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Growth Pattern and Fruit Characteristics of Six Common Fig (*Ficus carica* L.) Cultivars in Jordan

Ahmad F. Ateyyeh and Monther T. Sadler*

ABSTRACT

This research aimed to study the growth pattern of shoot, fruit and drupelet, and fruit characteristics of six common fig cultivars Ajlouni, Byadi, Khartamani, Khdari, Mwazi, and Zraki. Periodic measurements showed that the growth of the fruit and drupelet are characterized by two periods of rapid growth separated by a period of slow growth. Many fruit characteristics, which were fruit weight, volume, width and length, TSS%, TA%, fruit stalk length, peel thickness and pistil length, were measured and were in the range of 9.3-27.6 g, 9.3-29.0 ml, 2.59-3.78 cm, 2.48-5.03 cm, 21.46-26.75%, 0.28-0.59%, 6.9-16.4 mm, 1.87-3.16 mm and 3.89-4.74 mm, respectively. In addition, fruit skin color was yellowish green in 'Byadi', green in 'Mwazi', 'Khdari' and 'Ajlouni', and purple in 'Khartamani' and 'Zraki'. Regarding shoot length, the six cultivars grew in the same pattern. There were two growth phases, the first growth phase continued for about 6 weeks during spring, with a very rapid shoot length increase, and the second one was characterized by quite totally reduced shoot length and continued to the end of growing season. Moreover, the apical dominance was very strong in 'Zraki', strong in 'Khdari', moderate in 'Byadi' and 'Mwazi' and moderate to weak in 'Ajlouni'; while it was weak in 'Khartamani'. Application of these results in improving fig tree training is discussed.

KEYWORDS: *Ficus carica*; second crop; fruit; growth flushes; apical dominance, Jordan.

1. INTRODUCTION

The fig is believed to be indigenous to Western Asia and to have been distributed by man throughout the Mediterranean area (Morton, 1987). In Jordan, the area devoted to fig was about 567 ha which represent 0.64% of the area planted to fruit trees and the production was about 4152.9 Mt (Department of Statistics, 2003). This indicates the low interest on fig tree in Jordan, although it has been grown in Jordan for a long time.

Condit (1938) classified fig varieties into four different groups which are Caprifig, Smyrna, San Pedro and common fig types. The common type produces parthenocarpic fruits under the environmental conditions suitable to their cultivation. Most of the cultivars which grow in Jordan belong to the common fig type.

Fig fruit is multiple and develops from the entire inflorescence, including flower parts, sepals, peduncle and ovaries. The inflorescence is inside-out, with the succulent peduncle on the outside and the flowers on the inside, a syconium. Flower initials typically form at the axil of each leaf (Westwood, 1993).

The fruit growth pattern of Smyrna fig was studied by

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Crane and Brown (1950), Crane and Baker (1953) and Tsantili (1990), who found that Smyrna fig followed the double sigmoid growth curve. Similar growth pattern was found after the application of growth regulator-induced parthenocarpic fig (Crane, 1948). On the other hand, many researchers evaluated fruit characteristics of many fig cultivars such as fruit weight, fruit width, fruit length, pH, TSS%, and TA% (Koyuncu 1998; Koyuncu *et al.*, 1998; Ozeker and Isfendiyaroglu 1998).

Studies about fruit and shoot growth of fig tree on local common fig cultivars in Jordan are not available. Such studies help in facilitating orchard management under local conditions.

This study aimed to monitor the seasonal pattern of vegetative and fruit growth of six common fig cultivars Ajlouni, Byadi, Khartamani, Khdari, Mwazi, and Zraki. In addition, some fruit characteristics such as fruit weight, fruit volume, fruit width, fruit length, fruit skin color, TSS %, TA %, fruit stalk length, peel thickness and pistil length were studied.

2. MATERIALS AND METHODS

The field work was carried out in an experimental fig orchard at Al Mushaqar, which belongs to the National Center for Agricultural Research and Technology Transfer, during 2002/2003 season. The station situated at about 1000 m above sea level in an area characterized by cold winter and hot dry summer. The laboratory work was conducted in the Department of Horticulture and Crop Science, The University of Jordan.

Six common fig cultivars Ajlouni, Byadi, Khartamani, Khdari, Mwazi, and Zraki were selected to conduct this study. Four trees of each cultivar, which were 5 years old and uniform in size, were selected and arranged in randomized complete-block design.

