

## ORIGINAL ARTICLES

### Performance of 12 Introduced Olive Cultivars under Egyptian Conditions

Ayman A. Hegazi

Department of Pomology, Faculty of Agriculture, Cairo University, Giza, Egypt

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#### ABSTRACT

Performance of 12 olive cvs. introduced to Egypt in 1984 (Thrombolia, Strogylia, Villalonga, Cerasicola, Dermlali, Leccio Dela Corna, Roseciola, Boutellian, Ouslati, Mouslati, Enduri and Tansh) included vegetative characteristics, floral biology, fruit set, fruit characteristics and oil percentage of these cvs. were investigated under Egyptian conditions, (Giza Governorate), for two seasons 2008 and 2009. Julian dates of full bloom (FB) in the first season showed that bud break of Tansh, Roseciola and Leccio Dela Corna cvs. were significantly late compared to other cvs. while, the earliest date was observed in Mouslati cv. Growing degree days (GDD) at FB was significantly higher in Mouslati cv. compared to other cvs. While it was significantly lower in Tansh cv. Leaves density was the highest in Boutellian cv., while it was the lowest in Ouslati and Villalonga cvs. There was no significant difference between average leaf area of Villalonga, Mouslati, Leccio Dela Corna, Ouslati, Cerasicola, Roseciola, Boutellian and Strogylia cvs, while it was the lowest in Enduri, Tansh, Dermlali and Thrombolia cvs. compared to other cvs. Flowering density was significantly higher in Enduri, Ouslati, Cerasicola and Villalonga cvs. than in other cvs. Number of perfect flowers/inflorescence was significantly higher in Dermlali cv. while it was the lowest in Leccio Dela Corna and Enduri cvs. Fruit set was the highest in Tansh, Ouslati and Leccio Dela Corna and it was the lowest in Thrombolia cv. Fruit length, diameter, weight and flesh weight of Strogylia and Boutellian cvs. were the highest, while the lowest averages of previous characteristics were observed in Ouslati cv. Oil % of Leccio Dela Corna, Boutellian and Mouslati was the highest compared to other cvs, while the lowest oil % was observed in Cerasicola and Strogylia cvs. It could be concluded that, Leccio Dela Corna, Boutellian and Mouslati olives were superior in oil content. On the other hand, Strogylia and Boutellian were superior in fruit characteristics.

**Key words:** Olive cultivars – Performance – Vegetative characteristics-Floral biology – Fruit set – Fruit characteristics- Oil percentage.

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#### Introduction

Olive cultivation plays an important role in the economy of many countries not only increases the land values where the soil is unsuitable for other crops, but also contributes to soil conservation. It helps to compact problems of environment and that are currently of concern to nation authorities and international organization (Denis, 1977 and Kitsaki *et al.*, 2010). Olive (*Olea europaea* L.) is one of the oldest agricultural tree crops of remarkable cultural and economic importance in the Mediterranean Basin and it also represents a widely distributed fruit in the world (FAO, 2008). In the Mediterranean basin, where olives have been cultivated for thousands of years, hundreds of cultivars have been selected over the centuries for their adaptation to various microclimates and soil types throughout the world (Ferguson *et al.*, 1994).

Current olive groves are estimated at approximately 960 million olive tree, of which some 945 million (98% of the total) are found in the Mediterranean Basin countries where they cover approximately 9.3 million hectares (Barranco *et al.*, 2010).

Table olives are consumed throughout the world either processed as green olives or as black olives. Olive oil is mostly consumed (94%) by Mediterranean countries (Hartmann *et al.*, 1950). Area cultivated with olives in Egypt, increased rapidly from year to year and reached 150 000 feddans in 2010 produces 500 000 tons according to statistics of (Ministry Of Agriculture, 2010). Hegazi, (2001), Hegazi and Hegazi (2005a) and Hegazi, (2007) reported that floral characteristics varied according to olive cvs., the ratio of perfect to staminate flowers is a characteristic feature of each cultivar and may differ from year to year.

Blooming date and growing degree days (GDD) varied greatly according to cultivar, weather and location (Hartmann *et al.*, 1980, Hegazi, 2001 and Hegazi and Hegazi, 2005a).

Bartolini *et al.*, (1993) have ascertained that there are roughly 1200 named cultivars with over 3000 synonyms throughout the world. There is much confusion and uncertainty concerning the identifying of the olive trees cultivars. Great importance has been placed on identifying new cultivars that bear higher yields and

produce high oil quality in conformity with IOOC standards. Fourati *et al.*, (2003) found that 30 olive cvs. were varied in physical characteristics and chemical characteristics of fruits and were heterogeneity.

The aim of this investigation is to evaluate the performance of twelve olive cvs. under Egyptian conditions.

### Material And Methods

The present study was carried out during two successive seasons 2008 and 2009 on 27 years old twelve olive cvs. (Thrombolia, Strogylia, Villalonga, Cerasicola, Dermlali, Leccio Dela Corna, Roseciola, Boutellian, Ouslati, Mouslati, Enduri and Tansh) growing in clay soil at the farm of Agriculture Research Station at Faculty of Agriculture, Cairo University at distance of 4x4 meters and subjected to the same agricultural practices.

