International Journal of Innovation in Agriculture Sciences and Rural Development
Vol.1, NO.2 , P : 76 - 84
Received: 06 Des 2018
Accepted: 04 Mar 2019

Determination the chilling requirement of pistachio cv. Badamie Sefide Mahvelat and its strategic role in pistachio orchards management of Khorasan Razavi, Iran

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Abstract

Pistachio (*Pistacia vera* L.) is an important commercial nut in Iran which was adapted to the native climate. However, the climate change caused to warming winter recently in Iran. Determination of chilling requirement for pistachio trees helps to the researchers to identify the challenge of inadequate winter chilling in the warm winter condition. This experiment was conducted to determine chilling requirement for bud breaking in pistachio cv. Badamie Sefide Mahvelat as an adapted cultivar in Khorasan Razavi province and cv. Akbari. The branches with enough flower buds were taken from pistachio trees during November 2017 when the minimum and maximum temperatures reached to 7.9 °C and 18.2°C respectively. Cuttings with flower buds were kept under (5±1) °C for 0, 600, 800, 900, 1000, 1200 and 1300 h, respectively and were placed on green house under white light at (22±1) °C condition. Each treatment included 15 replications and study was carried out in completely randomized design. The results indicated that pistachio cv. Badamie Sefide Mahvelat needs a chilling period between 1000-1200 h. Additionally, floral bud breaking occurred homogeneously and it process followed a uniform subordinate in 1000 h and 1200 h treatments. Chilling requirement of cv. Akbari was determined between 1200-1300h.

Keywords: chilling requirement, climate change, cv. Badamie Sefide Mahvelat, Pistachio.

Introduction

Warmer winters due to the climate change may critically affect temperate tree species; all economically important fruit and nut tree species require cold winters for regular flower buds breaking and optimal development of fruits [1]. The estimates of chilling requirements for bud breaking are the primary means of quantification of variety chill accumulation needs and have served as a starting point for identifying species or varieties that may be defenseless to

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the warmer winters associated with the trend of climate change in recent decade [2].

Pistachio tree (*Pistacia vera* L.) is an important commercial nut in Iran and has adapted to the native climate. Iran rank No. 1 in pistachio production and harvest area in the world in 2017 [3]. *Mahvelat* is one of the most important areas in *Khorasan Razavi*, Iran, which has 21550 hectares pistachio production area [4]. The pistachio cv. *Badamie Sefide Mahvelat* is the most adapted cultivar which has been allocated the most harvest area in *Mahvalat* and *Khorasan Razavi* province as well. The knowledge related to the chilling requirement of pistachio cultivars are essential for economic production. Other studies had shown different chilling requirement in other pistachio cultivars [5, 6]. However, any study for determination the chilling requirement for cv. *Badamie Sefide Mahvelat* has not done yet. The chilling requirement means the best existing approximation for a threshold of sufficient cold accumulation of a plant species or a variety [2]. Insufficient chilling in pistachio leads to instability and a low percentage of bud break, late flowering, vegetative and generative development, late ripening, less leaves and reduced pollination, irregular development of the buds, thus reduced yield [1, 6].

The effective chilling requirements of fruit cultivars depend on several factors such as the genetic factors, the type of buds, latitude, rootstock, light and nutritional status [6].

Determination of chilling requirement for pistachio orchards helps to the researchers to identify the challenge of inadequate winter chilling in the warm winter condition. Erratic floral bud break, delayed flowering, sparse foliage and decreased yield of pistachio are reported due to an inadequate winter chilling, which could be addressed partly by hydrogen cyanamide (Dormex) treatments at 2 and 4% which are reported to increased floral bud break, advanced flowering period and improved vegetative growth of pistachio trees in comparison to the untreated control [7]. The researchers determinated chilling requirements of pistachio cultivars and reported that cv. *Kalle-Ghuchi* had the lowest chilling requirements (750–800 h) while, cv. *Ahmad-Aghaei* and *Owhadi* were intermediate (1000–1050 h, 850–900 h) [6]. The other researcher studied the chilling requirements of 4 pistachio cultivars in *Semnan*, Iran, and reported chilling requirements were estimated to be 1100 h for cv. *Khanjari*, cv. *Shahpasand*, and cv. *Abasali* [8].

This study carried out for first time aim to determination of chilling requirement of cv. *Badamie Sefide Mahvelat* as most adapted pistachio cultivar in *Khorasan Razavi* province, Iran.

Material and method

The experiment was conducted on '*Badamie Sefide Mahvelat'* and '*Akbari'* cultivars of pistachio in '*Mahvelat'* region of '*Khorasan razavi'* province, Iran during 2017-2018. The study site is in latitude 35°

0'42.15", longitude 58°46'58.93" and with an altitude of 930 meters above the sea level with a semi arid to arid climate.

