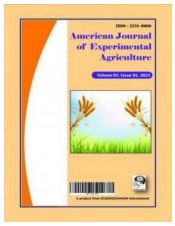

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The Determination of Some Agronomic Properties of Lines Selected among Domestic Dry Bean Populations Collected from Kelkit Valley and Artvin Province

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Authors' contributions

This work was carried out in collaboration between both authors. Author OS designed the study, wrote the protocol and wrote the first draft of the manuscript. Author HB reviewed the experimental design and all drafts of the manuscript. Author HB managed the analyses of the study. Author OS identified the plants. Authors HB performed the statistical analysis. Both authors read and approved the final manuscript.

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ABSTRACT

This study has been conducted to compare some agronomic properties of 23 bean lines selected among domestic dry bean populations collected from Kelkit Valley and Artvin province with the standard varieties. Domestic dry bean lines (23 number) and dry bean varieties (Zülbiye, Akdag, Goynuk 98, Sahin 90, Karacaşehir 90 and Onceler) have been used in the analysis. Trial has been established by sowing plants in 5 m rows with 70 cm gaps in augmented trial pattern on Samsun ecological conditions on 18.05.2011. Plant height, pods per plant, 100 seeds weight, seeds per plant and yield per plant have been determined. Variance analyses according to augmented pattern

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have been conducted on the collected data and group means were tested for significant ($p<0.05$) differences. Analysis has been determined that line K.1128 had the greatest plant height and 100 seeds weight with 106 cm and 48.62 g respectively where line A.26 had the greatest pods and seeds per plant with 68.66 and 261 respectively. Line K.1032 had the greatest yield per plant with 73.01 g. As a result, lines A.26, A.27 and A.341 among the dwarf lines and lines K.1012, K.1032 and K.1128 among the semi-dwarf lines have been chosen to be included in the yield trials.

Keywords: Dry bean; line; variety; agronomic properties; diversity.

1. INTRODUCTION

As legumes, beans are cultivated in almost all regions of Turkey to be used as dry and fresh beans; and thanks to its rich protein (18-35%), carbohydrate (56%) and vitamin content bean is a significant agricultural product [1]. Throughout the world, legumes ensure 22% of vegetable protein, and 7% of carbohydrates in the human diet, and 38% of proteins and 5% of carbohydrates in the animal diet [2]. Dry bean rank first among the legumes throughout the world with 29.2 million hectares of cultivated area, and 23.2 million tons of production; however, it ranks third in Turkey after chickpeas and lentils with 94.625 thousand hectares of cultivated area and 200.673 thousand tons of production [3]. In terms of yield average, its worldwide value is 810 kg ha^{-1}, while this value has reached 2.060 kg ha^{-1} in Turkey with the variety performance developed in recent years [4]. Even if the field cultivated area of dry bean, which is one of the significantly cultivated legumes and products of Turkey, changes from one year to another, it is one of the indispensable products due to its agricultural benefits and as it is one of the traditional agricultural products of cultivators in the Black Sea and Middle Anatolia Region. Studies on this plant will make great contributions to the cultivators by increasing the unit area profitability, in addition to ensuring great changes in cultivated areas by focusing on developing more healthy and delicious varieties with better quality, and on defining appropriate cultivation methods, especially considering the consumer demands [5]. In certain regions of Turkey, due to geographical reasons, trade is more likely to be traditional carried out for the needs of the family or to be sold in domestic bazaars, where input is limited and varieties are local. These areas are treasures offering domestic materials that until today have been produced through natural selection without losing flavor and are suitable for our taste. Breeders require such domestic populations more frequently in the studies to develop new varieties or to enrich the current varieties with certain characteristics, in consideration of consumer demands. The use of these materials in development studies without causing extinction due to several negative effects is very important in terms of agricultural sustainability.

Artvin province, one of the locations of the current study, is located on the far east of the Black Sea Region, neighboring Georgia, and the gate for eastern cities to the Black Sea. The total cultivated area of Artvin is 64.200 hectares, while 20.64% of this area can be irrigated. Six hundred and fifty hectares of cultivated area is spared for beans, and the legume bean has 1000 tons of production value; 40% of the bean cultivated area is in the Yusufeli district, while 21% of the cultivated area for beans is in the Ardanuc district [3].

