Middle East Journal of Applied Sciences
ISSN 2077-4613
Volume : 09 | Issue :02 |April-June| 2019
Pages: 421-433

Effect of Chilling Requirements on Flowering and Productivity of Some Native and Foreign Olive Cultivars under the Egyptian Conditions

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Received: 15 March 2019 / Accepted 05 May 2019 / Publication date: 15 May 2019

ABSTRACT

The present investigation was conducted during two successive seasons (2015/2016 & 2016/ 2017) on 6 olive cultivars, the native ones were (Toffahi, Aggizi Shame and Lewa) and the foreign were (Picual, Manzanillo and Dolce) grown in a private orchard at AL-Khatatba, Minufiya Governorate, Egypt.

The aim of this study is to investigate the effect of the chilling requirements on the flowering and productivity on the tested cultivars by three models of chilling units' calculation (UT, LC and NC models) and two methods of hourly counting (≤ 7.2 ˚C and ≤ 10 ˚C) to reach by the recommendation of the most suitable cultivars (whether native or foreign) which grown in this region under the recent changes of climate conditions.

The meteorological results noticed that, the second season was higher in chilling accumulation compared with the first season of the study in all tested models and methods. The calculations by chilling hours do not reflect the number of actual chilling units compared with the chilling models. (UT model) might be more compatible with the chilling units under the local conditions compared to the others two models (LC and NC models) whose results were much higher and might be more suitable with the other cooler areas.

Regarding to the phenological data, all dates of flowering were earlier in the second season than the first season, all cultivars of the study showed earlier full bloom in the second season than the first one. The 2nd season had higher significant values in all the Phenological characteristics compared with the 1st one. Toffahi and Aggizi Shame cvs. gave the highest significantly values in no. of inflo./shoot, flowering denisty and total numbers of flowers/inflo compared with the other cultivars. In addition, Aggizi Shame and El-Lewa cvs. produced the highest significant number of perfect flowers/inflo. and perfect flowers%, whereas Dolce cv. was the highest one in all the previous parameters compared with foreign cvs.

All cultivars the second season showed the superiority in number of fruit/ meter and yield/tree compared with the first season. Dolce cv. followed by Aggizi Shame achieved the greatest number of fruits/meter. While, Toffahi cv. followed by Dolce produced the maximum yield/tree.

We can concluded that, two native cultivars (Toffahi, Aggizi Shame) and one foreign cultivar (Dolce) gave the greatest values in most of the phenoligocal parameters and yield which it means that, there were the most adaptable cultivars compared with other cultivars under the same climatic conditions of investigation.

Keywords: Chilling requirements -olive cultivars - Chilling calculation models

Introduction

Olive tree (*Olea europaea* L.) belongs to the family Oleaceae. It can thrive and produce where other crops can't grow. It is considered to be an important fruit. It can be as a good candidate for planting in the new reclaimed areas, due to drought and salinity tolerance (Abou El-Khashab, 2002), the last statistics of the Ministry of Agriculture and Land Reclamation (2017) cited that the total grown olive area reached (239201 feddans), and the fruiting area is (216014 feddans) produced (1080206 tons).

Climate warming has affected chilling and heat accumulation rates for fruit trees in recent decades (Luedeling *et al.* 2011). Historic declines in winter chill have been detected in many warm fruit growing regions, and this trend will likely be exacerbated by future temperature increases (Darbyshire *et al.* 2011; Farag *et al.* 2010). Impacts of climate change on the flowering of fruits have aroused

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worldwide interest. Earlier flowering events have occurred for some fruits in many countries due to global warming (Grab and Craparo 2011; Guédon and Legave, 2008). However, some fruit trees grown in areas that are substantially warmer than their native habitat have displayed delayed flowering (Elloumi *et al.,*2013; Legave *et al.,*2013), hence we can say that, the global warming had the greatest impact on chilling requirements which is one of the most important environmental effects on olive production in winter (Omran, 2013).

Furthermore, initiation of olive cultivars differs from location to another and either depending on cultivars, such as Porlingis (1972) who found considerable variability among olive cultivars in their chilling requirements for maximum flowering some olive gave a high number of inflorescences when exposed to little chilling hours from 10°C to 14 °C but other cultivars requiring a high chilling hours for maximum flowering. As well, Boulis (1967) reported that flower bud differentiation of Chemlali olive trees began to initiate at the beginning of January and it remained dormant till the beginning of March. The flower organs started to develop two weeks before opening under Borg El-Arab conditions. Also, Michele *et al*., (1970) observed that physiological changes regarding bud differentiation in olive trees in Italy occurred between late November and early January according to cultivar. In the same way, Deng *et al*., (1988) revealed that, flower bud differentiation occurred before new shoots began and it depends on the accumulated low winter temperature. Else, it was pointed out that flower bud initiation and differentiation varied depending upon cultivars and treatment, as well as climatic conditions (Laz, 1993 and Abdel-Naeem, 2000).

Several models are in use for quantifying winter chill. Ratios between winter chill estimates calculated with these models differ strongly around the globe as well as between years and sites within growing regions (Luedeling *et al.,* 2013). Some of these models are reported by Ben Mohamed *et al.*, (2010) who compared between five of them. The first one and simplest which defined one chill unit as one hour below 7.2°C. The ‘Utah Model’ (UT), the ‘Low Chilling’ model (LC) and the ‘North Carolina’ model (NC). The fifth model (Positive Chill Unit model; PCU) which adopted the same unit factors used in UT model but ignored the negative daily totals.

