Cucurbit Germplasm in Turkey and Their Rootstock Potential

Prof. Dr. Nebahat SARI
Çukurova University
Department of Horticulture
Adana, TURKEY

Outline

- Importance of Genetic Resources
- Importance of Turkey for *Cucurbitaceae*
- Melon Genetic Resources
- Watermelon Genetic Resources
- Squash and Pumpkin Genetic Resources
- Cucumber Genetic Resources
- Snakemelon Genetic Resources
- Bottle Gourd Genetic Resources
- Minor Cucurbits Genetic Resources
- Cucurbit Rootstocks
- Conclusion

Importance of Genetic Resources

Plant genetic diversity has two types of values;

1. **Providing agronomic characteristics such us pest resistance, drought and other abiotic stress tolerance, plant stature as well as taste, color and other factors of cultural importance. These have global significance in that they provide important characteristics for breeding programs.**
2. **Genetic diversity is also an insurance against unknown future needs/conditions, thereby contributing to the stability of farming system at the local, national and global levels.**

Threats for Genetic Materials

- Genetic erosion occured by natural causes,
- Forest fire,
- Misuse of forest and agricultural fields,
- Excessive and unconscious use of fertilizer and pesticides,
- New hybrid cultivars with high agronomical traits,
- Changing climate and global warming,

Nowadays, many serious studies have been conducted for preserving genetic resources in many countries.

Turkey is an important and rich genetic diversity center.

Its location is in intersection of Euro-Siberian, Irano-Turanian and Mediterranean Phytogeographic regions.

In addition, Turkey is an immigration road as a bridge between three continents and Anatolia had climatologically different regions.

10 000 plant species show distribution in Turkey,

3 000 of them are endemics.

(Tan, 1998)

Cucurbitaceae

The *Cucurbitaceae* consists of two well defined subfamilies, eight tribes representing varying degrees of circumscriptive cohesiveness and about 118 genera and 825 species.

Turkey and Genetic Diversity

Turkey accepted as microcentres for many *Cucurbitaceae* species,

- ***C. melo*** **(Subtropical and Tropical Africa),**
- ***C. lanatus*** **(Subtropical and Tropical Africa),**
- ***C. sativus*** **(Central Asia and Himalayas),**
- ***C. moschata*** **(South America)**
- ***C. pepo*** **(South America)**

In almost all regions of Turkey *Cucurbitaceae* landraces are still grown by farmers and are highly variable in morphology and taste and also used as vegetable or pickling.

(Harlan, 1951)

The Status of National Gene Bank of Turkey

Cucurbitaceae genetic resources have been collected by the National Plant Genetic Resources and Plant Diversity Research Program (NPGRRP) since 1964. The total number of accessions collected is over 2400. Collecting of wild and cultivates species is still a priority.

Conservation

The National Seed Gene Bank operated since the beginning of 1970's at Aegean Agricultural Research Institute (AARI) to preserve the genetic resources collected since 1964.

The Status of National Gene Bank of Turkey

Storage facilities

The facilities of National Gene Bank (NGB) for seed collection have been designed for the needs of long-term (-18 °C), medium-term (0 °C) and short term (4 °C) storage for multi species crops and plants. Cryo-preservation and *in vitro* conservation facilities also exist for specific species.

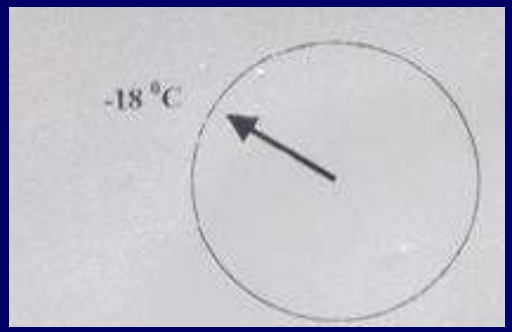
Documentation and data base system

All data (passport, collection, *in situ*, *ex situ* conservation, characterization and evaluation) are recorded on standard formats for better documentation.

National *ex situ Cucurbitaceae* collections of Turkey, at National Gene Bank, AARI (2015)

Botanical Name	English Name	Turkish Name	Number of Accessions
C. melo	Melon, Muskmelon, Cantaloupe	Kavun	700
C. melo flexuosus	Adjurmelon, Snakemelon, Serpentmelon	Acur	74
C. sativus	Cucumber	Hıyar	300
Cucumis spp.	-	-	8
C. lanatus	Watermelon	Karpuz	400
C. pepo	Squash	Yazlık kabak, Uzun kabak	200
C. moschata	Pumpkin	Kışlık kabak (bal kabağı)	100
C. maxima	Pumpkin	Kışlık kabak (kestane kabağı)	30
Cucurbita spp.	--	--	455
L. siceraria	Bottle gourd	Su kabağı	172
E. elaterium	Squirting cucumber	Eşek hıyarı, it keleği	5
TOTAL			2444

Turkish Gen Bank, AARI-IZMIR



Turkey *Cucurbitaceous* Production

Vegetable production of Turkey: 27 million tonnes on 1 million ha.

Cucurbitaceae **produces about 30 % of the total production.**

Major cucurbit sp.

- Watermelon
- Melon
- Cucumber
- Squash
- Pumpkin

Minor cucurbit sp.

- Snake melon
- Bottle gourd
- Bitter melon
- *Sechium edule*

Fruit bearing vegetables production of Turkey (10^3 tons)
(Turkish Statistical Institute, 2012)

Years	Melon-Watermelon	Cucumber	Squash	Pumpkin
1990	4950	1000	294	57
1994	5400	1140	285	62
1998	5815	1475	262	65
2002	6395	1670	280	65
2006	5571	1800	288	77
2010	5294	1739	341	89
2012	5710	1741	334	93

Melon Genetic Resources

Melons can be divided into two main groups as

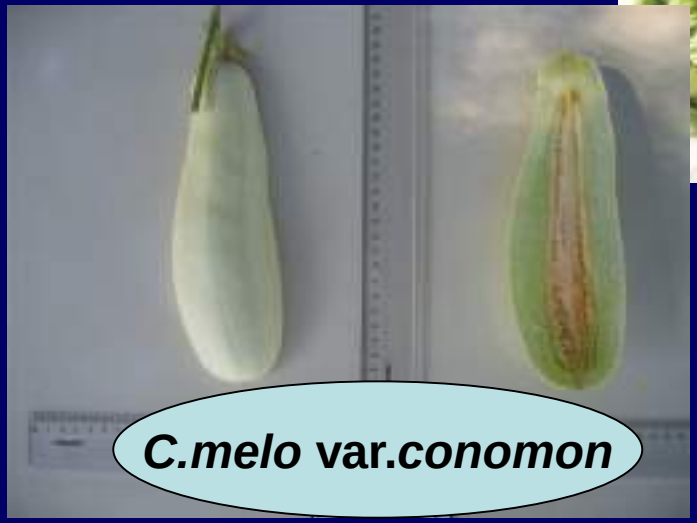
1. ***C. melo* ssp. *agrestis***
2. ***C. melo* ssp. *melo***
    1. ***cantalupensis***
    2. ***inodorus***
    3. ***flexuosus***
    4. ***conomon***
    5. ***dudaim-chito* and**
    6. ***momordica***

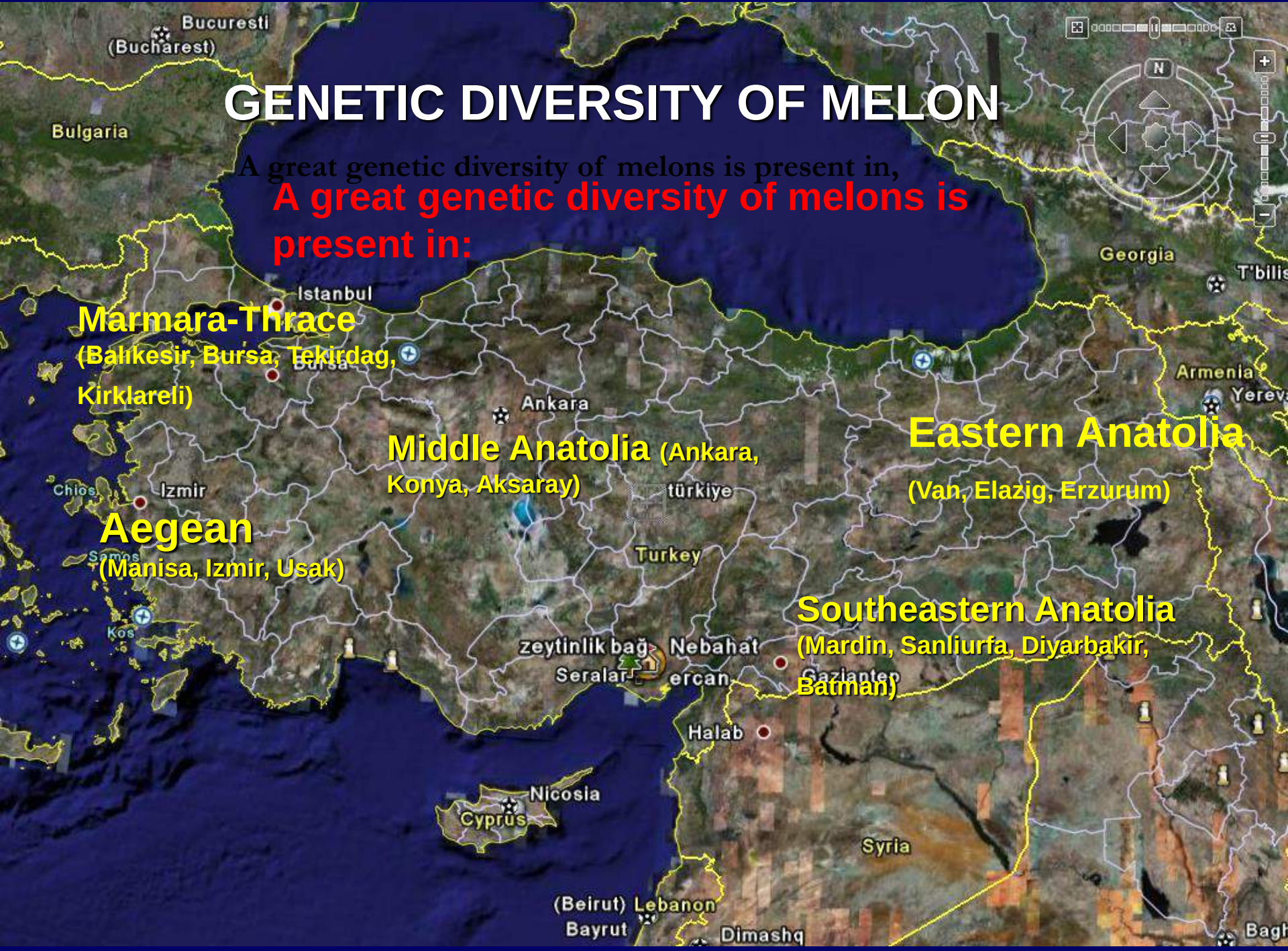
(Robinson and Decker-Walters, 1997)

