American-Eurasian J. Agric. & Environ. Sci., 21 (1): 22-38, 2021
ISSN 1818-6769

DOI: 10.5829/idosi.aejaes.2021.22.38

# Morphological and Productivity of Some Olive Genotypes Derived from a Breeding Program and Comparing with Their Parental Cultivars

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**Abstract:** An olive breeding program was initiated through the project of "Genetic improvement of Olive" (CFFC) IOC in 1994 aimed to obtain new cultivars from cross breeding between several local and foreign cultivars with desirable characteristics. The genotypes were planted by seedlings and established in the olive collection farm at Horticulture Research Institute Giza, Egypt. The present investigation was conducted during three successive seasons (2017, 2018 and 2019) to evaluate twelve of these genotypes (20 years old) and comparing these genotypes traits with the traits of their parental cvs., [Aggizi and Toffahi (the main table olive cvs., 'Egypt'); Chemlali (olive oil cv. 'Tunisia'); Arbequin (oil cv. and Manzanillo dual cv. 'Spain') as well as Kalamata (table olive cv. 'Greece')], to find out the most important characteristics of these genotypes comparing with parental and selecting the most superior ones that meeting the international market requirements and suitable for planting in this region. The genotypes and parental cvs. have been analyzed for traits of the olive tree according to the different parts of the tree (shoot, leaf, floral and fruits) in addition to fruit moisture , oil content and rooting ability. Herein, the greatest values of most the studied traits were significantly cleared in genotype 14. The earliest date of flowering fulfilled by Toffahi cv. (3rd season); whereas, Arbequin cv. was the latest one (1st season). Moreover, other genotypes and parental cvs. showed the greatest total number of flowers and perfect flowers/inflorescence in genotypes (13 & 14); the highest percent of perfect flowers and the minimal of staminate (male) flowers (14) during the experimental seasons. The highest fruit set % was clear in genotypes (14 & 79). A group of genotypes that derived from (Arbequin x Aggizi) gave utmost the highest records of yield crop and classificated as high oil content. Generally, we can classificated the tested genotypes as follow: the genotypes 15 and 68 as table olives, while the genotypes 53 and 69 for dual use and the genotypes 14, 79, 85 and 86 for oil production. In addition, the classification of rooting ability percent helps to divide the types of cuttings into easy, medium and hard to root. As that Arbequin cultivar was the highest in the ability to rooting %.

**Key words:** Olive · Evaluation · Genotypes · Cross breeding · Flowering · Fruiting · Yield · Oil and rooting

## INTRODUCTION

Olive (*Olea europaea*) is one of the most important fruit species that thrive successfully on many arid and semi-arid lands and play 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 [1, 2]. Three types of olive threes exist: for oil production, for table olives, for dual use (both oil and table) that have been generated from variability of olive germplasm, which accounted for more than 2000 cultivars [3]. Due to the technological advancement for harvesting the olive, the changes in agricultural policies and market liberalization, the olive research institutions in some producing-countries working to perform several breeding programs which searching for interesting genotypes with a high ecological plasticity, adaptable to new agronomical techniques, capable of producing high quality oil and for big table olive with good flavors and nutritional value of

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the olive product [4, 5]. In order to select new interesting genotypes, most of breeding programs have been focused on cross breeding among the main outstanding cultivars and selection within the progenies to increase the genetic variability [6, 7]. Evaluation of olive oil composition is considered as a compulsory task in any breeding program aiming at obtaining new olive cultivars [8].

In Egypt, olive is cultivated from ancient centuries. It is found in pharaoh's tombs and temples as pictures and fruits. Nowadays, olive trees play an important role in orchard establishment especially in new reclaimed areas that considered suitable for olive plantings [9]. So, the olive sector represents one of the most promising sectors in Egypt. As a result of increasing the local consumption of oil due to the awareness about the value of health and nutrient and failed of some fruit trees to succeed in the desert because of water salinity, For these reasons, the breeding programs are currently being carried out to obtain new olive cultivars with some of preferable traits [4]. The Olive breeding program has been initiated in Egypt since 1994 in horticultural research institute, by crossing between local and foreign cultivars to obtain new olive cultivars with some of preferable traits of oil and table cultivars. The objective of the breeding program was to improve the qualities of these cultivars and to obtain new olive cultivars with some of preferable traits such as early bearing, high productivity and oil content, resistance to pest and diseases, vigor suitability for mechanical harvesting and high quality of olive oil [10].

Therefore, the present study aimed to evaluate some morphological; floral and fruit characteristics; yield and oil content as well as rooting ability % of twelve olive genotypes derived through Genetic improvement of Olive (CFFC) IOC, of Horticulture Research Institute in Egypt and comparing these genotypes traits with the traits of parental cultivars to find out the most important desirable traits of these genotypes.

## MATERIALS AND METHODS

This study was carried out through three growing seasons (2017, 2018 & 2019) of twelve olive genotypes derived through the project of "Genetic improvement of Olive" (CFFC) IOC, of Horticulture Research Institute in Egypt and comparing these genotypes traits with the traits of 6 parental cultivars [Aggizi and Toffahi (the main Egyptian table olive Cvs.); Chemlali olive oil Cv. (Tunisia); Arbequin oil Cv. and Manzanillo dual Cv. (Spain) as well as Kalamata table olive Cv. (Greece)]. The aim of the study was to find out the most important desirable characteristics of these genotypes that will be improving the quality of the fruits and productivity.

The seedlings of the selected genotypes were 20 years-old; planted in the olive collection farm of Horticulture Research Institute, Giza, Egypt at 4 × 4 m apart in clay loamy soil, under drip irrigation system by Nile water. The plants were grown under the same geographical conditions, received regularly the recommended cultural practices and free from pathogens and physiological disorders. The sources of genotypes according to the project map of Olive improvement program are cleared in Table (1).

Soil chemical; physical characteristics and water chemical properties were determined by Soil, Water and Environmental Res. Inst. Agric. Res. Center, according to the methods as described by Jackson [11] and was summarized in Tables (2 & 3).

**Meteorological Data:** Temperature and relative humidity data at location was obtained by the National Meteorology Laboratory, Ministry of Agriculture.

Morphometric characteristics were used of the 12 olive genotypes and parental cultivars according to the different parts of the olive tree (shoot, leaf, floral characteristics and fruit set, fruit characteristics; moisture and oil content), in addition to rooting ability, for comparing these genotype traits with the traits of parental cultivars to select the most superior ones that meeting the international market requirements and suitable for planting in this region.

**Vegetative Characteristics:** The following characters were addressed by using the methodology for primary and secondary characterizations of olive:

**Shoot Characteristics:** Twenty shoots (one-year-old) were randomly selected around each tree canopy and labeled to study:

Shoot length (cm).

Shoot thickness (cm).

Number of internodes/shoot.

Internodes length (cm): the internodes length on the labeled shoots was record in late of March.

Leaves characteristics:

Leaves density: calculated as a number of leaves per meter.

Leaf length (cm).

Leaf width (cm).

Table 1: Sources of genotypes according to the project map of olive improvement program

| Tree number of the Genotypes project map | Crossing combination | Receptors |
|---|---|---|
| 13 | Chemlali x Toffahi | Chemlali ♀ |
| 14 | Chemlali x Toffahi | Chemlali ♀ |
| 15 | Aggizi x Arbequin | Aggizi ♀ |
| 53 | Manzanillo x Aggizi | Manzanillo ♀ |
| 68 | Toffahi x Kalamata | Toffahi ♀ |
| 69 | Toffahi x Kalamata | Toffahi ♀ |
| 75 | Arbequin x Aggizi | Arbequin ♀ |
| 77 | Arbequin x Aggizi | Arbequin ♀ |
| 79 | Arbequin x Aggizi | Arbequin ♀ |
| 81 | Arbequin x Aggizi | Arbequin ♀ |
| 85 | Arbequin x Aggizi | Arbequin ♀ |
| 86 | Arbequin x Aggizi | Arbequin ♀ |

Table 2: Physical and chemical properties of the soil under study

| Property | Value | Property | Value |
|---|---|---|---|
| Sand (%) | 27.48 | Available micronutrients (mg $kg^{-1}$) | |
| Silt (%) | 34.22 | Fe | 6.71 |
| Clay (%) | 38.30 | Mn | 6.52 |
| Texture | Clay loam | Zn | 4.68 |
| $CaCO_3$ $gkg^{-1}{}_3$ | 45.6 | Soluble ions (meq/L) | |
| EC (dS $m^{-1}$) | 2.92 | $Ca^{++}$ | 13.8 |
| pH (1:2.5) susp. | 7.88 | $Mg^{++}$ | 10.5 |
| Organic matter (%) | 2.29 | $Na^{+}$ | 4.6 |
| Available macronutrients (mg $kg^{-1}$) | | $K^{+}$ | 0.70 |
| N | 33.30 | $HCO_3^{-}$ | 5.8 |
| P | 5.50 | $Cl^{-}$ | 8.0 |
| K | 360 | $SO^{-}{}_4$ | 15.8 |

Table 3: The chemical analyses of the tested water sample (Nile water) collected from the experimental area

| | | Cations (meq/L) | | | | Anions (Meq/L) | | | |
|---|---|---|---|---|---|---|---|---|---|
| E.C (dS/m) | pH | $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $K^{+}$ | $HCO_3^{-}$ | $Cl^{-}$ | $SO_4^{-}$ | SAR |
| 0.55 | 7.84 | 1.50 | 1.53 | 1.32 | 0.18 | 1.40 | 1.40 | 1.73 | 1.07 |
| Some macro micro nutrients (ppm) | | | | | | | | | |
| N | P | K | Fe | Mn | Zn | Cu | Pb | Ni | B |
| 1.36 | 0.54 | 7.02 | 0.02 | 0.04 | 0 | 0.04 | 0.01 | 0.01 | 0.07 |

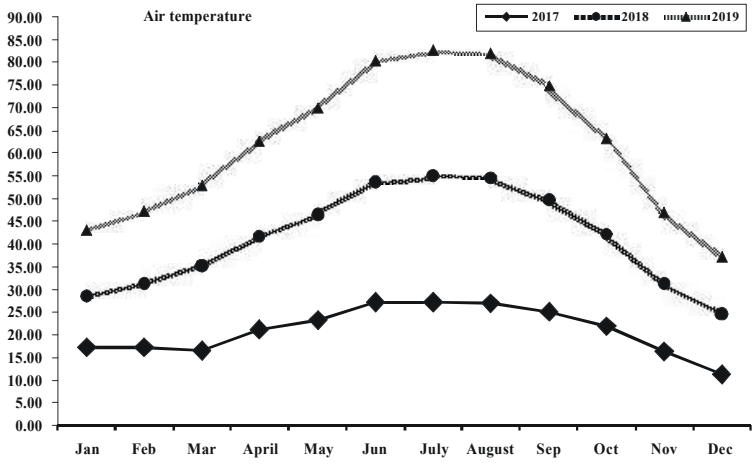


Fig. 1: Average air temperature from the experimental area during the three experimental seasons, 2017, 2018 and 2019

