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Vegetable Genetic Resources of Turkey

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ABSTRACT. Turkey is an important center for plant genetic resources and genetic diversity. It is also one of the domestication centers where ancient agriculture started. Traditionally small-scale agriculture in Turkey has been important in bringing together some species that have hybridized causing increases in variation. The status of vegetable species germplasm, collection and characterization activities, cultivar breeding programs and utilization of the vegetable genetic resources in Turkey are detailed. Conservation and maintenance of these valuable genetic resources are necessary because these populations are important sources of diversity that could be used in future breeding programs.

KEYWORDS. Characterization, genetic resources, Turkey, utilization, vegetable

INTRODUCTION

Turkey is one of the centers of origin, and/or, diversity of several crop plants, and many plant species. Turkey is endowed with a rich diversity of

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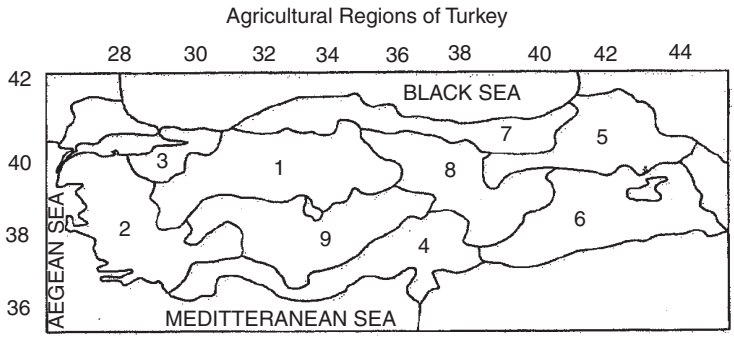
families (163), genera (1,225) and species (9,000) of plants (Tan, 1996; Özgen et al., 2000). Turkey also has centers of genetic diversity of many wild, transitional, and cultivated forms of annual and perennial, herbaceous and woody plants (Agaoglu et al., 1997). Turkey is one of the centers of origin of cultivated species of *Allium*, *Amygdalus*, *Avena*, *Beta, Cicer*, *Hordeum*, *Lens*, *Linum*, *Pisum*, *Prunus*, *Secala*, *Triticum* and *Vitis* (Tan, 1998).

About 40 wild plants are used as vegetables in Turkey (Abak and Düzenli, 1989). Two are localised in the east of the country (*Eremurus spectabilis* (Bieb.) Fedtsch. and *Rhoeum ribes* L.), one in Central Anatolia (*Polygonum cognatum* Meissner), and the others in the Mediterranean and Aegean regions (*Asparagus acutifolius* L., *Cichorium intybus* L., *Foeniculum vulgare* Miller, *Malva sylvestris* L., *Scolymus hispanicus* L., *Sinapis alba* L., *Sinapis arvensis* L., *Taraxacum officinalis* L., and *Urtica dioica* L.). Wild celery, *Apium groveolens* L., carrots, *Daucus* spp., rocket salad, *Eruca* spp., and lettuce, *Lactuca* spp., are commonly used as vegetable or salad plants. Many other wild plant species are used as salad and vegetable plants, but are not utilized in breeding development programs (Tan, 1996).

Turkey is fourth after China, India and the United States in world vegetable production. Over 50 vegetables species are grown in Turkey (Agaoglu et al., 1997; Küden, 1998). Turkey is located between 36° and 42° N and from 26° to 45°E, and is characterized by mountains in the central area, and flat coastal plains in other locations. Turkey is divided into nine agricultural regions (Figure 1): Middle North Anatolia region (1), Aegean region (2), Trakya-Marmara region (3), Mediterranean region (4), East Anatolia region (5), South East region (6), Black Sea region (7), Middle East Anatolia region (8) and Middle South Anatolia region (9). While the coastal regions enjoy milder climates, the inland Anatolian plateau experiences the extremes of hot summers and cold winters with low rainfall. The Aegean and Mediterranean coasts have cool rainy winters, and hot, moderately dry summers. Annual precipitation varies from 580 to 1,300 mm depending on location. The Black Sea coast receives the highest rainfall (Rize province: 2,200 mm), spread throughout the year. The Eastern region of Anatolia experiences a continental climate, with a long and very cold winter. Western and Southern Anatolia have a typical Mediterranean climate near the coast, with mild wet winters, and long, hot and dry summers (Güler, 2004).