Kelkit Valley, another dry bean production center, is the region formed by the Kelkit Creek, encompassing the cities Erzincan, Giresun, Gumushane, Sivas and Teat. Dry bean, one of the field crops cultivated in the soil of this region, are essential for the cultivators in the region. Bean is cultivated over a 6.400 hectare area in the Kelkit Valley; Sivas ranks first in cultivation with a 2.000 hectare area, and Gumushane ranks second after Sivas with 1.900 hectare cultivated area. The objective of the study was to define the agronomic characteristics by comparing the dwarf and semi-dwarf elliptic type lines selected via the pure line selection method among the dry bean genotypes collected from Artvin province and Kelkit Valley, where dry bean has genetic variability, locality still has an effect, and where the soil is rich in terms of elliptic populations, to the standard dry bean varieties.

2. MATERIALS AND METHODS

The material of this study included 23 dry bean lines (13 dwarf and 10 semi-dwarf) selected using selection method for three years among 128 elliptic seed type collected from their cultivated areas and characterized within the scope of TUBITAK projects called "*Collecting of Domestic Dry Bean Populations Aid to Artvin*

province, Characterization And Determination of Their Some Yield And Quality Traits (2005-2006)" and "*Collection of Domestic Bean (Phaseolus vulgaris* L.*) Populations in Kelkit Valley, Characterization And determination of Their Morphological And Agronomic Variations* (2008-2009)", and the Zülbiye, Akdag, Goynuk 98, Sahin 90, Karacasehir 90 and Onceler dry bean varieties to make a comparison to the previously mentioned 23 bean lines (Table 1).

Table 1. Certain characteristics of line/varieties included in the study

Line/Variety name	Characteristics	Line/variety name	Characteristics
A.13	Collected from Artvin province, Central district, Ortakoy village; pinto bean seed color; dwarf type form	K.1039	Collected from Gumushane province, Siran district, Kavakpınarı village; white seed color; semi-dwarf form.
A.14	Collected from Artvin province, Ardanuc district, Gumushane village; pinto bean seed color; dwarf type form	K.1044	Collected from Gumushane province, Siran district, Selimiye village; white seed color; semi-dwarf form.
A.20	Collected from Artvin province, Yusufeli district, Serinsu village; white seed color; dwarf type form	K.1046	Collected from Gumushane province, Siran district, Yesilbuk village; white seed color; semi-dwarf form.
A.26	Collected from Artvin province, Ardanuc district, Torbalı village; white seed color; dwarf type form	K.1047	Collected from Gumushane province, Siran district, Yesilbuk village; white seed color; semi-dwarf form.
A.27	Collected from Artvin province, Ardanuc district, Peynirli village; white seed color; dwarf type form	K.1121	Collected from Tokat province, Niksar district, Sorgun village; white seed color; semi-dwarf form.
A.40	Collected from Artvin province, Ardanuc district, Gumushane village; pinto bean seed color; dwarf type form	K.1128	Collected from Tokat province, Niksar district, Sorgun village; white seed color; semi-dwarf form.
A.107	Collected from Artvin province, Yusufeli district, Narlık town; pinto bean seed color; dwarf type form	K.1133	Collected from Tokat province, Niksar district, Isıklar village; white seed color; dwarf form.
A.341	Collected from Artvin province, Yusufeli district, Kılıckaya village; white seed color; dwarf type form	K.1154	Collected from Tokat province, Niksar district, Boyluca village; white seed color; semi-dwarf form.
A.349	Collected from Artvin province, Yusufeli district, Celtikduzu village; white seed color; dwarf type form	Karacasehir 90	Plant length 55-65 cm; white seed color; plump bean shaped; semi-dwarf type form.
A.367	Collected from Artvin province, Central district, berta village; pinto bean seed color; dwarf type form	Zulbiye	Plant length 40-50 cm; white seed color; navy bean shaped; dwarf type form.
A.378	Collected from Artvin province, Savsat district, Tepekoy village; pinto bean seed color; dwarf type form.	Sahin 90	Plant length 45-55 cm; white seed color; navy bean shaped; dwarf type form.

