www.biodicon.com BIOLOGICAL DIVERSITY AND CONSERVATION

ISSN 1308-8084 Online ISSN 1308-5301 Print

Research article/Araştırma makalesi
DOI: 10.46309/biodicon.2023.1223530
16/3 (2023) 192-202

Studies on genetic diversity of caprifig: caprifig genetic resources (*Ficus carica* var. *caprificus*) conservation and characterization project

Arzu AYAR [*1], Aytekin BELGE [1], Mesut ÖZEN [1], Berrin ŞAHİN [1], Çağlar KARACAOĞLAN [1]
ORCID: 0000-0002-2080-209X**;** 0000-0002-4470-833X; 0000-0002-2699-3827;
0000-0002-0258-7066; 0000-0003-1746-1455

[1] İncir Araştırma Enstitüsü Müdürlüğü, 09600 Aydın, Türkiye

Abstract

In this research, male fig (caprifig) genotypes collected within the scope of the project from Marmara, Mediterranean Regions, and mainly from the Aegean Region of Türkiye were evaluated according to some identification criteria for fig. Male fig trees produce in three different periods as Profichi (spring), Mammoni (summer), and Mamme (winter) fruits in a year. The most important of these are the Profichi fruits, which are used to ensure caprification in female figs. For the caprification process, Profichi fruits are hung on the female fig trees. Caprification occurs via fig wasp (*Blastophaga psenes* L.), which emerges from Profichi fruits. Quality characteristics and phenological observations of Profichi fruit was evaluated in this research. The average fruit weight of Profichi fruits is 7.7- 49.9 g; fruit width is 23.4-54.9 mm; fruit length is 27.7-59.7 mm. The number of fruits on the shoot was determined to be in the range of 2-10. The number of male flowers in Profichi fruits is 76-269, and the number of female (gall) flowers varied between 194-1193. In conclusion, this study has shown that there is a significant genetic diversity among domestic male figs in the Türkiye Fig Field Gene Bank.

Keywords: male fig, genetic resources, fig field gene bank, conservation

---------- * ----------

Erkek incir genetik çeşitliliği üzerine çalışmalar: erkek incir genetik kaynakları (*Ficus carica* var. *caprificus*) muhafaza ve karakterizasyonu projesi

Özet

Bu araştırmada, proje kapsamında Türkiye'nin ağırlıklı olarak Ege Bölgesi olmak üzere, Marmara ve Akdeniz Bölgelerinden toplanan erkek incir (caprifig) genotipleri, çeşit tanımlama kriterlerine göre değerlendirilmiştir. Erkek incir ağaçları, bir yıl boyunca ilek (bahar), ebe (yaz) ve boğa (kış) olmak üzere üç farklı periyotta meyve verir. Bunlardan en önemlisi ilek meyveleridir ve bu meyveler dişi incirlerde döllenmeyi sağlamak amacıyla kullanılır. Dişi incirlerde döllenme; ağaca file torbalar içinde asılan ilek meyvelerinden çıkan ilek arıcığı (*Blastophaga psenes* L.) vasıtasıyla gerçekleşir. Çalışmada genel olarak ilek meyve kalite özellikleri ve fenolojik gözlemleri değerlendirilmiştir. İlek meyvelerinin ortalama meyve ağırlığı 7.7-49.9 gr; meyve genişliği 23,4-54,9 mm; meyve büyüklüğü 27.7-59.7 mm ve sürgündeki meyve sayısının 2-10 aralığında olduğu belirlenmiştir. İlek meyvelerinde erkek çiçek sayısı 76-269; dişi (gal) çiçek sayısı ise 194-1193 arasında değişmektedir. Sonuç olarak; bu çalışma, Türkiye İncir Arazi Gen Bankası'nda bulunan yerel erkek incirler arasında büyük bir genetik çeşitlilik olduğunu ortaya koymuştur.

Anahtar kelimeler: erkek incir, genetik kaynaklar, incir arazi gen bankası, muhafaza

[*] *Corresponding author* / Haberleşmeden sorumlu yazar:Tel.: +902565811123-114; Fax.: +902565811124; E-mail:arzu.gocmez@tarimorman.gov.tr
 Geliş tarihi: 04.01.2023; Yayın tarihi: BioDiCon. xxx-xxxxxx

1. Introduction

Türkiye contains rich wild and cultivated fig forms. Male fig (caprifig) trees constitute one of the vaulable genetic resources in Türkiye. Caprifigs, used as pollinators, are essential to protect genetic resources and transfer the future. According to reference [3, 5], In the 1960s and 70s, by Ölçer (1968), Eroğlu (1982) and Aksoy et al. (1994), selection researches was initiated in Türkiye to develop new female fig varieties including pollinator figs. In 1960, 18 caprifig cultivars were evaluated according to phenological and pomological characteristics [17]. Eroğlu (1982) determined 58 caprifig genotypes in his selection study in the Aegean Region.

Fig Research Institute Directorate (Aydın/ Türkiye) is the institution primarily responsible for the conserving of caprifig genetic resources. It has aimed to conserve the caprifig cultivars and genotypes collected by survey and selection studies, etc., carried out in the fig growing regions of Türkiye, enrich the collection with new cultivars and genotypes, characterize them and provide genetic diversity for further breeding studies. The creation of the caprifig genetic resources plot began in the 1960s. As of 2022, the number of varieties and genotypes in caprifig genetic resources is 70 [2].

