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Full Length Research Paper

Morphological and phenological characterization of Turkish bean (*Phaseolus vulgaris* L.) genotypes and their present variation states

Seher Yıldız MADAKBAŞ[1]* and Meral ERGİN[2]

[1]Horticulture Department, Faculty of Agriculture, University of Ahi Evran, 40100, Kırşehir, Turkey.
[2]Department of Field Crops, Black Sea Agricultural Research Institute, Samsun, Turkey.

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In this study, seeds from 51 bean genotypes obtained from the Izmir Aegean Agricultural Research Institute were multiplied under ecological conditions of the Samsun province in 2006. Similarities and differences in terms of morphological variation were identified for 16 genotypes carrying the phenological, morphological and pod characteristics of fresh bean in 2007. It was determined that the length of time between sowing to sprouting had an important relationship and a positive correlation with the date of initial flowering, 50% flowering and pod width in the correlation matrix. In the principle component analysis (PCA), the two initial PC axis explained the 53.9% of the total variation. The cluster analysis was based on 19 parameters. Five groups were obtained and shown in a dendrogram. High levels of variation between bean genotypes were detected.

Key words: *Phaseolus vulgaris*, phenological observations, morphological measurements, variation, correlation, principle component analysis (PCA), cluster analysis.

INTRODUCTION

Bean has spread out worldwide after the discovery of Americas, its homeland region. Although the *Phaseolus* genus consists of approximately 230 species, the most widely produced members are *P.* vulgaris and *P. coccineus*. All of the beans cultivated in Turkey belong to the *P. vulgaris* species. Moreover, *P. coccineus* is most widely cultivated as ornamental plant (Vural et al., 2000; Anonymous, 2005a; Anonymous, 2005a, b,c). Bean has a 250 to 300 years old history in Turkey. Bean, having a very important place in the nutritiun of Turkish people, is cultivated both in coastal and inland regions of Turkey; it is easily cultivated in regions above 1000 m of altitude (Salk et al., 2008). Turkey is the 3rd ranking country in bean cultivation after China and Indonesia (603,653 tons), Samsun province ranks first with 63.36 tons of bean production in the Carşamba plain (Korkmaz, 2007; FAO, 2009).

*Corresponding author. E-mail: seheryldz@yahoo.com. Tel: +0 90 368 2114470. Fax: +0 90 368 2114453.

There are many local bean types adapted to the regional conditions of Turkey and a major population richness is present.This potential showing a great genetic richness has to be utilized. Both development of new varieties towards promotion of agricultural production and passing the genetical resources to the following generations without infliction of erosion is only possible through preservation and protection of the present populations. Gene resources obtained from any species do not get included in breeding programs unless they are identified through characterization; even if they are included they are quickly lost. It is for this reason that determining the properties of these acquired gene resources carries great importance both in terms of breeding studies and gene banks. (Anonymous, 2001; Balkaya and Yanmaz, 2001; Balkaya and Karagac, 2005; Karaagac and Balkaya, 2010).

In the recent years, use of multivariate analysis methods in data evaluation towards formation of quality gene pools inside the breeding programs has become a commonly used application. Multi-faceted examination of morphological properties allow detection of the observed

Table 1. Bean genotypes obtained from the İzmir Aeagean Agricultural Research Institute (IAARI) Gene Bank.

Registration numbers of bean genotypes from IAARI gene bank	Provinces the genotypes were collected from	Registration numbers of bean genotypes from IAARI gene bank	Provinces the genotypes were collected from
1.TR 69024 (P1)	Kütahya	27. TR 68805 (P27)	Kastamonu
2.TR 68795 (P2)	Kastamonu	28. TR 64967 (P28)	Çankırı
3.TR 66364 (P3)	Uşak	29. TR 37710 (P29)	Trabzon
4.TR 61640 (P4)	Aydın	30. TR 64813 (P30)	Konya
5.TR 45861 (P5)	Kars	31. TR 65066 (P31)	Çanakkale
6. TR 43313 (P6)	Edirne	32. TR 64950 (P32)	Ankara
7.TR 39076 (P7)	Aydın	33. TR 37961 (P33)	Tokat
8.TR 38054(P8)	Uşak	34. TR 61896 (P34)	Denizli
9.TR 37145 (P9)	Sinop	35. TR 62496 (P35)	Balıkesir
10. TR 35480 (P10)	Isparta	36. TR 65014 (P36)	Kastamonu
11. TR 64835 (P11)	Giresun	37. TR 50744 (P37)	Erzurum
12. TR 64760 (P12)	Niğde	38. TR 64772 (P38)	Denizli
13. TR 66752 (P13)	Bartın	39. TR 61608 (P39)	Aydın
14. TR 62021 (P14)	İzmir	40. TR 64792 (P40)	Adana
15. TR 38072 (P15)	Kütahya	41. TR 37673 (P41)	Rize
16. TR 65048 (P16)	Manisa	42. TR 40474 (P42)	Bitlis
17. TR 64871 (P17)	Samsun	43. TR 70427 (P43)	Amasya
18. TR 64982 (P18)	Afyon	44. TR 40497 (P44)	Van
19. TR 64798 (P19)	Isparta	45. TR 68985 (P45)	Eskişehir
20. TR 61761 (P20)	Muğla	46. TR 45861 (P46)	Kars
21. TR 44774 (P21)	Burdur	47. TR38458 (P47)	İstanbul
22. TR 68756 (P22)	Bolu	48. TR 45935 (P48)	Artvin
23. TR 64718 (P23)	Antalya	49. TR 64778 (P49)	Edirne
24. TR 65060 (P24)	Bolu	50. TR 37378 (P50)	Çorum
25. TR 64946 (P25)	İçel	51. TR 64714 (P51)	Mardin
26. TR 38319 (P26)	Kırklareli		

TR: Turkey, P: genotype.

variabilities in terms of certain properties. With increasing number of compared samples, methods of classical statistics become insufficient. Detection of variation and similarities through numerical taxonomic analysis methods, also known as multivariate analyses, requires a series of processes consisting of selections, measurements and analyses. The analysis stages are carried out easily with utilization of computer softwares and visualization opportunities render the comments more efficient (Tan, 2005). Similarities-differences and classifications between types determined using data obtained through characterization studies can be easily presented using cluster analysis and principle component analysis (PCA) (Oliveira et al., 1999; Rivera Martinez et al., 2004; Balkaya and Ergun, 2008).

This study aimed to characterize bean genotypes obtained from Izmir Aegean Agricultural Research Institute (IAARI) gene bank according to UPOV (International Union for The Protection of New Varieties in Plants) criteria and present in detail the current variability using multivariate analysis. Furthermore, determination of qualified genotypes to be used in bean breeding studies and their utilization was also intended.