The trees were 15 years old at the beginning of the study, and all trees had were irrigated and fertilized similarly. The cutting branches were prepared with the same diameter, internodes and length (nodes 4-6, cutting length 25-30 cm) in 23th November 2017 after entering the dormancy in mid-November, when the minimum and maximum temperatures reached to 7.9 °C and 18.2°C respectively. Cuttings branches were divided into 15 categories and were washed with distilled water. Cuttings surface were sterilized via spraying Copper Oxychloride and were wrapped in wet cotton textile. Then, The groups of cutting branches were stored at (5 ± 1) °C for 0, 600, 800, 900, 1000, 1200 and 1300 h (600-1200h for cv. *Badami Sefide Mahvelat*, 800h-1300h for cv. *Akbari*) respectively, for cuttings with flower buds. After cold treatments, the bottoms of all the cuttings were removed and placed in plastic cups with the basal 7-10 cm in distilled water, which was replaced each week, and were placed on green house under white light at (22±1) °C condition. The apical buds of each cutting were monitored 2-3 times per week for bud break sign. Bud break was defined as the first day when green tissue beneath the bud scales was observed. We used refrence [6] method in all steps for preparing the cutting and chilling process.

Source of Variation	df	Mean square Days at 22^0C to observe the first bud with green tissue
replicat	14	0.385 ns
Chilling	4	105.213**
Error	56	0.249
CV%	…	3.46%

The experiment was a Completely Randomized Design with 15 replications. Each treatment included 15 cuttings. Data were analyzed by statistical software MSTAT-C and means were compared by Duncan Multiple Range Test at 5% level.

Result:

Chilling requirement *cv. Badamie Sefid Mahvelat*

The result of data analysis showed the sufficient chilling requirement affected significantly on the time needed for bud break in cv. *Badamie Sefide Mahvelat* (Table 1).

Mean comparison revealed after the 1000 h chilling requirement, the number of days for flower buds break (11.8 days on average) were significantly less than 600 h (17.07days), 800 h (16.13 days) and 900 h (15.73 days) treatments (Figure1). The results have

Table1- Analysis of variance of the number of days until blooming bud break effected by different chilling time in cv. *Badamie Sefid Mahvelat*.

(* significant at 5%; ** significant at 1%; ns non- significant).

been represented in table 1. Never the less, there wasn`t any significant difference between 1000 h and 1200 h (11.6 days) chilling requirement statistically (Figure 1). In addition, the study on the data related to the process of other flower buds breaking in 10 days after the first bud break revealed that when the buds were exposed to 1000 h and 1200 h treatment, the rest of bud break happened more regular and quickly compare to the other treatments. So that, more than 50% of flower buds had been initiated to break and grow in the end of 10 days investigation (Figure 2). More over, bud breaking comprised homogeneous flower buds and it followed a uniform subordinate in 1000 h and 1200 h treatments (Figure 2). However, the other treatments have taken a different propensity in bud break procedure, so that the final percentage of bud break in 600 h, 800 h and 900 h were obtained 23.5%, 28% and 30.4% respectively at the end of 10 days study (Figure 2). Furthermore, the uniformity of bud break in 600 h, 800 h and 900 h were observed clearly less than 1000 h and 1200 h treatments. Data indicated the different behaviour of flower buds in the period between 15- 20 days at 22°C after putting cutting branches to green house, such that percentage of bud break in 900 h treatment increased 10.4%, but it was 19.1% and 21.2% in 1000 h and 1200 h respectively. Generally, the obtained results confirmed 1000 h-1200 h chilling requirement for flower buds break about cv. *Badamie Sefide Mahvelat*.

