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Evaluation of viability and germination of pollen grains of three local caprifig cultivars and their effect on some characteristics of fig fruits (*Ficus carica* L.)

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Key words: Caprifig, *Ficus carica*, flower stigma extract, pollen germination.

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Abstract: This research was carried out in fig fields in the village of Kafar-Jales, in the north of Syria. The analyses were conducted in the laboratories of the Faculty of Agriculture at Idlib University during the 2022 farming season, to evaluate the viability and germination of three local varieties of Caprifig (Bunduqi, Azraq, Panjani). The morphological characteristics, the date of the exodus of insects (*Blastophaga psenes*) from male fruits, the quantity of pollen, and the percentage of germination and viability were studied on four nutritive media at a temperature of 27°C. The measurements were taken after 24 h, 48 h, and 72 h. These three pollinators were used to pollinate three varieties of edible figs (white Satehi, Safrawi, and Habashi) to study the effect of pollen source on the productive characteristics of edible fig fruits. The result showed significant superiority of the Bunduqi cultivar over the rest of the cultivars in traits of the fruit's early ripening, pollen quantity, and date of departure of insects. The Azraq cultivar is found to be superior to Bunduqi and Panjani cultivars in the germination rate of pollen at all stages of the experiment and in all used media. The addition of stigma flower extract in culture media increased germination percentage by 35% for all studied Caprifig cultivars. The addition of 10% sucrose in the cultivation environment increased the percentage of pollen germination by 20%. The cultivars that were inoculated with the Panjani pollinator outperformed the characteristics of the length, diameter, and weight, demonstrating that the fruit's quality characteristics are affected by the genotype of the pollinator used. The results of this research can be beneficial for both fig growers and plant breeders, as they help to select the best pollinators and contribute to the development and improvement of the quality of the cultivated fig fruits.

1. Introduction

The fig was one of the first fruit trees domesticated during the Stone Age (Zohary and Spiegel-Roy, 1975). The results of a study of (Çalışkan and Dalkılıç, 2022) clearly showed that the southern regions of Turkey were one of the original centers of figs.

Figs spread in many areas due to their adaptation to different climates and soils (Mars, 2003). The fig tree is mainly found in the Mediterranean region because it is well adapted to the climatic conditions affecting this region (Ighbareyeh *et al*., 2018), and is one of Syria's most important fruit trees. Idlib governorate is at the forefront in production and the number of trees, with 40% of the cultivated area at the level of Syria (Syrian Statistical Group, 2021), where many female varieties are planted whose fruits are eaten fresh or dried. In addition, the caprifig trees are used for pollination purposes, which are residence to the pollinating fig wasp (*Blastophaga psenes*). *Ficus carica* L. belongs to the Moraceae family. The species contains two sexual forms: the male fig (caprifig) and the female fig (edible). The male fig produces pollen as it is male in practice, but at the same time, it contains female flowers with male flowers, which are functionally hermaphrodites. On the other hand, the female (edible) fig has only long-style female flowers that are monosexual (Stover *et al*., 2007). Fig pollen is carried by the fig wasp (*Blastophaga psenes* L.) that develops with the fig tree (Kjellberg *et al*., 1987).

In Syria, there are two different groups of figs. The first group is the male fig (caprifig), which spreads in many regions of the world, and its types are very close to each other (Condit, 1947). The fruits of this species are inedible and contain two types of flowers: male pollen-producing (near the ostiole), and female short-stylet (in two-thirds of the lower cavity). The wasp insect develops inside the tuberous flowers. This type produces three crops annually (Valdeyron and Lloyd, 1979; Stover *et al*., 2007; Flaishman *et al*., 2008). Summer profichi and its fruits pollinate the types of figs that need pollination. The Mammoni crop is used in the fall, and the Mammi crop is used in the winter (Anjam *et al*., 2017). The second group is the edible fig (Smyrna), which produces edible fruits with real seeds. This type contains long-style female flowers, which need to be pollinated by the pollen-bearing fig wasp from the profichi crop of caprifig to give fruits if pollination occurs (Armstrong, 2006). The fruit contains seeds inside, but in the absence of pollination, the inflorescences fall (Armstrong, 2006). This type of fig produces two crops per year, the Breba crop that ripens in early summer. In addition, the second (main) crop ripens at the beginning of autumn (Valdeyron and Lioyd, 1979). *Ficus carica* produces inflorescences called Syconia. The flowers are unisexual, either male, female, or gal flowers (female short-style), and the fruits are borne in the axilla of the leaf (Andersen, and Crocker, 2009; Aytürk, 2019).

