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# Changes in Some Physical and Chemical Fruit Properties during Fruit Development Stage of Chemlali and Mission Cultivars

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**Abstract** This work was carried out through 2011 and 2012 seasons on two olive oil cultivars, namely (Chemlali and Mission). Trees were 10 years old, grown in sandy soil, planted at 5x5 meters apart under drip irrigation system. The investigation aimed to study the changes in some physical and chemical fruit properties in relation to fruit development stage. Results proved that fruit of the three cultivars exhibited cycle growth pattern: Growth was rapid during the first fruit growth stage (6-8 weeks), while growth was slow during the second stage (3-4 weeks). The third stage is again one of rapid growth. The increment in fruit size comes mainly from increased moisture content of the fruit. Oil begins to accumulate in the fruit and increases gradually through July, August and reaches the maximum at the early of September. So, it is important for olive trees cultivars Chemlali and Mission grown under Ismailia - Egypt condition have adequate water needs for about 16 to 19 weeks after fruit set tell just before harvest to obtain high fruit and oil quality.

**Keywords:** Olive (*Olea europaea*), growth curve, physical and chemical fruit properties

## Introduction

*Olea europaea* L. is a medium-sized evergreen shrub/tree that grows and fruits well under a Mediterranean climate, and conceded one of the most important plants and widespread crops of the Mediterranean basin, which has longevity and adaptation to climatic conditions, also the olive fruits, are commercially valuable for oil content or for edible flesh. Olive trees, depending on the variety and growing conditions, can grow to a height of 15–20 m. However, for commercial production they are best trained and pruned to a height of 3–6 m depending on the harvesting method and the available technologies. Olive trees need sufficient winter chill to ensure fruit set and a

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long hot growing season to ripen the fruit, particularly if naturally black-ripe olives are required. The limiting factor for the reproduction of olives (fruit production) is determined by winter temperatures. Olive trees are long lived. They will survive under highly unfavorable situations, but if given luxury they will thrive but not necessarily be the most productive. The olive is subject to the biennial bearing phenomenon as experienced by many fruit trees, requiring horticultural intervention to even out the crop from season to season. There are varietal differences in the degree of biennial bearing. Olive fruit are classified a drupe fruit, as they are fleshy with the seed enclosed in a stone.

After pollination and along with the formation and growth of the pollen grain, the ovary walls enlarge and the fruit shapes. 6-7 months elapse from the time the fruit sets until it grows and matures. During these months, the fruit goes through various developmental stages and its growth pace is the same with all drupes of the stone fruit type. Three growth phases can be discerned. The first phase characterized by a great slope and lasts about two months (June-July). In this phase mostly the nucleus, as opposed to the flesh, develops. During August and September the second phase follows, main feature of which is a slower growth rate of the fruit. The fruit's flesh begins to develop and towards the end of the phase the nucleus hardens and ceases growth. Finally, the third phase begins in October in which the fruit grows again at a rapid pace. In this final phase, a rapid increase in the wet weight is observed which persists until the color changes from green to dark purple or black. In this respect Desouky *et al.* (2010) stated that, the fruit of *Olea* species is a drupe, the term "stone fruit" expresses the fact that the seed is surrounded by a hard shell or stone, the endocarp. This stone develops from the inner part of the ovary wall and the soft flesh from the outer part. When the fruit is very young the stone is soft but after a few weeks it begins to harden. The seed of the mature fruit is the embryo and the large halves. Hartmann and. Opitiz (1977) Reported that olive fruit exhibits a cyclic growth pattern. Growth is rapid during the first stage, slower during the second stage, in (July and August). The third stage, just before fruit starting to color, is again one of rapid growth and coincides with the color changes from green to straw to red to black. After few weeks from fruit set, oil begins to accumulate in the fruit. The amount of oil increases gradually through summer and fall, and reaches its maximum as fruits become completely black. Oil production, quantity and quality is greatly affected by many factors i.e., cultivar, oil accumulation and harvesting stage.

The fruit weight and fruit volume showed continuous increase from the beginning of fruit development till fruit reached its full weight when it was 26 weeks old (180 days from fruit set) in Hamed variety and about 28 weeks old (195 days from fruit set) in Chemlali variety. However, moisture content in

development olive fruits remained constant during the first two weeks. This was followed by intermittent variations until fruit starting to color (reddish-green). At this stage, the moisture content remained constant until the blacking of the fruit Ezzat and El-Azzouni (1963). The oil began to appear in Chemlali olive fruits after 60 days from fruit setting and reached its maximum (22%) after 185 days Boulis and Malaty (1965).The fruit weight and fruit volume of eight seedling olive cultivars increased through the season with a reduced rate of growth in the middle period development Hegazi (1970).The average flesh weight of olive fruit increased from the age of 60 days till the end of the sampling with a slow rate of increase during the middle stages of growth Hassan (1980).The aim of this investigation is studding fruit development stages for Chemlali and Mission olive cultivars grown under Ismailia - Egypt condition in order to be a guide for olive growers to determine suitable and adequate time for horticultural practices (i.e. fertilization, irrigation, harvest…).

