

Plant Genetic Resources Conservation in Turkey

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Abstract

Turkey is located at a significant position in the world from the viewpoint of plant genetic resources and genetic diversity. It is scientifically agreed that two of the Centers of Diversity and Centers of Origin; the Near Eastern and the Mediterranean overlap at Turkey. Turkey is the meeting ground of three phytogeographical regions; Euro-Siberian, Mediterranean and Irano-Turanian. Due to its great variety in geomorphology, topography and climate, Turkey has large diversity of habitats so it is very rich in plant species and endemism. Based on the information given by Davis (1965-1985) and Davis et al. (1988) the number of native ferns and seed plant species were stated as 8.745 by Kaya et al. (1998), 2.763 of which are endemic. In addition to these figures about 1.000 new species were listed by Güner et al. (2000). Altogether the number comes to a total of approximately 10.000. Conservation of genetic diversity in crop plants and their wild relatives is essential for Turkey. Status and conservation strategies of plant genetic diversity are discussed in this paper.

INTRODUCTION

Turkey is located at a unique position from the viewpoint of plant genetic diversity. There are about 10.000 plant species in a total land area of 78 million hectares. Richness in plant diversity is mainly due to rich variety of topography and climate over short distances. Two of the gene centers The Mediterranean and The Near-Eastern Gene Centers overlap in Turkey (Vavilov, 1994). Turkey is center of origin and/or diversity of many economically important crop plants as well as other plants. Some of the economically important plant species originating in Turkey are *Allium*, *Avena*, *Beta*, *Cicer*, *Lens*, *Linum*, *Medicago*, *Pisum*, *Secale*, *Trifolium*, *Triticum*, *Amygdalus*, *Cucumis*, *Malus*, *Pistachia*, *Prunus*, *Pyrus* and *Vitis*.

Agriculture and horticulture have a long history in Turkey. The information gathered from several excavations suggests that agriculture started to evolve in Anatolia almost 10.000 years ago. Early sites and crop remains found in these sites are given in Table 1 (Harlan, 1992).

Many scientists agree that wheat and barley were first domesticated in the Fertile Crescent of the Near East. Fertile Crescent is defined as a semi circle covering Palestine, Israel, western part of Syria, southeastern Turkey, eastern Iraq and western part of Iran. In addition to the previous information, several papers were published recently claiming that, wheat was first domesticated in Karacadağ of Turkey. Karacadağ is a volcanic mountain in the northern part of the Fertile Crescent. The scientists came to the conclusion after analyzing thousands of accessions collected from different regions of the world including Karacadağ (Heun et al., 1997; Diamond, 1997; Nesbit & Samuel, 1998; Lev-Yadun et al., 2000).

PHYTOGEOGRAPHIC REGIONS

Phytogeographically there are three regions overlapping in Turkey. These regions are Euro-siberian, Mediterranean and Irano-Turanian. Euro-Siberian Region extends along the most of North Anatolia in a narrower strip at European part of Turkey. Climatically this region is the rainiest one. In the eastern part annual precipitation exceeds 2.000 mm where tea is also grown. Most of the region is covered with forests. Some of the characteristic plants of the region are: *Abies nordmanniana*, *Acer campestre*, *Alnus glutinosa*, *Argyrolobolium calcynicum*, *Calamintha grandiflora*, *Carpinus betulus*, *Coryllus avellana*, *Coryllus corulna*, *Crataegus microphylla*, *Diospyros lotus*, *Euphorbia*

amydaloides, *Fagus orientalis*, *Galium odoratum*, *Hypericum bupleuroides*, *Lathyrus roseus*, *L. aureus*, *Lilium ponticum*, *Lycopodium* spp., *Papaver lateritium*, *Picea excelsa*, *Pinus nigra*, *P. sylvestris*, *Primula cortusifolia*, *Pyrola* spp., *Quercus* spp., *Ranunculus brutius*, *Rhododendron* spp., *Salvia glutinosa*, *Smilax excelsa*, *Trachystemon orientale*, *Tilia tomentosa* and *Valeriana alliariifolia*.

