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Morphological characterization of fig species (Ficus carica L.) widespread in northwestern Syria

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Abstract

This research was carried out in Idlib governorate in northwestern Syria during the years 2020, 2021 and 2022. 50 genotypes of edible figs grown in the region were identifzazied and characterized, according to the formal profiling criteria approved by the International Plant Genetic Resources Institute (IPGRI). The results showed that there were significant differences between the genotypes in most of the studied characteristics of the leaves (color, length, width, number of lobes, length of the stand, and number of leaves on the branch), and the genotypes varied in the characteristics of the fruit, whether quantity (number of fruits / branch, length, width, neck length, nozzle width, weight, TSS) or quality (external color, hardness, shape, top shape, stand shape, peel cracks, peel lines, pulp color, and drop on the fruit eye). The shape of the fruit ranged between spherical, oval and pear, and its color ranged from yellow, green, red, yellowish green, reddish green, pink, violet and black. Models varied in the presence of cracks and stripes on the surface of the rind of the fruit from absent to few to medium to many. As for the color of the pulp, it ranged from yellow, pink and red. The Khadrawi variety is superior in the characteristics of the weight and size of the fruits over the rest of the studied models, which gives it great importance in the processes of breeding and genetic improvement. The correlation analysis showed a positive linear correlation between fruit weight and length, width, neck length and nozzle width, and a positive linear correlation between the proportion of dissolved solids and the number of leaf lobes. The results of the cluster analysis of the characteristics of the studied models also showed that the studied genotypes were grouped into two main clusters, each cluster comprising three subgroups. The highest degree of kinship was between the Azuki and Zaibli styles, and between Shami and red porphy. Finally, the results of the research indicate that there is a great diversity between the genotypes studied, making it a key pillar in subsequent breeding programs.

Keywords: *figs, Ficus carica, genotypes, morphological characterization, genetic kinship.*

1. Introduction

Figs are one of the first fruit trees to be domesticated during the Stone Age, and the fig tree was known in ancient civilizations and propagated by cuttings as one of the oldest forms of fruit tree cultivation (Zohary and Spiegel-Roy, 1975). (Kislev et al. 2006) indicates that fig culture preceded cereal culture by about 1,000 years, where traces of figs dating back to the Stone Age were found in the Jordan Valley, which were charred dried figs.

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The fig ordinary Ficus carica L. belongs to the mulberry family Moraceae which includes 1400 cultivated species belonging to about 40 genera (Falistocco, 2009). The genus Ficus contains 750 species of woody trees and shrubs, distributed in the tropics and subtropics (Condit, 1969).

Genetic diversity is key to species survival and adaptation to environmental changes, and therefore the preservation of this difference has become essential (Platt et al., 2010; Huang et al., 2014). The interest in plant genetic resources and plant genetic diversity dates back to the beginning of the last century when the scientist Vavilov (1929) developed his theories about the centers of diversity of cultivated plants. The loss of genetic resources for many fruit species has increased the need to preserve existing available genetic resources, not only to ensure the survival of the species, but also to ensure the availability of the necessary feedstock for breeding programmes (Esquinas, 2005), where the risk of genetic erosion has become clear (Mars, 2001).

To better preserve and use genetic resources, the available genotypes must be studied and the most important variants selected (Giraldo, et al., 2010). Identifying plant material based on morphological and biological traits is important for managing genetic resources, preserving available genetic diversity, and establishing genebanks (Podgornik, et al., 2010), so the inclusion of phenotypic traits in any genetic improvement programme for the proper conservation and use of genetic resources is critical (Caliskan, et al., 2017).

The fig tree is one of the fruit trees that exhibits rich genetic diversity (Giraldo, et al., 2010) and constitutes an important biological resource that can be exploited for scientific and breeding purposes (Falistocco, 2020). Despite advances in molecular characterization in figs, formal characterization is always required and should be included in any program for the conservation and use of genetic resources (Giraldo, et al., 2005; Khadari, et al., 2005; Ikegami, et al., 2008; Achtak, et al., 2009).

Several studies have been conducted to characterize different varieties of figs in Turkey (Nalbant, 1997; Karadeniz, 2001; Küden, et al., 2005; Polat and Caliskan, 2008; Mikdat, 2009; Karadeniz and Bak, 2016; Karat, 2022; Nilüfer, et al., 2022). and in Tunisia (Mars et al.,1997; Aljane, et al., 2005; Saddoud, et al., 2008; Essid et al., 2021). All these studies showed significant genetic diversity in fig germplasm.

In a study conducted in the Punjab region of India, on the morphological characteristics of the fruits of 11 introduced varieties, significant varieties were found in the introduced varieties (Rattanpal, et al., 2015). The results of a study (Zolfaghari, et al., 2019) showed significant differences between the varieties studied for each trait studied. Twenty-five Slovenian entries were compared with fig varieties in Croatia, in a study (Podgornik, et al., 2010) with the aim of determining the degree of kinship and similarity between them, the results of the evaluation confirmed the importance of phenotypic traits in the characterization of fig genetic resources developed by (IPGRI and CIHEAM, 2003). In Albania (Koka, 2001) characterized local fig varieties based on pomological and agricultural characteristics with the aim of improving conservation and use of microbial plasma, the results showed a great variety of varieties.

(Benettayeb, et al., 2017) described eleven varieties of figs, using 45 morphological traits. The results showed that 20 quantitative traits and 7 qualitative traits were the most important to distinguish between varieties, and the characteristic of skin thickness, length and diameter of the fruit were the most discriminating and important variables.

In a study conducted by (Hssaini, et al., 2020) on a large sample of fig genotypes prevalent in Morocco, the studied genotypes showed significant difference based on morphological, chromatic and physicochemical traits, and most traits showed a high coefficient of differences and revealed a high level of phenotypic diversity among the genotypes studied.

Fig species are widespread in many regions of the world, mainly in the Mediterranean region due to their adaptation to different climates and soils (Mars, 2003). Syria is one of the main breeding grounds for the fig tree, as it has adapted to the climatic conditions prevailing in this region (Ighbareyeh, et al., 2018). (Fuller, et al., 2021) believe that figs were first domesticated in the Eastern Mediterranean rather than throughout the Mediterranean basin. The varieties of this tree have been subjected to severe genetic erosion as a result of the ongoing war and the migration of farmers from their lands in Idlib governorate, which occupies the forefront of fig production in Syria (SSG., 2021), which reflected negatively and severely on the genetic resources of this tree, hence the importance of this research in inventorying and characterizing existing genotypes in order to identify, preserve and later use them in breeding programs and genetic improvement of the tree.

2. Materials and methods of work

2.1 Research Location:

Samples were collected from 11 different areas within Idlib governorate: Ariha, Kafr Nabl, Kafr al-Qas, Martin, Qaminas, Maarat Misrin, Jisr al-Shughour, Salqin, Harem, Jabal al-Summaq, and Armanaz. Each area included a minimum of three sites.

2.2 Plant matter:

The plant material included all the genotypes that could be collected during the research, and the trees planted at the age of 7-10 years were studied, and readings were taken on 5 trees of each model and from each studied site during the years 2020, 2021 and 2022.

2.3 Descriptive study:

Initial descriptive keys (fruit color, size, leaf lobulation) were identified to distinguish the genotype from the first field observation (during July when the cultivated models are in the process of fruit formation). Subsequently, (in subsequent years) a comprehensive morphological characterization of five representative trees of the specific genotype was carried out at each study site according to the IPGRI and CIHEAM Fig Characterization Manual (IPGRI and CIHEAM, 2003), and has been used in a large number of fig characterization studies (Saddoud et al., 2011; Basheer-Salimia et al., 2012; Çalişkan and Polat, 2012; Trad et al., 2013; Ciarmiello et al., 2015; Belattar, 2022; Karat, 2022)

2.3.1 Biological traits:

❖ The crop that gives fruits:

1. The first crop Breba: present or absent.
2. The second (main) crop: present or absent.

❖ Buds open

❖ The beginning of fruit ripening:

1. Very early: before July 20.
2. Early: July 20-31.
3. Average earning: August 1-15.
4. Late: August 15-31.
5. Very late: after August 31.

❖ Full maturity: taken at the maturity of 50% of the fruits on the tree.

- First crop:

1. Very early: before May 15.
2. Early: May 16-31.
3. Medium early: June 1-15.
4. Late: June 16-30.
5. Very late: after July 1.

- Second crop (main):

1. Very early: end of July.
2. Early: August 1-10.
3. Average early: August 11-31.
4. Late: September 1-30.
5. Very late: after October 1.

2.3.2 Tree growth characterization standards:

❖ Nature of growth: standing, semi-standing, open, spreading, sagging, figure (1).

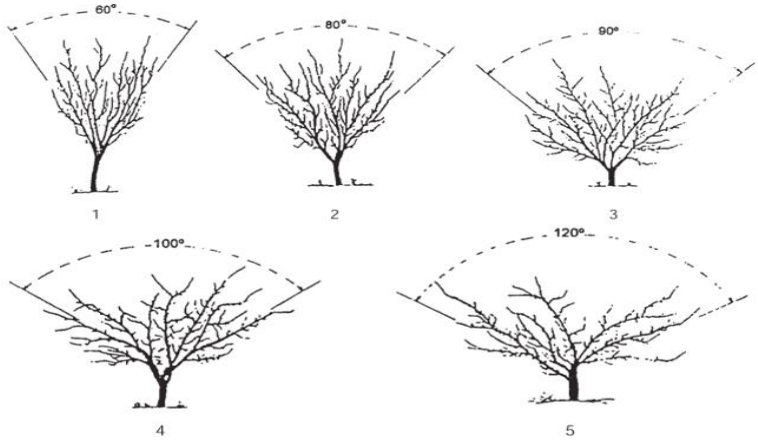

Figure 1 Nature of Growth in Fig Trees

❖ Tree growth strength: low, medium, high.

❖ Apical sovereignty: absent, present.

❖ Degree of branching: sparse, medium, dense.

❖ Terminal bud color: light green, green, reddish-brown, brown.

❖ Branch color: green, gray, brown, other colors.

❖ Terminal bud length (mm): The measurement was taken with a graduated ruler, and the measurements were taken during the ripening period of the first fruit on the branch.

❖ Terminal bud width (mm): The measurement was taken with a graduated ruler, and the measurements were taken during the ripening period of the first fruit on the branch.

