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Comparison of Utah and Positive Utah models for determining of chilling and heat requirements of some olive cultivars

M. Rahemi*, N. Navid Pour, S. Sedaghat

Department of Horticultural Science, College of Agriculture, Shiraz University, Shiraz, I.R. Iran

* Corresponding Author: rahemi@shirazu.ac.ir
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ABSTRACT- Determin**ing** of chilling and heat requirements of olive cultivars growing in Fars Province is important for the selection of cultivars that will exhibit satisfactory growth and development. The purposes of this study were determining the chilling and heat requirements of olive and comparison of Utah and Positive Utah Chill unit (PCU) models for determining the chilling requirements of olive cultivars. In this regard, chilling requirement of flower buds of 'Fishomi', 'Dezful', 'Zard', 'Dehghan' and 'Shiraz' cultivars were determined. Cuttings of these cultivars were taken during autumn when the mean temperature fell below 12°C. Cuttings were kept at 5 °C for periods of 0, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200, 1300, 1400, 1500, 1600, 1700 and 1800 h. Results indicated that the chilling requirements of 'Fishomi', 'Dezful', 'Zard', 'Dehghan' and 'Shiraz' were 900, 1000, 900-1000, 1000-1100 and 900 h, respectively. Results also showed that the PCU unit model was more efficient than the Utah for estimating chilling requirements under subtropical field conditions. Heat requirements from the end of dormancy to full bloom stage of these five olive cultivars were estimated as 199.2, 272.1, 245.2, 245.2, 321 growing degree days (GDDs), respectively. It was observed that 'Fishomi' had the lowest chilling requirement and 'Dehghan' obtained the highest one. Hence, 'Fishomi' can be recommended for cultivation in subtropical regions.

INTRODUCTION

Over the last hundred years, the earth warmed abnormally by about 0.74°C causing concern (Arora and Tanino, 2003). Fruit trees normally enter a dormancy period in the fall season. Following this period, they encounter some chilling and remain dormant until their chilling requirement is satisfied (Westwood, 1993). If the temperature during autumn and winter increases, the chilling requirement of trees is less likely to be satisfied and incomplete chilling requirement affects tree behavior in three main ways: a late bud break, a low level of bud break and lack of uniform of leafing and bloom (Galan et al. 2004). The physiological process leading to spring flowering starts in the preceding summer. Once induction is under way floral initiation in olive occurs by November after which flower parts form (Sibbet and Martin, 1994). In winter, temperature greatly influences the continuing development of flowers of olive cultivars and chilling in olive. This is required to release initiated floral buds from dormancy. In order to break dormancy and calculate the chilling requirement, the best temperature was considered to be between 2°C and 7°C (Arore et al., 2003 and Westwood 1993).

At 13ºC both chilling and warmth are sufficient for flowering but not for complete flower development (Sibbet and Martin, 1994). That is the reason why olive trees are not able to grow in tropical region (Rallo et al. 1981). Hacket and Harthman (1963 and 1964) showed that only 7.7% of axillary buds (6.1% floral and 1.6% vegetative) were able to develop when chilling was insufficient, whereas as many as 74% of axillary buds (73.6% of floral bud and 0.4% of vegetative bud) developed when the plants were well chilled (1862 h<7.2ºC).

The Utah model was developed by Richardson et al. (1974). In this model positive and negative hourly values are accumulated and net values are summed to obtain a specific chill unit requirement for a given cultivar. This model performed well under temperate conditions but failed to predict the end of dormancy under subtropical conditions; therefore, it is not applicable in sites where higher winter temperatures are experienced in subtropical and tropical locations (Partridge and Allam, 1980). One such adaptation for warm subtropical climates is the Positive Utah Model, in which the negative chill mechanism of the original Utah Model was removed (Linsley et al , 1995).

Determination of growing degree days (GDDs), also called growing degree units (GDUs), is a heuristic tool in phenology. Determination of growing degree days (GDDs) is a measure of heat accumulation used by horticulturists to predict plant development rates such as the date that a flower will bloom and reach maturity. Growing degrees (GDs) is defined as the number of temperature degrees above a certain threshold base temperature, which varies among crop species (McMaster and Wilhelm, 1997).

To overcome problems of restricted olive crop cultivation in tropical regions, and to prepare them for unexpected changes in weather conditions, identifying cultivars with low chilling requirements which are able to grow well in tropical regions is necessary. The first step can be evaluation of available cultivars and their genetic pools. Then with the selected low chilling cultivars, the breeding programs will be performed easily. Therefore, the aims of this research were: 1) determining some olive cultivars, indigenous to Fars Province, to identify the low chilling cultivars which were desired to cultivate in tropical regions, 2) determining chilling requirement by Utah and positive Utah Chill Unit (PCU) models and comparison of these models with laboratory method and introducing an efficient method in order to evaluate chilling requirements and 3) determining heat requirements of these cultivars to estimate olive flowering time..

MATERIALS AND METHODS

The experiment was conducted with five commercial olive cultivars: ‘Zard’, ‘Dehghan’, ‘Fishomi’, ‘Dezful’ and ‘Shiraz’ at Bash commercial orchard, Shiraz, Iran, during 2011-2012. The trees were 30 years old and received similar cultural practices such as irrigation and fertilization.

Cuttings with uniform diameter and number of buds were prepared (3 buds, cutting length 20 cm) on November 6th, when temperature reached 12ºC (minimum temperature). Cuttings were bundled into groups of five and wrapped in wet cheese cloth. Bundles were immersed in water and surface sterilized by benomyl (0.2%), and placed in plastic bags, which were stored at (5±1)ºC for 0, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200, 1300, 1400, 1500, 1600, 1700 and 1800 h, respectively for bud break. After the treatments were completed, bottoms of all the cuttings were removed. The cuttings were placed in plastic beaker with the basal 7-10 cm in distilled water, which was replaced each week and then were placed on laboratory benches under continuous white light at (22±1)ºC. Finally, time to the first flower bud break, time to the 50% flower bud break and the percentage of final bud break were recorded (Tabuenca and Herrero,1965).

