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Caprification efficiency of three Tunisian fig (*Ficus carica* L.) cultivars

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ABSTRACT

Fig tree (Ficus carica L.) is well adapted to agro-ecological conditions of Tunisia. Many cultivars are of Smyrna type and caprification is a common practice in all regions. However, this technique remains not well controlled. This study was carried out during two seasons 2008 and 2009 to better understand caprification efficiency on cultivars Zidi, Bidhi and Bither Abiadh varying the number of caprifigs and repetitions of caprification on each tree. Many parameters were recorded (fruit set, yield, fruit characteristics and shoot length for the following season). Results indicate that for Zidi two fruiting waves can be identified and that caprification at two dates scheduled on 10-14 days could be sufficient to have a satisfying yield and fruit quality (60 g per fruit, 19° Brix) without negative effect on shoot elongation. For the other cultivars, the effect of caprification was noted especially on the fruit set (70 % and 65 %, respectively, for Bidhi and Bither Abiadh) and the average fruit weight (50 g for Bither Abiadh and 52 g for Bidhi).

Key words: Fig, *Ficus carica*, caprification, efficiency, Tunisia.

INTRODUCTION

The common fig (*Ficus carica* L.) belongs to the Eusyce section of the Moraceae, with over 1400 species classified into about 40 genera [1]. The genus *Ficus*, comprised of about 700 species. Many traditional medicines in use are derived from these species such as *Ficus religiosa* [2] and *Ficus hispida* [3]**.** *Ficus carica* is a typical fruit tree of the Mediterranean area. Figs have been used for human consumption for centuries, and recently their nutritive and pharmacological values have been investigated [4, 5]. Tunisia is a favorable country for fig growing that is very promising and still regaining interest. Fig cultivars are numerous and well adapted to local agro-ecological conditions [6]. Some are of the Common type (parthenocarpic) that produce figs without pollination. Many others are of Smyrna type that need caprification [7]. The caprification (pollination) is quite a common practice in all regions and was cited as an important factor affecting the quality of fig fruits [8].

Syconia of some of the edible fig cultivars need to be caprified in order to be retained on the tree and produce edible figs with viable seeds. The caprification process must be repeated two or

three times because syconia of the edible figs become receptive gradually [9]. The general practice in caprification is to distribute the male figs at intervals of few days over a period of about three weeks. The number of figs dispensed, frequency of application, and length of caprification period depend on weather conditions [10]. In Turkey, about 25 caprifig fruits are used for each edible fig tree. In Iran, caprifigs are put inside tin containers that are hung on the trees [9, 11]. In California, male figs are placed inside paper bags or plastic containers that are stapled on the female trees [9]. In Tunisia, traditionally two to six caprifigs are connected with a wire or a stick passed through their neck is hung onto branches of female fig trees and the total number of caprifigs ranged between 20 and 40 per tree [8].

Caprifig trees with good quality and quantity of pollen are essential for a good caprification [12]. In Tunisia, prospections made in different regions permitted the identification of many male fig ecotypes. Differences were noted for fruit characteristics and date of pollen maturity [6]. Fig pollinator, because of ecological conditions, might be scarce. In some continental areas, caprifigs are rare and low winter temperatures impede the fig wasp to fulfill its life cycle. In addition, the non–synchronicity of the ripening of caprifigs and receptivity of the female edible figs is a major constraint [13, 14]. Thus, caprification remains very expensive [15]. The growers often faced difficulties in obtaining sufficient yield and high quality of fruits because the caprification remains not well mastered.

The main objective of this study was to better understand caprification efficiency and investigate its effect on fruit set, yield, fruit size, fruit quality and shoots growth for the following season of three Tunisian fig cultivars.

MATERIALS AND METHODS

This study was conducted during two successive years 2008 and 2009 in two fig orchards. The first experiment of caprification was carried out on two fig cultivars (Bidhi and Bither Abiadh) grown at Chott-Mariem (center-east Tunisia). Each cultivar is represented by six uniform trees, fifteen years old and cultivated under rain-fed conditions. Caprifig cultivars used in this experiment were Assafri and Jrani. Three trees of each cultivar were caprified four times and the three others were left uncaprified (control). The number of caprifigs installed each repetition varied according to the estimated number of receptive female figs (Table 1). On each tree, six shoots were selected prior to the caprification period to determine the fruit set (%) considered as the ratio of the fruit number to the flower bud number. During harvesting period, 20 mature fruits per cultivar were collected in order to determine fruit weight (g), fruit length (mm) and fruit diameter (mm).