Characterization of male fig cultivars and genotypes, conserved ex-situ and in-situ due to selection and breeding studies, is accepted as a primary and essential step in carrying out any future breeding program [20].

Morphological and pollinator characteristics of 6 standard cultivars and 90 caprifig genotypes grown in the Eastern Mediterranean region of Türkiye were determined. In the principle component analysis (PCA), the number of female (gall) flowers per fruit; *Blastophaga*'s-exit time, pollen viability, and germination percentages; the amount of pollen per flower and fruit were taken as the prominent parameters. Significant morphological and pollinator variability was seen among caprifig genotypes. Mersin06 and Osmaniye02 genotypes were found to be parthenocarpic among 90 caprifig genotypes. In addition to their use as pollinators, it has been concluded that they are valuable genetic resources to include in breeding programs [5].

In the Fig Research Institute Directorate, Umurlu caprifig field gene bank, 12 superior caprifig were determined suitable pollinators in Sarılop and Bursa Siyahı fig cultivars. Fruit and pollen size, shape class, and surface structure were determined in 12 caprifig genotypes. It was determined that the Kızılay-1 cultivar had larger fruit (33.5g) and larger ostiole opening (6.0mm) compared to other genotypes. SEM images of pollen grains of all samples except Mıstık and Mor Demirtaş were characterized as suboblate. On the other hand, the Mor Demirtaş cultivar was the longest in terms of pollen length (11.25 µm), and the Yanako-2 cultivar with the largest pollen width (13.34 µm) and pori diameter (2.26 µm). All genotypes were determined 2-porate. PC1 and PC2 (PCA) defined 73% of the genotypes. According to cluster analysis, genotypes were divided into groups [4].

Pollen was collected from a total of 24 individuals, including 20 caprifig genotypes sampled from Adana, Hatay, Kahramanmaraş, Mersin, and Osmaniye provinces in the Eastern Mediterranean Region and 4 standard caprifig varieties from Aydın in the Aegean Region of Türkiye to determine the pollen characteristics. Polar length, equatorial diameter, colpus width, pollen shape, porate number, porate width, exine thickness, and abnormal pollen ratio were determined as the most important distinguishing criteria [6].

310 fig genotypes in the Fig Research Institute Directorate fig field gene bank collected from 6 geographic regions (including caprificus) were analyzed with 14 SSR loci. 7 similarities, 54 clone-level similarities, 36 synonyms, and 22 homonymous differences were detected [8].

As in Türkiye, studies on the collection, characterization, and conservation of genetic resources have been made and continue to be conducted in many countries with caprifig genetic diversity.

The National Clonal Germplasm Repository (NCGR) fig collection in Davis, California, currently consists of 190 species and 78 fruit varieties. It contains a selection from 44 different regions, 40 advanced selections from plant breeders, 28 caprifigs, and a few species and hybrids [21].

The lack of sufficient caprifig trees to pollinate female figs in Tunisia is considered an essential constraint for developing the fig industry. The study focused on characterizing 8 local caprifig cultivars grown in coastal and continental conditions [12]. In Tunisia, fruit set, yield, characteristics, and shoot length data of female figs were recorded and evaluated in 2008 and 2009 to determine the efficiency of the caprification on Zidi, Bidhi, and Bither Abiadh female fig cultivars [11]. The identical genotypes which were grown in both regions (terrestrial and coastal regions) were compared. It was determined that tree growth, yield, fruit characteristics, TSS, and earliness situations were different [11, 13, 22].

By crossing male and female figs that produce parthenocarpic fruit, hybrid individuals that produce parthenocarpic fruit at a rate of 50% can be obtained. For this purpose, caprifigs UCR 228-20, 271-I and 347, which produce parthenocarpic fruit, were used as parents in California and Israel [5, 21].

The productivity of three pollen sources in Kazerun, Iran, was evaluated to determine the most effective pollinator in female figs ('Payves' and 'Sabz' (Smyrna type- female figs)). As a result, fruit length, skin color, total soluble dry matter content (TSS), total phenolics, flavonoids, and anthocyanins were significantly affected by pollen sources. There was no significant effect of pollen source on fruit size, weight, ostiole opening, fruit ripening time, and antioxidant capacity [19].

In Spain, 15 reference samples were fingerprinted using 21 SSR markers, along with 42 lines corresponding to 2 caprifig and 12 local varieties. A total of 77 alleles were uncovered, detecting a beneficial level of genetic variability in local germplasm pools [18].

In Iran, 53 caprifig accessions were analyzed for phenotypic diversity using 32 morphological criteria. Significant phenotypic diversity was detected among caprifig accessions according to morphological characteristics. As a result of PCA it was determined that the top ten components that contributed the most to petiole length and thickness, leaf length and width, fruit width, fruit shape, central lobe length, number of lobes and leaf shape explained 76.09% of the total morphological variation [14].

In Tunisia, 20 caprifigs were analyzed using improved SSR markers. The 13 pairs of primers were found to amplify 37 alleles in the studied accessions. The results obtained showed a low genetic diversity in the studied figs. Samples from different geographical regions were analyzed. No clear grouping based on geographic origin has been observed, which suggests an extensive exchange of caprifig plant material via vegetative propagation [9].