❖ Branch length: Take measurement with a graduated ruler during the ripening period of the first fruit on the branch. The length of the developing branch was measured in the year of study, and four branches from each of the four trees (a branch from each side) were studied, and according to the general average of the trees studied.

1. Short: less than 10 cm.
2. Medium: between 10-20 cm.
3. Long: between 21-35 cm.
4. Too long: longer than 35 cm.

❖ Branch width: Taking measurement with a graduated ruler during the ripening period of the first fruit on the branch. The width of the branch in the central phalanx was measured (average of three phalanges on the branch), and four branches from each of the four trees (a branch from each side) were studied, and according to the general average of the trees studied.

1. Thin: less than 10mm.
2. Medium: 10-15 mm.
3. Thick: greater than 15 mm.

❖ The length of the phalanx is cm

2.3.3 Description of papers:

The study took the first leaf containing a fruit in its armpit, and by four leaves representing the four sides of the tree, according to the average for each tree, then the average number of trees studied of each model (5 trees), and measurements were taken using a graduated ruler, during the period of maturity of the first fruit on the branch, and the measurements taken were as shown in Figure (2), and the following characteristics were studied:

❖ Leaf color: green, light green, dark green.

❖ Number of leaves/branch: Counting the leaves on the branch, for four branches of each tree, then taking the general average of the trees studied of each type: less than 4, 4-8, 9-12, more than 12.

❖ Leaf length (cm): Measure from the base of the leaf to the end of the central lobe.

❖ Sheet width (cm): Measure the maximum width of the sheet (Fig. 2-B).

❖ Number of lobes: Four leaves were taken from each of the four sides, and according to the number of lobes of the studied model: absent, three, five, seven, more than seven.

❖ Leaf holder length (cm): Figure (2-C).

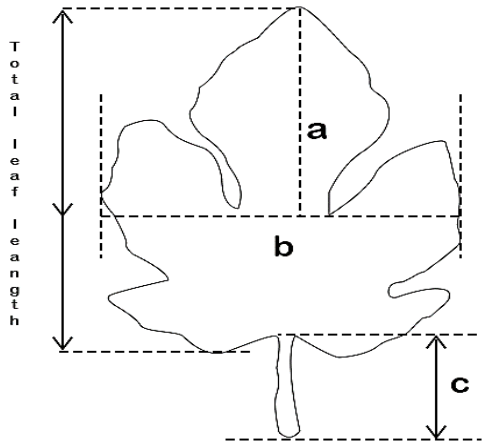

Figure 2: Length and width of the sheet and length of the leaf stand

2.3.4 Description of fruits:

To study the qualities of the fruits took the basal fruit on the branch during the middle of the ripening period.

A- Qualitative qualities of the fruit:

- ❖ Exterior color: black, purple, brown, green, light green, yellowish green, yellow.
- ❖ Fruit hardness
- ❖ Fruit shape: determine by calculating the indicator value I = (length/width)

1. Flounder: I > 0.9.
2. Spherical: I = 0.9-1.1.
3. Rectangle: I < 1.1.

- ❖ The shape of the apex of the fruit: flat, round, sharp, as in Figure 3.

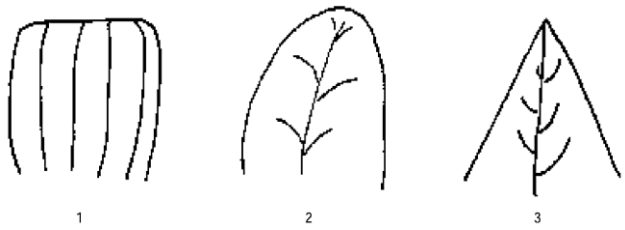

Figure 3 Fruit crest shapes

- ❖ Fruit bearing shape: Variegated polymorphic large, long and thin, short and thick, (Figure 4).

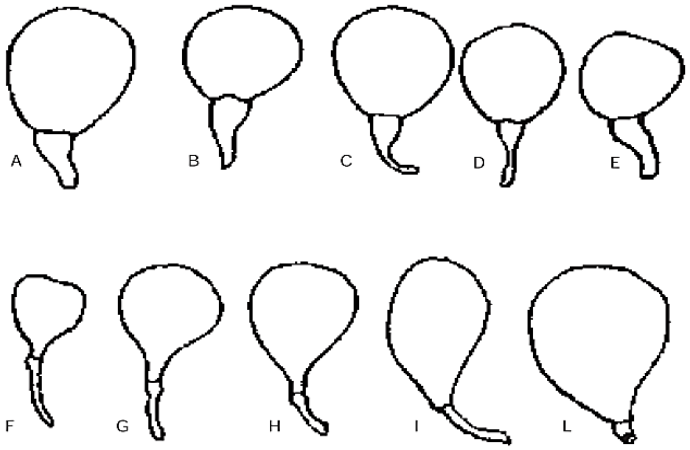

Figure 4 Fruit Bearing Shape (Condit, 1947)

- ❖ Cracks of the peel of the fruit: cracked peel, rare longitudinal cracks, microcracks, (Figure 5).

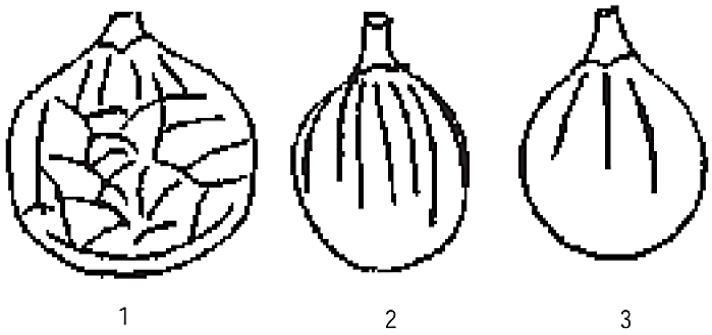

Figure 5 Cracks on the peel of the fruit

- ❖ Longitudinal lines on the surface of the fruit: non-existent, medium, prominent.
- ❖ Pulp color: white, amber (reddish-yellow), pink, red, dark red.
- ❖ Presence of drops on the eye of the fruit (present, absent)

B- Quantitative qualities of the fruit:

Quantitative measurements were taken on the fruits as shown in Figure 6.

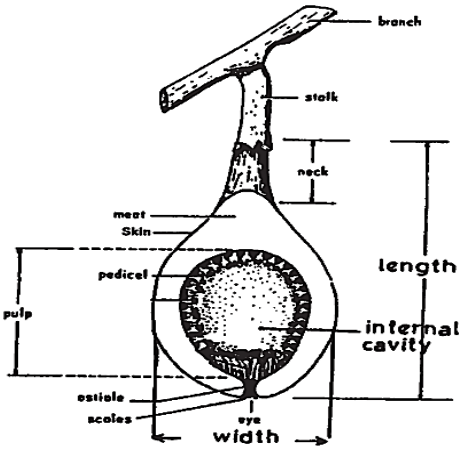

Figure 6: Length, width, neck and length of the fruit holder

- ❖ Number of fruits/branch.
- ❖ Fruit length (cm).
- ❖ Fruit width (cm).
- ❖ Fruit neck length (mm).
- ❖ Nozzle width (cm).
- ❖ Fruit weight (g): According to the average weight of 25 fruits taken randomly.
- ❖ Dissolved solids (TSS) (%).

3. Results and Discussion:

3.1 Inventory of fig varieties:

The plant material of this research included 50 genetic patterns of edible fig trees planted in Ula and at the age of 7-10 years, and readings were taken on 5 trees of each model during the years 2020, 2021 and 2022, where Table (1) shows the fig models spread in

Idlib governorate (according to the local name spread among farmers) in addition to the model code adopted in the study.

Table 1 Studied genotypes and codes used in the study

Model code	Genotype	Model code	Genotype	Model code	Genotype	Model code	Genotype	Model code	Genotype
1	Yellow Petite	**11**	Green Monthly	**21**	Khadrawi	**31**	Superficial Green	41	Bilious
2	Abu Kaf	**12**	black	**22**	Striped vegetables	**32**	Superficial petiole	42	Stallion
3	red	**13**	Abyssinian Black	**23**	Khadrawi Dot	**33**	Sultani	43	Karsawi
4	Red My Country	**14**	Sindhi Black	**24**	Burgundy	**34**	Red sumaci	44	Deer heel (yellow)
5	Ode Red	**15**	Winter Black (Abidi)	**25**	Rzezi	**35**	Black sumaci	45	Red deer heel
6	Shabati Red	**16**	Anzuki	**26**	Zaibli	**36**	Coastal sumaci	46	Masonic
7	Small Red	**17**	Hyena Pose	**27**	coastal	**37**	Sawadi	47	Mawardi
8	Red Medium	**18**	Halabi	**28**	Coastal Brown	**38**	Syrian	48	Patched
9	green	**19**	donkey	**29**	Coastal monthly	**39**	Red shanshari	49	Strip
10	Winter Green	**20**	Hayshi	**30**	Superficial White	**40**	Black shanshari	50	Wardani

3.2 Biological characteristics of the studied varieties:

Table (2) shown the most important phenological characteristics (yield, bud opening date, beginning and end date of ripening) of the studied fig varieties.