The aim of this project is to present available vegetable genetic resources of Turkey, distribution of species, their collection and characterization, present and ongoing cultivar breeding programs, and the

FIGURE 1. Agricultural regions of Turkey: 1 = Middle North Anatolia region, 2 = Aegean region, 3 = Trakya-Marmara region, 4 = Mediterranean region, 5 = East Anatolia region, 6 = South East region, 7 = Black Sea region, 8 = Middle East Anatolia region, and 9 = Middle South Anatolia region.



probable utilization of presented species. This detailed overview will give an insight to agricultural scientist about the present large genetic diversity in Turkey, and provide information about the species, their distribution and potential utilization of these genetic resources.

GENETIC RESOURCES

Vegetable genetic resources of Turkey are presented below according to their importance in Turkey and amount of research that has been conducted on the family, respectively.

Solanaceae. Many Solanaceous landraces are found in Turkey. These landraces are grown by producers in almost all regions. Over 1,500 accessions of Solanaceae have been collected since 1964 (Küçük, 2003). Seed material is preserved in the cold store genebank (Table 1) at the Aegean Agricultural Research Institute (AARI) in Izmir. Collection is still a priority in order to fill gaps in Turkish landraces, especially from the regions of the country in which they have never been systematically described.

Peppers (*Capsicum annuum* L.): Peppers have been grown for several thousand years in the Americas. Since their introduction into the Old World, peppers have been cultivated in various environments, and a number of different cultivars have been developed (Zewdie and Zeven, 1997). According to FAO records from 2004, Turkey's total pepper production was 1,790,000 Mt and was ranked 3rd in the world (Anon., 2004). Pep-

TABLE 1. *Ex-situ* collections of genetic material in Turkey.

	Scientific binomial	Collection sites (provinces)	Distribution	Number of Accessions
Solanaceae	(AARI, 1964-2000) [Z]			
	Capsicum annuum	59	Landrace or traditional cv.	800
	C. annum var. *grossum*	6	Landrace or traditional cv.	11
	C. annum var. *longum*	4	Landrace or traditional cv.	10
	C. frutescens	11	Landrace or traditional cv.	29
	Lycopersicon esculentum		Advanced cultivars	4
	Lycopersicon esculentum	57	Landrace or traditional cv.	540
	Solanum melongena	47	Landrace or traditional cv.	192
Total				**1586**
Cucurbitaceae	(AARI, 1964-2002)			
	Citrullus vulgaris		Advanced cultivars	2
	Citrullus vulgaris	40	Landrace or traditional cv.	330
	Cucumis melo	48	Landrace or traditional cv.	367
	Cucumis sativus	45	Landrace or traditional cv.	222
	Cucurbita pepo	41	Landrace or traditional cv.	138
	Cucurbita moschata	21	Landrace or traditional cv.	61
	Cucurbita maxima	6	Landrace or traditional cv.	9
	Cucurbita spp.	56	Landrace or traditional cv.	432
	Cucumis flexuosus	19	Landrace or traditional cv.	54
	Ecbalium elaterium	5	Landrace	5
	Lageneria spp.	3	Landrace	3
	Lageneria siceraria	1	Landrace	1
	Bryonica dioica	1	Landrace	1
Total				**1625**
Cucurbitaceae	(Univ. of Çukurova, 2002)			
	Citrullus vulgaris		Landrace or traditional cv.	45
	Cucumis melo		Landrace or traditional cv.	301
	Cucurbita spp.		Landrace or traditional cv.	14
	Luffa spp.		Landrace or traditional cv.	6
	Momordica		Landrace	1
	Others		Landrace	1
Total				**368**

	Scientific binomial	Collection sites (provinces)	Distribution	Number of Accessions
Brassicaceae	(AARI, 1964-2002)			
	Brassica oleracea	31	Landrace or traditional cv.	198
	Brassica spp.		Advanced cultivars	3
	Brassica spp.		Wild/weedy species	77
	Brassica rapa	13	Landrace or traditional cv.	24
	Brassica napus	5	Landrace or traditional cv.	15
	Brassica campestris	1		1
	Brassica nigra	8	Landrace or traditional cv.	65
	Brassica cretica	3	Landrace or traditional cv.	6
Total				**389**
Brassicaceae	(Univ. of Ondokuz Mayis, 2005)			
	B. oleracea var. *capitata*	28	Landrace or traditional cv.	95
	B. oleracea var. *acephala*	33	Landrace or traditional cv.	127
Total				**222**

[Z] Unless stated otherwise collections are at AARI.

pers are a vegetable that has a special place in Turkish cuisine and can be consumed either fresh or processed. Pepper production in Turkey has steadily increased over time. Seed used in cultivation comes mainly from local varieties and regional populations. Growers obtain seeds from their own farm or from neighboring growers (Abak, 1994).