The process of pollination in figs is called caprification, and the profichi crop is used for this process. Profichi crop produces much more pollen than the other two crops, and for a high-quality profichi crop, it is preferable to have a high pollen germination rate and a high amount of pollen produced (Balci *et al*., 2001). The research was conducted to study the characteristics of fruits and pollen for different genotypes of the caprifig. It was noted that there are discrepancies between them (Ilgın *et al.*, 2007; Çalışkan and Yaman, 2016; Çalışkan *et al*., 2021). Pollen viability, germination rate, and pollen quantity affect the yield of inoculated fruit trees. Different plants' pollen requires various growing media such as water, sugar solution, inorganic salts, and vitamins for successful germination (Stanley and Linskens, 2012. In a study conducted by Ilgın *et al*. (2007), it was found that pollen did not germinate at all on a medium without sucrose and increasing sucrose concentrations to 20% improved the percentage of pollen germination. To further improve the germination rate, several concentrations of H_3BO_3, KNO_3, and GA3 were added to media containing 20% sucrose. The germination rates of some caprifig pollen grains were higher than 70% with the addition of 0.050% H_3BO_3, followed by 0.025% KNO_3, and the germination rates of caprifig pollen were higher with the addition of these chemicals than sucrose 20% alone. Germination of caprifig pollen was increased to more than 70% by adding stigma exudates from long-style female flowers to the planting medium (Awamura *et al*., 1995). In a study by Ilgın *et al*. (2007), pollen viability was higher than that of pollen germination. This result was consistent with previous studies (Pearson and Harney, 1984; Bolat and Pirlak, 1999; Stanley and Linskens, 2012). Vego and Miljković (2012) found that the best conditions for pollen germination of caprifig were in a medium containing 3% sucrose and 0.01% boric acid solution at a temperature of 30°C in the dark. The selection of pollen of good quality and quantity is important in fig orchards, as several studies indicate that the caprifage variety used can influence the quality traits of fig fruits (Rahemi and Jafari, 2005; Gaaliche *et al*., 2011; Pourghayoumi *et al.*, 2012).

In this research, we will test the viability and germination of pollen grains in three cultivars of wild figs spread in northwestern Syria to determine the most efficient of these pollinators for female (edible) fig orchards. We will also study the effect of pollen

source on some characteristics of female (edible) fig fruits resulting from using these pollinators.

2. Materials and Methods

Plant materials

Three cultivars of caprifig have been studied in the Kafar-Jales area (5 km northwest of Idlib city). Year 2022, rainfed cultivation system, and the cultivars are Bunduqi, Azraq, Panjani (Fig. 1).

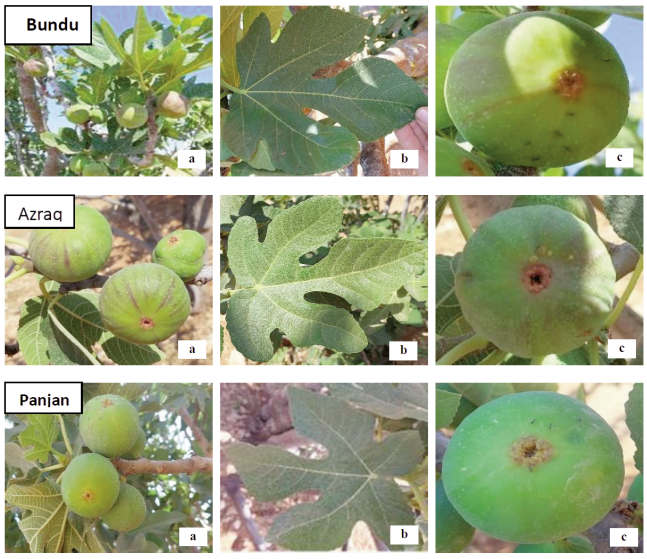

Fig. 1 - Fruits placement on the branch (a), and the shape of the leaves (b) and fruits (c) in Bunduqi, Azraq and Panjani caprifig.

The following characteristics were studied, which are the same characteristics that were studied by Çalışkan *et al.* (2017) on 60 Turkish caprifig cultivars. For each cultivar, these characteristics were studied:

a. number of fruits on the branch;
b. fruit diameter (cm);
c. fruit length (cm);
d. date of the expulsion of the *Blastophaga* insect from the fruits.
e. amount of pollen grains in male flowers.
f. pollen viability;
g. percentage of germination of pollen;
h. timeline of pollen germination rate evolution.

Three varieties of female (edible) figs, widely spread in the study area and economically important for fig growers, were selected: Habashi, white Satehi, and Safrawi (Fig. 2).

To study the quality of fig fruits, the same specifications that were studied in the research of (Gaaliche *et al*. (2012) were studied, where 20 fruits for each variety were studied as follows:

a) fruit length (cm);
b) fruit diameter (cm);
c) fruit weight (g);
d) total soluble solids percentage, TSS (%).

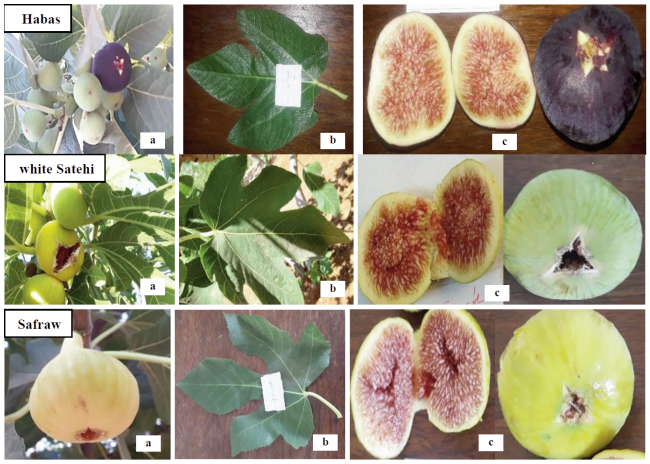

Fig. 2 - Fruits placement on the branch (a), leaves (b), and cross-section and full fruit (c) of Habashi, white Satehi and Safrawi female cultivars.