Five fruits of the second main crop distributed well around each tree were selected to study fruit growth; the fruits remained attached to the tree until the end of the experiment. The diameter at the point of greatest width of the fruit was measured every two weeks by digital caliper. On each date, fruit samples were collected and dissected under stereomicroscope to study drupelet development. Ten drupelets were selected in each fruit to measure ovary length, ovary diameter and style and stigma length.

To study fruit characteristics, ten fruits were collected randomly from around each tree at normal harvesting date to measure fruit weight, fruit volume, fruit width, fruit length, Total Soluble Solid (TSS)%, Titrable Acidity (TA) %, fruit stalk length, fruit stalk diameter and peel thickness. Fruit skin color was also recorded.

To study vegetative growth, five shoots of the previous season growth well distributed around each tree were selected, in addition, one shoot of the current growth that grew in spring on each previous season growth were also selected. The number of the current shoots grew on each selected previous season growth shoot was recorded and their length was measured every two weeks. To study the apical dominance, the length of the continuous growth from the apical bud of each selected shoot of previous season growth was measured.

Data Analysis

The results of this study were analyzed using the statistical program (Statistical Analysis System) from SAS Institute Corporation (SAS Institute Inc., 1999). One way analysis of variance was applied to all collected data. The comparisons among the treatments were carried out using least significant difference "lsd" test.

3. RESULTS

Fruit and Drupelet Growth

The curves of growth showed a remarkable similarity in fruit and drupelet growth habit of the six common fig cultivars (Fig. 1). The growth pattern of common fig fruit and drupelet was a double sigmoid as judged by fruit width, ovary length, ovary diameter and length of style and stigma.

The first growth period continued for about 4 weeks and was characterized by a rapid increase in fruit width and drupelets size. The second growth period is characterized by a greatly depressed rate of increase in fruit width and drupelet size, this period continued about 5 to 6 weeks. The third growth period, which was the shortest period and lasted only 2 weeks, was characterized by accelerated rates of increase in fruit width and drupelet size.

Fruit Characteristics

In this study, many fruit characteristics were measured (Table 1). Fruit weight and volume were in the range of 9.3-27.6 g, 9.3-29.0 ml, respectively, 'Zraki' had

the highest values (27.6 g and 29 ml, respectively), while 'Ajouluni' had the lowest ones (9.3 g and 9.3 ml, respectively). Fruit width and length were in the range of 2.59-3.78 cm, 2.48-5.03 cm, respectively, in addition, fruit width / fruit length ratio were in the range of 0.70-1.19, fruit length was longer than fruit width in 'Khartamani', 'Mwazi' and 'Ajouluni' but shorter than fruit width in 'Byadi' and 'Khdari' and about equal to fruit width in 'Zraki'. Fruit skin color was yellowish green in 'Byadi', green in 'Mwazi', 'Khdari' and 'Ajouluni', and purple in 'Khartamani' and 'Zraki'. TSS%, and TA% were in the range of 21.46-26.75%, and 0.28-0.59%, respectively, the fruits of 'Ajouluni' contained the highest TSS% (26.75) and TA% (0.59). Fruit stalk length and diameter were in the range of 6.9-16.4 mm and 3.3-14.2 mm, respectively, fruit stalk length of 'Khartamani' was the longest and fruit stalk length of 'Byadi' was the shortest, in addition, fruit stalk of 'Ajouluni' was the thinnest and fruit stalk of 'Mwazi' was the thickest. Peel thickness was in the range of 1.87-3.16 mm, it was the highest in 'Zraki' and 'Mwazi' and the lowest in 'Byadi' and 'Ajouluni'. The length of the pistil was in the range of 3.89 - 4.74 mm, and there was no significant difference among the six cultivars.

