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Full Length Research Paper

Morphological characterization of the local potato (*Solanum tuberosum* L.) genotypes collected from the Eastern Black Sea region of Turkey

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In this study, 58 villages were selected and a total of 146 samples were taken according to stratified sampling system. These genotypes were collected from production areas in high altitudes of the province of Artvin (41°10' 54"– 40° 49' 09" N and 42° 21' 49"- 41° 32' 40" E) and Rize (41° 02'43"-40° 46' 50" N and 41° 00' 22"- 40° 33' 26" E) located in the Eastern Black Sea region of Turkey. The genotypes were grown under Samsun (41°31′N, 35°35′E) ecological condition in 2006. Some morphological and agronomical characteristics of the genotypes were described according to the criteria developed for potato by the International Board for Plant Genetics Resources (IPBGR). Cluster analysis was performed to determine the relation among genotypes. Cluster analysis, based on 15 variables, identified 27 groups in the current study. The dendrogram was prepared to evaluate similarity between potato genotypes, and as such, all the obtained data showed that the collected material has a vast variation. These evaluations could assist breeders to select and identify genotypes with desirable characteristics for inclusions in variety breeding programs.

Key words: Potato, genotype, characterization, cluster, tuber, Turkey.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is the fourth most important crop in the world after wheat, maize and rice with 314.1 million tonnes annual production on 18.1 million hectares (Anonymous, 2010a). Potato production areas and production quantities in Turkey were recorded as 142.684 ha and 4.397.711 tonnes in 2009, respectively (Anonymous, 2010b). The mean potato yield (30 t/ha) in Turkey is much beyond the world's average and also most European countries' averages. Turkey has a very favorable geographical condition for potato production; therefore, potato is grown almost in all provinces in the country. The middle, north and northeast parts of the country have temperate climate, and as such, potato is grown as a main crop during summer months (Caliskan et al., 2010). Potato is among the basic food products in the Black Sea region (north of Turkey) along with corn and bean. It is one of the basic ingredients used as local food and without any alternative in the regional cuisine of the Black Sea region (Aytac et al., 2002).

Ilisulu (1957) reported that it had initially come to Turkey in the 1870's from north, Russia and Causcasia, and it had been grown in high uplands in Eastern Anatolia and the Black Sea region. There have been many migrations from Causcasia to Anatolia at the end of the 18th century and early in the 19th century. It is highly probable that these immigrants have brought potato to the region. As potato is still called with a Russian word "kartol" in Eastern Anatolia and Black Sea region, local genotypes in some areas are still grown. These potato genotypes are widely accepted by the farmers for various reasons such as cooking quality and taste of tubers. Among genotypes, there are significant types in terms of maturity period, disease resistance and tolerance against environmental stress factors (Aytac and Arslanoglu, 2004).

Potato production in Turkey totally depends on foreign cultivars, which are mainly from European countries such as Netherlands, Germany, France, England, Scotland and Ireland. It is thought that dependency of seed production system on imported seed as well as limited

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Table 1. Geographical origin and accession number of the 146 potato (*Solanum tuberosum* L.) genotypes studied.

Geographical origin			Accession number	Total
Provinces	**Districts**	**Villages**		
Artvin	Merkez Ardanuc Savsat Arhavi Murgul Yusufeli	Bıcakcılar, Gunyayla, Cevizli, Yuksekoba, Boyuncuk, Ozguven, Kupluce, Balaban, Serinsu, Boyalı, Ogdem, Cıralı, Yarbası, Narlık, Oruclu, Zeytinli, Gumushane Koyu, Naldoken, Asagı Irmaklar, Aydın, Peynirli, Kavaklı, Torbalı, Uzumlu, Cayagzı, Tepekoy, Susuz, Karaagac, Coraklı, Kayadibi, Cevizli, Damar, Arduclu, Ciritduzu, Dikyamac, Caglayan, Asagı Maden, Maden, Savas, Yukarı Maden, Cavdarlı , Kutlu, Pırnallı, Bagcılar, Gokcekoy, Veli Koy, Hocagir, Asagı Irmaklar, Incilli and Anacli	G-1….G-74 G-89….G-146	132
Rize	Gurdere Ikizdere Camlihemsin	Yukarı Kavron, Asagı Kavron, Ayder, Konaklar, Sevahel, Ilıca, Yerelma and Bakırkoy	G-75…G-88	14
		Total		146

research and development efforts are main reasons for the situation. Currently, there are 79 registered potato cultivars in the 'national cultivar' list and only one of them (Nif) was bred via crossing in Turkey, and this cultivar has never had a change in commercial production since its registration (Caliskan et al., 2010). However, only 16 to 22% demand for high quality and certified seed is supplied. The remaining demand is obtained either from stocked harvested seeds by the farmers, or from uncertified seed tubers sold at local markets (Temur et al., 2006). Consequently, there is a need to improve high-yield and high quality new potato varieties for Turkey (Arslanoglu, 2008; Caliskan et al., 2010; Gunel et al., 2010).

For a successful breeding program, genetic diversity and variability play a vital role. Population genetic diversity is a prerequisite for an effective plant–breeding program. It is a useful and essential tool for parents' choice in hybridization to develop high yield potential cultivars (Haydar et al., 2007; Gaur et al., 1978) and to meet the diversified goals of plant breeding (Haydar et al., 2007). Genetic diversity is also used to study the taxonomic relationship among genotypes and to choose varieties with good qualities and incorporate them into breeding programmes (Escribano et al., 1991; Cartea et al., 2002; Balkaya and Ergun, 2008). Hornokova et al. (2003) stated that the knowledge of genetic diversity's extent and the identification, differentiation and characterisation of genotypes and populations, respectively, provides an informative tool for the detection of duplicates in the collection, effective extension and better characterisation and use in breeding. Morphological characterization is the first step in description and classification of genetic resources (Smith and Smith, 1989).