Study the specifications of the Caprifig fruits

The fruits of caprifigs of the three varieties (Bunduqi, Azraq, Panjani) were harvested during the Profichi crop's emergence in June. The fruits were cut crosswise and placed on paper plates in the laboratory (cool and dry) to collect pollen. Pollen grains were taken from ten separate fruits for each variety using a cylinder gradient and we compared the varieties among them.

Pollen viability test

Pollen viability was tested using methylene blue dyes. The colored pollen grains, after adding methylene blue dye, were considered to live, while the non-colored pollen grains were considered dead. So, 100 pollen grains were counted, the percentage of colored pollen grains was calculated, and the process was repeated three times for each sample.

Pollen germination test

Germination rate was studied after 24, 48, and 72 h of cultivation in media (A, B, C, and D). 0.5 (g) of pollen was taken and grown in each petri dish. The pollen grain was considered germinated if the pollen tube length was greater than the diameter of the pollen grain. The exploding pollen grains were also ignored and were not considered germinated, which

was previously applied in a similar study (Khan and Perveen, 2008). The germination rate of pollen of the caprifig cultivars was studied on medium A (5% sucrose + 1 ppm boric acid + 1% agar), medium B (10% sucrose + 1 ppm boric acid + 1% agar), medium C (5% sucrose + 1 ppm boric acid + 1% agar + extract of stigma female flowers), and medium D (10% sucrose + 1 ppm boric acid + 1% agar + extract of stigma female flowers). The readings were taken 24 h, 48 h, and 72 h after culture. The pollen of the three varieties was grown in the cultivation media and incubated at a temperature of 27°C.). Gaaliche *et al*. (2013) had previously used these mediums to study caprifig pollen germination in a previous study.

Study the effect of pollen source on the characteristics of the edible fig fruits

The study was done on the fruits of the main crop, except Breba, because Breba falls due to the absence of pollinating insects, because it appears in April. So, sixty fruits of each female variety (white Satehi, Safrawi, and Habashi) were isolated at the beginning of their formation by cotton fabric bags that allow air to enter, and the diameter of the holes in them is smaller than the fig wasp insect. When insects started to emerge from the studied caprifig cultivars (Bunduqi, Azraq, Panjani), we took the fruit of the pollinated variety and put it in the bag with the female fruit of the studied varieties so that each female variety was inoculated with the three pollinators (each pollinator separately) at a rate of 20 fruits from each pollinator (20 replicates). The fruits were isolated for two weeks to ensure that the required pollinator was pollinated. The fruits were harvested in stages, so that the fruits are taken when they reach the stage of maturity, and the entire harvest period is during the month of August.

Experiment design and statistical analysis

Factorial experiment in completely randomized design (CRD) was used in the distribution of the experiment's coefficients. The data were statistically analyzed using the GenStat program, and L.S.D values were taken at a significance level of 5% and 1% for field and laboratory readings, respectively.

3. Results and Discussion

Maturity date (when insects begin to emerge) and characteristics of caprifig syconia

The results obtained (Table 1) show that the cultivar Bunduqi was early concerning the date of the emergence of insects. Insects began to emerge from the syconia of Bunduqi on 01/06/2022, with a difference of more than a week from the two other varieties (Panjani and Azraq), which makes this variety suitable for pollinating the female fruits of the early fig varieties, especially the first fruits that appear on the branch (where they fall in the absence of pollination). The emergence of insects from the syconia of this variety continued for a week. As for the cultivars Panjani and Azraq, the beginning of the release of insects in them was 8/6/2022 and lasted for 10 days, which makes them suitable for pollination of the edible fig variety whose flowers appear in the middle of flowering time.

As for pollen, it was arbitrarily classified s few in the flowers of the cultivar Azraq, abundant in the cultivar Panjani and very abundant in the cultivar Bunduqi (Table 1).

Pollen viability of caprifig cultivars

Pollen viability was studied in caprifig cultivars Azraq, Bunduqi, and Panjani using methyl blue dye

Table 1 - Specifications of the Syconia of the Profichi crop

Cultivar	Number of Syconia*	Syconia length (cm)	Syconia diameter (cm)	Pollen quantity	Syconia ripening (Insect exit)
Azraq	6.00 a	4.14 c	4.58 c	few	Medium (08-06-2022)
Bunduqi	6.20 a	5.12 b	5.40 a	very abundant	Early (01-06-2022)
Panjani	6.50 a	5.88 a	4.84 b	abundant	Medium (08-06-2022)
Mean	6.23	5.05	4.94		
L.S.D. (5%)	0.71	0.18	0.17	-	-
C.V. %	12.40	3.90	3.80	-	-

The presence of the same letter in each column indicates that there are no significant differences between the items.
* The quantity (few, abundant) is a random unit to compare pollen collected in a drum of different cultivars).