Table 2 Phenological traits of the studied fig varieties

Model code	The crop that gives fruit		Buds open	The beginning of maturity	Fully matured
	Crop The first	**Crop Second**			
01	absent	Is there	early	early	early
02	absent	Is there	medium	medium	medium
03	absent	Is there	medium	medium	medium
04	absent	Is there	medium	medium	medium
05	absent	Is there	medium	medium	medium
06	absent	Is there	medium	medium	medium
07	absent	Is there	medium	medium	medium
08	absent	Is there	medium	medium	medium
09	absent	Is there	Behind the times	Behind the times	Behind the times
10	absent	Is there	Behind the times	Behind the times	Behind the times
11	absent	Is there	Behind the times	Behind the times	Behind the times
12	absent	Is there	early	early	early
13	absent	Is there	early	early	early
14	absent	Is there	early	early	early
15	absent	Is there	early	early	early
16	absent	Is there	early	early	early
17	absent	Is there	early	early	early
18	absent	Is there	early	early	early

19	absent	Is there	early	early	early
20	absent	Is there	early	early	early
21	absent	Is there	early	early	early
22	absent	Is there	early	early	early
23	absent	Is there	early	early	early
24	absent	Is there	early	early	early
25	absent	Is there	early	early	early
26	absent	Is there	early	early	early
27	absent	Is there	early	early	early
28	Is there	Is there	early	early	early
29	absent	Is there	early	early	early
30	absent	Is there	early	early	early
31	absent	Is there	early	early	early
32	absent	Is there	early	early	early
33	absent	Is there	early	early	early
34	absent	Is there	early	early	early
35	absent	Is there	early	early	early
36	absent	Is there	early	early	early
37	absent	Is there	early	early	early
38	absent	Is there	early	early	early
39	absent	Is there	early	early	early
40	absent	Is there	early	early	early
41	absent	Is there	medium	medium	medium
42	absent	Is there	early	early	early
43	absent	Is there	early	early	early
44	absent	Is there	early	early	early
45	absent	Is there	early	early	early
46	absent	Is there	medium	medium	medium
47	absent	Is there	early	early	early
48	absent	Is there	medium	medium	medium
49	absent	Is there	medium	medium	medium
50	absent	Is there	early	early	early

Table 2 shows that most of the genotypes missed the first crop, with the exception of the coastal wine genotype, which gave two crops in the agricultural season. This finding is similar to a study (Çalişkan and Polat, 2012) that included 76 entrances of figs in Turkey, in which only two entrances found a first crop, and the rest of the inputs gave only a second crop. As for the second crop, it is present in all genotypes and is considered the main crop for the production of eaten figs. The diversity of genotypes is also noted in terms of early blooming of buds and the beginning and completion of maturity.

3.3 Tree Growth Characterization Standards:

Through our study, tree growth characterization data for the studied fig models were obtained as shown in Table (3).

Table 3 Tree Growth Characterization in Studied Fig Genotypes

Model code	**Nature of growth**	**The strength of tree growth**	Apical sovereignty	Branch	Terminal bud	Bud color	Branch color
01	Half standing	Medium	Exist	Sparse	conical	green	green
02	Widespread	Medium	Exist	Forked	conical	Light Green	Greenish Brown
03	Half standing	Medium	Exist	medium	conical	Light Green	Greenish Brown
04	Widespread	high	Exist	medium	conical	Light Green	brown

05	Sagging twigs	high	Exist	dense	conical	Light Green	Dark Brown
06	Half standing	high	Exist	medium	conical	Yellowish green	Light Green
07	Half standing	Medium	Exist	medium	conical	Light Green	Reddish brown
08	Widespread	high	Exist	medium	conical	Light Green	Reddish brown
09	Half standing	Weak	Exist	Sparse	conical	Light Green	brown
10	Existing	high	Exist	medium	conical	Light Green	brown
11	Sagging twigs	high	Exist	medium	conical	green	Greenish Brown
12	Existing	high	Exist	medium	conical	Yellowish green	brown
13	Existing	high	Exist	medium	conical	Yellowish green	Reddish brown
14	Existing	high	Exist	medium	conical	Yellowish green	Dark Brown
15	Half standing	Weak	Exist	medium	conical	Yellowish green	Reddish brown
16	Existing	high	Exist	medium	conical	Yellowish green	brown
17	Existing	high	Exist	medium	conical	Yellowish green	brown
18	Half standing	Weak	Absent	dense	conical	Yellowish green	brown
19	Existing	high	Exist	medium	conical	Yellowish green	brown
20	Sagging twigs	high	Absent	dense	conical	Yellowish green	brown
21	Widespread	Medium	Exist	medium	conical	Yellowish green	brown
22	Half standing	Medium	Exist	Sparse	conical	Yellowish green	brown
23	Half standing	high	Exist	medium	conical	Yellowish green	brown
24	Widespread	Medium	Absent	dense	conical	Yellowish green	brown
25	Medium	high	Absent	medium	conical	Yellowish green	brown
26	Existing	high	Exist	medium	conical	Yellowish green	brown
27	Existing	high	Exist	medium	conical	Light Green	brown
28	Sagging twigs	high	Exist	medium	conical	Light Green	brown
29	Widespread	high	Exist	medium	conical	green	Greenish Brown
30	It's open	high	Exist	medium	conical	Light Green	Greenish Brown
31	Half standing	high	Absent	medium	conical	Yellowish green	Light Brown
32	Half standing	high	Exist	medium	conical	Yellowish green	Light Brown
33	It's open	high	Exist	medium	conical	green	Light Brown
34	It's open	high	Exist	medium	conical	green	Greenish Brown
35	It's open	high	Exist	medium	conical	green	Greenish Brown
36	Existing	high	Exist	medium	conical	Light	Greenish Brown

						Green	
37	Existing	high	Exist	medium	conical	Yellowish green	Light Green
38	Existing	high	Exist	medium	conical	Light Green	Greenish Brown
39	Existing	high	Exist	medium	conical	Light Green	Reddish brown
40	Existing	high	Exist	medium	conical	Yellowish green	Reddish brown
41	Widespread	high	Absent	medium	conical	Light Green	Greenish Brown
42	Widespread	high	Exist	medium	conical	Yellowish green	Light Brown
43	Half standing	high	Exist	medium	conical	Light Green	brown
44	Existing	high	Exist	medium	conical	Yellowish green	brown
45	Existing	high	Exist	medium	conical	Yellowish green	brown
46	Half standing	Weak	Exist	Sparse	Wide conical	Light Green	Greenish Brown
47	Widespread	Weak	Exist	medium	conical	Light Green	Greenish Brown
48	Widespread	Weak	Exist	dense	conical	Light Green	Greenish Brown
49	Widespread	Medium	Exist	Sparse	conical	Light Green	Light Green
50	Widespread	Weak	Exist	dense	conical	Yellowish green	Greenish Brown

In a study (Giraldo et al., 2010) it was found that the tree's growth habit, size, and degree of branching are key traits that can be relied upon to distinguish between genotypes. It can be seen from Table (3) that the genotypes varied greatly in the tree growth characteristic, growth strength and branching. The appearance of the terminal bud was conical in all genotypes except petiolate yellow and Masonic was wide. The color of the bud varied from green to light green to yellowish green.

3-4- Characteristics of the branch:

Table (4) shows the most important quantitative characteristics of the bud and branch (length and width of the bud, length and width of the branch, and length of phalanges) of the fig species studied.

Table 4 Quantitative traits (length, width) of bud, branch and phalanx length of the studied genotypes

Model code	Bud length (cm)	Bud width (mm)	Branch length (cm)	Branch View (cm)	Phalange length (cm)
01	0.77	5.06	13.88	1.36	5.30
02	1.00	5.20	23.00	1.26	2.50
03	1.52	10.4	25.00	1.36	3.22
04	0.82	6.20	29.20	1.74	3.24
05	0.54	3.84	15.40	1.24	1.42
06	0.98	5.66	11.60	1.24	2.30
07	0.80	4.96	14.50	1.52	3.26
08	1.24	3.86	30.00	0.98	5.10
09	3.20	7.00	15.88	1.44	2.00
10	1.34	9.40	10.80	0.98	2.34
11	0.98	6.06	5.00	1.00	1.42
12	1.23	6.49	15.88	1.26	3.50

13	0.89	5.06	18.60	1.22	3.30
14	0.98	4.96	32.05	1.38	5.24
15	2.10	5.62	17.30	1.27	3.50
16	1.39	7.04	15.06	1.36	1.01
17	1.12	7.60	15.60	1.36	1.90
18	1.02	7.00	15.00	1.69	3.02
19	0.53	3.70	7.04	0.94	1.01
20	0.96	6.60	6.60	1.90	1.14
21	1.29	7.09	18.18	1.12	3.98
22	1.95	9.33	30.25	1.62	3.87
23	0.98	5.90	31.62	1.20	5.80
24	1.26	6.78	16.6	1.26	1.62
25	0.98	7.20	6.00	1.04	1.08
26	1.22	6.70	15.72	1.28	2.00
27	1.26	6.64	9.50	1.39	1.47
28	0.98	4.84	8.60	1.06	1.08
29	1.14	5.96	6.80	1.30	1.82
30	1.24	6.04	11.88	1.07	2.08
31	1.48	7.10	7.00	1.40	1.10
32	1.00	5.00	7.88	1.50	1.50
33	1.23	5.96	8.87	1.25	1.66
34	1.00	7.01	13.61	1.25	1.88
35	0.72	5.90	8.92	0.98	0.68
36	0.64	5.74	5.24	0.84	0.54
37	0.95	6.28	10.76	1.64	2.05
38	0.99	5.93	24.07	1.45	3.02
39	1.17	6.49	12.33	1.53	1.69
40	1.16	6.02	14.70	1.86	3.88
41	0.87	4.83	7.68	1.63	1.22
42	1.32	5.90	9.36	1.38	1.02
43	1.36	7.82	7.40	1.10	1.76
44	1.36	6.47	9.53	1.40	1.54
45	1.24	7.66	23.44	1.22	4.42
46	1.44	9.58	27.06	1.52	3.00
47	1.50	7.04	8.24	1.02	1.62
48	0.84	5.00	15.02	1.62	2.06
49	1.02	6.04	10.40	1.06	1.04
50	1.19	8.10	8.86	1.18	1.95
Overall average	1.10	6.22	14.79	1.32	2.52
CV%	17.8	14.5	22.6	14.5	29.4
L.S.D	0.19	0.85	3.18	0.18	0.70

As for the characteristics of the branch Table (4), the genotypes differed among themselves in the length, width and color of the branch, and the highest value of the branch length in the Sindhi black genotype was 32.05 cm, while the lowest value in the genetic type was monthly green and reached 5 cm. As for the width of the branch, the highest value was in the genotype Hishi (1.9 cm), and the lowest value was in the coastal porphyry genotype (0.84 cm). Models also differed among themselves in the color of the branch. The longest buds in the genotype were striped vegetables (1.95 cm) and the shortest in the genotype Hamari (0.53 cm). The widest terminal bud in the genotype was red (10.4 mm) and the lowest width in the donkey genotype was 3.7 mm. The average length of the phalanx was 2.52 cm, the highest length of the phalanx in the genotype Khadraoui was 5.8 cm and the lowest length in the coastal porphyry was 0.54 cm.

3-5- Characteristics of the paper:

Figure (7) and Table (5) show the most important leaf characteristics (leaf color, number of leaves on branch, leaf length, leaf width, number of lobes per leaf, and leaf holder length) of the fig models studied.