In Tunisia, 53 morphological features and 4 pollen descriptors of caprifig were studied to select the most distinctive features. Except for the number of anthers/flower and pollen viability, there were significant differences between genotypes in almost quantitative traits. It was stated that 40 characters among 53 morphological features and 4 pollen descriptors showed good discrimination power and could be used to distinguish caprifig trees [10].

Identification was performed using molecular markers and morphological characters to analyze genetic diversity and related relationships between female and caprifig genotypes grown under the same environmental conditions in the Tunisia ex situ fig germplasm bank. This study showed that there is significant genetic diversity among local figs [1]. For the purpose of collection, conservation, caracterization, documentation and evaluation of wild caprifig genetic resources in Tirana, different populations were evaluated in the northwest, central, and southwest (3 regions) of the country. Genotypes with different fruit colors were found. The number of gall flowers was found to be about 800-1200, and the other flowers were found in the range of 300-400 [15].

The phenotypic variability of wild female fig and caprifig genotypes in Risso was evaluated. Significant variations were observed among figs. Due to the increasingly pronounced effects of caprifigs on fruit quality and phytochemical properties of female figs, it has been found important to conserve caprifig genetic materials not only for pollination but also for fig breeding studies [16].

Measurements, observations, and evaluations were made using the identification list developed by UPOV and IPGRI in all domestic and foreign caprifig and female fig varieties and genotypes to be conserved with the collection program in 9 locations and 26 sub-locations in the Kerkennah Archipelago of Tunisia. In particular, the research showed that it is imperative to pay attention to threatened and rare varieties. The conservation program in farmer's orchards was found to be important for the conservation of traditional knowledge, the rehabilitation of varieties, and sustainable agriculture. The region was stated to be a suitable alternative [7, 11, 13].

In this project, to enrichment of genotypes with new survey, handing them down to the next generations, and to conserving and keeping the documentation for use in future breeding programs, and to carrying out annual maintenance operations in the collection was sustainable important target.

This research aimed at metric and non-metric characterization of caprifig genotypes/varieties which conserved in Umurlu caprifig field gene bank.

2. Material and methods

Caprifig genotypes found in Fig Research Institute Directorate fig field gene bank constituted the study material (Figure 1).

70% of the male figs used as material were collected from Aydın and İzmir Provinces of the Aegean Region, 11% from Balıkesir Province of the Marmara Region, and 17% from Hatay, Osmaniye, Mersin and Adana Provinces of the Mediterranean Region in Türkiye.

Abalı İlek, Hamza İlek, Ak İlek, Elma İlek, Büyük Konkur, Ak Erkek 2, Taşlık, Bardakçı and Bardacık caprifigs were registered variety in the caprifig field gene bank [2] .

Average fruit weight (g), fruit size (mm) (width, length and ostiole opening), fruit number per shoot (pieces/shoot), amount of *Blastophaga psenes* L., amount of male and female (gall) flowers, harvest time (day), foliation date, the birth date and ripening time criterias of Profichi fruit were evaluated (Table 1).

Figure 1. Male fig (caprifig) field gene bank (planted date:2009)

Table 1. Some descriptions used in caprifig genotypes

Fruit number per shoot /tree	The fruits amount were counted and determined on shoots of the trees.
Harvest date / period	The date on which the Fig wasp, which comes out of the of the Profichi fruit, was seen, was taken as the harvest start date. The last date of Fig wasp emergence was determined as the last harvest date.
Blastophaga psenes L. (pieces)	5 Profichi fruits, were placed in glass jars covered with tulle. *Blastophaga psenes* L. amount which comes out of 5 fruits, was counted every day.
Amount of male and gall flowers	Male and gall flowers in 5 Profichi fruits were counted one by one.
Profichi fruit weight (g)	Fruits were weighed with a precision scale sensitive to 0.01 g and their fruit weights were determined in g. It was determined by dividing the total weight of fruits from each variety by the number of fruits.
Profichi fruit width-length (mm) and ostiole width (opening) (mm)	Determined in mm with digital caliper. Fruit width was determined by measuring from the equatorial region, which is the middle part of the fruit. Fruit length was found by measuring the distance between the ostiole and the point where the neck of the fruit meets the petiole.
Fruit cavity	If the inside is completely full; there is no gap; The gaps up to the lentil volume; very small, The gaps between the lentil-chickpea volume; small; The voids up to the chickpea volume; medium, The voids larger than the chickpea volume; large.
Fruit shape index	It is expressed as the ratio of fruit width to fruit length. this value; If <0.9 oblonge, = 0.9-1.1 globose, >1.1 fruit shape is oblate.

3. Results

The leafing date generally was observed when two-leaf emergence appears in 50% of the tree between March 09 and April 14.

The birth of the profichi fruits generally was observed between March 05 and April 08, when budding and leafing occured (Figure 2).

