Research Article

Ekin
Journal of Crop Breeding and Genetics

11(2):53-59, 2025

www.ekinjournal.com

Ekin International biannual peer-reviewed journal

Characterization of Turkish Edible Pea (*Pisum sativum* L.) Gene Resources and Their Utilisation in Breeding Programs

Dürdane MART

Eastern Mediterranean Agricultural Research Institute, Adana-Türkiye

* Corresponding author e-mail: durdanemart@yahoo.com

Citation:
Mart D., 2025. Characterization of Turkish Edible Pea (*Pisum sativum* L.) Gene Resources and Their Utilisation in Breeding Programs. Ekin J. 11(2):53-59.

Received: 26.02.2025 ***Accepted: 25.06.2025*** ***Published Online: 31.07.2025*** ***Printed: 31.07.2025***

ABSTRACT

Total 70 different genotypes sourced from local edible pea (*Pisum sativum* L.) populations were obtained from the Izmir gene bank and sown in the Eastern Mediterranean Agricultural Research Institute to morphologically characterize the genotypes. This trial was conducted in 2013. Morphological characterization studies were carried out according to the identification list published by IPGRI for peas and the UPOV feature document for peas. The characteristics of the pea plants and their seeds were examined and the differences between these characteristics were determined. It was aimed to determine the vegetative characteristics of the related pea populations, to assist selections of pre-breeding material and start breeding studies for cultivar development.

Plant height, first pod height, number of main branches and number of pods per plant of the examined pea populations were 32-135 cm; 17-85 cm; 1-4; 1-26, respectively. The number of full pods per plant, pod length, number of grains per plant, grain weight per plant and plot yields values were varied between 1-30; 3-9 cm; 2-118; 1-83 g and 50-434 kg/9 m^2, respectively. It was determined that the number of pods, number of full pods, number of grains, plant straw weight and plant grain weight were effective on the first main component. Seed color, pod length, seed color, hilum color and plot yield were found to be effective on the second main component. In the third main component, the effect of plant height and first pod height characteristics was determined. It was concluded that there are promising genotypes in terms of breeding, and selection work should be continued in these genotypes.

Keywords: Pea, genetic resources, morphological characterization

Introduction

Pea (*Pisum sativum* L.) is an important legume vegetable crop which is an essential component of human nutrition (Sapre et al., 2022). Due to the high protein content (23-33%), there is an interest in growing this crop as a source of protein for humans and animals (Renata et al., 2021). There has been an increasing demand for diverse and more functional plant-based protein ingredients for food uses (Shen & Li, 2021). Pea proteins are emerging as a popular alternative to those conventional (deriving from animal and soy) due to their high protein content with interesting functionality, sustainability, availability and affordability (Boukid et al., 2021). Among the legume family, peanuts and soybeans are considered as commonly allergenic and regulations in many countries require special labeling and manufacturing control measures for foods containing peanuts or soybeans or ingredients derived from those two legumes. Peas are also legumes but are not on the lists of priority allergenic foods, so special labeling and manufacturing control measures are not needed for peas or pea-based ingredients. Peas contain comparatively high levels of protein (Taylor et al., 2021).

Pea as a cool-season legume crop grown in more than 85 countries, is the second most important grain legume and one of the major green vegetables in the world. While pea was historically studied as the genetic model leading to the discovery of the laws of

genetics, pea research has lagged behind that of other major legumes in the genomics era, due to its large and complex genome. The evolving climate change and growing population have posed grand challenges to the objective of feeding the world, making it essential to invest research efforts to develop breeding tools to support fast and continuous development of improved pea varieties (Pandey et al., 2021).

Climate change shifts abiotic (high temperature stress, cold stress, frost, wind, drought) and biotic (pathogens, pests) stress factors, and threats agricultural productivity around the world (Shahzad et al., 2015). As biotic stresses, fungal diseases of rust, powdery mildew, root rots, common root rot, wilt and ascochyta blight are the widespread and severe for the pea crop at different growth stages. Among abiotic stresses, heat, drought and frost are frequent which reduce quantity and quality of the product. Genetic improvement for these traits is important and needed. Conventional and molecular breeding approaches may accelerate breeding programmes for improvements (Parihar et al., 2020).

In past, some local and international studies on local pea gene resources in Türkiye, which is very rich in pea gene resources, have been carried out. Continuous examination of these sources with new researches is highly important whose diversity is increasing every year in terms of agronomic and quality characteristics, with the target of utilizing them in breeding programs. There are 34 species of legumes and 7.443 samples in the Aegean Agricultural Research Institute National Gene Bank (Tan, 2010). Conservation and sustainable use of these genetic resources, to ensure production is necessary to reduce the effect of climate change. The loss of these resources will also pose a threat to global food security in the long term (Ferranti, 2016).