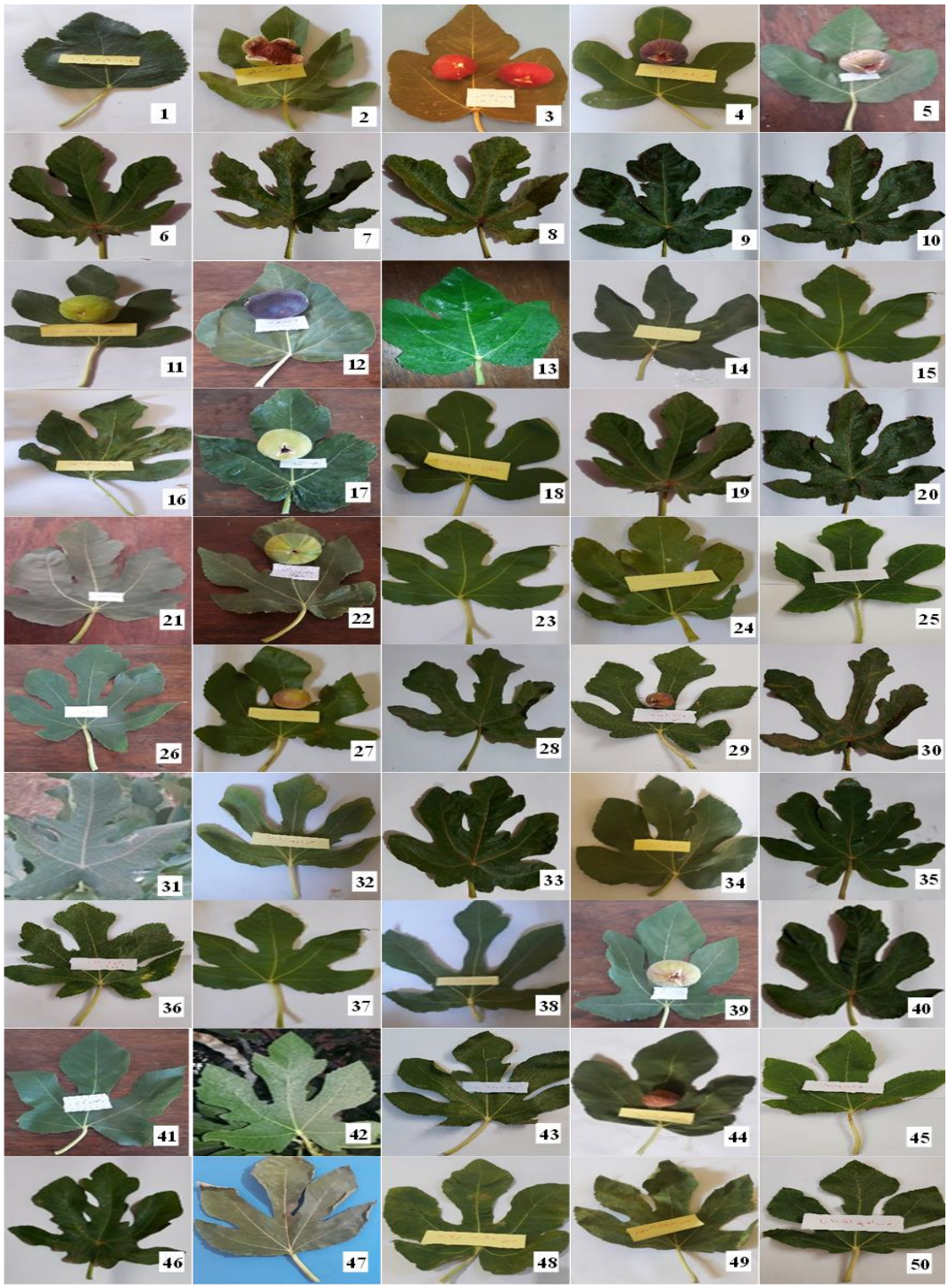

Figure 7: Paper in fig models studied (numbers denote the model code in the study)

Table 5 Leaf characteristics in fig models studied

Model code	Leaf color	Number of sheets /Section	Leaf length (cm)	Paper Width (cm)	Number of lobes Paper/	Stand length Sheet(cm)
01	green	8.00	18.88	18.22	3	6.71
02	green	5.00	21.36	20.30	5	6.06

03	green	5.30	19.30	18.28	3	5.82
04	green	9.30	17.90	18.88	5	7.92
05	green	7.40	17.16	15.00	3	7.00
06	green	10.80	24.80	23.40	5	6.92
07	green	6.40	18.32	17.00	5	5.50
08	green	7.60	15.70	14.60	5	5.54
09	green	4.80	18.80	17.36	5	6.02
10	green	8.80	23.70	21.92	5	6.40
11	green	6.40	22.00	19.92	5	5.92
12	green	9.10	20.46	18.18	1	6.13
13	Dark Green	8.84	23.63	22.72	5	8.72
14	green	7.60	20.80	19.97	5	6.17
15	Dark Green	5.55	22.85	19.39	5	8.81
16	Light Green	7.07	19.11	18.10	5	8.66
17	green	12.60	19.40	18.22	3	6.80
18	green	6.80	16.49	18.62	5	7.01
19	Dark Green	10.10	22.75	15.70	5	5.83
20	Dark Green	7.40	17.40	22.92	5	5.54
21	green	10.07	23.38	16.74	5	7.65
22	Light Green	6.30	17.23	22.32	5	6.27
23	Light Green	12.82	20.44	20.26	5	5.94
24	green	9.40	17.18	13.12	5	5.06
25	Light Green	5.60	24.68	23.66	5	7.94
26	Light Green	10.10	16.14	17.75	5	7.63
27	Light Green	10.88	17.71	17.42	5	6.99
28	Light Green	7.90	22.82	21.92	5	6.86
29	Light Green	11.28	20.50	20.40	5	6.22
30	Light Green	8.00	18.91	17.56	5	4.47
31	Light Green	10.4	21.46	18.06	5	8.84
32	Light Green	11.00	17.42	21.22	5	5.94
33	Light Green	7.05	19.82	17.56	5	6.49
34	Light Green	6.61	21.60	19.41	5	6.31
35	Light Green	6.00	15.40	17.10	7	6.06
36	Light Green	8.40	25.12	23.12	7	7.94
37	Light Green	6.27	16.51	15.79	5	5.21
38	Light Green	7.93	25.09	19.65	5	7.86
39	Light Green	7.73	20.19	17.83	5	9.53

40	Light Green	8.86	21.34	22.18	5	10.02
41	Light Green	7.34	18.49	17.45	5	5.97
42	Light Green	7.52	18.30	18.06	5	6.04
43	Light Green	10.76	21.99	20.21	7	6.12
44	Light Green	8.76	20.70	18.16	5	5.63
45	green	14.40	24.80	22.82	5	7.92
46	Light Green	9.00	19.16	15.12	5	5.56
47	Light Green	6.86	19.46	17.38	5	5.86
48	Light Green	9.36	16.18	18.20	5	9.20
49	Light Green	6.50	19.20	16.20	5	3.72
50	Light Green	7.60	16.30	14.77	5	7.04
Overall averag	-	8.28	20.18	18.87	-	6.80
CV%	-	19.40	9.60	9.00	9.30	13.90
L.S.D	-	1.53	1.83	1.62	-	0.90

It can be seen from Table (5) that the general average number of leaves on the branch for all genotypes was 8.29, the highest value in the deer heel was yellow (14.4), and the lowest value in the genotype was green (4.8). The leaves varied in length and width and the average year of leaf length in genotypes was 20.18 cm, with the highest value in the genotype being coastal porphyry (25.12 cm), and the lowest value in the genotype was black porphyry (15.4 cm). For the width of the leaf, the overall average for all genotypes was 18.87 cm, with the highest value in the Rzezi genotype (23.66 cm), and the lowest value in the Burgundy genotype (13.12 cm). These results were less varied in length and width of the paper compared to the results of Abdelsalam et al., 2019, the results of which were generally higher in terms of the length and width of the paper compared to Khadivi et al., 2018. For leaf holder length, the average for all genotypes was 6.81 cm, with the highest value in the genotype being black shanchari (10.02 cm), and the lowest value in the genotype Maari (3.72 cm). The number of leaf lobes is very important and essential for distinguishing between inputs and patterns in figs (Saddoud et al., 2008; Giraldo et al., 2010), for the number of lobes of the leaf, the number of lobes was 1 in the black model, 3 in the petiose yellow, red, oak red and hyena pose, 7 in the genotypes black porphyse, coastal porphyry and Karsaawi, while the number of lobes was 5 in the rest of the genotypes. These results were less varied compared to the results of the study (Abdelsalam et al., 2019), where it was found in his study to vary the number of lobes between (1, 3, 4, 5, 6, 7, 8, 10), while the results of the length of the leaf stand were consistent with the results of the previous study.

3-6- Qualitative qualities of the fruit:

Figure (8) and Table (6) show the most important qualitative characteristics (external color, hardness, shape, top shape, stand shape, peel cracks, peel lines, pulp color, and drop on the fruit eye) of the fruits of the fig models studied.