#### *Thermal accumulation:*

Thermal accumulation was estimated as growing degree-days (G. D. D) using meteorological data of Giza station. Measurements started at bud break for each of the studied cultivars.

G.D.D was estimated by accumulating the effective daily temperature from bud break throughout the growing season and recorded at (full bloom, 21 days after full bloom and 60 days after full bloom) using the following equation:

The effective temperature = Daily temperature – Base temperature.

Base temperature for olive is 15°C according to Morettini, (1950), Hegazi and Stino, (1982).

#### *Julian dates:*

Julian dates (JD) were used to express stage of flowering in number of days instead of absolute dates to enable statistical analysis to study the difference between olive cultivars. Julian dates express the days of the year as absolute successive numbers from 1<sup>st</sup> of January to 31<sup>st</sup> of December as 1-365 (Yehia, 1994), *i.e.* February 15<sup>th</sup> is equivalent to 46 JD and March 15<sup>th</sup> is 74 JD (100 Julian date = 10<sup>th</sup> of April 110, Julian date = 20<sup>th</sup> of April 120 Julian date = 30<sup>th</sup> of April), etc...

Julian dates was estimated as accumulated days from the year beginning to bud break, beginning of flowering, full bloom and end of flowering for each studied cultivars Yehia, (1994).

#### *Vegetative characteristics:*

At first of August in both seasons leaves density and leaf area were measured as follows:

- Leaves density: (Number of leaves / meter): Ten shoots were taken from each replicate and length of each shoot was counted with (cm) and number of leaves/ shoot and then number of leaves / meter was calculated.
- Leaf area (cm<sup>2</sup>): A sample of twenty leaves was collected from each tree (Three trees from each cultivar as replicates) to measure average leaf area by portable area meter-model L13000 made in USA.

#### *Floral characteristics:*

The following floral characteristics were studied for each cultivar:

- .Dates of bud break: (Beginning of bud emergence).
- .Beginning of flowering: (25% of flowers opened).
- .Full bloom: (50-70% of flowers opened).
- .End of flowering: (25% of flowers developed to fruits).
- .Floral biology: Samples of 20 floral shoots were taken randomly from each replicate (Three trees from each cultivar as replicates) to study the following:
  - i- Flowering density: (number of inflorescences per meter).
  - ii- Average length of inflorescence (cm).
  - iii- Total number of flowers/inflorescence.
  - iv- Total number of male flowers/inflorescence.
  - v- Total number of perfect flowers/inflorescence.
  - vi- Percentage of perfect flowers (expressed as percentage of perfect flowers to total number of flowers according to Hegazi and Stino, (1982) and Hegazi, (2001).

*Fruit set:*

Fruit set was expressed as number of fruits/meter of shoot length and was measured at two times (21 day after full bloom (21DAFB) as initial fruit set and at 60 day after full bloom (60DAFB) as final fruit set according to Hegazi and Hegazi (2005a) and Hegazi (2007).

*Fruit characteristics:*

Fruits of studied cvs. were harvested at a suitable time of harvest and 15 fruits from 3 replicates of each cv. were used to study the following characteristics.

Fruit length (cm), fruit diameter (cm), fruit weight (g), fruit shape index as (fruit L/D ratio), flesh diameter (cm), flesh weight (g), seed weight (g), seed length (cm), seed diameter (cm) and seed shape index as (seed L/D ratio).

*Oil %:*

Fruit samples (2 kgs) were taken from each replicate at purple colour stage. The seeds were removed and the flesh part of the fruit was dried at 70°C for three days to extract the oil in a soxhlet apparatus with petroleum ether (40/60 °C) for several hours. The solvent was removed by evaporation under reduced pressure and the oil was used to determine oil % according to (A.O.A.C, 1984).

*Experimental design and data analyses:*

The layout of the experiment was a complete randomized design with one factor, the obtained data were subjected to analysis of variance (ANOVA) according to Snedecor and Cochran, (1980) using Mstat-C Program (1989) was used to calculate least significant differences LSD to compare among means according to Waller and Duncan (1969) at  $P \leq 0.05$ .

**Results And Discussion***Julian dates:*

In the first season, it was noticed that Julian dates for bud break of Tansh, Roseciola and Leccio Dela Corna cvs. were significantly late (81.00, 79.67 and 78.67) than other cvs. (Table 1), while, the earliest date was observed in Mouslati cv. with Julian dates (61.00). In the second seasons, similar trend was observed (Table 2).

Concerning the beginning of flowering it was observed that Villalonga, Dermlali, Roseciola and Boutellian cvs. recorded (101.00, 101.00, 101.00 and 100.00) and were the latest cvs, while Cerasicola and Strogylia cv. were the earliest with average (94.00) for both cvs.

In the second season, the Julian date of beginning of flowering was late in Dermlali (102.00), while it was the earliest in Thrombolia cv. with average (91.00).

It was also noticed that FB was the latest in Roseciola, Dermlali and Villalonga cvs. (105.00, 104.00 and 104.00). While, Strogylia and Thrombolia cvs. (99.00 and 98.00) were the earliest.

In the second season, the same results were observed. In (2008) the end of flowering in Roseciola and Dermlali were also the latest (110.00 and 109.00) while, Enduri and Strogylia cvs. were the earliest with average (103.33 and 103.00).

