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Morphological Characterization of Pinto and Fresh Bean Genotypes Commonly Cultivated in Erzincan

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ABSTRACT: This study was carried out to determine the genetic diversity based on the morphological characteristics of pinto and fresh bean germplasm. In the study, 70 local pinto and fresh bean genotypes collected from Erzincan and four commercial varieties were used as control. 12 bean genotypes (5 pinto bean and 7 fresh bean genotypes) having string pod and inadequate seed were removed from the study in the first year. In the second year of the experiment, 58 genotypes were used and morphological characteristics were determined in these genotypes. All genotypes involved in the study showed different characteristics in terms of all morphological features. According to the cluster analysis, genotypes were divided into 3 groups. In the three groups, the first cluster includes 11.29% of total genotypes, second cluster including 37.1% of total genotypes and third cluster including %51.61 of total genotypes. The highest genetic distance was determined between ULU-44 and ÇYR-32 genotypes. Genotypes with different vegetative and generative characteristics were found in different groups.

Key words: Pinto bean, fresh bean, morphological, Erzincan

Erzincan'da Yaygın Yetiştirilen Barbunya ve Taze Fasulye Genotiplerinin Morfolojik Karekterizasyonu

ÖZ: Bu çalışmada Erzincan'da yetiştiriciliği yapılan barbunya ve taze fasulye genotiplerinin morfolojik karakterizasyonun yapılması amaçlanmıştır. Çalışmada Erzincan ilinden toplanan 70 yerel barbunya ve taze fasulye genotipi ve dört ticari çeşit kullanılmıştır. İlk yıl baklada kılçıklılık özelliğine sahip ve tohum alınamayan 12 fasulye genotipi (5 barbunya ve 7 taze fasulye) çalışmadan çıkarılmıştır. Denemenin ikinci yılında 58 genotip kullanılmış ve bu genotiplerde morfolojik özellikler belirlenmiştir. Çalışmada yer alan genotipler tüm morfolojik özellikler bakımından farklılık göstermiştir. Kümeleme analizine göre genotipler 3 gruba ayrılmıştır. Genotiplerin, % 11,29'u ilk kümede, % 37,1'i ikinci kümede, % 51,61'i ise üçüncü kümede yer almıştır. En yüksek genetik mesafenin ULU-44 ve ÇYR-32 genotipleri arasında olduğu görülmüştür. Farklı vejetatif ve generatif özelliklere sahip genotipler farklı gruplarda yer almıştır.

Anahtar kelimeler: Barbunya, taze fasulye, morfolojik, Erzincan

INDRODUCTION

Bean is an important species belonging to the leguminous family, grown both in the world and in our country in wide range (Dursun 1999; Maras *et al.* 2008). Within this species, *Phaseolus vulgaris* forms most of the bean species that are cultivated in the around of the word (Ulukapı and Onus 2014; Akbulut et al. 2013). In Turkey, both dried and fresh beans are an important food material in human nutrition (Tan 2002). The reason for this is contains high amounts of protein (approximately 22.6%) and carbohydrate (56%). In addition, beans of mineral material rich (Potassium, phosphorus, calcium, magnesium, sulphur, iron and manganese) are a particularly important source of iron. In 100 g of beans comprise approximately 5-15 mg of iron (Geil and Anderson 1994; Welch et al., 2000; Cejas et al., 2013). Our country has an important place in the world in terms of plant genetic diversity as well as being the gene center of many plant species. The bean, which has a significant place in our country both in terms of economic and human nutrition, has a high genetic diversity. The identification and evaluation of genetic diversity has a major significant for plant breeding programs. Some of the main objectives of breeders are to develop new varieties with disease resistance, durable to environmental stresses, high yields, and improved seed quality while sustaining or improving nutritive value for humans (Dursun, 1994). Assessing the morphological characteristics of the determination and identification of the relationship between the varieties of local beans is an important traditional method. According to their morphological characteristics, a plant can be distinguished from other plant groups by morphological markers (such as pod traits, flower structure, leaf shape and seed) (Erdinç, 2013).

This study was conducted to determine the genetic diversity based on the morphological characteristics of pinto and fresh bean germplasm and the correlation between morphological characteristics.

MATERIALS AND METHODS

Seventy pinto and fresh bean landraces were collected in district and villages of Erzincan province located East Anatolian region of Turkey in 2015

(Table 1). The characteristics such as, colour of seed, seed-shaped and seed size were used to identify and collected of different genotypes in the selected year. In 2016, selected bean genotypes and four commercial varieties were sowed along the drip irrigation pipes at Erzincan Horticultural Research Station. In the autumn of the 2016 year, 5 pinto bean (ULU-48, ULU-52, ULU-55, ÜZM-62, ÜZM-64) and 7 fresh bean (CVZ-17, CVZ-19, CVZ-20, EKM-37, KML-41, ULU47, YBŞ-70) genotypes having string pod and seed inaccessible were removed from the study in the first year. In 2017, the field experiment was undertaken at the randomized complete blocks design with three replications and each replication has 30 plants. Phenotypic and morphological observations in plant were made according to UPOV (International Union for The Protection of New Varieties of Plants) parameters (Dursun, 1999 and Balkaya, 1999). The studied parameters comprised; growth form, flower wingcolour, banner flower colour, vanes opening situation, style extension, leaf colour, tip leaf size, tip leaf shape, pod brittleness situation, roughness on the pod, pod ground colour, speckle status of pod, speckle colour of pod, speckles density of pod, degree of pod curvature, shape of pod curvature, pod tip shape, clarity of seed in pod, anthocyanin availability in hypocotyl, seed largeness, main colour in seed, second main colour in seed, number of colours in seed, seed uniformity, distribution of second main colour in the seed, hilum colour in seed, longitudinal section of seed, transversal section of seed, pod shape (width / thickness based on ratio).