There is a large genetic pool that can be used for breeding new cultivars. A pepper gene pool was created by collecting genotypes grown in the coastal regions of Turkey. Seventy different genotypes, chosen from the gene pool, were evaluated by modifying the International Plant Genetic Resources Institute and the International Union for the Protection of Plants (UPOV) (Keles et al., 2004). The results showed six main clusters when fruit and leaf shapes and seed weights were considered.

'Yaglik Pepper' populations (*Capsicum annuum* var. *conoides* Mill.) were collected from selected plants and fruits grown widely in the Bursa region in 1978. Morphological and pomological characteristics and yield were assessed during the selection. The number 28 line gave the highest yield and exhibited the best morphological, pomological and technical

characteristics. The cultivar candidate of the Yaglik population was named 'Yaglik 28' (Sürmeli and Gürsoy, 1985).

'Yalova Çorbacı 12', a bell pepper type, is a standard cultivar developed from the population of Çorbacı peppers between 1982 and 1987. Morphological and pomological characteristics and yield were assessed during selection. Number 12 was selected for the highest yield and the best characteristics. The standard variety of the Çorbacı population was named and registered as 'Yalova Çorbacı 12'. The weight of the fruit is 18-22 g, the skin color is yellowish-light green, and the fruit sweet to the taste (Sürmeli and Güngör, 1988).

Turkey is an important producer of spice peppers, especially in the south and south-east. One hundred and fifteen red, hot, pepper accessions for spice production, originally collected from the Kahramanmaras region of Turkey, were evaluated on quantitative and qualitative characters. Eleven types were selected for use in breeding research (Akinci and Akinci, 2004). There have been a few studies in the field of disease resistance, principally those dealing with *Phytophtora capsici* Leo. (Abak et al., 1992; Isbeceren, 1992). Two different studies directed to obtaining new cultivars with resistance for *P. capsici* are being carried out in a joint program between Çukurova University and the Alata Agricultural Research Institute.

Eggplant (*Solanum melongena* L.): One hundred and four eggplant populations collected from different locations in Turkey were used to characterize genetic resources in 1991, using the International Plant Genetic Resources Institute descriptors (Filiz and Özçalabı, 1992). Similarities and differences were determined regarding morphological variation of eggplant genetic resources collected from different eco-geographical regions of Turkey.

Cucurbitaceae. Cultivated species of this family in Turkey are *Citrullus lunatus* Thunb., *Cucumis flexuosus* L., *Cucumis sativus* L., *Cucurbita maxima* Duch., *Cucurbita moschata* Pour, and *Cucurbita pepo* L. In addition, *Lagenaria siceraria* (Molina) Standl., *Luffa cylindrica* L. and *Momordica charantia* L. are also grown although they are less important both economically and by production area (Küçük et al., 2002).

No wild types, or forms of genera, such as *Cucumis*, *Cucurbita*, *Citrullus* and *Lagenaria* have been found in Turkey. However, a rich genetic diversity of these species is found in Anatolia. In many crops, including cucurbit, diversity centers were identified in Anatolia (Harlan, 1951). Ekinci (1976) emphasized that Anatolia has a great genetic diver-

sity for melon, watermelon and squash. The same author also reported that the origin of melons, watermelons and some squashes grown in Ukraine and Russia is Anatolia; in addition, it was proposed that the cantaloupe melons of Europe originate from the Van area in eastern Anatolia. Pitrat et al. (1999), reported that Anatolia belongs to a secondary center of genetic diversity of melon. In almost all regions of Turkey, landraces of Cucurbitaceae are highly variable in morphology and taste. They are used as vegetables or for pickling.

The largest component of the genetic resources of the Cucurbitaceae family collected in Turkey is maintained in the Aegean Agricultural Research Institute (AARI). More than 1,600 accessions have been collected since 1964. Detailed information about these accessions is given in Table 1. The Faculty of Agriculture, University of Çukurova, has collected cucurbit accessions since 1990. The number of accessions at this university is over 300 (Table 1).

Ninety-six cantaloupe genotypes were collected from different locations of Turkey, and 30 types were selected as being promising for further breeding efforts. According to phenological, morphological and agronomic traits of plants from field experiments, selected genetic materials were divided into 6 groups (Günay et al., 1976).

The hybrid melon-breeding program for resistance to *Fusarium* sp. and powdery mildew is almost complete and hybrid cultivars will be released (Küçük et al., 2002). Nine breeding lines, developed by the Antalya Greenhouse Research Institute, were crossed with 58/2 melon line which is to resistant to races 0 and 1 of *F. oxysporium* f. sp. *melonis* (Leach) and F_1 progenies were generated. Among 47 lines tested to pathogen, 25 ones were found to be resistant to *Fusarium* wilt (Sarı et al., 1999).