The objective of this study was to determine the similarity and differences in respect to morphological variation of local potato (*S. tuberosum*) genotypes.

MATERIALS AND METHODS

One hundred and forty six potato genotypes used in the present study were collected from villages and districts of Artvin and Rize provinces of Eastern Black Sea region, Turkey. One hundred and thirty two of them were collected from 58 villages of Merkez, Ardanuc, Savsat, Arhavi, Murgul and Yusufeli districts of Artvin province and 8 villages of Gurdere, Ikizdere and Camlihemsin districts of Rize province (Table 1). The altitude of collection areas changed from 290 to 2060 m in Artvin and 780 to 2200 m in Rize.

The potato genotypes from 1 to 88 were collected during the harvest period in August 2004 and tubers were kept until planting time, but the potato genotypes from 89 to 146 were taken from farmers' storage at the beginning of April 2005. For the fact that transport was difficult due to heavy rainfall and rugged terrain, potato fields could not be reached. As a result of telephone calls made to farmers at the same period, the tubers of plant harvested by the farmers were put into storage. Each genotype consisted of a plant tuber (8 to 10 tubers/per plant). In the first year, in order to produce replicates for all tuber genotypes, potatoes were planted in the experimental area of the Agricultural Faculty of Ondokuz Mayis University, in 15 Nisan 2005. Tubers of each genotype were planted in a row, and row length was 3 m (spacing of row to row was 0.7 m, while spacing of plant to plant was 0.40 m). The harvest of genotypes were completed at the end of July, 2005 and the potato tubers were stored at 4°C and 80% moisture storage conditions in Agriculture Faculty of Ondokuz Mayis University until planting time. In the second year, the field component of this study was carried out in Bafra district of Samsun province, in 2006. The experimental site was located at 41°31′N, 35°35′E and was situated in the north of Turkey. The tubers of all genotypes were planted on the 3rd of March, 2006 in Bafra district characterized by a humid climate, with an annual average relative humidity of 72.0% and rainfall of about 708 mm (Anonymous, 2006), and a sandy loam soil with a pH of 6.5. The potato tubers (between 40 and 60 g weight of tuber) were planted on 5.6 m^2 plots in randomized block design with three replications. Planting was made at a distance of 0.70 x 0.40 m, with ten tubers planted per row and each measuring 4 m. However, each plot had two rows. Prior to planting, mineral fertilization was 100 kg N, 50 kg P and 100 kg K ha^{-1}, whereas N fertilizer at 50 kg ha^{-1} rate was side-dressed to potatoes at four weeks after planting. The experimental plots were sprinkler-irrigated with two weeks interval depending on soil moisture content, and as such, weeds were controlled by harrowing and hilling. Pest control is uniquely

Table 2. Description of the characters used in the morphological study of the potatoes.

Character	Description
Plant height (cm)	Measurements of the distance between the top point of the plant and the ground surface during harvest, using meter
Main stem number	Main stem number per plant
Growth habit	(1) Extremely erect, (3) erect, (5) semi-erect, (7) prostrate and (9) very prostrate
Foliage cover	(1) Very poor , (3) poor, (5) moderate, (7) good and (9) very good
Flower frequency	(1) Extremely rare, (3) rare (5) moderate, (7) high and (9) very high
Flower colour	(1) White, (2) violet and (3) blue (light)
Maturity time	(1) Very late (later than 120 days), (3) late (between 111 and 120 days), (5) moderate (between 101 and 110 days), (7) early (between 80 and 100 days) and (9) very early (shorter than 80 days)
Tuber shape	As stated verbally (1, globe; 2, short-oval; 3, oval; 4, long-oval; 5, long; 6, very long and 7, amorf)
Skin colour	As stated verbally (1, yellow; 2, red; 3, blue and 4, red and blue points)
Eye colour	As stated verbally (1, yellow; 2, red and 3, blue)
Light sprout colour	As state verbally (1, pink; 2, blue and 3, green)
Flesh colour	As stated verbally (1, white; 2, cream; 3, light yellow; 4, yellow and 5, dark yellow)
Eye depth	(1) Very deep, (3) deep, (5) medium, (7) shallow and (9) very shallow
Skin texture	(1) Very rough, (3) rough, (5) intermediate, (7) smooth and (9) very smooth
Dormancy	(1) Very short (shorter than 30 days), (3) short (between 31 and 60 days), (5) medium (between 61 and 90 days), (7) long (between 91 and 120 days) and (9) very long (longer than 120 days)

concerned with Colorado potato beetle (*Leptinotarsa decemlineata*) against which Arrivo (Cypermetrine: 200 gl^{-1}) was alternatively sprayed for a total of three sprays. Harvesting began on the 4th of July and lasted till on the 3rd of August.

Data on different morphological characters were recorded on individual plant basis from 10 randomly plants selected in each row of each replication. The morphological characters were described according to the IPBGR potato descriptors (Table 2) (Anonymous, 1985).

Statistical analysis of the data was performed using statistical package (11.0 for Windows), whereas hierarchical cluster analysis was performed using Ward's criteria (Balkaya et al., 2010). Cluster analysis was conducted on similarity estimates using the unweighted pair-group method with arithmetic average (UPGMA), from which a dendrogram representing the relationship among the accessions was obtained (Rohlf 1993; Balkaya and Ergun, 2008). The cluster analysis reveals linkages between classes of crops as well as between different crops (Jantschi et al., 2007), and as such, only morphological and agronomical characters were given in this article. Nonetheless, tuber utilization and tubering characteristics of 146 potato genotypes will be given in another article.

