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Characterization of Confectionary Sunflower (Helianthus Annuus L.) Genetic Resources of Denizli and Erzurum Provinces

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ABSTRACT: *Turkey has significant and unique plant diversity and plant genetic resources. Sunflower (Helianthus annuus L.) is one of the important oilseed and confectionary crop have significant diversity in Turkey. Therefore, within the framework of National Industrial Plant Genetic Resources Project, sunflower landraces have been collected and conserved ex situ at the National Gene Bank in Izmir, Turkey. Since the characterization of local variety and land race collections is also necessary for the utilization of those resources and help to optimize the germplasm management and utilization in plant breeding program. In this study agro-morphological characterization of fifty four confectionary sunflower accessions collected from Denizli and Erzurum provinces, and maintained long-term at National Gene Bank for assessing sustainable utilization. Principal Component 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. Thirty two characters were evaluated and multivariate analysis was performed for diversity determination those of confectionary sunflower accessions. The morphological variation was found high for most of the characters. There was no variation on leaf distribution on stem, stem hairiness, branching, leaf pubescence, leaf shape, seed type, seed hairiness, head flower color, pollen fertility, disk flower anthocyanin coloration. PCA showed that the first eight principal components accounted for 73.721 % of the total variation. In all principal components very variable one group was formed. The results indicated continuous variation model of confectionary sunflower landraces. While the informal seed exchange mechanism among the farmers involve the some degree of similarity of the some accessions collected from different localities. The diversity among and between the landraces is result of adaptation of different ecologies and the farmers' selection in their preferences.*

Keywords: *Confectionary sunflower, Helianthus annuus L., diversity, morphological variation, characterization, Principle Component Analysis (PCA).*

Denizli ve Erzurum Yöresi Çerezlik Ayçiçeği (Helianthus Annuus L.) Genetik Kaynaklarının Karakterizasyonu

ÖZ: *Türkiye bitki çeşitliliği ve genetik kaynakları bakımından çok özel bir konumda bulunmaktadır. Ayçiçeği (Helianthus annuus L.) önemli yağlık ve çerezlik bir bitki olup, halen yetiştirilmekte olan yerel çeşitleri büyük bir çeşitliliğe sahiptir. Bu nedenle, Endüstri Bitkileri Genetik Kaynakları Projesi çerçevesinde ayçiçeği yerel çeşitleri toplanmakta ve ex situ olarak Ulusal Gen Bankasında muhafaza edilmektedir. Bitki genetik kaynaklarının bitki ıslah çalışmalarında kullanımını kolaylaştırmak ve kullanımını yaygınlaştırmak için yerel çeşitlerin karakterizasyonu önemlidir. Bu nedenle bu çalışmada toplanarak İzmir'deki Türkiye Ulusal Gen Bankasında uzun süreli korumaya alınan elli dört adet çerezlik ayçiçeği yerel çeşidi agromorfolojik özellikler yönünden karakterize edilmiştir. Çerezlik ayçiçeği örneklerinin çeşitliliğinin belirlenmesinde Ana Bileşen Analizi (ABA) kullanılmıştır. Ayçiçeğinin yetişme yörelerindeki ekolojik farklılıkları morfolojik çeşitliliğe neden*

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olduğundan varyasyonun kantitatif yönleri aynı koşullarda kurulan deneme ile değerlendirilmiştir. Otuz iki karakter gözlenerek ABA analizi ile değerlendirilmiş ve yorumlanmıştır. Gözlenen karakterlerden sapta yaprak dağılımı, sap tüylülüğü, dallanma, yaprak tüylülüğü, yaprak şekli, tohum tüylüğü, tabla çiçek rengi, polen fertilliği ve disk çiçeklerindeki antosiyan dışındaki tüm diğer karakterlerde morfolojik varyasyon oldukça yüksek bulunmuştur. ABA analizinde, ilk sekiz ana bileşenin toplam varyasyonunun % 73.721 olduğu belirlenmiştir. Tüm ana bileşenlerdeki örnekler tek bir grup oluşturmuş ve bazı örnekler bu grup dışında dağılım göstermiştir. Analiz sonucu, çerezlik ayçiçeklerinde morfolojik yönden sürekli bir varyasyon olduğunu ve bu yerel çeşitlerin çeşitlilik gösterdiğini teyit etmiştir. Çeşitlilik farklı ekolojilere adaptasyon yanında çiftçinin seleksiyonu rol oynamakta, benzerlikler ise farklı bölgelerdeki çiftçiler arasındaki resmi olmayan tohum değişimlerinden kaynaklanmaktadır.