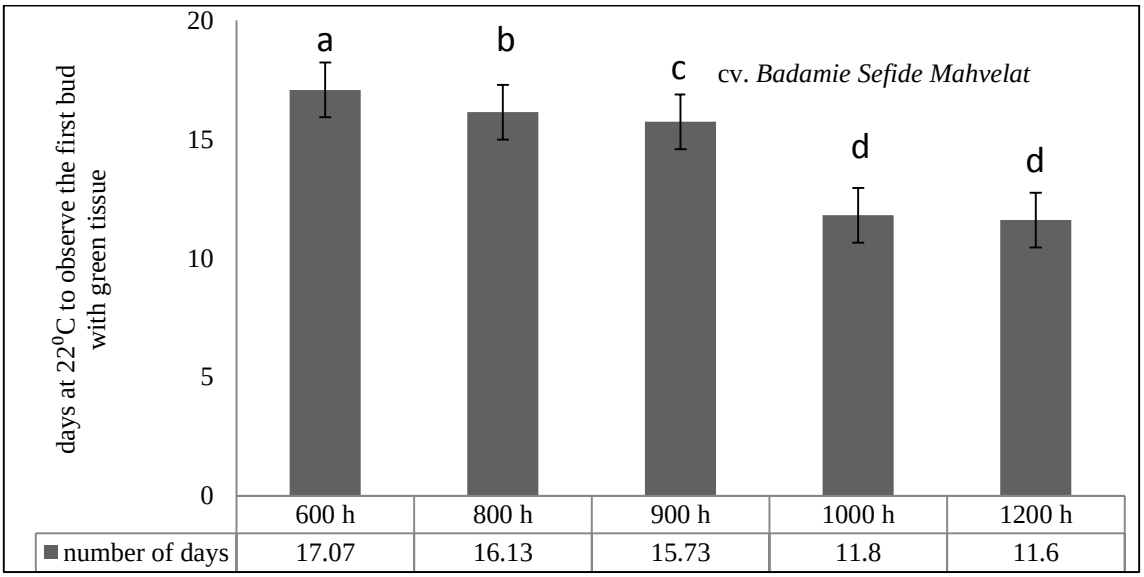
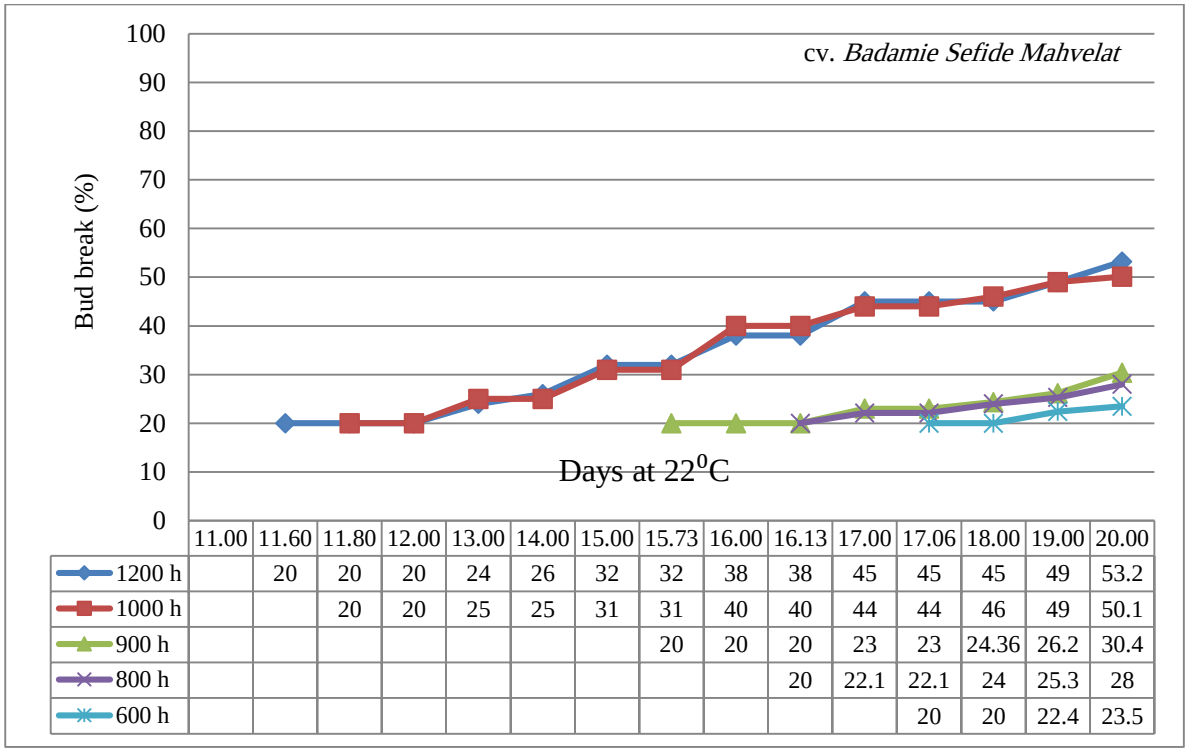


Figure (1) The rate of flower bud break in pistachio cv. *Badamie Sefide Mahvelat* under different chilling time (at 5 ± 1 °C).