The ripening of profichi fruits generally coincides with the period when female figs became receptive. Generally, skin colour of Profichi fruit turns to bright and light green as a sign of maturity. The scales around the ostiole opening begin to open. This date is also on which the female fig wasp, which comes out of the Profichi fruit, was seen. Generally, this period was observed between June 10-27 (2015), May 29- June 19 (2016) and May 29- June 25 (2022). In general, Şeytan 1, Mıstık İlek, Bozdoğan Kaba İlek, Sarı İlek, Frenk, Kıbrıslı, Damarlı and Gabalı genotypes had matured profichi fruits the earliest among the caprifigs.

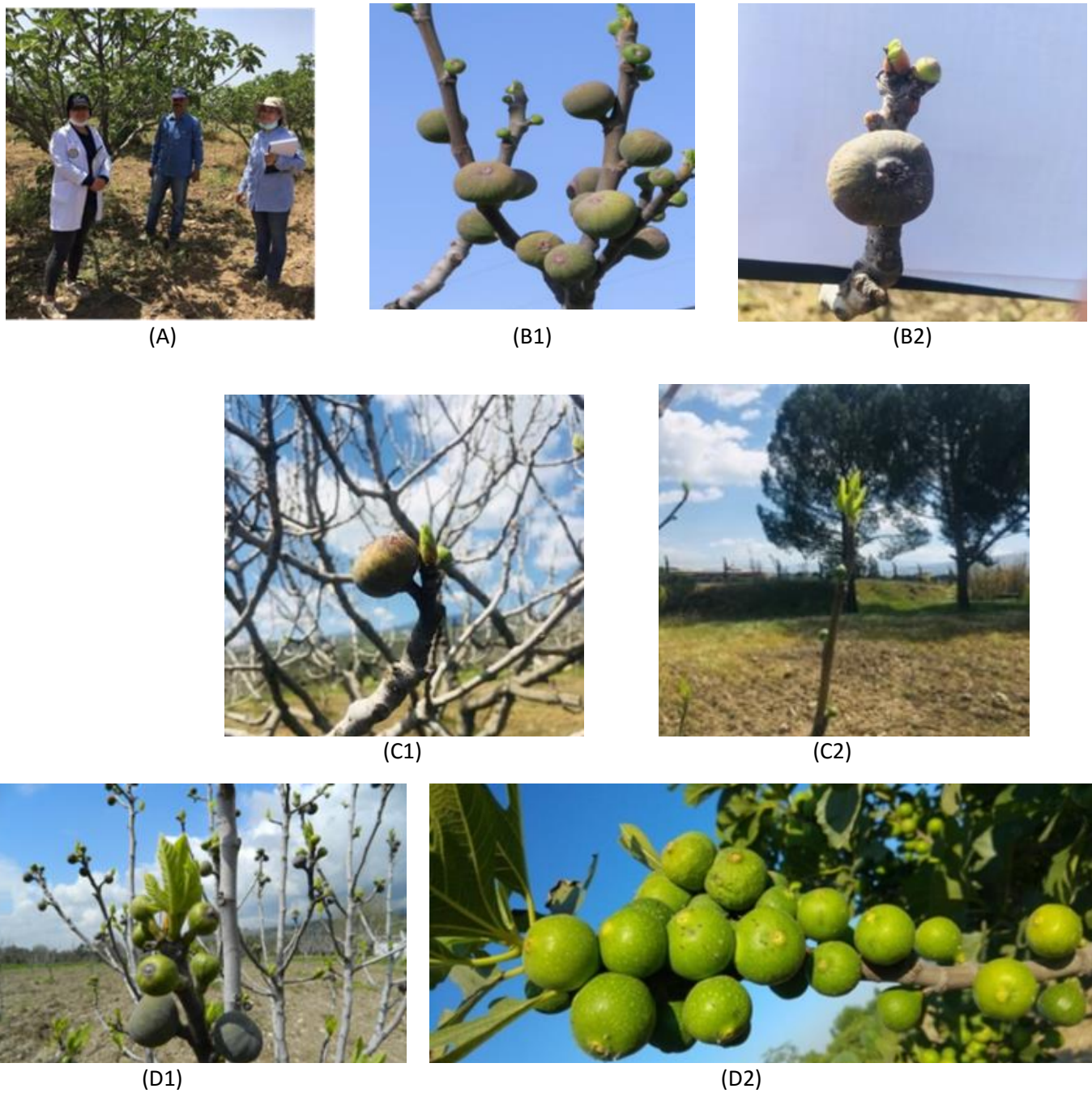

Figure 2. Phenological observation studies (A), mamme fruits on the branch (B1, B2), onset of leafing (C1, C2) and newly formed profichi fruits (D1, D2)

Generally, the average amount of profichi fruits on the shoot was detected between 2-10. It was counted as 3-8 (2015) and 2- 13 (2016) pieces/shoot.

The number of Mamme fruits on the caprifig tree varied according to years, genotype, tree age, and vigor. According to the phenological observations of 2021; approximately 100 or more in Bardakçı İlek, Hamza, Ak Erkek 1, Taşlık, Frenk, Mehmet Tosun genotypes, approximately 60-80 in Kızılay 1, Çaçaron, Şeytan 2, Çakın 1, Sarı İlek genotypes; It was determined in the range of 30-50 in Ömerbeyli Kaba İlek, Kuyucak İlek, Gabalı, Damarlı, Ak İlek, Aydın 2, Karabulut, Conkurt, Armut İlek, Kızılburun, Yanako 1, Adalı, Eşref 1, Eşref 2 genotypes. It was determined as 20 in other genotypes. The amount of mamme fruit is almost non-existent in Mor Demirtaş, Kara İlek, Hatay 20, Adana 10, Hatay 35, Mersin 05, Osmaniye 02, Hatay 13 and Adana 03 genotypes.