(Fig. 3). Table 2 shows the results of the pollen viability study for the three cultivars.

Table 2 shows no significant differences in the percentage of pollen viability among the three studied cultivars Panjani, Azraq, and Bunduqi. The highest percentage of viability was observed in the cultivar Panjani (99.67%) and the lowest percentage of viability in the cultivar Bunduqi (97.33%).

Study of the percentage of germination of pollen of caprifig on media (A, B, C, and D)

24 h after planting. Table 3 shows the superiority of the cultivar Azraq in the percentage of pollen germination over the two cultivars Panjani and Bunduqi after 24 h of cultivation on different media. The averages of germination rates were 20.85%, 9.63%, and 8.94%, respectively. There were no significant differences in the germination characteristics of the two cultivars Panjani and Bunduqi. The highest germination percentage was obtained in media B and D, with values of 16.35% and 16.16%, without significant differences. The two media B and D were significantly superior to medium C, which gave a germination rate of 11.80%. This was significantly superior to medium A, which gave a germination rate of 8.24%. As for the interaction between the caprifig variety and the medium used in cultivation, the interaction of the Azraq variety with the medium B and the interaction of the blue medium D variety achieved the highest germination rate of 24.69% and significantly superior to the other interactions (without significant differences between these two reactions). In comparison, the interaction of the Bunduqi cultivar with medium A achieved the lowest germination percentage of 5.02% after 24 h of pollen cultivation.

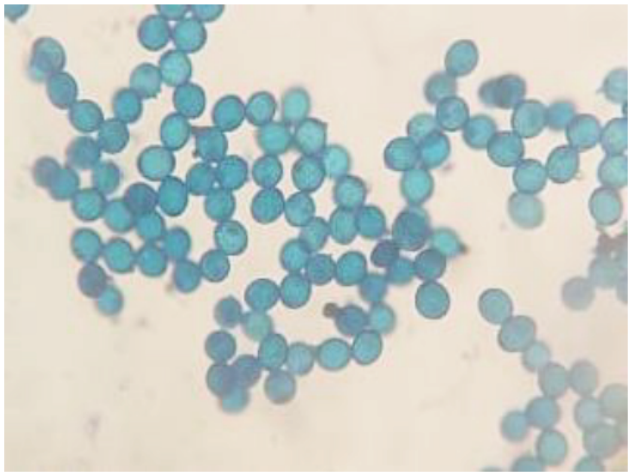

Fig. 3 - Pollen viability test using methylene blue.

Table 2 - Pollen viability percentage using methylene blue dye

Cultivar	Dye methylene blue (%)
Azraq	98.67
Bunduqi	97.33
Panjani	99.67
C.V.%	3.40
L.S.D. (1%) = Cultivar	3.47

Table 3 - Germination of pollen grains of caprifig cultivars after 24 h of planting on media (A, B, C, and D)

Cultivar	Medium				Average
	A	B	C	D	
Azraq	12.69	25.69	20.35	24.69	20.85 a
Bunduqi	5.02	13.02	5.02	12.69	8.94 b
Panjani	7.02	10.35	10.02	11.12	9.63 b
Average	8.24 c	16.35 a	11.80 b	16.16 a	13.14
C.V.%	7.28				
L.S.D. (1%) = Cultivar	1.10				
L.S.D. (1%) = Medium	1.27				
L.S.D. (1%) = (Cultivar x Medium)	2.20				
Pr. Cultivar	<0.001				
Pr. Medium	<0.001				
Pr. (Cultivar x Medium)	<0.001				
F. calculated. Cultivar	584.57				
F. calculated. Medium	148.35				
F. calculated. (Cultivar x Medium)	21.97				

The presence of the same letter in the same column or the same line indicates that there are no significant differences between the transactions.

Figure 4 show the pollen germination of Panjani, Azraq, and Bunduqi cultivars after 24 h of cultivation on media (A, B, C, and D).

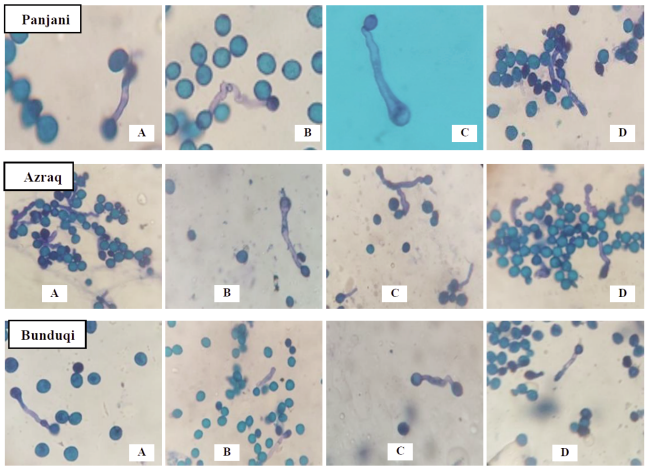

Fig. 4 - Germination of 'Panjani', 'Azraq' and 'Bunduqi' pollen after 24 h of cultivation on media (A, B, C, and D).