MATERIALS AND METHODS

Trial material consisted of 51 bean genotypes including 49 *P. vulgaris* and 2 *P. coccineus* (P27 and P38) species obtained from Izmir Aeagean Agricultural Research Institute (IAARI). IAARI gene bank registration numbers of bean genotypes and the provinces they were gathered from are reported in Table 1. Genotypes are coded as P1, P2 and P3 ranging from 1 to 51. Field trials were conducted in Samsun Black Sea Agricultural Research Institute (SBSARI).

The trial field was located between 36°21' eastern latitudes and 41°17' northern longitudes, at an altitude of around 4 m. Cultural practices were conducted regularly during the survey. Considering the results of soil analysis, a fertilization program consisting of 2.5 tons/da of burnt farm fertilizer, 50 kg/da of DAP (diammonium phosphate) as basement fertilizer and 20 kg/da of CAN (calcium ammonium nitrate) was applied both years the trial was performed. The fertilizers were applied by sprinkling. Prior to sowing, 200 mL of trifluraline based herbicide was applied per decare for weed control. The seeds were sown on 05.22.2006 and 05.17.2007. In 2006, multiplication of seeds obtained from IAARI gene bank was

Table 2. Criteria used in the characterization of bean genotypes.

Phenological properties
Germination time (day) (GT): Time between sowing of the seeds and when the plant was first observed
Initial flowering time(day) (IFT): Time between sowing of the seeds and when the first flowers were observed
50% flowering time (day) (IFT 50): Time 50% of the plants take to flourish
Plant
Growth type: 1. dwarf, 2. pole
Fruit (pod)
Flower colour: 1. white, 2 .purple, 3.pink
Pod colour: 1. green, 2. yellow, 3.red
Pod stringiness: 1. present, 2. absent
Pod spottiness: 1. present, 2. absent
Pod pigmentation: 1. red, 2. violet
Clarity of seed in pod: 1. low, 2. moderate, 3.prominent
Pod tip shape: 1. pointy, 2. blunt
Pod flesh shape: 1. narrow elliptic, 2. wide elliptic, 3. round
Pod curvature: 1. inwards, 2. outwards, 3. S-shaped
Bract shape: 1. narrow long, 2. round
Pod length (cm) (PL): Measured starting from flower stalk end point using digital caliper
Pod width (mm) (PW): Measured from the middle of the pod using digital caliper
Pod flesh thickness (mm) (PFT): Pods were laterally and measured with digital caliper
Bract length (mm) (BRL): Bract leaves were measured with digital calipers
Beak length (mm) (BKL): Pod tips were measured with calipers.

performed. In 2007, seeds from each genotype were sown in 2 m parcels in 4 rows with 50 × 20 cm dimensions (row distance × row length). Each parcel contained 40 plants. Following sowing, 250 g of trichlorphon based chemical mixed with 500 g of sugar and 10 kg of bran was applied per decare against mole-cricket damage. In identification of bean genotypes, along with properties we deemed important for bean, UPOV (International Union for The Protection of New Varieties in Plants) criteria and fresh bean agricultural value measurement tests of Ministry of Agriculture Variety Registration and Seed Certification Centre (VRSCC) were included in the list (Table 2) (Anonymous, 1982; Anonymous, 2005d). Phenological observations and morphological measurements were performed on the genotypes send from IAARI gene bank. The collected data were processed with ANOVA, SAS 9.1 and Minitab 13.0 package analysis programs (SAS, 2002; Minitab, 2000). Multiple range test, principle components analysis (PCA) and correlation and cluster analysis were applied to the data sets. Moreover the similarities and differences between genotypes were tried to be exhibitied using the factor coefficients indicating the basic component weights in order to better reveal the variation.

RESULTS AND DISCUSSION

Among bean genotypes sowed in 2006 only P22 did not germinated. Seeds of P22 genotype were assayed for germination tests and 85% germination rate was observed. In studies conducted on germination of bean seeds, it was reported that germination occurred in 7 to 10 days under conditions of optimal soil humidity and temperature; germinations could require 20 to 25 days under extreme conditions at 15°C and no germination was observed under 10°C and above 35°C (Demir and Yanmaz, 1994; Sehirali, 2002; Balkaya, 2004; Kurtar et al., 2004; Holley, 2010). The extreme temperatures in May of 2006 decresead the soil temperature. However, proper germination of other genotypes and no germination in P22 genotype lead one to think that this genotype is very sensitive to low soil temperatures. In 2007, P11 and P43 genotypes flowered, but they did not formed pods. Heat affects many biological processes of bean. Pollenation, seed adsorbtion and maturation are affected positively by suitable temperatures, whereas excessive temperatures prevent ovule and fruit formation and cause flower buds and young fruits to fall. The flowers fall, pods do not form and yields drop at temperatures especially above 30°C (Eti, 1996; Peksen, 2007; Madakbas et al., 2009).

The fact that P11 and P43 genotypes flowered late, in comparison to other genotypes, and that flowering coincided with warm periods prevented pod formation. In Table 3, bean genotypes are evaluated in terms of growth type, flower color and pod characteristics. In terms of growth type, only P26 genotype was detected to be dwarf, and other genotypes were detected to be poles. Flower colour varied between white, light purple and dark purple; pod colour varied between within light green, green and dark green. Stringiness was observed in all genotypes except P1, P2, P3, P10, P13, P16, P25, P26,

Table 3. Growth type, flower colour and pod properties of bean genotypes provided by Izmir Aeagean Agricultural Research Institute (IAARI) Gene Bank.