Determining the Chilling Requirement

To evaluate chilling requirement of olive cultivars in the orchard, a data logger (Laser Electronic. USA) was located in the orchard on November 15th and the chilling units were calculated according to the methods of Positive Utah and Utah (Linsely *et al*., 1995 and Richardson *et al*., 1974) and continued until bud swelling stage. The Utah and Positive Utah methods were calculated as

$$Utah = \sum_{t=1}^{t} TU, With\ TU = \begin{cases} T \le 1.4^{\circ}C & : 0 \\ 1.4^{\circ}C < T \le 2.4^{\circ}C & : 0-5 \\ 2.4^{\circ}C < T \le 9.1^{\circ}C & : 1 \\ 9.1^{\circ}C < T \le 12.4^{\circ}C & : 0.5 \\ 12.4^{\circ}C < T \le 15.9^{\circ}C & : 0 \\ 15.9^{\circ}C < T \le 18.00^{\circ}C & : -0.5 \\ T \ge 18.00^{\circ}C & : -1 \end{cases}$$

$$Utah + t = \sum_{t=1}^{t} TU+, With\ TU+= \begin{cases} T \le 1.4^{\circ}C & : 0 \\ 1.4^{\circ}C < T \le 2.4^{\circ}C & : 0-5 \\ 2.4^{\circ}C < T \le 9.1^{\circ}C & : 1 \\ 9.1^{\circ}C < T \le 12.4^{\circ}C & : 0.5 \\ T \ge 12.4^{\circ}C & : 0 \end{cases}$$

Determining the Heat Requirement

The estimates of growing degree days (GDDs) after 50% bud break in the orchard were calculated. B**y** the end of determination of chilling requirement, the GDDs were calculated according to the following formula:

$$GDDs = \Sigma(\text{mean diurnal temperature} - \text{base temperature}).$$

The base temperature of olive was 12.5ºC. Statistical analysis The experiment design was a randomized complete design with each treatment replicated four times using 5 cuttings per replica. Analysis of variance was performed using the SPSS software package and means were compared by Duncan's Multiple Range Test (DMRT). Differences between means at 5% (P<0.05) level were considered as significant.

RESULTS AND DISCUSSION

Determining the Chilling Requirement with Laboratory Method

‘Fishomi’ Cultivar

Percentage of Flower Bud Break

Our data showed that there was a significant variation in bud break of ‘Fishomi in response to chilling treatments**.** The least bud break rate 19.75% was observed in control treatment (no chilling) and it had no significant difference with 100 and 200 h treatments (22.5% and 23.5% bud breaks, respectively). By increasing chilling hour unit, the percentage of bud break increased too.. It was observed that 900 chilling h had the highest rate of bud break (90.25%) and showed significant difference with control and other chilling treatment bellow 900 h however it did not have any statistical difference with 1000, 1100, 1200, 1300, 1400, 1500, 1600, 1700 and 1800 h chilling, (91.25%, 90.75%, 91.25%, 92.5%, 91.25%, 92.25%, 92.5%, 94%, 94.75%, respectively) (Fig.1).

Number of Days to the First Flower Bud Break

The maximum period of time to the first flower bud break belonged to control treatment which had the mean of 21 days to the first bud break in 'Fishomi' cultivar. It had no significant differences with the 100, 200, 300 and 400 h chilling treatments, (20.25, 20, 20, 20 days to the first bud break, respectively). In 600, 700 and 800 h chilling treatments, the number of days to the first flower bud break reduced relatively (with the mean of 17, 16.75 and 17 days, respectively). Treatment of 900 h chilling reduced the number of days to the first bud break (11.75 days) which showed significant differences with other treatments bellow 900 h chilling, but it was not significantly different from chilling treatments above it (Fig. 2).

Number of Days to the 50% Flower Bud Break

Chilling treatments had a significant effect on the length of time to the 50% bud break, which belonged to the control treatment (29.25 days, no chilling), and had not significant differences with 100, 200, 300 and 400 h chilling, (28.75, 28.5, 28.75 and 28.5 days, respectively). Treatment of 500 h chilling had significant differences (26 days) with lower chilling h treatments, but it had no significant differences with higher chilling h treatments. Treatment of 900 h chilling with 18.75 days to the 50% bud break and the treatments higher than 900 h had significant differences with lower chilling h treatment and control treatment at 5% level DMRT (Fig. 3).

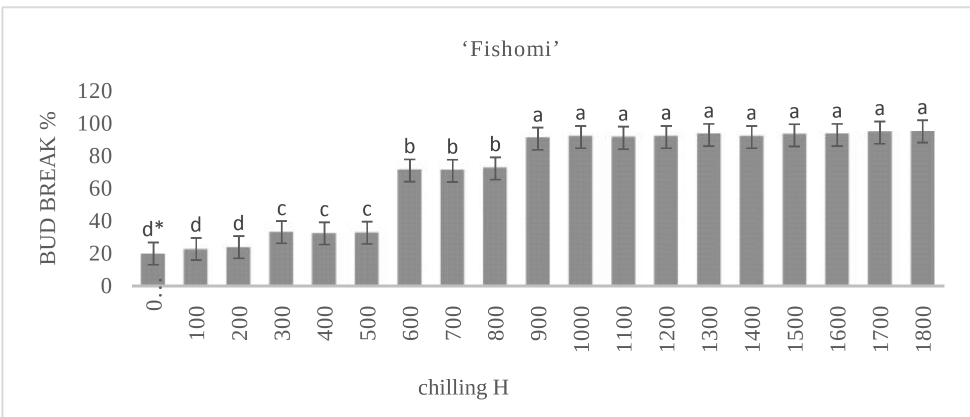

Fig.1. The percentage of Bud break of 'Fishomi' olive cultivar under different chilling hours.
*Columns with the same letter are not significantly different at 5% level DMRT