48 h after planting. The results of the statistical analysis of the percentage of pollen germination caprifig cultivars (Table 4) show that the Azraq cultivar was superior in the germination percentage of pollen grains to the two cultivars Panjani and Bunduqi after 48 h of planting on media (A, B, C, and D), with an average germination rate of 33.32%. There were no significant differences between the two cultivars Bunduqi and Panjani, whose germination rates reached 24.99% and 23.85%, respectively. As for the media used in cultivation, medium D (10% sucrose + extract of the stigma of female flowers) significantly outperformed the other cultivation media and gave a germination rate of 33.81%. Medium C (5% sucrose + extract of the stigma of female flowers) was significantly superior, with a germination rate of 29.88% over medium B (10% sucrose), which achieved a germination rate of 25.32%, and in turn significantly outperformed medium A (5% sucrose), which came in the last rank, with a germination rate of 20.55%.

Regarding the interaction between the caprifig variety and the medium used in cultivation, the interaction of the Azraq variety with medium D achieved the highest germination percentage, which amounted to 40.32%, and significantly outperformed all other interactions. On the other hand, the interaction of the Bunduqi cultivar with medium A achieved the lowest germination rate, which was 16.99% after 48 h of pollen cultivation.

Figure 5 show the pollen germination of Panjani, Azraq, and Bunduqi cultivars after 48 h of cultivation on media (A, B, C, and D).

72 h after planting. Table 5 displays the superiority of the cultivar Azraq in the percentage of pollen germination on the two cultivars Panjani and Bunduqi after 72 h of cultivation on media (A, B, C, and D), with an average germination rate of 64.16%.

Table 4 - Germination of pollen grains of caprifig cultivars after 48 h of planting on media (A, B, C, and D)

Cultivar	Medium				Average
	A	B	C	D	
Azraq	25.32	36.32	31.32	40.32	33.32 a
Bunduqi	16.99	18.66	31.66	32.66	24.99 b
Panjani	19.32	20.99	26.66	28.44	23.85 b
Average	20.55 d	25.32 c	29.88 b	33.81 a	27.39
C.V.%	5.37				
L.S.D. (1%) = Cultivar	1.69				
L.S.D. (1%) = Medium	1.96				
L.S.D. (1%) = (Cultivar x Medium)	3.39				
Pr. Cultivar	< 0.001				
Pr. Medium	< 0.001				
Pr. (Cultivar x Medium)	< 0.001				
F. calculated. Cultivar	584.57				
F. calculated. Medium	148.35				
F. calculated. (Cultivar x Medium)	21.97				

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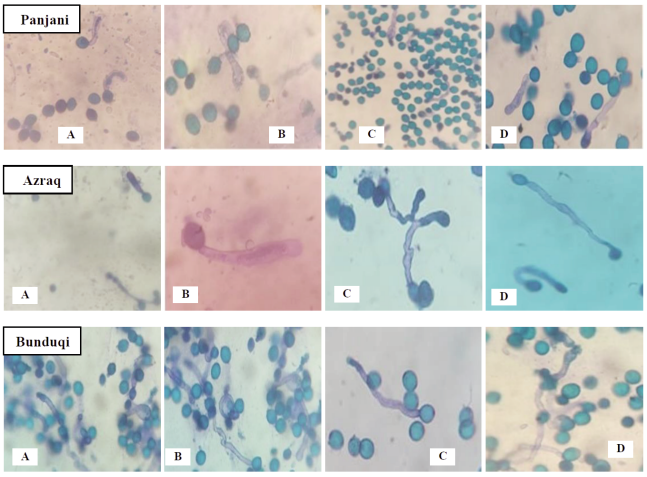

Fig. 5 - Germination of 'Panjani', 'Azraq' and 'Bunduqi' pollen after 48 h of cultivation on media (A, B, C, and D).

sucrose), which achieved a germination rate of 46.00%. Medium A (5% sucrose) came in the last rank with a percentage of germination of 38.33%. Regarding the interaction between the caprifig cultivar and the medium used in cultivation, the two interactions, the Azraq cultivar with the medium D, and the blue cultivar with the medium B were significantly superior to the other interactions, with a percentage of germination of 69.66% and 68.66%, respectively, without significant differences between them. The interaction of the Bunduqi cultivar with medium A achieved the lowest germination rate of 23.66% after 72 h of pollen cultivation. Figure 6 show the germination of pollen of cultivars Panjani, Azraq, and Bunduqi after 72 h of cultivation on media (A, B, C, and D).