Frequency chart of morphological traits was generated by using SPSS program. Correlation analysis was performed to evaluate the relationship between the characters. Clustering analysis for grouping of genotypes was obtained using the Ward method based on Square Euclidean Distance. Correlation and cluster analysis were performed in the SPSS version 24 program.

Table 1. Geographical origins and genotype codes of pinto and fresh bean landraces

Origin	Genotype Code	Type*	Origin	Genotype Code	Type*	Origin	Genotype Code	Type*
Erzincan-Bahçeliköy	BHÇ 01	P	Erzincan-Çatalarmut	ÇTL 26	F	Erzincan-Uluköy	ULU 51	P
Erzincan-Bahçeliköy	BHÇ 02	P	Erzincan-Çatalarmut	ÇTL 27	F	Erzincan-Uluköy	ULU 52	P
Erzincan-Bahçeliköy	BHÇ 03	P	Erzincan-Çatalarmut	ÇTL 28	F	Erzincan-Uluköy	ULU 53	P
Erzincan-Bahçeliköy	BHÇ 04	F	Erzincan-Çayırlı	ÇYR 29	F	Erzincan-Uluköy	ULU 54	P
Erzincan-Bahçeliköy	BHÇ 05	P	Erzincan-Çayırlı	ÇYR 30	P	Erzincan-Uluköy	ULU 55	P
Erzincan-Bahçeliköy	BHÇ 06	P	Erzincan-Çayırlı	ÇYR 31	P	Erzincan-Üzümlü	ÜZM 56	P
Erzincan-Bahçeliköy	BHÇ 07	F	Erzincan-Çayırlı	ÇYR 32	P	Erzincan-Üzümlü	ÜZM 57	P
Erzincan-Bahçeliköy	BHÇ 08	F	Erzincan-Çayırlı	ÇYR 33	F	Erzincan-Üzümlü	ÜZM 58	F
Erzincan-Bahçeliköy	BHÇ 09	P	Erzincan-Çayırlı	ÇYR 34	P	Erzincan-Üzümlü	ÜZM 59	P
Erzincan-Ballıköy	BKY 10	P	Erzincan-Çayırlı	ÇYR 35	P	Erzincan-Üzümlü	ÜZM 60	P
Erzincan-Ballıköy	BKY 11	P	Erzincan-Merkez	EBK 36	F	Erzincan-Üzümlü	ÜZM 61	P
Erzincan-Ballıköy	BKY 12	P	Erzincan-Ekmekli	EKM 37	F	Erzincan-Üzümlü	ÜZM 62	P
Erzincan-Ballıköy	BKY 13	F	Erzincan-Ilıç	ILÇ 38	F	Erzincan-Üzümlü	ÜZM 63	P
Erzincan-Bayırbağ	BYR-14	F	Erzincan-Kemah	KMH 39	F	Erzincan-Üzümlü	ÜZM 64	P
Erzincan-Cevizli	CVZ 15	P	Erzincan-Kemaliye	KML 40	F	Erzincan-Üzümlü	ÜZM 65	P
Erzincan-Cevizli	CVZ 16	P	Erzincan-Kemaliye	KML 41	F	Erzincan-Üzümlü	ÜZM 66	P
Erzincan-Cevizli	CVZ 17	F	Erzincan-Refahiye	RFH 42	P	Erzincan-Üzümlü	ÜZM 67	P
Erzincan-Cevizli	CVZ 18	F	Erzincan-Tercan	TRC 43	P	Erzincan-Üzümlü	ÜZM 68	P
Erzincan-Cevizli	CVZ 19	F	Erzincan-Uluköy	ULU 44	F	Erzincan-Üzümlü	ÜZM 69	P
Erzincan-Cevizli	CVZ 20	F	Erzincan-Uluköy	ULU 45	F	Erzincan-Yaylabaşı	YBŞ 70	F
Erzincan-Cevizli	CVZ 21	P	Erzincan-Uluköy	ULU 46	F			
Erzincan-Cevizli	CVZ 22	F	Erzincan-Uluköy	ULU 47	F			
Erzincan-Cevizli	CVZ 23	P	Erzincan-Uluköy	ULU 48	P			
Erzincan-Çatalarmut	ÇTL 24	P	Erzincan-Uluköy	ULU 49	F			
Erzincan-Çatalarmut	ÇTL 25	P	Erzincan-Uluköy	ULU 50	F			

***Note:** P: Pinto bean, F: Fresh bean

RESULTS AND DISCUSSION

Frequency of morphological characteristics

The bean genotypes showed genetic diversity in all of the characters studied. These genotypes according of studied traits were divided in different groups.

Growth habit

Genotypes based on the growth form were divided into 2 groups (Figure 1.A). The vast majority of genotypes (82.3%) have climbing growth habit.

Flower vanes colour

Genotypes according to flower vanes colour were placed white, lilac, violet and pink colour group (Figure 1.B). The lilac is group that contains most of genotypes (27%). The violet is group that contains minimum of genotypes (4%).

Flag flower colour

Genotypes were categorized into 3 groups according to flag flower colour. 14% of flag flower colour was white, 26% lilac, 14% violet and 8% pink (Figure 1.C).

Vanes opening situation

Three different vanes opening situation were observed in genotypes. 20% of genotypes flower vanes had open, 38% adjoining and 4% very open (Figure 1.D).

Style extension

Genotypes were divided into 2 groups according to style extensions. Most of the genotypes (95.2%) have style extensions (Figure 1.E).