In Egypt, beside many local wide spread and non-spread cultivars, many other foreign cultivars were imported during the period of 1980s. These cultivars achieved differences in flowering and productivity behavior, some of which were accepted and spread beside the local cultivars and the others had been proved the inability under the Egyptian conditions.

Based on all the above, this investigation was conducted to study the effect of climatic changes (by calculating the chilling requirements) on the flowering and productivity of some native and foreign olive cultivars grown under AL-Khatatba, Minufiya Governorate in Egypt using by three models of chilling units’ calculation and two methods of hourly counting, as an attempt to contribute to the development of a new vision of the validity of some olive cultivars, and thus to the implementation of the hopeful expansion strategy for olive crop in new reclaimed areas which into account by the decision makers.

Materials and Methods

This work was conducted during two successive seasons (2015-2016&2016-2017) on 19-years-old trees represented 6 olive cultivars, the native ones were [Toffahi, Aggizi Shame and Lewa cvs.] and the foreign cultivars were [Picual, Manzanillo (Spanishcvs.) and Dolce (French cv.)]. The trees were raised by cuttings and planted at 6 x 6 m. apart in a sandy soil of a private orchard at AL-Khatatba, Minufiya Governorate, Egypt (at 30.6 N latitude, 31.01 S longitudes and at an elevation of 17.9 m above sea level). The selected trees were of normal growth, uniform in vigour and subjected to drip irrigation system the experimental trees were subjected to the regularly recommended culture practices during the two years of the study and were free from pathogens. The experiment was set in a Complete Randomized Design with a total of sixty trees (10 trees/cultivar). This experiment was started in November 2015 to be ended in 2017 growing seasons. The Metrological data was obtained from climatic station of a neighbor farm (5 Km from the investigated farm).

The aim of this study is to investigate the effect of the chilling requirements on the flowering and productivity of some native and foreign olive cultivars by three models of chilling units’ calculation and two methods of hourly counting to reach by the recommendation of the most suitable cultivars (whether native or foreign) which grown in this region under the recent changes of climate conditions.

1. Meteorological data:

The present study included estimation of the chilling requirements based on the number of chilling hours as reported by Bennett (1949); Weinberger (1950) who defined one chill unit as one hour below 7.2°C. as the first method and simplest. This model was first developed for peaches in Georgia (United States) and probably the most common chilling model, and one that is used widely. In addition, chilling requirements ≤ 10°C was calculated as previously mentioned (Olive project, 2000).

We also compared between three models for calculating chilling requirements of the tested olive cultivars. The 'Utah Model' (UT) (Richardson *et al.,* 1974), the 'Low Chilling' model (LC) (Gilreath & Buchanan, 1981) and the 'North Carolina' model (NC) (Shaultout & Unrath, 1983) are defined in Table (1).

In addition to the above, chilling accumulation was calculated in 24 hours during the periods from 1st. Nov. (2015) to 15th Feb. (2016) and from 1st. Nov. (2016) to 15th Feb. (2017) (Sholokhova and Domanskaya, 1971; & Luedeling *et al.,* 2013). Chilling units' accumulation were calculated from hourly temperatures by dividing each of the investigated months according to hourly temperature ranges in each model and gets the corresponding values then calculated the total values per month separately. As shown in Table (1).

Table 1: Chill unit factors (CUF) used with Utah (UT), Low chilling (LC) and North Carolina (NC) models.

Utah Model (UT)		Low Chilling Model (LC)		North Carolina Model (NC)	
Temperature (⁰C)	**Chill Unit Factor (CUF)**	**Temperature (⁰C)**	**Chill Unit Factor (CUF)**	**Temperature (⁰C)**	**Chill Unit Factor (CUF)**
<1.5	0	≤1.7	0	≤1.5	0
1.5-2.4	0.5	1.8-7.9	0.5	1.6-7.1	0.5
2.5-9.1	1	8-13.9	1	7.2-12.9	1
9.2-12.4	0.5	14-16.9	0.5	13-14.6	0.5
12.5-15.9	0	17-19.4	0	16.5-18.9	0
16-18	-0.5	19.5-21.4	-0.5	19-20.6	-0.5
>18	-1	≥21.5	-1	20.7-22	-1
				22.1-23.2	-1.5
				≥23.3	-2

(Adapted from Carla *et al.,* 2004)

2. Phonological data and yield.

2.1. Flowering

2.1.1. Flowering time and duration:

Bud burst date, beginning of flowering; full bloom and end of flowering for each cultivar were recorded. Flowering duration was also determined from beginning and end of flowering in both seasons of the study.

2.1.2. Number of inflorescences per meter:

Ten shoots (one year old) were chosen at random and labeled for each replicated tree. Average numbers of inflorescences per shoot and per meter were calculated.

2.1.3. Flowering density:

Flowering density was calculated (Mofeed, 2009) according to the following equation:

$$\text{Flowering density} = \text{No. of inflorescences} \times \frac{100}{\text{Shoot length (cm)}}$$

2.1.4. Total number of flowers per inflorescence:

Thirty inflorescences at the middle portion of the shoot were randomly chosen from inner and outer portion of the tree canopy to determine the number of flowers per inflorescence.