	11.00	11.60	11.80	12.00	13.00	14.00	15.00	15.73	16.00	16.13	17.00	17.06	18.00	19.00	20.00
1200 h		20	20	20	24	26	32	32	38	38	45	45	45	49	53.2
1000 h			20	20	25	25	31	31	40	40	44	44	46	49	50.1
900 h								20	20	20	23	23	24.36	26.2	30.4
800 h										20	22.1	22.1	24	25.3	28
600 h												20	20	22.4	23.5

Figure (2) The different behaviour of floral buds in pistachio cv. *Badamie Sefide Mahvelat* during verity chilling times (5 ± 1 °C) since the beginning of the first bud breaks up to 10days after.

Chilling requirement *cv. Akbari*

The result of the analysis of variance showed the time needed for bud break was significantly influenced by different chilling time treatments in cv. *Akbari* (Table 2).

Table2- Analysis of variance of the number of days until flower bud break effected by different chilling time in cv. *Akbari*.

(* significant at 5%; ** significant at 1%; ns non- significant).

Source of Variation	df	Mean square
		Days at 22^{0}C to observe the first bud with green tissue
replicat	14	0.531**
Chilling	3	143.867**
Error	42	0.188
CV%	…	3.13%

The mean comparison of data revealed that when the Cuttings branches exposure to 1200 h and 1300 h at 5 ± 1 °C, the first green tissue of flower bud observed after 11.12 and 11.267 days (on average) respectively in green house at 22±1 °C (Figure 3). Nevertheless, the exposure to 800 h- 1000 h chilling caused to the observation of the first flower bud break after on average 16.933 and

16.133 days (at 22±1 °C) respectively which had a statistically significant difference compared to 1200 h and 1300 h treatments (Figure 3). Additionally, the results and interpretation related to the process of bud breaking corroborated when the chilling requirement was reached to 1200 h and 1300 h, buds breakage and the growth of buds occurred regular and earlier. As illustrated in Figure 4 after observing the first flower bud break, percentage bud break increased 36% in 1300 h and 35.1% in 1200 h treatment during 10 days of investigation, while it was 14% and 8.4% in 1000 h and 800 h respectively.

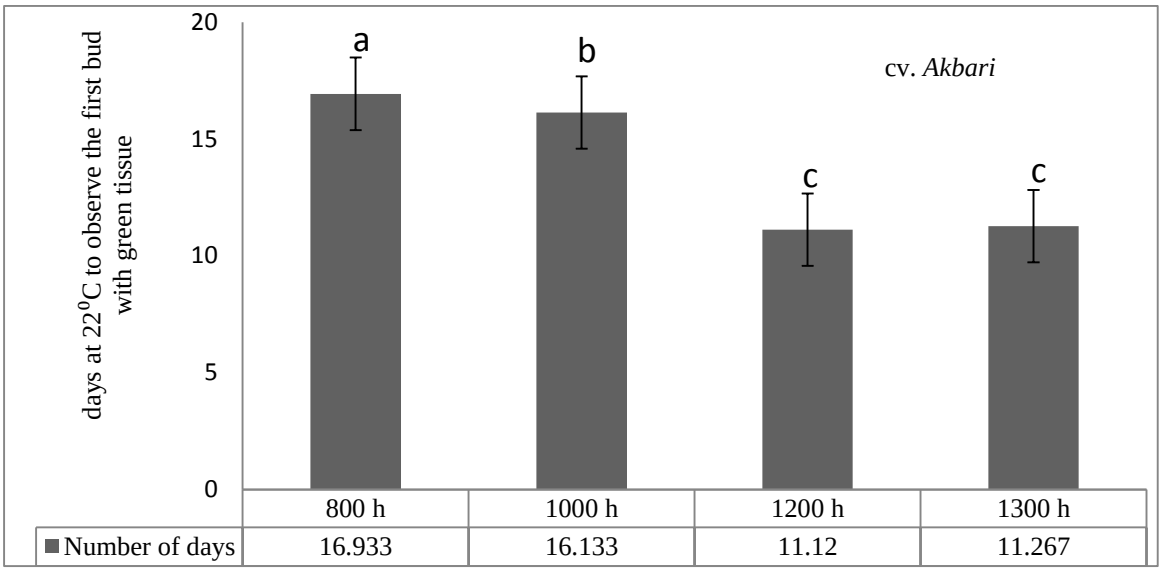


Figure (3) The rate of flower bud break cv. *Akbari* under effects of different chilling times (at 5 ± 1 °C).