RESULTS

Genetic grouping of 146 potato genotypes using the UPGMA clustering algorithm was shown in Figure 1. In the present research, cluster analysis grouped the genotypes into twenty-seven clusters, in terms of morphological and agronomic characters. Groups and sub-groups obtained from classification were given in Table 3 and cluster group means for 15 characters in 146 potato genotypes is shown in Table 4.

Among the twenty-seven different groups, group V was divided into four subgroups and it contained twelve genotypes. Groups B, U, X, W and Q1 consisted of only one cluster group, while the other groups were divided into two clusters' sub-groups (Figure 1). The twenty-seven groups and 49 subgroups could be considered to be distinct germplasm pools. However, general characteristics of investigated potato genotypes are subsequently given.

Group A

This group was divided into two subgroups that included twelve genotypes collected from Artvin province (Tables 1 and 3) and the average plant height was 64.6 cm (Table 4). Main stem number per plant was two and growth habit was erect, semi-erect and prostrate. Foliage cover was poor or good. This group had white and violet flower colour, while its tubers' size is globe and short-oval. Skin colour was yellow, while the colour of eyes was yellow and red. Flesh colour has all the colours, except for white. In addition, it was deep or shallow for eye's depth, while it was rough and smooth for skin texture. Dormancy period varied between 31 and 120 days (from short to long) in this group, while in terms of maturity, time was identified as moderate or early (from 80 to 110 days).

Group B

There were two genotypes in this group (Table 3). The average plant height was shorter than that of group A and the growth habit was extremely erect and erect (Table 4). It was obtained that foliage cover was very good and

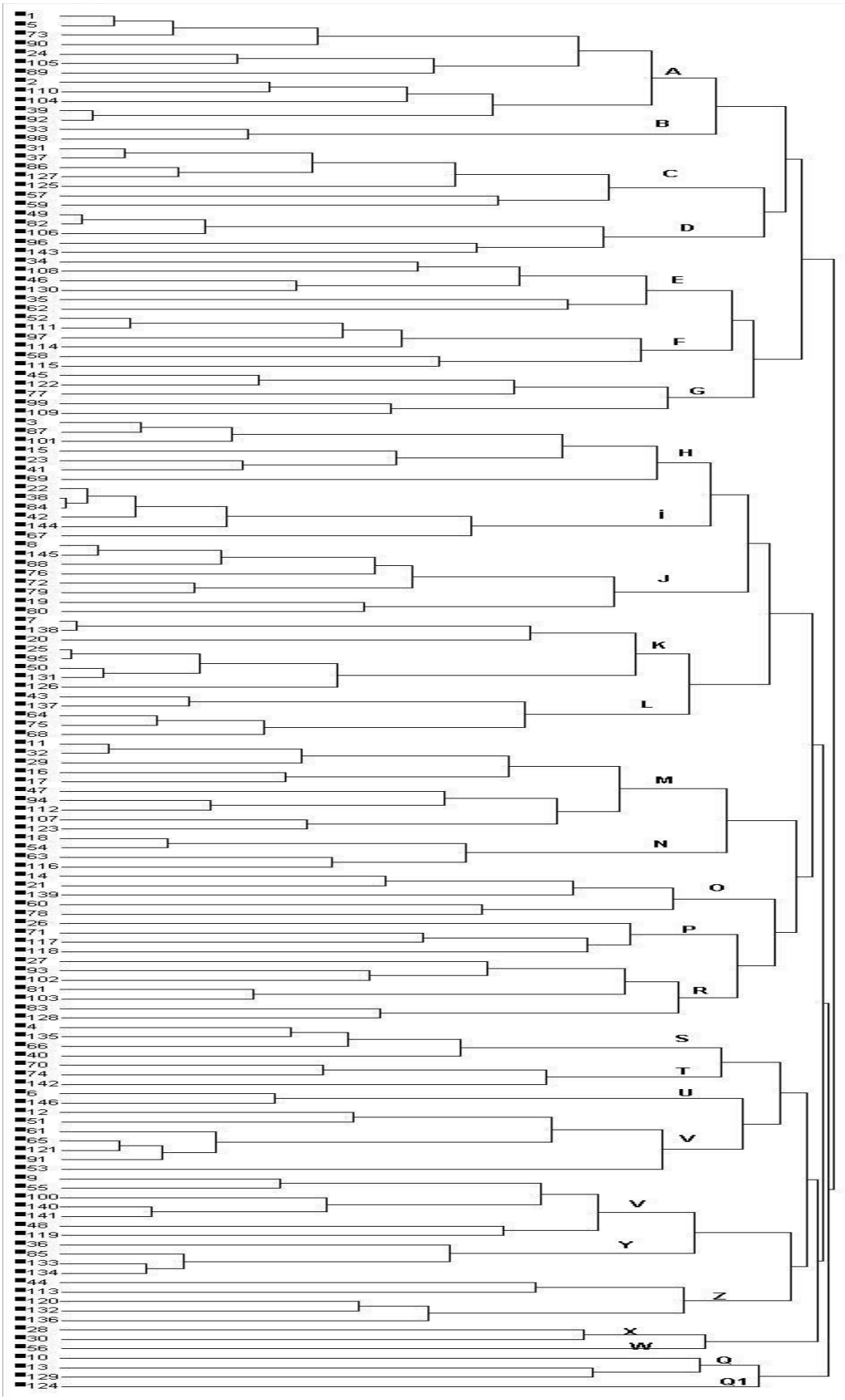

Figure 1. Genetic grouping of potato genotypes by cluster analysis.

Table 3. Potato genotypes' groups and sub-groups obtained from classification.

