Characterization of sunflower genetic resources of Turkey

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ABSTRACT

- Turkey is one of the most significant and unique country for plant genetic resources and plant diversity. Sunflower (*Helianthus annuus* L.) is one of the important oilseed crops and their landraces have significant diversity in Turkey. The characterization of local varieties and land race collections is also necessary for the utilization of those resources. Therefore, sunflower landraces were collected and conserved *ex situ* at the National Genebank within the framework of National Industrial Plant Genetic Resources Project.

- In this study agro-morphological variation of thirty six sunflower accessions collected from western Turkey and maintained long-term at National Gene Bank for assessing sustainable utilization is presented. Multivariate analysis (PCA) was performed for diversity determination of sunflower accessions. Ecological differences affect morphology of sunflower; thus, quantitative aspects of variation were evaluated using plants grown under same conditions. Twenty nine characters were evaluated and multivariate analysis was performed for diversity determination of sunflower.

- The morphological variation on the observed characters was found highly variable for most of the characters. There was no variation on pollen fertility, type of phyllotaxis, external petal color, number of head, Seed hairiness. Principal component analysis (PCA) showed that the first five principal components accounted for 70.370 % of the total variation. In all principal components only one group was formed which consist of oil types and confectionary types were separated from this groups. In some of the principal components the long seeded types of accessions were distributed outside of the group.

- The results indicated that the distinct groupings were determined in principal components and the results of analysis exhibited broad variation model of sunflower land races. The sunflower land races, especially the confectionary types were found very variable for morphological characters. The informal seed exchange mechanism among the farmers effect the some degree of similarity of the some accessions collected from different localities of different provinces.

- This information will help to optimize the germplasm management and utilization in plant breeding program.

Keywords: Sunflower, *Helianthus annuus* L., diversity, agro-morphological variation, Principle Component Analysis (PCA).

INTRODUCTION

Turkey is one of the distinctive countries for the plant diversity as being center of origin and/or center of diversity or microgene center for many crop species (Harlan; 1951; Tan, 2010; Karagoz *et al*, 2010). Sunflower which is originated in North America (Zeven and deWet, 1982) is an important vegetable oil sources and used as confectionary in Turkey. Although Turkey is not origin of sunflower, there is great morphological diversity on the land races because of the natural selection during the adaptation and farmers selection for the desired characteristics of their preference for the consumption (Tan, 2009). National Plant Genetic Resources Program (NPGRP) of Turkey is highly organized since 1960s with survey, collection, conservation both *ex situ* and *in situ* (including on farm conservation of land races), characterization and evaluation of existing genetic resources and genetic diversity (Tan, 2000; Tan, 2010). The Industrial Crops Genetic Resources Program of NPGRP responsible collection the various industrial crops landraces and wild species of industrial crops for long-term conservation at National Gene bank at Aegean Agricultural Research Institute (AARI). This program characterizes the industrial crops collections at the gene bank (Tan *et al*., 2009). While many environmental factors affecting the lost of wild species, the threats on landraces/local varieties are mainly the result of the replacement of landraces with modern varieties and changing the agricultural farming system.

Highly variable domesticated crops as well as landraces with unique characteristics are still grown by farmers in Turkey. Fragmentation of land holdings allows farmers to manage several fields and to keep local landraces; marginal agronomic conditions, especially steep slopes and heterogeneous soils of mountain agriculture, make local landraces competitive with improved cultivars, at least in part of farming system; Economic isolation creates market imperfection and lessens to competitive advantages of improved cultivars and cultural identity, traditions and preference of diversity lead farmers to keep local landraces are the factors affect the farmers, even modern farmers, to keep their landraces or traditional crops (Tan, 2009).

Three hundred seven confectionary and oilseed types of sunflower land races were collected from different part of Turkey and from different sources, such as fields, farmer storage, threshing place and local markets of the villages, and maintained long-term at National Gene Bank, so far. The collection and passport data, storage and characterization data are stored in National Plant Genetic Resources Data Base (Tan and Tan, 1998a; Tan and Tan, 1998b).

The genetic diversity plays an important role in plant breeding. Thus, the characterization of existing collection is essential for the breeders (Tan, 1993; Tan, 2005). Characterization of genetic resources collections of confectionary and oilseed sunflower is significant to assess collection diversity for increased utilization. The existing sunflower collections in the National collection have been started to characterize and evaluate for utilization at the breeding program at AARI. The accessions of the collection were also used in breeding program. Ege-2001 oilseed open pollinated variety developed and registered so far, and oilseed and confectionary type of germplasm, inbreed lines (A, B, and Rf) were developed and oilseed and confectionary varieties proposed for registration by using that collection (Tan, 2010). The main objectives of the present study were therefore to analyze the degree of similarity or differences among sunflower landraces to provide information that could be used for effective conservation, and to determine the extent of genetic diversity in sunflower landraces based on agro-morphological traits to provide information to enable germplasm management and utilization in plant breeding program.