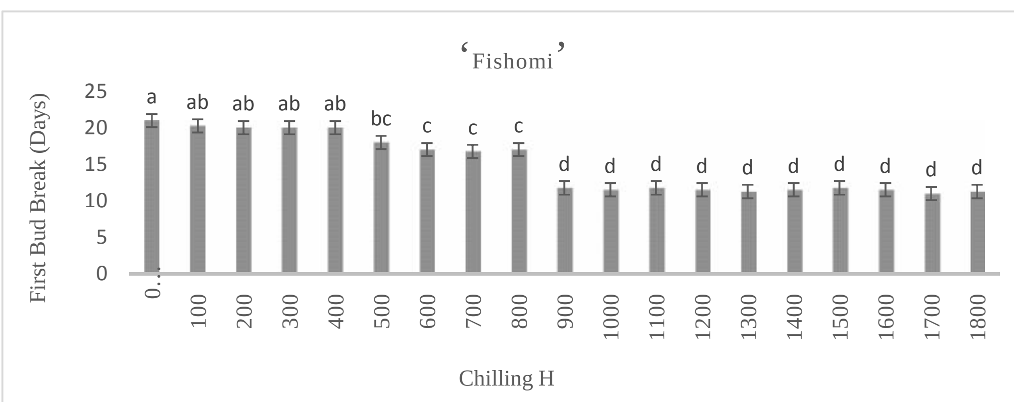

Fig.2. Number of days up to the first bud break of 'Fishomi' olive cultivar under different chilling hours.
*Columns with the same letter are not significantly different at 5% level DMRT

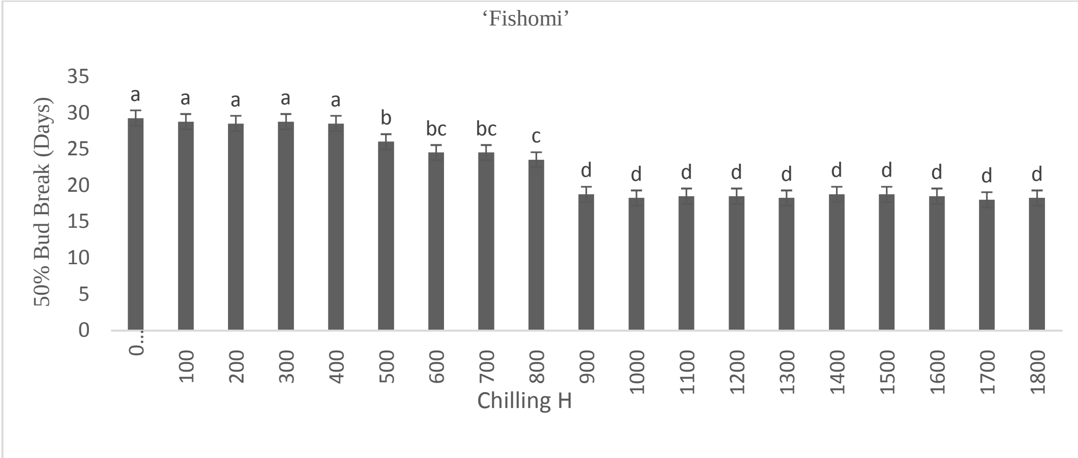

Fig.3. Number of days up to the 50% bud break of 'Fishomi' olive cultivar under different chilling hours.
*Columns with the same letter are not significantly different at 5% level DMRT

'Dezful' Cultivar

Percentage of Flower Bud Break

As indicated in Figure 4, the lowest percentage of bud break in 'Dezful' cultivar belonged to the control treatment with 30.25%. bud break. Furthermore, by increasing chilling hours up to 1000, the percentage of bud break was increased up to 90.75% and had significant differences with lower chilling hour treatments, but had no significant differences with further higher chilling h treatments (Fig. 4).

Number of Days to the First Flower Bud Break

Results of this study showed that no chilling treatment required the most days to show the first bud break (22 days). Although 1000 h chilling showed the minimum mean number of days to the first bud break in this cultivar (13.25 days), there were no significant differences with treatments above 1000 h chilling at 5°C (Fig. 5).

Number of Day to the 50% Flower Bud Break

Result showed that without chilling, number of days to the break of the 50% bud break increased. In control treatment number of days to the 50% bud break was 30.25 days, but by increasing chilling hours number of days to the 50% bud break reduced significantly. Treatment of 1000 h chilling at 5ºC had fewer number of days to the 50% bud break (16.5 days) and more than 1000 h chilling had a significant effect on reducing the number of days to the 50% bud break with this treatment in 'Dezful' cultivar (Fig. 6).

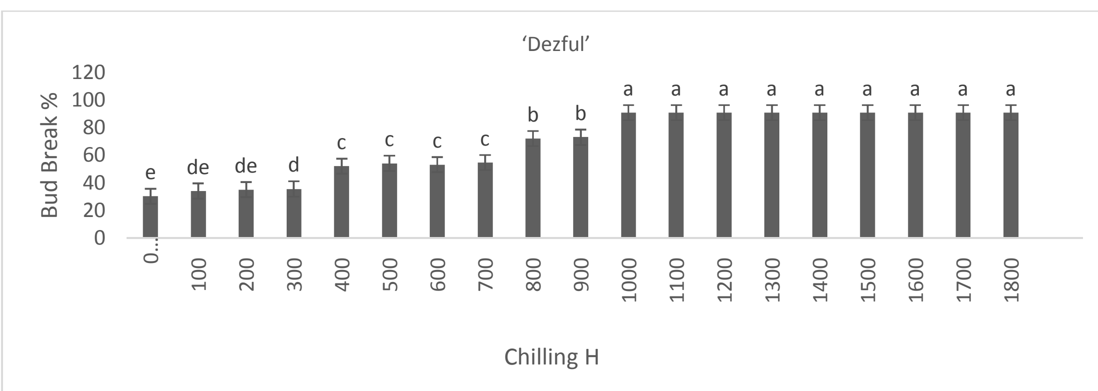

Fig. 4. The percentage of Bud break of 'Dezful' olive cultivar under different chilling hours.
*Columns with the same letter are not significantly different at 5% level DMRT