Table (1). Fruit characteristics of the studied fig cultivars.

| Characteristics | Cultivars | | | | | |
|----------------------------|------------|---------|--------------|---------|---------|----------|
| | Khartamani | Zraki | Byadi | Khdari | Mwazi | Ajouluni |
| Fruit Weight | 20.9 ab | 27.6 a | 19.8 b | 11.7 c | 22.4 ab | 9.3 c |
| Fruit Volume | 21.4 ab | 29 a | 24.5 a | 14.0 bc | 23.1ab | 9.3 c |
| Fruit width | 3.3 b | 3.78 a | 3.64 ab | 2.94 c | 3.54 ab | 2.59 d |
| Fruit Length | 4.53 ab | 3.95b c | 3.29 cd | 2.48 d | 5.03 a | 3.44 cd |
| Fruit width / fruit length | 0.73 | 0.96 | 1.11 | 1.19 | 0.70 | 0.75 |
| Fruit skin color | purple | purple | Yellow green | green | green | green |
| TSS % | 23.61 b | 21.76 b | 21.46 b | 22.2 b | 22.2 b | 26.75 a |
| TA % | 0.43 b | 0.44 b | 0.32 c | 0.28 c | 0.46 b | 0.59 a |
| Fruit stalk length | 16.4a | 10 b | 6.9 b | 7.3 b | 15 a | 9.1 b |
| Fruit stalk diameter | 5.4 c | 9.3 b | 4.8 c | 12.6 a | 14.2 a | 3.3 c |
| Peel thickness | 3.02 a | 3.16 a | 2 b | 2.6 ab | 3.16 a | 1.87 b |
| Pistil length | 4.36 a | 4.74 a | 3.89 a | 4.59 a | 4.41 a | 3.89 a |

Means in rows having the same letters are not significantly different at P=0.05.

Shoot Growth and Apical Dominance

Recording to the shoot length, the six cultivars grew in the same pattern; there were two growth phases, the first growth phase continued for about 6 weeks during spring and the shoot length increased rapidly. While the second growth phase characterized by no increase in the length of the shoot, this phase continued to the end of growing season (Fig 2).

The apical dominance in 'Zraki' was very strong since the apical bud grew and gave the longest shoot and the lowest lateral bud break in comparison to the other five cultivars (Table 2). In contrast, the apical dominance in 'Khartamani' was very weak since the apical bud grew and gave the shortest shoot and the highest lateral bud break in comparison to the other five cultivars. The average shoot length and the average shoot number of 'Zraki' was not significantly different in comparison to 'Khdari'. On the other hand, the average shoot length of 'Khartamani' was not significantly different in comparison to 'Ajlouni' and the average shoot number of 'Khartamani' was not significantly different in comparison to 'Byadi', 'Mwazi' and 'Ajlouni' (Table 2).

Table (2) : Shoot length and number of the six fig cultivars

| Cultivars | Shoot length (cm) | Shoot number |
|------------|-------------------|--------------|
| Khartamani | 13.65 d | 6.1 a |
| Zraki | 32.1 a | 1.65 c |
| Byadi | 23.9 bc | 4.8 ab |
| Khdari | 27.6 ab | 3.25 bc |
| Mwazi | 24.35 bc | 5.05 ab |
| Ajlouni | 17.85 cd | 4.6 ab |

Means in columns having the same letters are not significantly different at P=0.05.

4. DISCUSSION

The growth pattern of common fig fruit and drupelet was a double sigmoid (Fig 1). Tsantili (1990) found that the fruit of smyrna fig cultivar Tsapela, which is seeded cultivar, followed the same growth pattern. It is clear that a double sigmoid growth pattern is not dependent on pollination and seed production, while drupelet setting sexually or parthenocarpy could play a role in fruit growth and development since both of them grew in a similar pattern.

Many other fruits followed a double sigmoid growth curve such as peach (DeJong and Goudriaan, 1989), blueberry, grape, kiwifruit, pineapple and stone fruit (Coombe, 1976; Monselise, 1986). These fruit trees, in addition to common fig in this study, have different fruit types and grow in different climatic conditions, so the relationships between fruit type or climatic condition and fruit growth pattern could not be concluded.

Fruit characteristics such as fruit weight, volume, width and length, TSS, TA, fruit stalk length, peel thickness and pistil length were in the range of 9.3-27.6 g, 9.3-29.0 ml, 2.59-3.78 cm, 2.48-5.03 cm, 21.46-26.75%, 0.28-0.59%, 6.9-16.4 mm, 1.87-3.16 mm and 3.89-4.74, respectively. In similar studies on Smyrna fig cultivars, fruit weight, width and length, TSS, and TA ranged between 11.35-58 g, 3.1-5.25 cm, 2.2-6.2 cm, 16.6-20 %, and 0.11-0.3 %, respectively (Koyuncu *et al.*, 1998), and between 9.00–38.37 g, 24.40–43.60 mm, 22.00–39.80 mm, 11.90–24.30% and 0.13–0.34%, respectively (Koyuncu 1998).