MATERIALS AND METHODS

Thirty six sunflower landraces accessions that collected from Western part of Turkey within the framework of National Industrial Plant Genetic Resources Project of National Plant Genetic Resources Program and maintained long term at National Gene Bank were used in this study for characterization.

The accessions were grown two rows and fifty plants. Twenty randomly selected plants were observed from each sample (accessions). Twenty nine morphological characters of plant, head/flower and seed characteristics were observed (Table 1). The agronomic characters, days to flowering and days to physiological maturity were also recorded (IBPGR, 1985).

Statistical analysis and Multivariate Analysis (Principal Component Analysis-PCA) were carried out to determine the variation among the accessions (Sneath and Sokal, 1973; Clifford and Stephenson, 1975). The statistical values of quantitative characters were calculated (Steel and Torrie, 1980).

Table 1. The observed morphological characters (IBPGR, 1985).

Plant characteristics	**Head/flower characteristics**	**Seed characteristics**
Plant vigor	Head diameter (cm)	1000 seed weight (g)
Plant height (cm)	Head angle	Husk percentage (%)
Stem width (cm)	Head shape	Seed length (mm)
Branching	Head flower color	Seed width (mm)
Number of leaf	External petal color	Seed color
Leaf shape of cross section	Pollen fertility	Seed type (Oilseed / confectionary)
Leaf shape		Seed hairiness
Leaf width (cm)		
Leaf length (cm)		
Stem hairiness		
Leaf pubescence		
Leaf blistering		
Leaf serration		
Type of phyllotaxis		

RESULT

The morphological variation on the observed characters was found highly variable for most of the characters. There were no variation on pollen fertility, type of phyllotaxis, external petal color, number of head, Seed hairiness. All accessions have released the fertile pollen, with hairless seeds, dark yellow ray flower, and alternate leaf arrangements. Plants were mostly vigor. Stems were mostly pubescence. Leaf shape was observed mostly as triangular, but cordate and rounded leaves were also observed and recorded. Head angle was very variable at maturity, and all types were observed (0°, 45°, 90°, 135°, 180° and 225°). Head shapes were also presented as concave, flat, convex and misshapen. Type of branching was another diverse character, but mostly basal branching and top branching were observed. The fully branched with central head were also observed in some plants of some accessions. The variation on quantitative characters was shown in Table 2.

Principal component analysis (PCA) showed that the first five principal components (PRINs) accounted for 70.370 % of the total variation. The detailed result of principal component analysis with Latent Roots (Eigen values), Percentage Variance and Cumulative Variance values is given in Table 3. First two Principal Components (PRIN1 and PRIN2) accounted with 49.091 % of total variance. Plant height, leaf length, leaf width, seed length, Stem width and husk percentage were effective variables on PRIN1, and head size, pubescence on leaf and plant vigority were effective variables on PRIN2 to form the groups and the scattering the accessions. Only one group was formed which consist of oil types and confectionary types were separated from this groups (Figure 1). Second pairs of Principal Components (PRIN3 and PRIN4) accounted with 64.567% of total variance. Leaf shape is effective character on PRIN3 and seed length, head flower color, leaf edge and leaf shapes are effective characters on PRIN4. In this scatter one group was formed which consists of oil types and all confectionary types and some oil types with large seed were outside of this group (Figure 2). The third pairs of Principal Components (PRIN4 and PRIN5) accounted with 70.370 % of total variance were formed by the influence of effective variables seed length, head flower color, leaf edge and leaf shape on PRIN4 and type of branching, head flower color and Pubescence at stem on PRIN5. In this scatters one group were observed as in the other principal component pairs. Pattern was almost same the confectionary types were outside of the group (Figure 3).

DISCUSSION

Based on the results of the present study, sunflower landraces from west of Turkey displayed a considerable range of diversity for most of the morphological and agronomic traits studied. PC Analysis has proved as an effective method in grouping landraces that may facilitate the management and utilization in crop improvement by selecting a workable collection. The results indicated that the sunflower land races, especially the confectionary types were very variable for morphological characters. The separation and grouping of the scattered accessions within the principal components mostly depended on the types of accessions whether oilseed or confectionary types. The most of the confectionary and some long seeded oil types were scattered outside the groups in all principal components. The variation was observed not only among accessions but also within the accessions. The morphologically based groups showed some locality separation by germplasm origin, but in general, the origin did not consistent closely with the grouping pattern. The variation of the land races among and within the provinces and even in the villages on some characters brings up the consideration of the adaptation to different ecological conditions and also the different preferences of the farmers by selection. The informal seed exchange mechanism among the farmers effect the some degree of similarity of the some accessions collected from different localities of different provinces.

Tanksley and McCouch (1997) emphasized that narrowing of the genetic base occurred firstly when changing the wild species into a domesticated species and secondly when landraces were replaced by modern cultivars. Therefore the landraces, before the replacement with modern varieties should be collected, conserved and evaluated for source of breeding for the broad base. For this purposes the existing land races still growing by farmers are collected and started to characterize morphologically and use in the breeding programs of oilseed and confectionary types of sunflower.

Table 2. The statistical values of the quantitative characters.

