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CAPRIFICATION EFFICIENCY OF SOME TUNISIAN LOCAL FIG (*FICUS CARICA* L.) CULTIVARS

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Fig tree (*Ficus carica* L.) is well adapted to the 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. The present study was carried out to better understand caprification efficiency in cultivars 'Zidi', 'Bidhi' and 'Bither Abiadh'. Many parameters were studied as fruit retention, yield, fruit size and quality and shoot growth. In 'Zidi' two fruiting waves were identified and caprification at two dates scheduled on 10-14 days could be sufficient to have a satisfactory 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 retention (70% and 65%, respectively, for 'Bidhi' and 'Bither Abiadh') and the average fruit weight (50 g for 'Bither Abiadh' and 52 g for 'Bidhi').
Keywords: Fig, *Ficus carica*, caprification, efficiency, caprifig

INTRODUCTION

Fig tree (*Ficus carica* L.) is a typical fruit tree of the Mediterranean area where its cultivation is a long standing tradition. Regarding its geographic and climatic position, Tunisia is a favorable country for fig growing that is very promising and still regaining interest. Fig varieties are local, numerous and well adapted to local agro-ecological conditions (Mars *et al.,* 2009). Some are of the common type (parthenocarpic); many are of Smyrna type (need caprification) (Mars *et al*., 1998). The caprification is quite a common practice in all regions and an important factor affecting the quality of the fig fruits (Mars, 1995).

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 (Zare, 2008). The general practice in caprification is to hang the branches 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 (Condit, 1947). In Turkey, about 25 caprifig fruits are used for each edible fig tree (Roshanzadeh and Jahangere, 1998). In Iran, caprifigs are put inside tin containers that are hung on the trees (Zare, 2008; Javadi and Banihashemi, 2008). In California, male figs are placed inside paper bags or plastic containers that are stapled on the female trees (Zare, 2008). In Tunisia, two to six caprifigs are connected with a wire or a stick passed through their neck is hung onto branches of female fig trees. The total number of caprifigs ranged between 20 and 40 per tree (Mars, 1995).

Caprifig trees with good quality and quantity of pollen are essential for a good caprification (Küden and Tanriver, 1998). In Tunisia, prospections made in different regions permitted the identification of many male fig ecotypes. Several are cultivated and received names (Lahbib, 1984). Many others are unnamed but regularly used by farmers (Gaaliche, 2006). Differences were noted for fruit characteristics and date of pollen maturity (Mars *et al*., 2009). 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 (Ilgin et Küden, 1998; Oukabli *et al*., 2003). Thus, caprification remains very expensive (Mars *et al*., 2008). 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 the present study was to better understand caprification efficiency and investigate its effect on fruit retention, yield, fruit size, fruit quality and shoots growth for the following season of some local fig cultivars.

MATERIALS AND METHODS

The present study was conducted in two different localities. 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 five 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

variety were caprified four times and the two 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, five shoots were selected prior to the caprification period to determine the fruit retention (%) considered as the ratio of the fruit number to the flower bud number. During harvesting period, fifteen mature fruits were collected in order to determine fruit weight (g), fruit length (mm) and fruit diameter (mm).

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 parameters were recorded: fruit retention, total yield, fruit size and shoot growth for the following season SL08 (mm). In addition, morphometric measurements and chemical analysis carried out on samples of 15 mature fruits were for fruit weight (g), fruit length (mm) and fruit diameter (mm), ostiole diameter (mm), skin thickness (mm), peel thickness (mm), total soluble solids TSS (°Brix) and titrable acidity (g/L).

Data was analyzed statistically by running ANOVA (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 ($P<0.05$).

RESULTS AND DISCUSSION

For cultivars 'Bither Abiadh' and 'Bidhi', results showed significant effects of caprification on fruit retention and fruit size and dimension, except for fruit diameter of 'Bidhi' (Table 3). Fruit retention for 'Bidhi' and 'Bither Abiadh' was 70% and 65%, respectively 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 52.02g and 50.2g following caprification, but only 24g and 21.4g without caprification, respectively, for 'Bidhi' and 'Bither Abiadh' (Table 3). These results are similar to those reported by Condit (1947) 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.

Results of the second experiment showed that the highest percentage of fruit retention (61.7%) was obtained for the treatment 4 (5 repetitions), whereas the lowest (48.4%) was

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

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

Treatments	T1	T2	T3	T4
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

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-value*	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 retention (%)	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)

recorded for the treatment 1 (2 repetitions) (Table 4).

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 25 kg per tree, whereas the lowest yield was found for treatment 4 (5 repetitions) with a mean value of 15 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).

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 for the treatments T3, T4, T2 and T1, respectively. 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 (T1). Peel thickness changed between 4.1 mm (T2) and 4.7 mm (T3). For the total soluble solids, the lowest value was recorded for T2 (18.36°Brix), whereas the highest value was observed at the T1 (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).

Although no significant difference between the treatments as regards the shoot length was observed, the longest shoots (14.56 cm) of the following season (SL08) were obtained with treatment 2, while the lowest value (12.3 cm) was obtained with treatment 3 and 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.

The results of this study are in accordance with other reports.

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

Treatment	T1 (2 repetitions)	T2 (3 repetitions)	T3 (4 repetitions)	T4 (5 repetitions)
Fruit retention (%)	48.4	58.6	56.8	61.7

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	T1 (2 repetitions)	T2 (3 repetitions)	T3 (4 repetitions)	T4 (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)

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)

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

Treatment	T1 (2 repetitions)	T2 (3 repetitions)	T3 (4 repetitions)	T4 (5 repetitions)
SL 08 (cm)	13.2	14.5	12.3	12.3

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 (Rahemi and Jafari, 2008). In addition, Janic and Moore (1975) 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

The results of the first investigation proved that the caprification improved fruits retention 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. Preliminary 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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