Cultivated melon species

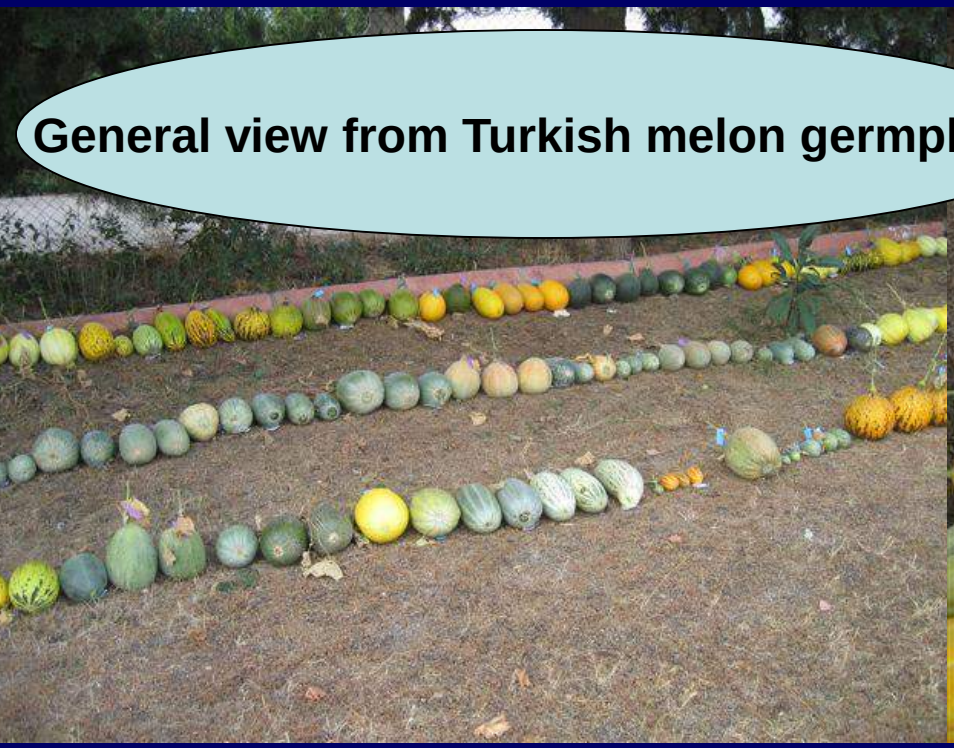
- *Cucumis melo* var. *cantalupensis*
- *C. melo* var. *inodorus*
- *C. melo* var. *reticulatus*
- *C.melo var.flexuosus*

Other melon species




GENETIC DIVERSITY OF MELON
A great genetic diversity of melons is present in,
A great genetic diversity of melons is present in:
Marmara-Thrace
(Balıkesir, Bursa, Tekirdag, Kirklareli)
Middle Anatolia (Ankara, Konya, Aksaray)
Eastern Anatolia
(Van, Elazig, Erzurum)
Aegean
(Manisa, Izmir, Usak)
Southeastern Anatolia
(Mardin, Sanliurfa, Diyarbakir, Batman)
Bucuresti
(Bucharest)
Bulgaria
Istanbul
Bursa
Ankara
Izmir
Chios
Samos
Kos
Turkey
türkiye
Georgia
T'bilis
Armenia
Yerev
zeytinlik bağ
Nebahat
Seralar
ercan
Halab
Nicosia
Cyprus
Syria
(Beirut) Lebanon
Bayrut
Dimashq

General view from Turkish melon germplasm



Middle Anatolia


Çumra


Ankara

Yuva

Kirkagac segregation


Sarı

Southeastern Anatolia

Tilmen

Patih

Simama
(queen pocket melon)

Midyat

Dilim

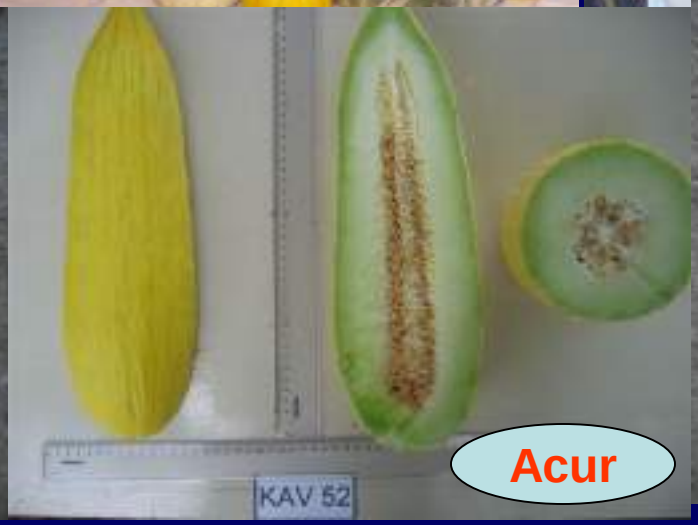
Harnubi

Aegean

Kirkagac

Kirkagac

Acur



Acur

Kuscular

Marmara-Thrace


Hasanbey


Gonen

Suluklu


Sari

Mediteranean

Leaf blade


Dev. of lobes: weak
KAV188


Blistering


Dev. of lobes: strong
KAV161


Undulation of margin

Watermelon Genetic Resources

The *Citrullus* genus contains 4 diploid species that thrives in Africa, Asia and Mediterranean (Levi et al. 2001).

1. *C. lanatus* (tropical and subtropical climates worldwide comprises the cultivated watermelon *C. lanatus* var. *lanatus* and *C. lanatus* var. *citroides* (Bailey) Mansf. which is known as citron)

2. *Citrullus colocynthis* (L.) Schrad,. (also known as bitter gourd, is a perennial wild species grown in northern Africa, southwestern Asia and the Mediterranean).

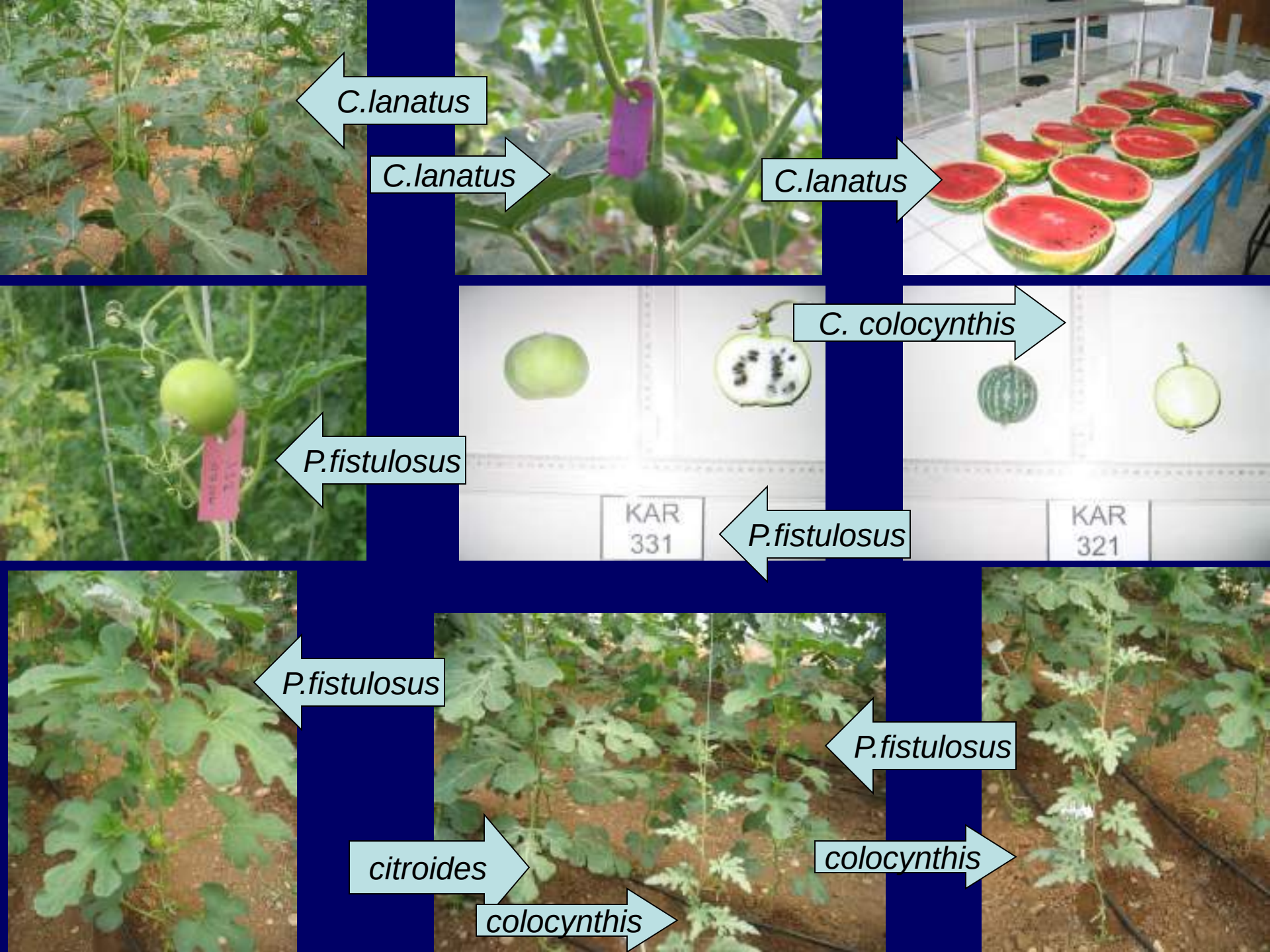
3.*Citrullus eccirrhosus* Cogn.

