 279 locations in 74 villages in 7 districts of the province. Landraces were sorted into 400 samples according to their growth habit, seed color, color pattern, and shape. Seeds were sown in Samsun, Turkey, in May 2005. To determine plant height, pods per plant, pod length, 100-seed weight, seed yield, and harvesting time of the bean population, frequency distributions of these properties were determined using all observation values from each sample. It was observed that plant height, pods per plant, 100-seed weight, and seed yield of the plants varied between 20 and 310 cm, 1 and 163 pods, 16.2 and 80 g, and 1 and 99 g, respectively. It was determined that these populations can be used in cultivar improvement programs and other breeding studies of both fresh consumption and dry seed yield of bean.

Key Words: Artvin, common bean, landraces, *Phaseolus vulgaris* L.

Artvin İlinden Toplanan Yerel Fasulye (*Phaseolus vulgaris* L.) Populasyonun Bazı Agronomik Özellikleri

Özet: Bu çalışma, Artvin ilinin, özellikle kurulan barajlar altında kalacak alanlar başta olmak üzere, yerel fasulye populasyonunun kaybolmadan toplanıp tohum verimini etkileyen bazı agronomic özelliklerinin tespiti amacıyla yürütülmüştür. İlin 7 ilçesinde, 74 köyden 279 noktanan yerel fasulye çeşitleri toplanarak, tane renk ve şekillerine göre 400 örnek oluşturulmuştur. Tohumlar mayıs 2005 tarihinde Samsunda ekilmiştir. Populasyonun bitki boyu, bakla sayısı, bakla uzunluğu, 100 tane ağırlığı, tane verimi ve hasat süresi bakımından genel durumunun belirlenebilmesi için her örnekten elde edilen tüm gözlem değerleri kullanılarak özelliklerin frekans dağılımları çıkarılmıştır. Populasyonda bitki boyu 20-310 cm, bitkide bakla sayısı 1-163 adet, bitkide tane verimi 1-99 g arasında değiştiği tespit edilmiştir. Populasyonun gerekse kuru tane gerekse taze tüketim amaçlı çeşit geliştirme ve ıslah çalışmalarında kullanılabileceği tespit edilmiştir.

Anahtar Sözcükler: Artvin, fasulye, *Phaseolus vulgaris* L., yerel çeşit

Introduction

Turkey has great potential with respect to its richness of culture forms and natural plant species distributed in its flora, as well as its botanic diversity (Tan, 1992). The common bean (*Phaseolus vulgaris* L.) arrived in Turkey in the 17th century. Despite its foreign origin, it has adapted well and has shown broad variation in the Black Sea region. The common bean is an agricultural crop cultivated for fresh pods and for dry seed all over Turkey, and is regarded as a national food. Beans are also a crop of considerable global importance as a grain legume plant with the largest cultivation area in the world.

Cultivar development studies have increased with the help of new techniques and seed policies, which have contributed to the arrival of many cultivars in Turkey in recent years. In addition to the positive contributions of

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new cultivars, especially to higher production levels, they have very important drawbacks, such as causing the abandonment and loss of local varieties. Yet, these materials are irreplaceable sources for the sustainability of agriculture.

As with many other crops, crop improvement studies and newly developed cultivars of the common bean have increased in Turkey in recent years. However, increasing demands for consumer diversity, interest in more balanced and healthy nutritional habits, the extent of the country's ecological variation, and the increase in pest populations that parallel agricultural development suggest that the current cultivars are inadequate and that new ones need to be developed. The improvement of bean cultivars that are appropriate for consumer demands, that are high yielding, disease and stress resistant, and that have rich nutritional content is the most important factor for maintaining its agriculture. It follows that conservation and protection of natural resources is one of the priority issues for sustainability of life in Turkey as well as the rest of the world.