## Material and methods

The present study was conducted on six olive trees of the two cultivars (Chemlali and Mission). The trees were 10 years old, grown in a sandy soil under drip irrigation system depending on wills in irrigation (Table 1) in private orchard in Ismailia – Egypt. The trees spaced 5 x 5 meter apart (168 trees\ acre) in a sandy soil (Table 2). The trees were received the same cultural practices that are recommended by Ministry of Agriculture. The trees were almost similar in vigor, free from any visible pathogenic symptoms and at the same bearing phase. Experimental trees were subjected to the ordinary horticultural practices and the work was conducted during 2011 and 2012 seasons. For somewhat, similar trees of each olive cultivar were selected. Study the changes in some physical and chemical fruit properties during fruit development stages of the two olive cultivars has a great importance for olive growers to modify some horticultural practices during fruit development stages.

Fruit sample (100 fruit per tree) was randomly collected as following: Collected at two weeks intervals (from May 14, 2011 and May 23, 2012) until early August of each season then collected Weekly intervals till early September (September 3, 2011 and 2012) and finally fruit sample collected twice every week till the harvest date (October 18, 2011 and October 17, 2012) for Chemlali cultivar and (October 20, 2011 and October 16, 2012) for Mission cultivar.

For each studied olive cultivar only healthy fruits, without any kind of infection or physical damage were subjected to the following physical and chemical fruit characteristics determination as follows:

***Fruit weight***

It was determined by weighing the samples (100 fruits) by ordinary balance with 0.01 gm sensitivity and average weight per fruit was calculated.

***Moisture content and dry matter content***

It were determined by drying the flesh in an oven at 60-80 ℃ until a constant weight A.O.A.C. (1975).

***Weight of Dry Matter other than oil:***

It was determined by the following equation (Dry Matter = fruit fresh weight – moisture content).

***Oil percentage:***

Fruit oil content was determined by means of the Soxhlett fat extraction apparatus using Hexan of 60-80 ℃ boiling point as described by A.O.A.C. (1975).

***Statistical analyses***

The data were subjected to analysis of variance and Duncan's multiple rang test was used to differentiate means at 5% Duncan (1955).

**Table 1:** Chemical characteristics of sandy soil used for the present study

| parameters | | | |
|---|---|---|---|
| | Surface sample | 30 cm depth | 60cm depth |
| pH | 8.02 | 8.70 | 8.11 |
| EC($dSm^{-1}$) | 3.80 | 0.80 | 1.70 |
| | Soluble cations (meq\l) | | |
| $Ca^{++}$ | 6.00 | 2.50 | 3.00 |
| $Mg^{++}$ | 4.00 | 1.50 | 1.50 |
| $Na^{+}$ | 28.60 | 4.40 | 12.90 |
| $K^{+}$ | 0.12 | 0.14 | 0.78 |
| | Soluble anions (meq\l) | | |
| $CO3^{=}$ | - | - | - |
| $HCO3^{-}$ | 4.40 | 2.40 | 2.00 |
| $Cl^{-}$ | 27.20 | 5.00 | 13.00 |
| $SO4^{=}$ | 7.12 | 1.14 | 3.18 |

**Table 2:** Chemical characteristics of water weal used for the present study

| parameters | values |
|---|---|
| pH | 7.49 |
| EC($dSm^{-1}$) | 4.40 |
| Soluble cations (meq\l) | |
| Ca++ | 7.50 |
| $Mg^{++}$ | 5.00 |
| $Na^{+}$ | 33.10 |
| $K^{+}$ | 0.16 |
| Soluble anions (meq\l) | |
| $CO3^{=}$ | - |
| $HCO3^{-}$ | 1.60 |
| $Cl^{-}$ | 40.00 |
| $SO4^{=}$ | 4.16 |

## Results and discussion

### *Fruit weight*

Data In Tables (3 to 6) and Figs (1 to 4), showed a considerable rapid increase in fresh fruit weight of Chemlali cultivar was noticed during the first stage of fruit development (from May14 until July 9). This increase in fresh fruit weight was mainly due to cell division and cell enlargement prevailing in this early stage. Therefore, vigor of tree, adequate nutrients, availability of soil moisture, crop density and fruit leaf ratio have been shown to influence fruit weight. At the end of this stage fruit weight attained (1.03 and 1.25gm) in the two seasons, respectively. After this rapid stage, slower increase was noticed (from Jul23 to Aug.27) and (from 22 Jul. to Aug.20) in the first and second season respectively, it could be a result of the decrease in auxin level in the fruit or the competition on the auxin between embryo and fruit flesh tissue. As a result of this competition the enlargement of the flesh is slow. After this time a sharp expand in the fleshy part was occurred (from 1.56 to 2.98gm) and (from 2.41 to 3.45gm) from Sept.3 to Oct. 18 and from Aug.27 to Oct. 17, in the two season, respectively. However, the marked increase in fruit fresh weight in the third stage could be a result of the increase in moisture content in the fruit. Consequently, the exogenous factors such as non available moisture, high temperature or sever evaporation conditions may decrease the growth rate of the fruits. Concerning the other cultivar somewhat followed similar fruit growth pattern. Fruit weight at the end of early stage (stage one) for Mission cultivar recorded (1.33 and 2.6gm) at Jul.23 and Aug. 6in the two seasons, respectively.

