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Investigation of the Relationship Between Genome Size and Some Agro-morphological Characteristics in Common Bean (*Phaseolus vulgaris* L.) Accessions

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ABSTRACT
The common bean (Phaseolus vulgaris L.), one of the most well-known members of the legume family, is a very important source of protein, carbohydrates, vitamins, and minerals in the human diet. The objective of this study was to determine the correlation between genome size and some agro-morphological characteristics of 154 common bean accessions investigated in Tekirdağ condition. Based on the results of the flow cytometric analyses, it was determined that the mean genome sizes of the accessions varied between 1.28 pg2C^{-1} and 1.55 pg2C^{-1}. When agro-morphological characteristics were investigated, it was observed that plant height ranged from 28.8 to 327 cm, flowering time from 36.8 to 55.6 days, first pod formation from 44.6 to 63.8 days, first harvest time from 58.6 to 80.6 days, vegetation period from 81.4 to 100.2 days, number of pods per plant from 9.2 to 109 pods plant^{-1}, number of seeds per pod from 1.66 to 7.34 seeds pod^{-1}, 100-seed weight from 7.64 to 140.25 g, and seed yield per plant from 6.74 to 80.64 g plant^{-1}. In the statistical analyses performed, it was found that the accessions had a wide variation in terms of all the characteristics studied ($P<0.01$). In addition, it was observed that dwarf beans flowered and formed pods earlier than climbing beans, but the number of seeds per plant, 100-seed weight, and seed yield per plant were higher in climbing beans compared to dwarf beans. Correlation analysis showed that there was a positive relationship between the genome sizes of accessions and some of their agro-morphological characteristics as flowering time, first pod formation, and vegetation period. In conclusion, the genetic resource collection of the common bean displayed significant variation for all characteristics investigated in the study and information on the genome size may provide alternative strategies to future breeding studies in selecting parents or genotypes with some specific agro-morphological characteristics.

Keywords: Common bean (*Phaseolus vulgaris* L.), Flow cytometer, Genome size, Agro-morphology, Variation, Correlation

1. Introduction

Common bean (*Phaseolus vulgaris* L.) is the most produced legume species in the world. Although its cultivation is spread all over the world, it is cultivated more in Asia and the American continent. According to Statpup data, in the 2022/23 cultivation season, the total bean planting area in the world was 35.3 million hectares and about 27.4 million tons of beans were produced (Burucu 2023). Common bean, which is a source of protein, carbohydrates, vitamins, minerals, fiber, iron, and zinc, ranks high in agriculture worldwide due to its high nutritional value and good market price (Choudhary et al. 2022). In addition, demographic growth and the decreasing arable land in the world increase the demand for legumes, especially beans, as food and feed (Caproni et al. 2019). Due to these reasons, breeding studies on beans have been intensified.

Genetic diversity is indispensable for the success of any breeding program and therefore researchers aiming to develop new varieties for a species would like to have prior information on genetic diversity available in their genetic resource collection and also within the species (Rana et al. 2015). The genome size is the total amount of DNA included in the nucleus of a genotype and it is an important indicator of the diversity. It is also used widely in many areas such as phylogeny, taxonomy, evolution and breeding studies since it is species-specific (Bennett & Leitch 1995; Ohri 1998; Özkan et al. 2003). Currently, the genome sizes of the materials to be used in studies are mostly determined by the flow cytometry method. Many studies investigating the relationship between the genome size of various species and factors, such as altitude, latitude-longitude, temperature, and precipitation, have been conducted in the literature (Bottini et al. 2000; Jakob et al. 2004; Smarda & Bures 2006; Wang et al. 2013; Souza et al. 2019; Chen et al. 2022). In addition, in some of the previous numerous correlations have been found between genome size and various plant characteristics such as chromosome size, cell size (Edwards & Endrizzi 1975; Bennett et al. 1983), nucleus size (Baetcke 1967), duration of cell division (Evans et al. 1972), body size, growth rate (Gregory et al. 2000), seed mass (Beaulieu et al. 2008), flower life (Zhang & Zhang 2021), metabolic rate, seed size, vegetative growth, flowering (Beaulieu et al. 2007; Tenaillon et al. 2016), stomatal size, flower or shoot phenology (Vesely et al. 2012). However, studies on the genome sizes of common bean genetic resource collections are limited (Ayonoadu 1974; Castagnaro et al. 1990; Beletti et al. 1997;

Mekki et al. 2007; Labotan et al. 2018; Tomlekova et al. 2024). The relationship between the genome sizes of the bean genetic resource collection, which was collected from various parts of the world and consisted of 154 accessions, and geographical features (altitude-latitude-longitude) was investigated for the first time in our previous study (Savaş Tuna et al. 2020). On the other hand, any study investigating the relationship between genome size and agro-morphological characters in bean genetic resource collections has not been encountered in the literature. However, in breeding studies, in addition to genetic diversity, morphological, phenological and agricultural diversity in plant species also constitute the first steps of research (Rana et al. 2015). The objectives of this study are to: (i) evaluate the genome size and some agro-morphological characteristics of the 154 common bean accessions included in the bean genetic resource collection under Tekirdağ conditions (ii) investigate the relationship between the genome sizes and agro-morphological characteristics of the accessions and (iii) explore how this information can aid in breeding studies of common bean.

2. Material and Methods

2.1 Plant material

154 common bean accessions obtained from different locations around the world including some Turkish landraces were used as plant materials in this study (Table 1).

The field experiment was established in the experimental area of the Namık Kemal University Faculty of Agriculture Field Crops Department (Süleymanpaşa, Tekirdağ-Turkey, 40°99'08.2", 40°99'08.2", 29 m). In the experiment, 6 seeds belonging to the same accession were planted in each row. The distances between and within the rows were determined as 50 x 30 cm for dwarf bean types and 80 x 40 cm for climbing bean types. Climbing beans were supported by wood sticks and weeds were periodically cleared from the field.

2.2. Measurement of agro-morphological characteristics

In each of the 5 plants randomly selected, nine different agro-morphological characteristics were examined. These characteristics included the plant height (PH), days to flowering (DTF), days until pod formation (DPF), harvest time (HV), vegetation period (VP), number of pods per plant (NPP), seeds per pod (SPP), hundred-seed weight (HSW), and seed yield per plant (SYPP). The methods listed in the International Board for Plant Genetic Resources. Descriptor list were utilized for in the examination of some of these characteristics (IBPGR 1982).

2.3. Determination of the genome size

To determine the genome sizes of the accessions, flow cytometry (FCM) was used. Preparation of suspensions of intact nuclei was performed using commercial kits from Sysmex Partec GmbH (Münster, Germany). As a standard, Lycopersicon esculentum (1.96 $pg2C^{-1}$ DNA) was utilized.

Approximately twenty milligrams of fresh leaf tissues of each common bean and twenty milligrams of standard leaf tissue were chopped simultaneously in a petri dish with 0.5 mL of extraction buffer to obtain a homogenized solution. This solution was transferred into a glass tube via a 30-µm filter. Following this, 2 mL of staining buffer (CyStain PI absolute P) was added to each tube. Prior to FCM analysis, the samples underwent a minimum 30-minute incubation in the dark at room temperature. A total of 5 seedlings were individually analyzed for each accession, with 5000 nuclei analyzed in each sample. The samples were analyzed using a flow cytometer (Sysmex Partec GmbH) and FloMax software. The relative G1 peak positions of both the sample and the standard were used to determine the genome size of the common bean seedlings. Samples with a coefficient of variation (CV) exceeding 3% were excluded from the calculations. The standard deviation of each accession’s genome size was calculated using appropriate measurements.

2.4. Chromosome analysis

Root tips harvested from germinating seeds were exposed to 2 mM of 8-hydroxyquinoline at 10 °C for 20– 24 h, and then, they were fixed in ethanol: acetic acid (3:1, v/v) (Pedrosa-Harrand et al. 2006). Somatic chromosome preparations were carried out based on Jenkins & Hasterok (2007). After roots were washed in 0.01M of citric acid-sodium citrate buffer (pH 4.8, 5 min, 4 times), they were enzymatically fragmentized for 3 hours at 37 °C in a mixture including 20% (v/v) pectinase (Sigma-Aldrich Corp., St. Louis, MO, USA), 1% (w/v) cellulase (Calbiochem, San Diego, CA, USA), and 1% (w/v) cellulase Onozuka R-10 (Serva). Following this, one dissected meristem of each sample was transferred onto a slide in a drop of 45% acetic acid. Then, a coverslip was pressed onto the slide. Preparations were evaluated using an Olympus BX51 light microscope. Images of cells exhibiting well-distributed mitotic chromosomes were captured with a Spot RT Slider CCD digital camera attached to the microscope.

Table 1- Accession code number, accession name and growing pattern, location, mean genome size and morpho-phenological characteristics of the common bean accessions used as material in the study, and significance group and standard deviation of these features and genome size