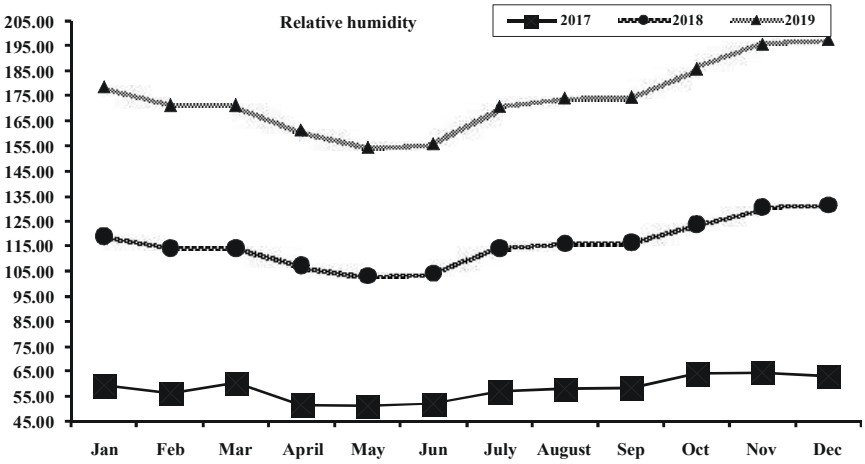


Fig. 2: Relative humidity from the experimental area during the three experimental seasons, 2017, 2018 and 2019

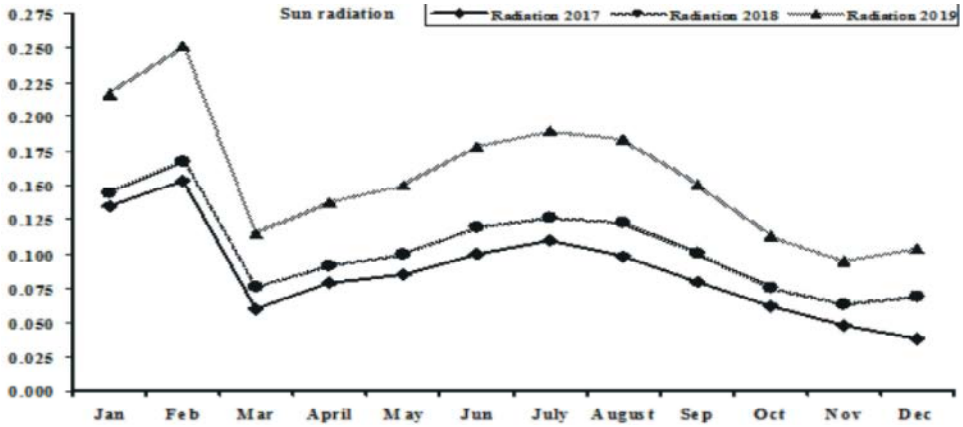


Fig. 3: Sun radiation degree from the experimental area during the three experimental seasons, 2017, 2018 and 2019

Leaf surface area ($cm^2$): Samples of approximately 40 adult leaves taken from the middle section of one year old shoots to determine average leaf surface area, according to following equation:

Leaf area =0.53 (length x width) +1.66 [12].

Leaf shape index (L/W): Elliptic (< 4), Elliptic, -lanceolate (4-6) and lanceolate (> 6), according the characterization of IOC [13].

**Floral Characteristics and Fruit Set %:**

Flowering date and duration:

Start of flowering date: when 10-25% of flowers were opened.

Full bloom date: when 50-80% of flowers were opened.

End of flowering date: developed when 25% of set fruits.

Flowering period: was calculated by the days between beginning of flowering and end of blooming.

Flowering density: calculated as a number of inflorescences/meter.

Inflorescence length (cm): short (< 2.5), medium (2.5-3.5) and long (> 3.5) according to IOC [14].

Total number of flowers/inflorescence: Total number of flowers per inflorescence was counted and characterization according the IOC [14] into Low (< 18), medium (18-25), high (> 25).

Number of perfect flowers/inflorescence.

Number of staminate flowers/inflorescence.

Perfect flowerer percent: calculated according to Hegazi and Stino, [15]; Rallo and Fernández-Escobar [16] and Hegazi [17] as the following equation:

$$\text{Perfect flower percentage}=\frac{\text{No. of perfect flowers}}{\text{No. of total flowers}}\text{x}100$$

**Fruit Set (%):** Fruit set was calculated after 60 days from full bloom according to Hegazi and Hegazi [18] and Hegazi [19] as a formula:

$$\text{Fruit set \%} = \frac{\text{No. of fruits}}{\text{No. of total flowers}} x100$$

**Yield (Kg/tree):** Fruits were harvested during ripe stage (pigmentation on more than 50% of the skin) and the average tree yield of each genotype was calculated.

**Fruit Characteristics:** Thirty of fresh olive fruits were randomly hand-picked from the evaluated genotypes to determine fruit and seed parameters according to the International Olive Council standard method IOC, [14] as the following categories:

Fruit, seed and flesh weight (g).
Fruit polar length (mm); Fruit cross-sectional width (mm); and fruit shape index Fruit shape: determined according the ratio between the length and the width (L/W) as follow: Spherical (< 1.25), ovoid (1.25-1.45), elongated: (> 1.45) [20].
Seed polar length (mm); seed cross-sectional; seed shape index (L/W) and flesh/seed ratio, flesh/fruit (%) and seed/fruit (%).

Moisture content in the fruit: samples of 100 g of whole olives, desiccated in the oven at 105ºC for 24 hours to tabulate the moisture content [13].

Percentage of oil content in the fruit (fresh and dry weight basis): samples were determined according to the A.O.A.C. [21].

The oil percent as dry weight is described as very low < 30, Low 30-40, medium 40-50, high 50-60 and very high > 60 [20].

**Rooting Ability of Evaluated Genotypes Cuttings %:** Sub-terminal cuttings of the selected twelve olive genotypes were taken (in the middle of spring or late summer) about (12-15 cm) long one-year shoots/season. Two pairs of terminal leaves on each cutting were retained and the basal cut was made just below the node. The cuttings were dipped in the solution of IBA at 4000 ppm for few seconds according to Kurd *et al*. [22] and Shereen [23] after that treated with benlate solution (3g /L) as fungicide. Then planted to a depth of 5 cm in a plastic box filled with a mixture of vermiculite and sand (1:2 volume), on rooting bench provided with basal heating and with mist system. After 70 days of planting, the cuttings were carefully excavated out of media and rooting percentage for each genotype was measured [24]. Rooting percent was described as: nil 0, very low 1- 20, low 20 - 40, medium 40 -60, high 60 - 80 and very high 80 – 100 [20].

**General Evaluation of the Twelve Evaluated Genotypes and Parental Cultivars under Egypt Condition:** The final evaluation was calculated on basis of 100 units, which were shared between main growth, yield and fruit quality characteristics which were (5) units for No. of inflorescences/m, (5) units for perfect flowers (%), (15) unit for fruit set /m, (10) units for fruit weight (g), (5) units for flesh/fruit weight, (30) units for the total yield/tree and (30) units for fruit oil (%) (dry weight basis) according to Elhusseiny [25].

**Statistical Analyses:** The experiment was arranged in a randomized complete blocks design and the obtained data were subjected to analysis of variance and significant differences among means were determine according to Snedecor and Cochran [26]. In addition significant differences among means were distinguished according to the Duncan multiple tests range Duncan [27].

## RESULTS AND DISCUSSION

Morphological traits, yield and fruit characteristics during (2017, 2018 and 2019 years) of twelve olive genotypes and their parental cultivars were evaluated as follow:

### Vegetative Characteristics

### Shoot Characteristics

**Shoot Length (cm):** The values of shoot length significantly differed according to olive genotypes and parental cultivars during three studied seasons. As shown in Table (4), it was cleared that olive genotypes 68 (Toffahi x Kalamata) recorded the highest values of shoot length than other genotypes and superior on parental cultivars. On the other side, the shortest shoot length was observed by olive genotype 14 (Chemlali x Toffahi) comparing with other genotypes and parental cultivars. This was true during seasons of study.

**Shoot Thickness (cm):** The maximum thickness of shoots (Table 4), is concomitant to olive genotype 53 (Arbequin x Aggizi) in both first and third season shared with Aggizi and Manzanillo cvs. in the first and second season respectively, following with genotype 15 in the first and second seasons. On the other side, there were an intermediate records represented between genotypes and their parental cultivars, the minimal thinnest values were recorded by genotype 81 during three studied seasons.