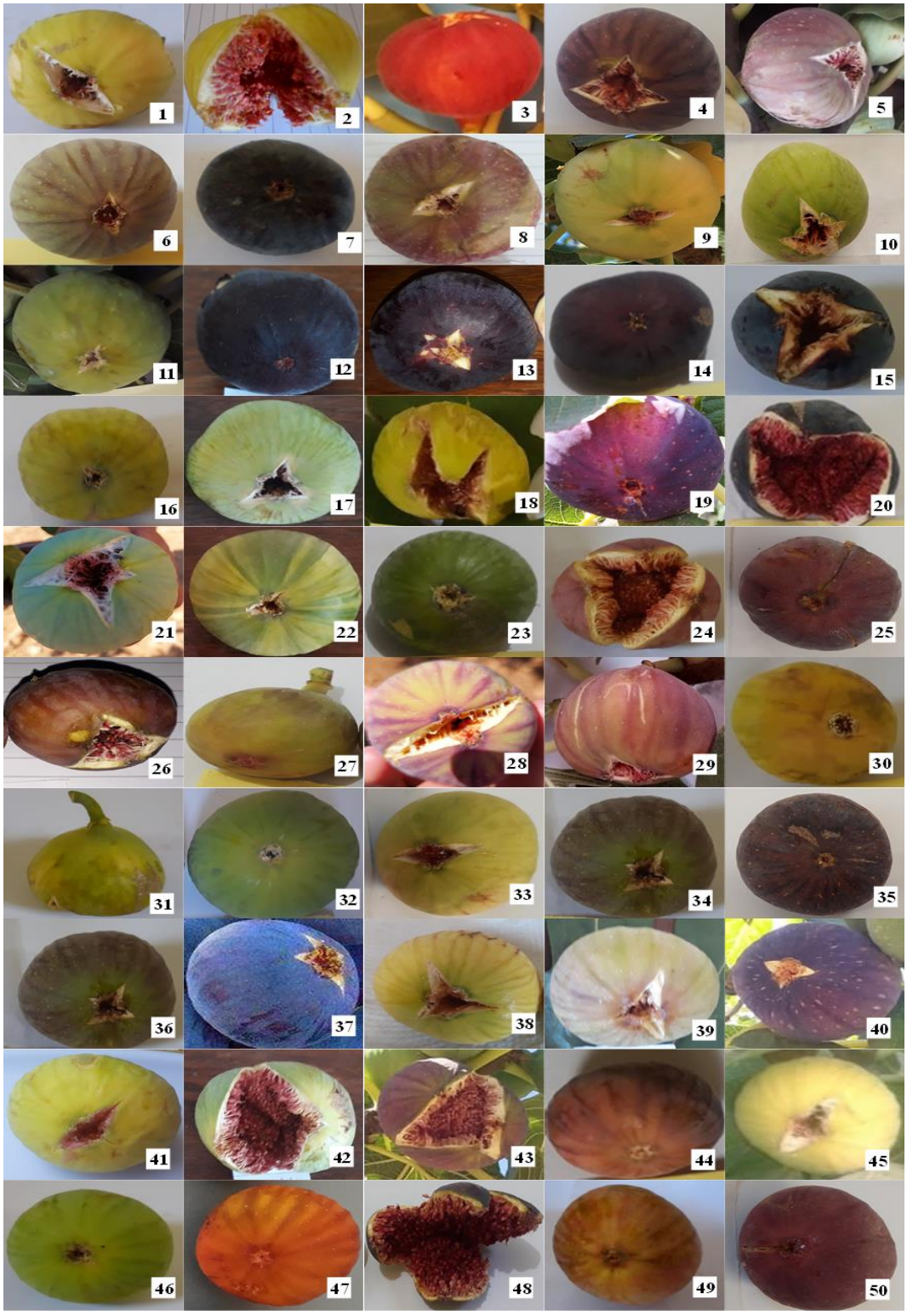

Figure 8: Fruit in fig models studied (numbers denote the model code in the study)

Table 6 Qualitative traits of the fruits of the studied genotypes of figs

Model code	Exterior color of the fruit	Fruit hardness	The shape of the fruit	The shape of the apex of the fruit	Fruit bearing shape	Cracks in the shell	Stripes on the fruit	Pulp color	A drop on the eye of the fruit
01	yellow	Medium hardness	Pears	Circular	Tall and thin	Micro cracks	Notable	red	Exist

02	yellow	Medium hardness	spherical	Circular	Tall and thin	Rare longitudinal	Does not exist	red	Absent
03	red	Medium hardness	Oval	Circular	Short and thick	Micro cracks	Protruding green color	Dark Red	Absent
04	Red striped with deep red	Medium hardness	Pears	Circular	Tall and thin	Cracked	Protruding darker than the crust	Pink	Absent
05	Reddish Green	Solid	Pears	Circular	Short and thick	Rare longitudinal	Notable	Pink	Absent
06	Green striped with red	Solid	Pears	Circular	Short and thick	Micro cracks	Protruding darker than the crust	Dark pink	Exist
07	red	Medium hardness	spherical	Circular	Tall and thin	Micro cracks	Notable	Dark pink	Absent
08	Red dotted white near neck	Medium hardness	spherical	Circular	Short and thick	Micro cracks	Protruding darker than the crust	Amber	Absent
09	Yellowish green	Solid	Pears	Circular	Tall and thin	Rare longitudinal	Protruding darker than the crust	yellow	Absent
10	Light Green	Soft	Oval	Flat	Short and thick	Micro cracks	Notable	Light pink	Exist
11	green	Soft	Pears	Flat	Short and thick	Rare longitudinal	Medium	Amber	Exist
12	black	Medium hardness	Pears	Flat	Tall and thin	Rare longitudinal	Medium	Pink	Exist
13	black	Soft	Oval	Circular	Short and thick	Cracked	Notable	Amber	Exist
14	Reddish black	Solid	Pears	Circular	Short and thick	Micro cracks	Notable	Pink	Exist
15	black	Soft	spherical	Flat	Short and thick	Micro cracks	Does not exist	Dark pink	Exist
16	Dark Red	Medium hardness	Oval	Flat	Short and thick	Rare longitudinal	Medium	Pink	Absent
17	yellow	Medium hardness	Pears	Circular	Tall and thin	Micro cracks	Protruding darker than the crust	Pink	Exist
18	yellow	Soft	Pears	Circular	Tall and thin	Micro cracks	It's a little light green in color.	Dark pink	Absent
19	Red dotted white near neck	Solid	Oval	Circular	Short and thick	Micro cracks	Notable	Pink	Exist
20	black	Solid	Oval	Circular	Short and thick	Rare longitudinal	Notable	red	Absent
21	Light Green	Medium hardness	Pears	Circular	Tall and	Rare longitudina	Protruding darker than	Dark pink	Exist

					thin	l	the crust		
22	Green striped with yellow	Medium hardness	spherical	Circular	Short and thick	Rare longitudinal	Notable	Dark pink	Exist
23	Dark Green	Solid	Pears	Flat	Short and thick	Micro cracks	Medium	Pink	Exist
24	Light Red	Solid	spherical	Flat	Tall and thin	Micro cracks	Medium	Light pink	Absent
25	pink striped with red	Soft	Pears	Circular	Tall and thin	Micro cracks	Medium	Amber	Exist
26	Dark Red	Soft	Pears	Flat	Short and thick	Cracked	Notable	red	Exist
27	Yellow striped with red	Medium hardness	Pears	Circular	Tall and thin	Rare longitudinal	Medium	Pink	Exist
28	Green striped in reddish brown	Soft	Pears	Flat	Short and thick	Micro cracks	Notable	Light pink	Exist
29	Greenish-red and dark stripes	Soft	Pears	Circular	Short and thick	Cracked	Protruding darker than the crust	Amber	Exist
30	yellow	Soft	Pears	Flat	Tall and thin	Micro cracks	Medium	Pink	Exist
31	Teal yellow	Medium hardness	Pears	Circular	Tall and thin	Micro cracks	Medium	Dark Red	Absent
32	Light Green	Soft	Pears	Flat	Tall and thin	Micro cracks	Notable	Amber	Exist
33	Teal yellow	Soft	Pears	Flat	Tall and thin	Micro cracks	Notable	Light pink	Exist
34	Light Green	Medium hardness	Pears	Flat	Short and thin	Densely longitudinal cracked	Notable	Dark Red	Exist
35	black	Medium hardness	Oval	Flat	Tall and thin	Longitudinal cracked	Notable	red	Exist
36	red	Medium hardness	Pears	Flat	Short and thick	Cracked	Protruding darker than the crust	Pink	Exist
37	Burgundy Black	Solid	Pears	Circular	Short and thick	Rare longitudinal	Notable	red	Exist
38	yellow	Medium hardness	Pears	Flat	Tall and thin	Cracked	Medium	Pink	Exist
39	Green striped with red and dotted	Medium hardness	Pears	Circular	Short and thick	Micro cracks	Protruding red color	Amber	Exist

	with white dots								
40	black	Medium hardness	Pears	Circular	Tall and thin	Micro cracks	Notable	Light yellow	Exist
41	Yellow and green stripes	Soft	Pears	Flat	Tall and thin	Cracked	Notable	Pink	Exist
42	Yellowish green	Medium hardness	Pears	Circular	Mediu m and thin	Micro cracks	Protruding darker than the crust	Amber	Absent
43	Purple striped with red	Medium hardness	Pears	Flat	Short and thick	Cracked	Protruding darker than the crust	red	Absent
44	pink striped with red	Soft	Pears	Circular	Tall and thin	Micro cracks	Protruding darker than the crust	Light Red	Exist
45	Golden yellow	Soft	Pears	Circular	Tall and thin	Micro cracks	Medium	Amber	Exist
46	Teal yellow	Soft	spherical	Circular	Tall and thin	Rare longitudina l	Protruding darker than the crust	Pink	Absent
47	red	Medium hardness	Pears	Flat	Tall and thin	Micro cracks	Medium	red	Absent
48	Red Purple	Soft	spherical	Circular	Short and thick	Rare longitudina l	Protruding darker than the crust	Amber	Exist
49	Yellowish green	Medium hardness	spherical	Circular	Mediu m and thin	Cracked	Medium	Dark Red	Absent
50	Red Purple	Medium hardness	Pears	Flat	Tall and thin	Micro cracks	Notable	red	Absent

We note from Table (6) that the external color of the fruit, the hardness of the fruit and the color of the pulp, differed greatly between the genotypes, for the shape of the fruit, it was spherical in the genotypes Abu Kaf, red small, red middle, black winter slave, Khadrawi striped, burgundy, Mason, Mashqa and Maari, and it was oval (flattened) in red, winter green, Abyssinian black, Anzuki, Hamari and Hayshi, and pears in the rest of the studied genotypes. Compared to a study (Çalişkan and Polat, 2012) on 76 fig entries in Turkey, 49 entrances were identified as spherical fruits, 12 oblong fruits and 15 flattened fruits. The apex of the fruit was either flat or round. The genotypes also differed in the form of the fruit bearer, where it was short and thin in the genetic pattern porphyry red, medium and high in the genotype stallion and naked, and short and thick in red and red oak and red Shabati and red middle and green winter and green monthly and black Abyssinian and black Sindhi and black winter and Anzuki and Hamari and Hishi and Khadrawi striped and Khadrawi point and Zaibli and coastal wine and coastal monthly and porphyry coastal and black and black and Karsaawi and Mashqa, and long and thin in the rest of the genotypes. There was also a very large variety in the characteristics of the rind of the fruit and in the color of the pulp of the fruit according to the genetic pattern studied. As for the fruit eye drops, they were absent in some models and present in others, and their colors varied according to the genotypes studied. As for the juiciness of the pulp, it was slightly juicy, medium or juicy.