The fruit cavity of the genotypes was generally in the middle group. Harvest times generally were determined between 8 days (Aydın2, Ak Erkek 1, Körpe İlek) and 12 days (Ömerbeyli Kaba Ilek, Yanako 1).

The average fruit size values of some genotypes are given in Table 2 (2015-2022). Average fruit weights of Profichi fruits were determined in the range of 7.7 (oblonge) (Barbaros)- 49.4 g (globoose) (Hacı Yusuf). Profichi fruit width 23.4 (Osmaniye 02)- 54.9 (Ayar Dolduran); fruit lengths were determined in the range of 27.7 (Osmaniye 02) - 59.7 mm (Bozdoğan Kaba İlek). Fruit shape indexes were determined as 0.7 (Damarlı)- 1.1 (Hatay 35). Regarding the ostiole opening, Mersin 05 had the smallest (0.6 mm), and Hatay 06 had the largest (6.4 mm) ostiole opening.

Table 2. Fruit quality metric datas in some caprifig genotypes

Genotypes	Average fruit weight (g)	Average fruit width (mm)	Average fruit lengths (mm)	Average ostiole opening (mm)	Fruit shape indexes
Bostancı	31.5	46.2	50.7	3.1	0.91
Hacı Yusuf	49.4	53.7	57.9	5.9	0,93
Çakın-2	34.0	49.2	49.4	3.8	1.00
Damarlı	18.1	38.0	53.4	2.7	0.71
Aydın-2	18.3	38.6	43.9	3.6	0.88
Ak Erkek 1	24.5	40.7	48.9	2.9	0.83
Ayar Dolduran	43.7	54.9	55.3	3.3	0.99
Bozdoğan Kaba İlek	42.1	49.1	59.7	2.4	0.82
Yanako 1	21.3	41.7	46.9	3.7	0.89
Körpe İlek	25.6	41.1	52.1	3.3	0.79
Barbaros	7.7	27.8	36.7	2.2	0.76
Mehmet Tosun	14.9	33.9	37.7	3.5	0.90
Hatay 06	29.0	41.9	46.9	6.4	0.89
Hatay 35	23.7	43.5	41.0	0.7	1.06
Mersin 05	15.9	35.7	42.6	0.6	0.84
Osmaniye 02	8.1	23.4	27.7	2.9	0.85

The number of male flowers in profichi fruits was determined in the range of 76 (Barbaros)- 269 (Hacı Yusuf). Gall flower number was found in the range of 194 (Hatay 20) - 1193 (Bozdoğan Kaba Ilek). The gall flowers are generally located near the stalk of fruit. Male flowers are usually located near the ostiole opening of fruit (Figure 3).

During the Profichi fruit ripening period with the swelling of the scales around the ostiole opening, female *Blastophaga psenes* L., which has wings and can fly, to continue its generation comes out of the Profichi fruits. As it emerges from the ostiole opening, it rubs against the pollens of the male flowers. Pollens is moved to female fig fruits via fig wasp.

The amount of *Blastophaga psenes* L was determined in the range of 21 (M.Tosun)- 501 (Çakın 2). Fig wasp exit times was generally determined as 3- 4 days (Figure 4).