Table 4: Shoot length (cm), shoot thickness (cm), No. of internodes/shoot and No. of internodes/meter of twelve olive genotypes and parental cultivars during 2017, 2018 and 2019 experimental seasons

| | Shoot length (cm) | | | Shoot thickness (cm) | | | No. of Internodes /shoot | | | Internodes length (cm.) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes and parental cultivars | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| 13 | 28.00B | 26.40 E | 32.10B | 3.00B | 2.90C | 2.90D | 15.60J | 14.60K | 14.60L | 1.79E | 1.81B | 1.96B |
| 14 | 15.40 J | 19.20M | 20.40N | 2.80D | 2.90C | 2.80E | 12.60N | 16.05I | 17.33H | 1.22L | 1.24IJ | 1.18P |
| 15 | 23.85 G | 25.60F | 27.82E | 3.05AB | 3.00B | 2.90D | 11.40Q | 12.45N | 14.18M | 2.09A | 2.06A | 2.20A |
| 53 | 25.30 DE | 27.60C | 29.25C | 3.10A | 3.00B | 3.20A | 12.20O | 13.40L | 15.30J | 2.07B | 2.06A | 1.91C |
| 68 | 29.40 A | 30.20A | 32.80A | 2.50G | 2.60F | 2.70F | 21.70B | 23.20A | 22.70B | 1.39J | 1.30GH | 1.44I |
| 69 | 26.40 C | 25.10G | 28.65D | 2.60F | 2.50G | 2.60G | 22.35A | 22.18B | 23.27A | 1.18M | 1.18K | 1.23N |
| 75 | 25.40 D | 23.60IJ | 26.40HI | 2.70E | 2.50G | 2.70F | 21.05C | 19.30E | 21.63C | 1.21L | 1.22I-K | 1.22N |
| 77 | 22.70 H | 23.90H | 25.30K | 2.40H | 2.70E | 2.60G | 19.05F | 20.30D | 21.08D | 1.21IL | 1.19JK | 1.29M |
| 79 | 23.50 G | 22.70L | 26.10J | 2.60F | 2.50G | 2.60G | 18.25F | 17.10G | 19.63C | 1.29K | 1.33FG | 1.33L |
| 81 | 25.10 DE | 28.20B | 27.55F | 2.30I | 2.40H | 2.50H | 16.35I | 19.30E | 17.23H | 1.54G | 1.46E | 1.60H |
| 85 | 24.30 DE | 23.40J | 26.75G | 2.70E | 2.50G | 2.70F | 15.15K | 15.15J | 15.15JK | 1.60F | 1.54D | 1.77E |
| 86 | 25.30 DE | 23.90H | 26.65GH | 2.80D | 2.90V | 2.90D | 17.85G | 18.70F | 19.38F | 1.42I | 1.28G-I | 1.38K |
| Chemlali | 22.40 H | 23.60IJ | 24.60L | 2.90C | 3.00B | 2.90D | 14.45L | 14.55K | 15.10K | 1.55G | 1.62C | 1.63G |
| Aggizi | 21.22 I | 23.70HI | 26.24IJ | 3.10A | 2.80D | 3.00C | 11.70P | 12.98M | 14.60L | 1.81D | 1.83B | 1.86D |
| Toffahi | 26.20 C | 27.30D | 29.10C | 2.50G | 2.60F | 2.65FG | 22.36A | 23.18A | 23.24A | 1.19M | 1.20JK | 1.20O |
| Arbequin | 24.90 E | 22.94K | 24.64L | 2.90C | 2.70E | 2.70F | 17.30H | 16.75H | 17.90G | 1.44H | 1.37F | 1.38K |
| Kalamata | 25.42 D | 25.66F | 22.75M | 2.51G | 2.60F | 2.58G | 20.80D | 21.10C | 16.17I | 1.22L | 1.27HI | 1.41J |
| Manzanillo | 24.90 E | 23.10K | 26.65GH | 3.00B | 3.10A | 3.10B | 13.10M | 12.90M | 15.21JK | 1.90C | 1.79B | 1.75F |

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test at 5% level

As comparing genotype 53 with parental cultivars it could be noticed that, the genotype 53 which recorded the maximum shoot thickness was superior to Arbequin cultivar during three studied seasons and Aggizi cv. in the second and third seasons.

**Number of Internodes/Shoot:** Number of internodes/shoot cleared vast variability between the tested genotypes and parental cultivars (Table 4). Toffahi cultivar (as a mother) acquired the highest number of internodes/shoot and this was reflected to the coupled genotypes 68 and 69 (Toffahi x Kalamata), while the least values was reflected to genotype 15 during studied seasons.

**Internodes Length (cm):** Data presented in Table (4) exhibit significant mark variation in internodes length among olive genotypes under study. Genotypes 15 appeared the maximum values of internodes length in the three studied seasons respectively with partnership with genotype (53) in the second season. Otherwise, the minimum of internodes length was differed from season to another and attained by genotype (69) in both first and second seasons in partnership with Toffahi cultivar in the first season and genotype (14) in the third one. As comparing theses genotypes with their parental cultivars, the genotype (15) was surpassed than (Aggizi & Arbequin) cultivars. On the other side, the shortest internodes length of Toffahi cv. (as a receptor) consequently reflected on genotypes 14 and 69 which exhibit the minimal one.

**Leaves Characteristics**

**Average Number of Leaves/Meter:** It is quite clear from the tabulated data of three studied seasons in Table (5) that, the genotype 77 and its parental cultivars (Arbequin & Aggizi) attained the highest values in the three studied seasons, shared with genotype 69 in the first season. The reverse was true with genotype 15 and 53 which recorded significantly the lowest value through the three studied seasons.

**Leaf Length (cm):** Regarding to the tabulated data in Table (5) that Kalamata cv. gave the highest leaf length in three studied seasons. On the contrary, the shortest leaf length was in concomitant to Manzanillo shared with Aggizi, Toffahi and Arbequin olive cultivars in three seasons.

**Leaf Width (cm):** Data in Table (5) shows obviously considerable variations in this respect, herein, the greatest values of leaf width was cleared in olive genotype 13 in the studied seasons, whereas the genotype 81, Toffahi and Manzanillo cultivars achieved the least width.

Table 5: No. of leaves/m, leaf length, leaf width, leaf surface area ($cm^2$) and leaf shape index of twelve olive genotypes and parental cultivars during 2017, 2018 and 2019 experimental seasons

| | No. of leaves/m | | | Leaf length (cm) | | | Leaf width (cm) | | | Leaf surface area ($cm^2$) | | | Leaf shape index | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes and parental cultivars | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| 13 | 111.51L | 110.61J | 119.63M | 6.05DE | 5.76G | 6.40C | 2.10A | 2.16A | 2.22A | 6.12EF | 6.50C | 6.2H | 2.88K | 2.66G | 2.88G |
| 14 | 163.70C | 167.20B | 166.61B | 5.86FG | 5.96E | 6.06EF | 1.80C | 1.85DE | 1.90D | 6.15EF | 6.41D | 6.43J | 3.26IJ | 3.22E | 3.19F |
| 15 | 95.60O | 97.27L | 104.90P | 6.15CD | 6.23CD | 6.31CD | 1.96B | 1.98C | 2.00C | 6.23 DE | 6.35E | 6.84C | 3.14J | 3.15EF | 3.16F |
| 53 | 96.45O | 97.10L | 101.62Q | 6.05DE | 5.78G | 7.11A | 1.79C | 1.89D | 1.99C | 6.05F-H | 6.12GH | 6.72F | 3.39HI | 3.05F | 3.57D |
| 68 | 144.23G | 153.64E | 138.41I | 6.65B | 6.71B | 6.77B | 2.00B | 2.07B | 2.14B | 6.52C | 6.69B | 6.97F | 3.33HI | 3.24E | 3.17F |
| 69 | 169.32A | 168.13AB | 162.41D | 6.21C | 6.23CD | 6.25D | 1.97B | 1.98C | 1.99C | 6.23DE | 6.50C | 6.85C | 3.15J | 3.15EF | 3.14F |
| 75 | 165.75B | 163.57C | 163.82C | 5.95EF | 5.96E | 5.97FG | 1.60E | 1.68G | 1.76FG | 6.06F-H | 6.10H | 6.82D | 3.73CD | 3.5D | 3.39E |
| 77 | 167.85A | 169.87A | 169.89A | 5.80G | 5.92EF | 6.00F | 1.30H | 1.40K | 1.50I | 6.12EF | 6.15G | 6.55G | 4.48A | 4.24A | 4.00A |
| 79 | 155.32D | 150.66F | 150.38E | 6.10CD | 6.12D | 6.14E | 1.65DE | 1.68G | 1.71G | 6.15EF | 6.35E | 6.75E | 3.70D-F | 3.64D | 3.59D |
| 81 | 130.28J | 136.88H | 125.05K | 5.75GH | 5.82FG | 5.89GH | 1.40G | 1.46J | 1.52HI | 9.09A | 6.12GH | 6.32K | 4.11B | 3.99B | 3.88AB |
| 85 | 124.69K | 138.49H | 128.04J | 5.65HI | 5.68GH | 5.71IJ | 1.50F | 1.54I | 1.58H | 5.97H | 6.10H | 6.47I | 3.77CD | 3.69D | 3.61D |
| 86 | 141.11H | 156.49D | 145.40G | 6.15CD | 6.26C | 6.37C | 1.70D | 1.72G | 1.74G | 6.27D | 6.38DE | 6.81D | 3.62EF | 3.64D | 3.66CD |
| Chemlali | 129.04J | 123.31I | 122.76L | 5.75GH | 5.77G | 5.79HI | 1.50F | 1.60H | 1.70G | 6.12EF | 6.27F | 6.29L | 3.83CD | 3.62D | 3.41E |
| Aggizi | 105.56N | 96.20L | 106.14O | 5.55IJ | 5.59HI | 5.63JK | 1.70D | 1.78F | 1.86DE | 6.00GH | 6.30F | 6.10M | 3.26IJ | 3.14EF | 3.03FG |
| Toffahi | 153.44E | 155.31DE | 148.45F | 5.45JK | 5.53IJ | 5.61JK | 1.45FG | 1.50IJ | 1.55HI | 6.10FG | 6.11H | 6.09M | 3.76C-E | 3.69D | 3.62D |
| Arbequin | 147.99F | 148.65FG | 142.82H | 5.55IJ | 5.57HI | 5.59JK | 1.61E | 1.71G | 1.81EF | 5.99GH | 6.12GH | 6.29L | 3.45GH | 3.26E | 3.09F |
| Kalamata | 134.22I | 147.00G | 142.11H | 6.85A | 6.95A | 7.05A | 1.76C | 1.81EF | 1.86DE | 8.19B | 8.29A | 8.25A | 3.89C | 3.84C | 3.79BC |
| Manzanillo | 109.24M | 107.93K | 109.27N | 5.35K | 5.41J | 5.57K | 1.50F | 1.52IJ | 1.54HI | 5.96H | 6.03 I | 6.09M | 3.57FG | 3.56D | 3.62D |

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test at 5% level.

**Leaf Surface Area:** Leaf surface area calculated the highest values in Kalamata cultivar and genotype 81 in (2018 & 2019) and 2017 respectively. on the contrary, the lowest values of leaf surface area attained by Manzanillo cultivar during the three seasons, Aggizi and Toffahi cultivars in the third season (Table 5).

**Leaf Shape Index:** Concerning the leaf shape index of twelve genotypes and parental cultivars in Table (5) it could be noticed that, the greatest leaf shape index scored by genotype 77 and 81 during the three studied seasons and the third season respectively, followed by genotype 81 in second and third season. Whereas the least one attained by genotype 13. Since, in most cases the increase in leaf length was relatively higher than leaf width in different olive genotype under study and this could be logically explained on the unparalleled values in leaf shape index with different olive genotypes under study. According to the methodology for primary characterization of olive varieties cited by the International Olive Oil Council (IOC) [13] and by other morphological studies on olive cultivars, all of tested genotype and parental cultivars classificated elliptic (< 4), except genotype 77 was elliptic – lanceolate (4-6).