Anahtar Sözcükler: *Çerezlik ayçiçeği, Helianthus annuus L., çeşitlilik, morfolojik varyasyon, karakterizasyon, Ana Bileşen Analizi (ABA).*

INTRODUCTION

Turkey is center of origin and/or center of diversity or micro-gene center for many crop species (Harlan; 1951; Tan, 2010; Karagoz *et al*, 2010). Sunflower 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 agro-morphological diversity on the landraces because of the natural selection during the adaptation and farmers selection for the desired characteristics of their preference for the consumption (Tan, 2009).

Highly organized National Plant Genetic Resources Program (NPGRP) of Turkey conducts with survey, collection, conservation both *ex situ* and *in situ* (including on farm conservation of landraces), characterization and evaluation of Turkish genetic resources and genetic diversity since 1960s (Tan, 2000; Tan, 2010). The Industrial Crops Genetic Resources Program of NPGRP is responsible for survey, collection, evaluation and characterization of industrial crops species (landraces and wild species (Tan and Tan, 2010; Tan and Tan, 201; Tan and Tan, 2012; Tan *et al*., 2012). 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. So, Industrial Crops Genetic Resources Program has yearly survey and collection program for long-term conservation of the collection at National Gene bank at Aegean Agricultural Research Institute (AARI). Three hundred seven confectionary and oilseed types of sunflower landraces has been 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; Tan, 2010; Tan 2010a; 2010b; 2010c; 2010d; Tan and Tan, 2010; Tan and Tan, 2011; Tan and Tan, 2012).

Highly variable landraces with unique characteristics are still grown by farmers in Turkey. Fragmentation of lands let farmers run several fields and to keep local landraces with application of traditional farming. 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 limitation and minimizes to competitive advantages of improved cultivars. Local 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).

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 at National Gene Bank have been characterized and evaluated for utilization at the breeding program at AARI. Ege-2001 oilseed open pollinated variety developed and registered so far, and oilseed and confectionary type of germplasm, inbreed lines [A (CMS), B (Maintainer), and Rf (Restorer)] were developed and oilseed and confectionary varieties proposed for registration by using that collection (Tan, 2010). The main objectives of the this study were to analyze the degree of similarity or differences among sunflower landraces and to determine the extent of genetic diversity in sunflower landraces based on agro-morphological traits to provide information and utilization in plant breeding program

MATERIALS AND METHODS

Fifty four confectionary sunflower accessions collected from Denizli province in West Turkey and Erzurum province in the East Turkey, and maintained long-term at National Gene Bank were characterized for assessing sustainable utilization.

The accessions were grown in two rows and fifty plants. Twenty randomly selected plants were observed from each accession. UPOV "Guidelines for the Conduct of Tests for Distinctness, Uniformity and Stability, Sunflower" were used to observe the thirty two morphological characters of plant, head/flower and seed characteristics (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 applied to conclude 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).

RESULTS

The morphological variation on the observed characters was found highly variable for most of the characters. There was no variation on leaf distribution on stem, stem hairiness, branching, leaf pubescence, leaf shape, kernel (seed) type, kernel (seed) hairiness, head flower color, pollen fertility, anthocyanin of external petal. All accessions have released the fertile pollen, and alternate leaf arrangements, hairy stem, absent branching, short hairy leaves, triangular leaf shape, confectionary type of kernel, dark yellow head flower. No anthocyanin coloration on the disk flower was observed. Plants were mostly vigor.

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

Plant characteristics
Plant height (cm)
Stem width (cm)
Branching
Leaf shape of cross section
Leaf shape
Leaf auricules
Leaf wings
Leaf pubescence
Leaf blistering
Leaf serration
Leaf width (cm)
Leaf length (cm)
Leaf distribution on stem
Stem hairiness
Stem diameter (cm)
Leaf angle of lowest lateral veins
Leaf: height of the tip of the blade compared to insertion of petiole
Head/flower characteristics
Head diameter (cm)
Head attitude
Head shape
Disk flower color
Disk flower anthocyanin coloration
Pollen fertility
Seed characteristics
1000 seed weight (g)
Seed length (mm)
Seed width (mm)
Seed main color
Seed type (Oilseed/confectionary)
Seed hairiness
Seed stripes
Seed shape