Breeding research was carried out to define the type of snake cucumber (*Cucumis melo* var. *flexuosus* Naud.) largely grown in the southeastern Anatolia region. Genetic resources were collected from several locations in this region. They were then detailed for their phenological and morphological properties, i.e., furrowed and light furrowed belong to *C. melo* var. *flexuosus* Naud. (Besirli and Yanmaz, 1999).

Cultivar selection studies have been conducted on pumpkin and squash populations in various parts of Turkey (Sağdıç and Akgün, 1979; Abak et al., 1990; Toprakkarıştıran, 1997; Düzeltir and Yanmaz, 2004; Balkaya et al., 2005). Twenty types of pumpkin for seed (*Cucurbita pepo* L.) were evaluated as superior using a weighted based ranking method. At the end of this research, 4 types (3/1, 9/1, 19/1 and 20/1) were selected as

being promising for further breeding efforts (Düzeltir and Yanmaz, 2004).

A cultivar breeding study on winter squash (*Cucurbita maxima* Duch.) and pumpkins (*Cucurbita moschata* Pour) was started in the Black Sea Region of Turkey in 2005 aimed at collection of winter squash and pumpkin genetic material of the Black Sea region, to identify the phenological, morphological and technological characteristics at Samsun ecological conditions, and to determine the potential genetical diversity in the Black Sea region (Balkaya et al., 2005a).

Cruciferae. Brassicas are widespread as wild, weedy and cultivated forms throughout Turkey (Davis, 1982; Küçük, 1996; Anon., 2005; Table 1). The Faculty of Agriculture, University of Ondokuz Mayis since 1998 has collected white head cabbage and kale accessions. The number of accessions at this university is over 200 (Table 1). The wild relative of *Brassica cretica* Lam. is found in South Anatolia. Wild *Raphanus raphanistrum* L. is distributed in the west and southern coastal regions of the country (Tan, 1996).

Cabbage (*Brassica oleracea* var. *capitata* L.): Modern head cabbage cultivars are descended from wild non-heading brassicas originating in the eastern Mediterranean and in Asia Minor. It is commonly accepted that the origin of cabbage is north European countries and the Baltic Sea coast (Baldwin, 1995; Monteiro and Lunn, 1998), and the Mediterranean region (Vural et al., 2000). The vegetables found in the cabbage group have spread to other regions of the world from these regions.

In Turkey, cabbage is the most economically important member of the genus *Brassica*. According to FAO records from 2004, Turkey's total cabbage production was 725,000 Mt and was ranked 13th in the world (Anon., 2004). Samsun province has a large share (23.7%) of Turkey's cabbage production (Anon., 2003).

In Turkey, *Brassica* breeding studies have been increased in relation to other vegetables. Cultivar selection studies have been conducted on cabbage populations in various parts of Turkey since 1980. The Aegean region, western Turkey, is the most important cabbage production area. The aim was to develop new varieties using mass selection from the varieties established in this region (Salk, 1982). The local cabbage variety, Köse, is grown in the Trakya region, especially in Edirne province. A breeding study was conducted on this variety, and some plants with superior characteristics were reproduced, but 'Köse' head cabbage could not be developed into a new cultivar (Sencan, 1980). Morphological characterization of 23 local white-headed cabbage varieties was determined at Atatürk Central Horticultural Research Institute (Simsek and Sürmeli, 1991), us-

ing the recurrent selection method. Two variety candidates (18-2 and 25-3), with uniform shaped head, a higher ratio of head formation and higher stuffed leaf quality, were developed. In Eastern Anatolia, local head cabbage populations were evaluated in the Kagızman, Van, Igdır, Erzurum, Agrı, Bayburt, Mus, Gümüshane and Erzincan provinces, and 11 genotypes were selected in terms of head weight, head diameter, earliness and uniformity in 1992 (Alan and Padem, 1995). In a study on the Ercis head cabbage population in Van province, the ratio of head formation, number of outer leaves covering the head and leaf thickness were 86.6%, 2-3 and 0.58-9.02 mm, respectively (Yasar et al., 1995). In another study, cabbage genetic resources of Turkey were determined between 1998-2000 (Yanmaz et al., 2000). The 150 populations collected were identified according to criteria adapted by UPOV for cabbage. Cabbages were divided on the basis of their head morphology into two groups: the 1st group was flat and round, dark green leaf color, medium hard with leaves having a thin midrib, stuffing type, and the 2nd group was round or long round, light green leaf color, with thick leaves and midrib, pickling type (Yanmaz et al., 2000). The multiplication and evaluation of these genotypes was carried out continuously at the Black Sea Agricultural Research Institute in Samsun. Thirty genotypes were selected during 1999-2002. In further studies, appropriate lines were evaluated during the S_2 inbreeding generations. According to the selection differentials and genetic improvement ratios at the end of the second inbreeding generations, genetic improvement at a rate of 1.2 to 83.9% was established in terms of head weight for 23 of 30 genotypes (Kar et al., 2002).