Differences in growth characteristics between olive genotypes and parental cultivars are in close conformity with the findings previously reported by Pritsa *et al*. [28]; Proietti *et al*. [29] and Mnastrie *et al*. [30].

**Floral Characteristics and Fruit Set (%)**

**Flowering Duration:** Data of start, end and duration period of flowering that presented in Table (6) and Figs. (4, 5 and 6) during the three experimental seasons, cleared that, begging of flowering of tested genotypes and parental cultivars occurred during the period from February 28$^{th}$ to March 21$^{st}$ during three studied season. In this concern, the earliest date of flowering fulfilled by Toffahi cultivar in the 3$^{rd}$ season. Whereas, Arbequin cultivar was the latest one (1$^{st}$ season). Similarly, the end of flowering started at March 19$^{th}$ in Toffahi cultivar (3$^{rd}$ season) till April 11$^{th}$, in Arbequin cultivar in 2017 season. As regard to the duration period of three studied seasons, it was ranged between (19-24) days. The aforementioned results agree with El-Badawy *et al*. [31] and Cesaraccio *et al*. [32] they noticed that, flowering habit differed according to cvs. and varied from one season to another. This may be due, to the differed in its thermal requirement and their physiological status. Moreover, the phonological behavior of olive tree is largely influenced by environmental factors such as temperature.

**Flowering Density (No. of Inflorescence /M):** There were variations among olive genotypes and parental cultivars during three seasons under study Table (7). The highest value was concomitant to genotype 14 in 2017 and 2019 seasons shared with genotype 81 in 2017 season and Aggizi cultivar in 2018 season, on the other side, the least value was attained by Manzanillo cultivar. This result goes generally with Bellini *et al*. [4]; El-Sayed [10] and Mikhail [9] reported that percentage of perfect flowers differed according to some factors such as cultivar, growing season, leaf to bud ratio, nutritional status and water stress during inflorescence development and vegetative vigor.

Table 6: Begging of flowering, end of flowering and duration period of twelve olive genotypes and parental cultivars during 2017, 2018 and 2019 experimental seasons

| | Begging of flowering | | | End of flowering | | | Duration period | | |
|---|---|---|---|---|---|---|---|---|---|
| Genotypes and parental cultivars | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| 13 | 8/3 | 7/3 | 6/3 | 31/3 | 29/3 | 28/3 | 23 days | 21 days | 22 days |
| 14 | 11/3 | 10/3 | 9/3 | 31/3 | 30/3 | 29/3 | 20 days | 20 days | 20 days |
| 15 | 6/3 | 5/3 | 4/3 | 26/3 | 25/3 | 24/3 | 20 days | 20 days | 20 days |
| 53 | 13/3 | 12/3 | 11/3 | 3/4 | 2/4 | 1/4 | 21 days | 21 days | 21 days |
| 68 | 8/3 | 7/3 | 6/3 | 30/3 | 29/3 | 28/3 | 22 days | 22 days | 23 days |
| 69 | 10/3 | 9/3 | 8/3 | 29/3 | 28/3 | 27/3 | 19 days | 19 days | 20 days |
| 75 | 12/3 | 11/3 | 10/3 | 31/3 | 30/3 | 29/3 | 19 days | 20 days | 20 days |
| 77 | 11/3 | 10/3 | 9/3 | 3/4 | 2/4 | 1/4 | 23 days | 23 days | 24 days |
| 79 | 13/3 | 12/3 | 11/3 | 5/4 | 4/4 | 3/4 | 23 days | 23 days | 23 days |
| 81 | 10/3 | 9/3 | 8/3 | 3/4 | 2/4 | 1/4 | 24 days | 24 days | 24 days |
| 85 | 18/3 | 17/3 | 16/3 | 9/4 | 8/4 | 7/4 | 21 days | 22 days | 22 days |
| 86 | 16/3 | 15/3 | 14/3 | 7/4 | 6/4 | 5/4 | 23 days | 22 days | 22 days |
| Chemlali | 13/3 | 12/3 | 11/3 | 2/4 | 1/4 | 31/3 | 20 days | 20 days | 21 days |
| Aggizi | 6/3 | 5/3 | 4/3 | 28/3 | 27/3 | 26/3 | 22 days | 22 days | 22 days |
| Toffahi | 2/3 | 1/3 | 28/2 | 21/3 | 20/3 | 19/3 | 19 days | 19 days | 19 days |
| Arbequin | 21/3 | 20/3 | 19/3 | 11/4 | 10/4 | 9/4 | 21 days | 21 days | 22 days |
| Kalamata | 16/3 | 15/3 | 14/3 | 8/4 | 7/4 | 6/4 | 23 days | 23 days | 23 days |
| Manzanillo | 11/3 | 10/3 | 9/3 | 31/3 | 30/3 | 29/3 | 20 days | 20 days | 20 days |

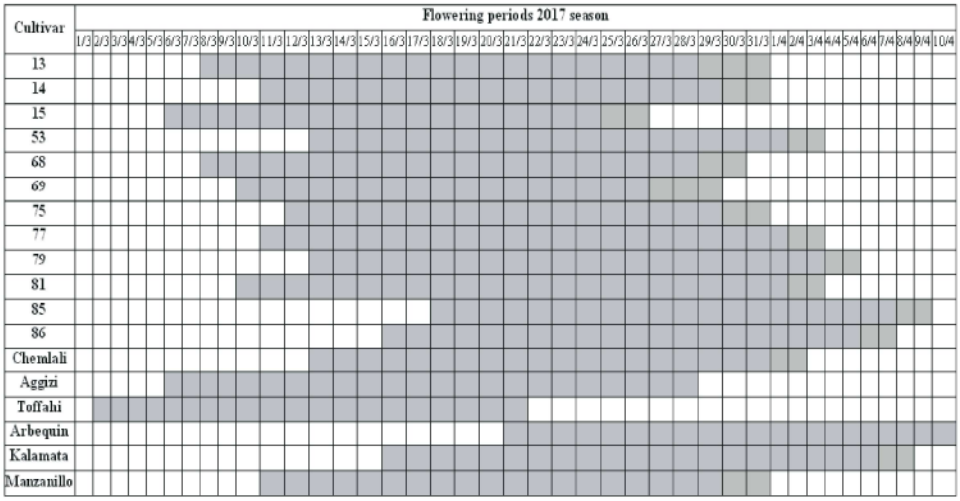


Fig. 4: Time of flowering (start, end and blooming) duration in 2017 season

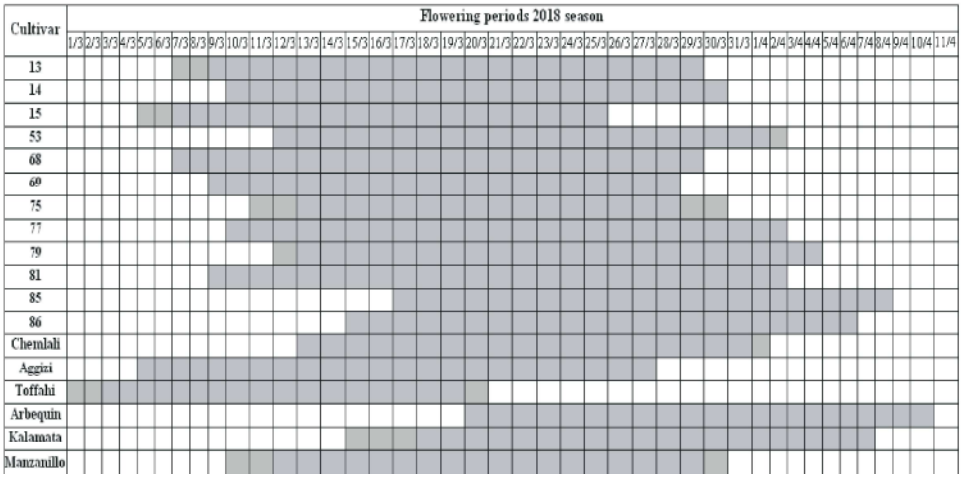


Fig. 5: Time of flowering (start, end and blooming) duration in 2018 season

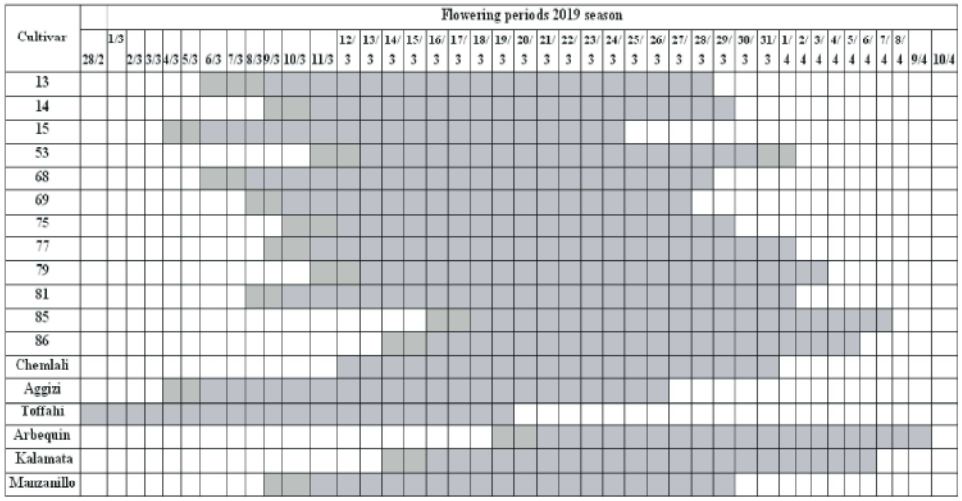


Fig. 6: Time of flowering (start, end and blooming) duration in 2019 season

Table 7: Flowering density (No. of inflorescences/m), inflorescence length (cm), total number of flowers/inflorescence and number of perfect flowers/ inflorescence of twelve olive genotypes and parental cultivars during 2017, 2018 and 2019 experimental seasons.