Leaf colour

Based on the leaf colour, genotypes were separated into three groups. 9.7% of leaf colour was light green, 41.9% dark green and 48.4% green. (Figure 1.F).

Tip leaf size

The genotypes observed three different tip leaf types. 30.6% of genotypes had wide, 11.3% small leaf and 58.1% intermediate size (Figure 1.G).

Tip leaf shape

Three different tip leaf shapes were viewed in genotypes. These groups are; quadrilateral, trigon and round. It was viewed that the vast majority of the cultivated varieties have a quadrilateral leaf structure (Figure 1.H).

Pod brittleness situation

In terms of this characteristic, genotypes are divided into two groups of brittle and not brittle. According to observations made, 77.6% of genotypes are brittle and 22.4% are not brittle (Figure 1.I). One of the desired attributes for genotypes is its easy brittle of pod.

Roughness on the pod

By classification based on the roughness on the pod, the genotypes were divided into 3 groups. According to the evaluations, 16.1% of genotypes are less rough and 16.1% rough and 66.7% smooth. (Figure 1.J). Texture and appearance of pod were rated by five experienced person in the region, studying in classify and packing commercial snap beans for export markets. The ground quality of the pods was categorized as rough or smooth. Pod texture scale formed; 1-extremely smooth surface, 2-smooth surface, 3-moderately smooth surface, 4-rough surface, and 5- very rough surface (Beshir et al., 2016).

Pod ground colour

Pod ground colours in bean were divided into 3 groups as light green, dark green and green. The majority of genotypes (66.1%) had green pod ground colour (Figure 1.K). According to a study done, consumers in the black sea region have been observed to prefer green and dark green colour pod of beans (Balkaya, 1999).

Speckle status of pod

Speckle status of pod was expressed as available or none. 51.6% of speckle status of pod was available, 48.4% none (Figure 1.L). All fresh bean genotypes was observed to speckles appearance on the pod. In another study, all of the fresh beans kinds were seen to be spotless (Madakbas *et al*, 2004). Most of the pinto bean genotypes were observed speckle on pod.

Speckle colour of pod

According to UPOV parameters, pod speckle colours of genotypes were divided into 3 groups: red, purple and colourless. Most of genotypes (38.7%) containing speckle have red colour (Figure 1.M). In another study, speckle colour of pod was observed in genotypes P13, P25, P29 and P40; pigmentation was determined red and violaceous. (Madakbas and Ergin, 2011).

Speckles density of pod

Genotypes according to speckle density of pod were divided into 4 groups; low, intermediate, dense and none. The most of genotypes (48.4%) had none of speckle colour of pod (Figure 1.N). In a study carried out in Aegean Agriculture Research Institute in İzmir; the 51 bean genotypes were appraised based on morphological characters. According to bean pigments, a majority of 51 genotypes has observed colourless. Red pigments were seen in 3 genotypes (Madakbas and Ergin, 2011).

Degree of pod curvature

Based on the degree of pod curvature, genotypes were assigned into five groups (Figure 1.O). These groups contained absent or very slight, weak, medium, strong and very strong. The most of genotypes had weak and medium that is degree of pod curvature. Desirable feature of varieties in the production of fresh beans is that they have uniform,

non-curling, smoothly shaped pod (Kar et. al., 2005). In 19.4% of the genotypes, it has been viewed absent or very slight to degree of pod curvature (Figure 1.O).

Shape of pod curvature

Based on the shape of pod, curvature genotypes were situated into two groups: Outward and inward. 1.6% of genotypes had round outward, 98.4% inward (Figure 1.P).

Pod tip shape

According to the pod tip shape, genotypes are divided into 3 groups. 9.7% of genotypes pod tip shape was blunt, 25.8% pointed and 64.5% from blunt to pointed (Figure 1.R). In a study conducted by Dursun (1999); pod tip shape has been identified sharp in all genotypes and standard varieties used in the study.

Pod shape (width / thickness based on ratio)

In this study, pod shape of genotypes were evaluated as flat and rounded. The majority of genotypes and all of the standard varieties have been detected flat of pod shape (Figure 1.S).

Clarity of seed in pod

According to clarity of seed in pod, it was determined diversity among genotypes. Based on this parameter; genotypes is divided into 3 groups; little (45.2%), salient (29%) and unclear (25.8%) (Figure 1.T). Seed salient of pod in bean is an undesirable feature.

Anthocyanin availability in hypocotyl

Anthocyanin availability in hypocotyl of the bean genotypes was grouped as available or none. In almost all genotypes (98.4%) was not detected to anthocyanin in hypocotyl (Figure 1.U).

Seed largeness

According to Dursun (1999), seed largeness was separated to 3 groups as small, medium and large. Studied genotypes in this research were divided into two groups: large and medium (Figure 1.V). The plant nutritional status and the healthy development of the organs in the plant are very effective in seed size development (Akbulut et al., 2013).

Main colour in seed

According to UPOV parameters, main colour seed of genotypes were divided into 11 groups: white, green or greenish, cream colour, yellow, light brown, brown, red, claret red, blue, purple and black. Studied genotypes in this research were divided into eight groups. According to main colour in seed, a majority of genotypes (58%) have been observed cream colour (Figure 1.Y). In another study, Isık (2012) reported 78.78% of genotypes had brown, 9.09% white, 3.3% purple colour. The colour genotypes demonstrated great variation take into account main seed colour (Sozen and Bozoglu, 2013).

Second colour in seed

Based on the second colour in seed, genotypes were placed into eight groups (Figure 1.Z). 32.3% of genotypes have not a second colour in the seeds. The second colour seen on the seed was usually detected as claret red (46.8%).