4. *Citrullus rehmii* De Winter (wild species endemic to Namibia (Meeuse 1962).



Watermelon is one of the most important fruit crops in Turkey. Watermelon has been cultivated over years in almost all part of Turkey.

Since watermelon is an open pollinated species, expansive polymorphism has been occurred over years in Turkey.


C.lanatus
C.lanatus
C.lanatus
C. colocynthis
P.fistulosus
KAR
331
P.fistulosus
KAR
321
P.fistulosus
P.fistulosus
citroides
colocynthis
colocynthis

GENETIC DIVERSITY OF WATERMELON

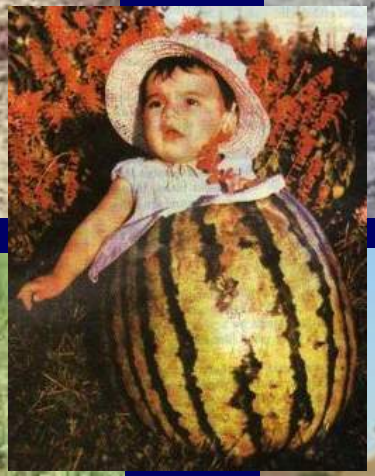
Watermelon genetic resources collections at the Cukurova University was initiated in 1993. Most regions in Turkey was visited and the accessions collected were characterized morphologically and molecularly. A great collection consist of 400 accessions was constructed by adding reference materials and different genotypes of other species provided from different gene banks. The wild types are not found in nature.

The richest regions of Turkey are the Southeastern, Aegean, Thrace and Middle Anatolia (Sari et al., 2007).

The most common Turkish watermelon local varieties are: Diyarbakır karpuzu (40-50 kilos/fruit), Tat karpuzu, Surme, Beyaz Kis, Siyah Kis, Halep Karasi, Cakal, Medine, Amerikan, Yerli, Gelin, Komando, Ankara, Kore, Akkarpuz, Karakarpuz, Cerezlik karpuz, etc.).