| | Flowering density (No. of inflorescences /m) | | | Inflorescence length (cm) | | | Total number of flowers/inflorescence | | | No. of perfect flowers / inflorescence | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes and parental cultivars | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| 13 | 107.9I | 111.0JK | 101.1O | 3.12A | 3.10A | 3.10A | 25.20B | 23.90B | 25.10B | 19.85A | 17.55B | 17.69A |
| 14 | 176.0A | 158.8D | 177.7A | 3.01C | 2.90E | 2.99B | 23.60D | 23.20C | 24.45C | 20.06A | 18.99A | 17.53A |
| 15 | 121.6H | 131.6H | 130.7K | 2.59O | 2.63I | 2.01J | 19.40I | 19.80H | 20.12G | 8.95E | 10.20F | 8.98E |
| 53 | 102.8J | 109.4K | 103.6N | 2.87H | 2.75G | 2.86D | 22.30F | 21.20F | 23.75D | 14.50B | 12.30E | 11.95D |
| 68 | 144.9B | 144.4F | 137.8I | 2.82J | 2.87E | 2.88D | 23.20E | 22.60D | 20.95F | 2.50I | 5.70L | 5.12I |
| 69 | 162.9B | 162.9C | 160.0C | 2.65N | 2.70H | 2.64H | 14.60L | 15.22K | 16.71JK | 5.20H | 6.40K | 5.90H |
| 75 | 157.9C | 159.8B | 154.4D | 2.95E | 3.01BC | 3.07A | 15.30K | 14.90L | 14.75N | 7.90F | 8.10I | 7.60FG |
| 77 | 164.8B | 167.8B | 161.5B | 2.97D | 3.10A | 2.99B | 15.62K | 15.90J | 16.77J | 8.01F | 7.99I | 7.15G |
| 79 | 109.4I | 113.2J | 117.4M | 3.03B | 3.12A | 2.70G | 14.14M | 14.85L | 16.15KL | 7.86F | 7.23J | 6.95G |
| 81 | 175.7A | 142.9F | 146.5F | 3.00C | 3.09A | 2.75F | 16.16J | 17.20I | 17.72I | 7.75F | 8.20I | 7.35G |
| 85 | 148.6D | 148.3E | 143.7G | 2.92F | 2.99CD | 3.00B | 14.85L | 14.15M | 15.60LM | 8.12F | 7.32J | 8.22F |
| 86 | 138.3F | 135.1G | 149.5E | 2.89G | 2.97D | 2.99B | 14.72L | 15.25K | 15.35M | 7.95F | 6.99J | 7.11G |
| Chemlali | 130.4G | 125.4I | 125.6L | 3.12A | 3.10A | 3.10A | 25.70B | 26.90A | 27.10A | 14.60B | 15.50C | 15.70B |
| Aggizi | 140.4F | 179.9A | 131.9J | 2.59O | 2.63I | 2.10I | 20.30H | 21.50E | 22.36E | 8.92E | 9.24G | 9.24E |
| Toffahi | 130.4G | 125.4I | 125.6L | 2.78L | 2.81F | 2.86D | 27.30A | 23.30C | 21.20F | 9.70D | 8.60H | 7.40G |
| Arbequin | 120.1H | 126.0I | 131.1JK | 2.69M | 3.03B | 2.90C | 24.22C | 23.80B | 23.70D | 12.20C | 12.70D | 14.60C |
| Kalamata | 138.4F | 144.6F | 141.1H | 2.80K | 2.90E | 2.90C | 21.60G | 20.70G | 18.30H | 7.30G | 8.60H | 8.10F |
| Manzanillo | 91.20K | 91.33L | 100.2P | 2.85I | 2.72GH | 2.82E | 22.50F | 19.90H | 24.60BC | 12.20C | 9.40G | 12.50D |

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test at 5% level

**Inflorescence Length (cm):** Concerning the inflorescence length in Table (7), Chemlali cultivar (as a mother) acquired the maximum inflorescence length and this was reflected to the genotype 13 which achieved the highest inflorescence length, while genotype 15 that derived from Aggizi x Arbequin has the minimal inflorescence length as the effect of Aggizi cultivar. Moreover, all of genotypes and parental cultivars had medium inflorescence length according to Barranco *et al*. [20]; Laaribi *et al*. [2] and IOC [14].

**Total Number of Flowers/Inflorescence:** Data in Table (7) illustrated that, the greatest number of total flowers/ inflorescence were detected by Toffahi followed by Chemlali cultivar in the first season, while Chemlali cultivar was superior in both of second and third season. Moreover, the increases of number of total flowers in genotype 13 and 14 due to genetic makeup of Chemlali cultivar. The reverse was true with group of genotypes 75, 85 and 86 that derived from (Arbequin x Aggizi) which recorded significantly least value.

Similarly according to the division of IOC (2015), the genotype 69 and all of genotypes that derived from (Arbequin x Aggizi) had low number of inflorescence per inflorescence (< 18 flowers), while other genotypes and parental cultivars had medium number of total number of flowers per inflorescence (18 - 25 flowers), except Chemlali cultivar which had high number of flowers per inflorescence (> 25).

Table 8: No of staminate flowers/inflorescence, perfect flowers (%), set fruit/m and yield (kg/tree) of twelve olive genotypes and parental cultivars during 2017, 2018 and 2019 experimental seasons

| | No of staminate (male) flowers/ inflorescence | | | Perfect flowers (%) | | | Fruit Set /m | | | Yield (kg/tree) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes and parental cultivars | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| 13 | 4.35K | 5.35K | 7.46J | 82.02B | 73.43B | 70.34B | 33.33D | 26.47H | 28.18I | 45.00C | 26.50DE | 32.00G |
| 14 | 3.54L | 4.21L | 6.92J | 85.00A | 81.85A | 71.70A | 59.12A | 39.79A | 43.64A | 48.00A | 29.00A | 43.00A |
| 15 | 10.45F | 9.60F | 11.14DE | 46.13H | 51.52F | 44.63H | 29.25H | 24.30K | 27.69J | 28.00J | 17.00J | 29.00HI |
| 53 | 7.80I | 8.90G | 11.80CD | 65.02C | 58.02C | 50.32F | 33.62D | 31.02D | 32.27E | 44.00D | 25.50F | 35.00F |
| 68 | 20.70A | 16.20A | 15.83A | 10.78L | 28.32N | 24.44M | 18.45L | 16.59N | 19.31L | 25.50L | 18.00I | 29.50H |
| 69 | 9.40G | 9.52F | 10.81EF | 35.62J | 37.45M | 35.31L | 25.85I | 23.26L | 28.18I | 28.00J | 16.00K | 25.50L |
| 75 | 7.40I | 6.80J | 7.15J | 51.63F | 54.36D | 51.53EF | 21.80K | 18.84M | 18.87M | 26.00KL | 14.00L | 29.00HI |
| 77 | 7.61I | 7.91HI | 9.62GH | 51.28F | 50.25G | 42.64JK | 33.07DE | 31.02D | 33.71D | 26.50K | 14.00L | 26.50K |
| 79 | 6.28J | 7.62I | 9.20H | 55.59DE | 48.69H | 43.03IJ | 38.33B | 33.04B | 36.04B | 47.50AB | 28.00B | 43.00A |
| 81 | 8.41H | 9.00G | 10.37FG | 47.96G | 47.67I | 41.48K | 25.85I | 23.02L | 28.27I | 28.00J | 18.00I | 26.50K |
| 85 | 6.73J | 6.83J | 7.38J | 54.68E | 51.73F | 52.69E | 35.39C | 32.93B | 34.09C | 47.00B | 27.50BC | 42.00B |
| 86 | 6.77J | 8.26H | 8.24I | 54.01E | 45.84J | 46.32G | 33.60D | 28.89F | 29.68G | 44.50CD | 27.00CD | 43.00A |
| Chemlali | 11.10E | 11.40D | 11.40C-E | 56.81D | 57.62C | 57.93D | 32.60EF | 30.15E | 33.65D | 36.00F | 20.50G | 41.00C |
| Aggizi | 11.38E | 12.26C | 13.12B | 43.94I | 42.98K | 41.32G | 31.47G | 25.40I | 32.57E | 34.00G | 19.00H | 39.50D |
| Toffahi | 17.60B | 14.70B | 13.80B | 35.53J | 36.91M | 34.91L | 31.30G | 25.09J | 29.04H | 32.00H | 17.00J | 38.00E |
| Arbequin | 12.02D | 11.10D | 9.10H | 50.37F | 53.36E | 61.60C | 32.28F | 31.56C | 34.00CD | 43.00E | 26.00EF | 40.50C |
| Kalamata | 14.30C | 12.10C | 10.20FG | 33.80K | 41.5L | 44.26HI | 23.09J | 14.14O | 24.09K | 28.00J | 12.50M | 24.00M |
| Manzanillo | 10.30F | 10.50E | 12.10C | 54.22E | 47.264I | 50.81F | 31.06G | 28.89F | 30.77F | 29.00I | 19.00H | 32.00G |

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test at 5% level.

**Number of Perfect Flowers/Inflorescence:** As shown in Table (7), genotypes 13 & 14 achieved the maximum records in total number of perfect flowers/inflorescence and superior on the parental cultivars. On the other side, the lowest value was attained by genotype 68. Similarly, other genotypes and parental cultivars were in between the aforesaid extremes.

**Total Number of Staminate (Male) Flowers/Inflorescence:** Tabulated data that presented in Table (9) demonstrated that the highest number of staminate flowers was detected by genotype 68 during three studied seasons, while the minimal one was achieved in genotype 14.

**Perfect Flowerer Percent:** Table (8) display obviously that, the highest percent of perfect flowers was statistically detected by genotype 14 comparing with other genotypes and parental cultivars during 2017, 2018 & 2019 experimental seasons. Anyhow, the least number of perfect flowers percent was significantly in concomitant to olive genotype 68 during the experimental seasons. Additionally, there was no apparent effect of parental cultivars on genotypes. In this concern, Osman [33] and Shereen [23] found that the percentage of perfect flowers in olive vary from year to year, tree to tree, shoot to shoot and inflorescence to inflorescence and the flowering density can be considered the major factor affected the percentage of perfect flowers.

**Fruit Set (%):** Data of the tested genotypes and parental cultivars in Table (8), showed a vast variability in the fruit set (%). Olive genotype 14 acquired the highest fruit set (%) at the three studied seasons respectively and superiority on the other genotypes and parental cultivars. The least fruit set percent obtained by genotype 68. Similarly, the present result goes partially in the line with that pointed out by Cuevas and Rallo [34]; Ferri *et al*. [35] and El-Badawy *et al*. [31], who reported that differences between olive cvs. in fruit set (%) due to a varying degree of self fertility and cross pollination requirements and percentage of perfect flowers that effects on determining fruit set percentage.