Table 1. Number of caprifigs installed per tree for cultivars Bidhi and Bither Abiadh

Date	Caprifig cultivar	Number of caprifigs per tree	
		Bither Abiadh	Bidhi
31 May	Assafri	24	24
04 June	Assafri	26	22
11 June	Assafri	20	18
18 June	Jrani	24	22

The second experiment was carried out on Zidi adult fig trees, ten years old and cultivated in irrigated conditions at Mhamdia (north-east Tunisia). Twelve trees were randomly selected (three trees per treatment) and four treatments of caprification were carried out varying the number of caprifigs and repetitions (Table 2). Many traits were recorded: fruits set, total yield, fruit size and

shoot length for the following season SL 2009 (mm). In addition, morphometric measurements and chemical analysis carried out on samples of 20 mature fruits were : fruit weight (g), fruit length (mm) and fruit diameter (mm), ostiole diameter, skin thickness (mm), peel thickness (mm), total soluble solids TSS (°Brix) and titrable acidity (g/L).

The yearly data were combined for the two years and analyzed statistically by running ANOVA (one way) of Statistical Package for the Social Sciences (SPSS) version 13.0. The means of cultivars were compared by Duncan's multiple range test ($P<0.05$).

Table 2. Total number of caprifigs installed per tree for cultivar Zidi

Treatment	T 1	T 2	T 3	T 4
Number of repetitions per tree	2 repetitions	3 repetitions	4 repetitions	5 repetitions
Dates of caprification	22 June 05 July	20 June 22 June 05 July	14 June 16 June 18 June 20 June	14 June 16 June 18 June 20 June 05 July
Total number of caprifigs per tree	32	44	72	80

RESULTS AND DISCUSSION

For cultivars Bither Abiadh and Bidhi, results showed significant effects of caprification on fruit set and fruit size and dimension, except for fruit diameter of Bidhi (Table 3). Fruit set for Bidhi and Bither Abiadh was, respectively, 70 % and 65 % when caprified and only 26 % and 42 % without caprification. For both cultivars, caprified figs were significantly larger and heavier than those uncaprified. The average fruit weight was 52.02 g and 50.2 g following caprification, but only 24 g and 21.4 g without caprification, respectively, for Bidhi and Bither Abiadh (Table 3). These results are similar to those reported by Condit [10] who found that 50 caprified Dottato (Kadota) figs averaged 44.4 mm in diameter and 45.4 g in weight, while 50 uncaprified figs averaged 38.1 mm in diameter and 32.3 g in weight.

Table 3. Mean values of the different parameters measured on fruit and degree of significance of differences between caprified and uncaprified fruits of cultivars Bither Abiadh and Bidhi

Parameter	Bither Abiadh				Bidhi			
	caprified	uncaprified	*F*	Sig.	caprified	uncaprified	*F*	Sig.
Fruit weight (g)	50.2	21.42	40.79	**	52.02	24.02	17.95	*
Fruit length (mm)	41.73	26.87	11.88	*	45.02	31.28	16.34	*
Fruit diameter (mm)	42.32	27.57	72.48	**	45.94	32.12	6.80	NS
Fruit set (%)	65	42	8.17	*	70	26	103.58	**

Sig. : degree of significance of the differences between treatments (: significant at P<0.05; ** significant at P<0.01 ; NS: non significant)*

Results of the second experiment showed that the highest percentage of fruit set (61.7 %) was obtained for the treatment 4 (5 repetitions), whereas the lowest (48.4 %) was recorded for the treatment 1 (2 repetitions) (Table 4).

Table 4. Variation of the rate of fruit set (%) according to the number of caprification repetitions for cultivar Zidi

Treatment	T 1 (2 repetitions)	T 2 (3 repetitions)	T 3 (4 repetitions)	T 4 (5 repetitions)
Fruit set (%)	48.4	58.6	56.8	61.7

The yield per tree varied according to the number of repetitions carried out for caprification. The high yield was recorded for treatment 1 (2 repetitions) with a mean value of 45 kg per tree, whereas the lowest yield was found for treatment 4 (5 repetitions) with a mean value of 25 kg per tree.