There are many variations in the geographical and topographical structure of Artvin province, the subject of this study. It is possible to see many crops or plants that can be cultivated in Turkey, from temperate to subtropical, in its natural flora or agriculture (Artvin Tarım İl Müdürlüğü, 2005). The surface area of Artvin province is 736,700 ha; 9% of the surface area consists of agricultural land and 13% consists of meadow-pasture land. Bean is one of the 3 most important agricultural crops in Artvin province. The sowing area of dry beans is 650 ha and annual production is 1002 t (Artvin Tarım İl Müdürlüğü, 2003). The variability of the Artvin common bean in terms of seed color, size and shape, plant type, and other plant properties is very high. Agriculture is performed traditionally in Artvin. Production is for family needs rather than for commercial purposes. Farmers consume 70% of their own production and send 30% to local markets. Mechanization is not used for many crops and the use of fertilizer, agricultural pesticides, and controlled and certified seeds is almost non-existent (Artvin Tarım İl Müdürlüğü, 2004). The seed stock used in beans is local cultivars unique to the region and not mixed with commercial cultivars. These landraces are irreplaceable sources that can be used in future research and their potential has not yet been discovered (Küçük et al., 2003).

One of the purposes of this study was to conserve the local genetic material by defining its properties before they disappear and to contribute to its sustainability. Another more important reason is the dam project on the Çoruh River. When completed, there will be 7 dams within the boundaries of the province. The construction of 3 of these dams has been completed to a large extent, preliminary work has been completed on the others, and expropriations have started. Primarily, Yusufeli district and parts of Ardanuç, Şavşat, and Merkez districts will be occupied by this construction or by the inundation basin of dams. Like many crops produced in these areas and plant resources present in the natural flora, beans are also at risk of being lost. Because of socio-economic problems, emigration takes place and agricultural land is being abandoned in the province. This shows that the risk of loss of many local agricultural crops is a threat to the entire province. Given this situation, the primary purpose of this study was to collect, for conservation, bean seed material regarded as local by the authors, not only in areas that will be flooded by dam projects, but also in the entire province, and to examine the general characteristics of some agronomic properties of this population. Thus, it will be determined if this population is a rich genetic source of benefit for cultivar breeding studies.

Materials and Methods

Characteristics of the Research Area

In this study there were 2 separate research areas from where material was collected and plant properties were determined by sowing and assessment.

Artvin province is located in the eastern Black Sea region and its topography is generally mountainous. There are nearly 30 rivers and numerous lakes within the boundaries of the province. In the coastal section of the province, a temperate and rainy climate dominates; towards the inland and high altitude sections, winters are long and very snowy, and summers are cool (Artvin Tarım İl Müdürlüğü, 2005).

The growing stage of this study was conducted at the Black Sea Agricultural Research Institute, which is 17 km from Samsun on the Çarşamba highway. Samsun province is located in the Middle Black Sea region's coastal section. The altitude of the experimental area is approximately 4 m. The experimental area was clay loam,

with a neutral pH and a high level of organic matter. The experimental area also had sufficient calcium and very high levels of phosphorus.

Winters are temperate and rainy in Samsun province. The major portion of the rain falls in the winter months and the rainfall in the summer months is lower. The rainfall, temperature, and humidity values in the months of May-October 2005, when the experiment was conducted, were close to long-term averages. Of the 370.8 mm of rain that fell in this period, 74% fell in the last 2 months. The highest temperatures were recorded in August and the average temperature for the cultivation period was 19.7 °C.

Material

The material for this study consisted of landraces of the common bean collected from Artvin province. Land that will eventually be flooded by dam projects that have been constructed or will be constructed, along with the province's sections that cultivate dry beans were targeted as collection sites. Collection sites were selected according to the stratified sampling method by considering the districts that cultivate beans and the number of villages within them. In all, 74 villages in 7 districts (Table 1) were visited and seed material was collected from 279 points. During collection, special effort was made to collect local varieties. The collected samples' uses were recorded on the basis of farmers' statements. The collection process was conducted based on passport information defined by the Department of Plant Genetic Research at the Aegean Agricultural Research Institute. The altitudes of local cultivar collection sites ranged between 200 and 2100 m. In the study region, farmers generally maintain an intercropping system; therefore, harvested seeds are a bulk population. Collected samples should be sorted according to growth habit, and seed color and shape in order to characterize the samples and compose suitable sowing density. Finally, collected common bean landraces were subsequently sorted into 400 samples.