2.1.5. Perfect flowers (%):

Thirty inflorescences were randomly chosen from inner and outer portion of the tree. The percentage of perfect flowers (as related to the total number of flowers of the inflorescence) was determined.

2.1.6. Length of inflorescence (cm):

Thirty inflorescences were randomly chosen from inner and outer portion of the tree. Average length of inflorescence in the middle portion of shoots were recorded.

2.2. Yield

2.2.1. Number of fruits/meter

Number of fruits per meter was calculated according to the following equation.

$$\text{No. of fruits/meter} = \text{No. of fruits x } \frac{100}{\text{Shoot length (cm)}}$$

2.2.2. Fruit yield (Kg/tree)

Average yield per tree was calculated from each studied tree as Kg/ tree.

3. Statistical analysis:

The experiment was arranged in a randomized complete blocks design in and the obtained data were subjected to analysis of variance and significant differences among means were determined according to Snedecor and Cochran (1980). In addition significant differences among means were distinguished according to the Duncan's multiple range test at 0.05 level of probability Duncan (1955).

Results and Discussion

1. Meteorological results

1.1. Calculating of chilling requirements by Chilling hours methods

The data in Fig. (1) concluded that, the total chilling hours which had collected as ≤ 7.2˚C were (356 and 491˚C), respectively in seasons (2015-2016 and 2016-2017), while they were (758 and 873 ˚C) respectively in the two studied seasons when it was calculated as ≤ 10˚C. It can be also noticed that, the increasing of the chilling hours in the second season compared with the first one.

According to the collected data in Fig. (2), the calculated chilling hours (≤ 7.2 and ≤10˚C) were increased in the second season compared to the first one. As shown with the area of arrow towards up, the maximum numbers of these hours were obtained during the period from 1st Jan. to 31thJan. [(194-224) and (348-358) ˚C], respectively under ≤ 7.2 and ≤ 10 in both seasons. However, the area of arrow towards down showed the minimum numbers of chilling hours which collected during the period from 1st November to 30th Nov. and it scored [(0-24) and (21-69) ˚C], respectively under ≤ 7.2 and ≤ 10 in both seasons.

From all the above, It can be noted that, the calculation in these simple methods(chilling hours calculation methods) do not reflect the number of actual chilling units, which require more complicated mathematical methods by implementing several models which we will present the most common models in this investigation.

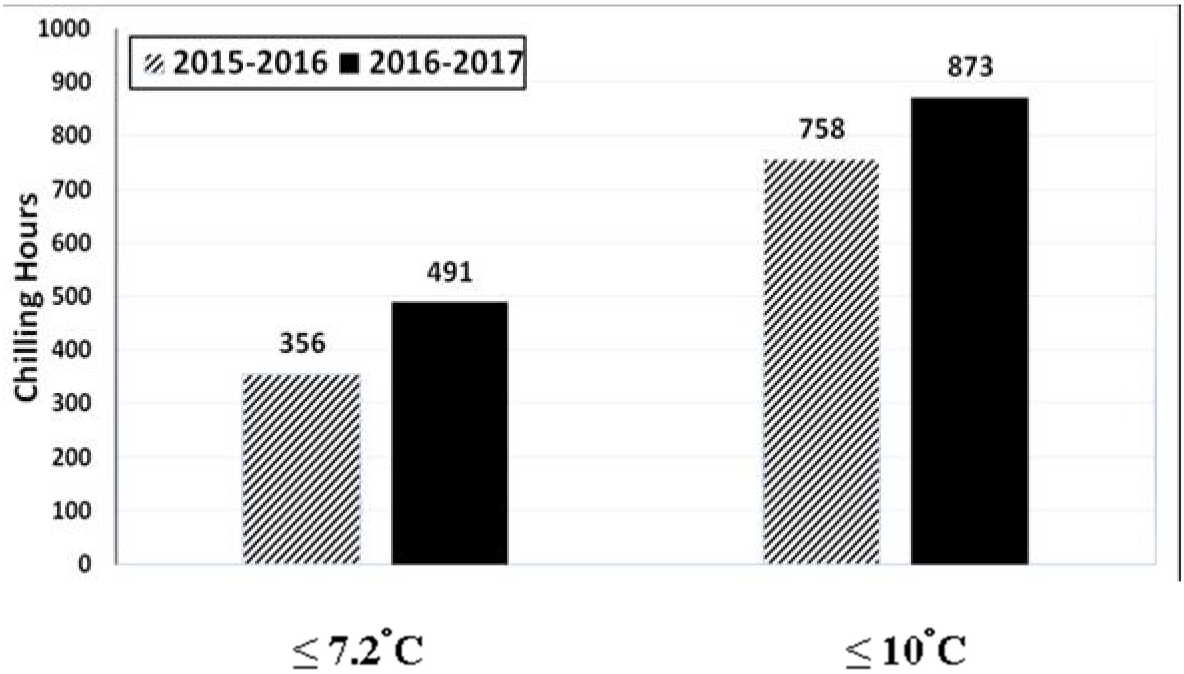

Fig. 1: Total Chilling hours calculated (≤ 7.2 and ≤ 10°C) in (2015-2016) and (2016-2017) seasons.