Acc. code	*Acc. name and growing pattern*	*Location-Company*	*Mean genome size (pg2C^{-1})*	*Plant height*	*Days to flowering*	*Days until pod formation*	*Harvest time*	*Vegetation period*	*Number of pods per plant*	*Seeds per pod*	*100-seed weight*	*Seed yield per plant*
1	Barbunya- C	Gölcük- Turkiye	1.33 ± 0.02 d-m	257.6 ± 12.8 c-n	43.6 ± 0.5 op	55.6 ± 0.5 mn	77.6 ± 0.5 c-f	89.6 ± 0.5 h-m	67.8 ± 40.1 a-g	2.6 ± 0.4 I-P	36.0 ± 8.3 e-B	47.1 ± 33.9 b-m
2	Yerli Barbunya- C	Bozdağ-İzmir- Turkiye	1.32 ± 0.02 e-m	226.8 ± 11.5 ı-B	47.6 ± 1.0 f-k	52.6 ± 1.0 p-u	68.6 ± 1.0 p-t	86.8 ± 0.8 p-v	59.2 ± 28.9 b-l	3.1 ± 0.3 A-P	35.0 ± 4.4 f-D	37.6 ± 18.8 c-B
3	Barbunya- C	Gölcük- Turkiye	1.32 ± 0.01 e-m	179.4 ± 30.7 v-F	46.8 ± 1.2 h-l	52.8 ± 1.2 p-t	68.8 ± 1.2 p-t	87.0 ± 0.9 o-u	30.2 ± 19.2 h-y	2.4 ± 0.6 M-P	41.8 ± 9.9 d-l	26.0 ± 12.3 h-G
4	Alacalı Ayşe- C	Gölcük- Turkiye	1.33 ± 0.02 d-m	212.4 ± 13.2 m-D	51.6 ± 1.0 bc	60.6 ± 1.0 b-e	80.6 ± 1.0 a	91.4 ± 0.5 ghı	27.6 ± 4.8 ı-y	2.9 ± 0.2 D-P	12.6 ± 1.3 NOP	9.0 ± 0.5 B-G
5	Sürmeli Barbunya- C	Bozdağ-İzmir- Turkiye	1.41 ± 0.04 bcd	218.2 ± 39.4 k-D	51.8 ± 1.2 bc	60.8 ± 1.2 bcd	69.8 ± 1.2 op	90.8 ± 1.2 g-k	47.8 ± 31.1 ı-y	2.9 ± 0.6 C-P	24.8 ± 14.9 n-O	19. ±4 13.9 m-G
6	Barbunya- C	Gölcük- Turkiye	1.33 ± 0.04 d-m	230.8 ± 27.5 g-z	46.8 ± 0.4 h-l	52.8 ± 0.4 p-t	74.6 ± 0.5 hı	86.4 ± 0.5 s-y	41.8 ± 12.1 f-y	3.1 ± 1.0 y-O	33.7 ± 6.6 f-F	25.0 ± 9.1 h-G
7	Sürmeli-Alacalı- C	Bozdağ-İzmir- Turkiye	1.38 ± 0.04 b-k	243.8 ± 15.9 d-t	49.8 ± 0.8 de	55.8 ± 0.8 mn	67.8 ± 0.8 s-y	86.6 ± 0.5 r-v	48.8 ± 7.0 e-u	3.7 ± 0.6 l-N	23.1 ± 3.0 s-P	27.7 ± 10.2 h-G
8	Sürmeli- C	Birgi-İzmir- Turkiye	1.40 ± 0.04 b-g	204 ± 37.9 p-D	51.8 ± 1.2 bc	57.8 ± 1.2 hık	79.8 ± 1.2 ab	92.2 ± 0.8 efg	31.80 ± 11.0 g-y	4.0 ± 0.4 g-K	24.8 ± 1.7 o-O	25.3 ± 9.9 h-G
9	Alacalı Ayşe- C	Bozdağ-İzmir- Turkiye	1.35 ± 0.03 c-m	234.8 ± 26.5 f-u	51.6 ± 0.5 bc	57.6 ± 0.5 hık	79.6 ± 0.5 ab	88.6 ± 0.5 ı-p	42.0 ± 2.8 f-y	3.6 ± 0.4 l-N	23.7 ± 1.6 r-O	36.6 ± 1.3 c-E
10	Yerli barbunya- C	Bozdağ-İzmir- Turkiye	1.32 ± 0.02 g-m	231.2 ± 15.8 g-v	7.0 ± 0.6 g-l	53.0 ± 0.6 p-t	79.0 ± 0.6 a-d	92.2 ± 0.8 efg	56.8 ± 45.1 b-n	3.0 ± 0.8 A-P	31.9 ± 11.3 f-H	53.0 ± 33.6 a-h
11	Alacalı Ayşe- C	Bozdağ-İzmir- Turkiye	1.43 ± 0.06 abc	217.8 ± 19.0 l-D	47.0 ± 0.6 g-l	54.0 ± 0.6 op	63.0 ± 0.6 D-G	86.6 ± 0.5 r-v	21.2 ± 10.8 n-y	3.4 ± 1.1 t-N	17.0 ± 1.9 G-P	11.9 ± 8.7 v-G
12	Barbunya- C	Gölcük- Turkiye	1.32 ± 0.05 e-m	236.8 ± 65.2 f-t	46.2 ± 0.8 Kn	50.2 ± 0.8 z-C	63.2 ± 0.8 C-F	86.6 ± 0.5 r-v	26.0 ± 13.7 k-y	2.8 ± 0.6 E-P	39.8 ± 5.6 d-p	42.3 ± 30.4 b-t
13	Sürmeli Ayşe kadın-D	Gölcük- Turkiye	1.32 ± 0.02 e-m	36.8 ± 5.6 MN	38.8 ± 0.8 uvy	44.8 ± 0.8 N	59.8 ± 0.75 KL	86.4 ± 0.5 s-y	18.0 ± 6.2 r-y	3.5 ± 0.7 r-N	26.7 ± 6.9 ı-O	12.5 ± 4.5 v-G
14	Barbunya- C	Bozdağ-İzmir- Turkiye	1.32 ± 0.03 g-m	311.8 ± 4.9 ab	48.8 ± 0.8 ef	54.8 ± 0.8 no	67.80 ± 0.8 s-y	91.6 ± 0.5 fgh	40.2 ± 22.3 f-y	3.8 ± 0.4 h-M	26.6 ± 3.9 ı-O	23.1 ± 12.3 k-G
15	Barbunya- C	Aydın-Çine- Turkiye	1.31 ± 0.03 i-m	327.0 ± 3.3 a	38.4 ± 0.5 vy	45.4 ± 0.5 MN	64.4 ± 0.5 BCD	88.4 ± 0.5 m-r	41.2 ± 13.3 f-y	3.8 ± 0.5 h-L	34.5 ± 4.7 f-E	45.7 ± 18.5 b-o
16	Barbunya- C	Kırklareli- Turkiye	1.28 ± 0.01 m	265.8 ± 9.2 b-l	38.0 ± 0.6 yz	44.6 ± 0.8 N	64.4 ± 0.5 BCD	86.6 ± 0.5 r-v	30.8 ± 5.8 h-y	4.0 ± 0.6 g-K	41.4 ± 4.4 d-m	44.1 ± 6.9 b-o
17	Bodur barbunya- C	Bandırma- Turkiye	1.29 ± 0.05 lm	118.6 ± 31.5 GH	43.0 ± 0.6 pr	51.2 ± 0.8 u-A	72.2 ± 0.9 lm	87.0 ± 0.6 o-u	28.6 ± 11.7 ı-y	4.2 ± 0.8-E	29.5 ± 12.7 h-L	37.2 ± 19.5 c-C
18	Barbunya- C	Aydın-Çine- Turkiye	1.30 ± 0.03 klm	248.8 ± 10.4 c-p	37.8 ± 0.8 yz	45.0 ± 0.6 N	63.0 ± 0.6 D-G	87.0 ± 0.6 o-u	34.6 ± 9.9 g-y	4.5 ± 0.3 d-y	40.5 ± 3.2 d-o	53.0 ± 18.0 a-h
19	Sırık barbunya- C	Bandırma- Turkiye	1.33 ± 0.02 d-m	296.4 ± 41.5 abc	45.6 ± 0.5lmn	52.6 ± 0.5 p-u	78.6 ± 0.5 a-e	88.6 ± 0.5 ı-p	38.6 ± 3.8 g-y	3.3 ± 0.4 v-N	31.9 ± 2.4 f-G	31.7 ± 5.1 d-G
20	Barbunya- C	Kırklareli- Turkiye	1.32 ± 0.04 d-m	130.0 ± 13.4 F-I	44.8 ± 0.4 no	50.8 ± 0.4 v-B	62.8 ± 0.4 EFG	86.6 ± 0.5 r-v	26.6 ± 11.2 k-y	4.3 ± 1.1 f-D	38.9 ± 3.8 d-s	44.2 ± 25.6 b-r
21	Barbunya- C	Bandırma- Turkiye	1.32 ± 0.05 g-m	247.0 ± 22.7 c-s	45.0 ± 0.6mno	52.0 ± 0.6 s-y	63.0 ± 0.6 D-G	87.0 ± 0.6 o-u	31.8 ± 4.3 g-y	4.5 ± 0.7 d-z	51.2 ± 5.4 b-e	48.2 ± 22.4 a-l
22	Krem boncuk- C	Bandırma- Turkiye	1.33 ± 0.02 d-m	272.6 ± 30.0 a-ı	46.6 ± 0.5 h-l	52.6 ± 0.5 p-u	72.6 ± 0.5 klm	86.6 ± 0.5 r-v	24.6 ± 10.9 k-y	3.1 ± 0.7 A-P	27.8 ± 15.9 ı-N	21.7 ± 8.2 k-G
23	Barbunya- C	Bandırma- Turkiye	1.30 ± 0.02 klm	258.8 ± 24.5 b-n	46.8 ± 0.4 h-l	52.8 ± 0.4 p-t	62.8 ± 0.4 EFG	86.6 ± 0.5 r-v	47.6 ± 22.9 e-u	4.7 ± 0.3 d-v	36.2 ± 4.1 e-A	59.7 ± 25.1 a-d
24	Boncuk Ayşe (III) - C	Bandırma- Turkiye	1.32 ± 0.04 e-m	282 ± 9.7 a-g	46.6 ± 0.5 h-l	55.6 ± 0.5 mn	67.6 ± 0.5 t-y	92.6 ± 0.5 d-g	13.0 ± 2.8 uvy	3.0 ± 0.1 A-P	21.6 ± 5.4 u-P	8.1 ± 3.3 D-G
25	Boncuk Ayşe (I) - C	Bandırma- Turkiye	1.34 ± 0.04 d-m	248.4 ± 11.0 c-r	51.0 ± 0.6 cd	59 ± 0.6 d-g	77.0 ± 0.6 efg	85.6 ± 0.5 t-A	75.8 ± 21.6 a-f	4.5 ± 0.4 d-z	27.0 ± 9.6 ı-O	52.0 ± 32.3 a-ı
26	Sarıkız fasulye-D	Bandırma- Turkiye	1.33 ± 0.04 d-m	48.2 ± 5. 2 MN	36.8 ± 0.8 z	47.6 ± 0.8 F-I	68.6 ± 0.8 p-t	84.6 ± 0.8 y-C	27.2 ± 4.7 ı-y	4.2 ± 0.5 g-I	14.0 ± 1.4 K-P	13.8 ± 3.6 s-G
27	Ayşe kadın-D	Edirne- Turkiye	1.34 ± 0.01 d-m	45 ± 5.5 MN	37.8 ± 0.4 yz	47.8 ± 0.4 F-I	69.8 ± 0.4 op	87.8 ± 0.4 m-s	18.0 ± 4.0 r-y	3.3 ± 0.3 v-N	22.7 ± 2.2 t-P	11.8 ± 4.6 v-G
28	Kumbar- C	Ödemiş-İzmir- Turkiye	1.35 ± 0.03 c-m	218.4 ± 20.3 k-D	46.6 ± 0.5 h-l	51.6 ± 0.5 t-z	63.6 ± 0.5 CDE	86.6 ± 0.5 r-v	24.8 ± 12.8 k-y	4.0 ± 1.1 g-K	25.3 ± 3.1 n-O	26.8 ± 13.6 h-G
30	Yerli Ayşe- C	Bozdağ-İzmir- Turkiye	1.38 ± 0.01 c-m	210.8 ± 39.5 m-D	37.8 ± 0.8 yz	47.8 ± 0.8 F-I	62.0 ± 0.6 FGH	87.0 ± 0.6 o-u	22.0 ± 5.5 m-y	4.5 ± 0.5 d-z	28.3 ± 3.8 ı-N	23. ±2 9.4 ı-G
31	Sarıkız- C	Bozdağ-İzmir- Turkiye	1.32 ± 0.03 g-m	256.8 ± 22.5 c-o	50.8 ± 0.4 cd	58.8 ± 0.4 e-h	71.6 ± 0.5 mn	93.6 ± 0.5 c-f	18.8 ± 4.3 o-y	3.2 ± 0.4 y-O	27.2 ± 1.8 ı-N	22.2 ± 14.0 k-G
33	Ayşe2- C	Bozdağ-İzmir- Turkiye	1.37± 0.05 b-l	178.2 ± 56.1 A-F	51.0 ± 0.0 cd	58.8 ± 0.4 e-h	77.6 ± 0.5 c-f	87.4 ± 0.5 o-t	15.8 ± 6.7 t-y	3.7 ± 1.0 ı-M	20.3 ± 3.3 z-P	10.5 ± 5.1 A-G
35	Sarı şeker- C	Bandırma- Turkiye	1.33 ± 0.03 d-m	232.4 ± 29.0 g-u	40.8 ± 0.4 st	50.8 ± 0.4 v-B	72.6 ± 0.5 klm	87.6 ± 0.5 n-s	27.0 ± 11.7 ı-y	4.9 ± 0.9 c-p	62.6 ± 16.3 bc	46.6 ± 21.2 b-n
36	Simav fasulye- C	Bandırma- Turkiye	1.37 ± 0.04 b-l	196 ± 73.4 s-E	46.8 ± 0.4 h-l	53.8 ± 0.4 op	66.6 ± 0.5 yzA	85.6 ± 0.5 t-A	54.0 ± 35.7 c-r	4.1 ± 0.3 g-H	20.9 ± 3.2 y-P	31.0 ± 20.3 d-G
38	Oturak fasulye -D	Gölcük- Turkiye	1.32 ± 0.02 e-m	50.4 ± 5.04 MN	38.6 ± 0.5 uvy	47.6 ± 0.5 F-I	70.6 ± 0.5 no	84.6 ± 0.5 y-C	26.0 ± 2.6 k-y	3.6 ± 0.3 m-N	38.1 ± 2.5 e-t	28.4 ± 7.6 g-G
39	Kaynarca- C	Kırklareli- Turkiye	1.33 ± 0.01 d-m	254.6 ± 16.9 c-p	51.8 ± 0.4 bc	58.8 ± 0.4 fgh	76.4 ± 0.5 fg	85.4 ± 0.5 u-B	10.6 ± 2.7 vy	3.7 ± 0.6 k-N	36.9 ± 1.8 e-y	9.9 ± 1.1 A-G
40	Horoz fasulye- C	Bandırma- Turkiye	1.35 ± 0.03 d-m	219.4 ± 33.8 k-D	51.6 ± 1.0 bc	58.6 ± 1.0 fgh	75.8 ± 0.4 gh	84.6 ± 0.5 y-C	22.6 ± 7.7 m-y	3.9 ± 1.3 h-K	22.5 ± 0.3 t-P	17.3 ± 9.3 o-G
41	Alman- C	Bozdağ-İzmir- Turkiye	1.34 ± 0.03 d-m	258.6 ± 37.5 b-n	51.8 ± 0.4 bc	61.2 ± 0.8 abc	74.0 ± 0.6 ık	90.6 ± 0.5 g-l	26.6 ± 11.5 k-y	4.1 ± 0.5 g-F	29.7 ± 3.7 h-L	21.5 ± 11.0 k-G
42	Kuru fasulye-D	Gölcük- Turkiye	1.35 ± 0.02 c-m	47.0 ± 11.4 MN	38.8 ± 0.4 uvy	47.8 ± 0.4 F-I	71.6 ± 0.5 mn	83.6 ± 0.5 B-E	47.8 ± 13.0 e-u	4.0 ± 0.3 g-K	35.8 ± 0.3 e-C	40.6 ± 3.7 b-v
44	Alman Ayşe tipi- C	Gölcük- Turkiye	1.37 ± 0.04 b-l	226.2 ± 48.2 ı-B	46.6 ± 0.5 h-l	53.6 ± 0.5 opr	62.6 ± 0.5 EFG	84.4 ± 0.5 z-D	35.2 ± 13.5 g-y	4.6 ± 1.4 d-v	30.5 ± 1.1 g-I	37.8 ± 23.5 c-A
45	Fasulye –D	Bozdağ-İzmir- Turkiye	1.33 ± 0.01 d-m	40.4 ± 5.1 MN	42.6 ± 0.5 pr	49.6 ± 0.5 B-E	71.6 ± 0.5 mn	83.6 ± 0.5 B-E	24.6 ± 11.6 k-y	3.0 ± 0.8 A-P	25.6 ± 8.7 m-O	20.9 ± 10.0 k-G
46	Horoz fasulye -D	Bandırma- Turkiye	1.33 ± 0.02 d-m	55.8 ± 5. 5 LMN	39 ± 0.6 uvy	48.2 ± 0.8 E-H	71.4 ± 0.5 mn	85.4 ± 0.5 u-B	37.6 ± 14.7 g-y	3.8 ± 0.4 h-M	36.3 ± 3.5 e-z	34.7 ± 12.8 d-G
47	Boncuk Ayşe- C	Bandırma- Turkiye	1.33 ± 0.02 d-m	234.4 ± 30.7 g-u	46 ± 0.0 lmn	52.8 ± 0.4 p-t	71.6 ± 0.5 mn	86.6 ± 0.5 r-v	23.0 ± 15.4 l-y	4.2 ± 0.7 f-D	30.3 ± 0.8 h-I	24.6 ± 15.8 h-G
48	Hatay taze oturak-D	Bandırma- Turkiye	1.30 ± 0.02 klm	43.0 ± 6.7 MN	38.8 ± 0.4 uvy	49.8 ± 0.4 A-D	69.6 ± 0.5 opr	86.6 ± 0.5 r-v	23.6 ± 3.1 k-y	3.5 ± 0.4 o-N	32.5 ± 1.6 f-G	20.9 ± 4.6 k-G
49	Boncuk Ayşe- C	Bandırma- Turkiye	1.35 ± 0.05 d-m	258.2 ± 36.0 b-n	47.0 ± 0.0 g-l	53.6 ± 0.5 opr	66.6 ± 0.5 yzA	86.4 ± 0.5 s-y	23.8 ± 17.8 k-y	3.4 ± 1.2 t-N	20.1 ± 7.2 B-P	22.4 ± 17.7 k-G
51	Ayşekadın-D	Edirne- Turkiye	1.37 ± 0.03 b-l	36.6 ± 9.1 MN	39.8 ± 0.4 tuv	49.6 ± 0.5 B-E	70.6 ± 0.5 no	85.6 ± 0.5 t-A	22.2 ± 3.5 m-y	4.7 ± 0.9 d-v	29.6 ± 2.8 h-L	20.7 ± 3.3 k-G
52	Gino tipi-D	Bandırma- Turkiye	1.35 ± 0.05 d-m	47.4 ± 4.3 MN	38.6 ± 0.5 uvy	48.6 ± 0.5 D-G	68.6 ± 0.5 p-t	86.6 ± 0.5 r-v	13.6 ± 3.0 t-y	5.2 ± 0.5 b-h	21.3 ± 1.1 v-P	10.4 ± 32.3 A-G