Line/Variety name	Characteristics	Line/variety name	Characteristics
K.1012	Collected from Gumushane province, Kelkit district, Gerdeksaray village; white seed color; semi-dwarf type form.	Goynuk 98	Plant length 40-50 cm; white seed color; navy bean shaped; dwarf type form.
K.1032	Collected from Gumushane province, Siran district, Yukarıkulaca village; white seed color; semi-dwarf form.	Akdag	Plant length 40-50 cm; white seed color; navy bean shaped; dwarf type form.
K.1033	Collected from Gumushane province, Siran district, Kozagac village; white seed color; semi-dwarf form.	Onceler	Plant length 40-50 cm; mottled pinto bean seed color; plump bean shaped; dwarf type form.
K.1036	Collected from Gumushane province, Siran district, Aksaray village; white seed color; semi-dwarf form.		

Table 2. Rainfall, temperature and humidity in 2011 and long term years (1974-2010) in Samsun climatic conditions

Months	Years	Mean temperature (℃)	Mean relative humidity (%)	Total rainfall (mm)
May	2011	15	84,1	66,1
	Long years	15,4	79,4	51,1
June	2011	20,6	76,9	49,6
	Long years	20,3	77,1	48
July	2011	24,3	77,9	26
	Long years	23,3	76,7	31,8
August	2011	23,4	74,4	14,2
	Long years	23,5	74,6	36,7
September	2011	19,8	77,3	39,1
	Long years	20	76,9	52,9

**Data were taken from Samsun Regional Meteorological Service (Anonymous, 2011)*

The trial was established at the Ambarkopru trial station (elevation 4 m) at the 17th kilometer of the Samsun-Ordu Highway, affiliated with the Directorate of Black Sea Agricultural Research Institute. It was determined that the soil of the Ambarkopru trial station is argillaceous loamy, pH is neutral, content of organic substances is low, lime is adequate, and phosphorus level is high. Meteorological values of the Samsun-Ambarkopru trial station for 2011 are given in Table 2 together with the averages covering long years. Climate-related data were provided from the Samsun-Carsamba Airport Meteorology Station (Table 2).

According to Table 2, no significant difference can be observed between the averages covering long years and temperature; however, the mean relative humidity value of May 2011 (79.4%) is observed to be greater than the relative humidity value of May covering long years.

Twenty-three elliptic seed type lines (13 dwarf and 10 semi-dwarf), and six standard varieties (one semi-dwarf) were cultivated on May 19, 2011, using an augmented test pattern. Five meters in length and seventy cm in width were ensured between lines during cultivation of each line at the number defined in 2010 according to the number of single plants.

Plants were cultivated in each of the 20 lines covering each growth group of each 6 varieties, together with the single plants. In the test, 26% of CAN fertilizer was used to ensure 5 kg of pure nitrogen per decare. To combat wild weeds, an herbicide with the effect of Linuron was used; and the cultivated areas were hoed three times, first of which occurred three-four weeks after the plants' first emergence from the soil. The cultivated area was irrigated five times using the drip irrigation method in order to meet the water need. The plants were harvested when ripe, and

were selected and marked before flowering and maturation. Plant height (cm), number of pods plant^{-1}, number of seeds^{-1}, 100 seeds weight (g) and seed yield per plant (g plant^{-1}) were analyzed based on 10 plants for each line and variety covered by the study. The data of the agronomic characteristics were examined by variance analysis according to the augmented test pattern; the grouping of averages for each characteristic was tested with $P<0.05$ probability.

3. RESULTS AND DISCUSSION

3.1 Plant Height

The average plant height values of the 23 lines selected via selection method before 2011 and 6 varieties are given in Table 3. The variance analysis revealed a significant ($P<0.01$) statistical difference between lines and varieties in terms of plant height. According to Table 3, the plant height of line K.1128 collected from the Tokat province, Niksar district, Sorgun village, ranked first with 106.00 cm; while line A.367 collected from the Artvin province, Central district, Berta village was included in the shortest plant height group with 35.50 cm. Furthermore, plant height average was observed to be 60.10 cm.

[6] stated that dry bean plant height was controlled by the genetic structure. In the study carried out [7] under ecological conditions, it was stated that the plant height may change from 17.67 cm to 49.71 cm. On the other hand, in another study carried out to determine the agricultural characteristics of commercial varieties developed through the selection method under the ecological conditions of Yozgat, plant height was determined to be between 25.44 and 68.89 cm [8].