Mediterranean region covers all areas bordering Mediterranean and southwestern part of the Thrace Region. Although west and south Anatolia share many leading species, there are considerable floristic differences, noticed at higher altitudes and in regard to endemism, which is considerably higher in Taurus than in the west. Evergreen shrubs, red pine and macchie dominate many of the Mediterranean territory. Characteristic plants of the region are: *Amygdalus orientalis*, *Arbutus* spp., *Cedrus libani*, *Ceratonia siliqua*, *Cistus creticus*, *Juniperus oxycedrus*, *Laurus nobilis*, *Lavandula stoechas*, *Myrtus communis*, *Nerium oliender*, *Olea europea*, *Pinus brutia*, *P. nigra*, *P. pinea*, *Pistacia lentiscus*, *P. terebinthus*, *P. atlantica*, *Sarcopoterium spinosum*, *Prunus microcarpa*, *Pyrus elaeagnifolia*, *Quercus* spp., *Styrax officinalis*, *Thymbra spicata* and *Vitex agnus-castus*.

Irano-Turanian Region is the largest. In a broad sense it extends from central Anatolia to Mongolia in the east. Climate of the region is continental and generally step vegetation dominates in the region. Some of the characteristic plants of the region are: *Acantholimon* spp., *Achillea* spp., *Artemisia* spp., *Astragalus* spp., *Bromus* spp., *Crataegus orientalis*, *Euphorbia tinctoria*, *Isatis glauca*, *Juniperus excelsa*, *Linum hirsutum*, *Medicago* spp., *Noaea mucronata*, *Onobrychis* spp., *Peganum harmala*, *Phlomis armeniaca*, *Pistacia khinjuk*, *Poa bulbosa*, *Prunus* spp., *Pyrus* spp., *Quercus* spp., *Rhamnus* spp., *Stipa* spp. and *Teuchrium orientale*. Phytogeographic regions of Turkey is shown in figure 1.

ENDEMISM

Turkey is rather rich in endemism. About 32 % of the plant species are endemic. Endemic plants are scattered in the Asian part. There are only 27 endemic species in the European Turkey. The first three genus with the highest number of endemics are *Astragalus*, *Verbascum* and *Centaurea*. List of ten genera with high number of endemics, their number and rate of endemism are given in table 2 (Kaya et al., 1998).

Among the plant families, *Compositae* takes the first place with having the highest number of plant species, followed by *Leguminosae* and *Labiatae* with 1168, 993 and 554 species respectively. The list of 10 seed plant families with large number of species in Turkey is given in table 3 (Kaya et al., 1998).

IMPORTANT ENDEMISM CENTERS OF TURKEY

Endemic plant species are concentrated at several locations mainly at the mountainous parts of the country. The highest number of endemics is found on Taurus Mountains mainly the central Taurus. Amanus Mountains in the south, Kaz Dağı Mountain in the North west, Antitaurus, North transition zone, northern and southern parts of Eastern Anatolia as well as Salt Lake in the center are other endemic rich regions of Turkey (Fig. 2).

Among the phytogeographic regions, Irano-Turanian has the highest number of endemic plants followed by Mediterranean and Euro-Siberian Region. Distribution of endemic taxa according to phytogeographical regions is given in table 4 (Kaya et al., 1998). It should be noted that some endemic taxa, which are represented in more than one region are not included in the list, therefore the total number in the table is less than to the country total of endemics.

WILD RELATIVES OF CULTIVATED CROPS

Turkey is the center of origin for many economically important crop plants such as the wild relatives of cereals. As mentioned above Anatolia is the meeting place of two centers of diversity and centers of origin. Turkey is one of the centers of origin of the economically important plant species such as *Triticum*, *Hordeum*, *Secale*, *Avena*, *Linum*,

Allium, *Cicer*, *Lens*, *Pisum*, *Medicago* and *Vicia*. About 25 wheat (*Triticum* and *Aegilops*), 8 barley (*Hordeum*), 5 rye (*Secale*) and 8 oats (*Avena*) relatives exist in Turkey. Turkey is also rich in wild food legumes and wild forages. There are 4 wild lentil (*Lens*), 10 chickpea (*Cicer*), 104 *Trifolium* (11 endemic), 34 alfalfa (*Medicago*), 42 sainfoin (*Onobrychis*), 60 vetch (*Vicia*) species (6 endemic) and 59 species of chickling vetch (*Lathrus*) species (20 endemic) in Turkey (Acikgöz et al., 1998). Turkey is described as microcentres for *Amygdalus* spp., *Cucumis melo*, *C. sativus*, *Cucurbita moshata*, *C. pepo*, *Malus* spp., *Pistachio* spp., *Prunus* spp., *Pyrus* spp. and *Vitis vinifera* (Tan, 1998).