Group	Sub-group	Genotypes	Number of material
A	1	G-1, G-5, G-24, G-73, G-89, G-90 and G-105	7
	2	G-2, G-39, G-92, G-104 and G-110,	5
B	1	G-33 and G-98	2
C	1	G-31, G-37, G-86, G- 127 and G-125	5
	2	G-57 and G-59	2
D	1	G-49, G-82 and G-106	3
	2	G-96 and G-143	2
E	1	G-34, G-46, G-108 and G-130	4
	2	G-35 and G-62	2
F	1	G-52, G-97, G-111 and G-114	4
	2	G-58 and G-115	2
G	1	G-45, G- 77 and G-122	3
	2	G-99 and G-109	2
H	1	G-3, G-15, G-23, G-41, G-87 and G-101	6
	2	G-69	1
I	1	G-22, G-38, G-42, G-84 and G-114	5
	2	G-67	1
J	1	G-8, G-72, G-76, G-79, G-88 and G-145,	6
	2	G-19 and G- 80	2
K	1	G-7, G-20 and G-138,	3
	2	G-25, G-50, G-95, G-131 and G-126	5
L	1	G-43 and G-137	2
	2	G-64, G-68 and G-75	3
M	1	G-11, G-16, G-17, G-29 and G-32	5
	2	G-47, G-94, G- 112, G-107 and G-123	5
N	1	G-18 and G-54	2
	2	G-63 and G-116	2
O	1	G-14, G- 21 and G-139	3
	2	G-60 and G-87	2
P	1	G-26	1
	2	G-71, G-117 and G-118	3
R	1	G-27, G-81, G-93, G-102 and G-103	5
	2	G-83 and G-128	2
S	1	G-4, G- 66 and G-135,	3
	2	G-40	1
T	1	G-70 and G-74	2
	2	G-142	1
U	1	G-6 and G-146	2
V	1	G-12, G-51, G- 61, G- 65 and G-121	5
	2	G-53	1
	3	G-9, G-55, G-100, G-140 and G-141	5
	4	G-48 and G-119	2
Y	1	G-36	1
	2	G-85, G-133 and G-134	3
Z	1	G-44 and G-113	2
	2	G-120, G- 132 and G-136	3
X	1	G-28 and G-30	2
W	1	G-56	1
Q	1	G-10	1
	2	G-13 and G-129	2
Q1	1	G-124	1

Table 4. Cluster group means for 15 characters in the 146 potato genotypes.

Cluster groups	PH*	MSN	GH	FC	FF	FLC	MT	TS	SC	EC	LSC	FEC	ED	ST	DR
A	64.6	2.0	3,5,7	3,5,7	1,3	1,2	5,7	1,2	1	1,2	1,2,3	2,3,4,5	3,5,7	3,5	3,5,7
B	43.3	1.9	1,3	9	1	1,2	3	1,2	1	1	1	5	5,3	3,5	3,5
C	60.1	4.3	3,5,7,9	7,9	3	1,2	3,5	1,2,4	1	1	3	2,4,5	3,5,7	3,5,7	5,7
D	71.0	3.4	3,5,7,9	3,7,9	3	2	5	1,2,3	1	1,2	1,2,3	3,4,5	5,7,9	7	5,7
E	56.6	7.4	1,3,5,7	3,5,7,9	1,3	1	3,5	1,2	1	1,2,3	1,2,3	4,5	5,7,9	3,5,7	7
F	81.9	3.6	1,3	3,5	3,5	1	1,3	1,3,7	1	1,2	1,3	2,4,5	7,9	3	3,5,7
G	103.4	6.5	5,7,9	5,9	1,3	1,2	3,5	1,2,3	1	1	1	2,5	5,7,9	3	5,7
H	36.4	1.6	3,5,7	3,5	3,5	1,2	5,7	2,3,4,5,7	1	1,2,3	1	1,2	3,5,7	3	5,7
I	51.1	1.8	1,3	1,3,5	3	1,2	3,5,7	3,4,5,7	1	1	1,2,3	1,2	3,5,7,9	3,5	5,7
J	43.8	2.8	3,5,7,9	3,5,7	1,3	1,2	3,5	1,3,5	1	1,2	1	1,2	5,7	3,7	5,7
K	45.9	3.1	5,7,9	5,7,9	1,3	1	3,5	2,4,5,6,7	1	1	1,2	1,2	1,3,5	3,5	5,7
L	73.8	3.2	1,3	3,5,9	3	1	3,5,7	4,5,7	1	1	1,2	1,2	3,5,7	3	5,7
M	35.9	1.9	3,5,7	1,3,5	1,3	1	5,7	2,3,4,5,7	1	1,2	1,2,3	1,2,3,4	3,5,7	5,7	5,7
N	32.2	2.9	1,3,5	3,5	3	1	1,3	1,2,3	1	1	1,3	1,2	3	3,5	3,5,7
O	30.8	1.3	3,7	3,5	1,3	1,2	5,7,9	1,5,7	1	1	1,2,3	1,2,4	3,5,7	3,5	1,3,7
P	53.8	1.1	3,7	3,5,7	1,3	1	3,7,9	5,6,7	1	1	1	1,2,4	3,5,9	3,5	1
R	45.2	1.4	5,7	3,5,9	1,3	1	3,5	1,2,4	1	1,2	1,2,3	2,4,5	3,5,7,9	5,7	1,3,5
S	65.4	2.4	3,5,7	7,9	1,3	1	3,5	7,6	1	1,2	1	1,2,3	9,7	5	5,7
T	42.4	2.0	3,5,7	5,7,9	1,3	1,2	3,5	7	1	2,3	3	1,2	5,7,9	7	5,7
U	82.9	7.5	7	9	1,3	1	3,5	5	1	3	1,2	2	5,7	3	3
V	57.3	3.5	3,5,7,9	3,5,7,9	1,3,5	1,2	1,3,5	2,3,5,7	1	1,2,3	1,3	1,2,5	3,5,7,9	3,5	1,3,5,7,9
Y	70.8	2.6	7,9	5,7,9	3	1,2	3,5	3,5,6,7	1	1	3	1,2	5	3	7
Z	77.3	3.8	1,3,5	5,9	3,5,7	1,2	3,5	5,6,7	1	1	1,2,3	1,2,4	5,7	3,5	1,7
X	69.4	1.3	5,7	5,9	3,7	3	3	7	1	1	1,3	4	3,7	7,5	7
W	39.0	1.1	3	3	3	3	5	4	1	1	1	4	3	3	1
Q	47.1	3.0	3,7,9	3,7,9	1,3	1,2	5,9	1,3,5	2	1	1,3	1,2	3,7	3,5,7	3,7
Q1	46.4	8.0	3	5	7	2	5	5	2	1	1	1	3	3	7

