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GENETIC RESOURCES OF SUNFLOWER (*Helianthus annuus* L.) IN TURKEY

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SUMMARY

Plant genetic resources are currently of great interest since they are related to the satisfaction of people's basic needs and to the solution of severe problems such as hunger and poverty. Turkey is one of the significant countries for the plant genetic resources and plant diversity. The conservation of plant genetic resources is necessary for the sustainable protection of genetic diversity, since Turkey encompasses areas of major centers of crop diversity and the centre of origin for globally significant crops, fodder plants and forages. Landraces of many of these crops are still used within traditional farming systems and pastures. Wild relatives and endemic species of the crop are found in their natural habitats in the rangelands and forest areas which occupy different ecosystems. The flora of Turkey consists of high endemism, about 3000 out of 9500 plant species. Turkey is described as microcenters for many crops also. The importance of the protection of existing plant diversity is highly recognized and various conservation programs exist. The National Plant Genetic Resources and Plant Diversity Program (NPGRDP) operate under the coordination of Aegean Agricultural Research Institute (AARI) of Ministry of Agriculture and Rural Affairs (MARA) involves *ex situ* (since beginning of 1960s) as well as *in situ* conservation, including on farm conservation (since 1990s).

The new uniform and high yielding varieties used in modern agriculture causes the erosion of genetic diversity of landraces, old and local cultivars. The collection and characterization of those genetic resources become very essential. Sunflower (*Helianthus annuus* L.) is one of the important oilseed crops for Turkey and sunflower landraces have significant diversity in Turkey as being one of the "Centres of Diversity" for sunflower. The existing sunflower landraces were collected within the framework of NPGRDP and maintained long term as *ex situ* at National Gene Bank and characterized for better understanding of the eco-geographic variation of sunflower landraces throughout the region, as well as for assessing sustainable utilization of those collections. The genetic resources of Turkey, eco-geographical distribution of sunflower lan-

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draces and the characterization result of agro-morphological variation of National sunflower collection are presented.

Key words: **sunflower, *Helianthus annuus* L., *ex situ* conservation, diversity, agro-morphological variation, eco-geographical variation**

INTRODUCTION TO NATIONAL PLANT GENETIC RESOURCES PROGRAM

Turkey is the center of origin and/ or center of diversity and micro genes for many crop species (Tan, 2009; Karagoz *et al.*, 2010). Two Center of Origins are situated in Anatolia. Turkey is also described as a microcenter for some crop species that are not originally from Turkey and they are different in many characteristics. Turkey is the meeting place of three phytogeographical regions: Euro-Siberian, Mediterranean and lrano-Turanian. Turkey's wealth in plants is apparent, which is proved by the fact that 3,000 out of the 9,500 plant species are endemic to the area.

Landraces are found in the areas where crop species first arose through domestication. Turkey also lies within the broad region of domestication of crops. Therefore, there are highly variable domesticated crops as well as landraces with unique characteristics. However, the adaptation of new crop cultivars, nitrogenous fertilizer, and increasing commercialization in agriculture has reduced the area of local crop production. While high yielding modem cultivars predominate, the local landraces are still cultivated in some of the regions.

"The National Plant Genetic Resources and Plant diversity Program of Turkey" has been highly organized since 1960s by the means of surveys, collections, conservations both *ex situ* and *in situ* (including farm conservation of land races), characterization and evaluation of existing genetic resources and genetic diversity (Tan, 2000; Tan, 2009; Tan, 2010a; Tan, 2010b). While many environmental factors affect the loss of wild species, the threatening factors 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.

Plant genetic resources activities started in 1963. Because of the importance of Turkey for plant genetic resources, these activities were reorganized in 1976 within the framework of National Plant Genetic Resources Research Project (NPGRRP). AARI has then become National Project Coordination Institute. Department of Plant Genetic Resources is responsible from the coordination of activities. The objective of national program is the exploration, collection, conservation (both *ex situ* and *in situ*), and evaluation of existing plant genetic resources and plant diversity including mushrooms of Turkey, not only for the present, but the future as well.

The *ex situ* conservation is implemented both for generative and vegetative collections which are preserved in seed gene and field gene banks, respectively. National Genebank at AARI has very modern facilities and international standards with 13 cold rooms working at -18°C for base collection, 0°C for active collection and 4°C for temporary storage. The national collection at National Genebank contains the landraces, wild and weedy relatives (both for seed and vegetative collections), other wild species which are important, especially in the economic terms (medicinal, aromatic, ornamentals *etc*.) and endemic plant species. The main users of the material are the plant breeders and researchers both from Turkey and abroad. The collecting activities are planned by giving the priority to the region and/or plant species under threat or to the plant species of interest for other national programs. Most of the collection kept in the gene banks is the representative of the existing variation of populations found in their growing site or where they are collected (Tan, 2010a; Tan, 2010b).