FOREST GENETIC RESOURCES

Forests cover about 20.2 million hectare, which is about 26 % of the total surface area. Forests are mainly concentrated at the coastal areas. The plants in this group include the natural or cultivated species used as fuel wood, or in timber industry. The forest trees also serve for protective (prevention of erosion and climatic, hydrologic and air pollution) and recreational purposes. Important forest trees are the followings: Pine species (*Pinus brutia*, *P. nigra*, *P. sylvestris*, *P. halepensis* and *P. pinea* (Stone pine), fir species (*Abies nordmanniana* subsp. *nordmanniana*, *A. nordmanniana* subsp. *bornmulleriana*, *A. nordmanniana* subsp. *equitrojani*, *A. cilicica* subsp. *cilicica*, *A. cilicica* subsp. *isaurica*), true cedar (*Cedrus libani*), beech (*Fagus orientalis*), oriental spruce (*Picea orientalis*), linden (*Tilia*), red alder (*Alnus* spp., 2 species), junipers (*Juniperus* spp., 8 species), oaks (*Quercus* spp., about 20 species). Number of woody plant species found in Turkey is 564, 76 of which are endemic.

FACTORS THREATENING PLANT GENETIC RESOURCES

It is generally accepted that present steppe dominant vegetation in great portion of the country is the result of long-term anthropogenic effects. Majority of the area was covered with forests in the past. Historically Turkey has been a pathway for many civilisations and hosted many of them. Movement of communities contributed to enrichment of genetic diversity by transferring mainly the cultivated species as well as the seeds of wild plants from one place to another. Threat to plant genetic resources begins with increase in population. The changes have become faster in the last century due to (1) agricultural activities (e.g., ploughing pastures for cultivation, over grazing in pastures, burning the stubble, excessive use of fertiliser and chemical, extension of high yielding cultivars); (2) industrialisation, urbanisation and construction of highways and dams; (3) harvesting plants from nature; (4) forestry activities and fires; (5) tourism activities particularly after 1950s.

As a result of the above mentioned and several other threats to biodiversity, significant portion of the endemic plant species are endangered. It was reported in The Red Data Book (Ekim et al., 1989) that about two third of the plant species in Turkey is under threat at several levels. Distribution of endemic plant species according to former IUCN danger categories is given in table 5.

CONSERVATION OF PLANT GENETIC DIVERSITY IN TURKEY

Legislative Status

Although the items in the Turkish Constitution are not directly related to the conservation of plant genetic diversity, the article 63 of the Constitution states that the government should protect its historical, cultural and natural values and resources as well as support and promote conservation efforts made by people. The Regulation on Collection, Conservation and Utilisation of Plant Genetic Resources puts forward the responsibilities of the related institutions, ministries and universities on several aspects of plant genetic resources in Turkey. The Regulation on the collection, production and export of wild flower bulbs (1995) is another important legislation to enable sustainable harvest of bulbs from the nature. In addition to these, the Law for Protection of Cultural

and Natural Values, Environmental Law, National Parks Laws, Bosphorus Law, Law for Specially Protected Regions, Pasture Law and Forestry Law provide opportunities for protection of nature and biological diversity, and facilitate activities related to the conservation of plant genetic diversity at different sectors.

International Agreements and Cooperation

Turkey has aimed to participate actively and to take in control the trade and conservation of natural and biological resources by signing several international agreements. A few of the important ones are; Convention on Conservation of European Wildlife and Habitats, Bern (1979), Convention on Protection of Internationally Important Wetlands Providing Habitats for Birds, Ramsar (1975), Agreement on Trading of Wildlife and Plant Species, Washington (1973), Convention on Biological Diversity, Rio (1992). The country gives solid efforts for the implementation of these international agreements.