53	Boncuk Ayşe- C	Bandırma- Turkiye	1.31 ± 0.03 i-m	249.2 ± 20.1 c-p	46.8 ± 0.8 h-l	54.8 ± 0.4 no	66.4 ± 0.5 yzA	100.2 ± 0.8 a	14.6 ± 1.9 t-y	1.9 ± 0.4 OP	41.4 ± 1.4 d-m	14.0 ± 3.6 s-G
54	Boncuk Ayşe- C	Bandırma- Turkiye	1.33 ± 0.02 d-m	229.8 ± 12. h-A8	47.8 ± 0.4 f-ı	55.6 ± 0.5 mn	67.0 ± 0.0 u-z	95.8 ± 0.4 bc	19.6 ± 2.7 o-y	3.0 ± 0.5 C-P	46.4 ± 3.4 b-g	21.6 ± 4.6 k-G
55	Sarıkız-D	Kırklareli- Turkiye	1.35 ± 0.04 d-m	40.4 ± 5.5 MN	38.6 ± 0.5 uvy	49.6 ± 0.5 B-E	63.6 ± 0.5 CDE	83.6 ± 0.5 B-E	27.0 ± 8.7 l-y	4.2 ± 1.1 f-F	27.3 ± 2.9 ı-N	28.2 ± 13.6 g-G
56	Horoz-D	Bandırma- Turkiye	1.33 ± 0.03 d-m	54.0 ± 3.7 MN	38.8 ± 0.4 uvy	46.8 ± 0.4 H-M	65.6 ± 0.5 zAB	83.6 ± 0.5 B-E	41.0 ± 6.1 f-y	3.6 ± 1.2 n-N	33.6 ± 10.4 f-F	30.2 ± 9.4 f-G
57	Çine 1-D	Aydın-Çine- Turkiye	1.32 ± 0.05 e-m	43.2 ± 4.8 MN	43.0 ± 0.6 pr	51 ± 0.6 v-B	68.4 ± 0.5 p-u	85.4 ± 0.5 u-B	23.2 ± 5.3 l-y	4.6 ± 0.4 d-v	18.3 ± 3.7 F-P	13.7 ± 14.0 s-G
60	Piyazlık- C	Kırklareli-Turkiye	1.55 ± 0.01 a	224.2 ± 10.5 ı-C	47 ± 0.0 g-l	53.8 ± 0.4 op	66.6 ± 0.5 yzA	100.0 ± 0.9 a	20.6 ± 2.9 n-y	1.7 ± 0.4 P	140.3 ± 2.3 a	27.6 ± 5.1 h-G
61	Soma kuru fasulye -D	Soma- Turkiye	1.31 ± 0.04 h-m	49.8 ± 2.9 MN	43.8 ± 0.4 op	50.8 ± 0.4 v-B	74.6 ± 0.5 hı	88.6 ± 0.5 ı-p	49.6 ± 17.6 e-t	3.1 ± 0.4 z-O	38.3 ± 2.4 e-t	36.2 ± 21.2 c-E
62	Sırık 40 günlük- C	Tokat- Turkiye	1.34 ± 0.03 d-m	273.8 ± 3.1 a-ı	51.0 ± 0.6 cd	58.8 ± 0.4 fgh	73.6 ± 0.5 ıkl	96.4 ± 0.5 b	22.0 ± 3.9 m-y	4.1 ± 0.3 g-G	31.4 ± 4.7 g-I	21.3 ± 20.3 k-G
63	Sırık boncuk- C	Tokat- Turkiye	1.35 ± 0.05 d-m	253.6 ± 15.5 c-p	46.8 ± 0.4 h-l	53.6 ± 0.5 opr	67.4 ± 0.5 t-y	91.6 ± 0.5 fgh	12.6 ± 2.1 uvy	4.5 ± 0.5 d-z	32.5 ± 1.9 f-G	12.9 ± 7.6 v-G
64	Sarıkız bodur-D	Tokat- Turkiye	1.33 ± 0.04 d-m	37.2 ± 4.4 MN	37.6 ± 0.5 yz	46.6 ± 0.5 I-M	63.6 ± 0.5 CDE	84.4 ± 0.5 z-D	24.0 ± 14.4 k-y	4.7 ± 0.8 d-v	26.3 ± 13.1 k-O	20.1 ± 1.1 k-G
65	Krem renkli- C	Niğde- Turkiye	1.35 ± 0.03 d-m	237.4 ± 19.3 f-t	41.8 ± 0.4 rs	50.8 ± 0.4 v-B	62.4 ± 0.5 EFG	83.6 ± 0.5 B-E	13.8 ± 1.7 t-y	3.2 ± 0.4 y-O	30.1 ± 1.5 h-K	11.0 ± 9.3 Z-g
66	Beyaz renkli- C	Niğde- Turkiye	1.37 ± 0.03 b-m	192.2 ± 51.2 t-E	46.4 ± 1.0 ı-m	53.4 ± 1.0 o-s	64.4 ± 1.0 BCD	86.4 ± 1.0 s-y	41.0 ± 25.4 t-y	3.3 ± 1.0 u-N	55.0 ± 37.9 bcd	28.1 ± 11.0 g-G
67	Alacalı fasulye- C	Antalya- Turkiye	1.33 ± 0.02 d-m	130 ± 18.0 F-I	40.0 ± 0.0 tu	50.8 ± 0.4 v-B	69.6 ± 0.5 opr	82.4 ± 0.5 EF	26.2 ± 6.3 k-y	6.1 ± 0.4 abc	36.9 ± 3.3 e-y	41.9 ± 3.7 b-u
68	Horoz- C	Antalya- Turkiye	1.36 ± 0.05 b-m	244.6 ± 16.4 d-s	46.6 ± 0.5 h-l	53.6 ± 0.5 opr	70.4 ± 0.5 no	86.4 ± 0.5 s-y	36.0 ± 14.7 g-y	4.5 ± 0.4 d-y	24.5 ± 0.9 o-O	28.6 ± 23.5 g-G
69	Şeker fasulye- C	Turkiye	1.33 ± 0.03 d-m	222.6 ± 26.1 ı-C	43.8 ± 0.4 op	51.8 ± 0.4 t-y	77.6 ± 0.5 c-f	87.6 ± 0.5 n-s	40.6 ± 10.1 f-y	5.0 ± 0.3 b-l	27.4 ± 5.2 ı-N	36.9 ± 10.0 c-D
70	Bombay- C	Bolu Mudurnu-Turkiye	1.55 ± 0.01 a	256.0 ± 25.2 c-o	42.6 ± 0.5 pr	52.6 ± 0.5 p-u	71.6 ± 0.5 mn	99.8 ± 0.8 a	19.8 ± 10.1 o-y	3.2 ± 0.2 y-O	64.7 ± 1.2 ab	19.3 ± 12.8 m-G
71	Dermason- C	Erzincan- Turkiye	1.38 ± 0.04 b-k	215.6 ± 15.2 l-D	43.6 ± 0.5 op	50.6 ± 0.5 y-B	62.6 ± 0.5 EFG	84.6 ± 0.5 y-C	25.6 ± 12.1 k-y	2.8 ± 0.4 E-P	34.5 ± 4.9 f-E	15.8 ± 15.8 p-G
72	İspir fasulyesi- C	Karadeniz- Turkiye	1.32 ± 0.02 e-m	244.4 ± 16.0 d-s	47.8 ± 0.4 f-ı	53.8 ± 0.4 op	70.6 ± 0.5 no	87.6 ± 0.5 n-s	13.8 ± 3.1 t-y	3.9 ± 0.3 h-K	31.5 ± 1.0 g-I	11.0 ± 4.6 z-G
73	Küçük dermason- C	Konya- Turkiye	1.35 ± 0.02 c-m	235.8 ± 15.8 f-t	43.8 ± 0.4 op	51.8 ± 0.4 t-y	61.8 ± 0.4 F-I	85.6 ± 0.5 t-A	31.6 ± 17.4 h-y	3.4 ± 0.6 s-N	29.9 ± 4.5 h-L	20.9 ± 17.7 k-G
74	Ebeköy- C	Bursa- Turkiye	1.33 ± 0.04 d-m	280 ± 15.7 a-h	42.6 ± 0.5 pr	50.6 ± 0.5 y-B	69.0 ± 0.5 opr	87.6 ± 0.5 n-s	22.0 ± 5.5 m-y	3.0 ± 0.7 A-P	34.3 ± 2.1 f-E	18.6 ± 4.0 m-G
77	Bulgaristan fasulyesi-D	Çorlu-Tekirdağ- Turkiye	1.32 ± 0.02 e-m	51.8 ± 5.0 MN	39.8 ± 0.4 tuv	48.8 ± 0.4 C-F	75.6 ± 0.5 gh	85.4 ± 0.5 u-B	54.8 ± 8.3 c-o	3.5 ± 0.4 p-N	28.5 ± 3.8 h-N	39.3 ± 1.0 c-z
78	Köy Pop 4 -D	Havsa-Edirne- Turkiye	1.37 ± 0.02 b-k	37.2 ± 6.1 MN	45.0 ± 0.0mno	49.8 ± 0.4 A-D	69.0 ± 0.5 opr	85.6 ± 0.5 t-A	18.0 ± 3.6 r-y	4.1 ± 0.2 g-F	28.7 ± 1.6 h-M	17.8 ± 1.1 n-G
79	Köy Pop 1-D	Havsa-Edirne- Turkiye	1.33 ± 0.03 d-m	40.4 ± 8.0 MN	42.6 ± 0. 5 pr	49.6 ± 0.5 B-E	75.6 ± 0.5 gh	87.6 ± 0.5 n-s	29.8 ± 2.4 h-y	4.1 ± 0.2 f-F	25.9 ± 4.4 l-0	22.0 ± 5.1 k-G
81	Köy Pop 3-D	Havsa-Edirne- Turkiye	1.36 ± 0.02 b-m	54.2 ± 2.9 MN	40.8 ± 0.4 st	47.8 ± 0.4 F-I	69.4 ± 0.5 opr	87.4 ± 0.5 o-t	32.6 ± 3.3 g-y	3.6 ± 0.2 n-N	35.8 ± 1.6 e-C	28.8 ± 12.0 g-G
82	Horoz-local population-D	Uzunköprü-Edirne-Turkiye	1.33 ± 0.03 d-m	47.0 ± 9.8 MN	41.6 ± 0.5 rs	51.6 ± 0.5 t-z	75.6 ± 0.5 gh	87.4 ± 0.5 o-t	27.6 ± 15.9 ı-y	3.6 ± 0.5 n-N	26.6 ± 5.5 ı-O	21.2 ± 4.7 k-G