PH = Plant height, MSN = main stem number, GH = growth habit, FC = foliage cover, FF = flower frequency, FLC = flower colour, MT = maturity time, TS = tuber shape, SC = skin colour, EC = eye colour, LSC = light sprout colour, FEC = flesh colour, ED = eye depth, ST = skin texture, DR = dormancy. *Description of the characters is given in Table 2.

flower frequency was extremely rare. Flower colour, skin colour, eye colour, light sprout colour and flesh colour were white, yellow, yellow, pink and dark yellow, respectively. However, these genotypes were classified as late (111 to 120 days).

Group C

This group contains seven genotypes and one of

them originated from Rize province (Tables 1 and 3). Average plant height of genotypes was 60.1 cm and they have 4.3 main stem number per plant (Table 4). Growth habit varied from erect to very prostrate form and foliage cover was good. They have globe, short and long oval tubers. They were harvested from 101 to 120 days and were classified as moderate and late.

Group D

This group consists of five genotypes collected from Artvin province, except for G-82 genotype (Tables 3 and 4). Plant height of these genotypes were 71 cm, while growth habit, foliage cover and tuber shape of genotypes in this group were same as group C. These genotypes were harvested in 101 to 110 days.

Group E

There were a total of 6 genotypes in this group (Table 3). It was determined that these genotypes had the maximum main stem number per plant (7.4) among all the groups, except for group U. Growth habit was from extremely erect to prostrate, while tuber shape was globe and short-oval. It was classified as late and moderate (Table 4).

Group F

The genotypes in this group were clustered into 2 subgroups (Table 3). Average plant height was 81.9 cm and the main stem number per plant was 3.6 cm. Genotypes' growth were erect and extremely erect. Foliage cover of this group was poor and moderate. Flower colour was white and rare or moderate flower frequency, while tuber shape was globe, oval and amorf. The quality trait of these genotypes was not very good according to tuber shape. Flesh colours of tubers in this group varied from cream to dark yellow, while eye depth of tubers was shallow and very shallow. Skin texture of these genotypes was rough, as in group G, H, L, U, Y, W and Q1. Dormancy period was similar to group A. These genotypes were classified as very late and late (Tables 2 and 4).

Group G

There was only one genotype from Rize region (Table 3) and it was determined that this group had the maximum plant height among all groups. It has main stem number per plant as 6.5 cm. Growth habit in this group varied from semi-erect to very prostrate, as in group K and foliage cover was very good. Tuber shape was globe, short-oval and oval. These materials were suitable for consumption in terms of tuber shape and flesh colour. Dormancy period of this group varied from medium to long as in groups H, I, J, K, L, M, S and T. This group's potatoes were harvested in 101 to 120 days (Table 4).

Group H

This group consisted of seven genotypes (Table 3) and they were clustered in two sub-groups. Plant height of genotypes was short, while the main stem number per plant was lesser. Growth habit was erect or prostrate and foliage cover was poor and moderate. Tuber shapes for this group were very different from short-oval to amorf, but flesh colour of tubers was determined as white and creamy. These genotypes were classified as moderate and early in terms of maturity time (Table 4).

Group I

There were 6 genotypes collected from Artvin province in this group, except for G-84 (Table 3). The plants of this group grow extremely erect and erect. Foliage cover was very poor and moderate. Tuber shape and eye depth of genotypes were very different. In terms of tuber shape, genotypes in this group were not very good. Maturity time of these genotypes varied from early to late, as in group L (Table 4).

Group J

This group consists of 8 genotypes and 4 of these were collected from Rize province (Table 3). Genotypes in this group have different growth habit (from erect to very prostrate) and foliage cover (poor or good). In this group, in terms of tuber shape, flesh colour and eye depth, genotypes were very good. It was classified as late and moderate in terms of maturity time, as in groups K, R, S, T, U, Y and Z (Table 4).

Group K

All genotypes in this group were collected from Artvin province and it consisted of 8 genotypes in total (Table 3). Tuber shape of this genotype varied from short-oval to amorf. Eye depth of tubers in group K was determined as very deep or deep and medium. However, it has rough and intermediate skin texture, as in groups N, O, P, V and Z.

Group L

There were a total of five genotypes in two sub-groups

(Table 3). Plant height was 73.8 cm. The genotypes' growth was extremely erect and erect. Tuber shape was long-oval, long and amorf, while eye depth was medium or shallow. These traits were important in terms of potato industry and food consumption.

Group M

Genotypes in this group were clustered into 2 subgroups and they were all collected from Artvin province. It comprised a total of ten genotypes and the average plant height was 35.9 cm. Groups M, N and O had minimum plant height among all groups (Table 4). Skin texture in this group was smoother than the other groups, as in group R, whereas tuber shape was very different. These genotypes were classified as moderate and early with respect to maturity time.