Regardless the significant differences among cultivars and according to Fig Descriptors (IPGRI and CIHEAM, 2003), the fruits of all six cultivars were classified as small fruits. 'Ajlouni', 'Khartamani' and 'Mwazi' were classified as oblong fruits, and 'Zraki' as globose, while

'Byadi' and 'Khdari' as oblate. The total soluble solids content and titrable acidity were high in all cultivars.

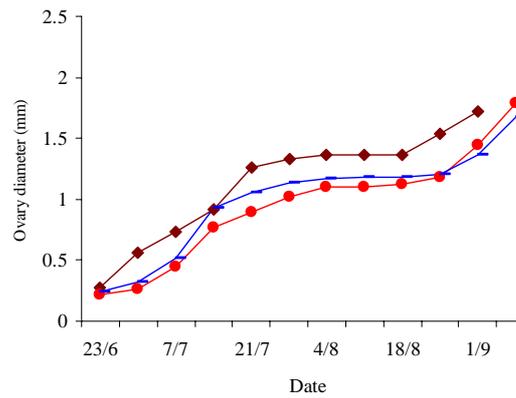
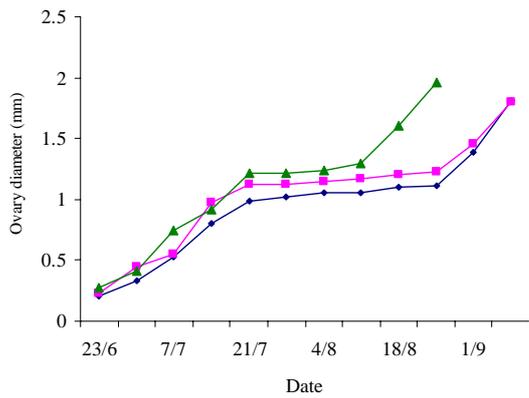
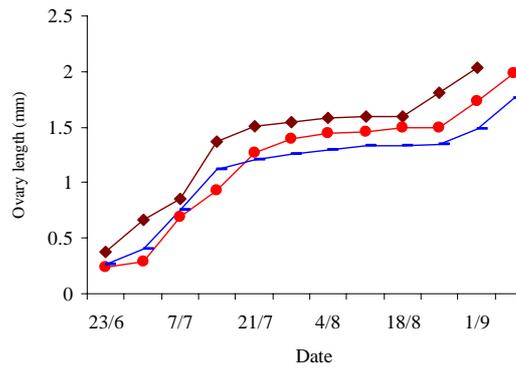
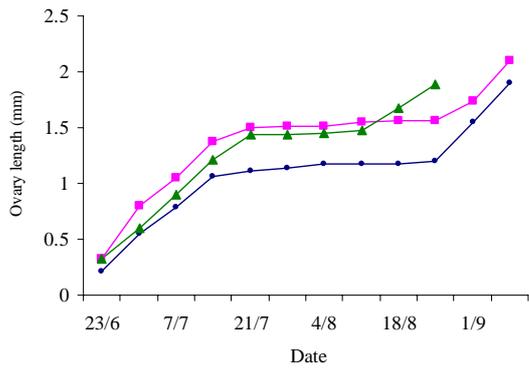
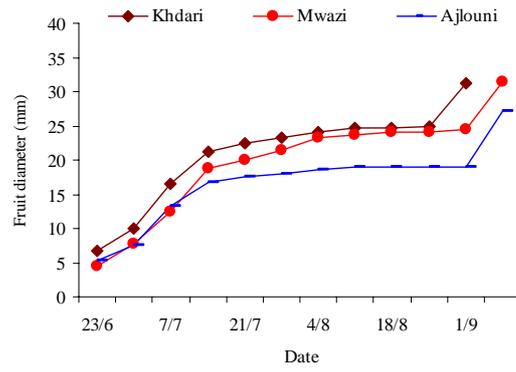
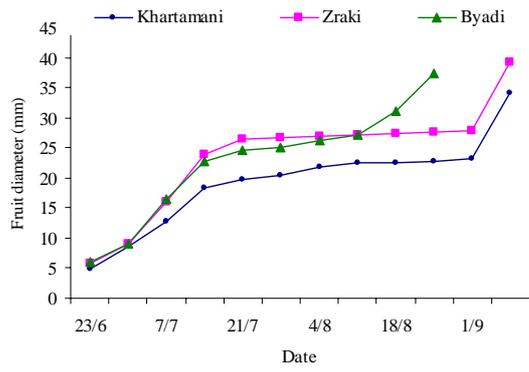
Very little fruits of the first crop grew on the previous season growth. The fruits of the second crop (main crop) started to grow at the end of the first growth phase on the current season growth. Since the production of the six studied cultivars depends mainly on the second crop, it is very important to follow suitable cultural practices that provide good conditions for the first growth phase to increase the shoot number and length. As for the six studied cultivars which produce mainly the second crop, it could be advised, in our conditions, to head back the previous season growth in winter to improve the first growth phase and decrease the strength of the apical dominance especially in 'Zraki' and 'Khdari'. Maimon (1998) worked on cultivars that produce breba figs (first crop) and pruned one year old fig trees to a height of 50