3.7 Quantitative qualities of the fruit:

Table (7) shows the most important quantitative characteristics (number of fruits/branch, length, width, neck length, nozzle width, weight, TSS) of the fruits of the fig models studied.

Table 7 Quantitative traits of fruits of the studied genotypes of figs

Model cod	Number of fruits /Section	Fruit length (cm)	Fruit Presentation (cm)	Neck length the fruit mm	Nozzle width (cm)	Fruit weight (g)	TSS (%)
01	5.46	5.56	4.80	21.98	0.98	49.56	18.72
02	5.00	6.00	4.80	4.00	4.20	57.00	18.60
03	7.20	4.40	4.20	6.00	0.52	53.40	19.40
04	4.00	3.00	4.00	5.40	1.52	35.16	18.84
05	5.00	3.50	5.50	15.00	2.96	58.60	18.10
06	4.00	6.00	5.20	10.00	1.02	52.48	18.60
07	6.00	5.00	4.50	7.84	2.50	31.20	19.00
08	7.00	4.00	5.02	3.06	2.80	54.00	19.20
09	3.00	2.50	3.00	5.00	0.24	36.50	18.80
10	5.00	6.16	4.88	15.40	1.96	53.80	19.06
11	6.20	1.34	5.02	4.98	0.30	51.20	19.30
12	5.50	5.88	5.36	14.20	2.42	53.35	16.90
13	4.99	4.75	4.83	10.04	1.13	49.08	16.00
14	6.20	6.55	6.91	14.90	1.16	54.33	18.40
15	5.46	4.10	5.07	8.35	1.02	54.20	18.44
16	4.51	4.10	3.52	8.34	0.90	40.11	19.97
17	4.60	4.72	5.04	12.80	0.86	50.80	18.40
18	7.80	4.06	3.77	10.20	2.25	44.35	19.15
19	5.60	3.51	5.20	15.00	0.45	52.10	18.99
20	4.00	4.52	4.80	4.64	1.02	54.20	17.00
21	5.72	6.90	6.51	5.62	1.27	129.55	18.00
22	5.49	5.41	5.29	6.03	0.96	51.44	16.41
23	7.40	4.88	4.14	4.68	0.32	44.48	16.76
24	6.18	3.62	5.16	15.00	3.50	62.76	18.00
25	6.00	2.60	2.54	2.98	0.28	29.68	20.00
26	6.17	3.70	3.49	15.8	0.67	43.98	19.25
27	5.92	4.30	3.40	13.73	0.41	47.02	18.12
28	7.28	4.00	3.98	9.82	1.00	48.60	19.00
29	6.10	2.60	5.04	9.62	1.02	36.74	19.20
30	4.88	4.05	4.71	3.43	0.96	45.20	19.24
31	3.50	4.46	4.98	19.78	0.47	48.12	19.00
32	6.58	4.53	4.02	3.91	2.02	50.20	18.64
33	5.87	5.51	5.09	9.33	1.00	53.67	20.00
34	4.39	3.36	3.63	5.85	0.52	32.74	20.33
35	3.40	3.36	5.08	9.70	0.30	51.00	19.10
36	4.78	3.50	3.22	4.80	1.02	50.60	19.02
37	4.52	4.17	4.25	1.93	0.54	52.60	16.98
38	5.33	4.25	5.40	5.76	2.01	53.13	18.24
39	6.10	4.97	4.99	13.97	1.11	53.39	19.45
40	4.14	3.00	3.14	8.20	0.34	30.04	17.96
41	4.59	4.64	4.71	10.19	2.63	49.67	17.84
42	4.80	3.50	3.52	3.02	0.62	35.08	22.98
43	4.68	3.38	5.29	2.35	1.19	41.76	22.18
44	4.72	2.65	2.71	2.94	0.39	27.40	18.59
45	9.00	2.74	3.80	3.96	0.36	27.66	22.20
46	4.00	4.58	5.06	11.60	1.42	55.04	17.98
47	5.40	5.08	4.36	10.20	0.60	40.06	19.28
48	4.58	3.48	4.02	1.96	0.34	35.28	20.10
49	9.06	5.10	5.56	19.14	3.08	56.98	16.96
50	3.76	5.14	4.29	5.71	0.32	54.71	22.66

Overall averag	5.35	4.55	4.66	9.25	1.002	52.12	18.74
CV%	20.8	9.9	10.8	20.8	47.4	7.2	10.15
L.S.D	1.06	0.43	0.24	1.83	0.71	3.57	1.33

We can see from Table (7) that the genotypes varied with different fruit characteristics, in the characteristic of the number of fruits on the branch, the general average of all genotypes was (5.35 fruits / branch), and the highest value in the genetic type Maari was 9.06 fruits / branch, and the lowest value in the genetic type is green (3 fruits / branch). As for the dimensions of the fruit, the largest length of the fruit in the genotype was green (9.9 cm), and the lowest length of the fruit in the genetic pattern was monthly green (1.34 cm). As for the width of the fruit, the highest value was in the Sindhi black genotype (6.91 cm), and the lowest value in the Rizizi genotype (2.54 cm). The genotypes varied by the length of the fruit neck, with values ranging from 21.98 mm in the yellow-petiolate genotype to 1.93 mm in the black-necked genotype. The results of this study were more varied compared to Çalişkan and Polat, 2012. In terms of fruit weight, the largest weight of the fruit in the genotype was Khadrawi (129.55 g), and the lowest weight of the fruit in the genotype was red deer heel (27.4 g). Comparing the results of this study in terms of fruit characteristics and a study (Abdelsalam et al., 2019), we note that the diversity is greater in the varieties of this study in terms of the length and width of the fruit and the weight of the fruit. Comparing the results with the results of the study (Çalişkan and Polat, 2008 on a group of Turkish genotypes, we find that the weight of the fruit in our studied genotypes is greater than in the study of Khadivi and Mirheidari, 2022). While the width of the fruit in 27.6% of the specimens studied in the research (Çalişkan and Polat, 2012) was large (50-60 mm) or very large (> 60 mm). The weight of the fruits ranged from 14.6 to 99 g, and the width of the fruits from 29.5 to 60.3 mm (Karaat, 2022). As for the total dissolved solids characteristic, the highest percentage was in the genotype Fahli (22.98%) and the lowest percentage in the genotype Abyssinian black (16%), this result is similar to the result of the study (Çalişkan and Polat, 2012) where the TSS ratio ranged between 16.00% and 27.10%, and the percentage of dissolved solids was lower in the varieties of this study compared to the Turkish varieties in the study (Abdelsalam et al., 2019). We note from Table (7) that the genetic type Khadrawi has a large fruit size and weight and is larger than the size of the fruits in previous studies, which gives it great importance in breeding processes to obtain large-sized and high-weight fruits.

3.8 Analysis of the correlation between the characteristics studied:

Table (8) shows the results of the linear correlation analysis between the quantitative characteristics of the fig models studied.

Table 8 Correlation Analysis between Studied Traits

Adjective	**The length of the bud is cm**	**Bud width mm**	**Branch length cm**	**Branch width cm**	**The length of the phalanx is cm**	**Number of papers / branch**	**Leaf length cm**	**Sheet width cm**	**Number of lobes**	**The length of the leaf holder is cm**	**Nozzle width cm**	**Number of fruits/branch**	**The length of the fruit is cm**	**The width of the fruit is cm**	**The length of the neck of the fruit mm**	**Fruit weight g**	**TSS**
The length of the bud is cm	1																

Bud width mm	.096	1															
Branch length cm	.046	.134	1														
Branch width cm	*.340	.094	.216	1													
The length of the phalanx is cm	.187	.017	**.787	.163	1												
Number of sheets/branch	-.021	.006	.054	-.036	.174	1	.										
Leaf length cm	.060	.032	-.082	-**.384	.052	.203	1										
Sheet width cm	.168	.083	-.050	.044	.081	.152	**.590	1									
Number of lobes	.055	.115	.051	-.083	.120	*.343	.151	.206	1								
The length of the leaf holder is cm	*.346	-.026	.034	.216	.080	.173	.310*	*.341	.036	1							
Nozzle width cm	-.183	-.259	.210	.010	.072	-.165	-.132	-.245	-.194	-.308*	1	.					
Number of fruits/branch	-.177	-.066	.207	-.227	*.293	.169	.091	.055	.219	-.190	.240	1					
The length of the fruit is cm	-.195	.073	.196	-.074	*.326	-.064	.087	-.010	-.226	-.144	.302*	.095	1				

The width of the fruit is cm	-.257	-.118	.246	-.150	.262	.051	.052	-.222	-.119	-.221	**.388	.084	**.637	1		
The length of the neck of the fruit mm	-.049	-.058	-.084	-.086-	-.012	.122	-.032	-.258	-.208	.027	.208	.109	.*323	**.372	1	
Fruit weight g	-.184	.031	.112	-.202	.127	.000	.067	-.264	-.229	-.078	.284*	.057	**.615	**.646	.176	1
TSS	-.076	.146	-.261	-.238	-.224	.065	.037	-.046	**.421	.138	*-.286	-.021	*-.312	*-.287	*-.282	*-.307	1

From Table 8, there is a positive linear correlation between the weight of the fruit and the length and width of the fruit and the width of the nozzle. There was also a positive linear correlation between the width of the fruit, the length of the fruit, the length of the neck of the fruit and the width of the nozzle, and there was a positive linear correlation between the percentage of dissolved solids and the number of leaf lobes, and the correlation was negative between the percentage of total dissolved solids and the length, width and weight of the fruit and the length of the fruit neck. This result is consistent with a study (Darjazi, 2011) which concluded that there is a positive linear correlation between the diameter of the fruit, the length of the neck of the fruit and the characteristic of the weight of the fruit, and a negative linear correlation between the length of the phalanx and the percentage of sugar and the weight of the fruit.

As we can see from Table (8), there is a positive linear correlation between the length and width of the sheet, as well as a positive linear correlation between the length of the leaf holder and the length and width of the sheet. The length of the branch was positively linear with the length of the phalangea, the width of the branch was negatively correlated with the length of the leaf, the length of the phalanx was positively correlated with the number of fruits/branch and the length of the fruit, and the number of fruits/branch was positively correlated with the number of lobes. The length of the bud was positively correlated with both the width of the branch and the length of the leaf bearer.