Growers prefer hybrid varieties for their uniformity of head size and maturity. However, there is no registered hybrid white head cabbage variety in Turkey. For this reason the most comprehensive study on improvement of F_1 hybrid white head cabbage cultivars was started in 1999 (Balkaya et al., 2005b). In this study, Turkish head cabbage genetic resources were evaluated and activities aimed at purifying the selected types are on going. Registration of new hybrid varieties is planned.

Kale (*Brassica oleracea* var. *acephala* L.): Kale is the one of the oldest forms of cabbage originating in the eastern Mediterranean, and has been introduced to many parts of the world (Hodges, 2004). Kale is mainly used as a green vegetable, widely grown in the Black Sea Region, but not commonly grown in the other regions of Turkey. Producers often use the tender leaves for human consumption, and older leaves for forage

(Balkaya, 2002). Kale production in Turkey was about 100,000 Mt in 2001 (Anon., 2003).

Diversity is maintained within kale populations in the Black Sea region, and it is still possible to collect valuable germplasm. Kale genetic resources were collected in 2001 from the Black Sea region, and evaluated according to morphological characters (Balkaya et al., 2004). In the first year, 127 kale populations were collected from different ecogeographical areas in this region. All populations of kale genotypes were examined with respect to morphological characteristics. Twenty-two types were evaluated as superior using a weight based ranking method. The population exhibited a range of 15.9-21.9 cm for leaf length, 10.4-13.2 cm for leaf width, and 0.26-0.35 mm for leaf thickness. Eleven types were selected as being promising for further breeding efforts (Balkaya and Yanmaz, 2005).

Radish (*Raphanus sativus* L.): Radish is an important commercial root vegetable, and an ancient domesticate (Sadhu, 1993). The Mediterranean region is thought to be where radish was originally domesticated (Rabbani et al., 1998). The largest part of radish genetic resources collected in Turkey is maintained in the AARI. One hundred and thirty-three accessions have been collected since 1964 (Anon., 2005). In 1989, radishes collected from 5 different locations in the Kozan and Kadirli areas of Adana province were chosen as breeding material. Thirteen different groups were selected based on shape. During 1989 and 1990, 13 lines were grown to produce seed at Çukurova University. By 1992 and 1993, two cylindrical and two round lines were determined to be more uniform and productive than others (Sarı et al., 1995).

Kohlrabi (*Brassica oleracea* var. *gongylodes* L.): Kohlrabi, a member of the Brassica group, has an edible tuber on its stem. West European countries are considered the area of origination of this vegetable (Günay, 1984). Kohlrabi is grown in the East Anatolian region of Turkey, but use and production are low. There have been no studies on the morphological characteristics and breeding of the kohlrabi genotypes in this region (Yanmaz, 2002).

Among the other *Brassica* species are broccoli (*B. oleracea* L. var. *italica* Plenck), brussel sprouts (*B. oleracea* L. var. *gemmifera* (DC.) Zenker) and cauliflower (*B. oleracea* var. *botrytis* L.). Cauliflower has been known in Turkey for a long time and is grown mainly in the Aegean, Marmara, and Mediterranean regions. There are no Turkish cauliflower varieties, so foreign varieties have been cultivated. Broccoli and brussel sprouts are new cultivars in Turkey during the last 15-20 years, and have

characteristics that allow them to be processed. Production, especially of broccoli, has increased in the last 5-10 years. Adaptation studies on these species are on-going (Odabas et al., 1995).

Leguminosae. Landraces of field and garden pea (*Pisum arvense* L. and *P. sativum* L.) and faba bean (*Vicia faba* L.) are grown in Turkey (Tan, 1996). Over 3,500 accessions of Leguminosae are in the AARI collection (Anonymous, 2005). Seed material is preserved in cold storage (Table 2). Furthermore, two hundred green bean accessions have been collected (Balkaya, 1999), with forty-eight of these preserved at the University of Ondokuz Mayis (Table 2).