Method

Seeds of 400 bean samples were sown, with one row in each plot, in May 2005. Row spaces were 50 cm for dwarf types and 70 cm for climbing types, and rows were 5 m long. Each row contained 50 plants. While sowing, fertilization with 0.4 kg pure N per hectare was applied. Immediately after sowing, herbicide treatment for wild weeds was applied. Irrigation was performed 4 times and hoeing 3 times during the period the plants needed to reach maturity. Agronomic properties were measured in 10 plants from each row.

Table 1. Names of districts and villages from where local common bean populations were collected, and the number of populations.

Name of districts	Name of village	Population numbers
MERKEZ	Ortaköy, Oruçlu, Berta, Çimenli, Pırnarlı, Sakalar, Kalburlu, Köseler, Bağcılar	26
ARHAVİ	Uğur, Uluköy, Ulukent, Dikyamaç, Sırtoba, Boyuncuk	16
ARDANUÇ	A.Irmaklar, Tütünlü, Naldöken, Ferhatlı, Soğanlı, Gümüşhane, Anaçlı, Peynirli, Aydın, Torbalı, İncilli	74
BORÇKA	Demirciler	2
MURGUL	Damar, Güngören, Ardıçlı	24
ŞAVŞAT	Eskale, Dereiçi, Ciritdüzü, Cevizli, Kayadibi, Atalar, Çoraklı, Susuz, Tepeköy, Küplüce, Çayağzı, Karaağaç, Kayabaşı, Çavdarlı, Üzümlü	59
YUSUFELİ	Narlık, Yarbaşı, Esendal, Dokumacılar, Bahçeli, Bakırtepe, Özgüven, Bademkaya, Çağlayan, Kılıçkaya, Tekkale, Sebzeciler, Ormandibi, Irmakyanı, İnanlı, Boyalı, Bostancı, Zeytincik, Çıralı, Öğdem, Serinsu, Sarıgöl, Çeltikdüzü, Alanbaşı, İşhan, Darıca, Yüncüler, Yağcılar	78
	SUM.	279

* Village names underlined will be flooded by dam projects.

Because 108 of the 400 samples did not flower or set pod, and did not yield seed, the other 292 samples were evaluated. Frequency distributions of properties were produced using all the observations and measurements that were made for each sample group. Graphics of frequency distributions were prepared with Microsoft Excel.

Results and Discussion

A part of the original material was collected and then the obtained data were sent to the National Plant Gene Bank. The general characteristics of the agronomic properties of the common bean population of Artvin were determined. Frequency distribution of the resulting data, on a percentage and accumulated basis, is given below to provide a database for future studies and for researchers who want to access the material from the gene bank.

Plant Height

Growth habit is one of the most important properties for classifying bean varieties because this property determines its cultivation method. Common beans are morphologically classified as determinate or indeterminate type. In dwarf types, there are 3-10 nodes on the main stem, the main stem always ends with a flower cluster, and, when this cluster forms, growth stops. For this reason, they are called determinate type. In climbing types, there are 11-35 nodes on the main stem, stems grow in a climbing style, and because their growth is not limited they are called indeterminate type (Sepetoğlu, 1994). In both types, different plant heights are seen, depending on genetics and environmental conditions. In this study, 30% of the 292 landraces were dwarf types, and 70% were semi-climbing or climbing types. According to Çiftçi and Şehirali (1984), the degree of heredity of plant height is in the range of 84.6%-92.00%. Bozoğlu and Gülümser (1999) reported that there is a positive and significant relationship between yield and plant height, and that the degree of heredity is high.