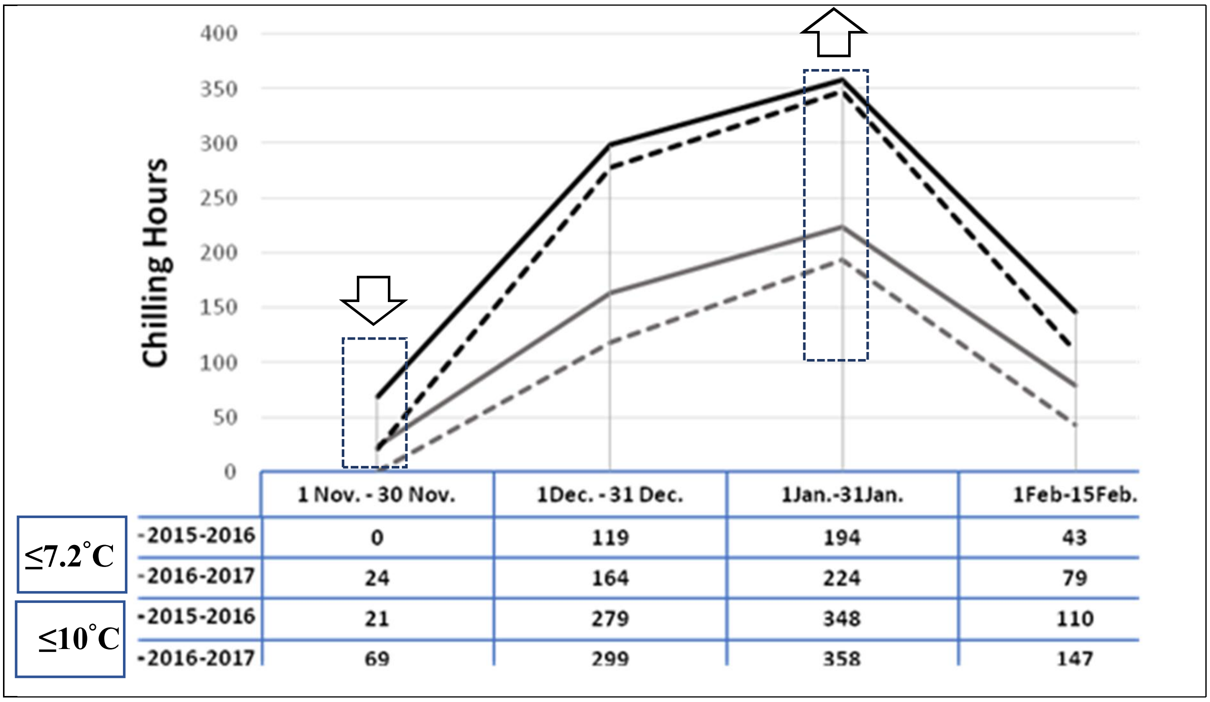

Fig. 2: Calculated monthly Chilling hours (≤ 7.2 and ≤ 10°C) in (2015-2016) and (2016-2017) seasons.

1.2. Calculating of chilling requirements by chilling units models

Data in Fig. (3) illustrated, the comparing between three models for calculating chilling units requirements, which were calculated in 24 hours during the period from 1st Nov. 2015 to 15th Feb. 2016 and 1st Nov. 2016 to 15th Feb.2017. Generally, all the tested models recorded higher chilling units in the second season compared with the first one. LC model gave the highest number of the chilling units (1046.5 and 1143 unit) followed by NC model which gave (743 and 884.5 unit), while UT model occupied the last position in the calculated chilling units with (91.5 and 334.5 units), respectively in (2015-2016) and (2016-2017) seasons.

It was noted that, (UT model) might be more compatible with the chilling units which known under the local conditions, that may drew attention to the validity and success of this model compared to the others two models (LC and NC models) whose results were much higher and might be more suitable with the other cooler areas.