In Turkey, green bean is the most economically important member of the family Leguminosae. According to FAO records from 2004, Turkey's total green bean production was 545,000 Mt and was ranked second in the world (Anon., 2004). Beans are cultivated throughout Turkey for fresh and dry use. Because of better adaptation of beans to various climatic regions, the most important variations observed are in fruiting characters, pod and seed size, and testa color.

Kıpçak et al. (1951) stated that bean populations collected in Turkey have been divided on the basis of seed shape. Round seed varieties have been found in the East Black Sea region. Varieties with kidney and elliptic shaped beans have been found in Kastamonu province. Flat kidney beans are widespread through Central Anatolia.

Cultivar breeding studies have been conducted on common bean populations in various parts of Turkey since 1960. Türkes (1990) identified four cultivar candidates of the Trakya region bean population through the Pedigree Selection method, according to earliness, pod shape and quality and yield traits. Bas et al. (1991) characterized, and bred, new cultivars from green bean populations in the Aegean region. Three hundred and sixty populations were collected during 1984-1985. Some cultivars exhibited the best performance in the autumn period. 'Zondra 86' was registered as a green bean cultivar. 'Demre type1' was found to be suitable for the Mediterranean region. The number 16 line of this genetic source was superior in yield and pod quality. This cultivar candidate was recommended for growing in a greenhouse during the spring and autumn period (Özçelik, 1999). Research was carried out with bean seeds having the characteristics of the population collected from areas of Içel province in the Mediterranean region during 1990-1996. Lines 14 of the climbing Ayse population, and dwarf line 21, were the most favorable lines for yield and quality. These lines were recommended as cultivar candidates for early spring (Tunar and Kesici, 1998). From 1995-1998, a study was

TABLE 2. *Ex-situ* collections of genetic material in Turkey.

	Scientific Binomial	Distribution	Number of Accessions
Leguminosae	(AARI, 1964-2004) [Z]		
	Phaseolus vulgaris	Advanced cultivars	4
	Phaseolus vulgaris	Landrace or traditional cv.	1273
	Pisum spp.	Landrace or traditional cv.	160
	Vicia faba	Landrace or traditional cv.	341
	Vicia spp.	Advanced cultivars	6
	Vicia spp.	Landrace or traditional cv.	1069
	Vicia spp.	Wild/weedy species	821
Total			**3674**
Leguminosae	(Univ. of Ondokuz Mayis, 2005)		
	Phaseolus vulgaris	Landrace or traditional cv.	48
Total			**48**
Beta	(AARI, 1964-2002)		
	B. adanensis	Landrace or traditional cv.	16
	B. corolliflora	Landrace or traditional cv.	26
	B. intermedia	Landrace or traditional cv.	58
	B. lomatogona	Landrace or traditional cv.	91
	B. macrohirza	Landrace or traditional cv.	6
	B. maritime	Landrace or traditional cv.	37
	B. trigyna	Landrace or traditional cv.	11
	B. trojona	Landrace or traditional cv.	17
	B. vulgaris	Landrace or traditional cv.	123
	B. vulgaris var. *altissima*	Landrace or traditional cv.	7
	B. vulgaris var. *cicla*	Landrace or traditional cv.	52
	B. vulgaris var. *crassa*	Landrace or traditional cv.	1
Total			**445**
Amaryllidaceae	(AARI, 1964-2004)		
	Allium cepa	Advanced cultivars	3
	Allium cepa	Landrace or traditional cv.	107
	Allium porrum	Advanced cultivars	1
	Allium porrum	Landrace or traditional cv.	68
	Allium sativum	Landrace or traditional cv.	360
	Allium spp.	Wild/weedy species	112
Total			**651**

	Scientific Binomial	Distribution	Number of Accessions
Umbelliferae	(AARI, 1964-2004)		
	Apium graveolens	Advanced cultivars	1
	Apium graveolens	Landrace or traditional cv.	7
	Anethum graveolens	Landrace or traditional cv.	20
	Daucus carota	Landrace or traditional cv.	100
	Daucus spp.	Wild/weedy species	66
	Petroselinum spp.	Landrace or traditional cv.	107
Total			**301**
Compositae	(AARI, 1964-2004)		
	Lactuca sativa	Advanced cultivars	2
	Lactuca sativa	Landrace or traditional cv.	181
	Lactuca sativa	Wild/weedy species	112
Total			**295**

[Z] Unless stated otherwise collections are at AARI.

undertaken to determine plant characteristics and select suitable green bean cultivars for fresh consumption from populations of the Black Sea region. In the first year of the study, 166 climbing and 34 dwarf types were collected. Thirty-one climbing and nine dwarf lines were selected by the pedigree selection method in the second year. In the third year, 7 promising climbing lines and 1 dwarf line were determined as cultivar candidates (Balkaya and Yanmaz, 1999).