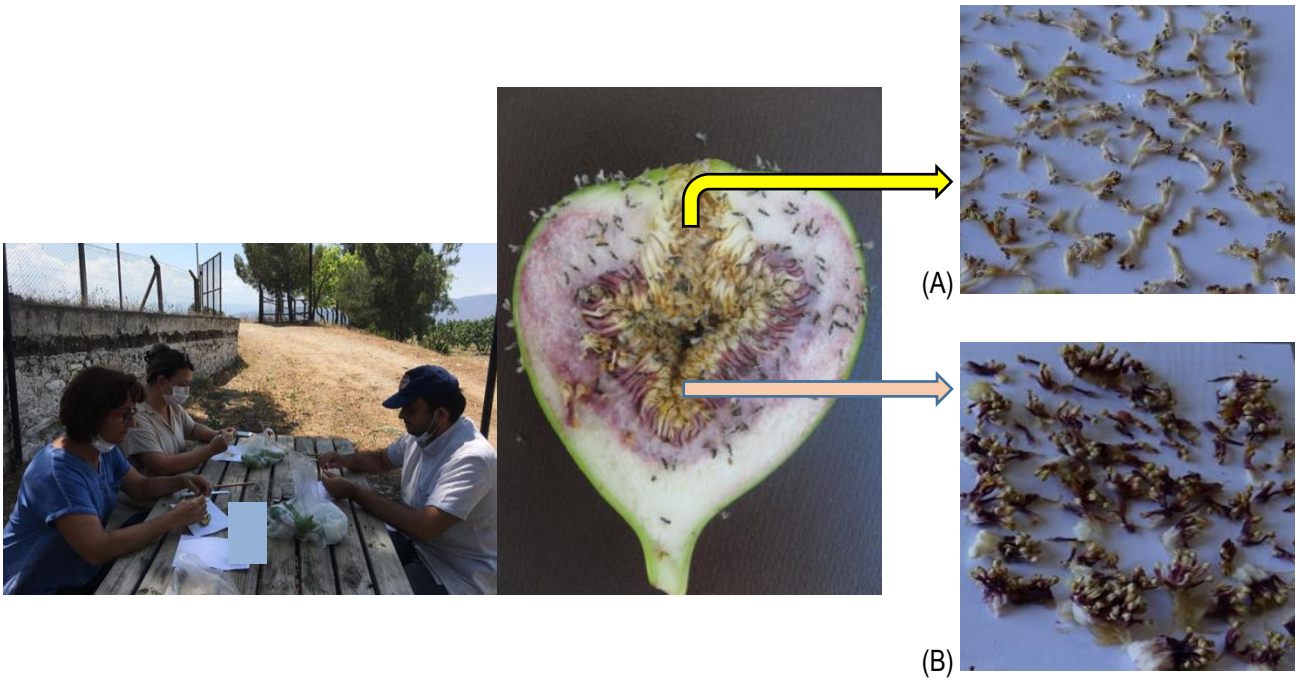

Figure 3. Detection of male flowers (A) and gall flowers (B) in fruit

Figure 4. Healthy profichi fruits, *Blastophaga pseneses* L. counting and emergence times observations

Every year, instead of the genotypes that dry out for any reason in the collection, their cuttings are taken, and their saplings are produced and planted. In this way, renewing the collection and continuing the conservation program in the project (Figure 5).

Figure 5. Production and planting of saplings of genotypes that are missing in the collection for any reason

In addition to the characterization and documentation information of the caprifig field gene bank to be passed on to future generations, the status of fruit sections, trees, and fruit branches of genotypes were recorded with photographs (Figure 6). As an example; the cross-section of the fruit, its condition on the branch and tree growth habit photos of some genotypes were given in Figure 7.

Figure 6**.** Photography and archive studies on male fig fruits and trees

Figure 7. Sections of fruit and fruit on the branch and tree growth habit photos of some caprifigs

4. Conclusion and discussion

In a different research, the first leafing dates were between March 10 and April 15 in 2015 under the conditions of the Eastern Mediterranean Region, and the fruiting of the Profichi fruit was between March 8 and April 16 [5].

It has been reported that some caprifig genotypes do not produce Mammoni (summer crop) and Mamme (winter crop) fruits on the tree or their numbers are low [5]. Similarly, in this research, it was observed that some genotypes did not produce/low produced Mamme fruit.

Some data ranges obtained from Profichi fruits by different researchers are given below.

Profichi fruit weight; 11.52-38.12 g [14]; 17.21-36.89 g [23]; 32 (Jrani)-29.5 (Dijebba2) g [12] and 8.96 (Kmaraş05)- 55.14 (Hatay02) g [5].

Profichi fruit width; 18.60-34.70 mm [14]; 37.54-50.25 mm [23] and 28.55 (Mersin15)- 60.66 (Hatay02) mm [5].

Profichi fruit length; 25.30-55.60 mm [14]; 40.54-64.04 mm [23] and 25.64 (Mersin15)- 67.68 (Hatay33) mm [5].

Ostiole opening; 5.80 (Caprifig1)-15 (Caprifig53) mm [14]; 6.6 (Assafri)- 8.1(Jrani) mm [12] ; 2.26- 5.80 mm [5] and 0.65-5.11 mm [23].

The number of Profichi fruits on the shoot; 5.71 (Jrani) - 6.32 (Assafri) pieces/20 cm [12] and 1.33 (Kmaraş06) - 9.70 (Hatay06) pieces/shoot [5].

Number of *Blastophaga*; 168-1,700 pieces/fruit (Eroğlu, 1982), 1350 pieces/fruit (Condit, 1947) [5]; 267 (Caprifig35)- 4 (Caprifig3) pieces/fruit [14]; 76 (Dijebba3)-450 (Assafri) (fertile galls per syconium counted) [12]; It was determined as 119-480 pieces/fruit in another study conducted in Hatay Province of Turkey [23].

Number of male flowers; 300-400 pieces/fruit [15]; 350 pieces/fruit (Condit, 1947), 6.0 (Kmaraş03)- 258.2 (Adana03) pieces/fruit and,

Number of female (gall) flowers; 75-450 pieces/fruit in a study conducted in Tunisia [12], 167.70 (Mersin16)-1121.2 (Hatay13) pieces/fruit, and it was stated that there is no female (gall) flower in Osmaniye02 genotype [5]; 244-771 [23]; 800-1200 pieces/fruit [15]. Flower pollen viability rates were found in the range of 64.99-91.53% [23]; 40.81%

(Mersin16)-100% (Kmaraş01) in different studies. The vitality rate of plants to be used as pollinator varieties is required to be >50% [5].

The caprifig genotypes in this research were generally examined in terms of phenological, pomological, etc. It can be said that their properties are generally similar when compared to the varieties in other studies.