Distribution of second main colour in the seed

According to UPOV criteria, bean was done 3 different groupings of around hilum, on half of grain and on entire grain. Studied genotypes in this research were divided into two groups: on half of grain and on entire grain (Figure 1.AA). Those without the second colour have been grouped as none. The majority of genotypes (64.5%) were found to have distribution of second main colour on entire seed.

Number of colours in seed

According to the UPOV criteria, the number of colours in the seed was determined to be one, two or more than two. In 32.3% of the genotypes have been viewed one colour, 66.2 % two and 1.6% more than two (Figure 1. AB).

Seed uniformity

Based on seed uniformity, genotypes were divided into 2 groups (not uniform and uniform). Most of the genotypes (88.7%) in the study have been determined that the varieties show uniform properties (Figure 1. AC). In a study made by Isık (2012); all of the 33 genotypes seed has been showed uniformity.

Hilum colour in seed

The hilum colour was separated to 2 groups: Same and different with main colour in seed. Most of the genotypes (88.7%) were found to be different colour (Figure 1. AD).

Longitudinal section of seed

67.7% of genotypes had kidney, 17.7% narrow kidney and 14.5% wide kidney (Figure 1. AE). According to Dursun (1999), bean was done 3 different groupings of narrow kidney, wide kidney and kidney in his study.

Transversal section of seed

Three different transversal sections of seed were observed in genotypes. 58.1% of genotypes had narrow egg, 35.5% narrow elliptical and 12% elliptical (Figure 1. AF).

Correlation among traits

Growth form showed significant negative correlation with pod ground colour, shape of pod curvature, clarity of seed in pod and significant positive correlation with speckling status of pod, speckle colour of pod, pod shape and second colour in seed. The majority of the genotypes worked were pinto beans and the remaining genotypes were fresh bean. Only one local pinto bean genotype has dwarf growth form. Flower vanes colour had significant

positive association with flag flower colour, second colour in seed and significant negative correlation with seed stature section. Flag flower colour displayed a significant positive correlation with speckle density of pod and second colour in seed. Pod ground colour showed significant negative correlation with pod shape, second colour in seed and positive correlation with clarity of seed in pod. Speckling status of pod showed very significant positive correlation with speckle colour of pod, speckle density of pod, number of colours in seed and seed uniformity. In addition, speckling status of pod showed significant negative correlation with main colour in seed and transversal section of seed. Speckle colour of pod had significant positive association with speckle density of pod, number of colours in seed, seed uniformity and significant negative correlation with main colour in seed. Speckles density of pod displayed a significant negative correlation with main colour in seed and a significant positive correlation with number of colours in seed. It was observed that the number of colours in the seed increased when the intensity of the speckle increased. Main colour in seed showed significant positive correlation with second colour in seed. Longitudinal section of seed showed significant positive correlation with transversal section of seed (Table 3). A lot of genotypes in our study have kidney shape with regard to longitudinal section of seed and elliptical shape with regard to transversal section of seed (Figure 1).

Cluster analysis

By envisioning the dendrogram, the genotypes were categorized into three groups. Using discriminant analysis revealed that 87% of the members constituted three groups. The first group (7 genotypes), had flower vanes colour, flag flower colour, speckle status pod, speckle colour pod, speckle density of pod more than and tip leaf size, pod brittleness situation, roughness on the pod, clarity of seed in pod, transversal section of seed less than other genotypes (Table 2). The first cluster includes 11.29% of total genotypes, second cluster including 37,1% of total genotypes and third cluster including %51,61 of total genotypes. The highest genetic distance was between ULU-44 and ÇYR-32 genotypes (Figure 2). According to Rahim et al. (2010), the genetic distance between genotypes is extremely important for plant breeding programs. Because hybrids of genetically distant genotypes have high yield and the cross between these genotypes can be used in provides the best heterosis in breeding programs.

CONCLUSIONS

This study has revealed that there is a significant genetic variation among genotypes in terms of the morphological characteristics examined. A number of genotypes showed different characters in view of the characters studied compared to the commercial cultivars. Especially genetically different genotypes are of great importance in breeding studies. By determining the variation between the genotypes, it is thought to be beneficial to the bean breeding studies to be carried out in this direction. The assessment of morphological characteristics in plant will help plant breeders identify the desired qualities in populations to be used pinto bean and fresh bean breeding programs in future.