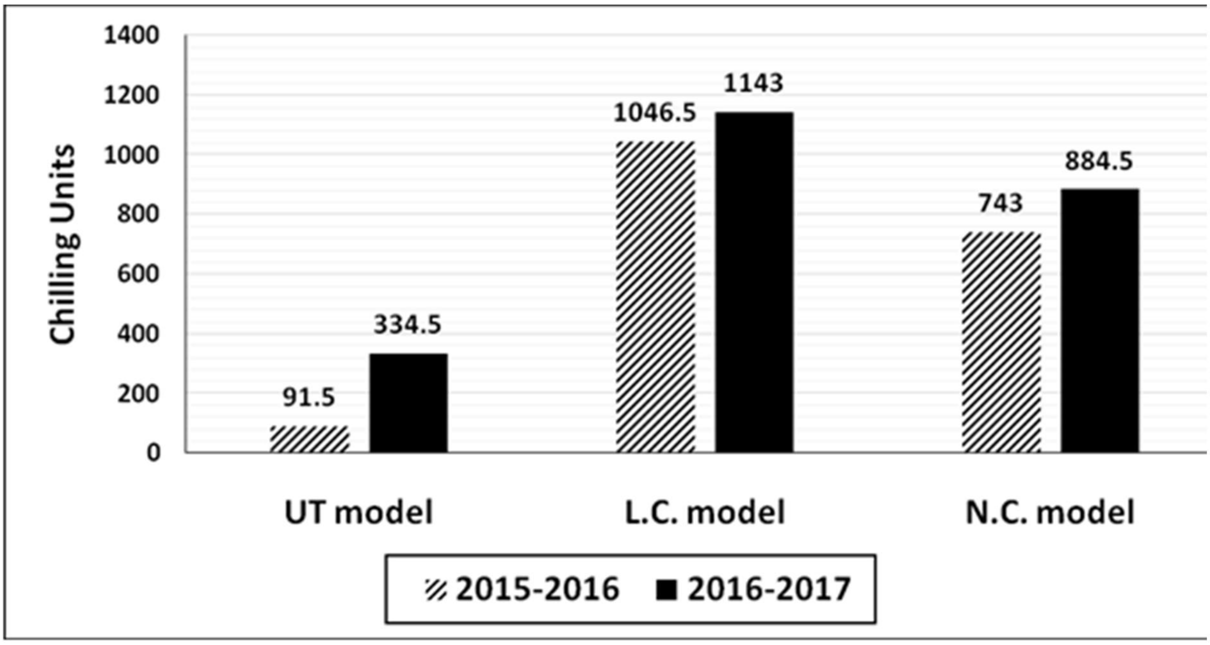

Fig. 3: Comparison between three models (UT, LC and NC models) to calculate the Total Chilling Units of (2015-2016) and (2016-2017) seasons.

1.3. Calculating of chilling requirements by UT model

The data in Fig. (4) explained that, total numbers of chilling units which were calculated by UT model (the most suitable model under the present study conditions) during the period from 1 Nov. to 15 Feb. were increased in the second season (334.5 unit) compared with the first season (91.5 unit). All months from November to February showed the superiority in favor of the second season of the first season. The period from 1st Jan. to 31st Jan. gave the highest number of chilling units (253.5 and 285 unit) followed by December which were (118-208 unit), respectively in (2015-2016) and (2016-2017) seasons. However, the negative chilling units which were shown during the period from 1st Nov. to 30th Nov. (-327.5 and -259 units), respectively in the two studied seasons, reflected what was subtracted form the total amounts of chilling units to obtain the actual chilling units.

When we compared the calculation of chilling hours (Fig.1) with the calculated chilling units by UT model (Fig.4), it is worthy to mention that, even there was a large numbers of chilling hours when calculated under ≤ 7.2 or ≤ 10°C., but it did not express the calculation of the actual chilling units which was clarified when calculated by UT model.

All these metrological results seem to agree with those reported by Richardson *et al.,* (1974); Shaltout and Unrath, (1983), who achieved that, the simplest model (Hours below 7.2 °C model, using the number of hours below a given base of 7.2°C), did not give satisfactory results. The number of hours required for the exit from dormancy, between seasons with different temperature regimes, was not consistent. It also did not account for chilling above this threshold and assumed an equal chilling effect of all temperatures below 7°C. In addition, UT model method appears to perform well under temperate conditions, while its accuracy decreases in sites where high winter temperatures occur. (Erez, 2000). Also, AbaynehMelke, (2015) revealed that, UT model is a competent under warm climate and excludes the negation influence of high temperatures.

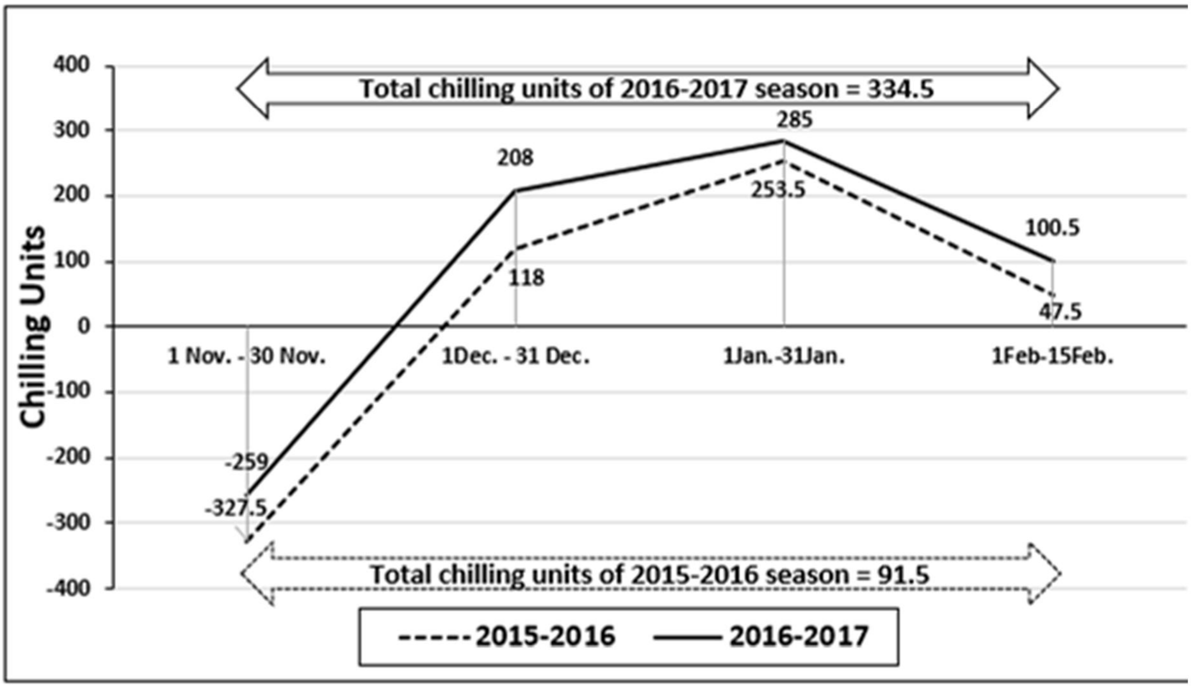

Fig. 4: Chilling Units calculated by UT Model in (2015-2016) and (2016-2017) seasons.