**Table 1:** Julian dates of 12 olive cvs. season 2008

| Cultivars         | Bud Break | Flower Beginning | FB     | Flower End. |
|-------------------|-----------|------------------|--------|-------------|
| Thrombolia        | 71.00     | 89.00            | 98.00  | 105.00      |
| Strogylia         | 73.00     | 94.00            | 99.00  | 103.00      |
| Villalonga        | 74.00     | 101.00           | 104.00 | 108.00      |
| Cerasicola        | 73.00     | 94.00            | 103.00 | 108.00      |
| Dermlali          | 64.33     | 101.00           | 104.00 | 109.00      |
| Leccio Dela Corna | 78.67     | 100.33           | 103.33 | 108.33      |
| Roseciola         | 79.67     | 101.00           | 105.00 | 110.00      |
| Boutellian        | 71.00     | 100.00           | 103.00 | 107.00      |
| Ouslati           | 64.00     | 97.00            | 100.00 | 104.00      |
| Mouslati          | 61.00     | 99.00            | 103.00 | 107.00      |
| Enduri            | 69.00     | 96.33            | 99.33  | 103.33      |
| Tansh             | 81.00     | 99.33            | 103.33 | 108.33      |
| L.S.D 5%          | 2.499     | 1.169            | 1.169  | 1.169       |

These results are in line with Hartmann *et al.*, (1980) and Hegazi (2001) Hegazi and Hegazi (2005a) they found that flowering dates varied according to cv., weather and location. Also, results are in agreement with Riberio *et al.*, (2006) who found that the onset and duration of flowering period are mainly determined by environmental factors such as meteorological conditions, soil and genetic factors of olive cultivars.

#### Growing degree days (G. D.D):

Growing degree-days (G.D.D) at FB was significantly higher (4774.93) in Mouslati cv. as compared to other cvs. while it was significantly the lowest (2743.73) in Tansh cv. this was noticed in both

**Table 2:** Julian dates of 12 olive cvs. season 2009

| Cultivars         | Bud Break | Beginning Flow. | FB     | End Flow. |
|-------------------|-----------|-----------------|--------|-----------|
| Thrombolia        | 70.67     | 91.00           | 100.00 | 106.33    |
| Strogylia         | 72.67     | 96.00           | 100.00 | 104.00    |
| Villalonga        | 73.33     | 100.33          | 103.00 | 108.67    |
| Cerasicola        | 72.67     | 94.00           | 102.67 | 108.00    |
| Dermlali          | 65.00     | 102.00          | 105.33 | 109.33    |
| Leccio Dela Corna | 76.33     | 100.33          | 104.33 | 107.67    |
| Roseciola         | 81.00     | 100.33          | 104.67 | 109.33    |
| Boutellian        | 71.67     | 98.67           | 102.00 | 107.33    |
| Ouslati           | 67.00     | 96.67           | 100.00 | 105.33    |
| Mouslati          | 62.33     | 98.00           | 102.33 | 106.67    |
| Enduri            | 71.00     | 97.00           | 99.33  | 105.00    |
| Tansh             | 82.00     | 100.33          | 105.00 | 109.33    |
| L.S.D 5%          | 1.942     | 1.632           | 1.632  | 1.390     |

seasons (Tables 3 and 4). Growing degree days at 21 DAFB was significantly higher (8387.93) for Mouslati cv. compared to other cvs. (Table 3). While the lowest GDD was observed in Tansh cv. as it averaged (6356.73).

Growing degree days at 60 DAFB in the first season was significantly higher (16039.33) for Mouslati cv. compared to other cvs. (Table 3), while it recorded the lowest value with Thrombolia cv. (13898.13).

**Table 3:** Growing degree-days (GDD) of 12 olive cvs. season 2008

| Cultivars         | FB      | 21 Day after FB | 60 Day after FB |
|-------------------|---------|-----------------|-----------------|
| Thrombolia        | 3173.00 | 6841.73         | 13898.13        |
| Strogylia         | 3063.07 | 6768.13         | 13948.73        |
| Villalonga        | 3578.33 | 7191.33         | 14717.80        |
| Cerasicola        | 3443.87 | 7067.07         | 14567.80        |
| Dermlali          | 4461.73 | 8072.73         | 15725.47        |
| Leccio Dela Corna | 3067.33 | 6679.67         | 14329.40        |
| Roseciola         | 3289.67 | 6832.13         | 14475.13        |
| Boutellian        | 3598.13 | 7716.93         | 14939.60        |
| Ouslati           | 3768.67 | 7473.07         | 14654.67        |
| Mouslati          | 4774.93 | 8387.93         | 16039.33        |
| Enduri            | 3218.33 | 6921.07         | 14101.67        |
| Tansh             | 2743.73 | 6356.73         | 14006.80        |
| L.S.D 5%          | 1.978   | 1.319           | 1.740           |

In (2009), it was observed that GDD at 60 DAFB was significantly higher (13804.00) for Dermlali cv. compared to other cvs. (Table 4). While the lowest for Thrombolia cv. (11369.07). These results were confirmed by Hegazi (2001) and Hegazi and Hegazi (2005 a) that GDD differed according to cultivar and season. Hegazi and Stino (1982) estimated heat units of 20 olive cvs. of the beginning and end of flowering and found that olive cvs. differed in heat units under Giza conditions, which recorded 180, 190 and 195 for Chemlali 1, Gordal and Coratina at beginning of flowering and recorded (301.5, 327.8 and 301.5) for the same cvs. at the end of flowering, respectively.