In this study, it was aimed to determine the morphological characteristics of these pea populations as pre-breeding materials before starting a breeding study for cultivar development.

Materials and Methods

Total 70 different genotypes sourced from local edible pea (*Pisum sativum* L.) populations were obtained from the Izmir gene bank (Table 1).

Genotypes were sown in the Eastern Mediterranean Agricultural Research Institute (Adana, Türkiye), under typical Mediterranean climatic conditions to morphologically characterize the genotypes. Sowing date was 8th December of 2012. Genotypes were randomly distributed in the plots where plots were including 4 rows each was at 5m length with 0,45 m interrow distance. Sowing was conducted on flat soil (no ridge) and fertilized with 25 kg N ha + 55 kg P_2O_5 in pure form which spread to plots as in DAP (18.46.0) form at pre-sowing stage. No pesticides were applied for pest and weed control. Weed control was done once by hand for weed control. Harvest date was 6th of July 2013. From each plot of 70 different populations, three plants representing the populations were selected and their characteristics were examined. Each parcel was harvested bulk for yield evaluations.

IBGRI (Anonymous, 1993) and UPOV (Anonymous, 2003) identification lists were used for characterization. Morphological characterization of plants during post-emergence stage was carried out according to the identification criteria determined by the International Plant Identification Center (IBGRI). To provide details on different form groups, the samples cropped in augmented design and the observed characters' data was analyzed by using Major Component Analysis (MCA), one of a multivariate analyzes (Tan, 1983), and the differences between the plant quantitative and qualitative characteristics were determined.

Results and Discussion

In terms of qualitative characteristics, the majority of the populations were in white seed color, round seed shape, yellow grain color and colorless hilum color class (Table 2).

In the analysis of sown seed characteristics, it was determined that the pea populations were round (54%), wrinkled (16%) and cornered (3%) in shape. It was observed that the harvested grain color was white (36%), green (24%), brown (23%), black (11%), yellow (3%) and brown-white (3%).

The grain color of the genotypes after sowing was determined to be yellow (35%), dark green (19%), green (17%), light green (7%), brown (2%) and purple (1%). Differences were detected for the ratios of sown seed colour and harvested grain colour. Reason of this change was that the grain color darkening during storage period. The hilum color of the genotypes was found to be colorless (74%) and black (26%).

In the study, agronomic characteristics of genotypes in field conditions were also determined, where the min, max and average values for each trait are given in Table 3.

Plant height, first pod height, number of main branches and number of pods per plant of the examined pea populations were 32-135 cm; 17-85 cm; 1-4; 1-26, respectively. The number of full pods per plant, pod length, number of grains per plant, grain weight

per plant and plot yields values were varied between 1-30; 3-9 cm; 2-118; 1-83 g and 50-434 kg/9 m^2, respectively. It was concluded that there are promising genotypes in terms of breeding and selection work should be continued in these genotypes.

Correlation Values Between Characters

The connection between the characteristics examined in the pea populations was investigated, and determined correlation values are given in Table 4.

According to the correlation analysis between the examined traits, the highest correlation (0.8) were found between plant height and first pod height. It was determined that there was a positive and significant relationships between the number of full pods and the number of empty pods on the number of pods per plant in order to increase the pea yield.

High level of significant correlations were found between plant height-first pod height; number of main branches-number of lateral branches; number of main branches-number of pods; number of lateral branches-number of pods; number of pods-number of grains, and plant seed weight-plot yield (Table 4).

Relationships between characters are important in revealing the feature emphasized in yield studies (Bozoğlu & Sözen, 2007). The most effective feature in determining the effects of the characters with each other is the climatic features (Ülker & Ceyhan, 2008; Mart, 2022a, 2022b, 2022c; Mart, 2023a; Mart et al., 2007a; Tugay Karagül et al., 2024).

The "Eigen Values of Major Components", "Percentage Variances" and "Percentage Cumulative Variance Values" among the investigated characteristics of the studied local pea populations are given in Table 5.

The main component percent variance values of the major three characteristics (plant height, first pod height and number of main branches) of the studied pea populations represent more than 50% of the pea genotypes. These three features were determined as important character traits to be considered in the differentiation of local populations among the features determined for the main component.

Conclusions

In this study, morphological characterization of local pea populations grown in Türkiye in winter in Eastern Mediterranean region was carried out. When the "distribution of pea populations in the main component", "weights in the first three main components" and "additives" were examined, it was determined that the number of pods, number of full pods, number of grains, plant straw weight and plant grain weight were effective on the first main component. Seed color, pod length, seed color, hilum color and plot yield were found to be effective on the second main component. In the third main component, the effect of plant height and first pod height characteristics was determined.