2. Phonological data.

2.1. Flowering dates and periods

Data in Table (2) concluded that, generally all dates of flowering were earlier in the second season than the first season, which indicated that, flower bud induction occurred in the second season faster than the first one because of chilling requirement units which were be available in the second season more than the first one. Regarding to inflorescence burst dates, all cultivars in the second season preceded the first one with 5 days except Dolce cultivar which was earlier in the second season by only 3 days. All local cultivars preceded (Dolce) with 8 days and (Mazanillo & Picual) with 10 days in the first season, whereas they preceded all the tested foreign cultivars with 10 days in the second season. With respect to full bloom dates, all cultivars of the study showed earlier full bloom in the second season than the first one. Moreover, local cultivars and Dolce forerun Manzanillo and Picual cvs. with 2 days in the full bloom date in both seasons of the study.

Table 2: Effect of chilling requirements on inflorescences burst and flowering dates in (2015-2016) and (2016-2017) seasons.

Cultivars	(2015-2016) season				(2016-2017) season			
	Inflor. Burst	Beginning of flowering	Full bloom	End of flowering	Inflor. Burst	Beginning of flowering	Full bloom	End of flowering
Toffahi	5 Mar.	3 April	13 April	18 April	1 Mar.	1 April	11 April	13 April
Aggizi Shame	5 Mar.	3 April	13 April	18 April	1 Mar.	1 April	11 April	13 April
El-Lewaa	5 Mar.	3 April	13 April	18 April	1 Mar.	1 April	11 April	13 April
Dolce	13 Mar.	7 April	13 April	18 April	10 Mar.	5 April	11 April	16 April
Manzanillo	15 Mar.	9 April	15 April	22 April	10 Mar.	7 April	13 April	18 April
Picual	15 Mar.	9 April	15 April	22 April	10 Mar.	7 April	13 April	18 April

As shown in Fig. (5), all cultivars in the first season took lower flowering periods than the second season except Dolce cv. which took the same number of flowering days (11 days) in the two seasons of the study. Besides, all local cvs. started their flowering and ended before the foreign cultivars

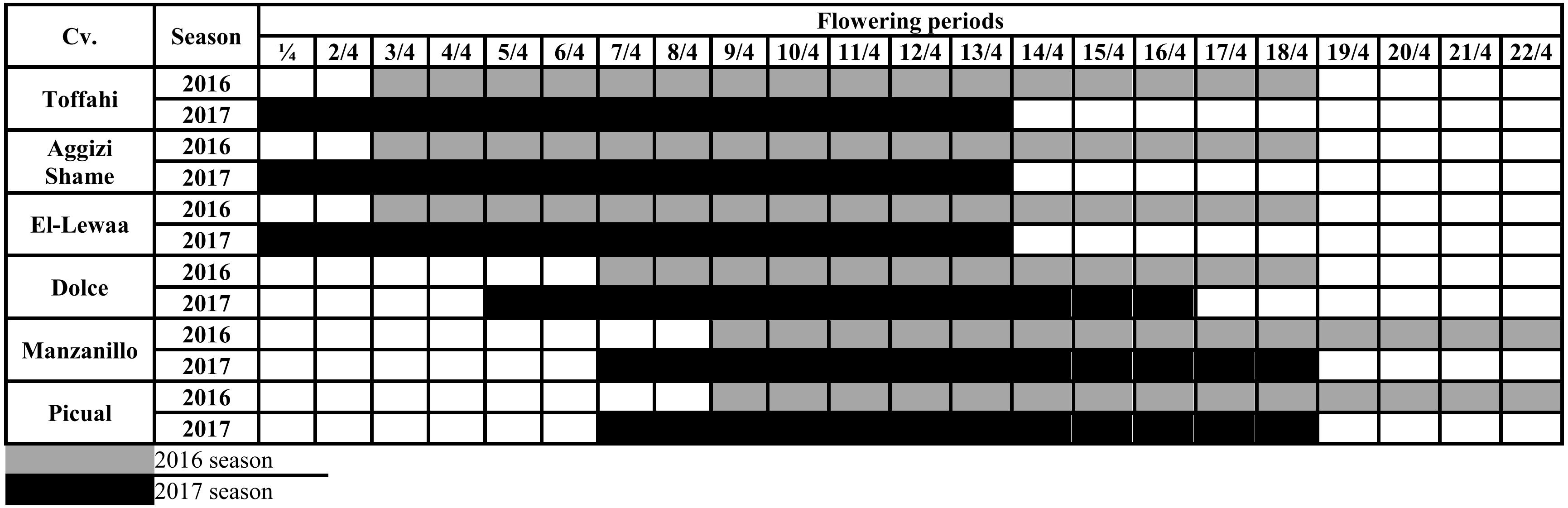

Fig. 5: Effect of chilling requirements on flowering periods in (2015-2016) and (2016-2017) seasons

except Dolce cv. which ended its flowering as the local cvs. in the first season. Manzanillo and Picual cvs. were the latest cultivars and took (14 and 12 days) respectively in the two seasons of the study.