Genotypes	Growth type	Flower colour	Pod colour	Pod stringiness	Pod spottiness	Pod pigmentation	Clarity of seed in pod	Pod tip shape	Pod flesh shape	Bract shape	Pod curvature
1.TR 69024 (P1)	Pole	P	G	A	A	A	L	PN	NE	NL	IW
2.TR 68795 (P2)	Pole	W	DG	A	A	A	L	PN	NE	NL	IW
3.TR 66364 (P3)	Pole	W	G	A	A	A	PR	PN	R	R	IW
4.TR 61640 (P4)	Pole	W	G	P	A	A	PR	PN	R	NL	IW
5.TR 45861 (P5)	Pole	W	G	P	A	A	PR	PN	R	NL	S
6. TR 43313 (P6)	Pole	DP	DG	P	A	A	PR	PN	R	R	IW
7.TR 39076 (P7)	Pole	W	DG	P	A	A	L	PN	WE	NL	A
8.TR 38054(P8)	Pole	W	DG	P	A	A	PR	PN	R	NL	IW
9.TR 37145 (P9)	Pole	DP	LG	P	A	A	L	PN	NE	NL	IW
10. TR 35480 (P10)	Pole	DP	G	A	A	A	L	PN	NE	NL	IW
11. TR 64835 (P11)	Pole	P	N	N	N	N	N	N	N	N	N
12. TR 64760 (P12)	Pole	W	LG	P	A	A	L	PN	NE	NL	A
13. TR 66752 (P13)	Pole	P	LG	A	P	R	M	PN	WE	NL	IW
14. TR 62021 (P14)	Pole	P	DG	P	A	A	L	PN	NE	NL	IW
15. TR 38072 (P15)	Pole	W	LG	P	A	A	L	PN	NE	NL	A
16. TR 65048 (P16)	Pole	W	G	A	A	A	L	PN	NE	NL	A
17. TR 64871 (P17)	Pole	W	G	P	A	A	L	PN	NE	NL	IW
18. TR 64982 (P18)	Pole	W	G	P	A	A	L	PN	NE	NL	A
19. TR 64798 (P19)	Pole	W	LG	P	A	A	L	PN	NE	NL	IW
20. TR 61761 (P20)	Pole	W	DG	P	A	A	L	PN	NE	NL	IW
21. TR 44774 (P21)	Pole	W	G	P	A	A	L	PN	NE	NL	A
23. TR 64718 (P23)	Pole	W	DG	P	A	A	L	PN	NE	NL	A
24. TR 65060 (P24)	Pole	W	DG	P	A	A	L	PN	NE	NL	A
25. TR 64946 (P25)	Pole	P	LG	A	P	R	L	PN	WE	NL	IW
26. TR 38319 (P26)	Dwarf	P	LG	A	A	A	L	PN	WE	NL	A
27. TR 68805 (P27)	Pole	W	DG	P	A	A	L	B	WE	NL	IW
28. TR 64967 (P28)	Pole	P	LG	A	A	A	L	B	WE	R	A
29. TR 37710 (P29)	Pole	P	G	A	P	V	L	PN	NE	NL	IW
30. TR 64813 (P30)	Pole	W	DG	P	A	A	L	PN	NE	NL	A
31. TR 65066 (P31)	Pole	W	LG	A	A	A	PR	PN	WE	NL	OW
32. TR 64950 (P32)	Pole	DP	LG	A	A	A	L	PN	NE	NL	IW
33. TR 37961 (P33)	Pole	P	G	A	A	A	L	PN	NE	NL	IW
34. TR 61896 (P34)	Pole	W	G	P	A	A	L	PN	NE	NL	IW
35. TR 62496 (P35)	Pole	W	G	A	A	A	PR	PN	NE	NL	A
36. TR 65014 (P36)	Pole	P	G	A	A	A	L	B	NE	NL	IW

Table 3. Contd.

37. TR 50744 (P37)	Pole	W	G	P	A	A	L	PN	NE	NL	IW
38. TR 64772 (P38)	Pole	W	DG	P	A	A	L	B	NE	NL	IW
39. TR 61608 (P39)	Pole	W	G	P	A	A	L	PN	R	NL	S
40. TR 64792 (P40)	Pole	P	LG	A	P	R	L	PN	NE	NL	A
41. TR 37673 (P41)	Pole	W	G	P	A	A	L	PN	NE	NL	IW
42. TR 40474 (P42)	Pole	W	G	P	A	A	L	PN	NE	NL	IW
43. TR 70427 (P43)	Pole	P	N	N	N	N	N	N	N	N	N
44. TR 40497 (P44)	Pole	W	G	P	A	A	L	PN	NE	NL	A
45. TR 68985 (P45)	Pole	W	DG	P	A	A	L	PN	NE	NL	IW
46. TR 45861 (P46)	Pole	W	G	P	A	A	L	PN	WE	NL	IW
47. TR38458 (P47)	Pole	W	G	P	A	A	PR	PN	NE	NL	IW
48. TR 45935 (P48)	Pole	W	G	P	A	A	L	PN	NE	NL	IW
49. TR 64778 (P49)	Pole	W	G	P	A	A	L	PN	NE	NL	IW
50. TR 37378 (P50)	Pole	W	G	P	A	A	L	PN	NE	NL	IW
51. TR 64714 (P51)	Pole	W	G	P	A	A	L	PN	WE	NL	OW

TR: Turkey; P: genotype; G: green; W: white; P: purple; R: red; V: violet; L:light; D:dark; P: present; A: absent; N: none; L: low; M: moderate; PR: prominent; PN: pointy; B: blunt; NE: narrow elliptic; WE: wide elliptic; R: round; NL: narrow long; IW: ınwards; OW; outwards; S: S-shaped.

P28, P29, P21, P32, P33, P35, P36 and P40 (Table 3). Stringiness of fresh bean is a very important feature in case of dried bean production. Stringiness is a most unwanted property in fresh bean since it lowers the market value. Even if certain fresh bean genotypes are superior in many other properties they are not preferred if stringy (Madakbas, 2005; Madakbas et al., 2010). However, in contrast to consumption as fresh bean, stringiness is overlooked in consumption as dried beans (Sözen 2006). Pod spottiness was observed in genotypes P13, P25, P29 and P40; the pigmentation was determined to be red and violaceous (Table 3). These 4 genotypes were easily distinguished because apart from other genotypes, they carried pinto bean like properties. Sixteen genotypes were determined to be suitable for use as fresh beans (P1, P2, P3, P10, P16, P26, P28, P31, P32, P33, P35, P36) and pinto beans (P13, P25, P29, P40). It was observed that when the harvest of fresh beans with pinto bean like properties is delayed, the seeds could be used as shelled broad beans (Balkaya and Ergün, 2008). Distinctiveness of seeds in pods were moderate for P13 genotype, mild or pronounced for the others (Table 3). Level of distinctiveness of seeds in pods varies according to how they are processed (dried, canned or pickled) and customer demands. Pod tip shape was blunt for genotypes P27, P28, P36, P38 and pointy for others. Pod flesh shape was round for P3, P4, P5, P6, P8, P39 most other genotypes were narrow elliptic with some wide elliptic (Table 3). The type of pod flesh shape, especially preferred for consumption, is narrow eliptic. However, the preferred pod flesh shape changes according to how it is consumed, which could be canned, pickled, dried or deep freezed (Balkaya, 1999; Sözen, 2006). Bract shape was determined to be round for P3, P6, and P28 genotypes and narrow long for the rest. Pod curvature was S-shaped for P5 and P39, outwards for P31 and P51 and inwards for the rest. No curvature was observed in P7, P12, P15, P16, P18, P21, P23, P24, P26, P28, P30, P35, P40 and P44 genotypes (Table 3). The consumer choice is towards non-curved varieties green pods. Pod straightness increases the market value of fresh bean where consumer preferences differ with regard to colour, shape and even taste between regions (Salk et al., 2008; Yanmaz, 2010).

Duncan's multiple range test analyses are given in Table 4 and the correlation matrix of germination date (day), date of initial flowering (day), 50% flowering date (day), pod length (cm), pod width (mm), pod flesh thickness (mm), bract

Table 4. Phenological observation and morphological measurement values of bean genotypes provided by Izmir Aeagean Agricultural Research Institute (IAARI) Gene Bank.