Fig.5. Number of days up to the first bud break of 'Dezful' olive cultivar under different chilling hours
*Columns with the same letter are not significantly different at 5% level DMRT

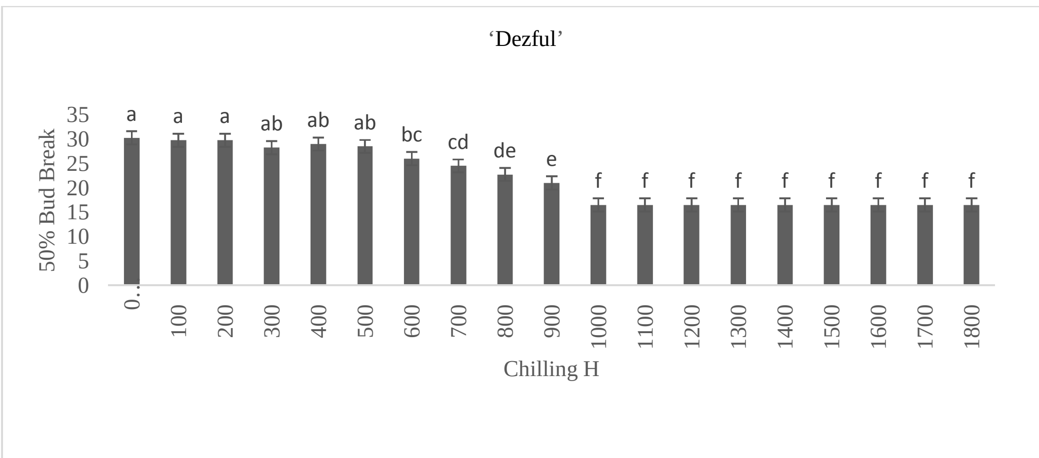

Fig. 6. Number of days up to the 50% bud break of 'Dezful' olive cultivar under different chilling hours.
*Columns with the same letter are not significantly different at 5% level DMRT

'Zard' Cultivar

Percentage of Flower Bud Break

The minimum percentage of bud break belonged to control treatment (without chilling) by 20% and by increasing chilling h gradually bud break increased and the maximum belonged to the treatment with 1000 h chilling at 5°C with 95% bud break. Furthermore, chilling had no significant effect on percentage of bud break (Fig.7).

Number of Days to the First Flower Bud Break, In this part of research, as expected, control treatment had the maximum mean of number of days (20.75) and again increasing chilling h significantly reduced the mean number of days to the first bud break which belonged to the treatment receiving 1000 h chilling at 5ºC (10.25 days). Treatments more than 1000 h chilling had no significant effect on number of days to the first bud break (Fig. 8).

Number of Days to the 50% Flower Bud Break, Results showed that the number of days to the 50% bud break reached the lowest value in 900 h chilling at 5ºC (16 days) and above it, their differences were not significant. Control treatment gained the maximum mean of number of days to the 50% bud break (30.5 days) (Fig.9).

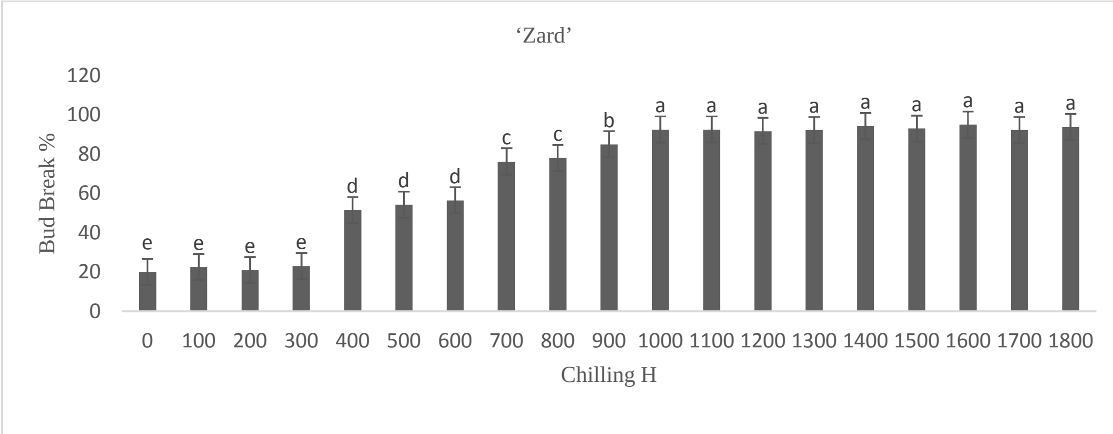

Fig. 7. The percentage of Bud break of ‘Zard’ olive cultivar under different chilling hours.
*Columns with the same letter are not significantly different at 5% level DMRT

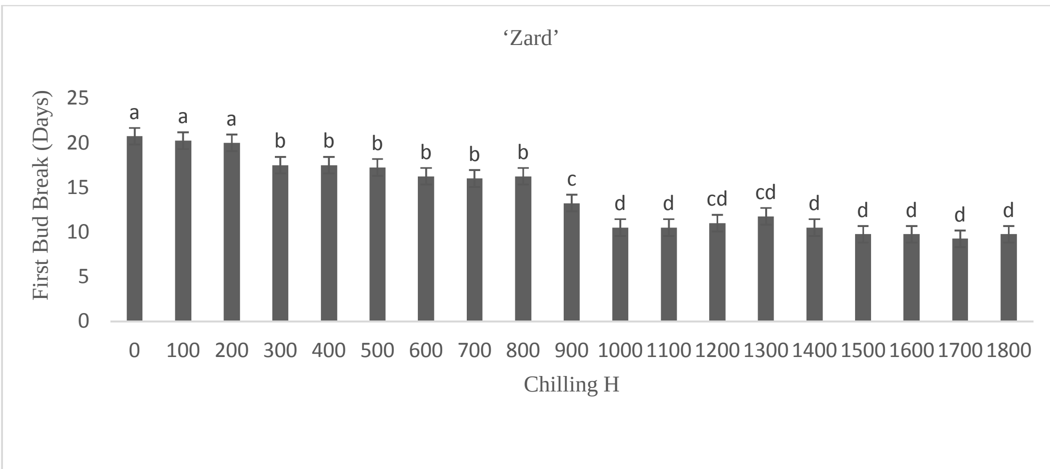

Fig. 8. Number of days up to the first bud break of ‘Zard’ olive cultivar under different chilling hours.
*Columns with the same letter are not significantly different at 5% level DMRT