Literature studies on male figs generally include studies on determining suitable pollinators in order to increase the yield and quality of female figs. However, as there is a need to develop new fig varieties in line with market needs changes day by day, the importance given to caprification studies is increasing. The fact that Turkish female fig genotypes need caprification reveals once again the importance of male figs. Provided that excessive caprification is avoided, caprification has an effect on improving fruit quality.

This project was referred to as an evaluation and research project in previous years. Therefore, male fig genetic resources also include studies conducted by different researchers. Therefore, some of the important studies carried out are given below as archive information.

310 fig genotypes in the Fig Research Institute Directorate fig field gene bank collected from 6 geographic regions (including caprificus) were analyzed with 14 SSR loci. 7 similarities, 54 clone-level similarities, 36 synonyms, and 22 homonymous differences were detected [8].

In conclusion some differences (1 identical [(Yanako 1 (57, Aydın) - Yanako 2 (59, Aydın)], 1 synonim [(Kara Ilek (28) - Kavun İlek (29)] and, 6 homonyms [(Kızılay 1 - Kızılay 2); (Şeytan 1 - Şeytan 2); (Çakın 1 - Çakın 2), (Ak Erkek 1 - Ak Erkek 2), (Kaba İlek (Bozdoğan) (53) - Kaba İlek (Ömerbeyli) (1)); (Büyük Konkur (34) - Küçük Konkur (38)] were found among caprifigs.

In terms of pollen amount, genotypes generally produced a moderate amount of pollen. The pollen germination power of the genotypes was found to be >78.90%. High pollen viability was found in Bostancı Ilek (96%) [4].

The vitality of caprificus genotypes in this project are found to be >50%.

The threat of genetic erosion poses a risk for caprifig genetic diversity. In reducing this risk, the field gene bank-collection orchards is significant in ensuring genotypes' sustainability and has become a universal corservation approach. In Türkiye, most female fig genotypes require caprification. The preservation and enrichment of the existing genetic richness and similar approaches are essential in developing high-quality fruit varieties in new breeding studies.

This research was carried out to collect, describe, protect, document and evaluate caprifig genetic resources. Also, it is an archive of fig gene sources. Rich genetic variation was found between genotypes in the metric and non-metric definitions of genotypes. The 'Fig (*Ficus carica* var *caprificus*) ‘The Genetic Resources Conservation and Characterization Project' is an ongoing project.

The collection of multiple data for the characterization of caprificus genetic resources in field conditions and the laboratory environment continues with similar to approaches and studies of other countries/researchers [4, 5, 6, 7, 11, 12, 13, 14, 15, 16, 19].

Acknowledgements

In this research, a part of 'Sarılop ve Bursa Siyahı İncir Çeşitlerine Uygun Tozlayıcıların Tespit Edilmesi Project final report' (2015-2018) (TAGEM/BBAD/14/A08/P07) data and ‘Fig (*Ficus carica* L.) Genetic Resources Conservation and Characterization Project’ (2015-.2022) (TAGEM/TBAD/Ü/20/A7/P9/1815) caprificus multiple data were used. About 70 caprifig genotypes were evaluated collectively in terms of metric and non-metric criteria.

References

[1] Aljane F., & Essid, (2018). Characterization and assessment of fig (*Ficus carica* L.) genetic resources in Tunisia: an overview. In Kallel A., Ksibi M., Dhia, H.B., Khelifi, N (Eds). A. Recent Advances in Environmental Science from the Euro-Mediterranean and Surrounding Regions, EMCEI 2017. Advances in Science, Technology & Innovation. (pp. 1355-1356) Springer, Cham, Switzerland.

[2] Ayar, A. (2022). İncir (*Ficus carica* L.) arazi gen bankaları ve çalışmaları. Biyolojik Çeşitlilik ve Koruma, 15 (3) , 308-319. DOI: 10.46309/biodicon.2022.1144871.

[3] Ayar, A., Seferoğlu, H. & Belge, A. (2022). Sarılop İncir Klonlarının Fenolojik Gözlem Verileri ve Ağaç Gelişim Özellikleri Yönünden Değerlendirilmesi. Uluslararası Anadolu Ziraat Mühendisliği Bilimleri Dergisi , 4 (2) , 42-53 . Retrieved from https://dergipark.org.tr/tr/pub/uazimder/issue/70074/1030007.

[4] Bilgin, AA., Mısırlı, A., Belge, A., & Özen, M. (2020). The pollen and fruit properties of *Ficus carica* caprificus. International Journal of Fruit Science 20(3), 1696-1705. DOI: 10.1080/15538362.2020.1828226

[5] Caliskan, O., Bayazid, S., Ilgin, M., & Karatas, N. (2017). Doğu Akdeniz Bölgesi doğal popülasyonundaki erkek incir (*Ficus carica* var. *caprificus*) genotiplerinin tanımlanması, moleküler karakterizasyonu ve muhafazası. TÜBİTAK TOVAG Proje No:114O034, Hatay, Türkiye.