It is concluded that there are promising genotypes in terms of breeding and selection work should be continued in these genotypes.

© Plant Breeders Union of Turkey (BİSAB)

Table 1. Pea Genotypes and Source Locations in Türkiye.

Record No	Location Province	Record No	Location Province	Record No	Location Province	Record No	Location Province
TR-33233	Çanakkale	TR-40710	Antalya	TR-49601	İzmir	TR-61284	Tekirdağ
TR-33238	Çanakkale	TR-40715	Antalya	TR-53742	Çanakkale	TR-61290	Tekirdağ
TR-33246	Çanakkale	TR-40682	Muğla	TR-53747	Çanakkale	TR-61298	Tekirdağ
TR-33372	Tekirdağ	TR-39061	Aydın	TR-53749	Tekirdağ	TR-61301	Giresun
TR-37374	Çorum	TR-39071	Muğla	TR-54386	Aydın	TR-61305	Denizli
TR-30686	Antalya	TR-43509	İstanbul	TR-54953	Tekirdağ	TR-61307	Tekirdağ
TR-30760	Adana	TR-43619	Sakarya	TR-54954	Tekirdağ	TR-61309	İzmir
TR-77732	Muğla	TR-43647	Sakarya	TR-61266	Tekirdağ	TR-61311	Edirne
TR-77733	Muğla	TR-26306	Muğla	TR-56016	Giresun	TR-32230	Muğla
TR-77735	Denizli	TR-42159	Hatay	TR-5478	Antalya	TR-61246	Kütahya
TR-77736	Muğla	TR-46023	Trabzon	TR-57120	Hatay	TR-61287	Çanakkale
TR-77737	Manisa	TR-44916	Adapazarı	TR-5479	İzmir	TR-67094	Tekirdağ
TR-80188	Aydın	TR-44939	İzmit	TR-58078	İzmir	TR-61431	Tekirdağ
TR-80189	Antalya	TR-46469	Gümüşhane	TR-71699	İzmir	TR-61324	Tekirdağ
TR-80192	Burdur	TR-49596	Antalya	TR-64147	Çanakkale	TR-69399	Tekirdağ
TR-80193	Burdur	TR-49598	Hatay	TR-61253	Çanakkale	TR-70382	Kırklareli
TR-80199	Muğla	TR-49599	İzmir	TR-61277	Tekirdağ		
TR-45933	Artvin	TR-49600	İzmir	TR-61280	Aydın		

Table 2. Characteristics of Qualitative Characters and % Frequency Values.

Characters	Score	Description	Piece	Frequencies (%)
Seed Shape	1	Round	37	54
	2	Cornered	21	3
	3	Wrinkly	11	16
Sown Seed Colour	1	White	25	36
	2	Green	17	24
	3	Yellow	2	3
	4	Black	8	11
	5	Brown	16	23
	6	Brown-white	2	3
	7	Light green	0	0
	8	Dark green	0	0
Harvested Grain Colour	1	Light green	5	7
	2	Green	12	17
	3	Yellow	24	35
	4	Brown	14	2
	5	Dark green	13	19
	6	Purple	1	1
	7	Light Brown	0	0
Hilum Colour	1	Black	18	26
	2	Colorless	51	74

Table 3. Simple Statistics of Quantitative Characters.

Characters	Min.	Max.	Average	Standard Error
Plant Height (cm)	32	135	80,9	24,6
First Pod Height (cm)	17	85	46,7	16,6
Number of Branches (piece)	1	4	1,7	0,83
Number of Lateral Branches (piece)	0	6	0,6	0,98
Pod Number (piece)	1	26	10,0	5,49
Filled Pod Number (piece)	1	30	9,7	5,61
Empty Pod Number (piece)	0	3	0,5	0,76
Pod Length (cm)	3	9	5,6	1,11
Seed Number (piece)	2	118	41,4	23,8
Straw Yield of Plant (g)	3	26	9,1	4,97
Grain Yield of Plant (g)	1	83	8,0	10,05
Parcel Yield (kg/9 m^2)	50	434	215,8	84,6

Table 4. Correlation Analysis of Traits Examined in Pea Populations.