Southeastern Anatolia

Southeastern Anatolia



Middle Anatolia

Marmara-Thrace

Silivri, Istanbul

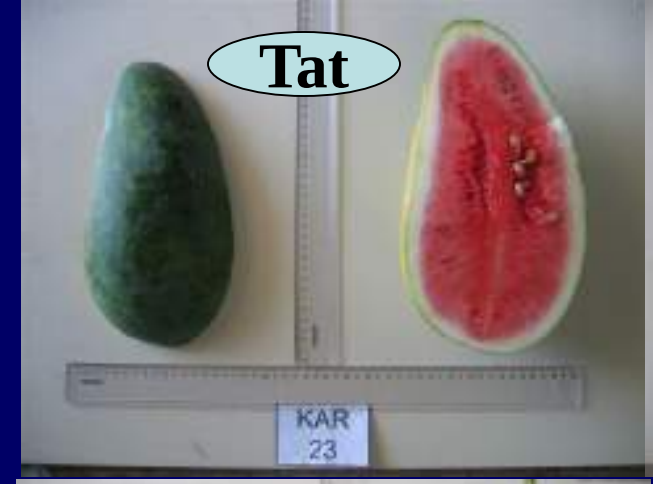
Tekirdag

Tekirdag

Kore

Mediterranean

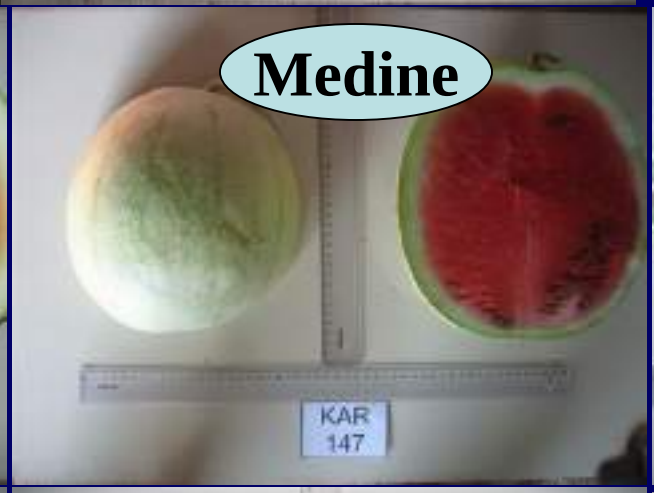
Watermelon Festival, Ceyhan/Adana


Tat
KAR
23


S.Baby
KAR
35


H.Karasi
KAR
38


Beyaz Kis
KAR
28B

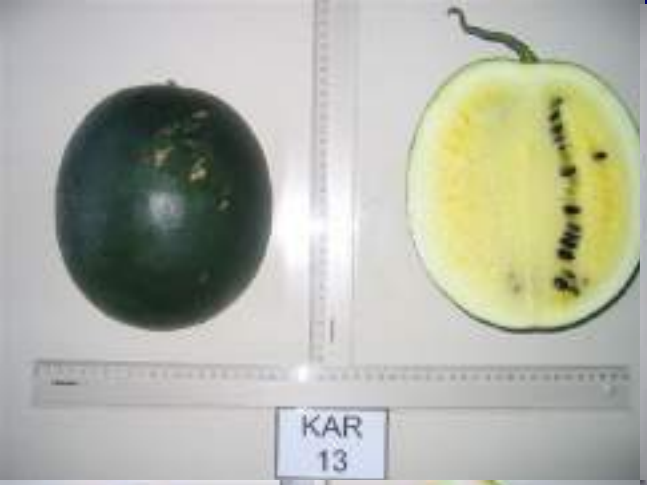

Medine
KAR
147

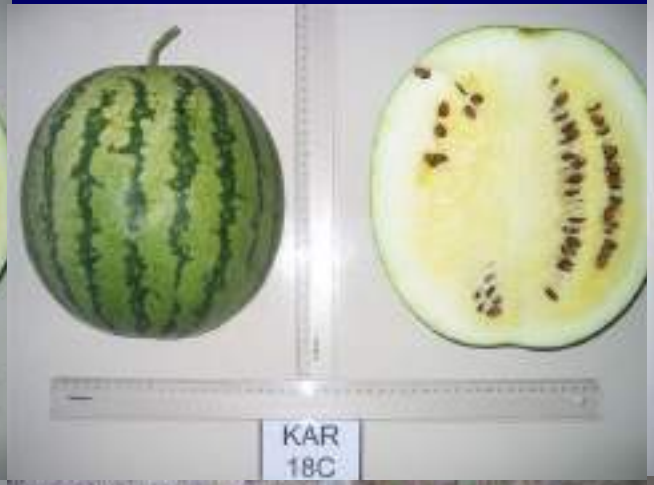

Komando
KAR
178


Zerzuri
KAR
243


Hacı
KAR
248


Karagilik
KAR
338


KAR
13


KAR
18C


KAR


KAR
217


KAR


KAR

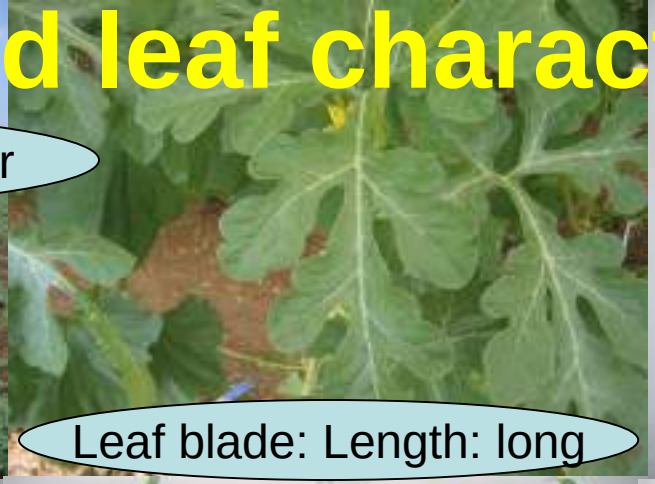

KAR
1

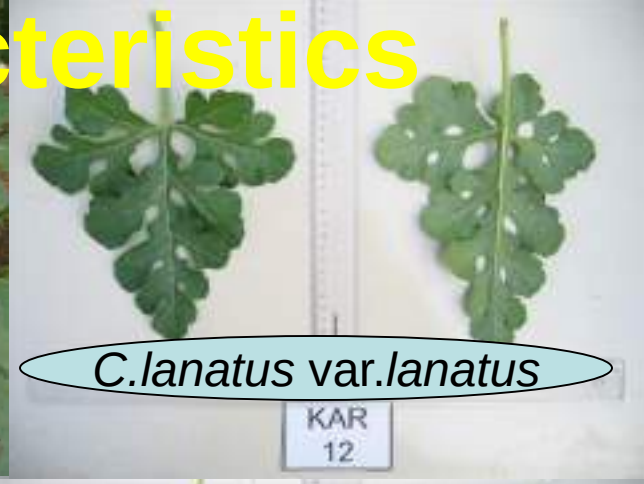

KAR
17 A

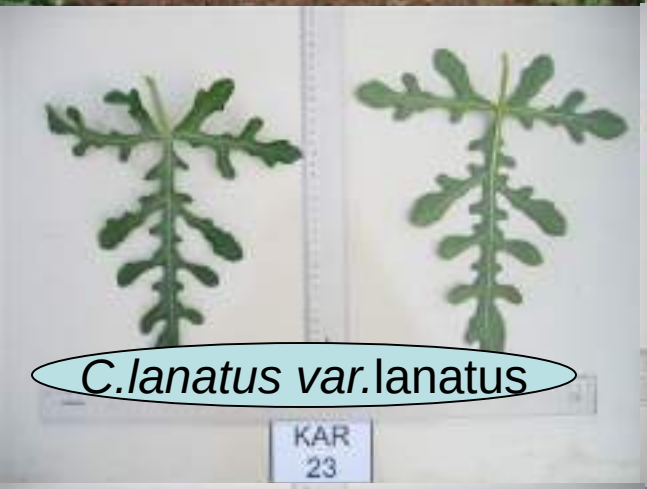

KAR
10

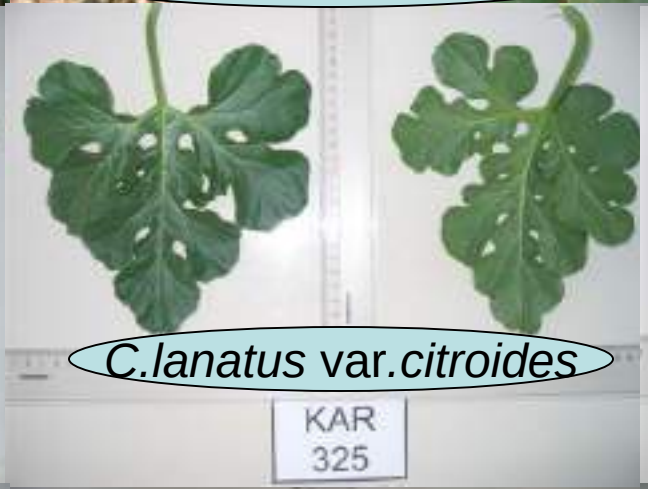

KAR

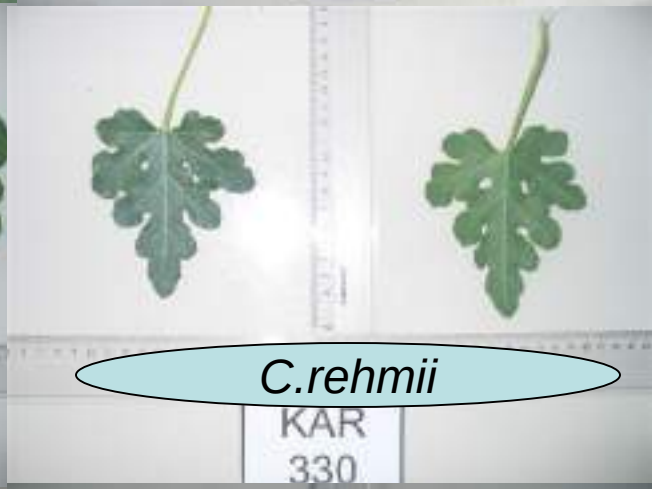
Plant and leaf characteristics

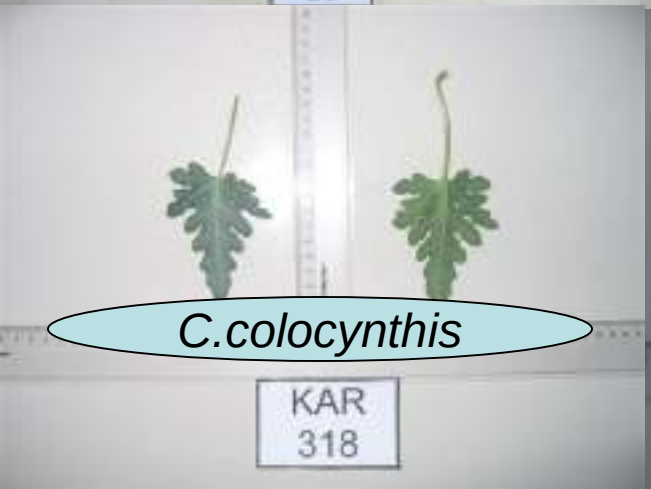


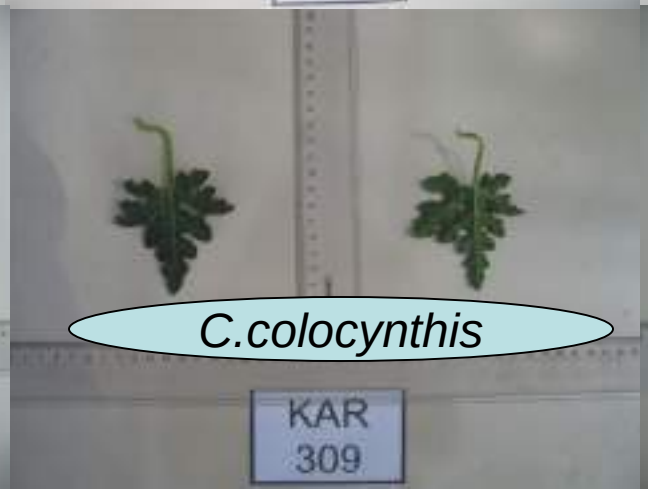




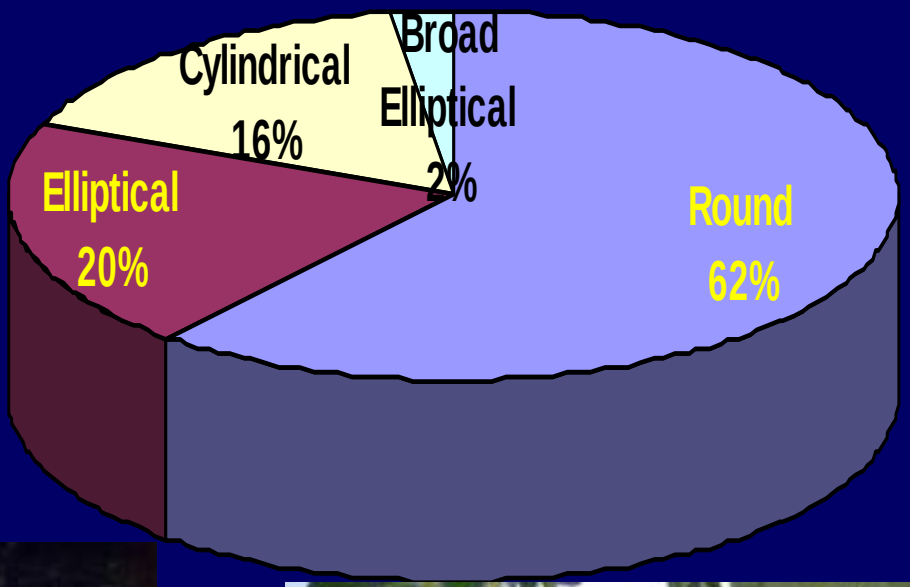




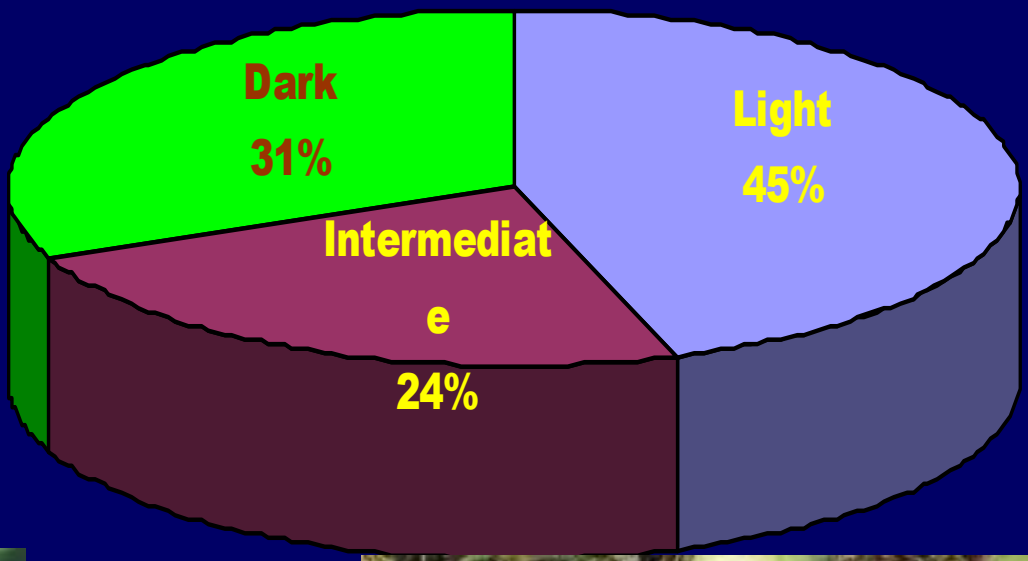




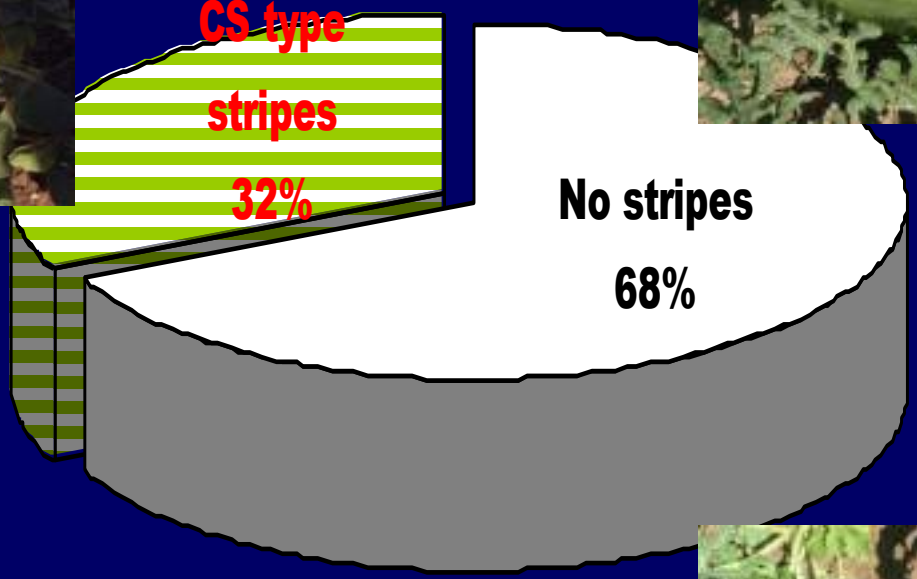
Fruit Shape



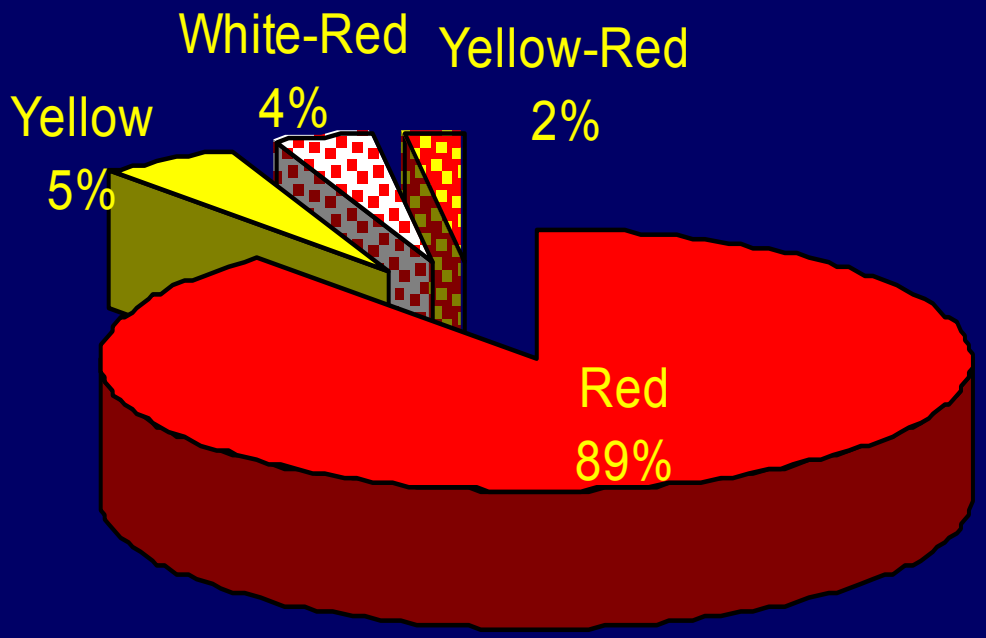
Fruit Skin Color



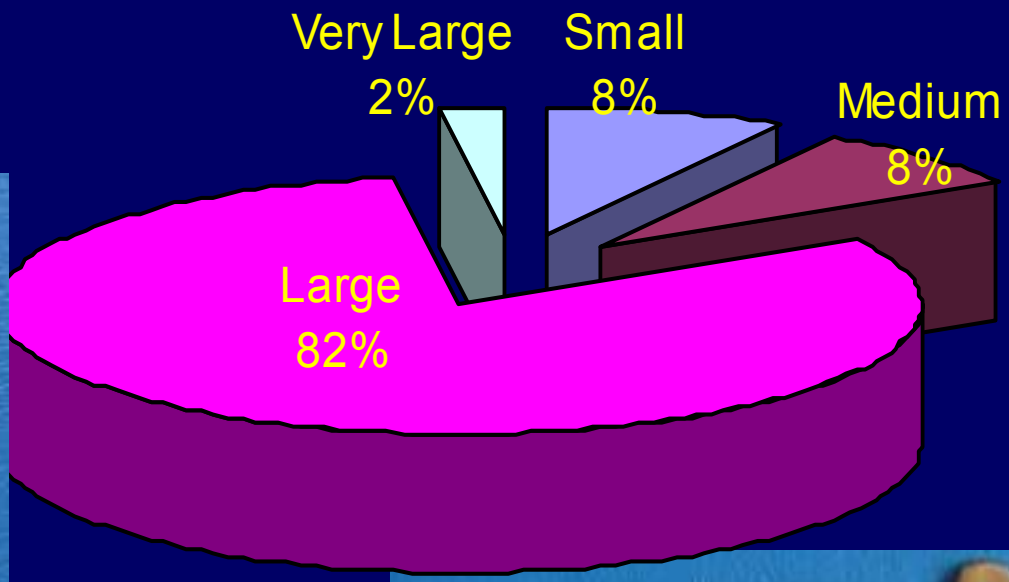
Fruit: Stripes



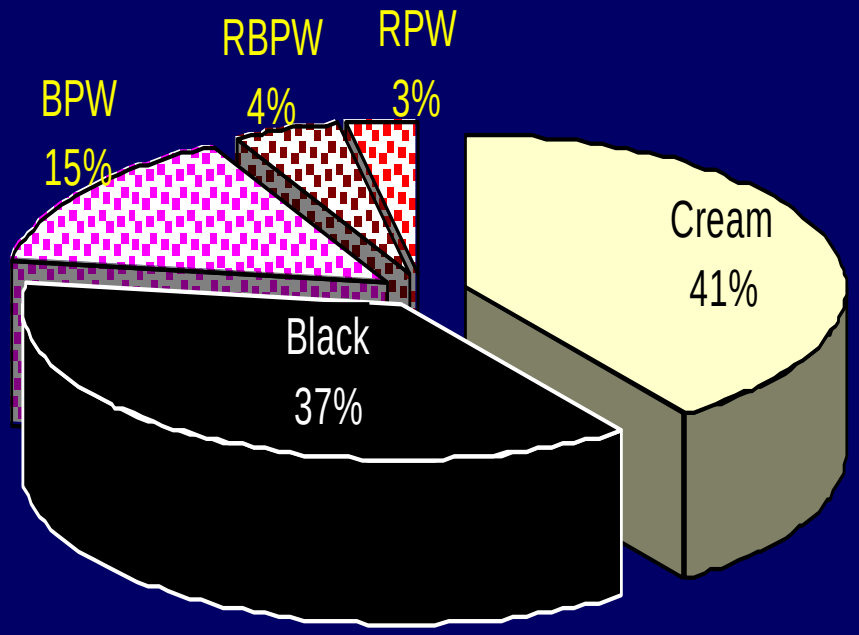
Fruit: Main color of flesh



Seed: Size

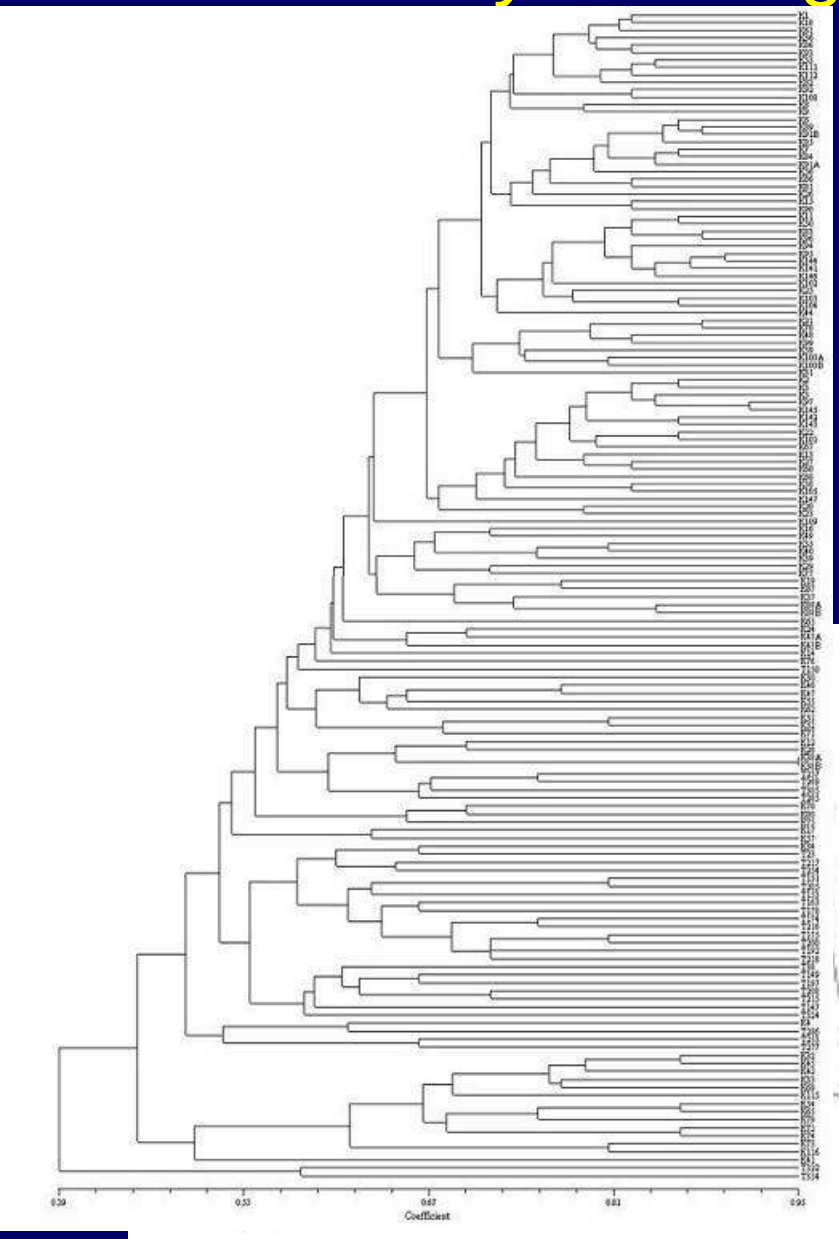


Seed: Ground color of testa

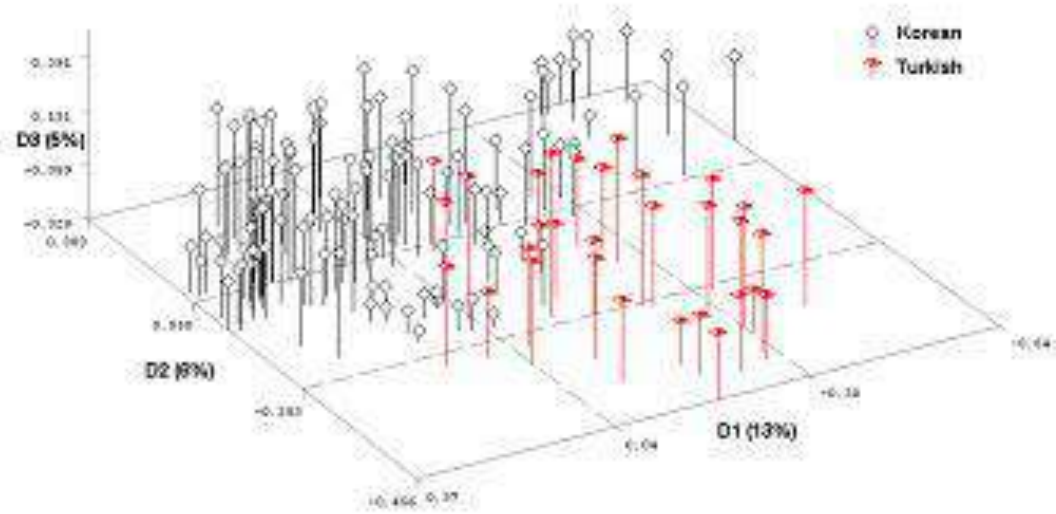


- **BPW: Brown patches on white,**
- **RBPW: Red-Brown patches on white,**
- **RPW: Red patches on white**

Dendrogram obtained from the UPGMA cluster analysis using NTSYS-PC Program



Three-dimensional plot of the genotypes based on their Eigen values