P.No	GT(day)*	P.No	IFT(day)	P.No	IFT_50 (day)	P.No	PL (cm)	P.No	PW (mm)	P.No	PFT(mm)	P.No	BRL (mm)	P.No	BKL (mm)
P5	6.00 ± 0.00a**	P 5	35.66 ±0.33 a	P 8	43.00 ±1.00 a	P 14	3.26 ±0.17 a	P 45	8.56 ±0.08 a	P 23	4.00 ±0.05 a	P 24	2.90 ±0.05 a	P 27	3.50 ±0.30 a
P1	6.33 ±0.33ab	P8	36.66 ±0.66 ab	P5	43.33 ±1.33 a	P21	8.70 ±0.11 b	P20	9.46 ±0.03 ab	P21	4.30 ±0.11 ab	P19	3.10 ±0.05 a	P45	4.20 ±0.20 ab
P4	6.33 ±0.33ab	P3	37.66 ±0.66 ab	P1	46.00 ±1.00 ab	P30	8.76 ±0.13 bc	P38	9.50 ±0.20 ab	P16	4.50 ±0.05 ab	P34	3.16 ±0.21 a	P6	4.40 ±0.17 b
P8	6.67 ±0.33ab	P6	38.00 ±1.00 ab	P2	46.00 ±1.15 ab	P29	8.80 ±0.05 bc	P6	10.00 ±0.15 bc	P19	4.50 ±0.05 ab	P21	3.23 ±0.88 a	P14	4.50 ±0.23 b
P7	7.00 ± 0.00a-c	P1	38.33 ±1.76 ab	P10	47.33 ±0.33 ab	P40	8.90 ±0.11 bc	P23	10.10 ±0.05 b-d	P20	4.60 ±0.25 b	P36	3.60 ±0.05 b	P32	4.60 ±0.20 b
P6	7.33± 0.33 b-d	P2	38.66 ±0.66 ab	P3	47.66 ±0.66 ab	P6	9.16 ±0.59 bc	P14	10.13 ±0.13 b-d	P39	5.53 ±0.06 c	P23	3.73 ±0.06 bc	P35	4.70 ±0.26 b
P3	7.67 ± 0.66 cd	P4	39.66 ±0.66 b	P6	48.33 ±0.88 b	P12	9.63 ±0.08 b-d	P7	10.33 ±0.14 b-e	P44	5.70 ±0.11 cd	P28	4.00 ±0.11 cd	P9	4.90 ±0.49 b
P2	8.00 ± 0.00 c-e	P10	39.66 ±0.66 b	P51	48.33 ±4.41 b	P32	9.73 ±0.14 b-e	P40	10.53 ±0.26 c-f	P15	6.13 ±0.06 de	P38	4.00 ±0.05 cd	P29	5.83 ±0.03 c
P10	8.00 ± 0.00 c-e	P51	39.66 ±3.18 b	P12	49.33 ±2.60 b	P27	9.76 ±0.14 b-e	P33	10.63 ±0.20 c-f	P47	6.23 ±0.03 ef	P15	4.10 ±0.05 de	P20	5.96 ±0.03 cd
P24	8.00 ± 0.00 c-e	P12	40.33 ±2.02 b	P4	49.66 ±0.88 b	P13	9.86 ±0.06 c-f	P21	10.70 ±0.05 c-f	P40	6.30 ±0.05 ef	P39	4.10 ±0.05 de	P8	6.00 ±0.37 cd
P39	8.00 ± 0.00 c-e	P25	44.00 ±1.73 c	P7	54.66 ±0.66 c	P25	10.40 ±0.23 d-g	P29	10.96 ±0.14 c-g	P8	6.43 ±0.18 e-g	P14	4.16 ±0.08 de	P38	6.20 ±0.15 cd
P9	8.33 ± 0.33 d-f	P44	44.00 ±1.00 c	P9	56.00 ±1.00 cd	P18	10.43 ±0.38 d-g	P47	11.00 ±0.25 c-g	P48	6.43 ±0.17 e-g	P18	4.20 ±0.15 d-f	P30	6.30 ±0.20 c-e
P12	9.00 ± 0.00 d-f	P16	44.66 ±1.76 cd	P16	56.33 ±1.85 c-e	P48	10.50 ±0.11 d-g	P8	11.03 ±0.37 c-g	P18	6.50 ±0.30 e-h	P40	4.20 ±0.05 d-f	P25	6.76 ±0.06 d-f
P17	9.00 ± 0.00 d-f	P13	46.33 ±1.85 c-e	P25	57.00 ±1.52 c-f	P42	10.53 ±0.26 d-g	P48	11.10 ±0.05 d-g	P28	6.53 ±0.27 e-ı	P9	4.23 ±0.13 d-f	P5	7.00 ±0.25 e-g
P23	9.00 ± 0.00 d-f	P39	46.66 ±1.45 c-e	P13	57.33 ±1.45 c-g	P37	10.56 ±0.06 d-h	P4	11.13 ±0.26 d-h	P29	6.53 ±0.08 e-ı	P16	4.23 ±0.08 d-f	P10	7.36 ±0.29 f-h
P15	9.33 ±0.33 fg	P7	47.33 ±0.33 c-f	P44	57.66 ±1.33 c-g	P10	10.73 ±0.32 d-ı	P3	11.23 ±0.40 e-ı	P9	6.63 ±0.06 e-j	P5	4.26 ±0.06 d-g	P34	7.36 ±0.12 f-h
P32	9.33 ±0.33 fg	P17	48.00 ±2.08 d-g	P17	58.66 ±2.72 c-h	P44	10.73 ±0.14 d-ı	P5	11.33 ±0.29 e-ı	P14	6.76 ±0.06 f-k	P29	4.33 ±0.14 d-h	P37	7.56 ±0.20 f-ı
P51	9.67 ±0.33 gh	P24	48.33 ±0.66 d-g	P15	59.33 ±0.66 c-h	P16	10.76 ±0.12 d-ı	P12	11.36 ±0.23 e-j	P33	6.96 ±0.08 g-l	P30	4.33 ±0.12 d-h	P26	7.63 ±0.18 g-ı
P21	9.67 ±0.33 gh	P36	48.33 ±0.66 d-g	P14	59.66 ±1.66 c-ı	P46	10.80 ±0.15 d-j	P17	11.46 ±0.08 f-k	P42	7.03 ±0.03 h-l	P44	4.46 ±0.06 e-h	P48	7.66 ±0.20 g-ı
P29	9.67 ±0.33 gh	P21	49.00 ±0.57 e-h	P24	59.66 ±0.88 c-ı	P36	10.90 ±0.05 e-k	P28	11.80 ±0.15 g-l	P41	7.06 ±0.12 ı-l	P6	4.56 ±0.13 f-h	P40	7.83 ±0.03 h-j