Table 5 - Germination of pollen grains of fig cultivars after 72 h of cultivation in media (A, B, C, and D)

Cultivar	Medium				Average
	A	B	C	D	
Azraq	53.66	68.66	64.66	69.66	64.16 a
Bunduqi	23.66	30.33	50.66	55.33	40.00 c
Panjani	37.66	39	54.33	57.7	47.17 b
Average	38.33 d	46.00 c	56.55 b	60.90 a	50.44
C.V.%	2.62				
L.S.D. (1%) = Cultivar	1.76				
L.S.D. (1%) = Medium	1.52				
L.S.D. (1%) = (Cultivar x Medium)	3.04				
Pr. Cultivar	< 0.001				
Pr. Medium	< 0.001				
Pr. (Cultivar x Medium)	< 0.001				
F. calculated. Cultivar	584.57				
F. calculated. Medium	148.35				
F. calculated. (Cultivar x Medium)	21.97				

The presence of the same letter in the same column or the same line indicates that there are no significant differences between the transactions.

The cultivar Panjani was also significantly superior to the cultivar Bunduqi, which came in the last rank, the germination rates for both were 47.17% and 40.00%, respectively. Concerning the agricultural media, all media differed significantly among themselves in the characteristic of the percentage of germination of pollen. Medium D (10% sucrose + extract of the stigma of female flowers) significantly outperformed the other cultivation media, with a germination rate of 60.90%. Medium C (5% sucrose + extract of the stigma of female flowers) was significantly superior, with a germination rate of 56.55% over Medium B (10%

Evolution of germination rate during the experimental time

The previous results show that the percentage of pollen germination increased for all the studied caprifig cultivars with the progression of the experiment. While the average percentage of germination for all tested cultivars after 24 h was 13.14%, the percentage increased to 27.39% after 48 h of planting, and it reached 50.44% after 72 h. The cultivar Azraq gave the best germination rate and outperformed the other cultivars in all stages of the experiment. The percentage of germination in this cultivar

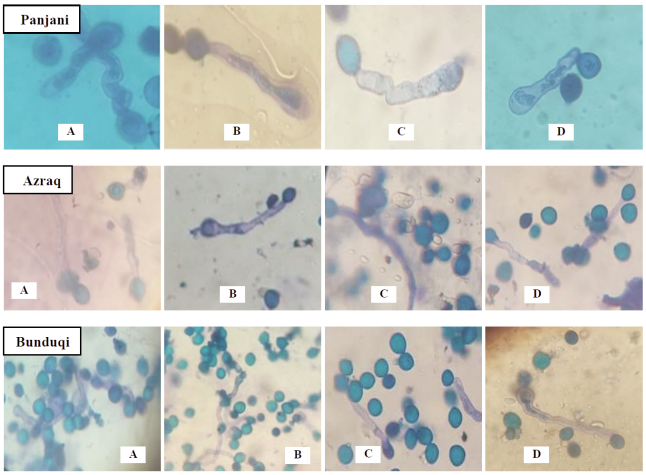

Fig. 6 - Germination of 'Panjani', 'Azraq' and 'Bunduqi' pollen after 72 h of cultivation on media (A, B, C, and D).

increased from 20.85% to 33.32% and then reached 64.16% after 24 h, 48 h, and 72 h of planting, respectively. As for the cultivar Panjani, the germination percentage increased from 9.63% to 24.99% and then to 47.17% after 24 h, 48 h, and 72 h, respectively. The percentage of germination in the Bunduqi cultivar increased from 8.94% to 23.85% and then to 40% after 24 h, 48 h, and 72 h, respectively. There were no significant differences in the germination percentages of Panjani and Bunduqi at the beginning of the experiment (after 24 h to 48 h of cultivation), but the cultivar Panjani gave a higher percentage of germination and outperformed the variety at the end of the experiment (after 72 h of cultivation).

This study is consistent with the study of (Ilgin *et al.*, 2007; Gaaliche *et al.*, 2013), where the germination rate increased with time and reached the highest value 72 h after planting.

Regarding the media used for cultivation, the percentage of germination increased in all media used in culture (A, B, C, and D) with the progression of the experiment. Also, media C and D (containing the extract of the female stigma) significantly outperformed the media A and B (which did not contain the extract of the female stigma) in most reading times and for all the studied caprifig cultivars. The average percentage of germination in media containing extract of the female stigma was 34.85%, while the average percentage of germination in media that did not contain extract of the female stigma was 25.80% (an increase in the percentage of germination was about 35% when the extract of the female stigma was added to the pollen culture medium). This proves the positive role of adding the extract of the long-style female stigma flowers in raising the percentage of pollen germination of caprifig varieties and increasing the growth of the pollen tube in them. These results are consistent with several previous studies (Ilgin *et al.*, 2007; Awamura *et al.*, 1995), where pollen germination from caprifig was increased to more than 70% when long-style stigmas were added to the pollen culture medium.