Fruiting of cultivar Zidi took place in two waves and differences were noted between the first and the second wave for all the treatments. Fruit diameter increased in a regular way for all treatments. Fruits of the first wave had a final diameter ranging between 3.65 and 4 cm, while the diameter of those of the second wave ranged from 2.82 to 3.29 cm. For the first wave, the treatment 4 (5 repetitions) gave the largest fruits. For the second wave, two repetitions were sufficient and allowed to obtain the largest figs. Differences were not statistically significant (Table 5).

Table 5. Mean values of the final diameter of figs resulting from the two waves and for the different treatments for cultivar Zidi

Fruiting wave	T 1 (2 repetitions)	T 2 (3 repetitions)	T 3 (4 repetitions)	T 4 (5 repetitions)	Mean (cm)	Sig.
Wave 1	3.89	3.91	3.65	4.00	3.86	NS
Wave 2	3.29	3.18	3.10	2.82	3.09	NS

Sig. : degree of significance of the differences between treatments (NS: non significant)

Differences among the treatments were not statistically significant in terms of fruit quality characteristics (Table 6). The average fruit weight varied according to the treatments. Values recorded were 56.1, 60.3, 65.5 and 68 g, respectively for the treatments T 3, T 4, T 2 and T 1. The treatment 1 (2 repetitions) presented the best average fruit weight (68.02 g) (Table 6). The highest length was obtained for treatment 2 (57.4 mm) whereas the lowest length was found with treatment 4 (55 mm). The range for ostiole diameter was between 9.94 mm (treatment 4) and 10,4 mm (treatment 2). Skin thickness ranged between 0.15 mm (T 2) and 0.4 mm (T 1). Peel thickness changed between 4.1 mm (T 2) and 4.7 mm (T 3). For the total soluble solids, the lowest value was recorded for T2 (18.36°Brix), whereas the highest value was observed at the T 1 (19.5°Brix). Treatment 2 provides the most acid fruits (2.15 g/L), while the fruits obtained following the treatment 4 are the least acid (1.25 g/L) (Table 6).

Table 6. Mean values of the different parameters measured on fruit and degree of significance between different treatments

	Fruit characteristics						
	Fruit weight (g)	Fruit length (mm)	Ostiole diameter (mm)	Skin thickness (mm)	Peel thickness (mm)	TSS (°Brix)	Titrable acidity (g/L)
Treatment 1	68.02	57.02	10.20	0.15	4.31	19.50	1.30
Treatment 2	65.50	57.41	10.45	0.20	4.11	18.36	2.15
Treatment 3	56.10	55.61	10.03	0.40	4.70	18.92	1.50
Treatment 4	60.34	55.00	9.94	0.21	4.60	19.10	1.25
F	1.88	1.90	0.78	2.40	0.96	0.56	4.64
Sig.	NS	NS	NS	NS	NS	NS	NS

Sig. : degree of significance of the differences between different treatments (NS: non significant)

Although no significant difference between the treatments as regards the shoot length was observed, the longest shoot (14.56 cm) of the following season (SL 2009) were obtained with treatment 2, while the lowest value (12.3 cm) was obtained with treatment 4 (Table 7). Therefore, we concluded that the fruiting of the current year had no effect on the vegetative growth of the following growing season.

Table 7. Variation of average shoot length according to the number of caprification repetitions for cultivar Zidi

Treatment	T 1 (2 repetitions)	T 2 (3 repetitions)	T 3 (4 repetitions)	T 4 (5 repetitions)
SL 2009 (cm)	13.2	14.5	12.3	12.3

The results of this study are in accordance with other reports. In Iran pollen did not influence significantly the fruit diameter and weight of Sabz cultivar. However, pollen source had a significant effect on fruit length, total soluble solids, ostiole diameter, and percentage of seed germination [16]. In addition, Janick and Moore [17] reported that the type of caprifig may have a significant effect on the color of both the fruit skin and its interior edible flesh and the size and shape of syconia.

CONCLUSION

Results of the present investigation proved that the caprification improve fruit set and fruit size, particularly for cultivars of Smyrna type as Bidhi and Zidi. The fruiting of Zidi takes place in two waves with important differences between the first and the second one. This may influence the date of caprification. Thus it is necessary to take account of the shift between the two waves by choosing spaced dates of caprification. Results indicate that it would be sufficient, for Zidi, to practice only two repetitions of caprification; one for the first wave at the second week of June and the other for the second wave at the end of June. But we may advise to increase the number of caprifigs brought in each repetition. Also, it appears that enough fruiting of the current year had no effect on the vegetative growth of the following growing season.

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