In order to identify this property, which is important for breeders and indirectly for consumers, the heights of 1929 plants were recorded. It was observed that plant height varied between 20 and 310 cm. Plants that grew to a maximum height of 99 cm accounted for 39.09% (Figure 1a). Plants with a height between 60 and 99 cm formed the largest group (30.54%) in the common bean population of Artvin. The second largest group (20.32%) was plants with heights between 100 and 139 cm. These 2 groups combined accounted for 50.86% (Figure 1a).

Field cropping is done on broad areas and maturity of cultivated plants at the same time is demanded. Cultivation for dry seed is done in the context of field cropping and bush types are preferred in Turkey. Amini et al. (2002) conducted a study on 576 bean accessions recorded in the gene bank. They reported that properties such as plant height and number of nodes on the main stem showed a great variation depending on the accessions. It was also established in the current study

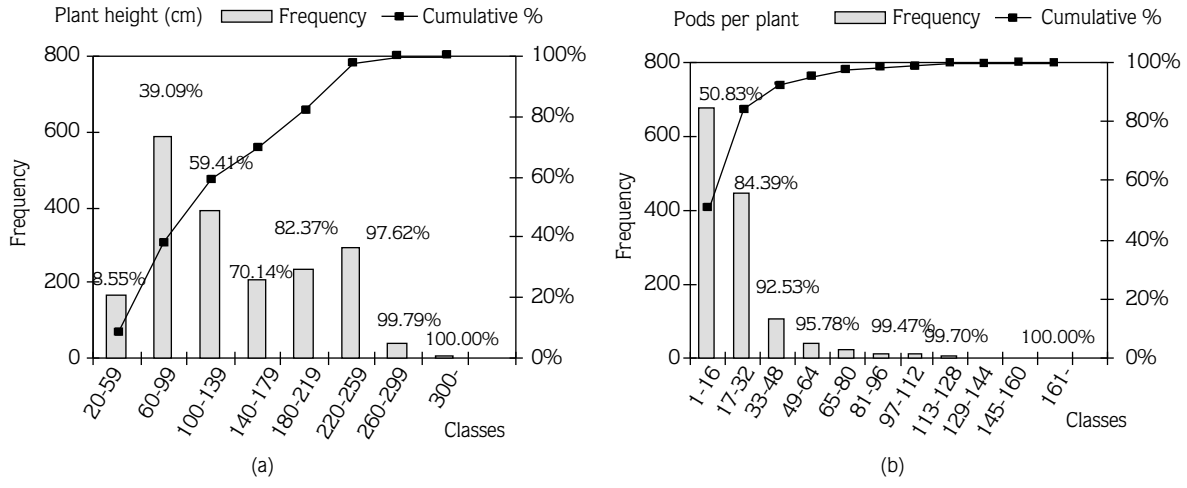

Figure 1. Frequency distributions of class percentages of Artvin's common bean population; a) plant height, b) pods per plant.

that the Artvin population shows a broad variation in plant height.

Number of Pods per Plant

Number of pods per plant is a property that determines seed yield (Bozoğlu and Gülümser, 1999) and has a more obvious effect than others (Arumugan, 1981). In this study, 1326 observations were made and the number of pods per plant varied between 1 and 163. Pods were harvested at the same time from all plants at dry maturity, regardless of whether they were for dry or fresh purposes, and were then counted. In 50.83% of the entire analyzed population, pods per plant ranged from 1 to 16 (Figure 1b). This was followed by samples that had 17-32 pods (33.56%). The samples that had 1-32 pods made up 84.39% of the population. There were some plants that had more than 100 pods per plant, but they accounted for only 1% of the total population.

The number of pods per plant, which almost all researchers regard as the most important property that affects yield, showed a very broad variation in the present study, as the collected material included dwarf and climbing types. In this population, 30% of the samples were dwarf type and the rest were the climbing type.