P34	9.67 ±0 .33 gh	P23	49.00 ±0.00 e-h	P39	59.66 ±1.76 c-ı	P2	11.00 ±0.25 f-l	P16	11.90 ±0.05 g-l	P46	7.13 ±0.08 j-l	P13	4.56 ±0.08 f-h	P36	8.06 ±0.12 h-j
P36	9.67 ±0.66 gh	P29	49.00 ±0.00 e-h	P29	60.00 ±0.00 d-ı	P5	11.13 ±0.14 g-m	P39	12.16 ±0.08 h-m	P35	7.16 ±0.03 j-l	P8	4.63 ±0.13 gh	P2	8.20 ±0.10 h-k
P48	9.67 ±0.33 gh	P41	49.00 ±0.00 e-h	P34	60.00 ±0.00 d-ı	P23	11.16 ±0.58 g-m	P46	12.16 ±0.08 h-m	P32	7.26 ±0.26 k-m	P10	4.63 ±0.06 gh	P41	8.26 ±0.03 ı-l
P14	10.00±0.00 g-ı	P14	49.33 ±0.88 e-ı	P36	60.33 ±0.88 d-j	P34	11.23 ±0.29 g-m	P13	12.23 ±0.28 ı-m	P31	7.36 l±0.21m	P17	4.63 ±0.12 gh	P21	8.36 ±0.17 ı-l
P16	10.00±0.00 g-ı	P26	49.66 ±0.33 e-j	P19	60.66 ±1.76 d-j	P8	11.40 ±0.55 g-m	P34	12.40 ±0.20 j-n	P17	7.50 ±0.15 l-n	P47	4.66 ±0.08 h	P17	8.40 ±0.15 ı-l
P20	10.00±0.00 g-ı	P27	49.66 ±0.33 e-j	P23	61.00 ±0.00 d-j	P17	11.43 ±0.29 g-m	P41	12.40 ±0.20 j-n	P12	7.73 ±0.12 mn	P2	4.70 ±0.00 ı	P12	8.60 ±0.20 j-l
P27	10.00±0.00 g-ı	P32	49.66 ±0.66 e-j	P27	61.00 ±1.52 d-j	P19	11.53 ±0.26 g-m	P15	12.46 ±0.23 k-n	P45	8.40 ±0.14 op	P12	5.06 ±0.08 ı	P33	8.90 ±0.05 k-m
P31	10.00±0.00 g-ı	P9	50.00 ±0.57 e-j	P32	61.33 ±1.33 e-k	P41	11.73 ±0.14 h-n	P24	12.50 ±0.20 k-n	P10	8.43 ±0.23 op	P26	5.06 ±0.12 ı	P23	9.06 ±0.17 lm
P33	10.00±0.57 g-ı	P19	50.00 ±1.00 e-j	P41	61.33 ±1.33 e-k	P47	11.73 ±0.17 h-n	P44	12.53 ±0.27 l-n	P27	8.43 ±0.32 op	P27	5.10 ±0.05 ıj	P13	9.43 ±0.18 mn
P35	10.00±0.00 g-ı	P28	50.00 ±1.00 e-j	P20	61.66 ±1.66 f-k	P20	11.86 ±0.06 ı-n	P42	12.73 ±0.14 l-n	P1	8.46 ±0.17 op	P35	5.13 ±0.08 ıj	P24	9.93 ±0.12 no
P38	10.00±0.00 g-ı	P30	50.00 ±0.57 e-j	P21	62.00 ±1.52 f-k	P28	11.96 ±0.08 j-n	P9	13.06 ±0.60 m-o	P34	8.53 ±0.08 o-r	P41	5.13 ±0.08 ıj	P31	10.13 ±0.08 no
P41	10.00±0.00 g-ı	P34	50.00 ±0.00 e-j	P28	62.00 ±1.73 f-k	P15	12.06 ±0.06 k-n	P18	13.40 ±0.23 n-p	P36	8.60 ±0.05 pr	P37	5.20 ±0.10 ıj	P39	10.20 ±0.15 no
P42	10.00±0.00 g-ı	P20	50.33 ±1.33 e-k	P42	62.00 ±0.00 f-k	P24	12.06 ±0.32 k-n	P27	13.73 ±0.26 o-r	P49	8.65 ±0.25 pr	P20	5.36 ±0.17 ı-k	P46	10.36 ±0.29 o
P47	10.00±0.00 g-ı	P31	50.33 ±1.33 e-k	P18	62.33 ±2.33 g-k	P9	12.16 ±0.29 l-o	P10	13.80 ±0.35 o-r	P38	8.80 ±0.05 pr	P3	5.43 ±0.17 ı-k	P18	10.40 ±0.30 o
P49	10.50±0.50 h-j	P33	50.33 ±0.33 e-k	P31	62.33 ±1.45 g-k	P33	12.26 ±0.14 m-o	P2	14.06 ±0.18 p-s	P7	8.86 ±0.23 pr	P42	5.46 ±0.14 jk	P28	11.13 ±0.41 p
P13	10.67±0.33h-k	P15	51.00 ±2.00 f-k	P30	63.00 ±1.52 h-l	P31	12.86 ±0.33 n-p	P1	14.10 ±1.45 p-s	P24	9.03 ±0.08 rs	P1	5.60 ±0.10 k	P1	11.26 ±0.03 p
P19	10.67±0.33h-k	P18	51.33 ±1.85 f-k	P37	63.66 ±1.20 h-l	P26	13.23 ±0.12 op	P49	14.35 ±0.15 p-t	P2	9.50 ±0.20 st	P25	5.70 ±0.05 kl	P7	11.83 ±0.23 pr
P25	10.67±0.66h-k	P38	52.00 ±0.00 g-k	P38	63.66 ±0.66 h-l	P1	13.26 ±0.52 op	P35	14.53 ±0.27 r-t	P13	9.60 ±0.15 t	P50	5.73 ±0.05 kl	P4	12.53 ±0.23 rs
P37	10.67±0.66h-k	P42	52.00 ±0.00 g-k	P26	64.00 ±1.00 h-l	P35	13.26 ±0.26 op	P31	14.60 ±0.23 r-t	P6	9.70 ±0.41 t	P48	6.00 ±0.03 lm	P15	12.56 ±0.38 rs
P18	11.00±0.57 ı-k	P46	52.00 ±0.00 g-k	P33	64.00 ±1.00 h-l	P45	13.40 ±0.20 p	P32	14.70 ±0.15 r-t	P25	10.00 ± 0.10 tu	P33	6.03 ±0.10 lm	P3	12.96 ±0.23 s