3.9 Cluster analysis:

The hierarchical cluster analysis gave the results shown in Figure 7.

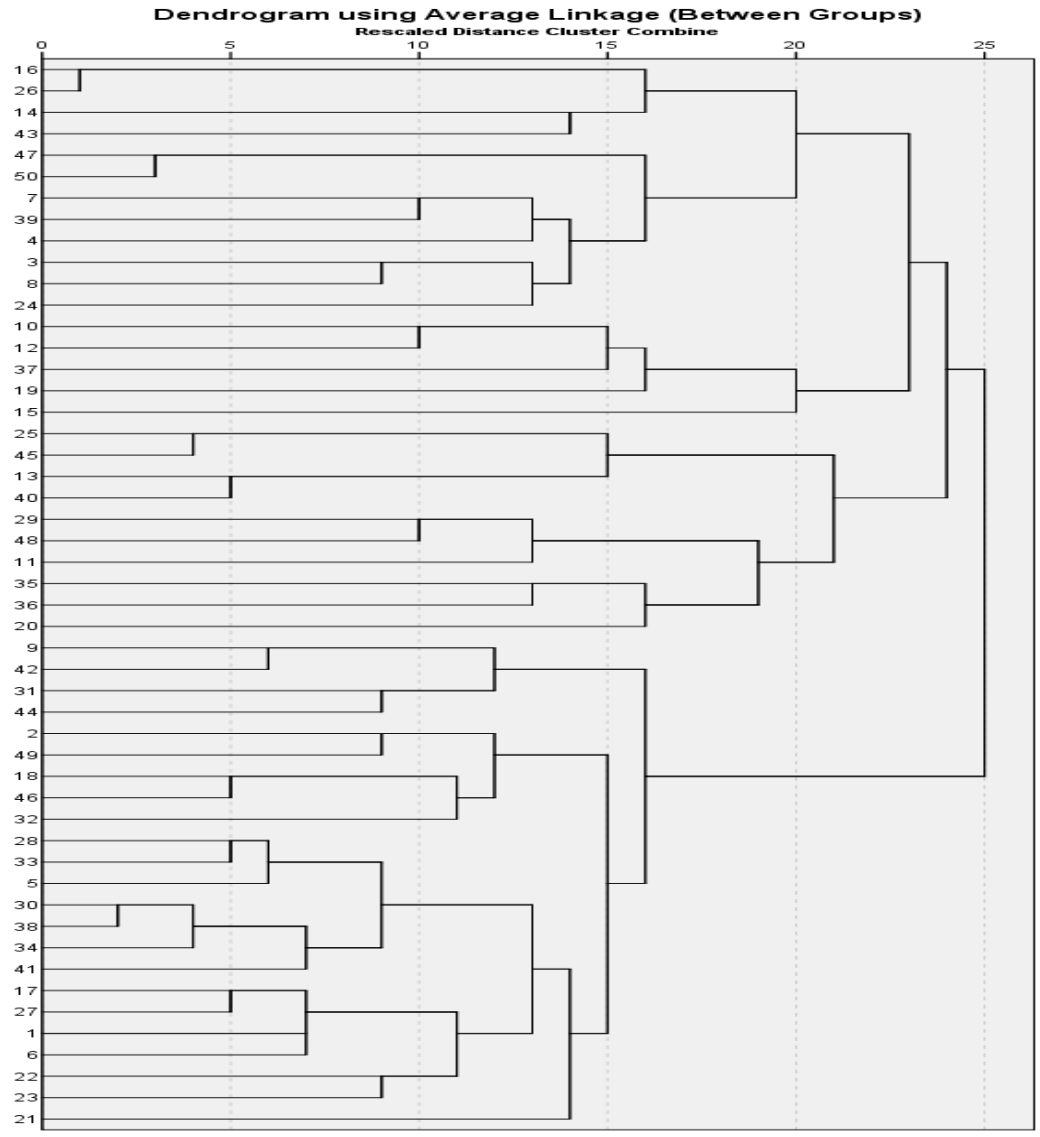

Figure (7) Cluster analysis tree to determine the degree of kinship between the studied genotypes

The results of the cluster analysis (Fig. 7) showed the following: The studied fig models were distributed into two main clusters, the first cluster was divided into three groups: group (A), which in turn was divided into two groups, under the first group included the models Anzuki, Zaibli, Rzizi, Sindi black and Karsawi, while under the second group included the models Mawardi, Wardani, small red, Shanshari red, baladi red, red, middle red and burgundy. Group (B) was also divided into two groups, the first group included black, winter green, black and red models, while under the second group it included winter black, group C divided into two groups, the first group included the models Rezizi, Kaab Al-Ghazal red, black Habshin Shanshari black, the second group included the models Mashqaa, coastal monthly, green monthly, black porphy, coastal porphy, and Hishi. While the second cluster included three subgroups, group (D) includes under two groups, the first includes Maari and Abu Kaf, the second includes the models Halabi, Masonic and superficial necked, subgroup (E) includes the models green, stallion, surface green and heel deer yellow, the third subgroup includes under two groups, one of which contains the style Khadrawi only, the second is divided into under two groups (f) and includes Khadrawi striped and Khadrawi point, and group (G) is divided into two groups, the first includes Sahili, Boz hyena, yellow neckline and red Shashabi, the second The models include Shami, red porphy, surface and biliary peroxide.

It can be seen from the figure that the highest degree of affinity was between Anzuki and Zaibli, in cluster I of group A, and between Shami and porphyry red in cluster II group F, followed by convergence between Rzezi and Kaab al-Ghazal red of cluster I, group A, under group I, and affinity between Mawardi and Wardani of cluster I, group A, under group II. The same degree of kinship between Shami and red porphyry on the one hand and white surfaces on the other hand from the second cluster subgroup (g).

Cluster analysis is useful in determining the degree of kinship between the studied models, which is important in breeding and crossbreeding programs between species and species, by reducing the number of inputs used in hybridization, insemination and reliance on genetically divergent parents, which provide a broad genetic base (Thanh et al., 2006). Cluster analysis has been used to determine the degree of morphological kinship between fig species in studies (Darjazi, 2011; Çalişkan and Polat, 2012; Abdelsalam et al., 2019).

Conclusions:

In this research, 50 genotypes of fig varieties widespread in northwestern Syria were studied and characterized. The models studied showed high qualitative and quantitative morphological diversity in all the characteristics studied.

- Tree and growth qualities: All models were distinguished by the presence of only the second crop except for the Burgundy coastal style, which gave two crops. The models also varied in maturity date, most of which were early or medium, while the models were green, winter green, and monthly green late maturation. The varieties also varied in the strength of tree growth, branching and the color of the buds, and the bud was conical in most models except the Masonic and yellow-petiolate style. The highest value for the length of the branch was 32 cm in the Sindhi black style.

- Leaf characteristics: The largest number of leaves on the branch in the model was yellow (14.4 leaves). The highest leaf length in the coastal porphyry model was (25.12 cm), and the largest leaf width was in the Rzezi model (23.66 cm). The highest value for leaf holder length in the genotype was black shanchari (10.02 cm). The number of lobes was 3 in the genotypes of winter green, black, oak red and Abyssinian black, and 7 in the genotypes Karsaawi and Kaab deer yellow, while the number of lobes was 5 in the rest of the genotypes.

- Characteristics of the fruit: The models varied in the shape of the fruit between spherical, oval and pear, and the color of the fruits ranged between yellow, green, red, yellowish green, reddish green, pink, violet and black. Models varied in the presence of cracks and stripes on the surface of the rind of the fruit from absent to few to medium to many. As for the color of the pulp, it ranged from yellow, pink and red. The highest value of the number of fruits on the branch in the genotype Maari (9.06 fruits/branch), and the largest fruit length in the genetic type Khadrawi was 9.9 cm. The highest value of the fruit width in the hereditary type was Ode Black and amounted to 6.91 cm. The largest length of the fruit neck was 21.98 mm in the genetics of yellow-petiolate. The highest weight of the fruit in the genotype Khadraoui was 129.55 g. The highest percentage of total dissolved solids in the stallion genotype was 22.98%.

- Correlation of qualities: There was a positive linear correlation between the weight of the fruit, the length and width of the fruit and the width of the nozzle. A positive linear correlation was also found between fruit width, fruit length, fruit neck length and nozzle width. There was a positive linear correlation between the TDS ratio and the number of leaf lobes, and the total TDS ratio, the length, width and weight of the fruit and the length of the fruit neck. There was a positive linear correlation between the length and width of the leaf, between the length of the leaf holder and the length and width of the leaf, the length of the branch was positively linear with the length of the

phalanges, the width of the branch was negatively correlated with the length of the leaf, the length of the phalanx was positively correlated with the number of fruits/branch and the length of the fruit, and the number of fruits/branch was positively correlated with the number of lobes. The length of the bud was positively correlated with both the width of the branch and the length of the leaf bearer.

- Genetic kinship: The fig models were divided into two main clusters, and each cluster in turn was divided into three subgroups. The highest degree of kinship was between the Azuki and Zaibli styles, and between Shami and red porphy. It is followed by the affinity between Rzezi and Kaab al-Ghazal red, the affinity between Mawardi and Wardani, and the same degree of kinship between Shami and porphyry red and superficial white.