Pumpkins and squash (*Cucurbita* spp.) Genetic Resources

Pumpkins and squash (*Cucurbita* spp.) are important crops and are grown in almost all arable regions of the world. The genus *Cucurbita* is native to the Americas.

There are three economically important *Cucurbita* species;

- *Cucurbita pepo*
- *Cucurbita maxima*
- *Cucurbita moschata*

In Turkey, we have very important genetic diversity for squash (summer or snack) and pumpkin.

Genetic Diversity of Squash and Pumpkin

In Turkey;
-Summer squash (*C. pepo*) are produced for immature fruits in greenhouse and open field.
-Squash seeds have been used as a snack. A great diversity of landraces exists in the Central Anatolia (Nevsehir, Nigde, Aksaray, Kayseri, Ankara) and Thrace (Edirne, Tekirdag, Kırklareli) areas. Varieties of naked-seed pumpkin are also produced.

-The cultivation of *C. maxima* is based on local open pollinated varieties which are maintained by farmers.

-Similarly, the current production of *C. moschata* is based on local varieties for home-consumption or sale in local markets. In a project supported by TUBITAK, 128 winter squash and 40 pumpkin populations were collected from different provinces by University of Ondokuz Mayıs (Balkaya et al. 2005). Winter squash and pumpkin populations of Samsun province showed a high variability for seed size, color and weight, etc. (Balkaya et al. 2005).

Cucurbita pepo for snack seed







Snack seed industry

Collection of genetic resources
and breeding new varieties
with high protein, fatty acids
and minerals by
Malatya Pazari A.S., Istanbul
and Ankara University

Pumpkins