#### Vegetative characteristics:

In the first season, it was noticed that leaves n. /m was the highest (169.33) for Boutellian cv. While it was the lowest (95.00 and 93.67) for Ouslati and Villalonga cvs. (Table 5).

There was no significant difference between average leaf area of Villalonga, Mouslati, Leccio Fela Corna, Ouslati, Cerasicola, Roseciola, Boutellian and Strogylia, while the lowest leaf area (3.93, 3.64, 2.93 and 2.85 cm<sup>2</sup>) was found in Enduri, Tansh, Dermlali and Thrombolia).

**Table 4:** Growing degree-days (GDD) of 12 olive cvs. season 2009

| Cultivars         | FB      | 21 Day after FB | 60 Day after FB |
|-------------------|---------|-----------------|-----------------|
| Thrombolia        | 1739.73 | 4660.67         | 11369.07        |
| Strogylia         | 1659.53 | 4581.80         | 11288.87        |
| Villalonga        | 2509.00 | 5475.80         | 13307.67        |
| Cerasicola        | 2285.93 | 5126.73         | 11894.73        |
| Dermlali          | 3005.00 | 5970.13         | 13804.00        |
| Leccio Dela Corna | 2488.13 | 5451.97         | 13286.00        |
| Roseciola         | 2077.67 | 4917.47         | 11685.80        |
| Boutellian        | 2158.87 | 5182.87         | 11991.13        |
| Ouslati           | 2352.00 | 5272.53         | 12031.00        |
| Mouslati          | 3294.80 | 6137.27         | 12905.93        |
| Enduri            | 1741.73 | 4664.67         | 11420.73        |
| Tansh             | 2267.60 | 5234.73         | 13065.80        |
| L.S.D 5%          | 2.165   | 2.440           | 1.946           |

**Table 5:** Vegetative characteristics of 12 olive cvs. seasons 2008 and 2009

| Cultivars         | 2008 Season |                           | 2009 Season |                           |
|-------------------|-------------|---------------------------|-------------|---------------------------|
|                   | Leaves N/m  | Leaf area cm <sup>2</sup> | Leaves N/m  | Leaf area cm <sup>2</sup> |
| Thrombolia        | 127.67      | 2.85                      | 121.67      | 2.94                      |
| Strogylia         | 114.67      | 4.51                      | 112.00      | 4.42                      |
| Villalonga        | 93.67       | 5.68                      | 97.00       | 5.77                      |
| Cerasicola        | 157.00      | 4.79                      | 158.67      | 4.90                      |
| Dermlali          | 99.33       | 2.93                      | 112.33      | 3.05                      |
| Leccio Dela Corna | 108.33      | 5.28                      | 107.67      | 5.37                      |
| Roseciola         | 122.33      | 4.74                      | 124.00      | 4.95                      |
| Boutellian        | 169.33      | 4.62                      | 165.00      | 5.33                      |
| Ouslati           | 95.00       | 4.89                      | 98.00       | 5.12                      |
| Mouslati          | 173.33      | 5.65                      | 176.67      | 5.73                      |
| Enduri            | 151.67      | 3.93                      | 156.00      | 4.13                      |
| Tansh             | 95.00       | 3.64                      | 98.33       | 4.17                      |
| L.S.D 5%          | 10.06       | 1.168                     | 5.296       | 0.795                     |

In the second season, similar trend was observed in characteristics of leaves n. /m and average leaf area (Table 5).

These results are in line with Mazinani *et al.*, (2008) and Ozilbey and Sefer (2008) they found that vegetative characteristics varied according to olive cvs.

#### Floral characteristics:

It was observed from data in table (6) that flowering density was significantly higher in Enduri, Ouslati, Cerasicola and Villalonga cvs. (60.33, 59.33, 57.67 and 55.67, respectively) than in other cvs. (Table 6). While, it was significantly lower in Tansh and Mouslati than in other cvs. as it averaged (16.00 and 18.00), respectively.

In (2009), flowering density of Enduri, Cerasicola, Ouslati, Villalonga and Dermlali cvs. was significantly higher (54.00, 53.33, 53.00, 52.00 and 50.33) than in other cvs. (Table 6). While the lowest flowering density (14.00, 14.00 and 10.67) was found with Tansh, Mouslati and Leccio Dela Corna cvs.

These results are in line with Hegazi (2001) that flowering density recorded (59.10, 56.97 and 49.93) for Eggizi Shami, Manzanillo and Picual. Also, Hegazi and Hegazi (2005 a) found that flowering density varied according to cultivar and season.

Concerning inflorescence length, data in table (6) indicated that inflorescences were significantly longer (3.67 and 3.17 cm) in Enduri and Ouslati cvs. than in other cvs. While it was significantly shorter (2.37 cm) in Strogylia cv.

In the second season, it was noticed that inflorescence length of Enduri cv. was significantly longer (3.68 cm) compared to other cvs. while, the lowest inflorescence length (2.43 cm) was found in Strogylia cv. (Table 7).