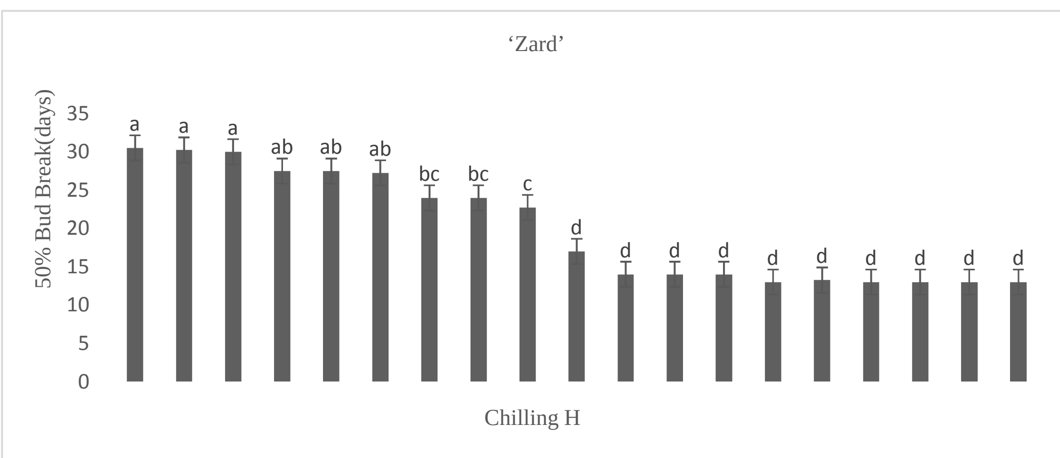

Fig. 9. Number of days up to the 50% bud break of ‘Zard’ olive cultivar under different chilling hours.
*Columns with the same letter are not significantly different at 5% level DMRT

'Dehghan' Cultivar
Percentage of Flower Bud Break

In this cultivar, the highest percentage of bud breaks was observed in 1100 h chilling at 5ºC (91.5%) and above it their differences were not significant. The lowest percentage of bud breaks belonged to the control treatment with 19.5% (Fig. 11).

Number of Days to the First Flower Bud Break

Results of this study showed that the 1100 h chilling at 5ºC significantly reduced number of days to the first flower bud to open (10.25 days) and had no significant differences with chilling treatments above 1100h. The maximum mean of day to the first bud break belonged to the control treatment (20 days) (Fig. 12).

Number of Days to the 50% Flower Bud Break

The minimum mean of days of the 50% bud break belonged to the chilling treatment 1000 h at 5ºC (15.75 days) and the differences were not significant in comparison with the greater chilling h treatments. 900 h chilling treatment with the mean of 20.75 days to the 50% bud break had statistical differences with other chilling treatments. Control treatment had the most days to the 50% of bud break with the mean of 30.5 days (Fig. 13).

'Shiraz' Cultivar
Percentage of Flower Bud Break

The percentage of bud break increased by increasing chilling hours. Control treatment with no chilling had the lowest percentage of bud break (16.25%), whereas in contrast to the control treatment, 900 h chilling treatment had the highest percentage of bud break (91.25%) but did not have any remarkable differences with the greater chilling hour treatments (Fig. 14).

Number of Days to the First Bud Break

The process of reducing the number of days to the bud break along with the increase in chilling hours was very distinguished in this cultivar. Results of chilling hours on the number of days to the first bud break are shown in Fig. 15. Control treatment had the most days to the first bud break (19 days). In comparison to the control treatment, 900 h chilling at 5ºC significantly reduced the mean number of days to the first bud break (10.75 days) but had no significant differences with chilling hours above it (Fig.15)

Number of Days to the 50% Bud Break

Comparison of the mean of data is shown in Figure 5C. Control treatment had the maximum number of days to the 50% bud break (24.25 days). Along with the increase in chilling hours to 900 h the number of days to the 50% bud break significantly reduced (13 days), but the differences with higher than 900 h chilling were not significant (Fig.16).

Determining of Chilling Requirements of Olive Cultivars with Positive Utah and Utah Models.

The time of flower bud swelling was different in olive cultivars and occurred on the following dates, 'Fishomi' on Feb.28th, 'Shiraz' on Mar.2th, 'Zard' on Mar.9th, 'Dezful' on Mar.11th and in 'Dehghan' on Mar.13th.

According to the Positive Utah model, the accumulation of chilling units in these cultivars was in the following order: 'Fishomi', 'Shiraz', 'Zard', 'Dezful' and 'Dehghan' with 907, 917.5, 975.5, 1001.5 and 1030.5 chilling units, respectively (Table 1).

According to the Utah model, the accumulation of chilling units in these cultivars was in the following order: 'Fishomi', 'Shiraz', 'Zard', 'Dezful' and 'Dehghan' with 735.5, 752.5, 801, 875 and 909.5 chilling unit, respectively (Table 1).

Determining Heating Requirements

Measurement of cumulative heat units showed that 'Dehghan' olive cultivar had the maximum heat units (321 GDDS) and 'Fishomi' cultivar had the minimum heat units (199.2 GDDS) (Table I).