Group N

This group included four genotypes (Table 3). Growth habit of genotypes varied from extremely erect to semi-erect, while foliage cover was moderate. Genotypes in group N were identified as late or very late (Table 4).

Group O

This group was clustered into two subgroups and there were a total of five genotypes. One genotype (G-87) originated from Rize province (Table 3). The genotypes in this group were suitable for comsumer and potato industry in terms of tuber shape and flesh colour. In addition, the genotypes in group O harvested between 80 and 110 days, were shorter than 80 days after tuber sowing and were classified as very early, early or moderate (Table 4). We selected this group because its maturity time was an important trait for farmers.

Group P

There was a genotype in the 1st subgroup and three genotypes in the 2nd subgroup (Table 3). Groups P and W have at least, the main stem number among all genotypes (Table 4). Tuber shape was long, very long and amorf. While eye colour and light sprout colour were very uniform, flesh colour and eye depth were not uniform in this group. Dormancy period of groups P and W were the shortest among all genotypes (shorter than 30 days). The genotypes in these groups were very important for second crop farming and short vegetation areas. For this reason, we selected groups P and W.

Group R

There were a total of seven genotypes in this group (Table 3). The genotypes were clustered in two subgroups and two genotypes were collected from Rize province. This group has a globe, short-oval and long-oval tuber shape, while the flesh colour is creamy and yellow or dark-yellow. Its eye depth is shallow and very shallow. Dormancy period of these genotypes varied from very short to medium and they were identified as late and moderate (Table 4).

Group S

This group consisted of four genotypes. Average plant height was 65.4, while main stem number per plant was 2.4. It has good foliage cover, long and amorf tuber shape, while its flesh colour is white, creamy and light yellow. Maturity time was identified as late and moderate. Dormancy period of these genotypes in this group was determined as medium (between 61 and 90 days).

Group T

The genotypes in this group were collected from Artvin province and there were three genotypes. Eye depth varied from medium to very shallow. These genotypes were not selected because it has amorf tuber shape (Tables 1 and 4).

Group U

There were only one cluster sub-group and 3 genotypes in this group. It has 82.9 cm plant height, 7.5 main stem number per plant, prostrate growth habit, very good foliage cover, long tuber shape, blue eye colour, pink and blue light sprout colour, shallow and medium eye depth, rough skin texture and short dormancy period. The quality traits of these genotypes were very good. As such, the genotypes in group U were selected for variety breeding studies.

Group V

Genotypes in this group were clustered into four subgroups (Table 3). There were a total of 13 genotypes and they were collected from Artvin province. Plant height of this group was 57.4 cm and the main stem number per plant was 3.5. Growth habit, foliage cover, tuber shape, eye colour, eye depth and dormancy period of genotypes were very different with one another. These materials were not homogenous in terms of all traits investigated for potato industry and farmers. However, maturity time varied from very late to moderate (Table 4).

Group Y

This group consisted of four genotypes in two cluster

groups (Table 3). It has a plant height of 70.8 cm and a main stem number per plant of 2.6. It is the only genotype in this group that was collected from Rize province. The genotypes were growth prostrate and very prostrate. In general, foliage cover was good, but tuber shape of genotypes was not uniform, in that it changed from short-oval to amorf. This group was identified to have late and moderate maturity time. It has white and cream flesh colour and a medium eye depth. Dormancy period of genotypes was long (between 91 and 120 days). However, this trait is important for the storage period of potato tubers.

Group Z

This group was clustered into two sub-groups. Plant height of genotypes was 77.3 cm, while the main stem number was 3.8. The plants in group Z grow from extremely erect to semi erect and the foliage cover was good. Tuber shape of genotypes was long and very long or amorf, whereas dormancy period in this group was very short and long.

Group X

There is only one cluster sub-group like groups W and Q1 (Tables 3 and 4). The two genotypes in this group were semi-erect and prostrate in growth, while flower colour was light blue, but tuber shape was amorf and not suitable for potato industry or consumption.

Group W

This genotype was erect in growth and the foliage cover was poor. It has blue flower, long-oval tuber shape, yellow flesh colour, deep eye depth and very short dormancy period. In addition, it was harvested in between 101 and 110 days and was classified as moderate.

Group Q

This group contains three genotypes in two sub-groups. Growth habit, foliage cover, tuber shape, eye depth, skin texture and dormancy period of these genotypes was very different for each genotype, but potatoes in this group were identified as moderate and very early. The quality traits of this genotype were very good for farmers in second crop conditions.

Group Q1

There was only one genotype in this group (Table 3) and the main stem number per plant was mostly found among all potato genotypes (Table 4). The genotype was collected from Artvin and it has an erect growth habit, moderate foliage cover, long tuber shape, white flesh colour and long dormancy period. This genotype was classified as moderate (between 101 and 110 days).

DISCUSSION

Skin colour was determined to be yellow in all potato genotypes, but groups Q and Q1 were red. Blue and red or the blue point of skin colour was not found among all potato genotypes as noted by IPBGR. Flower frequency of groups Z, X and Q1 was higher than other potato genotypes. As such, the gene pool is considered a valuable initial resource for plant breeding, because it contains co-adapted gene complexes with tolerance or adaptation to diseases and specific ecological conditions, and many plant species (Harlan, 1975; Williams et al., 1991).