Regarding total number of flowers/inflorescence in the first season it was significantly higher (30.67) in Enduri than in other cvs. (Table 6). While, total number of flowers/inflorescence was significantly lower (11.00) in Roseciola cv.

In the second season, similar trend was found that total number of flowers/inflorescence was significantly higher (32.67) in Enduri cv. compared to other cvs. (Table 7). While the lowest value was recorded for Roseciola cv. as it averaged (12.33).

Number of male flowers/ inflorescence was significantly higher (30.00) in Enduri cv. than in other cvs. While, it was significantly lower (7.67 and 4.33) in Roseciola and Dermlai cvs. (Tables 6 and 7).

Average number of perfect flowers/inflorescence in the first season was significantly higher (7.00) in Dermlali cv. compared to other cvs. (Table 6), while it was the lowest in Leccio Dela Corna and Enduri cvs. as it averaged (0.67 and 0.67). In (2009), it was noticed that average number of perfect flowers / inflorescence was significantly higher in Villalonga cv. compared to other cvs. as it averaged (6.67) (Table 7). While, the lowest average number of perfect flowers / inflorescence (3.00) was observed in Leccio Dela Corna, Roseciola and Tansh cvs. compared to other cvs.

**Table 6:** Floral characteristics of studied cvs. in season 2008

| Cultivars         | Flower density (%) | Inf. Length (cm) | Total N. flowers/inf | Number male flowers/inf | Number perfect flowers/inf | Perfect flowers % |
|-------------------|--------------------|------------------|----------------------|-------------------------|----------------------------|-------------------|
| Thrombolia        | 27.33              | 2.60             | 17.00                | 13.67                   | 3.33                       | 19.41             |
| Strogylia         | 45.00              | 2.37             | 18.67                | 17.00                   | 1.67                       | 8.81              |
| Villalonga        | 55.67              | 3.10             | 18.00                | 11.67                   | 6.33                       | 34.54             |
| Cerasicola        | 57.67              | 2.80             | 17.33                | 13.67                   | 3.67                       | 20.99             |
| Dermlali          | 55.00              | 2.40             | 11.33                | 4.33                    | 7.00                       | 70.39             |
| Leccio Dela Corna | 12.00              | 2.47             | 13.67                | 13.00                   | 0.67                       | 4.44              |
| Roseciola         | 37.00              | 2.43             | 11.00                | 7.67                    | 3.33                       | 28.90             |
| Boutellian        | 43.00              | 2.62             | 16.33                | 13.00                   | 3.33                       | 20.01             |
| Ouslati           | 59.33              | 3.17             | 19.33                | 13.67                   | 5.67                       | 29.30             |
| Mouslati          | 18.00              | 2.83             | 19.00                | 15.00                   | 4.00                       | 21.09             |
| Enduri            | 60.33              | 3.67             | 30.67                | 30.00                   | 0.67                       | 2.22              |
| Tansh             | 16.00              | 2.62             | 12.00                | 7.67                    | 4.33                       | 36.05             |
| L.S.D 5%          | 5.325              | 0.501            | 4.224                | 4.922                   | 3.077                      | 25.76             |

The highest percentage of perfect flowers was recorded with Dermlali cv. (70.39 %) in the first season and Villalonga cvs. (39.07 %) in the second one. Meanwhile, the lowest percentage was found with Enduri cv. in both seasons (2.22 and 14.27%, respectively) (Tables 6 and 7).

**Table 7:** Floral characteristics of studied cvs. in season 2009

| Cultivars         | Flower density (%) | Inf. Length (cm) | Total N. flowers/inf | Number male flowers/inf | Number perfect flowers/inf | Perfect flowers (%) |
|-------------------|--------------------|------------------|----------------------|-------------------------|----------------------------|---------------------|
| Thrombolia        | 24.67              | 2.60             | 18.00                | 13.67                   | 4.33                       | 24.11               |
| Strogylia         | 42.00              | 2.43             | 19.33                | 15.67                   | 3.67                       | 18.98               |
| Villalonga        | 52.00              | 3.10             | 18.67                | 12.00                   | 6.67                       | 39.07               |
| Cerasicola        | 53.33              | 2.85             | 17.33                | 13.33                   | 4.00                       | 23.19               |
| Dermlali          | 50.33              | 2.47             | 15.00                | 10.33                   | 4.67                       | 31.17               |
| Leccio Dela Corna | 10.67              | 2.53             | 15.00                | 12.00                   | 3.00                       | 20.07               |
| Roseciola         | 33.67              | 2.47             | 12.33                | 9.33                    | 3.00                       | 24.36               |
| Boutellian        | 39.67              | 2.63             | 17.00                | 13.67                   | 3.33                       | 19.64               |
| Ouslati           | 53.00              | 3.20             | 22.67                | 17.33                   | 5.33                       | 23.91               |
| Mouslati          | 14.00              | 2.85             | 19.33                | 15.00                   | 4.33                       | 22.45               |
| Enduri            | 54.00              | 3.68             | 32.67                | 28.00                   | 4.67                       | 14.27               |
| Tansh             | 14.00              | 2.60             | 13.33                | 10.33                   | 3.00                       | 22.69               |
| L.S.D 5%          | 3.920              | 0.340            | 2.447                | 2.601                   | 1.241                      | 6.828               |

These results are confirmed by Hartmann and Panetssos, (1961) and Shatat and Sawwan, (1986) who reported that percentage of perfect flowers differed according to some factors such as cultivar, growing season, leaf to bud ratio, nutritional status, water stress during inflorescence development and vegetative vigor.