**Yield (Kg/tree):** Data of the three years fruit yield presented in Table (8) demonstrated that, high differences were found between new olive genotypes and cultivars. Olive genotype 14 acquired the highest fruit yield at the three studied seasons respectively and superiority on the other genotypes and parental cultivars. Arbequin cultivar acquired the highest yield (Kg/tree) comparing with other cultivars and this was reflected to the genotypes 79, 85 and 86 (Arbequin x Aggizi) which achieved the maximum yield and superior on the other genotypes and cultivars. On the other side, the lowest yield was recorded in Kalamata as a table olive cultivar during 2017, 2018 & 2019 seasons. In general, the majority of genotypes that produced from (Arbequin x Aggizi) and (Chemlali x Toffahi) were characterized as a good yield. The aforementioned results goes partially in the line with that pointed out by Mikhail [9]; Yamen *et al*. [36] and Dridi *et al*. [37] who pointed that olive yield crop affected by several factors as biennial bearing phenomenon with different levels according to the cultivar genotypes, environmental factors and relatively independent of the number of flowers.

Table 9: Fruit weight (g), seed weight and flesh weight of twelve olive genotypes and parental cultivars during 2017, 2018 and 2019 experimental seasons

| | Fruit weight (g) | | | Seed weight (g) | | | Flesh weight (g) | | |
|---|---|---|---|---|---|---|---|---|---|
| Genotypes and parental cultivars | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| 13 | 3.67H | 3.71H | 3.72J | 0.57J | 0.59J | 0.56G-I | 3.10H | 3.12H | 3.16I |
| 14 | 3.85G | 3.92G | 3.91I | 0.65G | 0.63H | 0.66EF | 3.20G | 3.29G | 3.25H |
| 15 | 6.14C | 6.12BC | 6.16C | 0.77E | 0.79E | 0.80CD | 5.37B | 5.33B | 5.36B |
| 53 | 4.98D | 4.96D | 4.99E | 0.82D | 0.85D | 0.86BC | 4.16D | 4.11E | 4.13E |
| 68 | 4.78E | 4.74E | 4.81G | 0.74F | 0.71F | 0.74DE | 4.04E | 4.03E | 4.07F |
| 69 | 4.82E | 4.78E | 4.86F | 0.65G | 0.68G | 0.69EF | 4.17D | 4.10E | 4.17DE |
| 75 | 2.54I | 2.59I | 2.61K | 0.52K | 0.54L | 0.55HI | 2.02I | 2.05I | 2.06J |
| 77 | 2.22J | 2.26J | 2.29L | 0.59IJ | 0.61I | 0.61F-H | 1.63K | 1.65K | 1.68L |
| 79 | 4.24F | 4.28F | 4.32H | 0.63GH | 0.59J | 0.62F-H | 3.61F | 3.69F | 3.70G |
| 81 | 2.12K | 2.07K | 2.20M | 0.61HI | 0.64H | 0.65E-G | 1.51L | 1.43L | 1.55M |
| 85 | 1.80L | 1.87L | 1.89N | 0.31M | 0.37N | 0.35J | 1.49L | 1.50L | 1.54M |
| 86 | 2.25J | 2.32J | 2.30L | 0.52K | 0.56K | 0.55HI | 1.73J | 1.76J | 1.75K |
| Chemlali | 0.98M | 0.96N | 0.94P | 0.32M | 0.35O | 0.37J | 0.66N | 0.61N | 0.57O |
| Aggizi | 6.15C | 6.09C | 6.17C | 0.91C | 0.95B | 0.94B | 5.24C | 5.14D | 5.23C |
| Toffahi | 8.00A | 8.11A | 7.95A | 1.05A | 1.12A | 1.08A | 6.95A | 6.99A | 6.87A |
| Arbequin | 1.79L | 1.74M | 1.84O | 0.48L | 0.52M | 0.51I | 1.31M | 1.22M | 1.33N |
| Kalamata | 6.28B | 6.18B | 6.27B | 0.96B | 0.95B | 0.90B | 5.32B | 5.23C | 5.37B |
| Manzanillo | 5.03D | 4.99D | 5.07D | 0.91C | 0.87C | 0.88BC | 4.12D | 4.12E | 4.19D |

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test at 5% level.

Table 10: Fruit length (cm), fruit diameter (cm) and fruit shape index of twelve olive genotypes and parental cultivars during 2017, 2018 and 2019 experimental seasons

| | Fruit length (cm) | | | Fruit diameter (cm) | | | Fruit shape index | | |
|---|---|---|---|---|---|---|---|---|---|
| Genotypes and parental cultivars | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| 13 | 2.35F | 2.42EF | 2.38I | 1.78D | 1.86G-I | 1.78G | 1.32E | 1.38F | 1.34G |
| 14 | 2.47D | 2.53DE | 2.55F | 1.77D | 1.81FG | 1.80G | 1.40D | 1.40E | 1.42E |
| 15 | 2.85A | 2.79AB | 2.86B | 2.15B | 2.12B | 2.20B | 1.33D | 1.32G | 1.30H |
| 53 | 2.43DE | 2.39F | 2.44G | 1.89C | 1.86EF | 1.90F | 1.29EF | 1.28HI | 1.28I |
| 68 | 2.78B | 2.81AB | 2.79C | 1.92C | 1.91C-E | 1.93DE | 1.45CD | 1.47C | 1.45D |
| 69 | 2.65C | 2.71BC | 2.70E | 1.89C | 1.91C-E | 1.93DE | 1.40D | 1.42D | 1.40F |
| 75 | 1.97G | 1.95G | 1.98JK | 1.57E | 1.51J | 1.55I | 1.25FG | 1.29H | 1.28I |
| 77 | 1.99G | 2.00G | 1.99J | 1.71D | 1.74HI | 1.72H | 1.16HI | 1.15L | 1.16L |
| 79 | 2.33F | 2.30F | 2.40H | 1.90C | 1.95C | 1.96C | 1.23G | 1.18K | 1.22K |
| 81 | 1.95G | 1.98G | 1.98JK | 1.76D | 1.77GH | 1.79G | 1.11IJ | 1.12M | 1.11N |
| 85 | 1.94G | 1.96G | 1.97K | 1.38F | 1.40K | 1.41J | 1.41D | 1.40E | 1.40F |
| 86 | 1.98G | 1.99G | 1.98JK | 1.69D | 1.71I | 1.73H | 1.17H | 1.16L | 1.14M |
| Chemlali | 1.01I | 1.00I | 0.96M | 0.52H | 0.51M | 0.48L | 1.94A | 1.96A | 2.00A |
| Aggizi | 2.74B | 2.59CD | 2.71DE | 2.17B | 2.14B | 2.19B | 1.26FG | 1.21J | 1.24J |
| Toffahi | 2.75B | 2.83B | 2.72L | 2.54A | 2.51A | 2.55A | 1.08J | 1.09N | 1.07O |
| Arbequin | 1.66H | 1.74H | 1.72L | 0.89G | 0.89L | 0.88K | 1.87B | 1.96A | 1.95B |
| Kalamata | 2.87A | 2.91A | 2.95A | 1.91C | 1.92CD | 1.95CD | 1.50C | 1.52B | 1.51C |
| Manzanillo | 2.41E | 2.40EF | 2.44G | 1.91C | 1.89DE | 1.91EF | 1.26FG | 1.27I | 1.28I |

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test at 5% level.

Table 11: Seed length (cm), seed diameter (cm) and seed shape index of twelve olive genotypes and parental cultivars during 2017, 2018 and 2019 experimental seasons

| | Seed length (cm) | | | Seed diameter (cm) | | | Seed shape index | | |
|---|---|---|---|---|---|---|---|---|---|
| Genotypes and parental cultivars | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| 13 | 1.46FG | 1.47G | 1.48G | 0.75HI | 0.74F | 0.74IJ | 1.95D | 1.99C | 2.00B |
| 14 | 1.44G | 1.43H | 1.42H | 0.76H | 0.75F | 0.77GH | 1.89F | 1.91D | 1.84E |
| 15 | 1.74B | 1.72C | 1.75B | 0.84E | 0.82E | 0.85E | 2.07A | 2.10A | 2.06A |
| 53 | 1.72BC | 1.75B | 1.76B | 0.87D | 0.85D | 0.88D | 1.98C | 2.06AB | 2.00B |
| 68 | 1.79A | 1.77A | 1.79A | 0.87D | 0.88C | 0.87DE | 2.06A | 2.01BC | 2.06A |
| 69 | 1.65D | 1.66E | 1.68D | 0.82F | 0.80E | 0.82F | 2.01B | 2.08A | 2.05A |
| 75 | 0.71K | 0.72L | 0.71N | 0.69J | 0.71G | 0.72JK | 1.03N | 1.01I | 0.99J |
| 77 | 0.85I | 0.86J | 0.85L | 0.74I | 0.75F | 0.76HI | 1.15L | 1.15G | 1.12H |
| 79 | 1.47F | 1.49F | 1.51F | 0.79G | 0.76F | 0.79G | 1.86G | 1.96CD | 1.91CD |
| 81 | 0.87I | 0.85J | 0.88K | 0.76H | 0.75F | 0.77GH | 1.14L | 1.13G | 1.14H |
| 85 | 0.59L | 0.61M | 0.62O | 0.55M | 0.57I | 0.59M | 1.07M | 1.07H | 1.05I |
| 86 | 0.79J | 0.80K | 0.79M | 0.67K | 0.69G | 0.70K | 1.18K | 1.16G | 1.13H |
| Chemlali | 0.78J | 0.72L | 0.68O | 0.41N | 0.40J | 0.37N | 1.90F | 1.80E | 1.84E |
| Aggizi | 1.74B | 1.71C | 1.72C | 0.94B | 0.89C | 0.91BC | 1.85G | 1.92D | 1.89D |
| Toffahi | 1.80A | 1.71C | 1.63E | 0.99A | 0.97A | 0.92B | 1.82H | 1.76E | 1.77F |
| Arbequin | 0.99H | 0.94I | 0.97J | 0.65L | 0.62H | 0.64L | 1.52J | 1.52F | 1.52G |
| Kalamata | 1.55E | 1.42H | 1.02I | 0.95B | 0.93B | 0.97A | 1.63I | 1.53F | 1.05I |
| Manzanillo | 1.71C | 1.69D | 1.71C | 0.89C | 0.88C | 0.89CD | 1.92E | 1.92D | 1.92C |

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test at 5% level.