Pod Length

Joshi and Mehra (1983) analyzed the relationship between seed yield per plant and the heredity of 10 properties in bean cultivars from 42 regions. They reported that accession and phenotype effects on heredity variation (plant height, 100 seed weight, and number of pods per plant) can be used for selection, but that pod length and yield per plant were the principle selection criteria. Pekşen and Gülümser (2005) found pod length to be between 6.84 and 10.88 cm in the study they conducted for the purpose of defining the relationship between seed yield and properties related to yield in some bean (*Phaseolus vulgaris* L.) accessions.

In order to find the variation in Artvin landraces of common bean, we measured 2875 pods and determined that length varied between 4 and 22 cm. Pod length of 52.10% of the population varied between 10 and 12 cm and this was followed by 25.5% of the population that had pods 7-9 cm long (Figure 2a). Plants with pods between 4 and 12 cm accounted for 78.12% of the population. The group with the maximum pod length (22-24 cm) formed a very small portion (0.10%) of the population. Of particular note is that the plants with very short (4-9 cm) and very long (22-24 cm) pod lengths accounted for very small percentages of the population (Figure 2a). Long pods are preferred by consumers in the Black Sea region, especially for pickling purposes. Although they were few in number, the types with long pods can be used as a parent material for breeding with this target trait.

100-Seed Weight

Weight per 100 seeds is a quality that has a positive and significant effect on yield, and its degree of heredity is high (Bozoğlu and Gülümser, 1999). Çiftçi and Şehirali (1984) reported that the degree of heredity of 100-seed

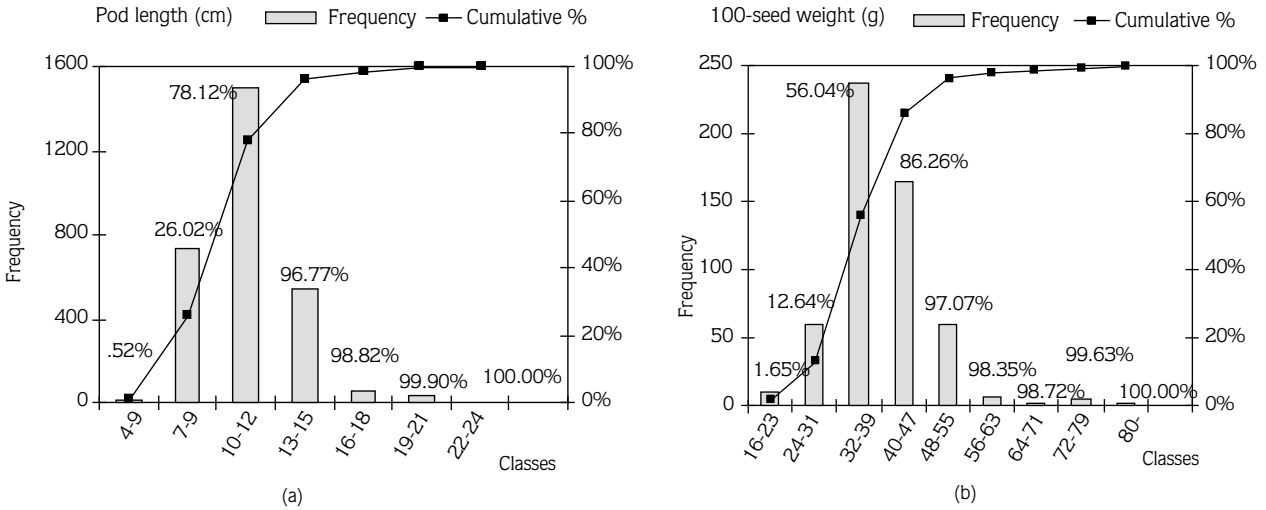

Figure 2. Frequency distributions and class percentages of Artvin's common bean population; a) pod length, b) 100-seed weight.

weight varies between 14.74% and 82.15%. In the present study population 100-seed weight varied between 16.2 and 80 g. The 100-seed weight of 41.75% of the population was between 32 and 39 g, and this was the largest group in the population (Figure 2b). The group with the highest 100-seed weight consisted of those 80 g and over, accounting for only 0.37% of the population. Different studies have reported that this value varies between 32.1 and 39.1 g (Şehirali 1988), 46 and 62 g (Escribano et al., 1991), and 16 and 59 g (Pekşen and Gülümser, 2005).