Moreover Fouad *et al.*, (1992) found that inflorescence length was longer in Koroneiki, Pocoma and Criolea olive cvs. than of Picual and Chemlali, while number of flowers/inflorescence were (25) in Koroneiki, Serrana and Souri and (15 flowers/ inflorescence in Picual cv.).

Also, Ferrara *et al.*, (1999) found that inflorescence length varied from (2.5 to 4.5 cm) according to cv. Furthermore Hegazi, (2001) mentioned that percentage of perfect flowers of Picual cv. was significantly higher than in Manzanillo and Eggizi Shami cvs. as it recorded (41.47, 40.11 and 28.87), respectively. Ferrara *et al.*, (2002) found that variability between olive cvs. in floral characteristics and fruit set maybe due to the influence of the genotype and the climatic conditions. Also, Hegazi and Hegazi (2005), Hegazi, (2007) and Mazinani *et al.*, (2008) mentioned that sex expression is affected by cultivars and weather conditions.

#### Fruit set:

In the first season, it was observed that average number of fruitlets/m was significantly higher at initial fruit set (21 DAFB) in Tansh, Ouslati and Leccio Dela Corna cvs. than in other cvs. as it averaged (21.67, 21.67 and 19.33 fruits/m) (Table 8). While the lowest average number of fruitlets/m was observed in Villalonga, Strogylia and Thrombolia as it is averaged (5.67, 5.33 and 4.33 fruits/m), respectively.

In (2008), the average number of fruitlets/m at final fruit set (60 DAFB) in Tansh, Leccio Dela Corna and Ouslati cvs. was significantly higher (20.67, 18.67 and 18.17 fruits/m) than in other cvs. (Table 8). While the lowest number of fruits/m was observed in Villalonga, Strogylia and Thrombolia as it averaged (5.00, 5.00 and 3.33 fruits/m).

In (2009), it was noticed that average number fruits/m was significantly higher (19.33 and 18.33 fruits/m) in Tansh and Ouslati cvs. compared to other cvs, while the lowest average number of fruits/m was found in Villalonga, Thrombolia and Strogylia as it averaged (4.50, 3.83 and 3.67 fruits/m) (Table 9).

**Table 8:** Initial and final fruit set of 12 olive cvs. season 2008.

| Cultivars         | Initial (Fruits/m) | Final (Fruits/m) |
|-------------------|--------------------|------------------|
| Thrombolia        | 4.33               | 3.33             |
| Strogylia         | 5.33               | 5.00             |
| Villalonga        | 5.67               | 5.00             |
| Cerasicola        | 10.00              | 9.33             |
| Dermlali          | 10.67              | 9.33             |
| Leccio Dela Corna | 19.33              | 18.67            |
| Roseciola         | 16.00              | 13.67            |
| Boutellian        | 8.40               | 8.00             |
| Ouslati           | 21.67              | 18.17            |
| Mouslati          | 12.67              | 11.00            |
| Enduri            | 6.00               | 5.67             |
| Tansh             | 21.67              | 20.67            |
| L.S.D 5%          | 2.621              | 2.605            |

These results are in line with Fouad *et al.*, (1992) and Hegazi, (2001) who found that fruit set differed according to cv. and environmental conditions, also they added that it was significantly higher in Picual cv. than in Manzanillo and Eggizi cvs.

Androulakis and Loupassaki, (1990) reported that differences between olive cvs. in percentage of fruit set is due to a varying degree of self fertility and cross pollination requirements and there are differences in fruit set even for the same cvs.

**Table 9:** Initial and final fruit set of 12 olive cvs. season 2009

| Cultivars         | Initial (Fruits/m) | Final (Fruits/m) |
|-------------------|--------------------|------------------|
| Thrombolia        | 5.00               | 3.83             |
| Strogylia         | 6.00               | 3.67             |
| Villalonga        | 7.00               | 4.50             |
| Cerasicola        | 11.33              | 9.83             |
| Dermlali          | 11.17              | 8.83             |
| Leccio Dela Corna | 17.00              | 15.67            |
| Roseciola         | 15.67              | 13.67            |
| Boutellian        | 8.00               | 7.00             |
| Ouslati           | 21.00              | 18.33            |
| Mouslati          | 13.67              | 11.33            |
| Enduri            | 7.67               | 5.67             |
| Tansh             | 21.67              | 19.33            |
| L.S.D 5%          | 2.445              | 2.120            |

These results came in agreement with Fouad *et al.*, (1992), Ferrara *et al.*, (2002) Hegazi and Hegazi (2005) who found that yield of olive cvs. varied according to olive cv., season and environmental conditions.

Also Mora *et al.*, (2008) and Rosati *et al.*, (2010) found that fruit set and yield are determined by genetic and environmental factors and relatively independent of the number of flowers.

#### *Fruit characteristics:*

Data presented in (Table 10 and 12) demonstrated fruit characteristics of the studied cvs. It was noticed that fruit length, diameter and weight of Strogylia and Boutellian cvs. were significantly higher compared to other cvs. while, the lowest was observed in Mouslati and Ouslati cvs.