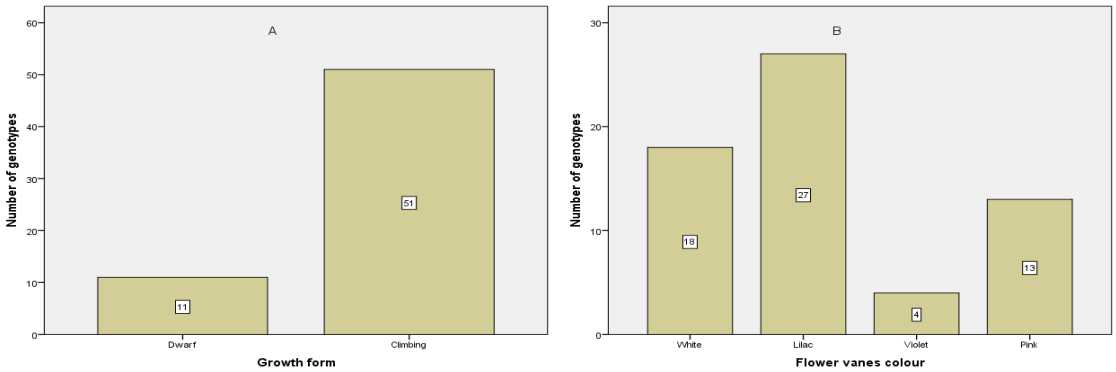
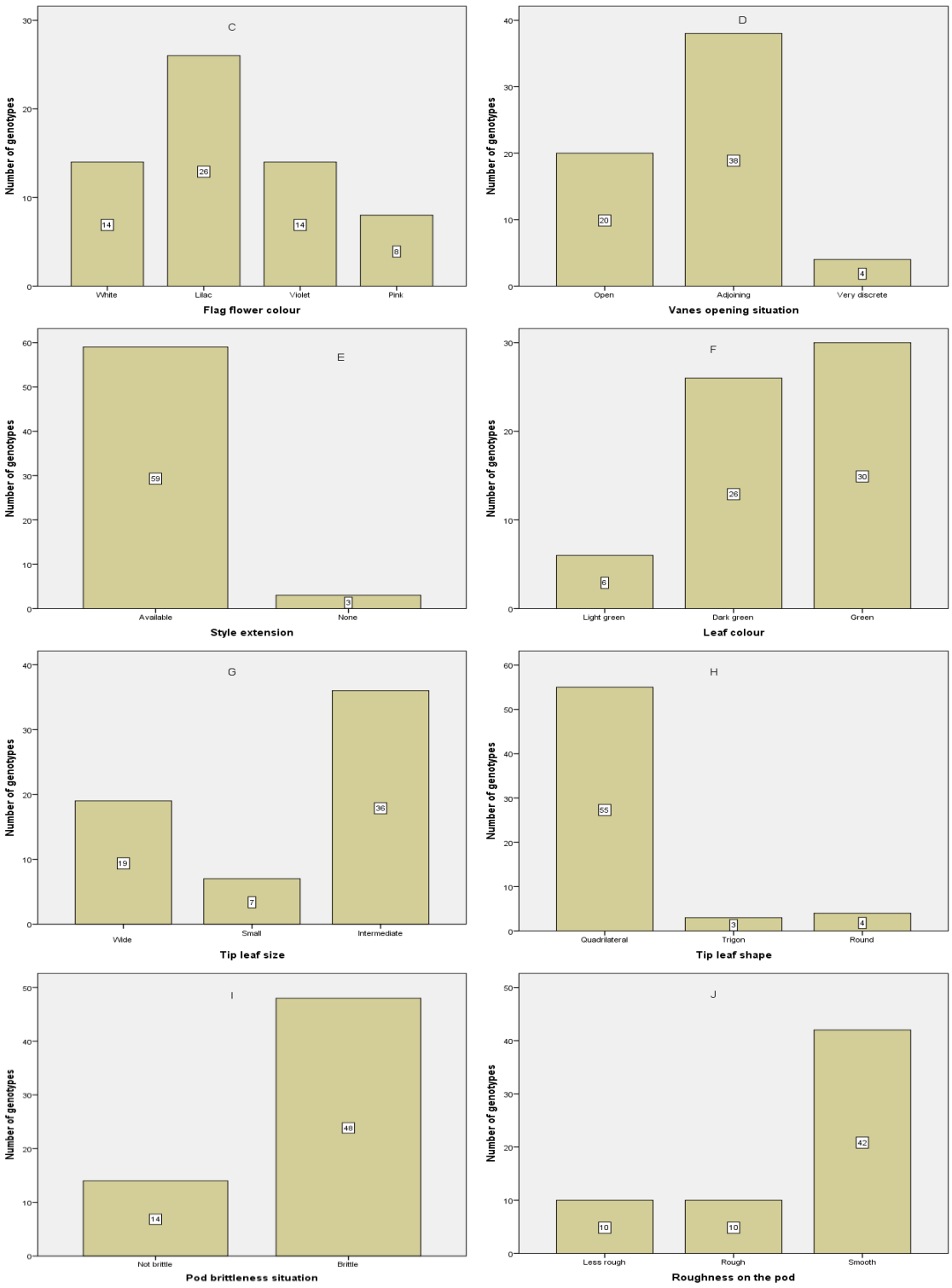