Table 4. Contd.

P30	11.00±0.00 ı-k	P49	52.00 ±0.00 g-k	P40	65.00 ±0.00 ı-l	P49	13.80 ±0.10 p	P30	14.90 ±0.15 s-u	P26	10.26 ±0.08 uv	4P9	6.20 ±0.21 mn	P19	13.80 ±0.70 t
P50	11.00±0.57 ı-k	P37	52.667 ±0.66 h-k	P46	65.00 ±0.00 ı-l	P39	15.20 ±0.00 r	P19	15.03 ±0.08 s-u	P30	10.66 ±0.17 vy	P31	6.26 ±0.26 mn	P16	14.26 ±0.20 t
P45	11.00±0.00 ı-k	P45	53.00 ±0.00 h-l	P49	65.00 ±0.00 ı-l	P4	15.26 ±0.31 r	P25	15.33 ±0.17 t-v	P37	10.73 ±0.14 vy	P4	6.30 ±0.00 mn	P47	16.80 ±0.15 u
P40	11.33 ±0.33 jk	P35	53.33 ±1.66 ı-l	P45	65.33 ±0.33 j-l	P3	15.66 ±1.55 r	P26	15.76 ±0.12 uv	P50	10.90 ±0.23 yz	P7	6.30 ±0.14 mn	P44	17.46 ±0.26 uv
P44	11.33 ±0.33 jk	P40	53.66 ±0.66 j-l	P35	66.33 ±1.66 kl	P7	16.20 ±0.50 rs	P36	16.26 ±0.59 v	P4	10.90 ±0.29 yz	P32	6.53 ±0.20 n	P42	17.90 ±0.37 v
P26	11.67 ±0.33 k	P47	54.33 ±1.20 kl	P47	66.33 ±0.88 kl	P38	16.20 ±0.11 rs	P50	16.40 ±0.15 vy	P5	11.10 ±0.21 yz	P45	8.36 ±0.05 o	P49	19.35 ±0.35 y
P28	11.67 ±0.33 k	P48	56.66 ±1.66 l	P48	68.00 ±3.00 k	P51	16.70 ±0.59 s	P51	16.45 ±0.23 vy	P51	11.33 ±0.29 z	P46	8.50 ±0.07 o	P51	19.50 ±0.37 z
P46	11.67 ±0.33 k	P50	61.66 ±1.66 m	P50	73.33 ±2.40 l	P50	18.10 ±0.19 t	P37	19.13 ±0.33 z	P3	11.36 ±0.23 z	P51	9.00 ±0.08 p	P50	19.52 ±0.45 z
% CV	23	% CV	19	% CV	21	% CV	20	% CV	17	% CV	18	% CV	20	% CV	23

*P: Population; No: number; GT: germination Time(day); IFT: ınitial flowering time (day); IFT_50: 50% flowering time (day); PL: pod length (cm); PW: pod width (mm); PFT: pod flesh thickness (mm); RL: bract length (mm); BKL: beak length (mm), **means followed by the same letter are not significantly different at P≤ 0.05.

second and third earliest germinating genotypes were P5, P1 and P4, respectively; the latest germinating genotypes were P44, P26, P28 and P46 with the last three taking equally long to germinate. In terms of length of time between sowing and initial flowering, P5 genotype ranked first with 35.66 days, followed next in line by P8 and P3 genotypes; P50 ranked last with 66.61 days (Table 4). Length of time between sowing and 50% flowering varied between 43 and 73.33 days, where P5, P8 and P3 genotypes ranked first and P50, P48 and P47 genotypes ranked last (Table 4). With respect to 50% flowering times recorded in the field studies, the dwarf beans were regarded as early flowering for 45 days, medium flowering for 50 days, late flowering for 50 and above; pole beans were regarded as early flowering for 50 days, medium flowering for 70 days and late flowering for 70 days and above (Balkaya and Yanmaz, 2003; Madakbas et al., 2009, 2010; Düzdemir and Ece, 2010). A significant variation between initial flowering time and 50% flowering time can be observed in Table 4. Significant variations in flowering period and time until initial flowering related to genotype and environmental conditions are reported by many researchers (Düzdemir and Akdag, 2001). With regard to 50% flowering times, P1, P2, P3, P4, P5, P8, P6, P10, P12, P51 genotypes were detected as early flowering with 43.00 to 49.66 days; P50 genotype as late flowering with 73.33 days and the rest of the genotypes were detected as medium-late flowering. P26 was the only dwarf late flowering genotype with 66 days of 50% flowering time (Table 4). Pod length varied between 3.26 and 18.10 cm. The shortest pod lengths were shape (mm) and beak length (mm) is given in Table 5. Table 4 shows the length of time (6.00 to 11.67 days) between sowing and germination. The first, displayed by P24, P19 and P34 where the longest bracts belonged to P51, P46 and P45 genotypes. P27, P45 and P6 genotypes had the shortest beak length where P50, P5 and P45 had the longest beak length (Table 4).

Sixteen genotypes carrying fresh bean and kidney bean properties that were obtained from IETAE gene bank and evaluated with regard to morphological, phonological and pod properties are going to be evaluated together with fresh bean genotypes collected from Middle Black Sea Region in 2002 and 2003 period and included in the breeding program.

Table 5 shows statistically significant and positive correlations between germination date and parameters including initial flowering date (0.658**), 50% flowering date (0.754**) and pod width (0.213*); between pod length and parameters including pod flesh thickness (0.204*) and beak length (0.226**); between pod width and pod flesh thickness (0.279**); between pod flesh thickness and bract length (0.228**). Also statistically significant but negative correlations are presented between germination date parameters including pod length (-0.199*) and pod flesh thickness (-0.260**); between initial flowering date and pod flesh thickness (-0.364**); between pod flesh thickness and beak length (-0,168*).

The regularity of the germination date directly affected pod width and 50% flowering date (Table 5) (Copur et al., 2005; Cinsoy et al., 2005; Kayaalp and Cankaya, 2008).

The primary component axes, eigen values, variation and cumulative variation ratios along with factor coefficients determining the weight values in the primary components, which occur as properties, are provided in Table 6 in detail. Since the morphological property data obtained from bean genotypes include both qualitative and quantitative data, we assumed the correlation matrix would display a good performance in the

Table 5. Correlation of phenological and morphological properties of beans genotypes obtained from Izmir Aeagean Agricultural Research Institute (IAARI) Gene Bank.

	GT	IFT	IFT_50	PL	PW	PFT	BRL	BKL
GT	1							
IFT	0.658**	1						
IFT_50	0.724**	0.955**	1					
PL	-0.199*	-0.026^{ns}	-0.025^{ns}	1				
PW	0.213*	0.079^{ns}	0.106^{ns}	0.094^{ns}	1			
PFT	-0.260**	-0.364**	-0.339**	0.204*	0.279**	1		
BRL	0.078^{ns}	0.083^{ns}	0.102^{ns}	0.227^{ns}	-0.048^{ns}	0.228**	1	
BKL	0.069^{ns}	0.009^{ns}	0.036^{ns}	0.266**	0.028^{ns}	-0.168*	0.017^{ns}	1

*GT:Germination time(day); IFT: ınitial flowering time (day); IFT_50: 50% flowering time (day); PL: pod length (cm); PW: pod width (mm); PFT: pod flesh thickness (mm); BRL: bract length (mm); BKL: beak length (mm); ns: no significant *:P ≤ 0.05, **: P ≤ 0.01.