Almost all leaf characters showed variation. Leaf blistering was mainly strong and medium; Leaf serration coarse and medium; Leaf shape of cross section flat and weakly convex; Leaf auricules medium and large; Leaf wings none or very weakly expressed and weakly expressed; Leaf

angle of lowest lateral veins acute and right angle or nearly right angle; Leaf height of the tip of the blade compared to insertion of petiole low and medium. Seed shape presented mainly as elongated, narrow ovoid and broad ovoid. Seed main color was white and whitish grey; Seed Stripes was observed with all types as none or very weakly expressed, weakly expressed and strongly expressed. Head attitude was variable at maturity; mainly half-turned down with straight stem and turned down with slightly curved stem were observed. Head shapes were presented as concave, flat, convex. In case of days to physiological maturity, they exhibited high range (97-104 days) and some of the accessions from Erzurum had shorter maturity period, *i.e.* 97 days, representing earliness. Similar pattern were observed in the days of flowering (48-60 days). The variations on quantitative agromorphological characters were shown in Table 2.

Principal Component Analysis showed that the first eight principal components (PRINs) was accounted for 73.721 % of the total variation. The detailed result of PCA with latent roots (Eigen values), percentage variance and cumulative variance values were given in Table 3. First two Principal Components (PRIN1 and PRIN2) accounted with 33.272 % of total variance. Head diameter, leaf shape of cross section, leaf distribution on stem were effective variables on PRIN1 while seed length, 1000 seed weight, head shape, and seed width were effective variables on PRIN2 to form the groups and the scattering the accessions. Highly variable one group was formed and some of the Erzurum accessions and Denizli accessions were separated from the outside of this group (Figure 1).

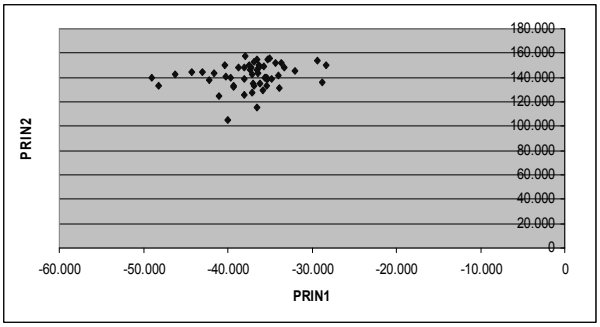

Figure 1. Distributions and grouping of the samples on PRIN1 and PRIN2.

Table 2. The statistical values of the agromorphological characters.

Statistical value	Days to flowering	Days to physiological maturity	Plant height (cm)	Head diameter (cm)	1000 seed weight (g)
Mean	50.87	100.69	206.69	21.47	152.44
Min.	46.00	97.00	162.90	16.70	80.60
Max.	60.00	104.00	226.30	25.70	183.50
S^2 (Variance)	6.61	3.43	173.22	3.19	385.82
S (Standard error)	2.57	1.85	13.16	1.79	19.64
SE $\bar{x}$ (Standard error of the mean)	0.35	0.25	1.79	0.24	2.67
CV (%)	5.05	1.84	6.37	8.32	12.89

Statistical value	Seed width (mm)	Seed length (mm)	Leaf width (cm)	Leaf length (cm)	Stem diameter (cm)
Mean	7.56	21.85	12.90	28.24	17.90
Min.	5.60	16.68	2.57	24.00	2.83
Max.	9.16	26.18	33.20	33.30	31.50
S^2 (Variance)	0.47	3.94	161.28	6.17	141.90
S (Standard error)	0.68	1.99	12.70	2.48	11.91
SE $\bar{x}$ (Standard error of the mean)	0.09	0.27	1.73	0.34	1.62
CV (%)	9.05	9.09	98.43	8.79	66.56

Table 3. Result of Principal Component Analysis.

PRINs	Latent Roots (Eigen values)	Percentage variance	Cumulative variance
PRIN 1	4.212	19.147	19.147
PRIN 2	3.107	14.124	33.272
PRIN 3	2.325	10.569	43.841
PRIN 4	1.970	8.956	52.797
PRIN 5	1.398	6.352	59.149
PRIN 6	1.222	5.554	64.703
PRIN 7	1.110	5.047	69.750
PRIN 8	0.874	3.971	73.721

Second pairs of Principal Components (PRIN3 and PRIN4) accounted with 52.797% of total variance. Leaf shape of cross section, leaf width, physiological maturity and plant height were effective character on PRIN3 whereas leaf width, leaf length, and leaf blistering were effective characters on PRIN4. In this scatter one compact group was formed and some accessions of Erzurum province with tall plant heights and with long vegetation period were split out this group (Figure 2).