After this rapid stage, slower increase was noticed. While in the third stage, fresh fruit weight increased from 1.99 to 3.45gm and from 3.41 to 5.25gm in the two seasons, respectively. The increment in flesh weight seems to be connected with the fruit moisture content, the higher the fresh fruit weight the higher the fruit content. As for fruit weight of third stage for Chemlali cultivar, similar trained to that of Mission cultivar was recorded. Fruit size increase in the third stage comes mainly from increased moisture content of the fruit, if the tree lacks soil moisture during this period, or if strong desiccating winds occur, the expected increase in fruit size cannot take place. These findings are in line with those reported by Hartmann and Opitiz (1977) and Desouky *et al.* (2010).

Larger fruits have a successively increasing proportion of mesocarp. Sofiene *et al*. (2011) found that cultivar mesocarp and endocarp size increased linearly with fruit size, with larger sizes favoring an increasingly greater mesocarp/endocarp ratio. Within the mesocarp, cultivar-based fruit size related directly to cell number and was established soon after bloom by cell division rate. In spite of different cell division rates, all cultivars showed similar timing of cell division activity, with the majority of cells produced in the two months after bloom but, surprisingly, a substantial number of cells formed during the following 6 months. Cell expansion was high throughout fruit growth and an important factor in achieving final fruit size, but cell size did not differ among cultivars at any time. We can conclude that fruit size differences among olive cultivars are due at the tissue level to both mesocarp and endocarp sizes and at the cellular level to cell division throughout fruit growth. Furthermore, since cell size is consistent among cultivars in spite of variable cell division, it is likely that cultivar differences in cell expansion accompany those in cell division.

**Table 3:** Fruit weight, moisture, oil and dry matter contents of Chemlali olive during 2011 season.

| Date | fruit weigh (gm) | Increase weigh% | Moisture content (gm) | Increase Moisture content % | dry weight (gm) | Increase dry weight % | Oil content (gm) | Increase Oil content % |
|---|---|---|---|---|---|---|---|---|
| 14/05/2011 | 0.15 u | 0 | 0.11 q | 0.00 | 0.04 q | 0.00 | 0.00 p | 0.00 |
| 28/05/2011 | 0.47 t | 213.33 | 0.33 p | 200.00 | 0.14 p p | 250.00 | 0.00 p | 0.00 |
| 11/06/2011 | 0.78 s | 65.96 | 0.515 o | 56.06 | 0.26 o | 85.71 | 0.005 p | 0.00 |
| 25/06/2011 | 0.90 r | 15.38 | 0.55 no | 6.80 | 0.34 n | 30.77 | 0.01 op | 100.00 |
| 09/07/2011 | 1.03 q | 4.44 | 0.59 mn | 7.27 | 0.403 m | 18.53 | 0.037 op | 270.00 |
| 23/07/2011 | 1.10 p | 6.80 | 0.62 lm | 5.08 | 0.438 lm | 8.68 | 0.042 no | 13.51 |
| 06/08/2011 | 1.17 o | 6.36 | 0.65 kl | 4.84 | 0.45 lm | 2.74 | 0.07 no | 66.67 |
| 13/08/2011 | 1.27 n | 8.55 | 0.70 k | 7.69 | 0.48 kl | 6.67 | 0.09 mn | 28.27 |
| 20/08/2011 | 1.31 mn | 3.15 | 0.70 k | 0.00 | 0.49 jkl | 2.08 | 0.12 lm | 33.33 |
| 27/08/2011 | 1.34 m | 2.29 | 0.70 k | 0.00 | 0.49 jkl | 0.00 | 0.15 kl | 25.00 |
| 03/09/2011 | 1.56 l | 16.42 | 0.86 j | 22.86 | 0.51 ijk | 4.08 | 0.19 jk | 26.67 |
| 06/09/2011 | 1.79 k | 14.74 | 1.02 i | 18.60 | 0.54 hij | 5.88 | 0.23 ij | 21.05 |
| 09/09/2011 | 1.97 j | 10.06 | 1.13 h | 10.78 | 0.56 ghi | 3.70 | 0.28 hi | 21.74 |
| 13/09/2011 | 2.15 i | 9.14 | 1.25 g | 10.62 | 0.59 gh | 5.36 | 0.31 gh | 10.71 |
| 17/09/2011 | 2.33 h | 8.37 | 1.37 f | 9.60 | 0.61 fg | 3.39 | 0.35 fg | 12.90 |
| 20/09/2011 | 2.45 g | 5.15 | 1.42 ef | 3.65 | 0.64 ef | 4.92 | 0.39 f | 11.43 |
| 24/09/2011 | 2.52 f | 2.86 | 1.45 de | 2.11 | 0.66 ef | 3.13 | 0.41 ef | 5.13 |
| 28/09/2011 | 2.60 e | 3.17 | 1.46 cde | 0.69 | 0.70 de | 6.06 | 0.44 de | 7.32 |
| 01/10/2011 | 2.69 d | 3.46 | 1.48 bcd | 1.37 | 0.74 cd | 5.71 | 0.47 cde | 6.82 |
| 05/10/2011 | 2.73 cd | 1.49 | 1.49 abcd | 0.68 | 0.76 bc | 2.70 | 0.48 bcd | 2.13 |
| 09/10/2011 | 2.78 c | 1.83 | 1.51 abc | 1.34 | 0.77 bc | 1.32 | 0.50 bcd | 4.17 |
| 11/10/2011 | 2.86 b | 2.88 | 1.52 ab | 0.66 | 0.81 ab | 5.19 | 0.53 abc | 6.00 |
| 16/10/2011 | 2.93 a | 2.45 | 1.54 a | 1.32 | 0.84 a | 3.70 | 0.55 ab | 3.77 |
| 20/10/2011 | 2.98 a | 1.71 | 1.54 a | 0.00 | 0.86 a | 2.38 | 0.58 a | 5.46 |