Turkey is member in many of international biodiversity related organisations such as World Bank, United Nations, Education, Science and Cultural Organisation, International Union for the conservation of Nature and Natural Resources, World Wide Fund for Nature, United States, Council of Europe-Center Naturopa, United Nations-Food and Agriculture (FAO), International Commission on Plant Genetic Resources- FAO, International Plant Genetic Resources Institute (IPGRI), International Center for Agricultural Researches in Dry Areas (ICARDA), International Center for Maize and Wheat Breeding, The Union of International Forest Research Organization (IUFRO), United Nations Development Program (UNDP), European Cooperative Program for Crop Genetic Resources Networks (ECP/GR), European Forest Genetic Resources Program (EUFORGEN).

Institutes Holding Plant Genetic Resources

Ministry of Agriculture and Rural Affairs (MARA), and Ministry of Forestry, are the leading institutions for implementation of the laws and regulations related to the conservation of natural resources. Aegean Agricultural Research Institute (AARI) is the leading responsible unit for conservation of plant genetic diversity of cultivated plants under the MARA where the main gene bank of the country is located. This institute provides coordination and cooperate especially with Central Research Institute for Field Crops, which has another gene bank to conserve the field crop genetic resources as well as the safety duplicate of the material stored at the AARI gene bank.

MARA has 56 research institutes working under the umbrella of The General Directorate of Agricultural Research (GDAR) and several production stations. Apart from storing seed material, there are a series of field gene banks of fruit tree species in each subject matter institutes like hazelnut, olive, fig, apricot, grape and Yalova Atatürk Central Horticultural Research Institute. It was reported by Gönülşen (1986) that there were 86 institutions holding fruit and grape genetic resources.

At the present all the subject matter horticultural research institutes and the production stations keep certain number of horticultural genetic resources as field gene bank. Number and kind of the genetic resources material kept at some of the major subject matter research institutions are as follows (GDAR, 2001):

Yalova, Atatürk Central Horticultural Research Institute; 301 apple, 30 apricot, 14 blackberry, 31 chestnut, 16 cornelian cherry, 3 currant, 9 fig, 4 goose berry, 12 kiwi, 121 grape, 27 nectarine, 30 olive, 7 persimmon, 64 plum, 297 pear, 119 peach, 37 pomegranate, 13 raspberry, 37 sour cherry, 14 strawberry, 177 sweet cherry and 156 walnut

Izmir, Olive Research Institute; 124 olive

Tekirdağ, Grape research Institute; 1494 grape

Gaziantep, Pistachio Research Institute; 38 pistachio, 40 grape, 25 almond

Malatya, Horticultural Research Institute; 218 apricot, 4 sour cherry, 2 quinsy, 13 apple, 21 almond, 9 pear, 20 raspberry, 22 walnut, 48 sweet cherry, 10 plum, 13 peach, 8

cornelian cherry

Erzincan, Horticultural Research Institute; 53 pear, 66 apple, 5 quinsy, 20 plum, 13 sweet cherry, 3 apricot, 30 grape.

The number of non-governmental organizations (NGOs) and their activities are improving every day. But, their contribution is not at desired level at the moment due to their inadequate budgets. However the Turkish Society for Protection of Nature (SPN), Foundation for Turkish Nature Conservation (FTNC), Turkish Erosion Prevention Foundation (TEPF), the Foundation of Conservation Afforestation and Natural Resources, Turkish Environmental Foundation efficiently involve in public awareness activities on conservation and restoration of environment.

Apart from the economically important agricultural plants, forest genetic resources are conserved in various categories in Turkey. Total of forest conservation areas is 3.749.673 ha. Conservation types, number and size of conservation areas given in Table 6 (Kaya et al., 1998).