83	Yerli yerel-C	Ovacık-Lüleburgaz-Kırklareli- Turkiye	1.36 ± 0.02 b-m	179.2 ± 54.4 y-F	45.0 ± 0.6mno	50.2 ± 0.4 z-C	72.2 ± 0.4 lm	88.8 ± 0.4 k-o	32.6 ± 8.8 g-y	4.4 ± 0.6 e-B	29.1 ± 5.5 ı-O	26.2 ± 4.7 h-G
84	Ballıhoca köyü-C	Muratlı-Tekirdağ-Turkiye	1.35 ± 0.01 d-m	149.6 ± 55.5 E-H	44.8 ± 0.4 no	52.2 ± 0.0 r-v	77.6 ± 0.5 def	87.6 ± 0.5 n-s	41.2 ± 22.5 f-y	3.7 ± 0.5 ı-M	20.1 ± 2.4 B-P	25.6 ± 2.1 h-G
85	Taze fasulye-D	Havsa-Edirne- Turkiye	1.31 ± 0.03 i-m	39.6 ± 2.3 MN	37.8 ± 0.4 yz	45.8 ± 0.4 K-N	59.8 ± 0.4 KL	81.6 ± 0.5 F	29.6 ± 5.5 h-y	5.1 ± 0.5 b-ı	39.4 ± 2.4 d-r	42.5 ± 16.8 b-s
86	Alacalı fasulye-C	Isparta- Turkiye	1.37 ± 0.03 b-l	270.0 ± 18.9 a-k	45.8 ± 0.4 lmn	54.8 ± 0.4 no	68.6 ± 0.5 p-t	84.6 ± 0.5 y-C	45.6 ± 28.1 e-v	3.0± 0.5 B-P	22.7 ± 0.6 t-P	27.1 ± 4.9 h-G
87	Barbunya-C	Isparta- Turkiye	1.30 ± 0.02 klm	260.8 ± 29.8 b-n	45 ± 0.0 mno	54.8 ± 0.5 no	72.6 ± 0.5 klm	87.4 ± 0.5 o-t	41.0 ± 20.2 f-y	3.6 ± 0.5 l-N	27.3 ± 4.5 ı-N	36.6 ± 0.7 c-E
88	Alacalı Ayşe -C	Burdur- Turkiye	1.31 ± 0.02 h-m	245.4 ± 22.1 c-s	47.6 ± 0.5 f-k	52.6 ± 0.5 p-u	68.8 ± 0.5 p-t	93.8 ± 0.8 cde	29.0 ± 9.9 h-y	4.3 ± 0.3 e-C	25.6 ± 4.3 m-O	23.9 ± 16.6 ı-G
89	İspir fasulye-C	Karadeniz- Turkiye	1.36 ± 0.03 b-m	262.4 ± 27.1 b-m	47.8 ± 0.4 f-ı	56.6 ± 0.5 lm	68.6 ± 0.5 p-t	93.6 ± 0.5 c-f	20.2 ± 9.0 o-y	4.1± 0.5 g-H	32.5 ± 2.8 f-G	21.3 ± 1.5 k-G
90	Taze fasulye-D	İzmir- Turkiye	1.33 ± 0.02 d-m	43.8 ± 8.1 MN	40.8 ± 0.4 st	46.8 ± 0.4 H-M	68.6 ± 0.5 p-t	85.6 ± 0.5 t-A	28.6 ± 7.8 ı-y	3.7 ± 0.4 ı-M	37.5 ± 4.6 e-u	28.2 ± 14.3 g-G
91	Sırık fasulye-C	İzmir- Turkiye	1.32 ± 0.03 e-m	227 ± 12.2 ı-B	45.6 ± 0.5 lmn	51.6 ± 0.5 t-z	61.6 ± 0.5 GHI	87.4 ± 0.5 o-t	10.4 ± 3.6 vy	4.8 ± 1.2 c-r	33.2 ± 1.9 f-F	18.8 ± 8.5 m-G
92	Oturak fasulye –D	Turkiye	1.32 ± 0.02 e-m	45.4 ± 3.3 MN	43.6 ± 0.5 op	53.6 ± 0.5 opr	72.4 ± 0.5 lm	85.4 ± 0.5 u-B	20.8 ± 5.3 n-y	3.6 ± 0.4 n-N	26.4 ± 2.9 f-F	18.6 ± 12.0 m-G
94	Oturak fasulye -D	Turkiye	1.33 ± 0.03 d-m	52.6 ± 4.6 MN	39.8 ± 0.4 tuv	49.6 ± 0.5 B-E	71.6 ± 0.5 mn	85.6 ± 0.5 t-A	34.0 ± 8.1 g-y	3.3 ± 0.4 u-N	36.4 ± 4.5 e-y	32.6 ± 10.3 d-G
95	Sırık fasulye-C	Turkiye	1.37 ± 0.04 b-l	242 ± 9.4 e-t	44.8 ± 0.4 no	51.8 ± 0.8 t-y	68.6 ± 0.5 p-t	87.4 ± 0.5 o-t	31.8 ± 5.1 g-y	5.1 ± 0.5 b-ı	23.3 ± 0.7 s-P	33.5 ± 1.2 d-G
96	Sırık fasulye-C	Torbalı- İzmir-Turkiye	1.37 ± 0.03 b-l	245.8 ± 28.6 c-s	54.8 ± 1.0 a	63.8 ± 1.0 a	75.6 ± 0.8 gh	89.4 ± 0.5 y-C	20.8 ± 2.4 n-y	4.8 ± 0.5 c-t	35.5 ± 1.5 e-D	22.5 ± 5.5 k-G
97	Sırık fasulye-C	Turkiye	1.34 ± 0.03 d-m	239.2 ± 8.4 e-t	48.8 ± 1.0 ef	56.8 ± 1.0 klm	67.6 ± 0.5 t-y	84.6 ± 0.5 y-C	36.6 ± 13.2 g-y	4.2 ± 0.5 f-E	28.3 ± 4.2 ı-N	30.8 ± 1.2 e-G
98	Fasulye çalı-C	Torbalı- İzmir-Turkiye	1.38 ± 0.03 b-k	225.2 ± 13.9 ı-C	47.8 ± 0.4 f-ı	53.8 ± 0.4 op	69.6 ± 0.5 opr	92.6 ± 0.5 d-g	48.6 ± 30.6 e-u	4.2 ± 0.6 f-E	27.0 ± 3.0 ı-O	39.9 ± 12.1 b-y
99	Kuru Alman-C	Torbalı- İzmir-Turkiye	1.37 ± 0.03 b-k	205.4 ± 53.9 o-D	47.8 ± 0.4 f-ı	52.8 ± 0.4 p-t	67.6 ± 0.5 t-y	87.6 ± 0.5 n-s	35.0 ± 43.7 g-y	3.7 ± 0.6 ı-M	31.9 ± 5.9 f-G	28.8 ± 5.8 g-G
100	Sırık fasulye-C	Turkiye	1.40 ± 0.03 b-f	249.2 ± 16.7 c-p	48.0 ± 0.0 fgh	53.8 ± 0.4 op	67.8 ± 0.4 s-y	87.4 ± 0.5 o-t	88.0 ± 36.6 a-d	4.5 ± 0.3 d-y	21.6 ± 5.7 u-P	39.8 ± 2.2 b-z
101	Oturak fasulye -D	Turkiye	1.35 ± 0.04 c-m	43 ± 5.1 MN	42.6 ± 0.5 pr	49.6 ± 0.5 B-E	70.6 ± 0.5 no	85.6 ± 0.5 t-A	41.0 ± 9.8 f-y	3.5 ± 0.4 o-N	20.2 ± 3.3 u-P	20.4 ± 5.2 k-G
102	Kuru fasulye-D	Torbalı- İzmir-Turkiye	1.33 ± 0.04 d-m	59. 6 ± 2.6 LMN	40.8 ± 0.4 st	48.8 ± 0.4 C-F	66.6 ± 0.5 yzA	85.6 ± 0.5 t-A	34.6 ± 3.6 g-y	4.2 ± 0.8 f-F	32.0 ± 0.8 f-G	34.9 ± 1.4 d-G
103	Sırık fasulye-C	Isparta- Turkiye	1.36 ± 0.03 c-m	270 ± 19.0 a-k	47.8 ± 1.0 f-ı	53.6 ± 0.5 opr	67.6 ± 0.5 t-y	87.6 ± 0.5 n-s	59.6 ± 5.0 b-k	4.5 ± 0.7 d-y	24.1 ± 3.9 p-O	64.00 ± 3.6 abc
104	Sırık fasulye-C	İzmir- Turkiye	1.36 ± 0.03 b-m	240.2 ± 8.5 e-t	47.6 ± 0. f-5k	54.6 ± 0.5 no	67.6 ± 0.5 t-y	86.6 ± 0.5 r-v	33.0 ± 5.2 g-y	4.4 ± 0.5 d-A	24.2 ± 3.5 p-O	24.3 ± 13.6 h-G
105	Oturak fasulye -D	Isparta- Turkiye	1.35 ± 0.04 d-m	39.6 ± 3.4 MN	40.0 ± 0.0 tu	46.8 ± 0.4 H-M	58.6 ± 0.5 L	83.6 ± 0.5 B-E	32.8 ± 9.8 g-y	4.0 ± 0.5 g-H	36.4 ± 1.5 e-y	20.7 ± 17.5 k-G
106	Sırık fasulye-C	Isparta- Turkiye	1.39 ± 0.03 b-i	216.8 ± 37.8 l-D	48.0 ± 0.0 fgh	54.8 ± 0.4 no	67.8 ± 0.4 s-y	86.6 ± 0.5 r-v	57.6 ± 42.0 b-m	3.6 ± 0.6 m-N	17.2 ± 2.9 G-P	30.3 ± 18.2 f-G
107	TR39074-C	Aydın- (AARI) -Turkiye	1.39 ± 0.04 b-h	220.4 ± 29.3 k-D	47.0 ± 0.0 g-l	52.8 ± 0.4 p-t	71.4 ± 0.5 mn	87.4 ± 0.5 o-t	29.0 ± 9.8 h-y	3.9 ± 0.7 h-K	21.8 ± 3.6 u-P	19.7 ± 5.7 l-G