Means having the same letters within a column are not significantly different at 5% level.

**Table 4**. Fruit weight, moisture, oil and dry matter contents of Chemlali olive during 2012 season

| Date | fruit weigh (gm) | Increase weigh% | Moisture content (gm) | Increase Moisture content % | dry weight (gm) | Increase dry weight % | Oil content (gm) | Increase Oil content % |
|---|---|---|---|---|---|---|---|---|
| 23/05/2012 | 0.18 s | 0.00 | 0.13 p | 0.00 | 0.05 k | 0.00 | 0.00 p | 0.00 |
| 07/06/2012 | 0.58 r | 222.20 | 0.42 o | 223.08 | 0.16 j | 220.00 | 0.00 p | 0.00 |
| 22/06/2012 | 1.00 q | 72.41 | 0.69 n | 64.29 | 0.28 j | 75.00 | 0.03 op | 0.00 |
| 07/07/2012 | 1.25 p | 25.00 | 0.85 m | 23.19 | 0.33 i | 17.86 | 0.07 no | 133.30 |
| 22/07/2012 | 1.43 o | 14.40 | 0.92 l | 8.24 | 0.41 hi | 24.24 | 0.10 mn | 42.86 |
| 06/08/2012 | 1.52 n | 6.29 | 0.94 l | 2.17 | 0.43 hi | 4.88 | 0.15 lm | 50 |
| 13/08/2012 | 1.58 m | 3.95 | 0.95 l | 1.06 | 0.44 gh | 2.33 | 0.19 l | 26.67 |
| 20/08/2012 | 1.90 l | 20.25 | 1.16 k | 22.11 | 0.47fg | 6.81 | 0.27 k | 42.11 |
| 27/08/2012 | 2.41 k | 26.84 | 1.56 j | 34.48 | 0.50 efg | 6.38 | 0.35 j | 29.63 |
| 03/09/2012 | 2.55 j | 5.81 | 1.67 i | 7.05 | 0.51 def | 2.00 | 0.37 ij | 5.71 |
| 06/09/2012 | 2.66 i | 4.31 | 1.70 hi | 1.80 | 0.54 def | 5.88 | 0.42 hi | 13.51 |
| 10/09/2012 | 2.72 h | 2.26 | 1.72 ghi | 1.18 | 0.55 de | 1.85 | 0.45 gh | 7.14 |
| 13/09/2012 | 2.78 g | 2.21 | 1.75 fgh | 1.74 | 0.56 de | 1.82 | 0.47 fgh | 4.44 |
| 17/09/2012 | 2.81 g | 1.08 | 1.76 fg | 0.57 | 0.56 de | 0.00 | 0.49 fg | 4.26 |
| 20/09/2012 | 2.87 f | 2.14 | 1.78 ef | 1.14 | 0.57 d | 1.79 | 0.52 ef | 6.12 |
| 24/09/2012 | 2.94 e | 2.44 | 1.80 de | 1.12 | 0.59 c | 3.51 | 0.55 de | 5.77 |
| 27/06/2012 | 3.08 d | 4.76 | 1.83 cd | 1.67 | 0.69 b | 16.94 | 0.56 cde | 1.82 |
| 31/9/2012 | 3.21 c | 4.22 | 1.86 cd | 1.63 | 0.77 ab | 11.59 | 0.58 bcd | 3.57 |
| 04/10/2012 | 3.32 b | 3.43 | 1.90 bc | 2.15 | 0.82 a | 6.49 | 0.60 abcd | 3.45 |
| 08/10/2012 | 3.36 b | 1.20 | 1.93 ab | 1.58 | 0.82 a | 0.00 | 0.61 abc | 1.67 |
| 13/10/2012 | 3.42 a | 1.79 | 1.96 a | 1.55 | 0.83 a | 1.22 | 0.63 ab | 3.28 |
| 16/10/2012 | 3.45 a | 0.88 | 1.97 a | 1.51 | 0.83 a | 0.00 | 0.65 a | 3.17 |

Means having the same letters within a column are not significantly different at 5% level.