Statistical values	Days to flowering	Days to physiological maturity	Plant height (cm)	Head diameter (cm)	1000 seed weight (g)	Husk percent age (%)
Mean	56,00	110,97	185,43	20,61	96,26	28,69
Min.	52,00	108,00	157,00	16,40	78,40	20,95
Max.	71,00	121,00	273,50	27,00	142,25	50,79
S^2 (Variance)	24,74	8,54	878,36	5,01	168,34	57,48
S (Standard error)	4,97	2,92	29,64	2,24	12,97	7,58
SE $\bar{x}$ (Standard error of the mean)	0,83	0,49	4,94	0,37	2,16	1,26
CV (%)	8,88	2,63	15,98	10,86	13,48	26,42

Statistical values	Stem width (cm)	Seed length (mm)	Seed width (mm)	Leaf width (cm)	Leaf length (cm)	Number of leaf
Mean	12,19	6,21	30,69	23,41	22,46	2,38
Min.	10,66	4,92	24,10	16,60	18,00	1,70
Max.	16,70	8,00	45,40	33,00	30,90	3,40
S^2 (Variance)	2,22	0,59	24,44	18,72	15,39	0,17
S (Standard error)	1,49	0,77	4,94	4,33	3,92	0,41
SE $\bar{x}$ (Standard error of the mean)	0,25	0,13	0,82	0,72	0,65	0,07
CV (%)	12,22	12,38	16,11	18,48	17,47	17,39

Table 3. Result of Principal Component Analysis.

PRINs	Latent Roots (Eigen values)	Percentage variance	Cumulative variance
PRIN 1	8.766	35.062	35.062
PRIN 2	3.507	14.029	49.091
PRIN 3	2.194	8.776	57.867

PRIN 4	1.675	6.700	64.567
PRIN 5	1.451	5.803	70.370

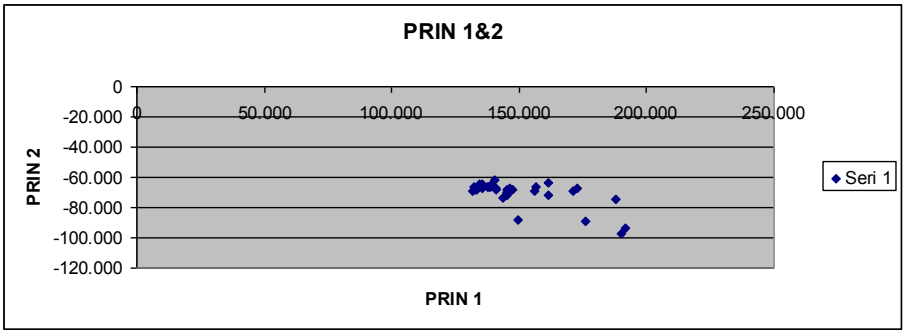

Figure 1. Distributions and grouping of the samples on PRIN1 and PRIN2.

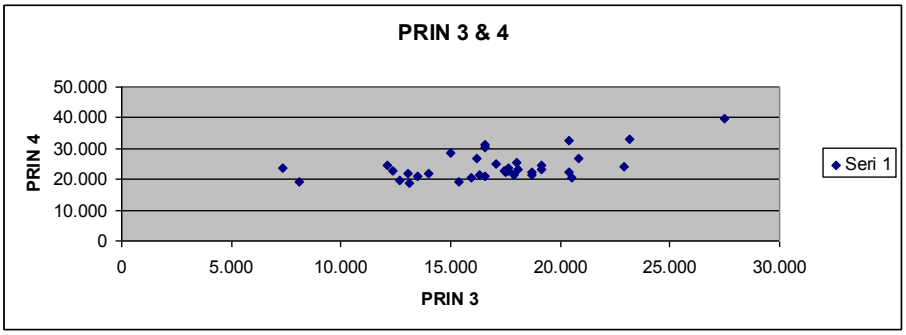

Figure 2. Distributions and grouping of the samples on PRIN3 and PRIN4.

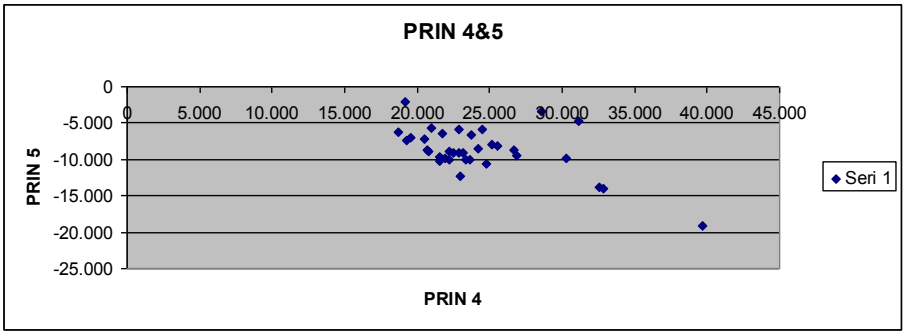

Figure3. Distributions and grouping of the samples on PRIN4 and PRIN5.

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