Karacasehir 90 is a semi-dwarf variety included in the control varieties, the plant height of which was determined to be 78.25 cm. Within the lines, K.1012, K.1032, K.1033, K.1036, K.1039, K.1044, K.1046, K.1047, K.1121 and K.1128 were included in the same statistical group. In another study carried out with the same semi-dwarf types included in this study, a positive and very significant relationship was found through correlation analysis [9]. According to this finding, seed yield was increased in line with increasing plant height. Hence, lines no. K.1128, K.1046, K.1047 and K.1033, both of which surpass the Karacasehir 90 variety, and show a statistical difference, were determined to be interesting. Dwarf types do not develop raceme and leech at the node tip of the plant body. According to the analyses of the dwarf types, a positive and very significant relationship between plant height and yield was determined; however, according to the result of the path analysis, the plant height was determined to have a lower effect on the yield, compared to the other characteristics [9]. Zülbiye, one of the five dwarf control variety used in variance analysis, had the greatest plant height value; however, all the varieties were presented to be included in the same group.

3.2 Number of Pods in Plant

According to the variance analysis on the number of pods in plant, one of the significant yield criteria, a significant ($P<0.05$) difference was determined between lines and varieties, and average values and groups are given in Table 4. The number of pods in the plants selected through the selection method was determined to be between 12.85 and 68.66. Line A.107, selected through selection method, and collected from the Artvin province, Yusufeli district, Narlık town, had the lowest number of pods (12.85), while line A.26, with dwarf characteristics and collected from the Artvin province, Ardanuc district, Torbalı village ranks first in terms of the number of pods in plant (68.66). Furthermore, the average number of pods in the plants was determined to be 28.56 for these line and varieties.

In the study carried out [10] between 1990 and 1998 to determine the agronomic characteristics and yield potentials of certain dry bean lines, the number of pods in plants was determined to be between 10.18 and 16.07. In another study carried out to determine certain yield and yield factors in Erzincan and Erzurum (Hınıs), the number of pods in plants was determined to be between 15.8 and 45.7 [11]. The average number of pods was observed to be 35.92 in control varieties; the Onceler variety was determined to have the highest number of pods in plant with 47.55 number of pods, while line A.26 surpassed all control varieties and revealed a statistical difference as well. Goynuk 98 had the lowest value of the control varieties (27.7), and fifteen of the lines were statistically lower than this value.

Table 3. Plant height values and statistical groups of the varieties included in the trial

Number	Line/ varieties	Plant height (cm)	Number	Line/ varieties	Plant height (cm)	Number	Line/ varieties	Plant height (cm)
1	K.1128	106.00 a	11	K.1039	71.00 e	21	**Goynuk 98**	46.32 f-i
2	K.1046	104.25 ab	12	**Zulbiye**	54.08 f	22	A.349	45.20 f-i
3	K.1047	93.25 bc	13	A.27	51.66 fg	23	K.1133	43.27 f-i
4	K.1033	87.50 cd	14	**Onceler**	51.62 fg	24	A.378	42.94 f-i
5	K.1012	87.25 cd	15	A.26	48.50 fgh	25	A.20	40.42 ghi
6	K.1036	81.00 cde	16	A.40	48.45 fgh	26	A.14	40.16 ghi
7	**Karacasehir 90**	78.25 de	17	**Akdag**	47.75 f-i	27	K.1154	39.68 hi
8	K.1032	77.50 de	18	**Sahin 90**	46.75 f-i	28	A.107	36.14 i
9	K.1121	74.00 e	19	A.13	46.57 f-i	29	A.367	35.50 i
10	K.1044	71.53 e	20	A.341	46.38 f-i			
Mean					**60.10**			
Lsd (5%)					**12.26**			

Table 4. Values of the number of pods and statistical groups of the varieties included in the trial

Number	Line/ varieties	Number of pods in plant	Number	Line/ varieties	Number of pods in plant	Number	Line/ varieties	Number of pods in plant
1	A.26	68.66 a	11	K.1044	31.04 c-j	21	A.349	21.20 j-n
2	**Onceler**	47.55 b	12	K.1012	30.75 c-j	22	A.13	19.85 j-n
3	K.1032	45.50 b	13	**Sahin 90**	27.80 d-k	23	A.378	19.47 j-n
4	**Karacasehir 90**	41.27 bc	14	**Goynuk 98**	27.70 d-k	24	A.40	18.18 k-n
5	K.1047	37.00 bcd	15	K.1133	26.30 d-l	25	K.1154	18.13 k-n
6	**Zulbiye**	36.32 b-f	16	K.1039	25.01 f-m	26	K.1036	17.00 k-n
7	**Akdag**	34.90 c-g	17	K.1121	23.70 g-n	27	A.14	14.83 lmn
8	A.341	34.11 c-h	18	K.1128	23.50 g-n	28	A.367	14.16 mn
9	K.1046	33.50 c-i	19	A.20	23.01 h-n	29	A.107	12.85 n
10	A.27	33.00 c-i	20	K.1033	21.83 i-n			
Mean					**28.56**			
Lsd (5%)					**11.72**			