**Table 5**. Fruit weight, moisture, oil and dry matter contents of Mission olive during 2011 season

| Date | fruit weigh (gm) | Increase weigh% | Moisture content (gm) | Increase Moisture content % | dry weight (gm) | Increase dry weight % | Oil content (gm) | Increase Oil content % |
|---|---|---|---|---|---|---|---|---|
| 14/05/2011 | 0.30 v | 0.00 | 0.20 o | 0.00 | 0.10 l | 0.00 | 0.00 n | 0.00 |
| 28/05/2011 | 0.59 u | 97.67 | 0.37 n | 85.00 | 0.22 k | 120 | 0.00 n | 0.00 |
| 11/06/2011 | 0.90 t | 54.24 | 0.58 m | 56.76 | 0.27 jk | 22.73 | 0.00 n | 0.00 |
| 25/06/2011 | 1.02 s | 12.09 | 0.65 m | 12.07 | 0.31 j | 14.81 | 0.01 n | 0.00 |
| 09/07/2011 | 1.24 r | 21.57 | 0.75 l | 15.38 | 0.50 i | 61.29 | 0.02 n | 100.00 |
| 23/07/2011 | 1.33 q | 7.26 | 0.82 kl | 9.33 | 0.507 hi | 1.40 | 0.023 n | 15.00 |
| 06/08/2011 | 1.45 p | 9.02 | 0.88 jk | 7.32 | 0.555 gh | 9.47 | 0.045 mn | 95.65 |
| 13/08/2011 | 1.57 o | 8.28 | 0.92 j | 4.55 | 0.6 fg | 8.11 | 0.05 mn | 11.11 |
| 20/08/2011 | 1.60 no | 1.19 | 0.92 j | 0.00 | 0.61 fg | 1.67 | 0.07 lm | 40.00 |
| 27/08/2011 | 1.65 n | 3.13 | 0.92 j | 0.00 | 0.61 fg | 0.00 | 0.12 l | 71.43 |
| 03/09/2011 | 1.99 m | 20.61 | 1.14 i | 23.91 | 0.63 ef | 3.28 | 0.22 k | 83.33 |
| 06/09/2011 | 2.29 l | 15.08 | 1.35 h | 18.42 | 0.65 def | 3.17 | 0.29 j | 31.82 |
| 09/09/2011 | 2.54 k | 10.92 | 1.52 g | 12.59 | 0.67 cde | 3.08 | 0.35 i | 20.69 |
| 13/09/2011 | 2.78 j | 6.45 | 1.70 f | 11.84 | 0.67 cde | 0.00 | 0.41 h | 17.14 |
| 17/09/2011 | 2.89 i | 3.96 | 1.72 ef | 1.18 | 0.70 bcd | 4.48 | 0.47 g | 14.63 |
| 20/09/2011 | 2.96 h | 2.44 | 1.74 def | 1.16 | 0.71 bc | 1.43 | 0.51 fg | 8.51 |
| 24/09/2011 | 3.05 g | 3.04 | 1.77 cdef | 1.72 | 0.74 b | 4.23 | 0.54 ef | 5.88 |
| 28/09/2011 | 3.14 f | 2.95 | 1.79 bcde | 1.13 | 0.80 a | 8.10 | 0.55 ef | 1.85 |
| 01/10/2011 | 3.21 e | 2.23 | 1.81 abcd | 1.12 | 0.82 a | 2.50 | 0.58 de | 5.45 |
| 05/10/2011 | 3.28 d | 2.18 | 1.84 abc | 1.66 | 0.83 a | 1.22 | 0.61 cd | 5.17 |
| 09/10/2011 | 3.33 cd | 1.52 | 1.86 ab | 1.09 | 0.83 a | 0.00 | 0.64 bc | 4.92 |
| 11/10/2011 | 3.38 bc | 1.50 | 1.87 ab | 0.54 | 0.83 a | 0.00 | 0.68 ab | 6.25 |
| 16/10/2011 | 3.41 ab | 0.89 | 1.87 ab | 0.00 | 0.84 a | 1.20 | 0.70 a | 2.94 |
| 20/10/2011 | 3.45 b | 1.17 | 1.88 a | 0.53 | 0.84 a | 0.00 | 0.73 a | 4.29 |

Means having the same letters within a column are not significantly different at 5% level.