Table 12: Flesh/seed ratio, flesh/fruit (%) and seed/fruit (%) of twelve olive genotypes and parental cultivars during 2017, 2018 and 2019 experimental seasons

| | Flesh/seed ratio | | | Flesh/fruit (%) | | | Seed / fruit (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| Genotypes and parental cultivars | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| 13 | 5.44F | 5.29G | 5.64D | 84.47D | 84.10DE | 84.95D | 15.53I | 15.90IJ | 15.05I |
| 14 | 4.92H | 5.22G | 4.92F | 83.12EF | 83.93E | 83.12E | 16.88GH | 16.07I | 16.88H |
| 15 | 6.97A | 6.75A | 6.70A | 87.46A | 87.09A | 87.01A | 12.54L | 12.91M | 12.99L |
| 53 | 5.07G | 4.84H | 4.80G | 83.53E | 82.86F | 82.77E | 16.47H | 17.14H | 17.23H |
| 68 | 5.46EF | 5.68D | 5.50E | 84.52D | 85.02C | 84.62D | 15.48I | 14.98K | 15.38I |
| 69 | 6.42C | 6.03C | 6.04C | 86.51B | 85.77B | 85.80C | 13.49K | 14.23L | 14.20J |
| 75 | 3.88K | 3.80K | 5.75I | 79.53H | 79.15H | 78.93G | 20.47E | 20.85F | 21.07F |
| 77 | 2.76M | 2.70M | 2.75I | 73.42J | 73.01J | 73.36I | 26.58C | 26.99D | 26.64D |
| 79 | 5.73D | 6.25B | 5.97C | 85.14C | 86.21B | 85.65C | 14.86J | 13.79L | 14.35J |
| 81 | 2.48N | 2.23O | 2.38M | 71.23K | 69.08L | 70.45K | 28.77B | 30.92B | 29.55B |
| 85 | 4.81I | 4.05J | 4.40H | 82.78F | 80.21G | 81.48F | 17.22G | 19.79G | 18.52G |
| 86 | 3.33L | 3.14L | 3.18J | 76.89I | 75.86I | 76.09H | 23.11D | 24.14E | 23.91E |
| Chemlali | 2.06O | 1.74P | 1.4N | 67.35L | 63.54M | 60.64L | 32.65A | 36.46A | 39.36A |
| Aggizi | 5.76D | 5.41F | 5.56DE | 85.20C | 84.40DE | 84.76D | 14.80J | 15.60IJ | 15.24I |
| Toffahi | 6.62B | 6.24B | 6.36B | 86.88B | 86.19B | 86.42B | 13.13K | 13.81L | 13.58K |
| Arbequin | 2.73M | 2.35N | 2.61L | 73.18J | 70.11K | 72.28J | 26.82C | 29.89C | 27.72C |
| Kalamata | 5.54E | 5.51E | 5.97C | 84.71CD | 84.63CD | 85.65C | 15.29IJ | 15.37JK | 14.35J |
| Manzanillo | 4.53J | 4.74I | 4.76G | 81.91G | 82.57F | 82.64E | 18.09F | 17.43H | 17.36H |

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test at 5% level

## Fruit Characteristics

**Fruit, Seed and Flesh Weight (g):** Fruit characters measurements of the new obtained olive genotypes and their corresponding genitors are given in Tables (9, 10, 11 and 12). Significant differences were observed according to fruit, stone and flesh weight. The highest fruit, seed and flesh weight value was obtained from Toffahi cultivar as a table olive cultivar, while the Chemlali cultivar as oil cultivar acquired the lowest fruit, seed and flesh weight during three studied seasons. Moreover, the (G85) gave the minimal seed weight in the partnership of Chemlali cultivar in the first and third season.

Fruit weight and flesh weight or percent are considered the most important parameters that used as descriptive fruit characters and thus are required for the new cultivar registration procedure for olive cultivar candidates in breeding studies according the description of fruit weight by Barranco *et al*. [20], the genotype 85, Chemlali and Arbequin had low fruit weight, the genotypes 13, 14, 75, 77 & 81 had medium fruit weight, the genotypes 53, 68, 69, 79 and manzanillo cultivar had high fruit weight and the genotype 15, Aggizi, Toffahi and Kalamata cultivar had very high fruit weight. On the other hand, Bellini *et al*. [4] classificated fruit as their weight to: less than (2.5 g) are usually classified as oil and the bigger than (2.5 g) are classified as table olive cultivars. Similarly, flesh percentage, is an important criteria for the classification of olive cultivars. Cultivars with more than 80% flesh are considered as table olive, while cultivars with less than (80%) flesh are classified as oil olive [5].

**Fruit Length, Width (cm) and Fruit Shape Index (L/W):** As regard to the presented data in Table (10), it could be noticed that, Kalamata olive cultivar significantly appeared the greatest length of fruit (2.87, 2.91, 2.95 cm) followed by genotype 15 (2.85, 2.79 and 2.86 cm) in the three season respectively, Toffahi olive cultivar achieved the maximum fruit width whereas, the least fruit length and width was in concomitant to Chemlali olive cultivar. Meantime, the ratio between the length and the width was calculated to determine the differences among the tested genotypes and parental cultivars in shape, it is appearing the superiority of Chemlali cultivar, otherwise Toffahi cultivar was the minimal one. According the description of IOC [14], the genotypes 77, 79, 81 & 86, Aggizi and Toffahi cultivar had spherical shape; the genotypes 13, 14, 15, 53, 69, 75, 77, 85 and Manzanillo cultivar had ovoid fruit shape and the genotype 68, Chemlali, Arbequin and Kalamata had elongated fruit shape. This result was the parallel with those found by Ozdemir *et al*. [5] and Yamen *et al*. [36] who reported that Length, diameter and length/ diameter ratio influence the olive shape which is important in characterization during breeding programs.

**Seed Length, Width (cm) and Seed Shape Index (L/W):** Data in Table (11) displays obviously that, the genotype 68 was the superior in seed length of the three studied seasons, also Toffahi cultivar had the superiority in the first season. Whereas, the least fruit length was concomitant to genotype 85. Moreover, the highest seed width acquired by Toffahi followed by Kalamata cultivars. However, the least records were attained by Chemlali cultivar. Referring to length/width ratio for seeds conformed to the seed shape index, it was Spherical in genotypes 75, 77, 81 and 86; Ovoid in Toffahi, Arbequin and Kalamata cultivars and Elliptic in genotypes 13, 14, 15, 53, 68, 75 and 79 as well as in Chemlali, Aggizi and Manzanillo cultivars.

**Flesh/Seed Ratio, Flesh/Fruit (%) and Seed/Fruit (%):** As regard to the presented data in Table (12), the highest value of flesh/fruit weight and flesh/seed ratio was obtained in genotype 15, while Chemlali cultivar achieved the least one. Otherwise, the highest seed/fruit (%) attained by Chemlali cultivar, whereas, the genotype 15 was the minimal one in three studied seasons respectively. In general, many studies on genotypes, revealed that, a high percentage of pulps means a better commercial value for both table and oil production [38, 2, 5].

**Moisture Content in the Fruit:** Regarding to the moisture content that presented in Table (13), it was demonstrated the superiority of genotype 69 in the three studied season as well as, Toffahi cultivar in the first season in moisture content, but decreased to the minimum in genotype 75 in the first season; Arpequin and Kalamata in the second season and genotype 81 and Chemlali cultivar in the third season. Moreover, the finding of many studies observed that, the moisture content is an important parameter for determined the quantity of oil, a high moisture content indicates at lower oil content [38, 36, 37].

**Percentage of Oil Content in the Fruit (Fresh and Dry Weight Basis):** Table (13) showed that the highest oil content as fresh weight and dry weight was attained by Chemlali and Arbequin, whereas, the lowest content attained by genotype 14 and genotype 79 for dry weight in the three seasons of study and Chemlali cv. in the 3$^{rd}$ season. While, Toffahi cultivar was the minimal one in fruits fresh and dry weights oil content in all studied seasons. Del Rio and Caballero [39] and Tous and Romero [40] divided olives into three groups (based on oil percentage on dry weight basis) as high (> 46%), moderate (38-46%) and low (< 38%). In the current research, according to the oil percentage on the basis of dry matter, all of genotypes and parental cultivars had the high oil percentage group whereas, genotypes 18, 68 and 69 had moderate oil percentage group and Aggizi and Toffahi cultivars had 'low' oil percentage group. Oil content in olive fruits is affected by several factors, especially genetic competence (Genotype) of the cultivar,

Table 13: Moisture content, oil content (dry weight basis); oil content (fresh weight basis): and rooting ability % of twelve olive genotypes and parental cultivars during 2017, 2018 and 2019 experimental seasons