Photo: A.Balkaya

Cucumber (*C. sativus*)

Cucumber (*C. sativus*) is of Asiatic origin and probably of Indian origin and was domesticated around 1500 BC (Pitrat et al. 1999).

China is considered a secondary centre of genetic diversification.

Cucumber is the second most important vegetable crops for greenhouses of Turkey after tomato. Since Turkey is not the center of the origin for cucumber, there is not a great genetic diversity.

Hybrid cucumber in greenhouses soily or soilless cultures

Antalya

Mersin

Snake melon (*C. melo* var. *flexuosus*)

Snake melon (*C. melo* var. *flexuosus*) are very long, grooved and consumed as cucumber in some Asiatic countries.

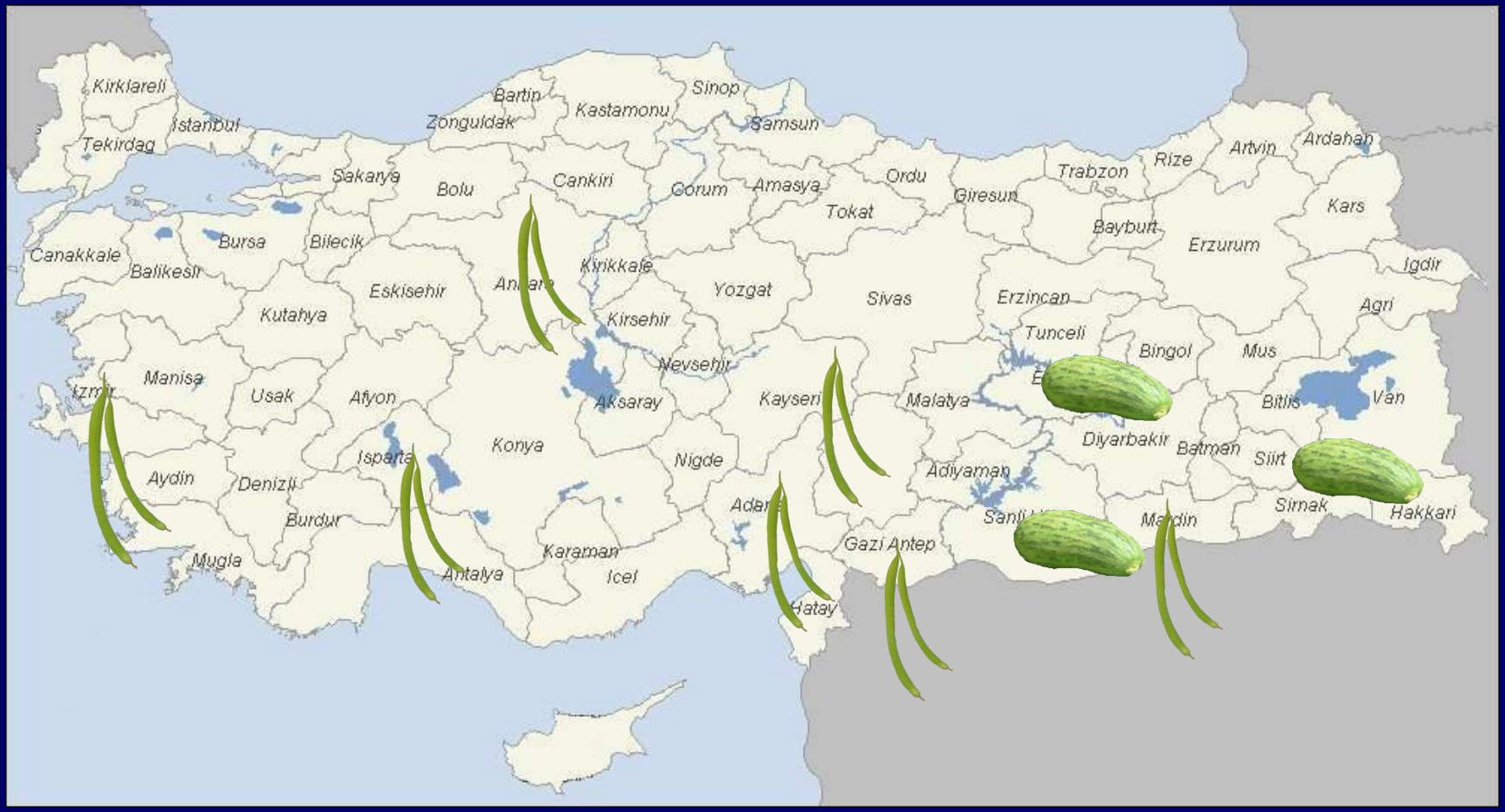
Turkey is located in the origin centre of snake melon. The origin centre of snake melon is accepted as South East Anatolia, Azerbaijan, Iraq, Palestine and Central Asia (Besirli and Yanmaz 1999). In this area, snake melon is used as fresh like cucumber or cooked or pickled.

Genetic Diversity of Snake melon

Turkey has valuable genetic resources of snake melon. Snake melon cultivation is located in Southeastern, Aegean and Mediterranean region of Turkey. There is great diversity as regarded to plant and fruit characteristics.

Genetic resources of snake melon were collected from Southeastern Anatolia region in 1992 and collected material was evaluated according to the different plant and fruit characters (Besirli and Yanmaz, 1999). Later, collecting activities and relationship with wild and cultivated melon-snake melon-cucumber as well as evaluation continued (Solmaz et al. 2004; Köse et al., 2012).