Figure 1. Frequency chart of morphological traits in bean genotypes study



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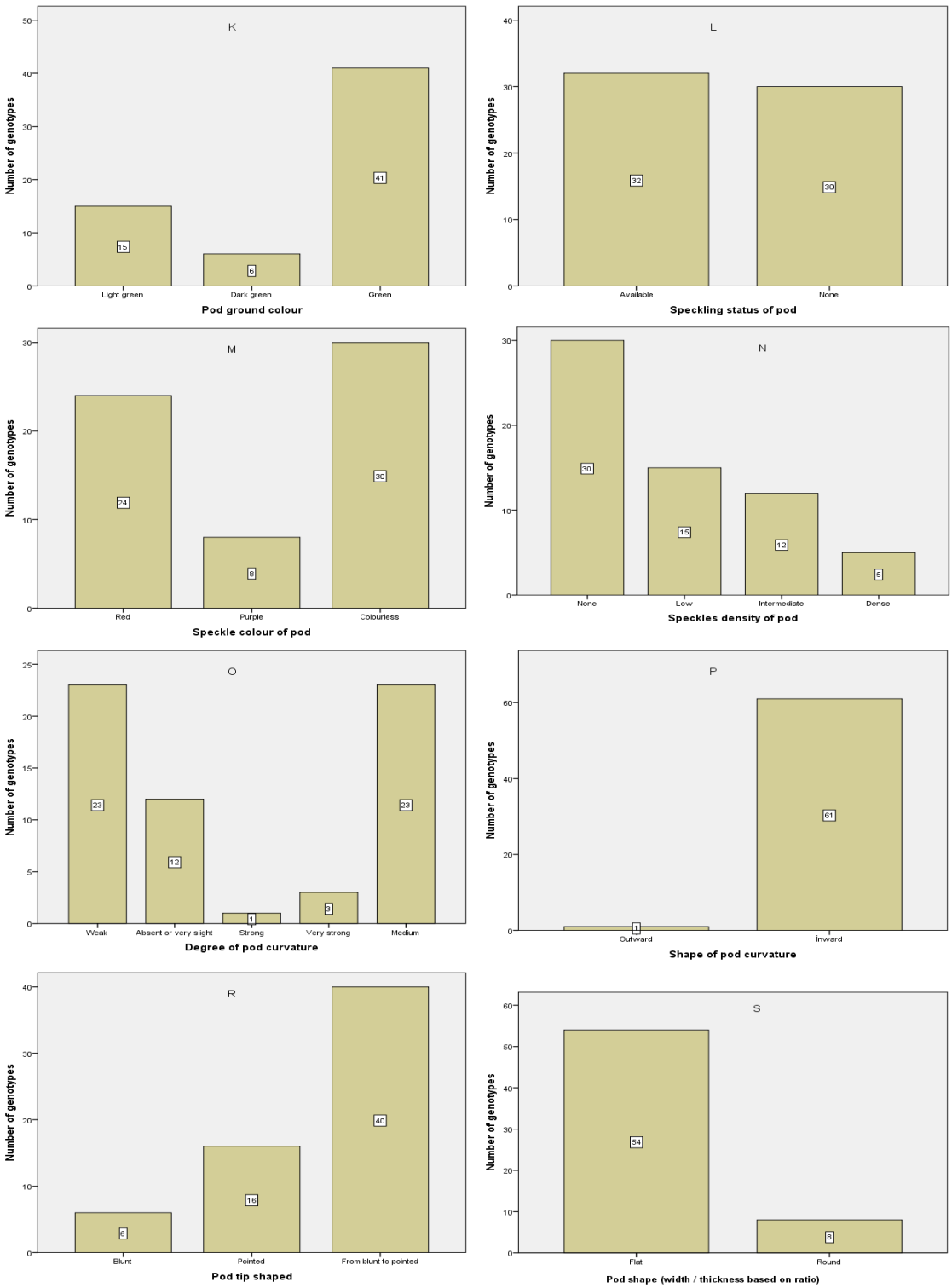

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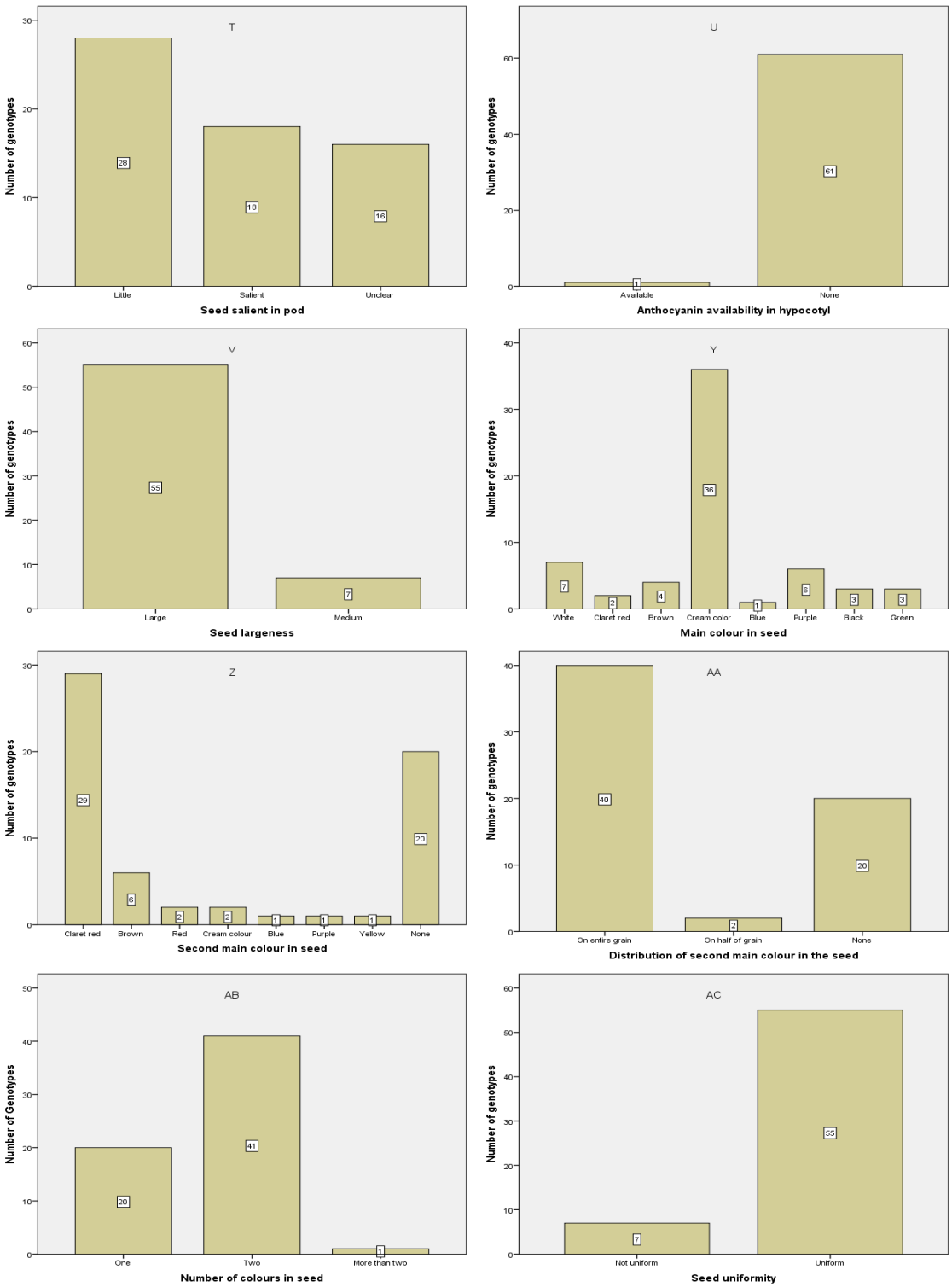