In Situ Conservation

Ex situ conservation has been the most widely accepted and implemented strategy for conserving plant genetic diversity, because it is reasonably easy and cost effective. Therefore many ex-situ conservation programs such as gene banks, clone banks, collection gardens were established worldwide up to today. Although it is a very effective strategy, there are several drawbacks associated with it. The main problem is that ex-situ conservation strategy does not allow continued evolutionary changes in plant populations due to lack of interactions between plants and their environments. In addition to this, they are able to represent only a very small portion of genetic diversity.

For the maintenance of genetic diversity, complex interactions and evolutionary changes should be involved in the conservation program. In situ conservation is a dynamic process and provides media for continued evolution of the target species with associated organisms. The purpose of in-situ conservation programs is to conserve variable populations of target species in their natural environment so that their genetic diversity can be maintained.

Turkey has accumulated rather an extensive experience on ex-situ conservation. But in-situ conservation of wild relatives of agricultural plants to complement ex-situ conservation programs has not been practised until 1993. After signing the CBD, Turkey planned to start an extensive in situ conservation program for selected crop wild relatives, some fruit trees and forest tree species with a fund provided by the GEF. Ministry of Agriculture (MARA), Ministry of Forestry (MOF) and Ministry of Environment (MOE) were the principle partners of the project. Main target species selected in the frame work of the project were 5 progenitors of wheat namely *Aegilops speltoides* ssp. *speltoides*, *A. speltoides* spp. *ligustica*, *A. squarrosa*, *Triticum boeoticum* and *T. dicoccoides*; 2 fruit species plum and chestnut, and some forest tree species such as *Abies equi-trojani*, *Pinus brutia* and *P. nigra*. Selected sites for the project were Ceylanpinar State Farm at the south eastern part, Kazdağ at the north west and Amanos Mountains on the Anatolian Diagonal at the south. The project is the largest one in the world among similar projects, from the viewpoint of number of target species and the area covered.

There are various models for in situ conservation of genetic resources of wild relatives of crop plants and forest trees. However, one type of in situ conservation program is that the Gene Management Zone (GMZ) approach seemed to be convenient for wild relatives of crop species and commercially important tree species. GMZs are in-situ gene conservation areas where the evolutionary processes take place in populations of endangered, or economically important plant species as well as species with high potential of genetic diversity and differentiation. The primary function of GMZs is protection of genetic resources either as a single target species or as entire community, but it could be also managed for other economic benefits such as grazing and timber harvesting as long as the other uses do not threaten the primary function of GMZ. In site selection or population selection, highest priority is to capture the core variability within

the species in the areas that represent the variability of the region.

The project has been designated around the following five components:

- a. Site survey and inventories
- b. Designation of GMZs
- c. Data management
- d. Development of a National Plan for in situ conservation
- e. Provide the institutional strengthening within and between MARA, MOF and MOE.

The project has started in 1993 and continued for 5 years. As a result of the project 6 sites were selected at the Ceylanpınar State Farm for wild wheat relatives (Karagöz, 1998). Additionally several sites were selected as GMZ for in situ conservation of the other target species. The project has given impetus to development of infrastructure for data management and determination of genetic diversity by means of modern biotechnological methods. A Geographical Information System (GIS) for data management and monitoring the selected sites was developed. The GIS and Remote Sensing Laboratory of the MARA was developed to serve as the thematic Clearing House Mechanism of the country, which is one of the obligations set by the CBD. Another significant outcome of the project is the preparation of the National Plan for In situ Conservation of Genetic Diversity, which is another obligation set by the CBD. The National Plan functions as a useful guide to plan short and long-term conservation objectives and activities. The project has been a model for similar conservation activities to be arranged at the other parts of the country.