**Table 6.** Fruit weight, moisture, oil and dry matter contents of Mission olive during 2012 season.

| Date | fruit weigh (gm) | Increase weigh% | Moisture content (gm) | Increase Moisture content % | dry weight (gm) | Increase dry weight % | Oil content (gm) | Increase Oil content % |
|---|---|---|---|---|---|---|---|---|
| 23/05/2012 | 0.40 s | 0.00 | 0.26 n | 0.00 | 0.14 l | 0.00 | 0.00 o | 0.00 |
| 07/06/2012 | 0.70 r | 133.33 | 0.47 m | 80.81 | 0.213 k | 52.14 | 0.02 no | 0.00 |
| 22/06/2012 | 1.10 q | 57.14 | 0.74 l | 58.46 | 0.328 j | 53.99 | 0.032mno | 60.00 |
| 07/07/2012 | 1.61 p | 46.37 | 0.99 k | 33.78 | 0.555 i | 69.21 | 0.065 mn | 103.13 |
| 22/07/2012 | 2.05 o | 27.33 | 1.29 j | 30.30 | 0.68 h | 22.52 | 0.08 lm | 23.67 |
| 06/08/2012 | 2.60 n | 26.83 | 1.55 i | 20.16 | 0.92 g | 35.29 | 0.13 l | 62.50 |
| 13/08/2012 | 2.71 m | 4.23 | 1.56 i | 0.65 | 0.94 fg | 2.17 | 0.21 k | 51.54 |
| 20/08/2012 | 2.86 l | 5.54 | 1.62 i | 3.85 | 0.98 f | 4.26 | 0.26 k | 23.81 |
| 27/08/2012 | 3.41 k | 19.23 | 2.00 h | 23.46 | 1.08 e | 10.20 | 0.33 j | 26.92 |
| 03/09/2012 | 3.82 j | 12.02 | 2.29 g | 14.50 | 1.12 de | 3.70 | 0.41 i | 24.24 |
| 06/09/2012 | 4.10 i | 7.33 | 2.44 f | 6.55 | 1.13 de | 0.89 | 0.53 h | 29.26 |
| 10/09/2012 | 4.32 h | 5.36 | 2.59e | 5.15 | 1.14 d | 0.89 | 0.59 g | 11.32 |
| 13/09/2012 | 4.53 g | 4.86 | 2.66 de | 2.70 | 1.2 c | 5.26 | 0.67 f | 13.56 |
| 17/09/2012 | 4.63 f | 2.21 | 2.71 cd | 1.88 | 1.21 c | 0.83 | 0.71 f | 5.97 |
| 20/09/2012 | 4.75 e | 2.59 | 2.75 bc | 1.48 | 1.22 c | 0.83 | 0.78 e | 9.86 |
| 24/09/2012 | 4.82 e | 1.47 | 2.76 abc | 0.36 | 1.24 bc | 1.63 | 0.82 e | 5.13 |
| 27/06/2012 | 4.92 d | 2.07 | 2.79 abc | 1.09 | 1.24 bc | 0.00 | 0.89 d | 8.54 |
| 31/9/2012 | 4.97 d | 1.01 | 2.80 ab | 0.36 | 1.25 abc | 0.81 | 0.92 d | 3.37 |
| 04/10/2012 | 5.09 c | 2.41 | 2.83 ab | 1.07 | 1.28 ab | 2.40 | 0.98 c | 6.52 |
| 08/10/2012 | 5.15 bc | 1.18 | 2.83 ab | 0.00 | 1.28 ab | 0.00 | 1.04 b | 6.12 |
| 13/10/2012 | 5.22 ab | 1.36 | 2.83 ab | 0.00 | 1.29 ab | 0.78 | 1.10 a | 5.77 |
| 16/10/2012 | 5.25 a | 0.57 | 2.84 a | 0.35 | 1.29 ab | 0.00 | 1.12 a | 1.81 |

Means having the same letters within a column are not significantly different at 5% level.