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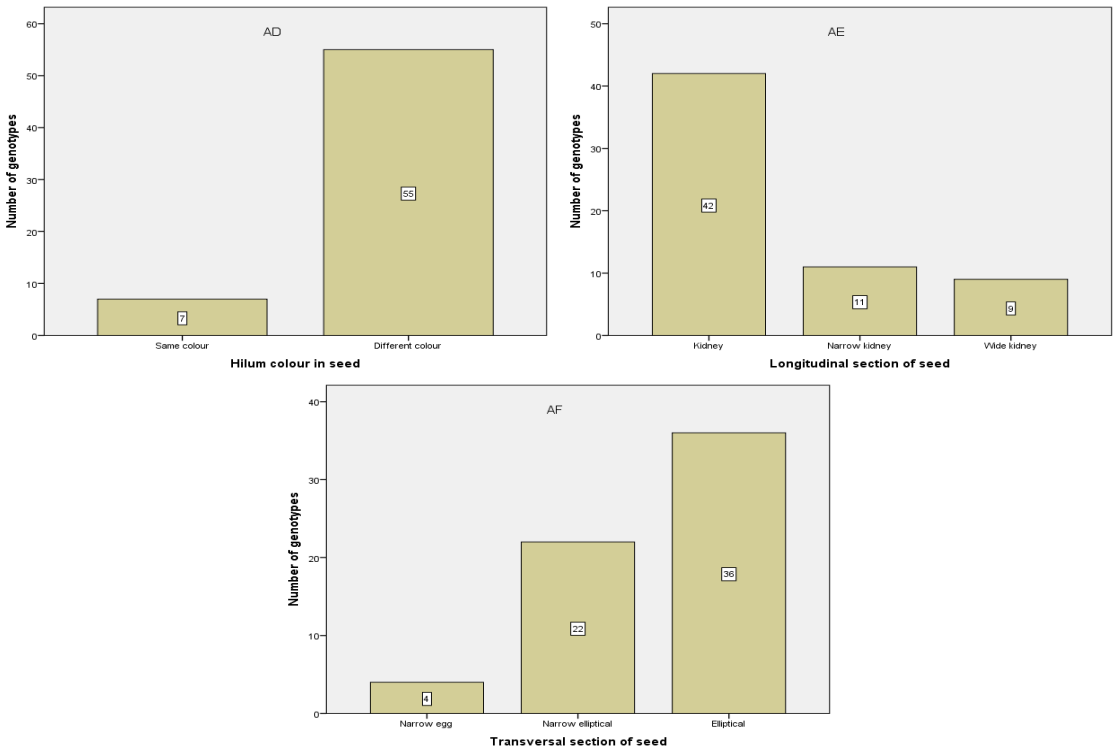

Figure 1. continue

Table 2. Mean comparison of characters for each cluster in been genotypes

Traits	Group 1	Group 2	Group 3
Growth form	0,94	0,82	0,00
Flower vanes colour	1,87	1,73	1,00
Flag flower colour	2,10	1,95	1,00
Vanes opening situation	0,32	0,68	0,00
Style extension	0,97	0,91	1,00
Leaf colour	1,39	1,23	2,00
Tip leaf size	1,13	1,18	2,00
Tip leaf shape	2,90	2,82	3,00
Pod brittleness situation	0,74	0,82	1,00
Roughness on the pod	1,29	1,68	2,00
Pod ground colour	0,84	0,77	2,00
Speckle status of pod	1,00	0,00	0,00
Speckle colour of pod	1,23	0,00	0,00
Speckles density of pod	1,58	0,00	0,00
Degree of pod curvature	1,45	1,45	0,00

Traits	Group 1	Group 2	Group 3
Shape of pod curvature	0,00	0,00	1,00
Pod tip shape	0,71	0,95	1,00
Pod shape	0,87	0,86	0,00
Clarity of seed in pod	0,84	1,05	1,00
Anthocyanin availability in hypocotyl	0,00	0,00	0,00
Seed largeness	1,94	1,91	2,00
Main colour in seed	2,19	5,77	5,00
Second colour in seed	6,71	7,00	5,00
Distribution of second main colour in the seed	2,00	2,00	2,00
Number of colours in seed	1,03	0,32	1,00
Seed uniformity	0,23	0,00	0,00
Hilum colour in seed	1,00	1,00	1,00
Longitudinal section of seed	0,90	0,95	0,00
Transversal section of seed	0,52	1,09	2,00

Table 3. Correlation coefficients between different morphological characters of bean genotypes