References

1. Abdelsalam, N. R., Awad, R. M., Ali, H. M., Salem, M. Z., Abdellatif, K. F., & Elshikh, M. S. (2019). Morphological, pomological, and specific molecular marker resources for genetic diversity analyses in fig (Ficus carica L.). HortScience, 54(8), 1299-1309.
2. Achtak, H., Oukabli, A., Ater, M., Santoni, S., Kjellberg, F., & Khadari, B. (2009)."Microsatellite markers as reliable tools for fig cultivar identification". Journal of the American Society for Horticultural Science, 134(6), 624-631.
3. Aljane, F., Ferchichi, A., & Boukhris, M. (2005, May). "Pomological characteristics of local fig (Ficus carica) cultivars in Southern Tunisia". In III International Symposium on Fig 798 (pp. 123-128).
4. Basheer-Salimia, R., Awad, M., Hamdan, Y., & Shtaya, M. (2012). Genetic variability of some Palestinian fig (Ficus carica L.) genotypes based on pomological and morphological descriptors. An-Najah University Journal for Research-A (Natural Sciences), 27(1), 83-110.
5. Belattar, H. (2022). Characterization of twenty-two fig cultivars (Ficus carica L.) collected in north-eastern Algeria. International Journal of Sciences and Natural Ressources, 1(2), 28-36.
6. Benettayeb, Z. E., Bencheikh, M., Setti, B., & Chaillou, S. (2017). "Genetic diversity of Algerian fig (Ficus carica L.) cultivars based on morphological and quality traits". Hortic Soc India, 74(3), 311-316.
7. Çalişkan, O., & Polat, A. A. (2012). Morphological diversity among fig (Ficus carica L.) accessions sampled from the Eastern Mediterranean Region of Turkey. Turkish Journal of Agriculture and Forestry, 36(2), 179-193.
8. Ciarmiello, L. F., Piccirillo, P., Carillo, P., De Luca, A., & Woodrow, P. (2015). Determination of the genetic relatedness of fig (Ficus carica L.) accessions using RAPD fingerprint and their agro-morphological characterization. South African Journal of Botany, 97, 40-47.
9. Condit, I. (1941)."Fig characteristics useful in the identification of varieties". Hilgardia, 14(1), 1-69.
10. Condit, I.J. 1969. Ficus: The Exotic Species. University of California Division of Agricultural Sciences
11. Condit, I.J., 1947. The fig. Waltham, Mass. Cronica Botanica, USA. p. 222.
12. Darjazi, B. B. (2011). Morphological and pomological characteristics of fig (Ficus carica L.) cultivars from Varamin, Iran. African Journal of Biotechnology, 10(82), 19096.
13. Esquinas-Alcázar, J. (2005)." Protecting crop genetic diversity for food security: political, ethical, and technical challenges". Nature Reviews Genetics, 6(12), 946-953.
14. Essid, A., Aljane, F., Neily, M. H., Ferchichi, A., & Hormaza, J. I. (2021). Assessment of genetic diversity of thirty Tunisian fig (Ficus carica L.) accessions using pomological traits and SSR markers. Molecular Biology Reports, 48, 335-346.

15. Falistocco, E. (2009). Presence of triploid cytotypes in the common fig (Ficus carica L.). Genome, 52(11), 919-925.

16. Falistocco, E. (2020). The millenary history of the fig tree (Ficus carica L.). Adv Agric Hortic Entomol, 2020(5).

17. Fuller, D. Q., Barron, A., Champion, L., Dupuy, C., Commelin, D., Raimbault, M., & Denham, T. (2021)."Transition from wild to domesticated Pearl Millet (Pennisetum glaucum) revealed in ceramic temper at three middle Holocene sites in Northern Mali". African Archaeological Review, 38(2), 211-230.

18. Giraldo, E., López-Corrales, M., & Hormaza, J. I. (2010)."Selection of the most discriminating morphological qualitative variables for characterization of fig germplasm". Journal of the American Society for Horticultural Science, 135(3), 240-249.

19. Giraldo, E., Viruel, M. A., López-Corrales, M., & Hormaza, J. I. (2005). "Characterisation and cross-species transferability of microsatellites in the common fig (Ficus carica L.)". The Journal of Horticultural Science and Biotechnology, 80(2), 217-224.

20. Hssaini, L., Charafi, J., Razouk, R., Hernández, F., Fauconnier, M. L., Ennahli, S., & Hanine, H. (2020). Assessment of morphological traits and fruit metabolites in eleven fig varieties (Ficus carica L.). International Journal of Fruit Science, 20(sup2), 8-28.

21. Huang, P., Feldman, M., Schroder, S., Bahri, B. A., Diao, X., Zhi, H., ... & Kellogg, E. A. (2014). Population genetics of Setaria viridis, a new model system. Molecular Ecology, 23(20), 4912-4925.

22. Ighbareyeh, J., Suliemieh, A., Ighbareyeh, M., Daraweesh, A. Q., Ortiz, A. C., & Carmona, E. C. (2018)." Impact of bioclimatic and climatic factors on Ficus carica L. yield: increasing the economy and maintaining the food security of Jerusalem in Palestine". Transylvanian Review, 26(34).

23. Ikegami, H., Nogata, H., Hirashima, K., Awamura, M., & Nakahara, T. (2009)."Analysis of genetic diversity among European and Asian fig varieties (Ficus carica L.) using ISSR, RAPD, and SSR markers". Genetic Resources and Crop Evolution, 56(2), 201-209.

24. IPGRI and CIHEAM. 2003."Descriptors for fig". International Plant Genetic Resources Institute, Rome, Italy, and International Centre for Advanced Mediterranean Agronomic Studies, Paris, France. 52p.

25. Karaat, F. E. (2022). Morphological Characterization of Promising Fig (Ficus carica L.) Genotypes from Southeastern Turkey. Erwerbs-Obstbau, 64(3), 315-324.

26. Karadeniz, T. (2001, May). "A study on some fruit characteristics and propagations of these by hardwood cuttings of local fig cultivars grown in ordu (Turkey)". In II International Symposium on Fig 605 (pp. 107-112).

27. Karadeniz, T., & Bak, T. (2016). "Clonal selection in Siyah cultivars at Black Sea Region of Turkey". Journal of Hygienic Engineering and Design, 14, 66-68.

28. Khadari, B., Oukabli, A., Ater, M., Mamouni, A., Roger, J. P., & Kjellberg, F. (2005)."Molecular characterization of Moroccan fig germplasm using intersimple sequence repeat and simple sequence repeat markers to establish a reference collection". HortScience, 40(1), 29-32.

29. Khadivi, A., & Mirheidari, F. (2022). Selection of the promising fig (Ficus carica L.) accessions using fruit-related characters. Food Science & Nutrition, 10(9), 2911-2921.

30. Khadivi, A., Anjam, R., & Anjam, K. (2018). Morphological and pomological characterization of edible fig (Ficus carica L.) to select the superior trees. Scientia Horticulturae, 238, 66-74.

31. Kislev, M. E., Hartmann, A., & Bar-Yosef, O. (2006). "Early domesticated fig in the Jordan Valley". Science, 312(5778), 1372-1374.

32. Koka, T. (2001, May). Studies on local fig (Ficus carica L.) germplasm in Albania. In II International Symposium on Fig 605 (pp. 87-89).

33. Küden, A. B., Bayazit, S., & Çömlekcioglu, S. (2005, May). "Morphological and pomological characteristics of fig genotypes selected from Mediterranean and Southeast Anatolia regions". In III International Symposium on Fig 798 (pp. 95-102).

34. Mars, M. (2003). "Conservation of fig (Ficus carica L.) and pomegranate (Punica granatum L.) varieties in Tunisia". In Conserving biodiversity in arid regions (pp. 433-441). Springer, Boston, MA.

35. Mars, M., Chebli, T., & Marrakchi, M. (1997, June). Multivariate analysis of fig (Ficus carica L.) germplasm in southern Tunisia. In I International Symposium on Fig 480 (pp. 75-82).

36. Mikdat, Ž. (2009)."Fruit performances of the selected fig types in Turkey". African Journal of Agricultural Research, 4(11), 1260-1267.

37. Nalbant, M., Sahin, N., & Aydin, S. (1997, June). "Fig genetic resources at the fig research institute (Aydin/Turkey)". In I International Symposium on Fig 480 (pp. 43-48).

38. Nilüfer, A. K. S. U., ÖZCAN, M., & AYDIN, E. (2022). "Artvin, Giresun, Ordu illerinde Sofralık ve Reçellik İncir Seleksiyonu". Anadolu Tarım Bilimleri Dergisi, 37(2), 317-330.

39. Platt, A., Horton, M., Huang, Y. S., Li, Y., Anastasio, A. E., Mulyati, N. W., ... & Borevitz, J. O. (2010). The scale of population structure in Arabidopsis thaliana. PLoS genetics, 6(2), e1000843.

40. Podgornik, M., Vuk, I., Vrhovnik, I., & Mavsar, D. B. (2010). "A survey and morphological evaluation of fig (Ficus carica L.) genetic resources from Slovenia". Scientia Horticulturae, 125(3), 380-389.

41. Podgornik, M., Vuk, I., Vrhovnik, I., & Mavsar, D. B. (2010). "A survey and morphological evaluation of fig (Ficus carica L.) genetic resources from Slovenia". Scientia Horticulturae, 125(3), 380-389.

42. Polat, A. A., & Caliskan, O. (2008)." Fruit characteristics of table fig (Ficus carica) cultivars in subtropical climate conditions of the Mediterranean region". New Zealand Journal of Crop and Horticultural Science, 36(2), 107-115.

43. Rattanpal, H. S., Sidhu, G. S., & Bons, H. K. (2015, August). "Tree and fruit characteristics of fig cultivars grown in Punjab". In V International Symposium on Fig 1173 (pp. 117-120).

44. S.S.G. (2021). Syrian Statistical Group. Central Statistical Organization. Syrian.

45. Saddoud, O., Baraket, G., Chatti, K., Trifi, M., Marrakchi, M., Mars, M., & Salhi-Hannachi, A. (2011). Using morfological characters and simple sequence repeat (SSR) markers to characterize Tunisian fig (Ficus caricaL.) cultivars. Acta Biologica Cracoviensia. Series Botanica, 53(2).

46. Saddoud, O., Baraket, G., Chatti, K., Trifi, M., Marrakchi, M., Salhi-Hannachi, A., & Mars, M. (2008). Morphological variability of fig (Ficus carica L.) cultivars. International Journal of Fruit Science, 8(1-2), 35-51.

47. Thanh, V.C., P.V. Phuong, P.H.H. Uyen, P.P. Hien (2006). "Application of protein electrophoresis SDS-PAGE to evaluate genetic purity and diversity of several varieties". Proceedings of International Workshop on Biotechnology in Agriculture. Nong Lam University Ho Chi Minh City, October20-21, PP:192-194.

48. Zohary, D., & Spiegel-Roy, P. (1975). Beginnings of Fruit Growing in the Old World: Olive, grape, date, and fig emerge as important Bronze Age additions to grain agriculture in the Near East. Science, 187(4174), 319-327.

49. Zolfaghari, M. R., Salimpour, F., Sharifnia, F., Peyvandi, M., & Marandi, S. J. (2019). "Infraspecific morphological and genetic variations of Ficus carica L". from Iran. Biologija, 65(3),209-220.