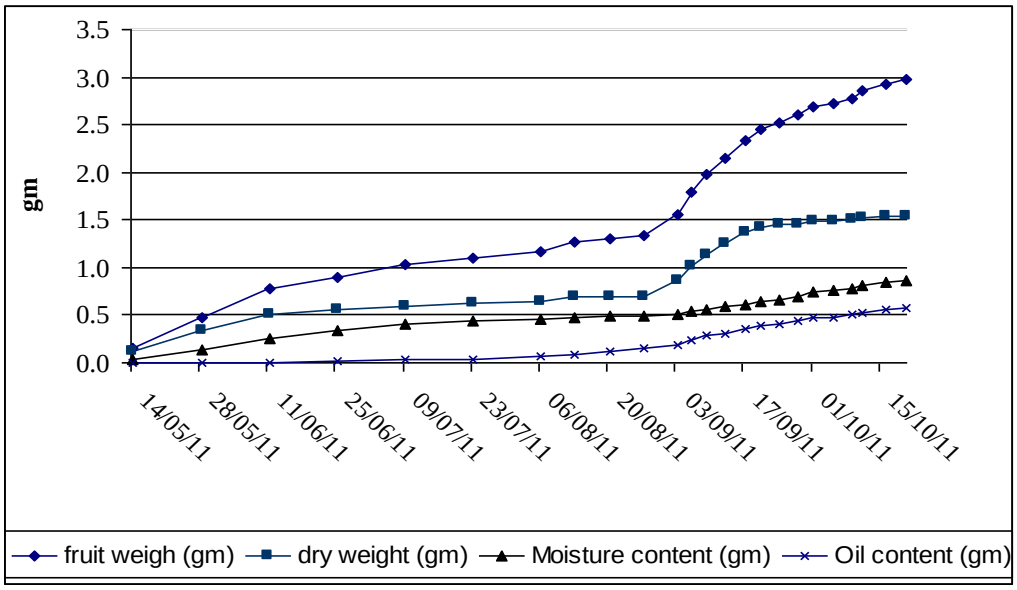


**Fig. 1**. Fruit weight, moisture, oil and dry matter contents of Chemlaliolive during 2011 season

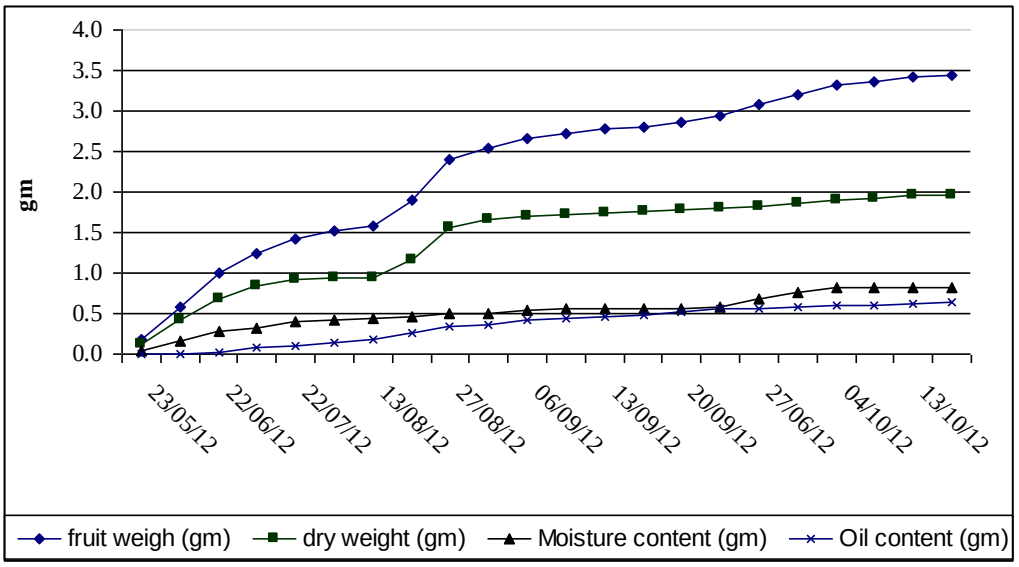


**Fig. 2:** Fruit weight, moisture, oil and dry matter contents of Chemlaliolive during 2012 season

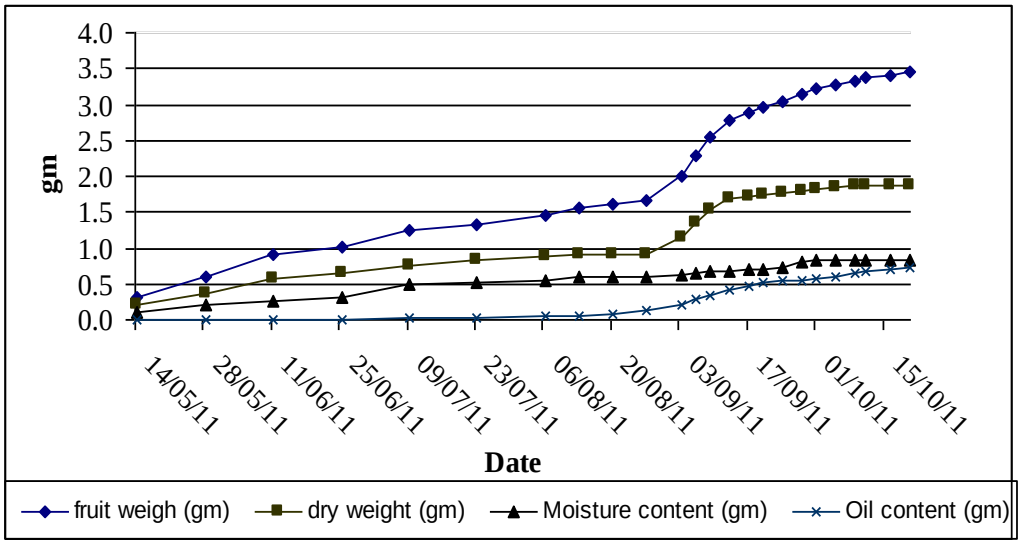


**Fig. 3:** Fruit weight, moisture, oil and dry matter contents of Mission olive during 2011 season

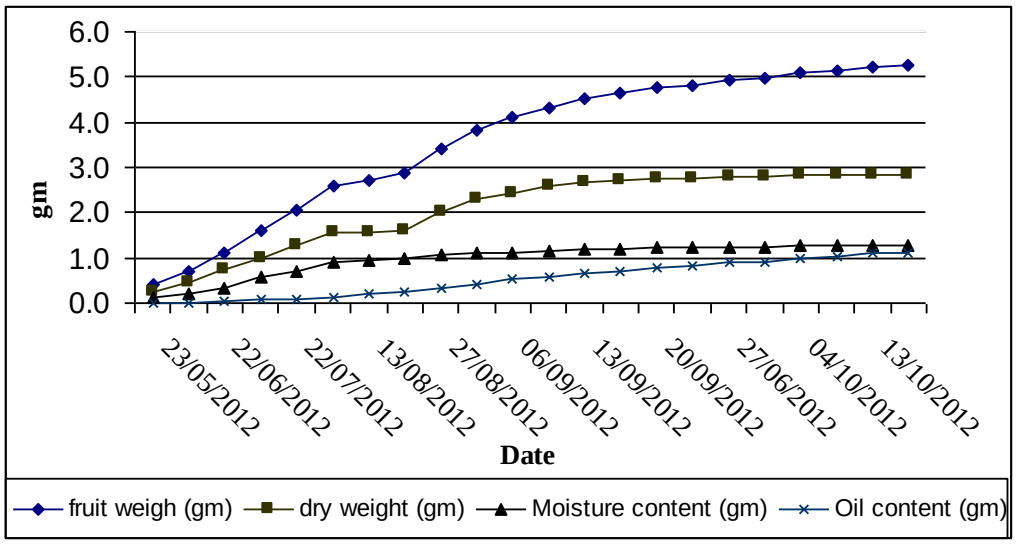


**Fig. 4:** Fruit weight, moisture, oil and dry matter contents of Mission olive during 2012 season

***Moisture content***

Data concerning the changes in fruit moisture content and its rate of change in Chemlali and Mission are presented in Tables (3 to 6) and Figs (1 to 4). For the Chemlali in the first season, it could be seen that fruit moisture content markedly increased in the early stage of fruit development from May 14 to June 25, 2011, moisture content value raised from 0.2 to 0.65gm (more than three folds increase). Increase in fruit moisture content turned to very slow rate from July 9 to Aug.27, 2011 (only about 41% increase), after which the rate of moisture increased sharply from 0.92gm/fruit at Aug. 17 to 1.72gm/fruit at Sept. 17, 2011 (about 87% increase). Fruit moisture content tended to fluctuate towards the end of the season. Data of the second season show that fruit moisture content markedly increased during the early fruit development stage(May 23 to July 22, 2012)followed by a very slow increase from Aug.6 till Aug.20, then a sharp increase fromAug.27 till Sept.20 (about 38% increase). Fruit moisture content showed a steady increase value towards the ripening stage. Data of the other cultivars showed somewhat similar growth pattern which showed a sizeable increase in fruit moisture content, followed by a period of decreasing develop rate, while the last phase was characterized by a rapid rate of moisture increase. Generally, it can be mentioned that the timing of each phase and its duration differed according to the cultivar and season. It is interesting to note that the change in fruit moisture content is greatly connected with the fruit growth development in fresh weight. These findings are in harmony with those of Hassan (1980), Fouad, *et al.* (1992) and Kaynas *et al.* (1992) who mentioned that moisture content showed wide variation according to cultivars and seasons. Similar results were obtained by Ezzat and Azzouni, (1963) and Desouky *et al*. (2010).

Manrique *et al.* (2001) reported that, at flowering stage the mesocarp has 12% of its final cell number and less than 5% of its final size. Approximately 80% of mesocarp cells are produced in the first two months of growth, when fruit growth rate is maximum, and 20% between this time and fruit maturity. Cell expansion is high throughout fruit growth, with final cell area at maturity more than double than at 2 months. Therefore, Water availability affected the seasonal pattern of fruit growth.