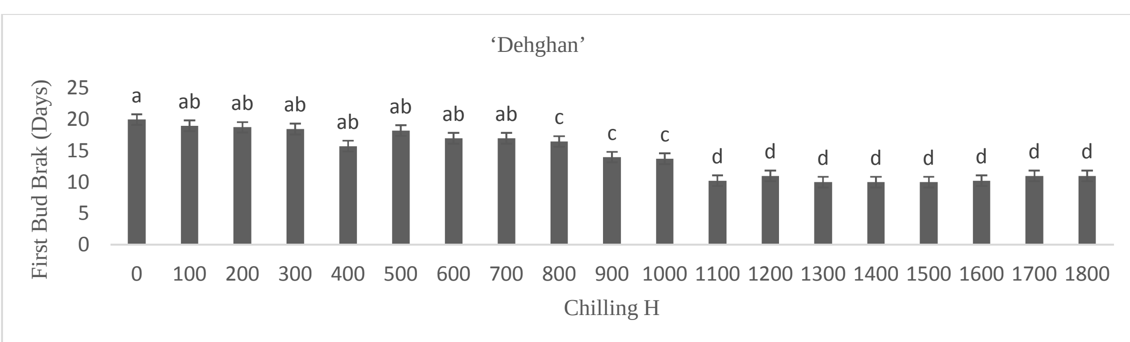

Fig. 10. The percentage of Bud break of 'Dehghan' olive cultivar under different chilling hours.
*Columns with the same letter are not significantly different at 5% level DMRT

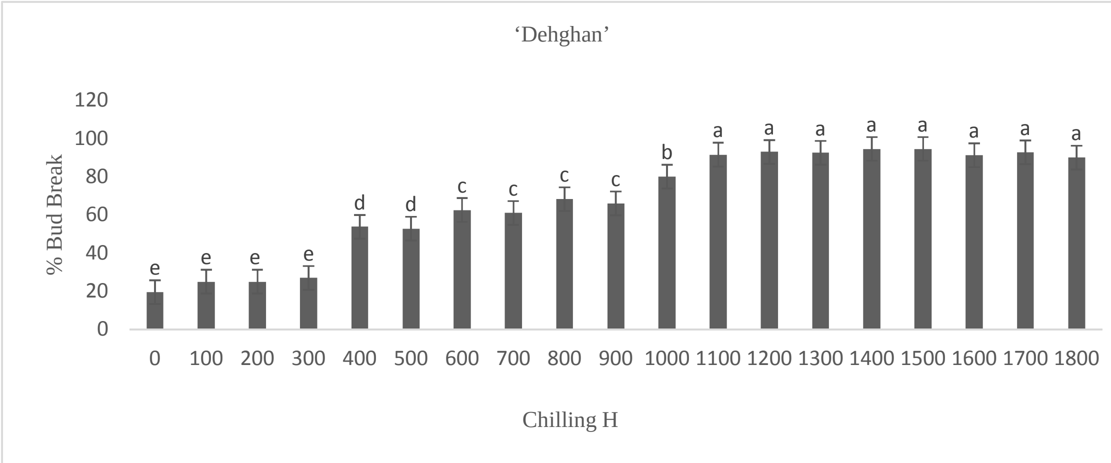

Fig 11. The percentage of Bud break of 'Dehghan' olive cultivar under different chilling hours.
*Columns with the same letter are not significantly different at 5% level DMRT

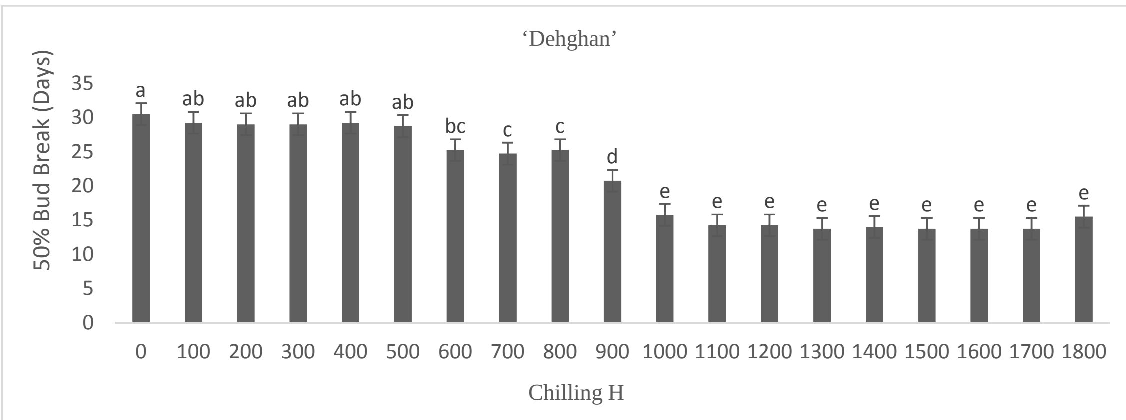

Fig. 12. Number of days up to the 50% bud break of 'Dehghan' olive cultivar under different chilling hours.
*Columns with the same letter are not significantly different at 5% level DMRT