To be useful for plant breeders, genetic resources must be characterized by morphological and agronomic traits (Martins et al., 2006). For this reason, there is need to collect, characterize and evaluate remnant local genotypes before they disappear (Balkaya and Ergun, 2008). The main goal of potato breeding is to develop potential varieties that ensure the highest and stable production in a range of environments (Haydar et al., 2007). The cluster analysis has different genotypes on the basis of similarity and thus provides a hierarchical classification (Sozen and Bozoglu, 2007). The clustering of local potato genotypes, collected from Artvin and Rize provinces in the Eastern Black Sea Region of northern Turkey, on a dendrogram into twenty-seven separate groups resulted from their different morphological and agronomic characteristics. The present research has identified the relationship between local potato genotypes. In general, no association was observed for clusters within the collection zone. This lack of association may be a result of tuber transport from village to village or from province to province by humans. Another possibility, may be that it suited the ecological conditions of the region, and these local genotypes are widely accepted by the farmers for reasons such as cooking quality and taste of tubers (Aytac and Arslanoglu, 2004; Arslanoglu, 2008). Several differences among pinto bean populations (Balkaya, 1999; Sozen and Bozoglu, 2007), sweet potato populations (Tairo et al., 2008; Veasey et al., 2007), potato genotypes (Mondal et al., 2007; Haydar et al., 2007; Abbas et al., 2008; Arslanoglu, 2008) and winter squash genotypes (Balkaya et al., 2010) were observed for most of the morphological and agronomic characters, as shown in the present study. Racho et al. (2001) stated that 113 wild potato clones were clustered into 51 subgroups in terms of isoenzymatic patterns, whereas Karuri et al. (2010) found that dendrogram was highly variable

among the morphological characters of 89 sweet potato genotypes and as such, obtained phenotypic characters that separated the genotypes into two major clusters.

It is important to select the lines that are superior in terms of genetic diversity and agronomical properties during the improvement studies (Sandhu and Gopal, 2006; Pandey et al., 2005). Karaca (2004) selected 9 genotypes among 63 potato genotypes in terms of maturity time, tuber shape and plant height. However, Escribano et al. (1997) and Galvan et al. (2006) have suggested that the use of morphological traits should be complemented with more accurate techniques to achieve reliable evaluation and characterization of species diversity. Therefore, in recent years, successful results could be obtained using DNA markers and molecular techniques in the determination of genetic traits for variety improvement (Abbas et al., 2008; Tairo et al., 2008). Besides, conservation and maintenance of this valuable genetic material is necessary, because these populations are an important diversity source which could be used in breeding programmes (Balkaya and Yanmaz, 2001, 2005).

In conclusion, we have presented some characteristics of local potato genotypes grown in Turkey, which are first introduced and have not been characterized. An analysis of morphological and agronomic traits showed that genetic variation was high among the local potato genotypes sampled. Clusters obtained in this study may provide a basis for further study, and it could be selected separately for each in terms of traits investigated further as potato breeding programs. These evaluations could assist breeders to select and identify genotypes with desirable characteristics for inclusions in variety breeding programs.

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REFERENCES

Abbas SJ, Rasool G, Ullah Shah SR, Iqbal A (2008). Analysis of Genetic Diversity in Pakistani Potato Cultivars By Using Randomly Amplified Polymorphic DNA (RAPD) Primers. American-Eurasian J. Sustain. Agric. 2: 50-53.

Anonymous (1985). Potato Variety Descriptors. International board for plant genetic reseources. Minimum list of characteristics of potato varieties (*Solanum tuberosum* ssp *tuberosum)*. Editors Mackay GR, Hijink MJ, Mix G. IPBGR Secretariat, Rome.

Anonymous (2006). Turkish States Meteorological Service Records of Samsun Province, Turkey.

Anonymous (2010a). FAOSTAT- Agriculture, (http://faostat.fao.org/site/339/default.aspx).

Anonymous (2010b). Turkish Statistical Institute, (http//www.tuik.gov.tr).

Aytac S, Ayan AK, Karaca E (2002). Karadeniz Bölgesi'nde Patates Tarımında Karşılaşılan Sorunlar. 3th National Potato Congress. 23-27 September 2002, Bornova, Izmir-Turkey (In Turkish). Proceedings Book, 1: 151-156.

Aytac S, Arslanoglu F (2004). Increasing potato yield in the Black Sea Region of Turkey. Proceeding of the meeting of the physiology section of the european association for potato research. Acta Horticulture, 684: 21-25.

Arslanoglu F (2008). Three Agronomical Traits of The Local Potato (*Solanum tuberosum* L.) Ecotypes Growning The farmer fields in highlands of the Eastern Black Sea Region. Turk. J. Field Crops, 13: 70-76.

Balkaya A (1999). A Research on Collection of Genetic Researches, Characterization of Green Bean (*Phaseolus vulgaris* L.) And Selection of Suitable Types for Fresh Consumption in The Black Sea Region (In Turkish). Unpublished Phd Thesis, University of Ondokuz Mayis, Turkey.

Balkaya A, Yanmaz R (2001). Conversation Facilities of Plant Genetic Resources and Working Systems of Seed Gene Banks. Ekoloji Çevre Dergisi 39: 25-30. (In Turkish).

Balkaya A, Yanmaz R (2005). Promising Kale (*Brassica oleracea* var. *acephala)* Populations From Black Sea Region, Turkey. New Zealand J. Crop Horticult. Sci. 33: 1-7

Balkaya A, Ergun A (2008). Diversity and Use of Pinto Bean (*Phaseolus vulgaris*) Populations From Samsun, Turkey. New Zealand J. Crop Horticult. Sci. 36: 189-197.

Balkaya A, Ozbakir M, Kurtar ES (2010). The phenotypic diversity and fruit characterization of winter squash (*Cucurbita maxima*) populations from the black Sea Region of Turkey. Afr. J. Biotechnol. 9: 152-162.