The 100-seed weight is very important because it affects yield and consumers prefer large seeds in Turkey. It is a generally emphasized and desired trait of all developed cultivars, except for situations involving special purposes. It is concluded that Artvin material, regardless of seed color, makes up a very rich genetic resource with respect to 100-seed weight.

Seed Yield per Plant

Seeds yield per plant is an important property with respect to obtaining seeds, both for dry and fresh consumption. According to Çiftçi and Şehirali (1984), the degree of heredity of plant seed yield was 44.29%-75.44%. Bozoğlu and Gülümser (1999) showed that seed yield has a low degree of heredity compared to other properties, and is significantly affected by cultivation conditions.

In the present study, seed yield per plant varied between 1 and 99 g in the common bean population of Artvin province. Pekşen and Gülümser (2005) found that seed yield per plant varied between 2.56 and 36.83 g in their study. It was natural for yield to show a broad variation in the Artvin population because the material had dwarf- and climbing-type plants. Mekbib (2003) stated that the yield of indeterminate semi-bush and determinate bush growth types are more stable than indeterminate climbing growth-type accessions. Tohme (1987), in a study of the yield of F6 lines and their parents, determined 3 plant types (a: bush; b: original; c: basic stem) and established that the yield of types (a) and (b) was 30% more than for type (c).

Because the present study encompassed the general status of Artvin's bean population, yield per plant of dwarf and climbing types, and different seed colors were not interpreted separately. The yields were determined separately in all 292 samples that reached physiological maturity, a general average was produced for these samples, and frequency distributions based on them were generated.

The largest group in the population had seed yield per plant of 12-23 g (38.51%). Plants that yielded 23 g or less accounted for 73.12% of the population (Figure 3a). The group with the highest seed yield accounted for only 0.34% of the population. The percentage of samples

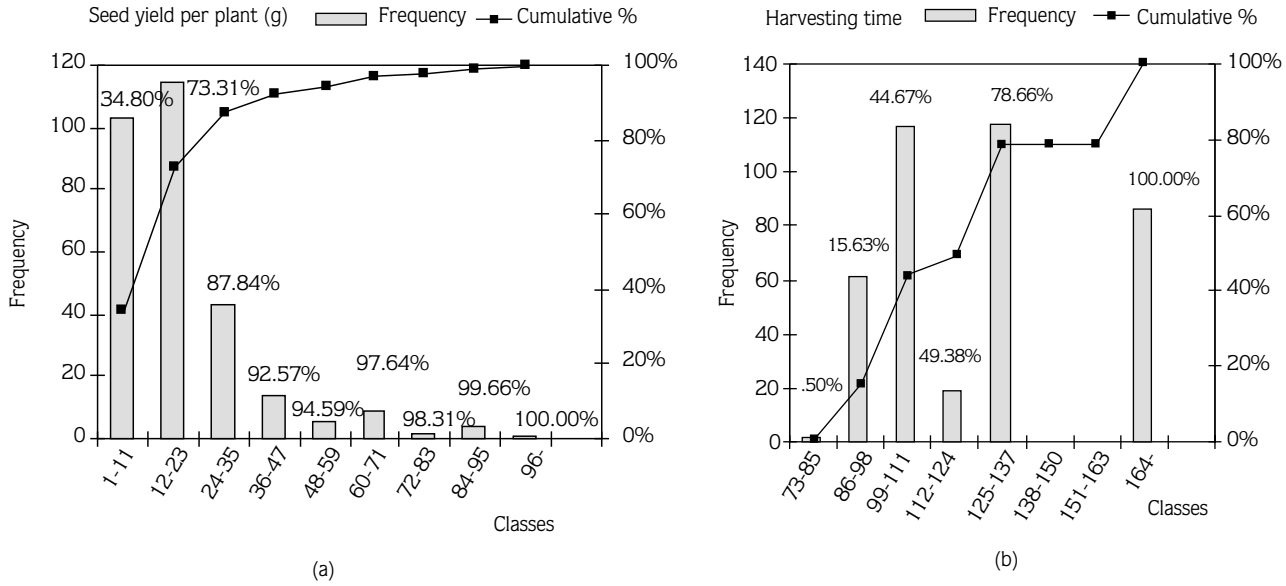

Figure 3. Frequency distributions of class percentages of Artvin's common bean population; a) seed yield per plant b) harvesting time.