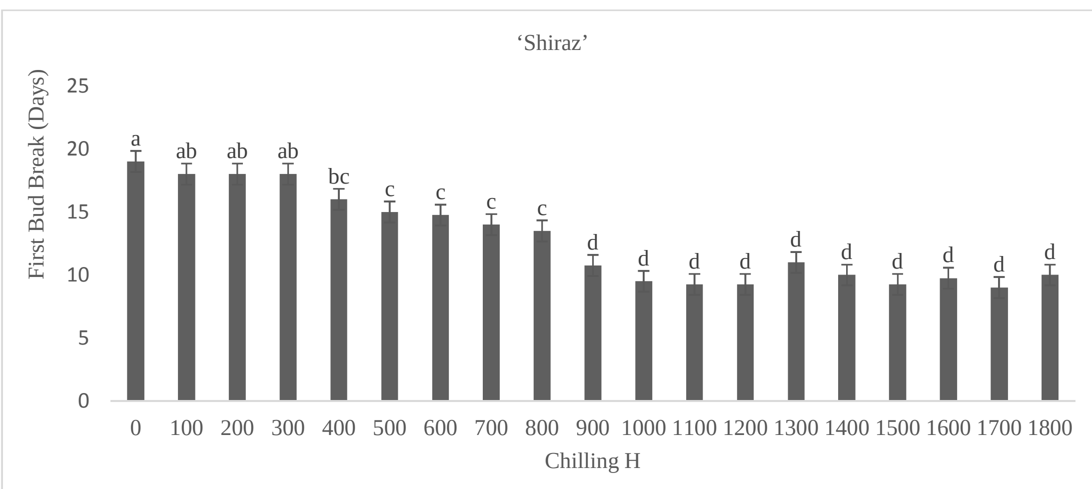

Fig. 13. Number of days up to the first bud break of 'Shiraz' olive cultivar under different chilling hours.
*Columns with the same letter are not significantly different at 5% level DMRT

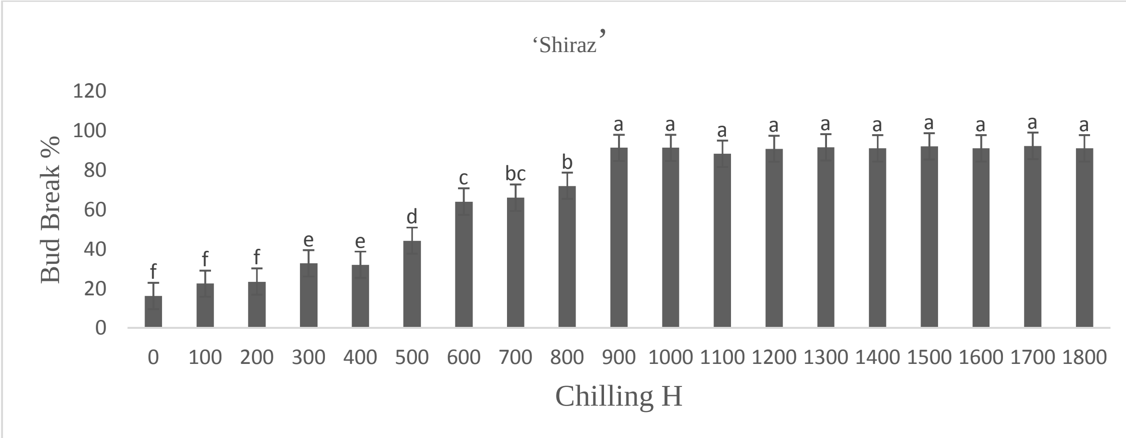

Fig. 14. Number of days up to the first bud break of 'Shiraz' olive cultivar under different chilling hours.
*Columns with the same letter are not significantly different at 5% level DMRT

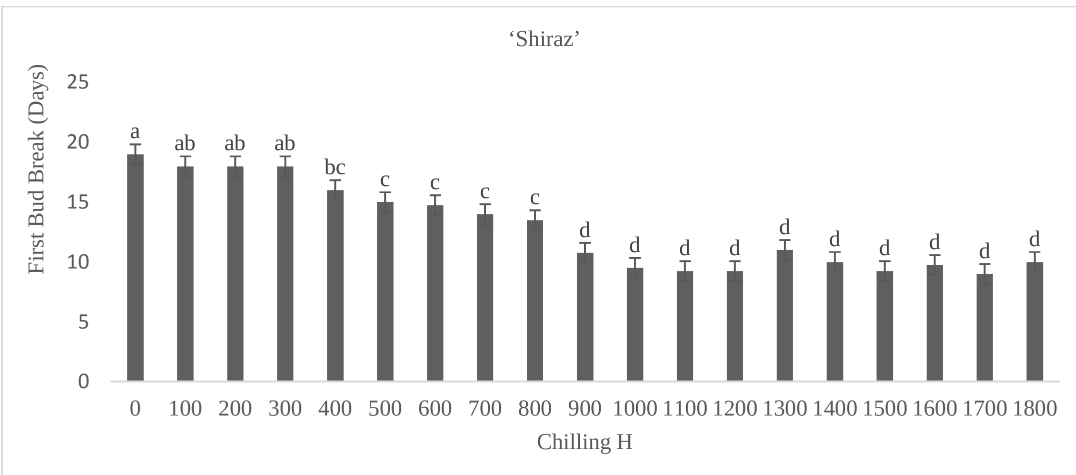

Fig. 15. Number of days up to the 50% bud break of 'Dehghan' olive cultivar under different chilling hours.
*Columns with the same letter are not significantly different at 5% level DMRT

Table 1. Accumulation of effective chilling unit of olive cultivars in the field according to the Utah and the Positive Utah models and measurement of cumulative heat units (GDD) required for flowering.

Olive cultivar	Time of bud swelling	Accumulation of chilling units according to Positive Utah model	Accumulation of chilling units according to Utah model	Measurement of growing degree days (GDDs)
'Fishomi'	Feb 28	907.0	735.5	199.2
'Shiraz'	Mar 2	917.5	752.5	209.3
'Zard'	Mar 9	975.5	801.0	245.2
'Dezful'	Mar11	1001.5	875.0	272.1
'Dehghan'	Mar13	1030.5	909.5	321.0

Results of this study were similar to the temperate fruit crops; that is, flower bud developed when shoots of olive trees were exposed to the chilling temperature during winter (Table 1). In regions with inadequate winter chilling to overcome chilling requirements, spring growth is not satisfactory (Antonio et al., 2009).