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Growth form (1)	1															
Flower vanes colour (2)	0,1	1														
Flag flower colour (3)	0,1	0,8**	1													
Pod ground colour (4)	-0,3*	-0,09	-0,06	1												
Speckling status of pod (5)	0,3*	0,2	0,2	-0,1	1											
Speckle colour of pod (6)	0,3*	0,2	0,1	-0,1	0,9**	1										
Speckles density of pod (7)	0,2	0,2	0,3*	-0,1	0,8**	0,7**	1									
Shape of pod curvature (8)	-0,3*	-0,1	-0,1	0,3*	-0,1	-0,1	-0,1	1								
Pod shape (9)	0,4**	-0,1	-0,05	-0,4**	0,01	0,01	0,03	-0,4**	1							
Clarity of seed in pod (10)	-0,3*	-0,2	-0,1	0,4**	-0,2	-0,2	-0,2	0,01	-0,1	1						
Main colour in seed (11)	0,1	0,03	0,03	-0,2	-0,4**	-0,3*	-0,4**	0,1	-0,1	0,1	1					
Second colour in seed (12)	0,4**	0,4**	0,3*	-0,3*	0,2	0,2	0,2	-0,1	0,02	-0,3*	0,4**	1				
Number of colours in seed (13)	0,2	0,1	0,2	0,1	0,7**	0,6**	0,6**	0,1	-0,1	-0,2	-0,4**	0,01	1			
Seed uniformity (14)	0,2	0,1	0,01	-0,2	0,4**	0,3*	0,2	-0,1	-0,02	-0,1	-0,2	,01	0,4**	1		
Seed stature section (15)	0,2	-0,3*	-0,2	-0,2	-0,1	-0,03	-0,07	-0,2	0,3*	-0,2	-0,1	0,01	-0,1	-0,2	1	
Transversal section of seed (16)	-0,1	-0,2	-0,3	-0,1	-0,4**	-0,2	-0,4**	0,1	-0,1	-0,2	-0,1	-0,2	-0,2	-0,2	0,4**	1

Note: *,**significant at 5% and 1% probability level respectively

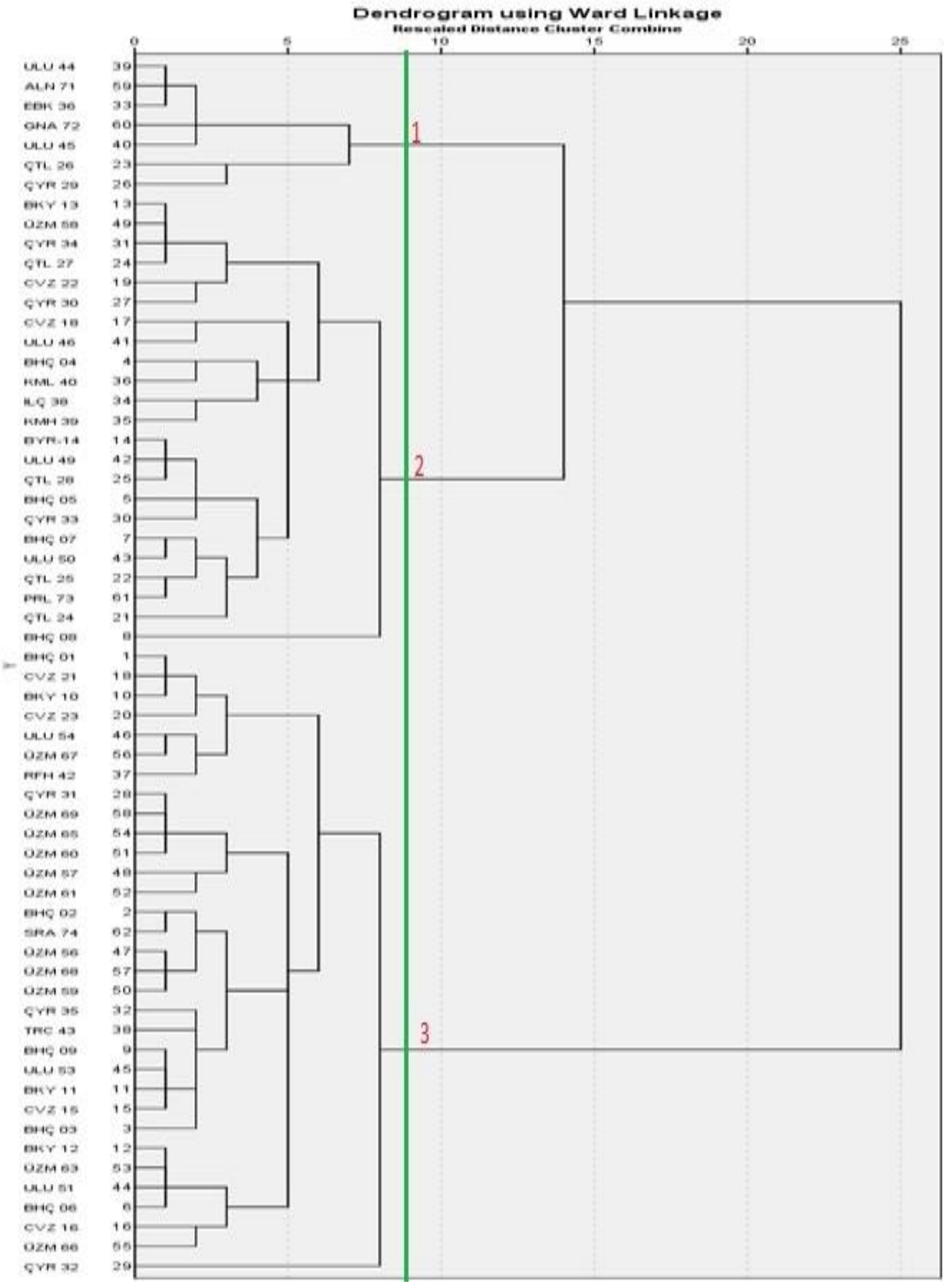

Figure 2. Dendrogram of bean landraces and control cultivars constructed morphological characters

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