	Plant Height	First Pod Height	Number of Branches	Number of Lateral Branches	Pod Number	Filled Pod Number	Empty Pod Number	Pod Length	Seed Number	Seed Shape	Seed Colour	Grain Colour	Hilum Colour	Straw Yield of Plant	Grain Yield Per Plant	Parcel Yield
Plant Height	1	0,888**	0,023	-0,155	0,106	0,129	-0,185	-0,129	0,02	-0,181	-0,086	0,113	0,410**	0,051	0,164	0,164
First Pod Height		1	0,063	-0,214	0,024	0,057	-0,153	-0,233	-0,047	-0,194	-0,041	0,008	0,397**	0,061	0,010	0,010
Number of branches			1	0,380**	0,634**	0,665**	0,149	-0,198	0,647**	-0,104	0,139	-0,138	0,561**	0,094	0,011	0,011
Number of lateral branches				1	0,393**	0,360**	0,262*	-0,073	0,314**	-0,148	0,028	0,016	0,195	0,035	0,227	0,227
Pod number					1	0,971**	0,495**	-0,054	0,901**	-0,074	-0,091	0,135	0,600**	0,121	0,093	0,093
Filled pod number						1	0,396**	-0,053	0,928**	-0,109	-0,117	0,15	0,645**	0,155	0,095	0,095
Empty pod number							1	-0,038	0,305*	0,098	-0,088	0,082	0,146	0,006	-0,027	-0,027
Pod length								1	-0,006	0,286*	-0,294	0,514**	-0,022	-0,174	0,236	0,236
Seed number									1	0,023	-0,001	0,077	0,558**	0,136	0,045	0,045
Seed shape										1	0,235	0,276*	-0,02	-0,079	-0,199	-0,199
Seed colour											1	-0,392**	-0,032	0,013	-0,293	-0,293
Grain colour												1	0,216	-0,041	0,149	0,149
Hilum colour													1	0,490**	0,010	0,010
Straw yield of plant														1	-0,113	-0,113
Grain yield per plant															1	1,000**
Parcel yield																1

* The correlation is significant at the 0.05 level. ** Correlation is significant at the 0.01 level.

© Plant Breeders Union of Turkey (BİSAB)

Table 5. Eigen Values, Variances (%) and Cumulative Variances (%) of Main Components.

No	Examined Features	Eigen Value	Variance (%)	Cumulative Variance (%)
1	Plant height	4,35	27,21	27,21
2	First pod height	2,76	17,27	44,48
3	Number of branches	2,24	13,99	58,46
4	Number of lateral branches	1,47	9,17	67,63
5	Pod number	1,10	6,85	74,48
6	Filled pod number	0,95	5,93	80,41
7	Empty pod number	0,78	4,88	85,28
8	Pod length	0,60	3,77	89,05
9	Seed number	0,42	2,60	91,65
10	Seed shape	0,41	2,54	94,19
11	Seed colour	0,33	2,09	96,28
12	Grain colour	0,30	1,87	98,15
13	Hilum colour	0,14	0,87	99,02
14	Straw yield of plant	0,09	0,54	99,56
15	Grain yield of plant	0,05	0,33	99,89
16	Parcel yield	0,02	0,11	100,00

References

Anonymous, (1993). Descriptors for chickpea (*Cicer arietinum* L.). International board for plant genetic resources, Rome, Italy, 31. http://www.bioversityinternational.org/e-library/publications/detail/descriptors-for-chickpea-cicer-arietinum-l/

Anonymous, (2003). Broad bean *(Vicia faba* L. var. *major Harz)* guidelines for the conduct of tests for distinctness, uniformity and stability. http://www.upov.int/edocs/tgdocs/en/tg206.pdf

Boukid F, Rosell CM & Castellari M, (2021). Pea protein ingredients: A mainstream ingredient to (re)formulate innovative foods and beverages. *Trends in Food Science & Technology, 110, 729-*742. https://doi.org/10.1016/j.tifs.2021.02.040

Bozoğlu H & Sözen Ö, (2007). Some agronomic properties of the local population of common bean (*Phaseolus vulgaris* L.) of Artvin province. Turkish Journal of Agriculture and Forestry, 31, 327–334.

Ferranti P, (2016). Food sustainability, security, and effects of global change. In reference module in food science. Elsevier. https://doi.org/10.1016/B978-0-08-100596-5.03445-4

Mart D, (2023). Characterization and principle component analysis for some characteristics of local spring sown chickpea (*Cicer arietinum* L.) genotypes. Türk Tarım ve Doğa Bilimleri Dergisi, 10(2):420-430. https://doi.org/10.30910/turkjans.1129493

Mart D, (2022a). Investigation of the morphological characteristics of chickpea (*Cicer arietinum* L.) cultivars cultivated under irrigated and non-irrigated conditions sown in winter and early spring. Turkish Journal of Range and Forage Science, 3(2):75-83. https://doi.org/10.51801/turkjrfs.1207788

Mart D, (2022b). Characterization of Turkey local winter sown chickpea (*Cicer arietinum* L.) populations using principle component analysis. ISPEC Tarım Bilimleri Dergisi, 6(2):407-418. https://doi.org/10.46291/ISPECJASvol6iss2id316

Mart D, (2022c). Determination of some characteristics of eding pea (*Pisum sativum* L.) genotypes. MAS Journal of Applied Sciences, *7*(2):506-518. https://doi.org/10.52520/masjaps.v7i2id202

Mart D, Cansaran E, Karaköy T & Şimşek M, (2007).