cm in summer to produce new growth for a breba crop for the next year.

On the another hand, Mordogan *et al.* (2002) found that the organic fertilization, which consisted of cow and sheep manure and was applied in March, enhanced vegetative growth and significantly affected shoot length, width and number of nods per shoot, this let to increase the number of fruits per shoot and thus affecting productivity.

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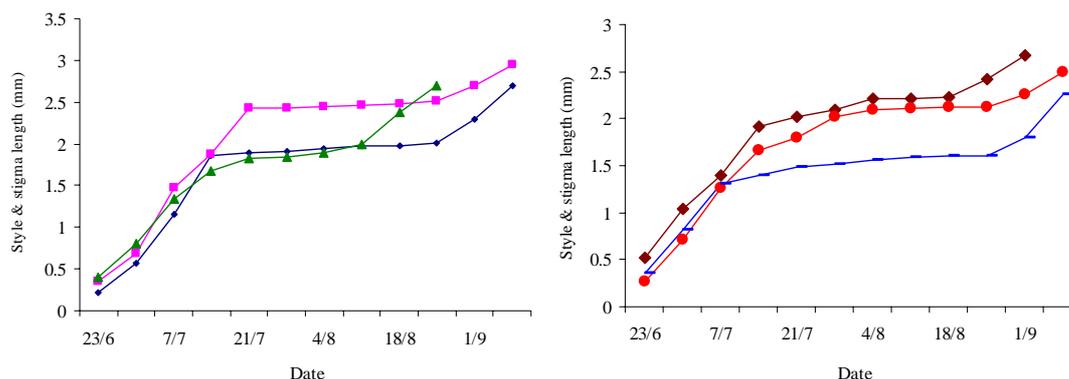


Fig. 1. Growth pattern of the fruit and drupelet parts of the studied fig cultivars.

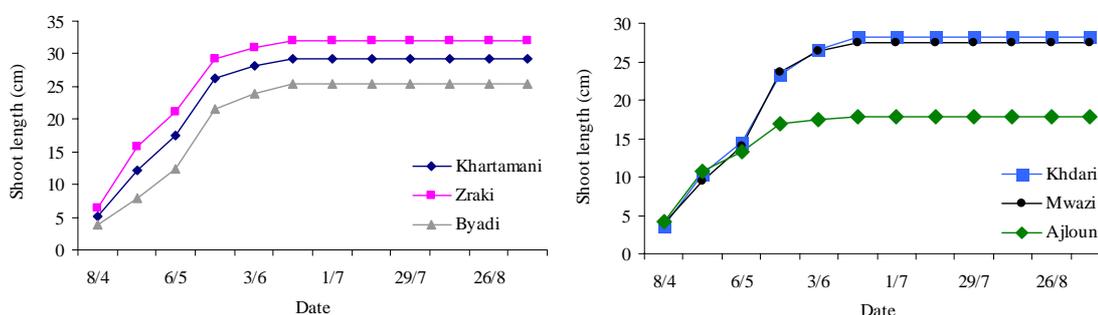


Fig. 2. Shoot growth pattern of the studied fig cultivars

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|----------|------------|--------------|-----------|-----------|-----------|------|
| 16.4-6.9 | %0.59-0.28 | %26.75-21.46 | 5.03-2.48 | 3.78-2.59 | 29.0-9.3 | 27.6 |
| | | | | 4.74-3.89 | 3.16-1.87 | |

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