108	TR43497 -C	İstanbul -(AARI) - Turkiye	1.36 ± 0.02 b-m	252.2 ± 7.3 c-p	47.6 ± 0.5 f-k	53.6 ± 0.5 opr	67.6 ± 0.5 t-y	86.6 ± 0.5 r-v	109.0 ± 37.6 a	4.3 ± 0.3 e-C	23.0 ± 0.3 s-P	80.6 ± 16.9 a
109	TR62091-C	İzmir - (AARI) -Turkiye	1.35 ± 0.03 c-m	36.0 ± 5.7 MN	44.8 ± 0.4 no	51.6 ± 0.5 t-z	75.6 ± 0.5 gh	91.4 ± 0.5 ghı	12.6 ± 3.4 uvy	4.0 ± 0.5 g-K	30.6 ± 1.0 g-I	13.7 ± 18.2 s-G
110	TR28094 -C	Muğla- (AARI) -Tur	1.37± 0.03 b-m	259.8 ± 15.6 b-n	48.4 ± 1.0 efg	58.2 ± 0.8 ghı	68.2 ± 0.8 r-v	87.2 ± 0.8 o-u	43.0 ± 20.4 e-y	4.4 ± 0.2 d-A	18.8 ± 1.0 E-P	27.1 ± 8.3 s-G
111	TR33486-C	Kırklareli-(AARI) -Tur	1.39 ± 0.03 b-h	173.8 ± 9.6 C-F	49 ± 0.9 ef	57.4 ± 0.5 ıkl	67.4 ± 0.5 t-y	85.4 ± 0.5 u-B	22.6 ± 2.1 m-y	2.9 ± 0.4 C-P	29.2 ± 1.1 h-L	13.7 ± 9.8 s-G
112	TR65047-C	Manisa-(AARI) -Tur	1.40 ± 0.03 b-g	179.0 ± 44.7 z-F	45.0 ± 0.0mno	51.8 ± 0.4 t-y	67.8 ± 0.4 s-y	93.8 ± 0.4 cde	65.2 ± 22.0 a-h	3.6 ± 0.6 n-N	28.1 ± 1.3 ı-N	44.6 ± 11.0 b-p
113	TR38090 -C	Balıkesir (AARI) -Tur	1.36 ± 0.05 b-m	246.4 ± 14.9 c-s	47.8 ± 0.6 f-ı	54.8 ± 0.8 no	66.8 ± 0.8 v-A	85.6 ± 0.5 t-A	63.0 ± 18.8 b-ı	4.8 ± 0.2 c-t	26.1 ± 3.2 l-O	56.7 ± 11.9 a-g
114	TR43097 -C	Çanakkale (AARI) -Tur	1.38 ± 0.03 b-k	115.2 ± 11.1 HIK	49.8 ± 0.4 de	59.4 ± 0.5 c-f						
115	TR43574 -C	Sakarya (AARI) -Tur	1.31 ± 0.03 h-m	240.4 ± 15.1 e-t	47.6 ± 0.5 f-k	53.6 ± 0.5 opr	73.6 ± 0.5 ıkl	88.6 ± 0.5 m-p	31.0 ± 15.4 h-y	3.7 ± 0.5 ı-M	29.6 ± 1.1 h-L	28.5 ± 4.4 g-G
117	TR57759 -C	Tekirdağ (AARI) -Tur	1.35 ± 0.04 d-m	169.4 ± 9.6 D-G	48.0 ± 0.0 fgh	54.6 ± 0.5 no	67.6 ± 0. t-y5	84.4 ± 0.5 z-D	25.8 ± 5.2 k-y	4.2 ± 0.5 f-D	12.7 ± 2.9 M-P	15.4 ± 10.0 r-G
118	Volare -C	May- Turkiye	1.36 ± 0.03 b-m	209 ± 12.4 n-D	42.8 ± 0.8 pr	49.6 ± 1.0 B-E	64.6 ± 0.5 BC	85.6 ± 0. t-A5	26.8 ± 12.2 ı-y	4.6 ± 1.2 d-v	22.4 ± 10.9 t-P	21.2 ± 1.2 k-G
119	Taze fasulye-D	Korkuteli- Antalya-Tur	1.35 ± 0.05 d-m	43.6 ± 5.6 MN	38.2 ± 0.4 yz	47.2 ± 0.4 G-K	69.2 ± 0.4 o-s	85.0 ± 0.0 v-B	32.6 ± 4.2 g-y	5.0 ± 0.5 c-m	15.9 ± 3.50H-P	20.3 ± 2.5 k-G
120	Yerli2-D	Bursa- Turkiye	1.31 ± 0.02 h-m	38.0 ± 3.7 MN	42.8 ± 0.4 pr	48.8 ± 0.4 C-F	64.6 ± 0. BC5	85.6 ± 0.5 t-A	23.6 ± 4.6 k-y	5.1 ± 0.7 b-k	20.3 ± 7.6 z-P	21.4 ± 13.9 k-G
121	Helda-C	Vilmorin- Turkiye	1.37 ± 0.04 b-l	222.6 ± 28.8 ı-C	45.8 ± 0.4 lmn	51.8 ± 0.4 t-y	60.8 ± 0.4 HIK	83.8 ± 0.4 A-E	16.6 ± 1.6 s-y	3.1 ± 0.6 y-O	23.8 ± 6.0 p-O	12.3 ± 27.0 v-G
122	Sırık fasulye-C	Isparta- Turkiye	1.39 ± 0.04 b-i	233.4 ± 31.5 g-u	44.8 ± 0.4 no	50.8 ± 0.4 v-B	59.8 ± 0.4 KL	82.4 ± 0.5 EF	27.2 ± 6.5 ı-y	4.9 ± 0.5 c-n	24.9 ± 1.8 n-O	26.0 ± 32.0 h-G
123	Purple teepe 141-D	Kienpenkerl- Germany	1.39 ± 0.03 b-i	31.4 ± 1.9 N	38.6 ± 0.5 uvy	45.6 ± 0.5 LMN	65.4 ± 0.5 AB	81.4 ± 0.5 F	18.4 ± 4.7 p-y	3.7 ± 0.8 ı-M	11.1 ± 4.1 OP	20.1 ± 7.8 k-G
124	Sarıkız Village Variety-D	Turkiye	1.32 ± 0.03 e-m	37.4 ± 1.0 MN	39.8 ± 0.4 tuv	47.8 ± 0.4 F-I	62.8 ± 0.4 EFG	85.6 ± 0.5 t-A	22.0 ± 5.0 m-y	5.1 ± 0.8 b-k	19.0 ± 6.2 E-P	13.5 ± 3.6 u-G
125	Barbunya-C	Turkiye	1.32 ± 0.02 f-m	254.2 ± 5.3 c-p	47.6 ± 0.5 f-k	53.6 ± 0.5 opr	68.6 ± 0.5 p-t	84.6 ± 0.5 y-C	56.8 ± 19.1 b-n	4.0 ± 0.9 g-K	27.0 ± 3.6 ı-O	45.4 ± 2.8 b-o
128	Ayşe kadın Village Variety-C	Trabzon- Turkiye	1.31 ± 0.02 i-m	235 ± 17.8 f-u	44.8 ± 0.4 no	51.6 ± 0.5 t-z	70.6 ± 0.5 no	85.6 ± 0.5 t-A	24.6 ± 10.5 k-y	4.8 ± 0.5 c-s	19.5 ± 7.7 D-P	20.4 ± 2.8 k-G
129	Güz fasulyesi Village Variety-D	Trabzon- Turkiye	1.40 ± 0.04 b-f	41.6 ± 2.9 MN								
131	Solista-C	Marshalls- England	1.38 ± 0.02 b-k	225.4 ± 29.3 ı-C	46.6 ± 0.5 h-l	54.6 ± 0.5 no	63.6 ± 0.5 CDE	83.6 ± 0.5 B-E	55.0 ± 8.7 c-o	5.5 ± 1.4 a-f	42.2 ± 15.2 d-k	48.5 ± 4.8 a-k
132	Algarve-C	Marshalls- England	1.35 ± 0.02 c-m	247.8 ± 20.4 c-s	45.8 ± 0.8 lmn	51.8 ± 0.8 t-y	60.4 ± 0.5 IK	84.4 ± 0.5 z-D	36.2 ± 11.3 g-y	3.9 ± 0.4 g-K	30.8 ± 2.7 g-I	26.6 ± 8.2 h-G
133	Magnum Village Variety-D	Turkiye	1.33 ± 0.02 d-m	44.0 ± 4.3 MN	42.8 ± 0.4 pr	48.8 ± 0.4 C-F	59.6 ± 0.5 KL	84.6 ± 0.5 y-C	36.6 ± 4.8 g-y	5.7 ± 0.3 a-e	19.9 ± 1.3 C-P	35.7 ± 21.2 c-F
134	Limka-C	Holland seed- Holland	1.44 ± 0.02 ab	227.4 ± 26.0 ı-B	44.8 ± 0.4 no	50.6 ± 0.5 y-B	60.6 ± 0.5 HIK	84.6 ± 0.5 y-C	52.6 ± 5.4 c-s	4.7 ± 0.6 d-u	27.1 ± 0.9 ı-N	38.0 ± 9.7 c-A
136	Yerli 25 Village Variety-C	Beypazarı- Turkiye	1.31 ± 0.03 i-m	295 ± 22.3 a-d	45.6 ± 0.5 lmn	50.6 ± 0.5 y-B	72.4 ± 0.8 lm	87.2 ± 0.8 o-u	52.2 ± 36.2 d-s	4.8 ± 0.4 c-r	42.5 ± 24.2 d-ı	29.1 ± 26.1 f-G
137	Yerli 23 -C	Antalya- Turkiye	1.40 ± 0.04 b-g	196.6 ± 50.5 r-E	43.8 ± 0.4 op	51.6 ± 0.5 t-z	72.4 ± 0.5 lm	86.4 ± 0.5 s-y	94.8 ± 56.1 ab	4.8 ± 0.6 c-s	63.1 ± 37. bc	18.9 ± 4.7 m-G
138	E-Z Pick -D	Johnny seed- USA	1.40 ± 0.05 b-e	31.2 ± 4.1 N	42.6 ± 0.5 pr	48.6 ± 0.5 D-G	65.6 ± 0.5 zAB	82.6 ± 0.5 DEF	27.8 ± 3.9 ı-y	7.3 ± 0.7 a	20.1 ± 1.9 B-P	29.1 ± 11.4 f-G
139	Yerli 4-C	Erzincan- Turkiye	1.36 ± 0.03 c-m	286.6 ± 7.1 a-f	47.6 ± 0.5 f-k	57.6 ± 0.5 hık	76.4 ± 0.5 fg	88.6 ± 0.5 m-p	24.0 ± 12.6 k-y	4.9 ± 0.4 c-o	21.9 ± 12.4 u-P	27.9 ± 1.6 h-G
140	Dellinel 3155-D	Twinplus- Holland	1.38 ± 0.03 b-k	49.4 ± 8.9 MN	43.6 ± 0.5 op	49.6 ± 0.5 B-E	63.6 ± 0.5 CDE	87.6 ± 0.5 n-s	13.8 ± 3.4 t-y	3.6 ± 0.6 n-N	22.9 ± 2.9 t-P	8.7 ± 19.3 C-G
141	Maxi bell-D	Johnny seed- USA	1.40 ± 0.02 b-f	42.4 ± 5.5 MN	43.0 ± 0.0 pr	48.8 ± 0.4 C-F	61.8 ± 0.4 F-I	82.8 ± 0.4 C-F	25.4 ± 4.7 k-y	5.3 ± 0.2 b-g	14.2 ± 2.2 K-P	16.5 ± 13.1 p-G
142	Provider -D	Johnny seed- USA	1.32 ± 0.02 e-m	37.0 ± 3.7 MN	41.0 ± 0.0 st	47.8 ± 0.4 F-I	67.6 ± 0.5 t-y	84.6 ± 0.5 y-C	16.8 ± 2.3 s-y	4.5 ± 0.9 d-y	26.2 ± 7.2 k-O	17.8 ± 12.8 n-G
143	Piyazlık-C	Peru	1.36 ± 0.01 b-m	177.8 ± 45.0 B-F	45.8 ± 0.4 lmn	50.8 ± 0.4 v-B	60.8 ± 0.4 HIK	82.6 ± 0.5 DEF	31.2 ± 9.9 h-y	4.9 ± 1.1 c-n	21.8 ± 2.1 u-P	24.4 ± 0.7 h-G
144	Taze fasulye-D	Bulgaria	1.36 ± 0.03 c-m	39.2 ± 2.3 MN	40.8 ± 0.4 st	47.8 ± 0.4 F-I	63.8 ± 0.4 CDE	82.6 ± 0.5 DEF	33.8 ± 2.4 g-y	4.7 ± 0.2 d-u	29.7 ± 3. h-L2	38.3 ± 3.7 c-A
145	Mexican bean-D	USA	1.37 ± 0.06 b-l	28.8 ± 1.6 N	41.6 ± 0.5 rs	48.6 ± 0.5 D-G	69.6 ± 0.5 opr	81.4 ± 0.5 F	13.2 ± 3.9 uvy	3.4 ± 0.7 t-N	31.7 ± 4.7 g-H	16.9 ± 3.7 o-G
147	Sarıkız (Commercial) -D	Küçükçiftlik-Turkiye	1.33 ± 0.01 d-m	46.6 ± 5.3 MN	39.8 ± 0.4 tuv	49.8 ± 0.4 A-D	72.4 ± 0.5 lm	96.4 ± 0.5 b	15.0 ± 1.4 t-y	2.8 ± 0.3 F-P	23.7 ± 3.8 r-P	8.0 ± 3.4 EFG
148	Gino (Commercial) -D	May- Turkiye	1.35 ± 0.07 d-m	42.4 ± 7.8 MN	41.8 ± 0.4 rs	51.6 ± 0.5 t-z	73.4 ± 0.5 Ikl	87.6 ± 0.5 n-s	26.0 ± 5.4 k-y	2.4 ± 0.4 L-P	28.6 ± 2.8 h-N	13.6 ± 4.2 t-G
149	Elinda (Commercial) -D	May- Turkiye	1.35 ± 0.03 d-m	32.0 ± 2.3 N	41.6 ± 0.5 rs	48.2 ± 0.8 E-H	63.6 ± 0.5 CDE	83.6 ± 0.5 B-E	18.0 ± 1.8 r-y	3.3 ± 1.0 v-N	37.3 ± 1.0 e-v	13.2 ± 4.9 u-G
150	Serra (Commercial)-C	May- Turkiye	1.36 ± 0.02 b-m	183.6 ± 55. u-E7	43.8 ± 0.4 op	51.6 ± 0.5 t-z	60.6 ± 0.5 HIK	82.6 ± 0.5 DEF	19.0 ± 4.1 o-y	4.5 ± 0.4 d-y	36.3 ± 5.3 e-A	21.5 ± 1.9 k-G
153	Yalova 17 (Commercial) -D	AHCRI / Yalova-Turkiye	1.32 ± 0.02 e-m	42.4 ± 3.2 MN	41.0 ± 0.0 st	47 ± 0.0 H-L	61.6 ± 0.5 GHI	85.6 ± 0.5 t-A	17.0 ± 3.2 s-y	2.6 ± 0.2 K-P	21.0 ± 4.6 y-P	8.9 ± 5.7 B-G
155	Alman Ayşe (Commercial)-C	Altın tohum- Turkiye	1.37 ± 0.04 b-k	231 ± 35.1 g-y	46.0 ± 0.0 lmn	51.8 ± 0.4 t-y	60.8 ± 0.4 HIK	82.6 ± 0.5 DEF	39.8 ± 19.1 f-y	5.8 ± 1.3 a-d	29.9 ± 3.7 h-L	46.7 ± 15.4 b-m
156	Sarıkız (Commercial) -D	Neobi	1.33 ± 0.02 d-m	45.2 ± 5.9 MN	47.6 ± 0.5 f-k	53.6 ± 0.5 opr	74.6 ± 0.5 hı	86.0 ± 1.1 s-z	21.0 ± 8.4 n-y	4.0 ± 0.8 g-K	18.9 ± 2.6 E-P	11.3 ± 1.2 y-G