Media B and D (containing 10% sucrose) significantly outperformed media C and D (containing 5% sucrose) in most reading times and for all studied caprifig cultivars, where the average percentage of germination in media containing 10% sucrose was 33.09%. The average percentage of germination in media containing 5% sucrose reached 27.56% (an increase in germination percentage was about 20% when the level of sucrose in the cultivation medium increased from 5% to 10%). This confirms the importance of increasing the percentage of sucrose in the cultivation medium of pollen of caprifig varieties to raise the percentage of germination. This is consistent with the results of Ilgin *et al.* (2007), who found that increasing the concentration of sucrose to 20% led to an increase in the percentage of pollen germination but increasing the percentage of sucrose above 25% in the cultivation medium led to a decrease in the percentage of pollen germination. However, our results do not agree with the results of Zeybekoglu *et al.* (1997), who found that the best germination rate of pollen of caprifig cultivars was at a concentration of 5% of sucrose.

Effect of pollen type on the fruit quality of edible fig cultivars

Fruit length

Table 6 displays the significant superiority of the pollinator Panjani over the two pollinators, Bunduqi and Azraq, in the characteristic of the fruit length of the edible fig variety, with a value of 4.62 cm. The Bunduqi pollinator was significantly superior to the Azraq pollinator, with a fruit length of 4.23 cm and 4.11 cm, respectively. As for the edible fig cultivars, the Safrawi and Habashi fig cultivars (without significant differences) were significantly superior to the white Satehi cultivar, and the fruit length values were 4.89 cm, 4.80 cm, and 3.26 cm, respectively. In terms of the effect of the interaction of the pollinated variety with the edible fig variety on the characteristic of the length of the fruit, the interaction of the caprifig cultivar Panjani with Safrawi achieved the highest

Table 6 - Effect of the pollinated variety on the characteristic of fruit length in edible fig varieties

Caprifig	Fruit length (cm)			Average
	Habashi	White Satehi	Safrawi	
Azraq	4.59	3.36	4.39	4.11 c
Bunduqi	4.77	3.08	4.83	4.23 b
Panjani	5.04	3.35	5.46	4.62 a
Average	4.80 a	3.26 b	4.89 a	4.32
C.V.%	3.60			
L.S.D. (1%) = Caprifig	0.06			
L.S.D. (1%) = Edible fig	0.05			
L.S.D. (1%) = (Caprifig x Edible fig)	0.10			
pr. Caprifig	<.001			
pr. Edible fig	<.001			
pr. (Caprifig x Edible fig)	<.001			
F. calculated. Caprifig	169.59			
F. calculated. Edible fig	2031.91			
F. calculated. (Caprifig x Edible fig)	64.10			

The presence of the same letter in the same column or the same line indicates that there are no significant differences between the transactions.

value (5.46 cm) and significantly outperformed all other interactions. The interaction of the caprifig variety Bunduqi with white Satehi was in the last place with a fruit length of 3.08 cm.

Fruit diameter

The pollinator Panjani was significantly superior to the pollinated Bunduqi and Azraq pollinators in terms of the diameter of the fruit of the female variety, with a value of 5.34 cm (Table 7). Also, the Bunduqi pollinator was significantly superior to Azraq pollinator with a fruit diameter of 4.88 cm and 4.75 cm, respectively. As for the edible fig cultivars, the Habashi was significantly superior to Safrawi and white Satehi cultivars. Safrawi was significantly superior to the white Satehi cultivar, with a fruit diameter of 5.78 cm, 4.76 cm, and 4.43 cm, respectively. In terms of the effect of the interaction of the inoculated variety with the edible fig variety on the characteristic of the diameter of the fruit, the interaction of

Table 7 - Effect of the inoculated variety on the fruit diameter in edible fig varieties

Caprifig	Fruit diameter (cm)			Average
	Habashi	White Satehi	Safrawi	
Azraq	4.59	3.36	4.39	4.11 c
Bunduqi	4.77	3.08	4.83	4.23 b
Panjani	5.04	3.35	5.46	4.62 a
Average	4.80 a	3.26 b	4.89 a	4.32
C.V.%	3.60			
L.S.D. (1%) = Caprifig	0.06			
L.S.D. (1%) = Edible fig	0.05			
L.S.D. (1%) = (Caprifig x Edible fig)	0.10			
pr. Caprifig	<.001			
pr. Edible fig	<.001			
pr. (Caprifig x Edible fig)	<.001			
F. calculated. Caprifig	169.59			
F. calculated. Edible fig	2031.91			
F. calculated. (Caprifig x Edible fig)	64.10			

The presence of the same letter in the same column or the same line indicates that there are no significant differences between the transactions.

the caprifig variety Panjani with the edible fig variety Habashi significantly outperformed all other interactions, with a fruit diameter of 6.08 cm. In contrast, the interaction of the caprifig cultivar Azraq with Safrawi came at the last position with a fruit diameter of 4.18 cm.