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Tables

Table 1. Plant remains from selected early sites.

| Approximate dates (BC) | Sites | Plants |
|-------------------------------|--------------|------------------------------------------------------------------------------------------|
| 7200-6500 | Çayönü | Wild einkorn, emmer and barley; domesticated einkorn, emmer, pea, lentil, vetch and flax |
| 6750 | Hacılar | Wild einkorn; domesticated emmer |
| 6500 | Can Hasan | Wild einkorn; domesticated einkorn, emmer, wheat, barley (2 rowed), lentil, vetch |
| 6000-5000 | Çatal Höyük | Domesticated einkorn, emmer, wheat, barley (naked), pea, vetch |
| 6000-5000 | Erbaba | Domesticated einkorn, emmer, wheat, barley (2 rowed and naked), pea, lentil, vetch |

Table 2. List of 10 genera with high number of endemism.

| Genera | No of species | No of endemic species | Rate of endemism (%) |
|---------------------|----------------------|------------------------------|-----------------------------|
| 1 <i>Astragalus</i> | 401 | 243 | 61 |
| 2 <i>Verbascum</i> | 233 | 186 | 80 |
| 3 <i>Centaurea</i> | 177 | 109 | 62 |
| 4 <i>Hieracium</i> | 101 | 66 | 65 |
| 5 <i>Campanula</i> | 106 | 55 | 52 |
| 6 <i>Silene</i> | 131 | 53 | 40 |
| 7 <i>Onosma</i> | 90 | 53 | 59 |
| 8 <i>Allium</i> | 143 | 50 | 35 |
| 9 <i>Galium</i> | 102 | 49 | 48 |
| 10 <i>Alyssum</i> | 91 | 45 | 49 |

Table 3. The list of 10 seed plant families with large number of species in Turkey.

| FAMILIES | Native | Endemic | bancý Exotics Yab Exotics | Cultivated | TOTAL |
|---------------------------|---------------|----------------|----------------------------------|-------------------|--------------|
| 1 <i>Compositae</i> | 1144 | 436 | 16 | 8 | 1168 |
| 2 <i>Leguminosae</i> | 977 | 391 | 0 | 16 | 993 |
| 3 <i>Labiatae</i> | 551 | 245 | 1 | 2 | 554 |
| 4 <i>Crucifereae</i> | 516 | 199 | 2 | 4 | 552 |
| 5 <i>Gramineae</i> | 486 | 52 | 7 | 22 | 515 |
| 6 <i>Caryophyllaceae</i> | 469 | 189 | 0 | 0 | 469 |
| 7 <i>Scrophulariaceae</i> | 467 | 245 | 3 | 0 | 470 |
| 8 <i>Umbelliferae</i> | 420 | 120 | 1 | 2 | 423 |
| 9 <i>Liliaceae</i> | 412 | 139 | 2 | 8 | 422 |
| 10 <i>Boraginaceae</i> | 306 | 112 | 3 | 1 | 310 |

Table 4. Distribution of endemic taxa by phytogeographic regions in Turkey.

| PHYTOGEOGRAPHIC REGIONS | | Number of Endemic Taxa |
|--------------------------------|-----------------|-------------------------------|
| 1 | Euro-Siberian | 218 |
| 2 | Mediterranean | 1016 |
| 3 | Irano –Turanian | 1221 |

Table 5. Distribution of endemic plant species in Turkey according to the former IUCN danger categories.

| IUCN category | Number of endemic species |
|--------------------------|----------------------------------|
| Ex (Extinct) | 8 |
| E (Endangered) | 46 |
| V (Vulnerable) | 183 |
| R (Rare) | 1701 |
| I (Indeterminate) | 49 |
| K (Insufficiently known) | 282 |
| O (Out of danger) | 5 |
| nt (non threatened) | 798 |

Table 6. Type, number and size of forest conservation areas in Turkey.

| Conservation Types | Numbers | Total Area (ha) |
|-----------------------------|----------------|------------------------|
| National Parks | 31 | 612.112 |
| Nature Conservation Areas | 32 | 82.023 |
| Nature Parks | 11 | 46.872 |
| Natural Monuments | 54 | 74 |
| Seed Stands | 322 | 32.914 |
| Gene Conservation Forests | 16 | 2.816 |
| Wildlife Conservation Areas | 109 | 1.800.000 |
| Specially Protected Regions | 12 | 418.800 |
| Protection Forests | 48 | 360.130 |
| Rest and Camp Areas | 415 | 12.770 |
| State Farms | 38 | 381.162 |
| Total : | | 3.749.673 |

Figures



Fig. 1. Phytogeographic regions of Turkey.



Fig. 2. Important endemism centers of Turkey.