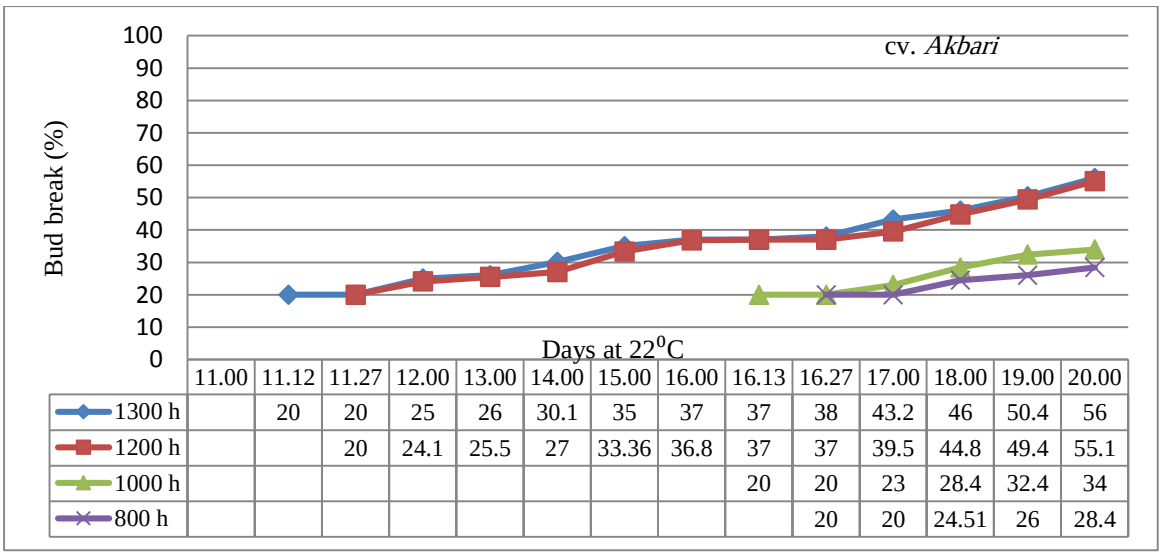


Figure (4) Different behaviour of floral buds cv. *Akbari* during verity chilling times (5 ± 1 °C) since the beginning of the first bud break up to 10days after.

Discussion

The results related to the presented study revealed that the both pistachio cultivars had a different response to verity chilling period. The Physiological phenomenon of flower bud breaking occurred via achievement of chilling time between 1000-1200 h in cv. *Badamie Sefide Mahvelat* homogenously and quickly. Chilling requirement of cv. *Akbari* was determined between 1200-1300h. Therefore, cv. *Badamie Sefide Mahvelat* can be an earlier blooming cultivar compare to cv. *Akbari*. During an investigation, the chilling requirement was determinated for cv. *Akbari* about 1200 h and introduce the genetic factors as a reason of differ chilling necessity for bud breaking [8]. The another study revealed that, enrichment chilling requirement increased yield of pistachio cv. *Mateure* due to homogenous flower bud breaking and may not abscission floral buds [7]. Also, the other research demonstrated that 1400 h (vegetative buds) and 1200 h (Reproductive buds) chilling requirement caused to regular and fast bud break in cv. *Akbari* [6].

Chill may be indirectly affecting the yield through flowering time, carbohydrate reserve and vegetative vigor [9]. Moreover, insufficient chilling result to non overlap male and female flowering in pistachio hence reduces pollination [1, 2]. A positive and significant correlation between nut yield and chilling accumulation was observed in the Mediterranean region with high temperature registered in the late winter [7, 10, 11]. The Phenomenon of climate change has followed warm winter in Iran. Determination of chilling requirement provides the facility to understand sufficient or insufficient chilling requirement for pistachio trees in the garden based on winter temperatures survey. In addition, it can be noted that via utilizing some techniques such as winter oil spraying, especially soybean oil; it is possible to minimize the inappropriate outcomes of inadequate chilling in the pistachio gardens .

Overall, a lot more research is needed into what exactly drives the progression of trees through the dormancy phase, what physiological processes and genetic mechanisms underlie this progression, and how these processes can be manipulated. The scientists explained about the knowledge gaps and he declares that more work is needed on manipulating orchard climates and the breaking of individual buds. However, what's important is that via the studying process of climate change and understanding how the weather would change in the future, we can find promising solutions for sustainable production in the future[12].

Conclusions

The results of presented study indicated that pistachio cv. Badamie Sefide Mahvelat needs a chilling period between 1000-1200 h. Additionally, floral bud breaking occurred homogeneously and it process followed a uniform subordinate in 1000 h and 1200 h treatments. Chilling requirement of cv. Akbari was determined between 1200-1300h.

Acknowledgment

The authors wish to thank A. H. Sherafati the supervisor researcher of *Feiz Abad*e *Mahvelat* Pistachio Research Station *Khorasan Razavi*, Iran.

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