***Dry matter content***

Data concerning the changes in dry matter other than oil during fruit development of Chemlali and Mission are presented in Tables (3 to 6) and Figs (1 to 4). According to the obtained data in the first season in Chemlali, it could be seen that, the early phase was characterized by a rapid rate of increase. The

rate of increment in fruit dry matter content was 120, 22.7 and 14.8 for the three sampling data, respectively. Thereafter the increment in dry matter turned to the slow rate till the fruit attained the harvesting stage. Data of the second season, whereas the rate of increase reached its highest value during the early fruit development stage after which the rate of increase was characterized by a slow rate of increase. Regarding the other cultivar, the same pattern was found whereas timing of each phase and its duration differed according to cultivar and season. The high rate of increase in the dry matter other than the oil probably due to carbohydrate accumulation during the early development stage. Therefore, a sizable amount of metabolic compounds goes into fatty acids and oil.

### *Oil content*

According to Tables (1 to 6) and Figs (1 to 4), for Chemlali cultivar in the first season, it could be seen that the period from May 14 till Aug. 20, the fruit oil content was rather low; it never exceeded 0.12gm/fruit. Oil begins to accumulate in the fruit in September. Fruit oil content increased from 0.19 to 0.58gm/fruit from Sept.3 till Oct.20. Data of Chemlali cultivar showed similar pattern for the second season, also the other olive cultivar(Mission cv.) followed the same trend, where the rate of oil accumulation was rather slight till about the second half of August. Rate of oil accumulation differed according to tested cultivar and season of study. Results obtained in this work are in conformity with those of Hartmann and Opitiz (1977)who reported that the amount of oil increases gradually through fall and winter, and reaches its maximum in late December and January, as fruits becomes completely black. Similar observations were recorded by Tous *et al.* (1997) who found that oil accumulation in Arbequina cultivar fruits between (165 and 195 days after fruit set) seems to be an optimum harvesting period, where oil content is high enough. Also, the obtained results are in line with the findings of Ezzat and Azzouni (1963) and Desouky *et al.* (2010).So, it is important for olive trees cultivars Chemlali and Mission grown under Ismailia - Egypt condition have adequate water needs for about 19 to 20 weeks after fruit set tell just before harvest to obtain high fruit and oil quality.

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