Table 6. Eigen value, variation and principal component axes concerning evaluated properties as a result of principal component analysis (PCA).

Eigen values	2.8114	1.5043
Variation (%)	0.351	0.188
Cumulative Variation (%)	0.351	0.539

The principal component analysis		
Properties	**PC1**	**PC2**
GT (day)	0.511	0.076
IFT (day)	0.557	0.073
IFTt_50 (day)	0.568	0.104
PL (cm)	-0.097	0.545
PW (mm)	0.079	0.450
PFT(mm)	-0.296	0.462
BRL (mm)	0.014	0.477
BKL(mm)	0.048	0.193

*GT: Germination time(day); IFT: ınitial flowering time (day); IFT_50: 50% flowering time (day); PL: POD LENGTH (cm); PW: pod width (mm); PFT: pod flesh thickness (mm); BRL: bract length (mm); BKL: beak length (mm).

primary component analysis (PCA). Many researchers standardize their data sets with the correlation matrix in a wide range of studies making it a method of choice (Wiley, 1981; Mohammadi and Prasanna, 2003). At the end of analysis, 8 distinct principle component axes were obtained from 8 identifying qualities evaluated. These axes represented 90.84% of the total variation. Eigen values for the first 8 principle components were between 1.02-4.87.

The fact that eigen values are above 1 indicates that the evaluated principle component weight values are reliable (Mohammadi and Prasanna, 2003). Özdamar (2004) reported that for the factor coefficients to be reliable, the principle component axes must explain 2/3's of the total variation. Upon review of the analysis results, it was observed that 2/3's of the total variation is easily explained (53.9%) with just the first two principle components (Table 6). Therefore, these axes were considered in evaluation of the analysis. The first principle component axis covers 35.1% and the second principle component covers 18.8% of the total variation (Table 6). In a study conducted by Coelin et al. (2006), the first eigen value explained the 46% and the first two variables explained the 88.23% of the variation. Three genotypes most unrelated with regard to morphological and agronomical properties were identified and combinations of these genotypes were recommended for inter-population breeding studies. As reported by Rivera-Martinez (2004) and Keles (2007), sum of the first three eigen values must be 50% minimum for the chart to be of reliable significance. They also stated that eigen values of first three components below 50% indicate high

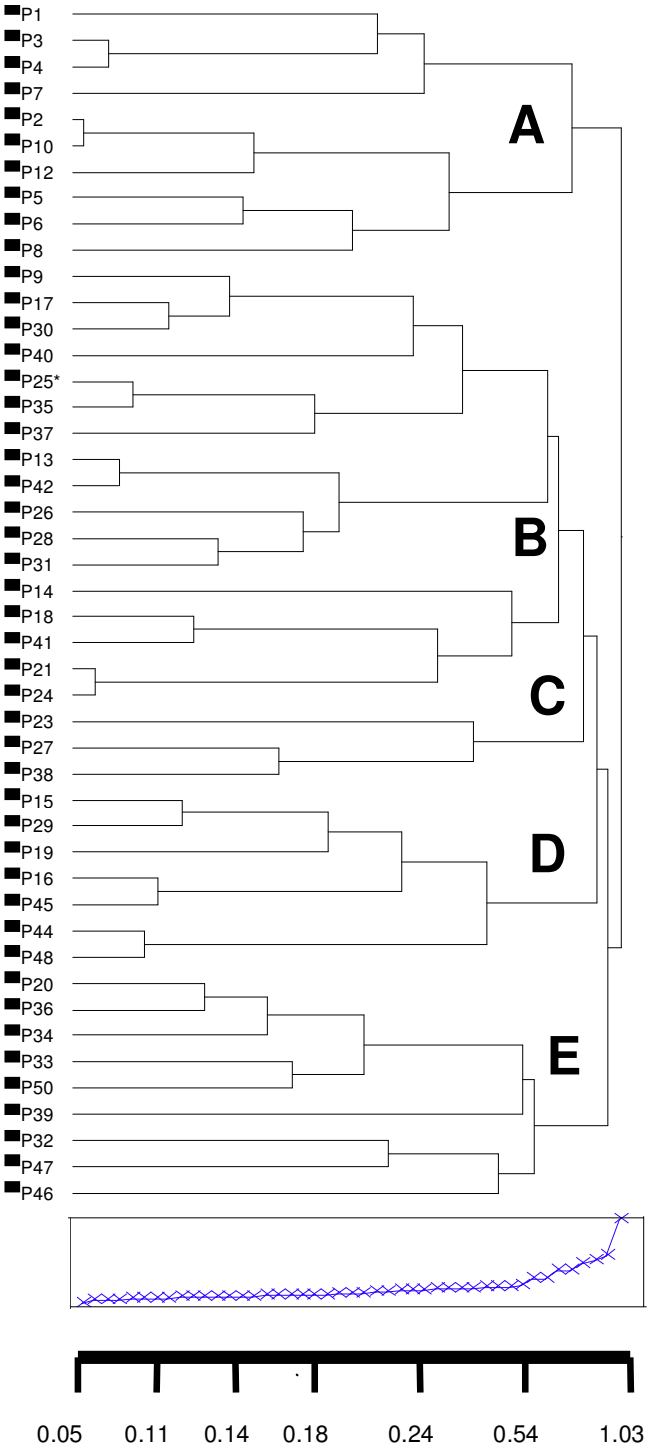

Figure 1. Cluster analysis of bean genotypes provided by Izmir Aeagean Agricultural Research Institute (IAARI) Gene Bank.

genetic variation. The values for principle component weights of properties in the PCA were regarded as important if above 0.3 (Brown, 1991).

In the first principle component axis, the initial flowering time, 50% flowering time and germination time scored above 0.3 upon evaluation of quality weight values. Therefore, in the first PCA these traits were represented. The second primary component consisted of pod length, pod width, pod flesh thickness and bract length. At the end of primary component analysis, factor coefficients of identifying qualities were evaluated and the attributes scoring a coefficient value higher than 0.3 in the first two PCA were determined. These qualities were detected to display the variation among the analyzed population best bean. Even though the beak length scored higher than 0.3 in the first 8 PCA, they were not included in the first two PCA, which represented 53.9% of the variation (Table 6). At the end of the PCA, it can be concluded that morphological variability was very high based on the cumulative variation ratio and that acquired values and results from other characterization studies are concurrent. According to the International Center for Tropical Agriculture (CIAT) idenfitication criteria, Garcia et al.(1997) analysed beans cultured from Saltito, Durango, Mexico (wild) and cv. Bayo Mecentral with regard to growth type, flower color, pod color, hypcotyl color, the first and the last days of flowering, physiological maturation date, hypocotyl and stem length (cm), total number of branches, number of pods per plant, number of seeds per plant and number of nods on the main stem. They reported that growth type of wild populations vary greatly and showed positive correlation with 13 variables; several very important correlations were detected in cultivated populations as well. The authors also established once again that principle component analysis (PCA) explained only 70% of agricultural and morphological variables, linear combination and total variation, but breeding processes play an important role in variation loss. Lezzoni and Pritts (1991), Mohammadi and Prasanna (2003) stated that when principle component analysis explains the majority of the variation of the first two or three components it would be a very suitable technique for grouping. In the principle component, Eigen value above 1.0 will provide much more information on variation because if principle components explain the variation enough, maximum coverage for the original variation indicates that variation will be very high.