157	40 günlük Amerikan Atlantis (Commercial) -D	Arzuman- Turkiye	1.32 ± 0.02 e-m	42.2 ± 2.6 MN	52.2 ± 1.0 bc	57.4 ± 0.8 ıkl	77.4 ± 0.5 def	91.4 ± 0.5 ghı	20.0 ± 4.5 o-y	3.3 ± 0.6 v-N	27.5 ± 3.3 ı-N	12.7 ± 8.9 v-G
158	Demir Magnumax (Commercial) –D	Arzuman- Turkiye	1.31 ± 0.06 i-m	52.2 ± 2.0 MN	55.6 ± 0.5 a	61.6 ± 0.5 ab	75.6 ± 0.5 gh	88.6 ± 0.5 m-p	37.4 ± 2.1 g-y	5.1 ± 0.6 b-h	30.2 ± 1.1 h-K	24.3 ± 12.5 h-G
159	Simbo Saddle (Commercial) -D	Arzuman- Turkiye	1.31 ± 0.04 i-m	48.6 ± 2.2 MN	53.0 ± 0.0 ab	58.6 ± 0.5 fgh						
161	Yunus 90-D	TZAI / Eskişehir-Turkiye	1.38 ± 0.04 b-k	52 ± 4.4 MN	42.8 ± 0.4 pr	53.8 ± 0.4 op	72.6 ± 0.5 klm	82.6 ± 0.5 DEF	9.4 ± 4.1 vy	1.7 ± 0.3 P	29.8 ± 1.0 h-L	8.2 ± 2.8 D-G
162	Village Variety (şeker) -D	EAARI / Erzurum-Turkiye	1.31 ± 0.04 g-m	255.8 ± 19.1 c-p	48.6 ± 0.5 ef	54.6 ± 0.5 no	77.4 ± 0.5 def	89.4 ± 0.5 ı-n	79.2 ± 24.8 a-e	4.1 ± 0.4 g-F	40.9 ± 1.9 d-n	68.5 ± 1.3 ab
163	Hınıs variety (şeker) -D	EAARI / Erzurum-Turkiye	1.34 ± 0.04 d-m	212 ± 20.4 m-D	45.8 ± 0.4 lmn	51.8 ± 0.4 t-y	65.8 ± 0.4 zAB	83.6 ± 0.5 B-E	89.8 ± 43.3 abc	3.0 ± 0.2 B-P	30.4 ± 3.5 h-I	59.5 ± 5.0 a-e
164	Mecidiye (barbunya) -D	EAARI / Erzurum-Turkiye	1.35 ± 0.04 d-m	42.8 ± 6.0 MN	40.6 ± 0.5 st	49.6 ± 0.5 B-E	70.6 ± 0.5 no	87.4 ± 0.5 o-t	54.4 ± 1.4 c-p	3.9 ± 0.5 h-K	47.9 ± 4.2 b-f	57.7 ± 3.7 a-f
165	Aras 98-D	EAARI / Erzurum-Turkiye	1.31 ± 0.03 i-m	41.0 ± 2.0 MN	40.8 ± 0.4 st	48.8 ± 0.4 C-	73.6 ± 0.5 mn	83.6 ± 0.5 B-E	25.6 ± 2.7 k-y	4.1 ± 0.3 g-H	30.8 ± 0.7 g-I	26.7 ± 4.4 h-G
166	Yakutiye 98-D	EAARI / Erzurum-Turkiye	1.33 ± 0.03 d-m	46.6 ± 6.1 MN	40.8 ± 0.4 st	45.8 ± 0.4 K-N	58.8 ± 0.4 L	86.6 ± 0.5 r-v	12.8 ± 2.1 uvy	3.2 ± 0.3 y-O	26.7 ± 0.7 ı-O	8.8 ± 3.3 C-G
168	Eskişehir 855-D	TZAI / Eskişehir-Turkiye	130 ± 0.04 klm	58.0 ± 1.7 LMN	41.0 ± 0.0 st	47 ± 0.0 H-L	64.6 ± 0.5 BC	88.6 ± 0.5 m-p	41.2 ± 3.9 f-y	3.9 ± 0.3 h-K	26.7 ± 2.0 ı-O	18.9 ± 2.2 m-G
169	Şehriali 90-D	TZAI / Eskişehir-Turkiye	1.36 ± 0.04 b-m	37.4 ± 4.1 MN	43.0 ± 0.0 pr	46.8 ± 0.4 H-M						
170	Önceler-D	TZAI / Eskişehir-Turkiye	1.35 ± 0.01 c-m	45.6 ± 3.4 MN	42.6 ± 0.5 pr	52.6 ± 0.5 p-u	71.6 ± 0.5 mn	95.4 ± 0.5 bc	9.2 ± 3.0 y	2.6 ± 0.4 I-P	7.6 ± 0.6 P	6.7 ± 2.5 G
1 71	Karacaşehir 90 -C	TZAI / Eskişehir-Turkiye	1.34 ± 0.07 d-m	107.0 ± 13.5 H-L	45.8 ± 0.4 lmn	51.6 ± 0.5 t-z	69.6 ± 0.5 opr	84.6 ± 0.5 y-C	43.0 ± 3.0 e-y	6.6 ± 0.4 ab	15.5 ± 0.7 I-P	30.1 ± 5.0 f-G
172	Bulduk-C	TZAI / Eskişehir- Turkiye	1.34 ± 0.03 d-m	289.8 ± 6.4 a-e	48.6 ± 0.8 ef	58.6 ± 0.5 fgh	71.6 ± 0.5 mn	86.6 ± 0.5 r-v	11.2 ± 4.2 vy	4.9 ± 0.3 c-p	18.2 ± 0.7 F-P	7.0 ± 11.5 FG
173	Akın-D	Geçit Kuşağı TAE/Eskişehir- Turkiye	1.33 ± 0.02 d-m	64.8 ± 5.2 KN	42.8 ± 0.4 pr	50.8 ± 0.4 v-B	66.6 ± 0.5 yzA	84.4 ± 0.5 z-D	25.8 ± 2.0 k-y	2.7 ± 0.2 H-P	32.3 ± 1.6 f-G	12.9 ± 2.4 v-G
174	Göynük 98-D	TZAI / Eskişehir-Turkiye	1.36 ± 0.02 b-m	57.2 ± 3.2 LMN	40.6 ± 0.5 st	50.6 ± 0.5 y-B	67.6 ± 0.5 t-y	94.4 ± 0.5 bcd	24.2 ± 2.3 k-y	3.0 ± 0.3 C-P	26.4 ± 0.7 k-O	8.9 ± 6.9 B-G
175	Zülbiye -D	BSARI / Samsun-Turkiye	1.37 ± 0.05 b-m	49.8 ± 3.3 MN	48.6 ± 0.5 ef	58.6 ± 0.4 fgh	78.4 ± 0.5 b-e	87.4 ± 0.5 o-t	18.2 ± 3.0 p-y	2.3 ± 0.4 NOP	21.8 ± 2.0 u-P	8.6 ± 2.3 C-G
176	Akdağ-D	BSARI / Samsun-Turkiye	1.31 ± 0.02 i-m	55.6 ± 6.8 LMN	49.8 ± 0.4 de	54.6 ± 0.5 no	79.4 ± 0.5 abc	87.4 ± 0.5 o-t	39.2 ± 8.4 g-y	2.7 ± 0.4 G-P	44.4 ± 2.7 c-h	29.9 ± 1.5 f-G
177	Terzibaba-D	EAARI / Erzurum-Turkiye	1.38 ± 0.03 b-k	87.6 ± 6.2 IM	49.6 ± 0.5 de	56.6 ± 0.5 lm	69.6 ± 0.5 opr	84.6 ± 0.5 y-C	37.0 ± 19.5 g-y	3.3 ± 0.3 u-N	17.1 ± 2.6 G-P	13.2 ± 2.2 u-G
			Mse:0.002	Mse:622.51	Mse:0.48	Mse:0.5	Mse:0.53	Mse:0.92	Mse:304.34	Mse:0.46	Mse:59.2	Mse:191.3