Amaryllidaceae. Wild, weedy and cultivated forms of Amaryllidaceae found in Turkey are presented in Table 2 (Anon., 2005). There is no current project on the evaluation and characterization of these genetic resources.

Onions are very important in China, India, the United States of America and Turkey. In Turkey, onion is the most economically important vegetable. According to FAO records from 2004, Turkey's total dry onion production was 1,750,000 Mt and was ranked 4th in the world (Anon., 2004).

Only a few studies involving onion breeding have occurred in Turkey (Bayraktar, 1958; Akgün, 1970; Besirli et al. 2004). Ten lines of red onion were evaluated for fresh consumption, roundness and sweetness characteristics by the recurrent pedigree selection method in the Marmara-Trakya region. A cultivar candidate will be registered in the next few years (Besirli et al., 2004).

Malvaceae. Okra (*Hibiscus esculentus* L.): Okra is one of the most popular summer vegetables in Turkey, and produced mainly from local genetic sources. The most important characteristic of these sources is homogenous young fruits, although plant characters are not very homogenous. These sources are suitable as starting material for breeding. Four hundred and sixty-one okra populations have been collected and stored at the AARI (Anon., 2005).

In Turkey, okra is not as economically important compared to other vegetable species. According to FAO records from 2004, Turkey's total okra production was 35,500 Mt and was ranked 8th in the world (Anon., 2004). Bas and Koludar (2001) collected 45 okra landraces from Turkey. They were evaluated for phenotypic traits. Considerable variation was found in leaf shape and color, and fruit shape and length at maturity. Cultivar selection studies have been conducted on okra populations in various part of Turkey since 1980 (Inan, 1986, 1988, 1991, 1996).

'Amasya' okra has been grown in Amasya and Çorum provinces for centuries. The local cultivars presented wide differences in plant height, plant and fruit shape, and fruit color. A selection program was conducted in Yalova from 1989-1995 and 5 lines were selected. Line 612 was selected as a cultivar candidate (Inan, 1995). 'Denizli' okra has been grown widely in Denizli province. Between 1987 and 1995, line 212 was selected as best with respect to yield, earliness, fruit quality, and plant growth (Inan, 1996). During the selection studies, five candidate varieties were obtained (Inan, 1998).

Chenopodoceae. Beet (*Beta* sp.): Turkey is one of the centers of origin of beet, with species of *Beta* and *Corollina* widely distributed in Turkey (Tan, 1992). *B. vulgaris* subsp. *Adanensis* (Pamuk.) and *B. vulgaris* subsp. *Provulgaris* (Ford-Lloyd & J. T. Williams) are found from sea level to 700 m above sea level, mainly in coastal areas and some inland habitats under coastal influence. Species within section Corollinae are *B. corolliflora* Zoss, *B. intermedia* (Bunge), *B. lomatogona* (F. et M.), *B. macrorhirza* (Stev.), and *B. trigyna* W. et K. They are found inland from 550 to 2,300 m above sea level (Tan and Inal, 2002). Diverse forms and landraces of vegetable, table, and fodder beets have been grown and used locally for generations in Anatolia.

Surveying and collecting *Beta* species was systematically initiated in the late 1960s in various parts of Turkey. As a result, 445 beet samples (Table 2) have been collected and stored at the AARI (Tan and Inal, 2002).

One hundred and sixty-five populations of *Beta* spp. were evaluated for 23 morphological characters. Principle Component Analysis (PCA)

was used to interpret the diversity. The results of analysis exhibited a broad morphological variation model section for *Beta* in Turkey (Tan et al., 2003).

Spinach (*Spinacia oleracea* L.): Surveying and collecting of spinach species were systematically initated in the late 1960s in various parts of Turkey. A total of 157 spinach samples (156 landraces, 1 advanced cultivar) were collected (Anon., 2005). Evaluation and characterization of spinach is planned for the future.

Umbelliferae. Carrot (*Daucus carota* L.): The genus *Daucus,* including carrot, has many wild forms that grow mostly in the Mediterranean region and southwest Asia (Peterson and Simon, 1986). Over 300 accessions of Umbelliferae have been collected since 1964 (Anon., 2005). Seed material is preserved in the AARI (Table 2). There is no project currently underway to evaluate and characterize these genetic resources.