3.3 Number of Seeds per Plant

According to the studies, the number of seeds is the most important characteristic that affects yield. In the current study, according to the variance analysis in terms of the number of seed in plant, a significant ($P<0.01$) statistical difference was determined between line and varieties. Values reflecting the number of seeds in the plants were determined to be between 47.42 and 261.00 (Table 5).

In the study carried out [12] to determine the agronomic and quality characteristics of certain bean types under the ecological conditions of the Middle Anatolian region, the number of seeds in plant was determined to be between 30.00 and 138.45. Line A.107, collected and selected from the Artvin province, had the lowest value in terms of the number of seeds in the plant (47.42), similar to the number of pods in plant, while line A.26 had the highest value in terms of the number of seed (261.00), similar to the number of pods in plant. Furthermore, the average number of seeds in plant was determined to be 86.24 for these varieties.

In the analysis in terms of varieties, Sahin 90 was determined to have the lowest number of seed (70.48), while Karacasehir 90 ranked first with 161.12 number of seeds. Upon the comparison of those 23 lines included in the test to the control varieties in terms of the number of seeds in plant, dwarf type A.26 and semi-dwarf type K.1032 were determined to surpass all varieties.

3.4 100 Seeds Weight

According to the results of variance analysis in terms of 100 seeds weight, a significant ($P<0.01$) difference was observed between line and varieties. The 100 seeds weight of the line and varieties was determined to be between 18.49 and 48.62 g (Table 6). In their study carried out under the conditions of Konya, [13] determined 100 seeds weight to be 40.33 g, while the same weight was found to be between 17.33 and 46.33 g in the study carried out under the ecological conditions of Karaman [14].

Line A.26, collected from the Artvin province, Ardanuc district, Torbalı village, and selected using the selection method, ranked last in terms of 100 seeds weight (18.49 g) among all varieties. On the other hand, line K.1128, collected from the Tokat province, Niksar district, Sorgun village and selected using the selection method, ranked first with 48.62 g. In the analysis conducted in terms of 100 seed weight, the average 100 seeds weight of the line and varieties was determined to be 40.2 g.

According to the evaluation in terms of the varieties, the Karacasehir 90 variety ranked last in 100 seeds weight (22.40 g), while the Zulbiye variety ranked first (45.85 g). According to the results of the comparison between those 23 lines and control varieties in terms of 100 seeds weights, semi-dwarf lines K.1012 and K.1128 were determined to surpass all the varieties. Line K.1012 was determined to be included in the same statistical group with Zülbiye, which had the highest value in terms of 100 seeds weight. In the study carried out [15], under the ecological conditions of Tokat, to determine yield and yield components of populations, lines, and varieties having different characteristics, 100 seeds weight was determined to be between 13.50 and 19.01 g (Table 6).

3.5 Seed Yield per Plant

The values reflecting the seed yield per plant for 23 lines and 6 number standard varieties selected through the selection method are given in Table 7. No significant statistical difference was detected among those 23 lines and varieties in terms of seed yield. According to Table 7, line A.14 ranked last among all lines and varieties (17.57 g) in terms of seed yield. On the other hand, line K.1032 ranked first with 73.01 g. In terms of average seed yield in semi-dwarf plants, semi-dwarf line K.1032 was determined to surpass the seed yield values of all varieties. In the study carried out [16] under the ecological conditions of Samsun, six bean genotypes were used (four bean varieties and two populations), and seed yield per plant was determined to be between 4.56 and 14.90 g, according to the two-year average. Based on the results of the varieties, Sahin 90 variety ranked last (26.85 g) in terms of seed yield, while the Onceler variety ranked first with 50.12 g. The semi-dwarf line K.1032 was determined to be the only line to surpass all varieties in terms of seed yield average (Table 7).