Acc: Accession, C: Climbing, D: Dwarf, AARI: Aegean Agricultural Research Institute, AHCRI: Atatürk Horticultural Central Research Institute, TZAI: Transitional Zone Agricultural Institute, EAARI: East Anatolian Agricultural Research Institute, BSARI: Black Sea Agricultural Research Institute, Mse: Mean squares error

Standard deviation and Significance group values are added after 3rd column.

2.5. Statistical analysis

To assess differences in genome size and agro-morphological characters, One Way Analysis of Variance (One Way ANOVA) was used. Duncan's test was utilized to determine differences between groups. The relationship between the genome sizes and agro-morphological characters of the accessions was determined using correlation analysis.

3. Results and Discussion

The results obtained in the study are presented in Table 1. Based on these results there was a significant variation in genome size and agro-morphological characteristics among the common bean accessions investigated. ANOVA results revealed that the differences among the accessions were statistically significant for all the characteristics studied ($P<0.01$). In Duncan's analysis, it was determined that the accessions were divided into a large number of groups (Table 1). Similarly, in previous studies with different bean genetic resource collections, have also been reported a wide range of variations in both qualitative and quantitative characteristics (Nemli et al. 2017; Nadeem et al. 2020; Elkoca et al. 2022; Ketema & Geleta 2022; Kul & Yıldırım 2023; Ikanı et al. 2024).

The FCM analysis revealed that the mean genome size of the common bean accessions ranged from 1.28 to 1.55 pg2C–1, with the species mean being 1.35 pg2C–1 (Table 1). Moreover, the means of genome sizes of the climbing and dwarf-type common bean accessions were very similar at 1.35 and 1.34 pg2C–1, respectively. However, variability was higher in the climbing-type beans (1.55 – 1.28 pg2C–1) compared to the dwarf-type beans (1.30 – 1.40 pg2C–1). Two of the climbing bean accessions (60 and 70) had a significantly higher genome size (mean was 1.55 pg2C–1) compare to the other accessions studied. The lowest genome size mean (1.28 pg2C–1) also belonged to a climbing type (16th accession). These findings were consistent with previous studies reporting wide variations in genome size in bean germplasm (Ayonoadu 1974; Castagnaro et al. 1990; Nagl & Treviranus 1995; Beletti et al. 1997; Barow & Meister 2002; Mekki et al. 2007; Labotan et al. 2018; Tomlekova et al. 2024). Minor differences among the different studies could be attributed to the use of different techniques, methods, internal standards, and accessions, or technical issues (Dolezel & Bartos 2005). Also, mutations can cause changes in genome size and genome structure (Tomlekova et al. 2024). Additionally, all of the accessions were found to have 22 chromosomes ($2n = 2x = 22$) (Figure 1).

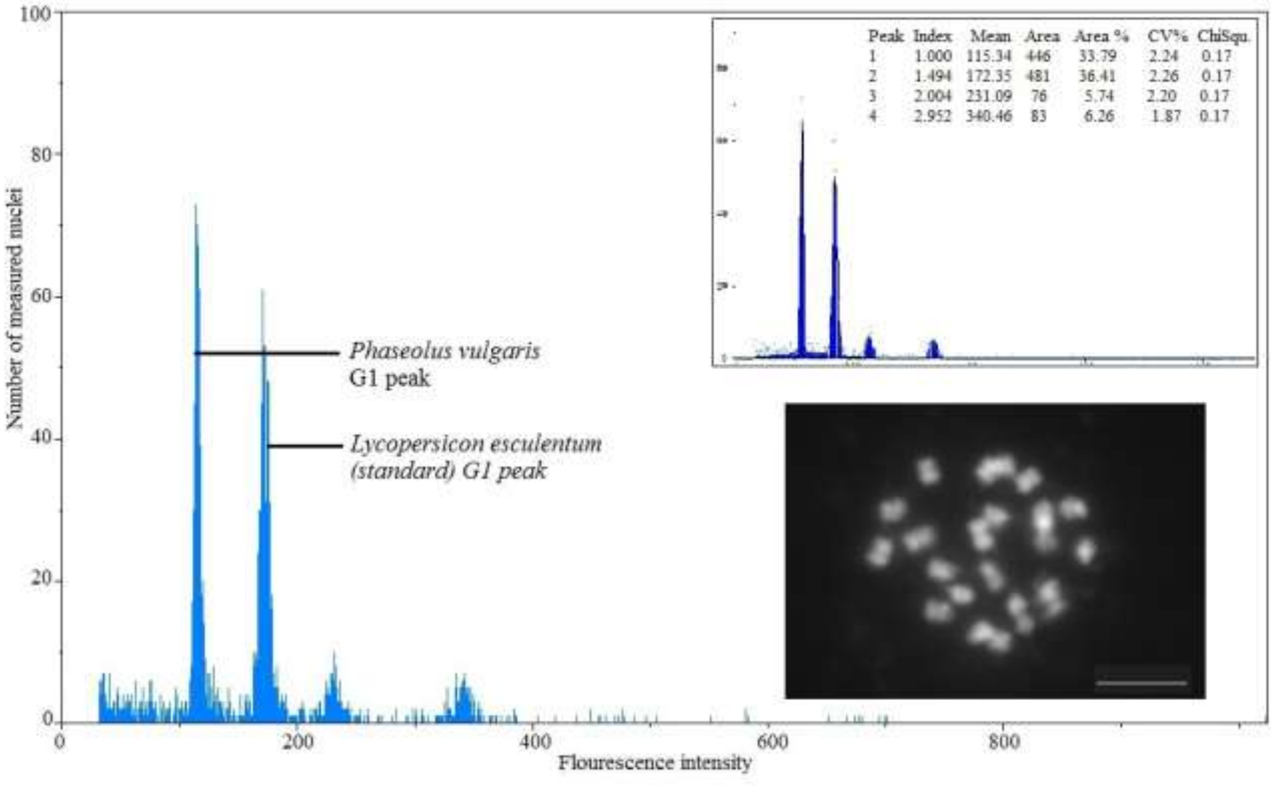

Figure 1- Relative positions of the G1 peaks of *Phaseolus vulgaris* L. (sample number: 120–2) and internal standard (*L. esculentum* Mill.) plants and mitotic chromosomes of the accession (genome size: 1.31pg2C^{-1}, scale bars = 5 µm)

In this study, it was determined that the plant heights of common bean accessions ranged between 28.8 and 327 cm (mean = 158.1 ± 149.54 cm) (Table 1). Plant lengths in climbing beans ranged between 107 and 327 cm (mean = 230.11 ± 110.26 cm), while plant lengths of dwarf beans were between 28.8 and 87.6 cm (mean = 45.3 ± 30.33 cm). It was observed that in terms of plant length, the 15th, 14th, 19th, and 136th accessions had the highest values (≥ 250 cm), while the 145th, 138th, 123rd, and 149th

accessions had the lowest values (≤ 32 cm). In some studies in the literature, it has been stated that the plant height ranged between 24.55-72.28 cm (Pekşen & Gülümser 2005), 19.50 – 101.20 cm (Stoilova et al. 2005), 27-40 (Boros et al. 2014), 20.3-118.0 (Basavaraja et al. 2021), 29.6-260 cm (Elkoca et al. 2022), and 66.40- 313.47 cm (Ikanı et al. 2024). In their study conducted with dwarf beans, Coelho et al. (2009) reported that the plant height was between 30.0 and 51.0 cm. The results obtained in the current study are consistent with other studies, and it is thought that the differences may have been due to differences in accessions used, the growing environment (climatic factors, soil structure, etc.), and planting time. Accessions with higher plant height can be used for the purpose of breeding fodder type common bean cultivars.

The number of days to form the first flowers varied between 36.8 and 55.6 days (mean = 44.8 ± 9.43) among the accessions (Table 1). The variation was larger in dwarf types (36.8 – 55.6 days) compared to climbing types (37.8 – 54.8 days). The 158th, 96th, and 159th accessions had the longest flowering time (≥ 53 days), while the 26th, 64th, 85th, 30th, 27th, 18th, and 119th accessions had the shortest flowering time (≤ 38.2 days). These results were consistent with the findings from different studies reporting wide variation in flowering times in bean germplasms (Scully & Wallace, 1990; Stoilova et al. 2005; Coelho et al. 2009; Boros et al. 2014, Rana et al. 2015; Caproni et al. 2019; Elkoca et al. 2022; Basavaraja et al. 2023; Kouam et al. 2023; Kul & Yıldırım, 2023; Ikanı et al. 2024). The early flowering observed in some accessions indicates that they are early maturing and these genotypes could be explored in future crossbreedings to develop early maturing varieties. In the study, it was also noticed that none of the plants belonging to the 129th accession flowered. Temperature and precipitation are crucial parameters for flowering (Loko et al. 2018). High temperatures negatively impact flowering and seed sets in some plant species (Porch et al. 2013; Assefa et al. 2019). Seeds belonging to 129 accessions were collected from Trabzon (Turkiye), a province located on the Black Sea coast. Trabzon receives abundant rainfall and has lower temperatures compared to Tekirdağ. The unsuitability of temperature and precipitation for the plant may have prevented the flowering in those plants.

The time from seed sowing to the first pod formation in the plant was calculated in days. It was determined that the pod formation period of accessions varied between 44.6 and 63.8 days (mean = 52.2 ± 9.67) (Table 1). In dwarf-type accessions, the time to the first pod formation varied from 44.8 to 61.6 days (mean = 49.8 ± 8.63 days), while it varied from 44.6 to 63.8 days (mean = 53.7 ± 9.60 days) in climbing types. This means that, compared to dwarf types, the first pods formed later in climbing types. Samples belonging to the 129th accession could not form pods since they did not flower. The accessions that formed pods the latest (≥ 61.2 days) were the 96th, 158th, and 41st accessions, respectively. On the other hand, the accessions that formed pods early (≤ 45 days) were the 16th, 13th, and 18th accessions, respectively.

The study showed that the harvest time varied between 58.6 and 80.6 days (mean = 68.9 ± 11.01 days) among the accessions (Table 1). It was observed that the mean first harvest time was between 58.6 – 79.4 days (mean = 68.8 ± 10.40 days) in dwarf-type accessions, while it was between 59.8 – 80.6 days (mean = 68.9 ± 10.43 days) in climbing types. As seen, both types had quite similar mean in terms of harvest time. Whereas the 4th, 8th, and 9th accessions had the longest first harvest time (≥ 79.6 days), the 105th and 166th accessions had the shortest first harvest time (≤ 58.8 days). It was observed that the obtained data were consistent with the findings of Scully & Wallace (1990), Pekşen & Gülümser (2005), Stoilova et al. (2005) and Coelho et al. (2009). Since it was determined that the 129th accession did not form pods, while 3 accessions (114th, 159th, and 169th) formed pods but did not produce seeds and the pods shed, the data in the study pertain to 150 accessions. This could be due to temperature because high temperatures during flowering can significantly reduce seed set rates in beans. It has been reported that night temperatures above 18 °C may reduce pollen viability in beans and thus prevent seed formation (Porch et al. 2013; Assefa et al. 2019).

The study determined the number of days from planting to harvest for each plant. A total of 150 accessions were harvested, and it was found that the vegetation period of the accessions ranged from 81.4 to 100.2 days (mean = 87.2 ± 9.63) (Table 1). There was no statistically significant difference in this characteristic between climbing beans, whose vegetation period ranged from 82.4 to 100.2 days (mean = 87.8 ± 9.13), and dwarf beans, whose vegetation period ranged from 81.4 to 96.4 days (mean = 86 ± 7.68). The accessions with the longest vegetation period (≥ 99.8 days) were the 53rd, 60th, and 70th accessions, while the accessions with the shortest vegetation period (≤ 81.6 days) were the 145th, 123rd, and 85th accessions. Some previous studies have reported that the time to maturity ranges between 70-133 days (Scully & Wallace 1990), 101-132 days (Boros et al. 2014), and 71-166 days (Rana et al. 2015). The results are consistent with other studies. However, the differences between the results may be due to climatic, environmental, and genetic factors.