Today, about 55.500 accessions over about 2700 species are kept in the National Gene Bank at AARI, Izmir and about 10.000 field crop species accessions, including safe duplicates of AARI National Gene Bank are kept at Turkey Gene Bank in Ankara, The Gene Bank of Field Crop Central Research Institute. Total accessions at two gene banks at Izmir and Ankara include more than 65.000 accessions (Tan, 2010a; Tan, 2010b).

About 7000 vegetatively propagated materials with about 100 species, mainly fruit genetic resources, are kept in the field gene banks at 15 national institutes (including AARI). The 31250 herbarium specimens of national collection and 161 moss and lichen collection specimens with 50 Genus are kept at AARI Herbarium with modern facilities. About 700 macro mushroom specimens are preserved at AARI fungarium.

In situ conservation is aimed at the maintenance of the wild crop relatives or genetic resources of wild plant species in their natural habitats and local races in their cultivated localities on-farm. The first project started in 1993 with the purpose to focus on the conservation of genetic diversity of wild crop relatives and wild fruit species in their natural habitats. The second project is *In situ* Conservation of Threaten Species and Management of Their Ecosystem. This project was carried out at wetlands in Central Anatolia between 2000 and 2003. The third project was conducted on selected landraces on-farm conservation in North West Transitional Zone. During those projects the focused and associated species were collected and conserved *ex situ*.

COLLECTION, CONSERVATION AND CHARACTERIZATION OF SUNFLOWER GENETIC RESOURCES

Sunflower which originally comes from the North America (Zeven and de Wet, 1982) is an important vegetable oil source in Turkey, as well as in the world.

Although Turkey is not the origin of sunflower, there is a great morphological diversity of the land races because of the natural selection during the adaptation, as well as farmers' selection for the desired characteristics necessary for the consumption. Those factors affect even modern farmers and influence them to keep their landraces or traditional crops (Tan, 2002; Tan, 2010a; Tan, 2010b):

1. Fragmentation of land allows farmers to manage several fields and to keep local landraces,
2. Marginal agronomic conditions, especially steep slopes and heterogeneous mountain soil, make local landraces competitive with improved cultivars, at least when farming system are taken into account,
3. Economic isolation creates market imperfection and decreases the competitive advantages of improved cultivars,
4. Cultural identity, traditions and preference of diversity make farmers keep local landraces.

The National Plant Genetic Resources Research Project concentrated on the collection and conservation of plant species either under threat, or required by the National Crop Research Projects. In both cases the direct and indirect benefits are derived from these efforts. The improved varieties released from the National Plant genetic resources collection are the direct benefit of the countries belonging to the agricultural sector.

"The Industrial Crops Genetic Resources Program", as a part of National Program, has a responsibility to collect various industrial crops landraces and wild species for long-term conservation at National Gene bank at Aegean Agricultural Research Institute (AARI), and characterizes the collections at the gene bank (Tan *et al.*, 2010; Tan, 2010a; Tan, 2010b).

From different provinces and different sources, like fields, farmer storage and local markets of the villages, three hundred nine confectionary types and oilseed type sunflower land races were collected and permanently stored at National Gene Bank. Figure 1 shows the collection sites of sunflower land races. The collection, passport and characterization data are stored in the National Plant Genetic Resources Data Base (Tan and Tan, 1998a; Tan and Tan, 1998b).

The characterization and evaluation program of plant genetic resources is being carried out with the collaboration of National Crop Research and Breeding Program. Therefore, the respective crop scientists (breeder/agronomist, pathologist) get opportunity to evaluate and identify the accessions for their utilization in crop improvement program. The utilization of plant genetic resources could be further enhanced if that material is fully evaluated and utilized by research scientists.

The genetic diversity plays an important role in plant breeding. Since hybrids of parental lines with diverse origin generally display a greater heterosis than those between closely related parents (Tan, 1993; Tan, 2005), the characterization of existing sunflower collection is essential for the breeders. Characterization of genetic resources collections of confectionary and oilseed sunflower is important for the assessment of the collection diversity enhanced utilization. The existing sun-

flower collections began to be characterized and evaluated for utilization at the breeding program at AARI. About 2000 oilseed open pollinated varieties have been developed and registered so far, as well as oilseed and confectionary type of germplasm and varieties proposed for registration (Tan, 2010).