Fruit L/D ratio was significantly higher in Cerasicola, Dermlali cvs. than in other cvs. with averaged (1.74 and 1.67), while, the lowest fruit L/D ratio was observed in Enduri, Mouslati and Tansh cvs. as it averaged (1.53, 1.47 and 1.45, respectively).

Flesh diameter was significantly higher in Strogylia cv. (0.83 cm) compared to the other cvs. while it was the lowest (0.34 cm) in Ouslati cv. Also, flesh weight was significantly higher in Butellian cv. (8.25 g) compared to other cvs. While the lowest flesh weight was observed in Ouslati and Mouslati cvs. compared to other cvs. as it averaged (1.62 and 1.42 g).

Seed weight and length of Cerasicola were significantly higher than in other cvs. as it averaged (1.04g and 1.73 cm), while these characteristics were significantly lower in Ouslati cv. compared with other cvs.

**Table 10:** Fruit characteristics of 12 olive cvs. season 2008

| Cultivars         | Fruit length cm. | Fruit diameter cm. | Fruit weight g. | Fruit LID ratio | Flesh diameter cm. | Flesh weight g. | Seed weight cm. | Seed length | Seed diameter cm. | Seed LID ratio | Oil % |
|-------------------|------------------|--------------------|-----------------|-----------------|--------------------|-----------------|-----------------|-------------|-------------------|----------------|-------|
| Thrombolia        | 2.37             | 1.75               | 6.29            | 1.35            | 0.64               | 5.50            | 0.80            | 1.46        | 0.49              | 3.00           | 29.33 |
| Strogylia         | 2.70             | 2.17               | 8.59            | 1.24            | 0.83               | 7.81            | 0.78            | 1.43        | 0.50              | 2.87           | 27.33 |
| Villalonga        | 2.33             | 1.43               | 3.87            | 1.62            | 0.52               | 4.90            | 0.97            | 1.32        | 0.43              | 3.06           | 30.33 |
| Cerasicola        | 2.27             | 1.30               | 3.75            | 1.74            | 0.43               | 2.71            | 1.04            | 1.73        | 0.43              | 4.05           | 27.00 |
| Dermlali          | 2.40             | 1.43               | 4.12            | 1.67            | 0.45               | 3.24            | 0.88            | 1.63        | 0.53              | 3.09           | 33.33 |
| Leccio Dela Corna | 1.75             | 1.13               | 2.54            | 1.55            | 0.42               | 2.10            | 0.43            | 1.30        | 0.47              | 2.82           | 35.67 |
| Roseciola         | 2.39             | 1.45               | 3.58            | 1.65            | 0.50               | 2.87            | 0.72            | 1.67        | 0.46              | 3.66           | 30.33 |
| Boutellian        | 2.60             | 2.07               | 8.90            | 1.26            | 0.56               | 8.25            | 0.65            | 1.53        | 0.70              | 2.19           | 35.33 |
| Ouslati           | 1.58             | 0.98               | 1.85            | 1.61            | 0.34               | 1.62            | 0.23            | 1.01        | 0.30              | 3.35           | 28.33 |
| Mouslati          | 1.65             | 1.12               | 1.88            | 1.47            | 0.41               | 1.42            | 0.47            | 1.00        | 0.37              | 2.68           | 35.33 |
| Enduri            | 1.73             | 1.13               | 2.38            | 1.53            | 0.41               | 2.03            | 0.35            | 1.05        | 0.30              | 3.48           | 33.67 |
| Tansh             | 2.60             | 1.79               | 6.77            | 1.45            | 0.72               | 5.88            | 0.89            | 1.59        | 0.55              | 2.89           | 29.00 |
| L.S.D5%           | 0.127            | 0.107              | 0.523           | 0.087           | 0.068              | 0.408           | 0.337           | 0.076       | 0.064             | 0.520          | 1.151 |

Seed diameter was higher (0.70 cm) in Boutellian cv. than in other cvs. while, the lowest seed diameter was observed in Enduri cv. as it averaged (0.30 cm).

Seed L/D ratio was significantly higher (4.05 and 3.66) in Cerasicola and Roseciola cv. than in other cvs, while, the lowest seed L/D ratio was observed in Mouslati and Botellian cv. as it averaged (2.68 and 2.19).

The obtained results in both seasons showed that oil content was significantly higher in Leccio Dela Corna, Boutellian and Mouslati than in other cvs. while, the lowest oil % was observed in Strogylia and Cerasicola cvs. (Tables 10 and 11).

In the second season, fruit diameter of Strogylia was also higher (2.25 cm) than that of other cvs. (Table 11). While, the lowest fruit diameter was observed in Enduri, Leccio Dela Corna, Mouslati and Ouslati as it averaged (1.17, 1.13, 1.09 and 1.07cm). Flesh diameter and weight recorded the similar trend with the first season (Table 11).

Seed weight of Cerasicola was significantly higher (1.11 g) compared to other cvs. while, it was significantly lower (0.47 and 0.39 g) in Enduri and Mouslati cvs.

Seed length was significantly higher (1.77 cm) in Cerasicola compared to other cvs. While, the lowest seed length was observed in Enduri and Mouslati as it averaged (1.06 and 1.04 cm), respectively.