All the previous results are in harmony with those who showed the effect of chilling requirements on flowering delaying and periods. As well, results of Deng *et al*. (1988) stated that the differences in the degree and time of bud differentiation between years appeared to depend on the accumulated low winter temperature. Likewise, Orlandi, *et al.* (2004) bring to light that, the more Egyptian range of temperature determines a more constant chilling accumulation. The more variation in chilling hours prompts a higher variation in terms of the reproductive budburst date. Also, Menzel *et al.* (2006), who examined changes in the phenology of a large number of species, found the delayed phenology over time, in spite of temperature increases. Else, Campoy *et al.* (2011) noticed that, if chilling requirements are not met, irregular, delayed and asynchronous flowering and fruit set are observed in the following growing season. Furthermore, statistical evidence of a relationship between warm winters and late flowering has recently been produced for walnuts in California (Luedeling and Gassner 2012). In addition, recent climate change had substantial impacts on the phenology of temperate plants, with many species showing advances in the timing of flowering in spring (Luedeling *et al.* 2013).

2.2. Flowering characteristics and yield

Table (3) proved that, (Toffahi and Aggizi Shame cvs.) gave the highest significantly values in No. of inflo./shoot, flowering density and total numbers of flowers/inflo compared with the other cultivars, whereas Dolce cv. gave the highest significant values compared with the other foreign cultivars. Conversely, Manzanillo cv. recorded the minimum values of such previously mentioned parameters compared with all studied cultivars. This was true in both studied seasons. Generally, the 2nd season had higher significant values in all the previous characteristics compared with the 1stseason. Aggizi Shame in the second season gave the highest significant numbers of inflor./shoot whereas Toffahi cv. in the second season was the best in flowering density and number of flowers/ inflor.

In Table (4), the results noticed that, Aggizi Shame and El-Lewa cvs. produced the highest significant number of perfect flowers/inflo. and perfect flowers% compared with all other cultivars, whereas Dolce cv. was the highest one compared with only the foreign cvs. Toffahi and Picual took the last order in perfect flowers/inflo. Whereas, Picual cv. recorded the lowest percentage of perfect flowers. Statistical analysis showed the superiority of the second season mean compared with the mean of the first one. Aggizi Shame (both seasons and El-Lewa (2nd season) transcend the other cultivars in number of perfect flowers/inflo. and perfect flowers percentage.

According to the presented data in Table (5), with all cultivars the second season of the study showed statistically the superiority in number of fruit/ meter and yield compared with the first season. Dolce cv. followed by Aggizi Shame achieved the greatest number of fruits/meter. While, Toffahi cv. followed by Dolce produced significantly the maximum yield/tree and these results due to that Toffahi cv. is characterized by high fruit volume compared with other cultivars. On the other hand, the least number of fruits/meter was achieved by Manzanillo and the same in yield followed in ascending order by Picual cv. Generally, in the second season Dolce cv. gave the highest number of fruits/meter while Toffahi cv. followed by Dolce then Aggizi Shame gave the maximum yield/tree.

All these results agree with those old studies by Porlingis (1972), who figured out that, among olive cultivars in their chilling requirements for maximum flowering some olives give high number of inflorescence when exposed to little chilling hours from 10 °C to 14 °C but other cultivars requiring a high chilling hours for maximum flowering. Many researches were executed to deal with the adaptation of olive tree to improve productivity Hartmann (1953) and Hartmann *et al.,* (1980). Also, studies concerning environmental conditions influenced olive trees behavior, specially its bearing habit, yield (Hartman and Whisler, 1975, Pinney and Polito, 1990 and Rallo and Martin, 1991). In addition, environmental conditions play an important role in growth and productivity of olives kinds as productivity varies according to environmental and climate conditions. (Sheba, 2001). A similar range of chilling hours occurs in olive growing areas especially around the Mediterranean Sea and the Middle East. Olive trees, especially local varieties growing in parts of southern Greece and Italy, northern Africa, and countries along the eastern Mediterranean basin, mostly require only a few hundred chilling hours to produce commercial crops. (Kailis and Harris, 2007). As well, Omran (2013) achieved that; chilling requirement is one of the most important environmental effects on olive production in winter.

Table 3: Effect of chilling requirements on no. of inflo., flowering density and total no. of flowers/inflo. in (2015-2016) and (2016-2017) seasons.

Cultivars	No. of inflorescences/shoot						Flowering Density						Total numbers of flowers/inflo.					
	(2015-2016) season		(2016-2017) season		Mean		(2015-2016) season		(2016-2017) season		Mean		(2015-2016) season		(2016-2017) season		Mean	
Toffahi	12.33	cd	15.67	b	**14.00**	**B**	68.47	cd	121.80	a	**95.12**	**A**	14.87	a	15.10	a	**14.98**	**A**
Aggizi Shame	11.00	d	20.67	a	**15.84**	**A**	63.40	d	114.60	b	**89.01**	**B**	13.08	b	13.40	b	**13.24**	**B**
El-Lewaa	8.00	e	8.33	e	**8.17**	**D**	50.65	ef	51.83	e	**51.24**	**E**	12.60	c	12.60	bc	**12.60**	**C**
Dolce	13.60	b-d	14.70	c	**14.15**	**AB**	68.36	cd	74.85	c	**71.60**	**C**	11.15	d	13.70	ab	**12.43**	**C**
Manzanillo	7.30	e	7.73	e	**7.52**	**D**	44.43	f	47.10	ef	**45.77**	**F**	9.05	e	10.19	de	**9.62**	**D**
Picual	11.10	d	11.17	d	**11.14**	**C**	66.80	d	46.48	ef	**56.64**	**D**	11.15	cd	12.81	b	**11.98**	**C**
Mean	**10.56**	**B**	**13.05**	**A**			**60.35**	**B**	**76.11**	**A**			**11.98**	**B**	**12.97**	**A**		

* Means followed with the same letter (s) within each column or rows are not significantly different according to Duncan's Multiple Range test at 5 % level.