Çukurova ve Orta Anadolu Bölgesinden toplanan yerel nohut (*Cicer arietinum* L.) populasyonlarının bazı önemli özelliklerinin belirlenmesi, seleksiyonu ve kalitatif karakterlerinin karekterizasyonu. *Tarla Bitkileri Araştırma Enstitüsü Dergisi, 16*(1-2), 61-72 (in Turkish).

Pandey AK, Rubiales D, Wang Y, Fang P, Sun T, Liu N & Xu P, (2021). Omics resources and omics-enabled approaches for achieving high productivity and improved quality in pea (*Pisum sativum* L.). Theoretical and Applied Genetics, 134(3): 755-776. https://doi.org/10.1007/s00122-020-03751-5

Parihar AK, Dixit GP, Bohra A, Gupta DS, Singh AK, Kumar N & Singh NP, (2020). Genetic advancement in dry pea (*Pisum sativum* L.): Retrospect and prospect. In S. S. Gosal & S. H. Wani (Eds.), Accelerated plant breeding (Vol. 3, Food legumes, pp. 283-341). Springer Nature. https://doi.org/10.1007/978-3-030-47306-8_10

Renáta Š, Nicolette V, Monika B, Stanislav K, Eliška G, Veronika M & Ľudmila S, (2021). Enhanced in situ activity of peroxidases and lignification of root tissues after exposure to non-thermal plasma increases the resistance of pea seedlings. Plasma Chemistry and Plasma Processing, 41, 903-922. https://doi.org/10.1007/s11090-021-10160-z

Sapre S, Gontia-Mishra I, & Tiwari S, (2022). Plant growth-promoting rhizobacteria ameliorates salinity stress in pea (*Pisum sativum*). Journal of Plant Growth Regulation, 41(2):647-656. https://doi.org/10.1007/s00344-021-10329-y

Shahzad R, Waqas M, Khan AL, Hamayun M, Kang SM & Lee IJ, (2015). Foliar application of methyl jasmonate induced physio-hormonal changes in *Pisum sativum* under diverse temperature regimes. Plant Physiology and Biochemistry, 96:406-416. https://doi.org/10.1016/j.plaphy.2015.08.020

Shen Y & Li Y, (2021). Acylation modification and/or guar gum conjugation enhanced functional properties of pea protein isolate. Food Hydrocolloids, 117, 106686. https://doi.org/10.1016/j.foodhyd.2021.106686

Tan A, (2010). Türkiye gıda ve tarım bitki genetik kaynaklarının durumu: Gıda ve tarım için bitki kaynaklarının muhafazası ve sürdürülebilir kullanımına ilişkin Türkiye ikinci ülke raporu. ETAE Yayın, 141. Ege Tarımsal Araştırma Enstitüsü, Menemen, İzmir (in Turkish).

Tan A, (1983). Sayısal taksonomik yöntemlerle varyasyonun saptanması. EBZAE, 30. Menemen (in Turkish).

Taylor SL, Marsh JT, Koppelman SJ, Kabourek JL, Johnson PE & Baumert JL, (2021). A perspective on pea allergy and pea allergens. Trends in Food Science & Technology, 116, 186-198. https://doi.org/10.1016/j.tifs.2021.07.017

Tugay Karagül E, Niksarlı İnal F & Kaya E, (2024). Nohut (*Cicer arietinum* L.) yerel çeşitlerinin agro-morfolojik karakterizasyonu. Anadolu Ege Tarımsal Araştırma Enstitüsü Dergisi, 34 (Özel Sayı), 149-159. https://doi.org/10.18615/anadolu.1464905 (in Turkish)

Ülker M & Ceyhan E, (2008). Determination of some agricultural characters of common beans (*Phaseolus vulgaris* L.) genotypes in Central Anatolian ecological condition. Selçuk Üniversitesi Ziraat Fakültesi Dergisi, *22*(46):77-89 (in Turkish).

© Plant Breeders Union of Turkey (BİSAB)