Seed diameter was significantly higher (0.76 cm) in Boutellian cv. than in other cvs. while, the lowest seed diameter was observed in Ouslati and Enduri cvs. as it averaged (0.34 and 0.31 cm).

**Table 11:** Fruit characteristics of 12 olive cvs. season 2009

| Cultivars         | Fruit length cm. | Fruit diameter cm. | Fruit weight g. | Fruit LID ratio | Flesh diameter cm. | Flesh weight g. | Seed weight cm. | Seed length | Seed diameter cm. | Seed LID ratio | Oil % |
|-------------------|------------------|--------------------|-----------------|-----------------|--------------------|-----------------|-----------------|-------------|-------------------|----------------|-------|
| Thrombolia        | 2.45             | 1.82               | 6.47            | 1.34            | 0.73               | 5.62            | 0.85            | 1.49        | 0.53              | 2.82           | 29.33 |
| Strogylia         | 2.78             | 2.25               | 8.80            | 1.23            | 1.87               | 7.78            | 1.02            | 1.44        | 0.52              | 2.74           | 27.33 |
| Villalonga        | 2.45             | 1.48               | 6.00            | 1.65            | 0.58               | 5.07            | 0.93            | 1.28        | 0.50              | 2.56           | 31.33 |
| Cerasicola        | 2.38             | 1.38               | 3.89            | 1.73            | 0.50               | 2.78            | 1.11            | 1.77        | 0.46              | 3.90           | 27.33 |
| Dermlali          | 2.52             | 1.50               | 4.17            | 1.67            | 0.48               | 3.29            | 0.89            | 1.66        | 0.55              | 3.04           | 34.00 |
| Leccio Dela Corna | 1.85             | 1.13               | 2.53            | 1.63            | 0.52               | 2.05            | 0.50            | 1.32        | 0.51              | 2.60           | 36.00 |
| Roseciola         | 2.47             | 1.52               | 3.70            | 1.61            | 0.55               | 2.94            | 0.76            | 1.67        | 0.51              | 3.36           | 31.67 |
| Boutellian        | 2.70             | 2.16               | 8.73            | 1.25            | 0.61               | 8.05            | 0.69            | 1.57        | 0.76              | 2.06           | 36.00 |
| Ouslati           | 1.66             | 1.07               | 2.13            | 1.56            | 0.38               | 1.46            | 0.67            | 1.13        | 0.34              | 3.31           | 29.00 |
| Mouslati          | 1.63             | 1.09               | 1.82            | 1.50            | 0.46               | 1.42            | 0.39            | 1.04        | 0.39              | 2.68           | 36.00 |
| Enduri            | 1.79             | 1.17               | 2.52            | 1.55            | 0.44               | 2.05            | 0.47            | 1.06        | 0.31              | 3.45           | 34.67 |
| Tansh             | 2.72             | 1.86               | 6.87            | 1.45            | 0.76               | 5.96            | 0.91            | 1.62        | 0.60              | 2.71           | 29.67 |
| L.S.D.5%          | 0.129            | 0.118              | 0.294           | 0.146           | 0.056              | 0.346           | 0.285           | 0.070       | 0.053             | 0.415          | 1.265 |

These results are in line with Hassan, (1996), Fourati *et al.*, (2003), Hegazi and Hegazi (2005b), Hegazi (2007) and Mazinani *et al.*, (2008) that fruit physical characteristics varied according to olive cv. and that average fruit weight, size, and seed weight was higher in Tefahi cv. than in Koroneiki. Hassan, (1996) also found that flesh / fruit was significantly higher in Tefahi cv. than in Koroneiki and Arbequina and this trend was also observed with seed length and diameter.

The obtained results mentioned above are confirmed by Hassan, (1996) who found that oil percentage in Koroneiki cv. was higher than that of Tefahi cv. Ferrara *et al.*, (1999), Fourati *et al.*, (2003) and Hegazi and Hegazi (2005b) and Hegazi (2007) who found that oil percentage and oil quality varied according to olive cvs.

*From the obtained results, it could be concluded that:*

- 1- Julian dates for bud break of Tansh, Roseciola and Leccio Dela Corna cvs. were significantly late compared to other cvs., while, the earliest date was observed in Mouslati cv.
- 2- Leaves density (leaves n. /m) was the highest in Boutellian cv. while it was the lowest in Ouslati and Villalonga cvs.



- 3- Flowering density was significantly higher in Enduri, Ouslati, Cerasicola and Villalonga cvs. while, it was significantly lower in Tansh and Mouslati than in other cvs.
- 4- Number of perfect flowers / inflorescence ranged from 0.67 in Enduri and Leccio Dela Corna to 7.00 in Dermlali cv.
- 5- Fruit set was the highest in Tansh, Ouslati and Leccio Dela Corna and the lowest was in Thrombolia cv.
- 6- Fruit characteristics (fruit length, diameter, weight and flesh weight) of Strogylia and Boutellian cvs. were the highest, while the lowest previous characteristics were observed in Ouslati cv.
- 7- Oil % of Leccio Dela Corna, Boutellian and Mouslati was the highest compared to other cvs. while the lowest oil % was observed in Cerasicola and Strogylia cvs.

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