| | Moisture (%) | | | Oil % (dry weight basis) | | | Oil % (fresh weight basis) | | | Rooting ability (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotypes and parental cultivars | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| 13 | 66.95C | 64.48H | 66.75F-H | 53.15B | 47.78F | 51.47E | 18.19G | 16.41EF | 17.11E | 21.50FG | 23.00E | 23.50F |
| 14 | 66.75C | 64.77GH | 66.95FG | 54.00A | 54.45A | 56.91A | 19.11A | 19.25A | 19.59A | 19.00K | 24.50D | 25.50E |
| 15 | 70.15B | 69.15C | 73.01B | 47.78F | 46.29G | 51.7E | 17.83I | 11.78H | 11.30G | 19.50JK | 22.50E | 22.50GH |
| 53 | 64.48DE | 67.10D | 66.95FG | 51.47D | 53.15B | 51.95E | 18.70D | 17.69C | 18.16C | 19.00K | 20.00G | 21.00JK |
| 68 | 70.45B | 69.15C | 68.1D | 40.22H | 42.59H | 47.78F | 12.68L | 13.14G | 12.50F | 17.50L | 16.00J | 15.50O |
| 69 | 72.15A | 70.65A | 74.35A | 40.22H | 37.07K | 40.65H | 11.20N | 10.88I | 10.43H | 16.50M | 17.00I | 17.50N |
| 75 | 62.99F | 65.45FG | 67.10EF | 52.02C | 47.50F | 52.31DE | 12.04M | 18.22B | 17.83CD | 19.50JK | 21.50F | 19.50M |
| 77 | 64.65DE | 66.35DE | 68.09DE | 53.15B | 47.95F | 53.95BC | 18.29F | 17.06D | 16.97E | 21.50FG | 20.00G | 20.50KL |
| 79 | 66.32C | 65.95EF | 66.75F-H | 53.95A | 52.92B | 56.91A | 18.94B | 18.70B | 19.11B | 20.50HI | 18.50H | 21.50IJ |
| 81 | 64.05D-F | 65.99EF | 64.48JK | 52.92B | 49.86E | 53.95BC | 17.11J | 16.97D | 17.83CD | 21.00GH | 19.00H | 22.00HI |
| 85 | 64.37DE | 64.48H | 65.75HI | 53.17B | 52.25C | 56.19A | 18.94B | 18.22B | 18.20C | 22.00EF | 20.00G | 20.00LM |
| 86 | 64.85DE | 56.89J | 65.37IJ | 51.90C | 51.95C | 54.45B | 18.81C | 18.81C | 18.16C | 20.00IJ | 20.50G | 21.50IJ |
| Chemlali | 65.11D | 64.65GH | 64.05HI | 50.11E | 51.18D | 56.15A | 18.06H | 17.19D | 17.69D | 22.50E | 24.00D | 23.00FG |
| Aggizi | 70.15B | 69.62BC | 70.35C | 19.85I | 22.95L | 26.03J | 5.93O | 6.97J | 7.72I | 53.00C | 55.00C | 57.00B |
| Toffahi | 71.68A | 70.15AB | 69.85C | 18.08J | 19.85M | 18.25K | 5.12P | 5.93K | 5.50J | 52.00D | 55.00C | 52.00D |
| Arbequin | 64.37DE | 63.16I | 65.12IJ | 50.03E | 49.33E | 53.14CD | 18.50E | 17.01D | 18.11C | 60.00A | 58.00A | 58.00A |
| Kalamata | 63.75EF | 63.45I | 68.09DE | 40.35H | 38.20J | 39.28I | 16.97K | 16.76DE | 17.19E | 10.05N | 9.92K | 10.25P |
| Manzanillo | 63.95D-F | 66.66DE | 65.95G-I | 42.92G | 39.36I | 41.87G | 18.52E | 16.97D | 17.11E | 55.00B | 56.00B | 53.00C |

Means within a column having the same letters are not significantly different according to Duncan's Multiple Range Test at 5% level.

Table 14: List of some morphological descriptors and oil content of the twelve evaluated genotypes and parental cultivars according to (IOC) under Egypt condition

| Genotypes and parental cultivars | Leaf shape index | Fruit shape index | Fruit weight | Flesh/ seed | Oil content in dry weight |
|---|---|---|---|---|---|
| 13 | Eleptic- lanceolate | Ovoid | Medium | Medium | High |
| 14 | Eleptic- lanceolate | Ovoid | Medium | Medium | High |
| 15 | Eleptic- lanceolate | Ovoid | Very high | Medium | Medium |
| 53 | Eleptic- lanceolate | Spherical | High | Medium | High |
| 68 | Eleptic- lanceolate | Elongated | High | Medium | Medium |
| 69 | Eleptic- lanceolate | Ovoid | High | High | Medium |
| 75 | Eleptic- lanceolate | Ovoid | Medium | Low | High |
| 77 | Lanceolate | Spherical | Medium | Low | Medium |
| 79 | Eleptic- lanceolate | Spherical | High | Medium | High |
| 81 | Eleptic- lanceolate | Spherical | Medium | Low | High |
| 85 | Eleptic- lanceolate | Ovoid | Low | Low | High |
| 86 | Eleptic- lanceolate | Spherical | Medium | Low | Medium |
| Chemlali | Eleptic- lanceolate | elongated | Low | Low | High |
| Aggizi | Eleptic- lanceolate | Spherical | Very high | Medium | Very low |
| Toffahi | Eleptic- lanceolate | spherical | Very high | Medium | Very low |
| Arbequin | Eleptic- lanceolate | elongated | Low | Low | High |
| Kalamata | Eleptic- lanceolate | elongated | Very high | Medium | High |
| Manzanillo | Eleptic- lanceolate | ovoid | High | Low | High |

climatic conditions and soil type, agricultural practices and harvesting date [41]. In general, the total oil contents of olive cultivars in our study were closely matched the results of the previous studies on international imported cultivars and the result on local cultivars [37, 10, 31].

**Rooting Ability %:** Rooting ability percentage of the semi-hardwood cuttings taken from tested genotypes and parental cultivars cleared in Table (13) illustrated that the rooting percent varied from 10.05, 9.92 and 10.25 % in Kalamata cv., to reach 60.00, 58.00 and 58.00 % in Arbequin cv. during the three studied seasons. Accordingly, genotypes 68 & 69 and Kalamata cultivar classified as very low, whereas each of Aggizi, Toffahi, Arbequin and Manzanillo cultivars were classified as medium. As the previous study, the classification of rooting ability percent helps to divide the types of cuttings into easy and hard to root [42 , 23].

**General Evaluation of the Twelve Evaluated Genotypes and Parental Cultivars under Egypt Condition:** Data in Table (15) that obtained from this investigation was selected to a system of numerical evaluation of tested genotype. The final evaluation was calculated on basis of 100 units, which were shared between No. of inflorescences/m, perfect flowers (%), fruit set /m, fruit weight (g), flesh/fruit weight, yield and fruit oil (dry weight basis) (%) characteristics which were specified as

Table 15: General evaluation of the twelve evaluated genotypes and parental cultivars during average three seasons (2017, 2018 and 2019) under Egypt condition

| | No. of inflorescences/m | | Perfect flowers (%) | | Fruit set /m | | Fruit weight (g) | | Flesh/fruit weight | | Yield (Kg/tree) | | Fruit oil (%) dry weight basis | | Total units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | Units 5 | % | Units 5 | % | Units 15 | % | Units 10 | % | Units 5 | Kg/tree | Units 30 | % | Units 30 | 100 |
| 13 | 106.3 | 3.12 | 75.26 | 4.73 | 29.33 | 9.26 | 3.70 | 4.61 | 84.50 | 4.74 | 34.50 | 25.88 | 50.80 | 27.65 | 79.99 |
| 14 | 170.5 | 5.00 | 79.52 | 5.00 | 47.52 | 15.00 | 3.89 | 4.85 | 83.39 | 4.68 | 40.00 | 30.00 | 55.12 | 30.00 | 94.53 |
| 15 | 128.0 | 3.75 | 47.43 | 2.98 | 27.08 | 8.55 | 6.14 | 7.66 | 87.19 | 4.89 | 24.67 | 18.50 | 48.59 | 26.45 | 72.78 |
| 53 | 110.5 | 3.24 | 57.79 | 3.63 | 32.30 | 10.20 | 4.98 | 6.21 | 84.16 | 4.72 | 34.83 | 26.12 | 52.19 | 28.41 | 82.53 |
| 68 | 142.4 | 4.18 | 21.18 | 1.33 | 18.12 | 5.72 | 4.78 | 5.96 | 84.72 | 4.75 | 24.33 | 18.25 | 43.53 | 23.69 | 63.88 |
| 69 | 167.9 | 4.92 | 36.13 | 2.27 | 25.76 | 8.13 | 4.82 | 6.01 | 89.09 | 5.00 | 23.17 | 17.38 | 39.31 | 21.40 | 65.11 |
| 75 | 157.3 | 4.61 | 52.51 | 3.30 | 19.84 | 6.26 | 2.58 | 3.22 | 79.20 | 4.44 | 23.00 | 17.25 | 50.61 | 27.55 | 66.63 |
| 77 | 169.2 | 4.96 | 48.06 | 3.02 | 32.60 | 10.29 | 2.26 | 2.81 | 73.11 | 4.10 | 22.17 | 16.63 | 51.68 | 28.13 | 69.94 |
| 79 | 113.3 | 3.32 | 49.10 | 3.09 | 35.80 | 11.30 | 4.28 | 5.34 | 85.67 | 4.81 | 39.50 | 29.63 | 54.59 | 29.71 | 87.2 |
| 81 | 155.0 | 4.55 | 45.70 | 2.87 | 25.71 | 8.12 | 2.13 | 2.66 | 70.27 | 3.94 | 24.00 | 18.00 | 52.24 | 28.43 | 68.57 |
| 85 | 146.9 | 4.31 | 53.03 | 3.33 | 34.14 | 10.78 | 1.85 | 2.31 | 81.47 | 4.57 | 38.83 | 29.12 | 53.87 | 29.32 | 83.74 |
| 86 | 141.0 | 4.13 | 48.72 | 3.06 | 30.72 | 9.70 | 2.29 | 2.86 | 76.27 | 4.28 | 38.17 | 28.63 | 52.77 | 28.72 | 81.38 |
| Chemlali | 127.1 | 3.73 | 57.45 | 3.61 | 32.13 | 10.14 | 0.96 | 1.20 | 63.89 | 3.59 | 32.50 | 24.38 | 52.48 | 28.56 | 75.21 |
| Aggizi | 136.7 | 4.01 | 42.75 | 2.69 | 29.81 | 9.41 | 6.14 | 7.65 | 84.79 | 4.76 | 30.67 | 23.00 | 22.94 | 12.49 | 64.01 |
| Toffahi | 127.1 | 3.73 | 35.78 | 2.25 | 28.48 | 8.99 | 8.02 | 10.00 | 86.49 | 4.85 | 29.00 | 21.75 | 18.73 | 10.19 | 61.76 |
| Arbequin | 125.7 | 3.69 | 55.11 | 3.47 | 32.61 | 10.29 | 1.79 | 2.23 | 71.88 | 4.03 | 36.50 | 27.38 | 50.83 | 27.67 | 78.76 |
| Kalamata | 141.4 | 4.15 | 39.85 | 2.51 | 20.44 | 6.45 | 6.24 | 7.78 | 85.00 | 4.77 | 21.50 | 16.13 | 39.28 | 21.38 | 63.17 |
| Manzanillo | 94.5 | 2.77 | 50.76 | 3.19 | 30.24 | 9.55 | 5.03 | 6.27 | 82.37 | 4.62 | 26.67 | 20.00 | 41.38 | 22.52 | 66.92 |

shown in Table (14) to: (5) units for No. of inflorescences/m, perfect flowers (%) and flesh fruit weight; (10) units for fruit weight (g); (15) units for fruit set, (30) units for the total yield/tree and fruit oil (%) (dry weight basis). Within each criterion, the genotypes that gave the highest value received the "full mark" for it, i.e. all the units specified for this criterion and the other tested genotypes received lower units calculated. From the tabulated data the genotypes (G14, G79, G85, G53, G13) achieved the highest units, while the genotypes (G68&G69) achieved the least units [25].

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