It was observed that the number of pods per plant of the accessions ranged from 9.2 to 109 pods plant^{-1} (mean = 32.5 ± 52.21) (Table 1). Climbing beans were found to produce more pods (10.4 – 109 pods plant^{-1}, mean = 36.6 ± 51.07) than dwarf beans (9.2 – 54.8 pods plant^{-1}, mean = 26.9 ± 22.99). The 108th, 137th, and 163rd accessions had the highest number of pods per plant (≥ 89.8 pods plant^{-1}). Those with the least number of pods per plant were the 170th and 161st accessions (≤ 9.4 pods plant^{-1}). Studies by different researchers have generally reported that the number of pods per plant ranges from 4.2 to 105 pods plant^{-1} (Pekşen & Gülümser 2005; Boros et al. 2014; Rana et al. 2015; Basavaraja et al. 2021; Elkoca et al. 2022; Basavaraja et al. 2023; Kouam et al. 2023; Kul & Yıldırım 2023; Ikanı et al. 2024). This supports the results obtained in this current study. There is a highly positive relation between number of pods per plant and yield. Therefore, the accessions with higher number of pods per plant could be useful in increasing the grain yield of common bean.

Randomly 10 pods were taken from each accession, and the seeds were counted and averaged. Based on this, it was calculated that the number of seeds per pod varied between 1.66 and 7.34 seeds pod^{-1} (mean = 3.93 ± 2.86) (Table 1). The number of seeds per pod in climbing beans was found to vary between 1.66 and 6.58 seeds pod^{-1} (mean = 4 ± 2.46), and in dwarf beans, it varied between 1.68 and 7.34 seeds pod^{-1} (mean = 3.8 ± 2.86). As seen, the mean numbers of seeds per pod in climbing and dwarf types were very close to each other. Whereas the number of seeds per pod was the highest (≥6.14 seeds pod^{-1}) in the 138th, 171st, and 67th accessions, it was the lowest (≤ 1.68 seeds per pod) in the 60th and 161st accessions. These results were consistent with the findings of different studies reporting the number of seeds per pod (Pekşen & Gülümser 2005; Boros et al. 2014; Rana et al. 2015; Basavaraja et al. 2021; Elkoca et al. 2022; Basavaraja et al. 2023; Kul & Yıldırım 2023; Ikanı et al. 2024). The number of seeds per pod is another important yield component and therefore it should also be taken into consideration when selecting genetic materials to include in breeding programs related to grain yield.

Hundred-seed weight (100-seed weight) of the accessions were found to vary between 7.64 and 140.25 g (mean = 29.86 ± 71.02) (Table 1). The 100-seed weights of climbing beans ranged from 12.62 to 140.25 g (mean = 31.38 ± 68.91), while those of dwarf beans ranged from 7.64 to 47.91 g (mean = 27.37 ± 20.14). On average, the 100-seed weight of climbing beans was found to be higher than that of dwarf beans. The 100-seed weight of the 60th accession (140.25 g) was remarkably higher than that of the other accessions. The 100-seed weights of the 70th, 137th, and 35th accessions were found to be close to each other (≥ 62.6 g). The accessions with the least hundred-seed weights were the 170th and 123rd accessions (≤11.05 g). In many previous studies, 100-seed weights have been reported to range between 3.5 and 125.3 g (Pekşen & Gülümser 2005; Stoilova et al. 2005; Coelho et al. 2009; Boros et al. 2014; Rana et al. 2015; Basavaraja et al. 2021; Caproni et al. 2019; Basavaraja et al. 2023; Kouam et al. 2023; Kul & Yıldırım 2023; Ikanı et al. 2024). The results obtained are consistent with other studies. The differences may be due to the use of different materials in the studies and differences in climate, soil structure, altitude, planting time, etc.

It was determined that the seed yield per plant ranged between 6.74 and 80.64 g plant^{-1} (mean = 26.72 ± 38.23) among accessions (Table 1). The seed yield per plant ranged between 7.04 and 80.64 g plant^{-1} (mean = 30.15 ± 37.64) in climbing beans, while it ranged between 6.74 and 57.69 g plant^{-1} (mean = 21.4 ± 26.23) in dwarf beans. It was observed that the mean seed yield per plant of climbing beans was higher than that of dwarf beans. In addition, the 108th accession had the highest seed yield per plant (80.64 g plant^{-1}), followed by the 162nd and 103rd accessions (≥63.98 g plant^{-1}). On the other hand, the 170th, 172nd, and 147th accessions had the lowest seed yield per plant (≤8.00 g plant^{-1}). The results were consistent with the findings of Pekşen & Gülümser (2005), Basavaraja et al. (2021), and Elkoca et al. (2022). However, Kul & Yıldırım (2023) reported that the seed yield per plant varied between 49.99 and 217.73 g in their study with dwarf beans collected from Erzurum province. When the results were compared, it was noticed that the yield in the dwarf beans investigated in our study was low. The reason for these differences among all of these studies may be due to both different genotypes and environmental conditions.

The correlation coefficient is the most important multivariate measure for evaluating the relationships between different characteristics (Rana et al. 2015). In the current study, correlation analysis revealed positive correlations between genome size and first flowering time (0.165*), first pod formation (0.166*), and vegetation period (0.175*) (Table 2).

Table 2- The correlation between genome size and morpho-phenological characteristics

	GS	*PH*	*DTF*	*DPF*	*HV*	*VP*	*NPP*	*SPP*	*HSW*
PH	0.101								
DTF	0.165*	0.520**							
DPF	0.166*	0.514**	0.866**						
HV	-0.102	0.037	0.337**	0.490**					
VP	0.175*	0.276**	0.264**	0.361**	0.328**				
NPPP	0.037	0.266**	0.152	0.098	0.095	-0.068			
SPP	-0.047	-0.031	-0.124	-0.007	-0.092	-0.278**	0.093		
HSW	-0.098	-0.003	-0.072	-0.086	-0.015	0.141	0.122	-0.026	
SYPP	-0.123	0.312**	0.011	-0.046	-0.024	-0.088	0.733**	0.181*	0.185*

*: P<0.05, **: P<0.01; GS= genome size, PH= plant height, DTF= days to flowering, DPF=days until pod formation, HV= harvest time, VP= vegetation period, NPP= number of pods per plant, SPP= seeds per pod, HSW= hundred -seed weight, SYPP= seed yield per plant

There is a positive relationship between genome size and cell cycle duration (Baetcke et al. 1967; Bennett et al. 1983). In plants with large genome sizes, the growth period increases, and the plant's lifespan exceeds since the vegetation period lengthens (Rayburn et al. 1994; Zhang & Zhang 2021). Those with smaller genome sizes tend to reproduce earlier because they grow faster (Knight et al. 2005). For these reasons, these studies support that as the genome size increases, first flowering, first pod formation, and vegetation period also increase. The obtained data are also consistent with studies investigating the relationship between genome size, vegetation period, and flowering (Knight et al. 2005; Beaulieu et al. 2007; Tenaillon et al. 2016; Bilinski et al.

2018; Comertpay 2019). However, flowering does not depend only on genetic structure. Flowering time reflects a plant's adaptation to the environment by organizing its different growth stages according to the local climate, and it can also vary depending on the plant's ecological niche. For example, studies focusing on geophytes and invasive species have found a negative relationship between genome size and first flowering (Vesely et al. 2012; Fridley et al. 2015). Additionally, some species that flower in early spring can exhibit rapid growth and development despite having unusually large genomes (Bennett & Leitch, 2005). In this current study, no statistically significant relationship was found between genome size and 100-seed weight. Similar to our study, previous studies have also found no relationship between genome size and seed weight or 100-seed weight (Vesely et al. 2012). On the other hand, Beaulieu et al. (2008) reported a strong positive correlation between genome size and seed weight. In studies, numerous physiological or ecological correlations have been found between genome size and relevant phenotypes. In a study conducted with these accessions, a positive correlation between genome size and altitude was found (Savaş Tuna et al. 2020). Therefore, it can be said that some plant characteristics are also affected by altitude.

As shown in Table 2, there is a positive correlation between plant height and first flowering time (0.520), first pod formation (0.514**), vegetation period (0.276**), number of pods per plant (0.266**), and seed yield per plant (0.312**). As plant height increases, plants flower and form pods later, and have a longer vegetation period. In addition, the number of pods per plant and seed yield per plant also increased. These results are supported by other studies. For example, Kouam et al. (2023) reported a positive correlation between plant height and seed number per pod and seed yield of plants, while Basavaraja et al. (2021) and Ketema and Geleta (2022) found a positive correlation between plant height and number of pods per plant and number of seeds per pod.

First flowering time is positively correlated with pod formation date (0.866**), first harvest time (0.337**), and vegetation period (0.264**). The pod formation times, harvest times, and vegetation periods of early-flowering accessions are shorter than other accessions. Studies have shown that flowering time is negatively correlated with seed yield per plant (Kamfwa et al. 2015), seed number per plant (Loko et al. 2018), number of pods per plant, number of seeds per pod (Elkoca et al. 2022), and 100-seed weight (Basavaraja et al. 2023). Kouam et al. (2023) found a positive correlation between flowering time and pod number and seed yield. Flowering time is an important determinant of dry matter production and seed yield (Jung & Muller 2009). In addition, since early flowering may also increase the number of harvests, flowering time is one of the important factors affecting yield.

Correlation analysis revealed positive correlations between pod formation date and first harvest time (0.490**), pod formation date and vegetation period (0.361**), and first harvest time and vegetation period (0.328**). The analysis also showed positive correlations between the number of pods per plant and seed yield per plant (0.733**), the number of seeds per pod and seed yield per plant (0.181*), and 100-seed weight and seed yield per plant (0.185*). Previous studies have also reported similar positive correlations between 100-seed weight and seed yield (Basavaraja et al. 2023) and the number of seeds per pod (Basavaraja et al. 2021; Ketema & Geleta 2022). Additionally, it has been found that there is a positive correlation between seed yield per plant and the number of pods per plant, between number of seeds per pod and 100-seed weight, and also between the number of pods per plant and number of seeds per pod (Basavaraja et al. 2021). In another study, a positive correlation was determined between 100- seed weight and the number of pods per plant (Ikani et al. 2024). Similar findings have also been observed in studies carried out by other researchers (Asati & Sing 2008; Pandey et al. 2013). Information on correlations between characteristics is very important in initiating a breeding program. This information provides an opportunity for the simultaneous selection of genotypes with the desired characteristics. Especially in studies conducted to increase yield, the relationships between characteristics such as seed yield per plant, 100-seed weight, number of pods per plant, and number of seeds per pod will be helpful. In studies conducted with beans, seed yield has been the most heritable and genetically advanced quantitative characteristic, followed by 100-seed weight, pod length, and number of pods per plant (Basavaraja et al. 2023).

In the study, a negative correlation was found between the vegetation period and the number of seeds per pod (-0.278**). Similarly, negative correlations were also found between the number of pods per plant and flowering time, 100-seed weight and flowering time and the number of seeds per pod (Ikani et al. 2024). The characteristics such as the number of seeds per pod, the number of pods per plant, and 100-seed weight are among the important yield components and affect plant yield directly. Therefore, longer vegetation periods or flowering times that negatively affect these features may cause low yield. The results obtained in the current study are in agreement with the previous findings of Rayburn et al. (1994) and Ikani et al. (2024). It is also well known that environmental factors such as temperature, precipitation, photoperiod, altitude, and soil structure. also affect the performance of plants in addition to the genetic structure of the plant.

4. Conclusions

In this study, the relationship between the genome sizes and some agro-morphological characteristics of the common bean genetic resource collection (154 accessions) under Tekirdağ-Turkey conditions was investigated, and it was determined that there is a positive correlation between the genome sizes of accessions, flowering time, first pod formation, and vegetation times. Additionally, it was seen that genetic resource collection of the common bean had a wide variation in terms of genome size and agro-morphological characteristics. Based on the results obtained in the study, when accessions are compared by taking into account some characteristics (seed yield per plant, 100-seed weight, number of pods per plant, number of seeds in pods, etc.), it can be suggested that the 108th, 137th, 162nd, and 163rd accessions can be grown to consume fresh while the 137th, 35th, 66th, and

21st accessions can be grown to consume dry in the Tekirdağ conditions. Although the 60th and 70th accessions had high 100-seed weights, they are not recommended because their seed yield and pod number were well below average and these plants were affected by heat. The results of this study may assist common bean breeders in selecting suitable accessions for their breeding programs based on their goals.

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