[6] Caliskan, O., Bayazit, S., Kılıc, D., Ilgin, M., & Karatas, N. (2021). Pollen morphology and variability of caprifig (*Ficus carica* var. *caprificus*) genetic resources in Turkey using multivariate analysis. Scientia Horticulturae, 287, 110283. DOI: 10.1016/j.scienta.2021.110283

[7] Debbabi, O. S., Khanfir, E., Mohamed, A.D., & Massaoud, M.M. (2021). Ethnobotanical and on farm genetic surveys of Fig (*Ficus carica* L.) genetic resources in Kerkennah Islands. International Journal of Hortic. Sci. and Techology 8(2),153-163. DOI: 10.22059/ijhst.2020.310191.396

[8] Ergül, A., Büyük, BP., Hazrati, N. Yılmaz F., Kazan, K., Arslan, N., … & Çobanoğlu F. (2021). Genetic characterisation and population structure analysis of Anatolian figs (*Ficus carica* L.) by SSR markers. Folia Horticulturae. 33(1), 49–78. DOI: 10.2478/fhort-2021-0005

[9] Essid, A., F. Aljane, A. Ferchichi, & J.I. Hormaza. (2015). Analysis of genetic diversity of Tunisian caprifig (*Ficus carica* L.) accessions using simple sequence repeat (SSR) markers. Hereditas 2015, 152:1. DOI: 10.1186/s41065-015-0002-9

[10] Essid A., Aljane, F., & Ferchichi, A. (2017). Morphological characterization and pollen evaluation of some Tunisian ex situ planted caprifig (*Ficus carica* L.) ecotypes. South African Journal of Botany, 111, 134-143. DOI: 10.1016/j.sajb.2017.03.001.

[11] Gaaliche, B., Hfaiedh, L., Trad, M., & Mars, M. (2011). Caprification efficiency of three Tunisian fig (*Ficus carica* L.) cultivars. J. Nat. Prod. Plant Resour., 1(3), 20-25.

[12] Gaaliche, B., Zarrouk, I., & Mars, M. (2017). Agro-phenological behaviour of several caprifigs grown in two different ecological areas in Tunisia. Acta Hortic. 1173(1173), 149-156.DOI: 10.17660/ActaHortic.2017.1173.25

[13] Gaaliche, B., Saddoud, O., & Mars, M. (2012). Hindawi, International Scholarly Research Notices In: Xu, X., Koba, T., Aitken, K. (Academic Eds.) Morphological and pomological diversity of fig (*Ficus carica* L.) cultivars in Northwest of Tunisia. DOI: 10.5402/2012/326461

[14] Khadivi- Khub, A., & Anjam, K. (2014). Characterization and evaluation of male fig (caprifig) accessions in Iran. Plant Systematics and Evolution, 300, 2177–2189. DOI: 10.1007/s00606-014-1038-4

[15] Kokaj, T. (2018). Genotype identıfıcatıon of Roshnık Varıety. Agriculture University of Tirana/ Institute of Plant Genetic Resources. International Journal of Agriculture, Environment and Bioresearch, 3(06).136-145.

[16] Mirheidari, F., Khadivi, A., Moradi, Y., & Paryan, S. (2020). Phenotypic variability of naturally grown edible fig (*Ficus carica* L.) and caprifig (*Ficus carica* var. *caprifi*cus Risso) accessions. Scientia Horticulturae, 267(1).109320. DOI: 10.1016/j.scienta.2020.109320

[17] Öncel, H. (1969). İncir yetiştiriciliğinde ilek ve ilekleme. Ziraat İşleri Genel Müdürlüğü Yayınları, İstanbul, Türkiye.

[18] Perez-Jiménez M., López B., Dorado G., Pujadas-Salvá A., Guzmán G., & Hernandez P. (2012). Analysis of genetic diversity of southern Spain fig tree (*Ficus carica* L.) and reference materials as a tool for breeding and conservation. Hereditas, 149 (3), 108-113. DOI: 10.1111/j.1601-5223.2012.02154.x

[19] Pourghayoumi, M., Bakhshi, D., Rahemi, M., & Jafari, M. (2012). Effect of pollen source on quantitative and qualitative characteristics of dried figs (*Ficus carica* L.) cvs 'Payves' and 'Sabz' in Kazerun – Iran. Scientia Horticulturae, 147, 98-104. DOI: 10.1016/j.scienta.2012.08.026

[20] Rezq Salimia, B., Awad, M, Hamdan, Y., & Shtaya, M. (2013). Genetic variability of some Palestinian fig (*Ficus carica* L.) genotypes based on pomological and morphological descriptors. An-Najah Univ. J. Res. (N.Sc.). 27, 84-110

[21] Stover E., & Aradhya M. (2005-2008, May,16). Fig genetic resources and research at the US National Clonal Germplasm repository in Davis, California. III. International Symposium on Fig. Vilamouran, Algarve (Portugal). DOI: 10.17660/ActaHortic.2008.798.6.

[22] Trad, M., Gaaliche, B., Renard, C.M.G.C, & Mars, M. (2013). Plant natural resources and fruit characteristics of fig (*Ficus carica* L.) change from coastal to continental areas of Tunisia. Journal of Agricultural Research and Development.3(2), 022-025, Retrieved from http://www.e3journals.org.

[23] Yaman, S. & Çalışkan, O. (2016). Hatay'dan seçilmiş bazı erkek incir genotiplerinin (*Ficus carica* var.*caprificus*) tozlayıcı özellikleri. Anadolu. J. Agr. Bilim. 31:315–320. DOI: 10.7161/omuanajas.269983.