Table 4: Effect of chilling requirements on no. of perfect flowers/inflo. and perfect flowers (%) in (2015-2016) and (2016-2017) seasons.

Cultivars	No. of perfect flowers/ inflo.						Perfect flowers (%)					
	(2015-2016) season		(2016-2017) season		Mean		(2015-2016) season		(2016-2017) season		Mean	
Toffahi	6.27	c	5.27	cd	**5.77**	**D**	42.98	f	35.05	g	**39.02**	**F**
Aggizi Shame	10.37	a	10.50	a	**10.43**	**A**	79.56	b	78.66	b	**79.11**	**A**
El-Lewaa	6.33	c	11.50	a	**8.92**	**B**	50.11	e	91.28	a	**70.69**	**B**
Dolce	6.30	c	9.01	b	**7.66**	**C**	56.10	d	65.86	c	**60.98**	**C**
Manzanillo	4.53	d	4.43	d	**4.48**	**E**	49.62	e	42.79	f	**46.20**	**E**
Picual	6.30	c	5.81	cd	**6.06**	**D**	56.72	d	46.54	f	**51.63**	**D**
Mean	**6.68**	**B**	**7.75**	**A**			**55.85**	**B**	**60.03**	**A**		

* Means followed with the same letter (s) within each column or rows are not significantly different according to Duncan's Multiple Range test at 5 % level.

Finally, production sites must have sufficiently cold and long winters. When the climate of a given production site warms, cultivar choices may have to be updated to avoid yield losses due to insufficient chilling. (Luedeling *et al.,* 2013).

Table 5: Effect of chilling requirements on no. of perfect flowers/inflo. and sex expression (%) in (2015-2016) and (2016-2017) seasons.

Cultivars	No. of fruits/ meter			Yield (Kg/tree)		
	(2015-2016) season	(2016-2017) season	Mean	(2015-2016) season	(2016-2017) season	Mean
Toffahi	11.00 fg	14.00 cd	**12.50 C**	39.60 c	50.40 a	**45.00 A**
Aggizi Shame	12.00 ef	15.00 c	**13.50 B**	32.40 e	40.50 c	**36.45 C**
El-Lewaa	10.00 gh	13.00 de	**11.50 C**	27.90 g	35.10 d	**31.50 D**
Dolce	20.00 b	25.00 a	**22.50 A**	36.00 d	45.00 b	**40.50 B**
Manzanillo	9.00 h	12.00 ef	**10.50 D**	18.90 j	25.20 h	**22.05 F**
Picual	11.00 fg	14.00 cd	**12.50 C**	23.10 i	29.60 f	**26.35 E**
Mean	**12.17 B**	**15.50 A**		**29.65 B**	**37.63 A**	

* Means followed with the same letter (s) within each column or rows are not significantly different according to Duncan's Multiple Range test at 5 % level.

Regarding to the relation between cultivars and chilling requirements, all the previous phonological results were compatible with those who studied that relation and concluded that, Toffahi and Aggizi Shame were the most delaying in flowering and the least chilling requirement cultivars. While Picual required the highest chilling requirements and the most late in flowering during the project of Fac. of Agric.Univ. of Fayoum, where the research team studied the chilling requirements (≤ 10 °C) of several cultivars under Fayoum Governorate such as (Toffahi, Aggizi Shame and Picual.. etc.) (Olive Project, 2000). Also, Ahmed (2001), who tested the different behavior of the two cultivars (Picual & Aggezi) probably may be due to the different adaptation in the two different cultivars in to a definite climate, and concluded that, the chilling requirement of Aggezi (Egyptian) cultivar may satisfy requirements of olive trees for bud break earlier as a native variety in Egypt in comparison with Picual the (Spanish) one. Likewise, Sheba (2001) confirmed in the same year in other region that, Aggezi cv. considered of the lower chilling cv., while as, Picual cv. requires more chilling requirement.

Conclusion

Calculation of chilling hours did not enough to express the actual chilling units that were clarified with the calculation by UT model which is the most suitable one under the conditions of the study compared with other tested chilling models. All phonological characteristics and yield were affected by the changes of chilling units which differ between the studied seasons. Two native cultivars (Toffahi, Aggizi Shame) and one foreign cultivar (Dolce) gave the greatest values in most of the phonological parameters and yield which it means that, there were the most adaptable cultivars compared with other cultivars under the same conditions of investigation. This study pointed out the attention needs to be drawn to the urgent need to conduct many other researches to develop a new cultivar map, especially for the new expansion of olive cultivation and to examine the validity of different cultivars in each region. Thus, contribute to the implementation of the hopeful expansion strategy for olive crop in new reclaimed areas which into account by the decision makers.

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