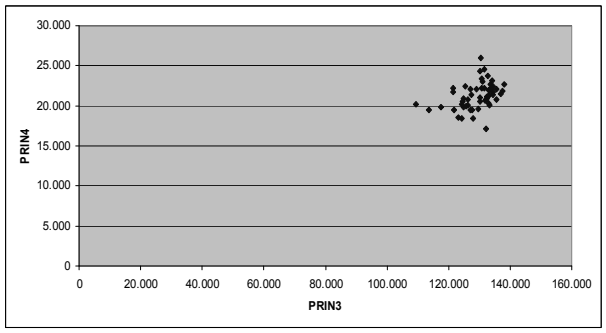

Figure 2. Distributions and grouping of the samples on PRIN3 and PRIN4.

The third pairs of Principal Components (PRIN5 and PRIN6) accounted with 64.703% of total variance were formed by the influence of effective variables leaf blistering on PRIN5 and head attitude on PRIN6. In this scatters, one group were observed as in the other principal component pairs. Pattern was almost same with other scatters and some accessions were scattered outside of the group (Figure 3). The accessions in this group were very distinct from each other mainly with their very variable characteristics of head attitude. Some of the Erzurum and Denizli accessions were scattered from the group in different directions.

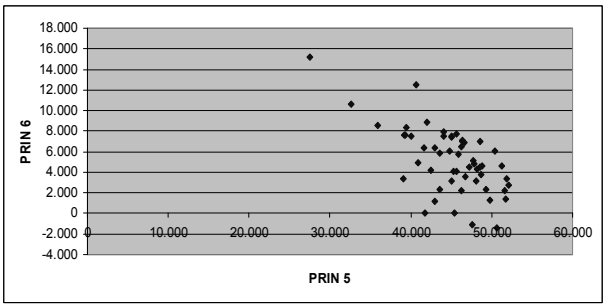

Figure 3. Distributions and grouping of the samples on PRIN5 and PRIN6.

The fourth pairs of Principal Components (PRIN7 and PRIN8) accounted with 73.721% of total variance were formed by the influence of effective variables, leaf distribution on stem, plant height, and seed stripes on PRIN7 and leaf distribution on stem, leaf blistering, seed shape and plant height on PRIN8. In this scatters one group were observed (Figure 4). The distribution pattern was very diverse.

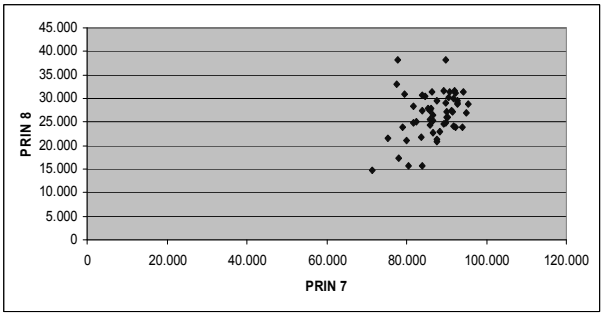

Figure 4. Distributions and grouping of the samples on PRIN7 and PRIN8.

DISCUSSION

Results of the present study showed that the confectionary sunflower landraces from Denizli (in the west Turkey) and Erzurum provinces (from East of Turkey) displayed a considerable range of diversity for most of the morphological and agronomic traits. The results indicated that the confectionary sunflower landraces especially were very variable for morphological characters. The variation was observed not only among accessions but also within the accessions. The most of the confectionary and some long seeded oil types were scattered outside the groups in all principal components. 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 confectionary type of landraces 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. While the informal seed exchange mechanism among the farmers affect the some degree of similarity of the some accessions collected from different localities. The diversity among and between the landraces is result of adaptation of different ecologies and the farmers' selection in their preferences.

PC Analysis has proved as an effective method in grouping landraces that may facilitate the management and utilization in crop improvement by selecting a set of collection. 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 broaden the genetic base. For this purposes the existing confectionary landraces still growing by farmers are collected and characterized morphologically to use in the breeding programs of confectionary types of sunflower.

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