The first step to check chilling requirements of local cultivars is to obtain cultivars with low chilling requirements. In this experiment, by surveying the period to the half of bud burst and the percentage of total bud urst at various chilling treatments, chilling requirements of selected cultivars were estimated. The time to bud break after chilling treatment depends on its heat requirement. We observed that cultivars with a lower heat requirement had an earlier bud break, in spring (Table 1) and it was in agreement with previous studies which indicated that the lower the bud heating requirement, the earlier the bud break. Furthermore, due to the dependence of the chilling requirement to heating requirement, it can be concluded that factors which changed chilling requirements of the buds are effective on heat requirement as well (Citadin et al., 2002).

Length of chilling period is effective on breaking dormancy. By increasing the length of chilling period, breaking bud dormancy will be more uniform and faster. Therefore, in this study, olive chilling treatments significantly increased the rate of bud break in comparison with the control (Figs. 1, 4, 7, 10, & 13).

Our study showed that there were significant differences between the number of days to the first bud break and the number of days to 50% bud break in response to chilling period. Besides that, it was observed that by increasing the chilling period, the percentage of bud break increased (Figs. 1-16) and the results were consistent with the findings of other researchers (Citadin et al., 2002; Couvillon and Erez, 1985; Warmund and Krumme, 2005).

Chilling requirement is satisfied when growth begins. Although chilling requirement is eliminated in winter season (when the weather is cold enough to begin growth), ecodormancy continues in buds and with the start of warm temperature, it ends and causes bud break and growth gets started. It was reported that flowering of the olive tree was promoted more at 12.5ºC than at any other constant temperature. 12.5ºC was considered optimal temperature for chilling completion and heat accumulation for anthesis. Furthermore, temperature fluctuations can either delay flower bud initiation or promote it (Alcela and Barranco, 1992).

We found that cultivars with a higher chilling requirement had their growth and flowering delayed in spring and also their heat requirement was higher. For instance, the chilling requirement of 'Dehghan' cultivar had the highest chilling and heat requirement than other cultivars (Table 1). Delayed growth and flowering in cultivars which had a higher chilling requirement is the result of interaction between chilling and heating requirements. In other words, trees with an incomplete chilling requirements, need more heat requirement than those with a complete chilling requirement (Swartz and Powell, 1981).

CONCLUSIONS

The chilling requirement of 'Fishomi', 'Dezful', 'Zard', 'Dehghan' and 'Shiraz' cultivars were 900, 1000, 900, 1000, 1000, 1100, 900 h respectively. Our results indicated that the positive Utah chill method under warmer winter was more efficient than Utah method for estimation of the chilling requirement according to field conditions. Heat requirement from the end of dormancy to full bloom stage was evaluated at 199.2, 272.1, 245.2, 245.2, 321 GDDs, respectively. It was observed that 'Fishomi' had the lowest chilling requirement and 'Dehghan' obtained the highest one. We concluded that Therefore, 'Fishomi' is recommended for cultivation in subtropical region.

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مقایسه مدلهای یوتا مثبت و یوتا به منظور تعیین نیاز سرمایی و گرمایی برخی ارقام زیتون

مجید راحمی*، **نگار نوید پور، سحرصداقت**

گروه علوم باغبانی، دانشکده کشاورزی، دانشگاه شیراز، شیراز، ج.ا. ایران

*نویسنده مسئول

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درجه رشد روز

(growing degree days)

چکیده- تعیین نیاز سرمایی و گرمایی در ارقام بومی زیتون استان فارس یکی از عوامل مهم جهت رشد و نمو بهینه درخت زیتون می‌باشد. این پژوهش به منظور بررسی تعیین نیاز سرمایی جوانه گل زیتون و تعیین نیاز سرمایی ارقام زیتون با استفاده از روش یوتا و یوتا مثبت و مقایسه این مدل‌ها با نیاز سرمایی آزمایشگاهی و ارائه روشی کارا برای اندازه‌گیری نیاز سرمایی در منطقه انجام شد. دراین پژوهش نیاز سرمایی و گرمایی ارقام 'فیشمی تخم کبکی'، 'دزفول '،'زرد'، 'دهقان'و'شیراز ' تعیین شد. جهت تعیین نیاز سرمایی، قلمه‌هایی از شاخه یک ساله ارقام زمانی‌که دمای محیط به ۱۲ درجه سانتی‌گراد رسید، جمع‌آوری شدند. قلمه‌ها به مدت ۰، ۱۰۰، ۲۰۰، ۳۰۰، ۴۰۰، ۵۰۰، ۶۰۰، ۷۰۰، ۸۰۰، ۹۰۰، ۱۰۰۰، ۱۱۰۰، ۱۲۰۰، ۱۳۰۰، ۱۴۰۰، ۱۵۰۰، ۱۶۰۰، ۱۷۰۰و ۱۸۰۰ ساعت در دمای ۵ درجه سانتی گراد قرار داده شدند. نیاز سرمایی ارقام فیشمی تخم کبکی، دزفول، زرد، دهقان، شیراز به ترتیب ۹۰۰، ۱۰۰۰، ۹۰۰ تا ۱۰۰۰، ۱۰۰۰ تا ۱۱۰۰ و ۹۰۰ ساعت برآورد شد. روش یوتا مثبت روش کاراتری نسبت به روش یوتا برای تعیین نیاز سرمایی بود و داده‌های آن با نتایج به‌دست آمده از طریق روش آزمایشگاهی نزدیک‌تر بود. نیاز گرمایی ارقام از مرحله پایان خفتگی تا تمام گل به ترتیب ۱۹۹/۲، ۲۷۲/۱، ۲۴۵/۲، ۳۲۱ و ۲۰۹/۳ درجه رشد روز (growing degree days) برآورد شد. نتایج نشان داد که رقم فیشمی تخم کبکی دارای کمترین نیاز سرمایی و رقم دهقان بیشترین نیاز سرمایی را داراست. بنابراین رقم فیشمی تخم کبکی با نیاز سرمایی و گرمایی کمتر را می توان در مناطق نیمه گرمسیر برای کاشت پیشنهاد نمود.