The data to be used in the cluster analysis are evaluated taking also into consideration the principle component analysis (PCA) results. The qualities with low factor coefficients were excluded from the cluster analysis. At the end of cluster analysis, the difference coefficients varied between 0.05 and 1.03 and showed agglomeration within 5 groups (Figure 1). Upon analysis of the branching patterns, 10 subgroups were detected under 5 groups:

Group A: Consisted of 2 subgroups and 10 genotypes. The most closely related genotypes were P2 and P10 under Subgroup 2. This group contained the medium-late genotypes. While most genotypes shared being collected from the Aegean Region, they formed a varying group with regard to place of acquisition, stringiness, pod

properties and pod, bract and beak length.

Group B: Consisted of 3 subgroups and 17 genotypes forming the most crowded group. The genotypes most closely related are P21 and P24 from the Subgroup 3. P26 dwarf genotype and P13, P25 and P40 genotypes carrying fresh pinto bean properties took place in this group. Aside from P13, P31 and P35 genotypes members of this group had mild clarity of seed. All except P28 genotype had pointy pod tips and narrow long bract shape in this group. This group contained medium-late flowering genotypes too. Variation was observed with regard to stringiness, pod properties, in addition to pod, bract and beak length and place of collection.

Group C: Contained the least number of genotypes with 3 genotypes in 1 subgroup. This group contained medium-flowering, stringy, white flowered and narrow long bracted genotypes with mild seed clarity and no fresh bean like properties. However, it showed variation with regard to other pod properties in addition to pod, bract and beak length.

Group D: This group consisted of 2 subgroups and 7 genotypes. This group of pole bean genotypes included white flowered genotypes, except P29 which had pinto bean like properties, and genotypes with mild seed clarity, pointy pod tip, narrow-eliptic pod flesh and narrow long bract shape. It also includes late flowering genotypes with medium pod length, pod width and pod flesh thickness. Variation with regard to stringiness, pod color, bract and beak length was detected.

Group E: Consisted of 3 subgroups and 9 genotypes. In this group of pole beans, seed clarity in pods was mild except P47; pod tips were pointy except P36; pod flesh shapes were narrow-eliptic except P39 and P46; bract shapes were narrow long; and pod curvatures were inward out except P39. In this group, 8 genotypes were medium-late flowering except P50, which was late flowering. Variation with regard to flower color, pod color and stringiness was observed. The group with most variation with regard to pod length, pod width, pod flesh thickness, bract and beak length was Group E.

Stoilova et al. (2005) performed morphological characterization of 30 local bean genotypes originating from different regions of Portugal and Bulgaria using IPGRI criteria. To reveal the differences between genotypes, they analysed 20 morphological, phenological and agronomical traits. They used cluster analysis to determine the variation and seperated the populations in to 5 main groups according to this analysis. At the end of the study, they have reported significant variation among genotypes. Madakbas et al. (2006) performed cluster analysis to differentiate the lines using data obtained from characterization studies based on UPOV criteria and determined that the lines were not similar. Oz et al. (2003) and Sözen (2006) stated that in the agricultural studies an abundance of observations should be performed based on consumer and producer demands, adding that the economically important qualities in plants show polygenic inheritance and evaluation of characters seperately sometimes produces faulty comments and suggestions; they proposed that utilization of multivariate analysis methods allows simultaneous analysis of multiple characters. The researchers stated that classification of similar genotypes was carried out with cluster analysis, but characterization with regard to morphological and phenological properties was affected greatly by environmental conditions. Brown-Guedira et al. (2000) defined cluster analysis as an analysis where distance between genotypes in a cluster of two or more genotypes is below the overall genetic average, and distance between clusters is greater than that of the cluster containing them.

With regard to origins of bean genotypes collected from IAARI, the genotypes seemed to be distributed randomly into the 5 groups. Regions were not gathered in the Beans from same regions were not grouped together in the cluster analysis because since bean is a self-pollinating plant the farmer can produce his own seeds and exchange them within and between regions. The fact that inter-regional seed transitions occur frequently causes some qualities to have polygenic character and variation to increase because of agroecological conditions. Since beans from Turkey are of Andean origin, they posess a narrow genetic base. Within this narrow genetic base distinctive properties may not be so easily detected. Research shows that beans with red seeds are obtained from beans with black seeds and because of this selectional pressure majority of parents with red seeds are veiled (Beebe et al., 1997).

Conclusıon

Translocation of crops within various regions plays an important role in the development of agriculture world-wide. Translocations between provinces on common trade routes took place since the beginning of history. Even though Turkey is a gene pool center for bean, the fact that it is located on transit routes between western and eastern countries increased the local importance of diversity and production of bean. In order to preserve the rich biological diversity that is corroding away under varying pressures, collection programs should be initiated and the collected material should be preserved in gene banks (Anonymous, 2004; Muhuku, 2006). Genetic materials with different qualities that are thought to be suitable for dry, fresh and industrial use should be analyzed and the promising genotypes should be taken into breeding programs. The recent use of standard varieties for production purposes causes a decrease in

the genetic diversity. With this purpose in mind, the collected gene sources should undergo identification according to bean idenfitication criteria. The various idenfitication studies performed with field trials need of extended periods of times and are easily affected by environmental conditions because of insufficient participation of certain morphological characters; therefore, differences may occur between genotypical and phenotypical properties leading to inconclusive results (Oz et al., 2003; Madakbas et al., 2006; Madakbas, 2006). To overcome this issue and lead the breeder to more accurate diagnoses, biotechnological advancements are being made use of. Molecular methods used in diagnosis of species and varieties make it possible to analyse plant genetic makeup more closely.

While it is difficult to reveal differences between types by morphological characterization, these differences can be revealed much more easily and accurately using molecular techniques such as RAPD, RFLP, AFLP and SSR, which are used in molecular characterization (Miklas et al., 2000, 2005; Anushri et al., 2004; Mukeshimana et al., 2005; Naderpour et al., 2010).

At the end of this study, 49 of 51 bean genotypes collected from various regions of Turkey were evaluated and characterized. High amounts of morphological variability were found among bean genotypes. Furthermore, a fresh bean collective perspective on the current situation in morphological variation and its dimensions was provided with this study. Detailed information was obtained on the morphological variability of bean genotypes. Evaluation of variability in plant qualities will aid the vegetable breeders by detecting desired qualities in populations that will be used in the future bean breeding programs. We plan to contiunue these studies until new fresh bean varieties are obtained for use in Turkey.

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