Celery (*Apium graveolens* L.): Celery research studies were started to adapt different genetic materials from landrace and foreign resources (Inan and Türkes, 1996; Küçük et al., 2004). A breeding program for new celery cultivars was also carried out. In Turkey, celery-breeding programs have been directed to root type celery. Celery has been grown over the years in the Marmara region, Bursa and Çanakkale provinces. Four lines from the populations, numbered 6 to 9, from the Aegean region were determined as cultivar candidates (Küçük et al., 2004).

Compositae. Lettuce (*Lactuca sativa* L.): The genus *Lactuca* comprises about 100 species: 17 European, 10 North American, 33 tropical East African, and about 40 Asian species (Rulkens, 1987). Lettuce is a popular leaf vegetable. The stalk is also eaten, and the seeds can be used for oil production. The vegetable contains vitamins B and C and the seeds contain vitamin E (Vries, 1997). Rulkens (1987) presumed that *L. sativa* probably originated from Iraq and Iran. Boukema et al. (1990) stated that domestication of lettuce took place in southwest Asia in the region between Egypt and Iran. Wild, weedy and cultivated forms of *L. sativa* in Turkey are presented in Table 2 (Anon. 2005).

There have been some studies involving lettuce breeding in Turkey (Sencan and Sürmeli, 1980; Tunar and Kesici, 1998). Çatak populations of lettuce are largely grown in the Mediterranean region of Turkey. Breeding of the Çatak lettuce population by the single plant selection method was carried out in Içel province between 1990 and 1995. Five lines were selected, and the number 18 line was the best for yield and quality (Tunar and Kesici, 1998). There is no current project underway to evaluate and characterize this genetic resource.

Artichoke (*Cynara scolymus* L.): Artichoke is grown largely in the Aegean and Marmara regions of Turkey. Research was carried out to develop standard varieties from populations of Bayrampasa and Sakiz artichokes of the Marmara, Aegean and Mediterranean regions, using the vegetative clonal selection method, at the Atatürk Central Horticultural Research Institute between 1987-1996. Lines B-1 and 6 for Bayrampasa population and S-2 and 4 for Sakiz population were found to be promising for development into standard cultivars (Sürmeli et al., 1998).

DISCUSSION

Genetic resources for a cultivated crop are generally regarded as the gene pool of cultivars, species, and genera that can be utilised as sources of additional genetic variation for crop improvement (Bliss, 1981). The intensive activity of genetic improvement, together with the technological development of agricultural inputs, has led in developing countries to the replacement of many local varieties by a few uniform modern cultivars (Morico et al., 1998). Cultivar replacement is reported to be main cause of genetic erosion around the world (Sehirali and Özgen, 1987; Tan, 1998). In recent decades the awareness of a high degree of genetic erosion led to the establishment of seed and field genebanks located both in developed countries (poor in genetic resources) and in developing countries (rich in genetic resources). Around the world, only a small portion of the vegetable landraces has been collected and evaluated.

Turkey is one of the domestication centers where ancient agriculture began. Vavilov (1951) described two important centers (Near East and Mediterranean) in the country. Species endemism is also high. Presumably, this factor is connected with the climatic and topographic diversity of Turkey. Turkey's environment is diverse, ranging from subtropical to cold temperate zones. This ecological diversity has contributed to high genetic diversity, and allowed successful introduction and cultivation of a great number of vegetable species.

The Turkish National System for conservation and utilization of genetic resources is well organized. Since the 1960s the conservation of plant diversity has become government policy. In the 1970s and 1990s the system was revised and guidelines for the 'Regulation of Collection, Conservation and Utilization of Genetic Resources' was prepared (Tan and Tan, 1998; Tan, 2001). *Ex situ* conservation activities have been undertaken since 1964. Collection activities are systematically planned, survey collections are conserved as genetic resources at the Turkey Seed

Gene Bank in Izmir, and evaluation results are well documented. The main users of the genetic material are plant breeders and researchers from Turkey and abroad. This rich vegetable genetic diversity becomes important to plant breeding programs, especially when landraces are utilized to improve cultivars. The wild crop relatives in the first gene pool of crops are also used in cultivar improvement. In Turkey, Vegetable Improvement Programs were started in the 1990s. These programs have provided improved cultivars. Many registered vegetable cultivars are released from those plant genetic collections, and cabbage, cucumber, eggplant, melon, peppers, squash, tomato, and watermelon hybrid cultivar breeding projects are on-going. Some of these unique genetic resources may not be suitable for standard cultivars in terms of productivity and plant characteristics, but their genetic content should be conserved.

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