The morphological variation on the observed characters was found highly variable for some characters. Twenty-six morphological characters of plant, head/flower and seed characteristics have been observed (Table 1).

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

Plant characteristics	Head/flower characteristics	Seed characteristics
Plant vigority	Number of head	Husk percentage (%)
Plant height (cm)	Pollen fertility	Seed length (mm)
Stem width (cm)	External petal color	Seed shape
Stem color	Head flower color	1000 seed weight (g)
Pubescence at stem	Head size (cm)	
Type of branching	Head angle	
Number of leaf	Head shape	
Leaf color	Head weight (kg/a)	
Pubescence on leaf		
Leaf wing		
Leaf edge		
Leaf shape		
Leaf width (cm)		
Leaf length (cm)		

There was no variation of pollen fertility. All accessions released the fertile pollen. Plants were mostly vigor. Stems were mostly pubescence. Leaf shape was observed mostly as triangular, but cordate and rounded leaves were also noticed and recorded. Head angle vas very variable at maturity, and all types were observed (0°, 45°, 90°, 135°, 180° and 225°). There were also concave, flat, convex and misshapen heads. The type of branching was another variable character, but mostly basal branching and top branching were observed. A fully branched central head was also observed in some plants of some accessions. The variation on quantitative characters was shown in the Table 2, with minimum, maximum values and variances of the characters (Tan 2010; Tan and Tan, 2011).

Table 2: The variation on the quantitative characters (Tan and Tan, 2011)

Statistical values	Days to flowering	Days to maturity	Plant height	Head size	1000 seed weight	Husk percentage	Seed Length	Number of leaf	Leaf width	Leaf length	Stem width
			(cm)	(cm)	(g)	(%)	(mm)		(cm)	(cm)	(cm)
Min.	52.00	108.00	157.00	16.40	78.40	20.95	10.66	26.00	16.60	18.00	1.70
Max.	70.00	115.00	238.80	27.00	109.00	40.73	14.92	43.00	29.00	24.60	3.40
Mean	54.93	110.29	174.36	20.04	92.55	25.87	11.57	30.43	21.48	20.60	2.23
S^2 (Variance)	16.8095	3.1005	302.6380	4.4914	81.1013	19.2756	0.6667	13.0688	5.9906	3.1807	0.1015
S (Standard error)	4.10	1.76	17.40	2.12	9.01	4.39	0.82	3.62	2.45	1,78	0.32
SE $\overline{X}$ (Standard error of the mean)	0.7748	0.3328	3.2876	0.4005	1.7019	0.8297	0.1543	0.6832	0.4625	0.3370	0.0602
CV (%)	7.46	1.60	9.98	10.58	9.73	16.97	7.06	11.88	11.40	8.66	14.27

Sunflower land races, especially the confectionary types were very variable taking morphological characters into account. The distinct separation on the morphology of accessions mostly depended on the types of accessions whether oilseed or confectionary types. The variation was also observed, not only among accessions, but also within the accessions.

Although locality separation by germplasm origin was observed in the accessions, generally, the origin did not correspond closely with the grouping pattern. The variation of the land races among and within the provinces and even in the villages brought up the consideration to adapt to different ecological conditions and also the different preferences of the farmers selection. The similarity of some accessions collected from different localities of different provinces may result in the informal seed exchange mechanism among the farmers (Tan 2010; Tan and Tan, 2010).

Figure 1: Sunflower land races collection sites in Turkey.

Landraces show varying degrees of morphological and genetic integrity and may change with time, but they are recognized by farmers on the basis of a number of morphological and agronomic criteria. However, genetic resources scientists and breeders may look to preserve in particular are crops and their varieties, as a means of ensuring that the maximum possible range of plant genetic resources is available today and in the future. Therefore the landraces, should be collected before the replacement with modern varieties, conserved and evaluated as a source of breeding. For this purposes the existing sunflower land races of oil and confectionary types still grown by farmers are collected and characterized morphologically and used in the sunflower breeding programs.

Sunflower genetic resources have been used in sunflower breeding program to develop new varieties. Improved germplasm, and breeding lines (A, B and *Rf* lines)

of oilseed and confectionary type of sunflower germplasm, hybrids and open pollinated variety (Ege 2001) have been developed by conventional breeding techniques. New oilseed and confectionary type of sunflower hybrids and open pollinated varieties will be released next year.

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