Caliskan ME, Onaran H, Arioglu H (2010). The Overview to the Turkish Potato Sector: Challenges, Achievements and Expectations. Potato Agrophysiology, Proceedings of the International Symposium on Agronomy and Physiology of Potato, 20-24 September 2010, Nevşehir, Turkey, Proceeding Book, pp. 1-11.

Cartea ME, Picoaga A, Soengas P, Ordas A (2002). Morphological Characterization of Kale Populations From Northwestern Sapin. Eupytica, 129: 25-32.

Escribano MR, Ron AM, Santalla M, Ferreira JJ (1991). Taxonomical Relationship Among Common Bean Populations From Northern Spain. Eupytica 76:1-6.

Escribano MR, Santalla M, Ron AM (1997). Genetic diversity in pod and seed quality traits of common bean populations from Northwestern Spain. Eupytica, 93: 71-81.

Gaur PC, Gupta PK, Kishore H (1978). Studies on genetic divergence in potato. Euphytica, 27: 361-368.

Gunel E, Kuşman N, Tugrul KM, Yılmaz A, Agırnaslıgil T, Onaran H (2010). Starch and Sugar Plant Production, Turkey VII. Technical Congress of Agricultural Engineers, 11-15 January 2010, Ankara, Turkey, Proceeding Book, 377-396 (In Turkish).

Galvan MZ, Menendez-Sevillano MC, De Ron AM, Santalla M, Balatti PA (2006). Genetic diversity among wild common beans from Nortwesthern Argentina Based on Morpho-Agronomic and RAPD data. Genet. Reseour. Crop Evol. 53: 891-900.

Harlan JR (1975). Our vanishing genetic reseources. Science, 188: 619-621.

Haydar A, Ahmed MB, Hannan MM, Razvy MA, Mondal MA, Salahin M, Karim R, Hossain M (2007). Analysis of genetic diversity in some potato varieties grown In Bagledesh. Middle-East J. Scientific Res. 2: 143-145.

Hornokova O, Zavodna M, Zakova M, Kraic J, Debre F (2003). Diversity of common bean landraces collected in the western and eastern CArpatien. Chech J. Genet. Plant Breed. 39: 73-83.

Ilisulu K (1957). Turkiye'de yetiştirilen Patates Çeşitlerinin Başlıca vasıfları Uzerinde Araştırmalar. Ankara Universitesi Ziraat Fakultesi Yayınları. Publication number: 118: p. 248. Ankara, Turkey (In Turkish).

Jantschi L, Sorana DB, Carmen ES (2007). National Trends on Agricultural Crops Production: Cluster Analysis. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluc-Napoca, Romania, 63: 194-202.

Karaca E (2004). A study on some phenologic, morphologic, agronomic

and technologic characters of different originated Potato collected surrounding Ordu City (In Turkish). Unpublished Master Thesis, Ondokuz Mayıs University, Turkey.
Karuri HW, Ateka EM, Amata R, Nyende AB, Muigai AWT, Mwasame E, Gichuki ST (2010). Evaluating diversity among Kenyan sweet potato genotypes using morphological and SSR markers. Int. J. Agric. Biol. 12: 33-38.
Martins SR, Vences FJ, Miera LE, Barrosa MR, Carnide V (2006). RAPD analysis of genetic diversity among and within portuguese landraces of common white Bean (*Phaseolus vulgaris* L.). Scientia Horticulturae, 108: 133-142.
Mondal MAA, Hossain MM, Rasul MG, Shalim Uddin M (2007). Genetic Diversity in Potato *(Solanum tuberosum* L). Bangledesh J. Bot. 36:121-125.
Pandey SK, Singh SV, Manivel P (2005). Genetic variability and causal relationship over seasons in potato, Crop Res. Hisar, 29: 277-281.
Racho BHG, Augustin E, Baptista ta Silva J, Viegas J (2001). Isoenzymatic variability in wild potatoes. Pesq. Agropec. Bras, Brasilia, 36: 781-791.
Rohlf FJ (1993). Numerical taxonomy and multivariate analysis system. Exeter Software, Department of ecology and evoluation, State University of New York, United States.
Sandhu SK, Gopal J (2006). Assessment of genetic diversity in potato germplasm for spring season crop, Crop-Improvement, 33: 78-83.
Smith JSC, Smith OS (1989). The description and assessment of distances between inbred lines of maize: The utility of morphological, biochemical and genetic descriptors and a scheme fort He Testing of distinctiveness between Inbred Lines. Maydica, 34: 151-161.
Sozen O, Bozoglu H (2007). Determination of morphologic and agronomic variability of white dry bean germplasm from artvin province. VII. Field Crops Congress, 25-27 June 2007, Erzurum, Turkey, Proceeding Book, 1: 601-604 (In Turkish).
Tairo F, Mneney E, Kullaya A (2008). Morphological and agronomical characterization of sweet potato (*Ipomoea batatas* (L.) Lam.) germplasm collection from Tanzania. Afr. J. Plant Sci. 2: 077-085.
Temur A, Terlemez N, Yılmaz K (2006). To analyze in terms of yield and quality of Potato varieties in the National Cultivar list in 2006. 06-08 September 2006, 4th. National Potato Congress, Potato Research Institute, Nigde, Turkey (In Turkish). Proceedings Book, 1: 103-113.
Veasey EA, Silva JRQ, Rosa MS, Borges A, Bressan EA, Peroni N (2007). Phenology and Morphological Diversity of Sweet Potato (*Ipomoea batatas*) Landraces of the Vale Do Riberia. Sci. Agric. (Piracicaba, Braz.), 64: 416-427.
Williams CN, Uzo JO, Peregrine WTH (1991). Vegetable Production In The Tropics. In: Intermediate Tropical Agriculture Series, Longman Scientific And Technical, Essex.