having seed yield per plant more than 48 g was quite low; however, 7.5% of the population had seed yield per plant more than 48 g. Despite the fact that yield, more than other qualities, is affected by environmental factors, the authors think that these may be used in breeding programs.

Harvesting Time

Although the Black Sea region is important for bean cultivation, it has many agricultural problems. In particular, temperate summers and rainy falls cause harvesting and then drying problems for crops that reach dry maturity in fall. For this reason, dry beans that have a short vegetation period are preferred in the Black Sea region. Şehrali (1998) reported that the maturation period in dwarf types varied between 70 and 80 days, 80 and 90 days for semi-climbing types, and 130 and 140 days for climbing types. Balkaya and Yanmaz (2003) designated climbing types with a harvest period less than 70 days as early, between 71 and 85 days as medium, and more than 86 days as late, and dwarf types with a harvest period between 40 and 50 days as early, between 51 and 70 days as medium, and more than 72 days as late. Liu and Shisong (1997) tested 174 local bean cultivars in different environmental conditions and 6 local cultivars with a harvest period less than 50 days were defined as early.

Although 400 samples were sown in the present study, 108 showed a different reaction to day length and did not produce seed. In the remainder of the material, the harvest period, which was defined as the time between sowing and drying of 80% of pods, varied between 73 and 170 days. With respect to harvest period, a large portion of the population was late; 15.3% had a harvesting time of less than 99 days versus 99-111 days for the largest group (Figure 3b). There were no groups that had a harvest period between 150 and 163 days. Those with harvesting periods more than 164 days were all climbing types and they accounted for 23.34% of the population. Wu et al. (1992) established that, among 425 bean types in China, dwarf types matured early and semi-climbing types had high yield.

Conclusion

Turkey is very rich with respect to plant diversity and is lucky with respect to sustainability of agriculture because of the advantages provided by its geographic diversity. The most significant point in sustainability is natural resources and their conservation. Artvin province, which was the subject of this study, is rich in genetic resources because of its traditional agricultural structure, and diverse geography and soils. However, the socio-economic situation in the province indicates that a portion of these resources is at risk of being lost. The study material was collected from 74 of the province's villages at altitudes between 200 and 2100 m, and was later evaluated.

In all, 30% of the study population was bush types, which are preferred for cultivating dry seed. Pods per plant correlated to yield positively and varied widely in the study population. Pod length ranged from 4 to 22 cm. Pod length for both dry and fresh consumption was found to be suitable for selection. Seed yield per plant showed great variance among the sample. Evaluating some agronomic properties of the bean population, it was concluded that this common bean population is an appropriate genetic resource for all forms of consumption in Turkey. Earlier types (regarding harvesting time) were not encountered in the population, which consisted of dwarf and climbing types; however, this conclusion does not bode well for selection programs in the Black Sea region.

The material collected for the present study has been deposited in the National Plant Gene Bank; hence, genetic material with broad variation has been conserved for future studies. The authors think that morphological and molecular descriptions of this material and a determination of its cultivation requirements will contribute significantly to Turkey's bean production.

The population of local common bean collected from Artvin province, especially those with high 100-seed weight and yield, and dwarf types should be a useful resource for sustainable bean farming in the Black Sea region and serve as worthy germplasm for a national grain legume crops breeding program.

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References

Amini, A., M. Ghannadha and C. Abd-Mishani. 2002. Genetic diversity and correlation between different traits in common bean (*Phaseolus vulgaris* L.). Iranian Journal of Agricultural Science, 33: 605-615.