Table 5. Values of the number of seeds and statistical groups of the varieties included in the trial

Number	Line/ varieties	Number of seeds per plant	Number	Line/ varieties	Number of seeds per plant	Number	Line/ varieties	Number of seeds per plant
1	A.26	261.00 a	11	K.1047	79.00 d	21	A.349	61.40 d
2	K.1032	168.50 b	12	**Akdag**	77.93 d	22	A.378	59.41 d
3	**Karacasehir 90**	161.12 b	13	K.1046	76.50 d	23	K.1039	59.00 d
4	A.27	144.33 b	14	A.20	74.57 d	24	A.367	58.50 d
5	**Onceler**	134.25 bc	15	K.1121	74.10 d	25	A.13	51.42 d
6	A.341	89.22 cd	16	K.1128	71.00 d	26	K.1033	50.00 d
7	K.1044	88.28 cd	17	**Sahin 90**	70.48 d	27	A.14	48.50 d
8	K.1012	87.50 cd	18	A.40	67.18 d	28	K.1036	48.00 d
9	**Zulbiye**	85.30 cd	19	K.1133	62.60 d	29	A.107	47.42 d
10	**Goynuk 98**	81.95 cd	20	K.1154	62.54 d			
Mean					**86.24**			
Lsd (5%)					**54.72**			

Table 6. Values of 100 seeds weight and statistical groups of the varieties included in the trial

Number	Line/ Varieties	100 seed weight (g)	Number	Line/ varieties	100 Seed weight (g)	Number	S	100 seed weight (g)
1	K.1128	48.62 a	11	**Goynuk 98**	43.94 b-e	21	**Sahin 90**	39.40 f-i
2	K.1012	46.24 ab	12	K.1032	43.31 b-f	22	K.1121	38.68 ghi
3	**Zulbiye**	45.85 ab	13	K.1033	42.60 b-g	23	**Onceler**	38.00 hi
4	A.378	45.32 ab	14	K.1044	42.19 b-g	24	A.367	37.46 h-j
5	A.40	44.94 abc	15	K.1039	40.93 c-h	25	A.349	37.21 h-j
6	K.1133	44.32 bcd	16	A.20	40.90 c-h	26	A.14	36.47 ij
7	**Akdag**	44.22 bcd	17	K.1154	40.24 d-i	27	A.27	32.84 j
8	A.13	44.22 bcd	18	K.1036	39.87 e-i	28	**Karacasehir90**	22.40 k
9	K.1046	44.03 bcd	19	A.107	39.79 f-i	29	A.26	18.49 k
10	K.1047	44.00 b-e	20	A.341	39.54 f-i			
Mean					**40.20**			
Lsd (5%)					**4.13**			

Table 7. Values of seed yield per plant of the varieties included in the trial

Number	Line/ Varieties	Seed yield per plant (g)	Number	Line/ Varieties	Seed yield per plant (g)	Number	Line/ Varieties	Seed yield per plant (g)
1	K.1032	73.01	11	K.1128	34.84	21	K.1154	25.21
2	**Onceler**	50.12	12	A.341	34.61	22	K.1039	24.05
3	A.26	48.57	13	K.1047	34.54	23	A.349	22.86
4	A.27	44.84	14	K.1046	33.86	24	A.13	22.80
5	K.1012	40.38	15	A.40	30.32	25	A.367	22.03
6	**Zulbiye**	39.45	16	A.20	29.52	26	K.1033	21.26
7	**Akdag**	38.83	17	K.1121	28.54	27	K.1036	19.14
8	**Goynuk 98**	37.12	18	K.1133	27.67	28	A.107	18.96
9	K.1044	36.92	19	**Sahin 90**	26.85	29	A.14	17.57
10	**Karacasehir 90**	36.20	20	A.378	26.81			
Mean					**32.65**			
Lsd (5%)					**----------**			

4. CONCLUSION

The data on the characteristics analyzed in this study, carried out in 2011 in order to compare the agronomic characteristics of the lines selected from domestic dry bean populations in Artvin province and Kelkit Valley and to determine the lines to be included in preliminary yield trials in 2012, were used to define the lines surpassing control varieties in 5 characteristics. The lines marked for at least three characteristics were determined to be included in the preliminary yield trials in 2012.

Dwarf lines A.26 (Ardanuc/Artvin), A.27 (Ardanuc/Artvin) and A.341 (Yusufeli/Artvin); semi-dwarf lines K.1012 (Kelkit/Gumushane) and K.1032 (Siran/Gumushane) were determined to be appropriate for preliminary yield trials in the selection studies in 2012.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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