Snake melon growing area



Snake melon genetic resources

Snake melon morphological and molecular characterizations







Bottle Gourd (*Lagenaria siceraria*)

Lagenaria siceraria is commonly known as the white-flowered bottle gourd. Annual monoecious, vigorous climber species and five wild perennial dioecious species are cultivated. The genus *Lagenaria* also contains five wild species:

L. brevifilora (Benth) Roberty,

L. abyssinica (Hook F.) Jeffrey,

L. rufa (Gilg) Jeffrey, *L. spherica* (Sonder) Naudin

L. guineensis (G. Don) Jeffrey (Motimoto et al. 2005).

The fruits of bottle gourd are generally eaten like fruit of *C. pepo* in some part of world. The mature fruit is often scooped out and the skin used as containers, bowl, music instrument, decorative purposes or in some cases, fishing floats. Shoots, tendrils and leaves are also cooked and the seeds are removed for oil extraction or for use in cooking. Seeds, tendril and young leaves are also used for some medical purposes (Herklots 1972; Moerman 1998; Manandhar 2002). Furthermore, *L. siceraria* is used as rootstocks for watermelon against soil-born diseases and low soil temperature. *L. siceraria* shows high compatibility rate with watermelon (Lee 1994; Oda 1995; Yetisir and Sari 2003).

Genetic Diversity of Bottle Gourd

Although Turkey is not center of origin for *L. siceraria,* the landraces of *L. siceraria* shows great diversity. Genetic diversity of *L. siceraria* is found in Southern and Western parts of Turkey (Yetişir et al., 2008).

In addition, bottle gourd is used as a rootstock for watermelon soil-borne diseases.

Decorative

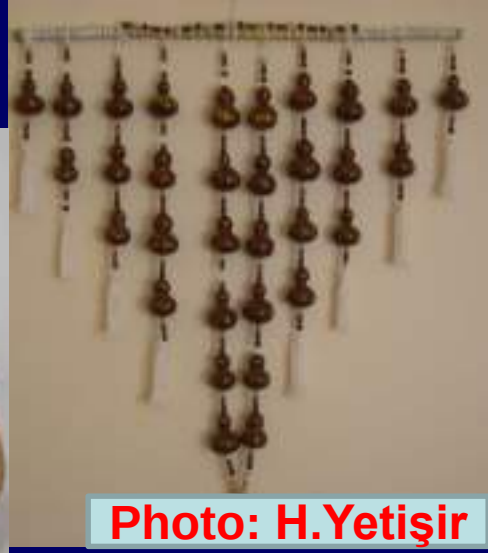
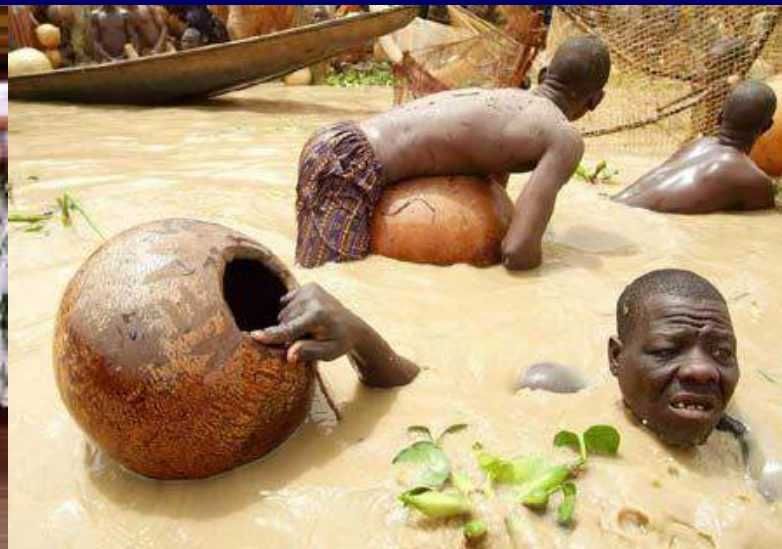


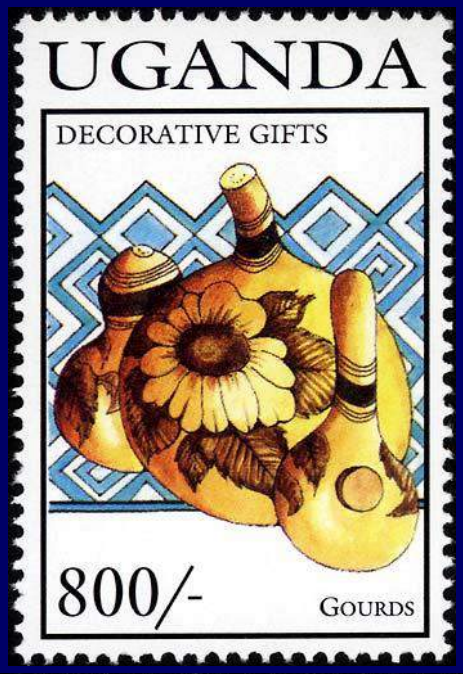
Photo: H.Yetişir

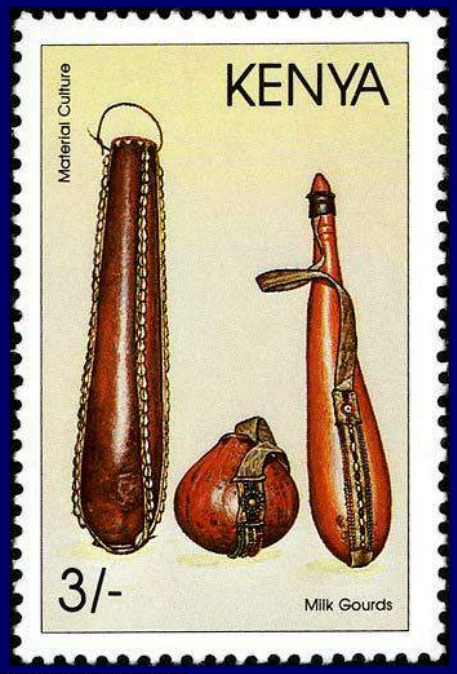
Decorative

Music instrument and swimming tool



Postage Stamp





Eaten as a vegetable

Stew with meat and chickpea

Plant, flower and fruits











Rootstock

Photo: H.Yetişir

Collection and characterization of bottle gourd

Photo: H.Yetişir

Genetic Diversity of Minor Cucurbits

In Turkey, *Luffa* spp. is very common in home gardens as a climbing plant and for the production of sponge that is sold in local markets. *Ecbalium elaterium* (L.) A. Rich. is widespread in Mediterranean region as a wild plant. However *Sechium edule* (Jack.) Swartz and *Momordica charantia* L. are less common species.

Luffa spp.

Antakya, Turkey

Photo: H.Yetişir

Sechium edule

Antalya

Momordica spp.

Photo: H.Yetişir

Grafting in Cucurbitaceae and Cucurbit Rootstocks

Grafting in vegetables was initiated in Japan and Korea in the late 1920s with watermelon grafted onto bottle gourd for control of Fusarium wilt (Ashita, 1927).

At present, grafting is used in

- watermelon
- tomato
- eggplant
- melon
- cucumber
- pepper

WHY GRAFTING?

- High yield and quality
- Strong plant growth
- Disease and pest resistance
- Tolerance to low soil temperatures
- Tolerance to soil salinity
- Promoting the uptake of water and nutrients
- Environmental protection (less spraying)

Hürriyet

EKONOMİ

GÜNDEM | PLANET | EKONOMİ | SPOR | KELEBEK

Hava Durumu | Sinema | Astroloji | Tv Rehberi | Piyasanet | E- Gazete | Canlı Skor | En İyi On

EKONOMİ ANA SAYFA | ÖZEL RÖPORTAJLAR | EKO - ANALİZ | ENERJİ

Kabak karpuz satana 50 bin lira 'ağız tadını bozdun' cezası kesilecek

19 Haziran 2011 | A A

Denizli hal yönetimi "Kabak aşılı karpuzlara" ağız tadı kaçırıyor gerekçesiyle yasak getirdi. Yasağı çiğneyen hal esnafınaysa 50 bin lira ceza verilecek. Yılda ortalama 4 milyon ton karpuzun üretildiği Türkiye'de ilk defa Denizli'deki gibi bir uygulamaya gidiliyor.

DENİZLİ hal yönetimi "Kabak aşılı karpuzlara" ağız tadı kaçırıyor gerekçesiyle yasak getirdi. Yasağı çiğneyen hal esnafınaysa 50 bin lira ceza verilecek. Karpuzu topraktaki