Artvin Tarım İl Müdürlüğü. 2003. Artvin Tarım Master Planı. Tarım ve Köy İşleri Bakanlığı, Tarım İl Müdürlüğü, Artvin.

Artvin Tarım İl Müdürlüğü. 2004. Fizibilite Raporu. Tarım ve Köy İşleri Bakanlığı, Tarım İl Müdürlüğü, Artvin.

Artvin Tarım İl Müdürlüğü. 2005. Artvin Tarım İl Müdürlüğü web sayfası: www.artvintarim.gov.tr

CIAT 2006. http://www.ciat.cgiar.org/beans/growthhabits.htm#home. International Center for Tropic Agriculture.

Balkaya, A. and R. Yanmaz. 2003. Bazı taze fasulye çeşit adayları ile ticari çeşitlerin morfolojik özellikler ve protein markörler yoluyla tanımlanmaları. Tarım Bilimleri Dergisi 9: 182-188.

Bozoğlu, H. and A. Gülümser. 1999. Kuru fasulyede (*Phaseolus vulgaris* L.) bazı tarımsal özelliklerin korelasyonları ve kalıtım derecelerinin belirlenmesi üzerine bir araştırma. Türkiye 3. Tarla Bitkileri Kongresi, Adana, 15-18 Kasım 1999: 360-365.

Çiftçi C.Y. and S. Şehrali. 1984. Fasulye (*Phaseolus vulgaris* L.) çeşitlerinde değişik özelliklerin fenotipik ve genotipik farklılıkların saptanması. Ankara Üniversitesi Fen Bilimleri Enstitüsü Yayın No TB 4, 17 s. Ankara.

Escribano, M.R., A.M. Ron, M. Santalla and J.J. Ferreira. 1991. Taxonomical relationship among common bean populations from northern Spain. CAB Abstr. 1993-94 (An Auta. Dei. Vol: 20, 3-4: 17-27).

Joshi, B.D. and K.L. Mehra. 1983. Genetic variability in french bean (*Phaseolus vulgaris* L.). Progressive Horticulture, 15: 109-111.

Küçük, A., S. Mutlu, A. Gürpınar, C. Balkan and B. İçer. 2003. Sebze Genetik Kaynakları Araştırma Projesi. TAGEM/TA/BB/98-17-02-003. Bitki Genetik Kaynakları Program Değerlendirme Toplantısı, Tekirdağ.

Liu, X. and Q. Shisong. 1997. Elite French bean germplasm in Shandong province. Horticulture Abs. No: 7167.

Mekbib, F. 2003. Yield stability in common bean (*Phaseolus vulgaris* L.) genotypes. Euphytica 130: 147-153.

Peşken, E. and A. Gülümser. 2005. Bazı fasulye (*Phaseolus vulgaris* L.) genotiplerinde verim ve verim unsurları arasındaki ilişkiler ve path analizi. OMÜ Zir. Fak. Dergisi, 20: 82-87.

Sepetoğlu, H. 1994. Yemeklik Dane Baklagiller. Ege Üniv. Zir. Fak. Ders Notları No:24, İzmir.

Şehirali, S. 1988. Yemeklik Tane Baklagiller. Ankara Üniversitesi Ziraat Fakültesi Yayınları: 1089, Ders Kitabı: 314, Ankara.

Tan. A. 1992. Türkiye'de bitkisel çeşitlilik ve bitki genetik kaynakları. Anadolu J. of AARI 2: 50-64.

Tohme, J.M. 1987. Relationships between morphological and physiological characteristics and yield of dry bean (*Phaseolus vulgaris* L). cultivars differing in their plant architecture. Dissertation Abstracts International, 48/3: 615 B.

Wu, G., F. Gu, Z.W. You and L. Xu. 1992. Survey and preliminary study of bean germplasm resources in North-east China. Plant Breeding Abst. 062: 10122.