Fruit weight

From Table 8, it appears that the pollinator Panjani was significantly superior to the pollinated Bunduqi and Azraq in the fruit weight of the edible fig variety, with a value of 53.83 g. The Bunduqi pollinator was significantly superior to the Azraq pollinator with a fruit weight of 48.90 g. While the Azraq pollinator came in last place with a fruit weight of 47.32 g. As for the edible fig cultivars, the Habashi fig cultivar was significantly superior to Safrawi and white Satehi cultivars. Safrawi also outperformed the white Satehi cultivar (the fruit weight values of the edible fig cultivars were 56.73 g, 49.07 g, and 44.28 g, respectively). Regarding the interaction of the caprifig pollinated variety with the edible fig variety and its effect on the characteristic of the weight of the fruit, the interaction of the caprifig cultivar Panjani with the edible fig cultivar Habashi significantly outperformed all other interactions, the weight of the fruit in this interaction was 59.40 g. The interaction of the caprifig cultivar Azraq with the edible fig cultivar Safrawi gave the lowest value of the fruit weight (42.90 g).

Total soluble solids percentage

Table 9 shows no significant differences between caprifig varieties in their effect on the TSS % in the edible fig fruits inoculated with these pollinators. The values were 22.35%, 22.22%, and 21.32% after inoculation with Panjani, Azraq, and Bunduqi cultivars, respectively. Thus, no effect of the inoculated variety was observed on the TSS percentage in the edible fig fruits. As for the female cultivars, the White Satehi cultivar was significantly superior to both cultivars Habashi and Safrawi in terms of the TSS %, which amounted to 25.35%, 20.78%, and 19.75%, respectively (and there were no significant differences between the two cultivars Habashi and Safrawi). Regarding the effect of the interaction of the caprifig pollinator variety with the edible fig variety on the characteristic of the TSS % in the fruits of the pollinated varieties, the interaction of the caprifig cultivar Panjani with the edible fig cultivar White Satehi significantly outperformed all other interactions, with a TSS % of 26.45%. In the latest place, the interaction of the caprifig cultivar Bunduqi with the edible fig cultivar Habashi came with a TSS % of 18.55%.

Our results agreed with the findings of Pourghayoumi *et al.* (2012), who indicated the significant effect of the pollen source on the length of the fruit in the edible fig varieties pollinated with these pollinators. However, our results did not match the results of same study regarding the effect of the pollen source on the TSS % feature.

Table 8 - Effect of the pollinated variety on the characteristic of the weight of the fruit in the edible fig varieties

Caprifig	Fruit weight (g)			Average
	Habashi	White Satehi	Safrawi	
Azraq	55.45	43.6	42.9	47.32 c
Bunduqi	55.35	43.2	48.25	48.90 b
Panjani	59.4	46.05	56.05	53.83 a
Average	56.73 a	44.28 c	49.07 b	50.03
C.V.%	5.00			
LSD (1%) = Caprifig	0.90			
LSD (1%) = Edible fig	0.90			
LSD (1%) = (Caprifig x Edible fig)	1.57			
pr. (Caprifig x Edible fig)	<.001			
pr. Caprifig	<.001			
pr. Edible fig	<.001			
F. calculated. Caprifig	109.85			
F. calculated. Edible fig	376.28			
F. calculated. (Caprifig x Edible fig)	26.87			

The presence of the same letter in the same column or the same line indicates that there are no significant differences between the transactions.

Table 9 - Effect of the inoculated variety on the TSS % in the fruits of edible fig varieties

Caprifig	TSS (%)			Average
	Habashi	White Satehi	Safrawi	
Azraq	21.85	24.75	20.05	22.22 a
Bunduqi	18.55	24.85	20.55	21.32 a
Panjani	21.95	26.45	18.65	22.35 a
Average	20.78 b	25.35 a	19.75 b	21.96
C.V.%	9.40			
LSD (1%) = (Caprifig x Edible fig)	1.28			
LSD (1%) = Caprifig	0.74			
LSD (1%) = Edible fig	0.74			
pr. (Caprifig x Edible fig)	<.001			
pr. Caprifig	0.013			
pr. Edible fig	<.001			
F. calculated. Caprifig	4.50			
F. calculated. Edible fig	126.35			
F. calculated. (Caprifig x Edible fig)	11.09			

The presence of the same letter in the same column or the same line indicates that there are no significant differences between the transactions.

4. Conclusions

This research demonstrated that the cultivar Bunduqi was the earliest caprifig cultivar in terms of fruit ripening, the abundance of pollen, and the time of the release of Blastophaga insects. Therefore, it is recommended to use it in pollinating early female fig varieties. Also, the pollen viability was very high in all studied cultivars, and there were no significant differences between cultivars in this trait. Furthermore, the Azraq cultivar significantly outperformed Panjani and Bunduqi cultivars in pollen germination percentage in all phases of the experiment and in all media used in cultivation. Adding stigma flower extract in cultivation media increased the germination rate by 35% for all studied caprifig cultivars. Furthermore, increasing the proportion of sucrose (10%) in the cultivation medium increased the pollen germination percentage by 20% for all cultivars of caprifig (compared to 5% sucrose). Finally, the caprifig variety used in pollination had a clear effect on the weight, diameter, and length of the fruit in the pollinated edible fig varieties. Consequently, the Panjani variety was superior to the rest of the pollinators in improving these traits. The results of this research are important for both fig growers and plant breeders, as they help to select the best pollinators and contribute to the development and improvement of the quality of the cultivated fig fruits.

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