Negative news about grafted watermelons

Production should be banned

Stomachache and diarrhae

Fazlası karın ağrısı ve ishal yapıyor

ÜRETİMİ YASAKLANMALI

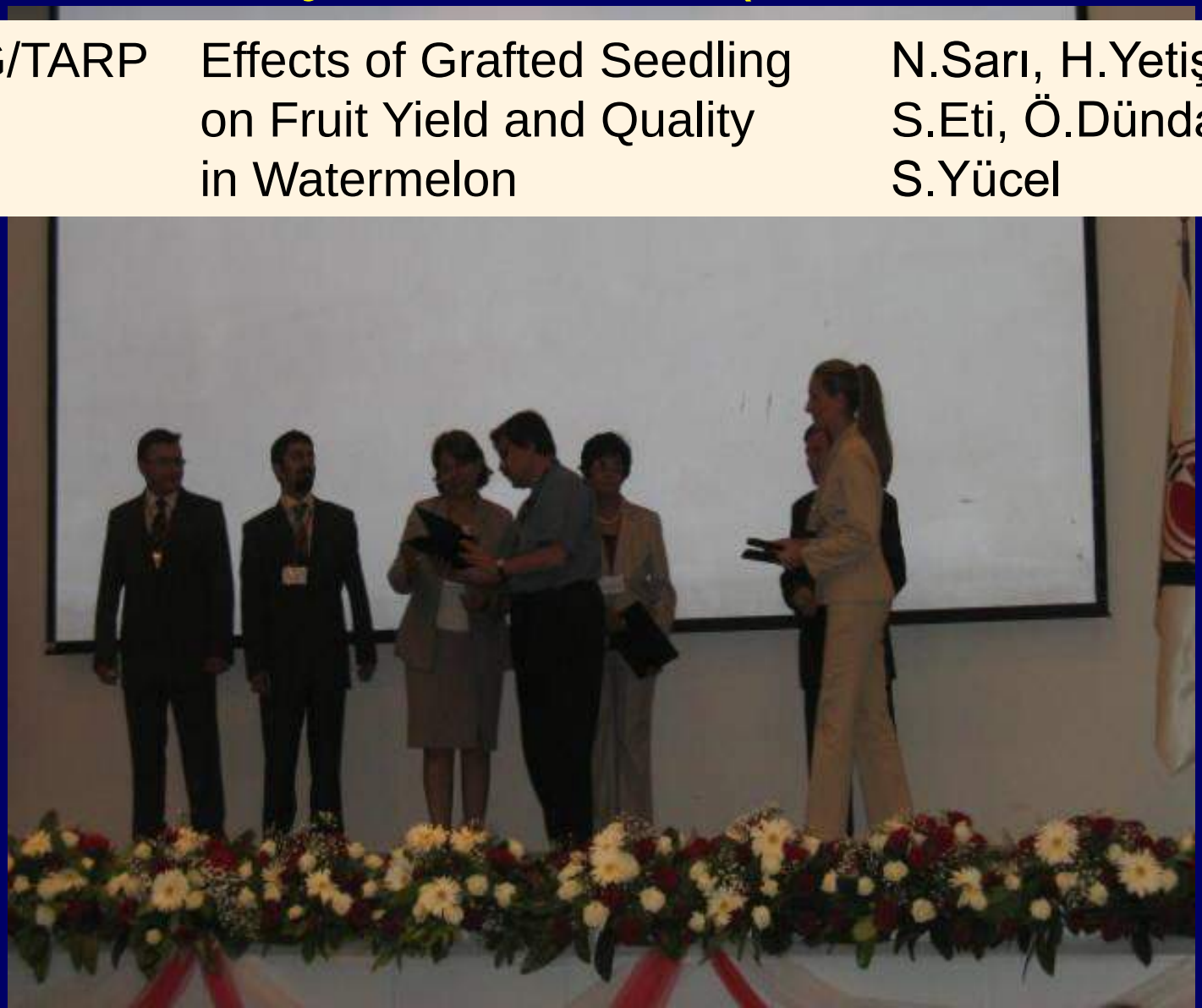
Grafting's History in Turkey

Why has not grafting in vegetables improved in Turkey until 2000?

- Turkey had large enough area for plant rotation (watermelon)
- Use of some chemical for soil-borne diseases
- Intensive labor input and high costs of grafted seedling
- Lack of technology and information about grafted seedling production

First *Cucurbitaceae* Grafting Project was Awarded by TÜBİTAK (23 June 2006)

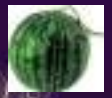
TOGTAG/TARP 2410	Effects of Grafted Seedling on Fruit Yield and Quality in Watermelon	N.Sarı, H.Yetişir, S.Eti, Ö.Dündar, S.Yücel



Vegetable Grafting in Turkey (2014)

Total 143 millions grafted seedlings


65 millions tomato (12 rootstocks)


60 million watermelons (23 rootstocks)


10 millions eggplant (2 rootstocks)

8 millions cucumber+melon (7.5 millions of them is cucumber)

Cucurbit Rootstocks (2014)

- Produce 60 millions watermelon seedlings; needs to 72 millions rootstock seeds.
- Produce 8 millions cucumber+melon seedlings; needs to 10 millions rootstock seeds.

Most Commonly Used Cucurbit Rootstocks in Turkey (2014)

- Nun 90-75 (Nunhems); 30 million seeds/year*
- TZ 148 (Tézier); 12 million seeds/year*
- RS 841 and Kremna (Seminis); 12 million /year*
- Maximus (Antalya tarım); 3 million seeds/year*
- Macis (Nunhems); 2 million seeds/year**
- Others*** (about 15 rootstocks): 20 million/year

*: *C. maxima x C. moschata*

**: *Lagenaria* spp.

***:Obez (Multi), Jumbo (Enza Zaden), Shintosa (Fito), Zorba (Grainvoltz), Carnivor (Syngenta), Ferro (R-Z)…..

Rootstocks

Pumpkins (*Cucurbita* spp.)

Rootstocks

Bottle gourd (*Lagenaria* spp.)

Rootstocks
Ash Gourd (*Benincasa* spp.)

Rootstock Growing

Rootstocks growing

Strong root system

Photo: H.Gül

Preparation of Rootstocks

Photo: H.Gül

Preparation of Scion

Photo: H.Gül

Rootstock + Scion

Photo: H.Gül

Intensive care unit

Grafted seedling ready to planting

Photo: H.Gül

Grafted Watermelon Growing in the Mediterranean Region of Turkey

Photo: H.Gül

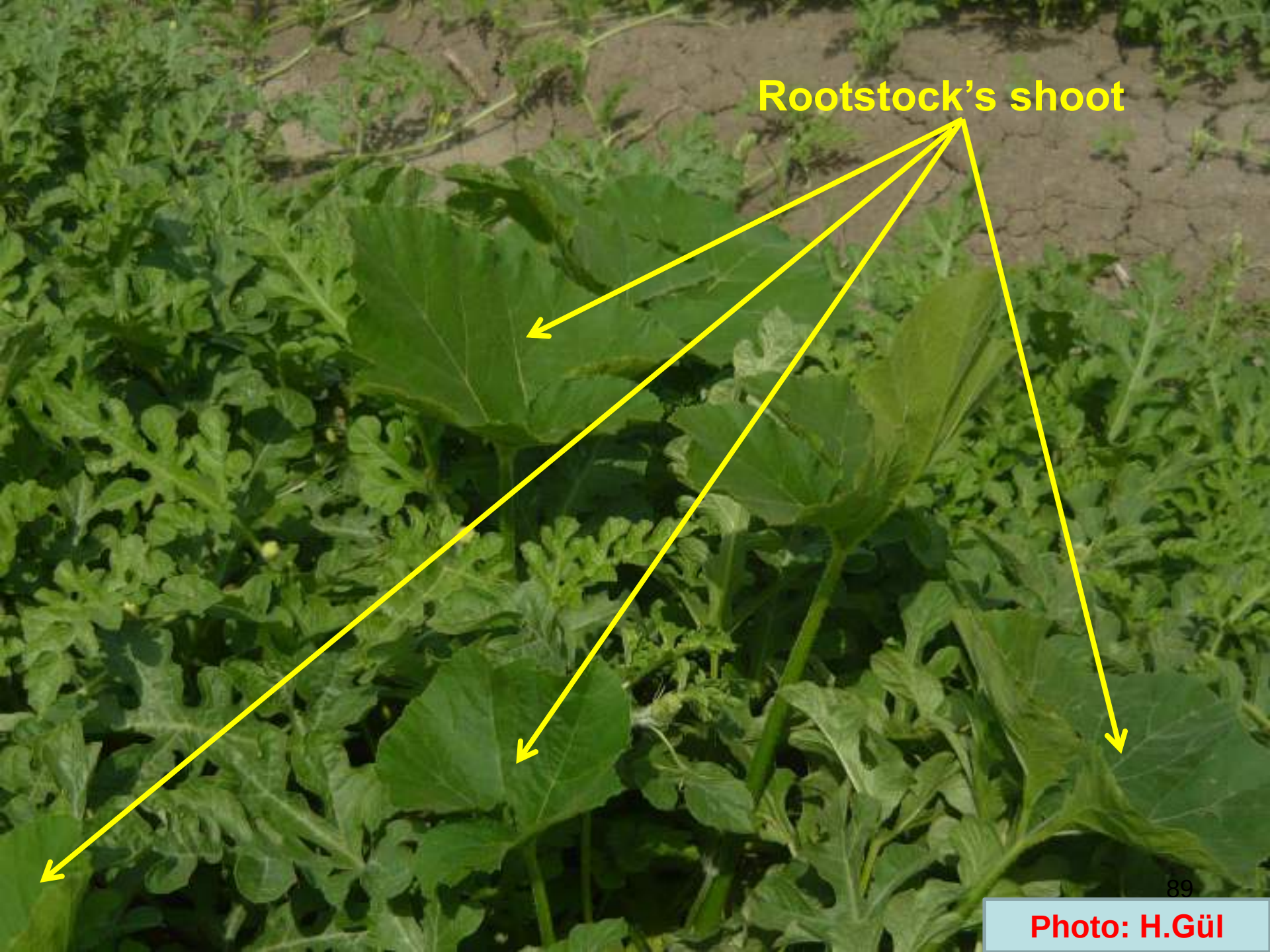


Photo: H.Gül

Photo: H.Gül

CONCLUSION

Cucurbitaceae **is one of the most important families with significant genetic resources in Turkey. The number of accessions increased from 1616 in the Turkish Gene Bank and 387 accessions in the universities in the years 2000 (Kücük et al. 2002), to 2444 in the Turkish Gene Bank (AARI) and about 2000 in the universities and research institutes. Breeding lines and hybrid cultivars are not included in these quantities. However, duplications probably exist in this collections.**

CONCLUSION

- **Grafting in *Cucurbitaceae* was started with watermelon in 2001 by Yetişir and Sari, continued with melon by Yarşi and Sari in 2004 in Turkey.**
- **Collection and characterization of *Lagenaria* by Yetişir et al., *Cucurbita* by Balkaya et al. and *Citrullus lanatus* var. *citroides* by Sari et Solmaz.**
- **Pest and some abiotic stress factor tests are made and still contuining.**
- **Rootstocks breeding of *Lagenaria*, *Cucurbita maxima* x *Cucurbita moschata* and *Citrullus lanatus* var. *citroides* still are ongoing projects…...**

Vegetable GRAFTING

THANK YOU FOR YOUR ATTENTION…