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Chilling Requirement Evaluation of the Abjosh Cultivar (*Vitis vinifera*) in Afghanistan

Ali Jawed Safdary[1], Ahmad Jawid Ahamdi[2], Nasratullah Habibi[3]*, Gul Agha Sadiq[4]

[1]*Department of Horticulture, Faculty of Agriculture, Samangan Higher Education Institute, Samangan, Afghanistan*
[2]*Department of Agronomy, Faculty of Agriculture, Samangan Higher Education Institute, Samangan, Afghanistan.*
[3]*Department of Agronomy, Faculty of Agriculture, Balkh University, Balkh, Afghanistan*
[4]*Department of Horticulture, Faculty of Agriculture, Kunduz University, Kunduz, Afghanistan*

*Corresponding author: Nasratullah Habibi (*nasratullah.habibi14@gmail.com*)

Abstract

This study was conducted to determine the chilling requirement of the Abjosh grape (local cultivar). The experiment was carried out based on randomized complete block design with three replications. The grape cuttings were treated at 5°C for (0, 100, 200, 250, 300, 350, 400, and 500 hrs) as chilling treatments at Samangan Higher Education Institute in the autumn of 2018. The traits such as the percentage of bud breaking, number of days to the first bud breakage, number of days to 50% of bud breaking, and number of days to the last bud breaking were measured. The results showed that the percentage of bud breaking increased significantly, as the chilling hrs (hours) increased. By the increasing of cold duration, the percentage of bud breaking in 500 hrs increased to 80% whereas, number of days to the first bud breaking, 50% of bud breaking and the number of days to the last bud breaking were decreased to 13, 14, and 16 days, respectively. Though, there were no significant differences between the 400 and 500 cold hrs in all indicators. The findings revealed that at least 300 hrs of cold duration is essential to reach an acceptable percentage of bud breaks, but further elaboration is needed.

Keywords: Abjosh Grape Cultivar, Chilling Requirement, Grape Cuttings.

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Ethical: This study follows all ethical practices during writing.

1. Introduction

The Abjosh cultivar is one of the most well-known and widely cultivated crops in the Samangan province of Afghanistan [1, 2]. Recently, chilling requirement determination of crops have been considered more important globally because of partial hibernation due to warm winter caused lots of financial yield losses annually [2]. Failure to meet the cold requirements of plants is a major problem in crop production in temperate climates, and the grapevine is no exception. Therefore, determining the cold requirement of grapes is considered obligatory.

Grapes and other temperate fruit varieties may pass the dormancy period [3, 4]. Winter dormancy is a genetic necessity for grapes, and this rest period is essential for the grape growing cycle. In warm regions, where grape spring growth is not satisfactory due to the lack of sufficient winter coldness, chilling is an essential factor for fruit cultivars that allows the budding process to occur normally [5]. The results of many studies have shown that cold requirement in most fruit trees, including grapes, requires a minimum temperature in terms of time duration and amount to remove dormancy, so far, all grape varieties require coldness to break dormancy. Coldness can be the main contributor to grape growth, yet, cold is more likely to be an optional factor for grape growth [6].

Many fruit crops require coldness to break their winter dormancy. Insufficient chilling may cause a decrease in bud breaking [7] delayed bud breakage, poor flower development, irregular fruit growth, delay in the flowering season, and delay in subsequent crop growth [8]. Investigating the chilling requirement and forecasting of flowering dates in different climates plays a crucial role in the successful production of horticultural products in the market [9]. However, hibernation is a key point in the annual cycling of horticultural plants such as fruits, thus the trees need to break the hibernation to develop flowering [10]. Perennial plants in temperate to semi-tropical regions enter the hibernation period to avoid freezing damage in winter, and until they receive a certain amount of winter cold, their cooling requirement is not met. Furthermore, the chilling requirement plays a basic role in the cultivar selection of a specific geographic area too. Horticulturists select varieties of fruit species suitable for a location-based on their cooling needs. Meant for the selection process, identifying the regional winter cold, the cooling need of the species and genotypes using the different measuring models are needed [11].

Choosing a suitable model is important for estimating the cooling requirement and the factors that vary the models' usages in different years and regions should be identified, but so far, very few factors have been identified. The cold requirement of each plant is better studied with specific models. Amongst the models, the Weinberger model, which places the buds at temperatures below 7 °C, can be used to determine the cooling requirement of deciduous plants [11]. The insufficient cold duration through a dormancy period needs applying appropriate treatments to break bud dormancy to ensure the commercial production of grapes. Methods such as cooling with water, treating shoots with hot water, scratching, mineral oils, and bending of shoots have been used to stimulate bud sprouting in grapes, which can be used to break the sleeping period of buds too [12]. Based on a study, the chilling requirement amount of grape was estimated to be between 100 and 400 h; grape cuttings (Vitis. riparia) were frozen at 500 (control), 1000, 1500, and 2000 hrs, so the chilling requirement of grapevine was determined 1500 hrs at temperatures below 7 °C [13]. The chilling requirement of the grape cultivar (Tamuncidin) was reported between 500 and 800 hrs in the northe of Chile and 430 hrs in the Aconcagua valley of Chile. This study aimed to determine the chilling requirement of the Abjosh grape cultivar and its response to the coldness.

2. Materials and Methods

2.1. Laboratory Experiment

Cuttings of the Abjosh cultivar were prepared in the autumn of 2018 when the average temperature reached 10 °C. The position of the productive buds is distinctive in branches; the most productive position of annual branches is between 4 to 12 buds. It was also observed that the selected branches were similar in terms of length, the number of buds, and branch position on the tree [3, 14]. The cuttings were prepared from the lower part of the branch between the fourth to sixth buds. The cuttings were about 15 to 25 cm in length with two buds. The cuttings were wrapped inside the paper and aluminum foil after floating in fungicides. Then they were chilled at 5 °C for (0, 100, 200, 250, 300, 350, 400, and 500 hrs) as chilling treatments in a cold room. The experiment was carried out based on randomized complete block design with three replications. After providing the necessary cold requirement, the cuttings rinsed with distilled water and kept in glasses containing distilled water, immediately. Underneath of the cuttings were cut and kept in pots under the continuous light condition and room temperature (22±3 °C). Indicators such as the percentage of bud breaking, number of days to the first bud breaking, number of days to 50% bud breaking, and number of days to the last bud breaking were measured. Counting buds began when the green tissues were observed under the buds' scales [15].

2.2. Statistical Analysis:

The data were analyzed with RStudio v4.3 (Austria). The significant differences were defined at 5% ($p<0.05$) and the graphs were drawn by RStudio.

3. Results

3.1. Percentage of Bud Breaking

The results showed that there was a significant difference between the control (no cooling) and chilled treatments except for the 100 and 200 hrs chilling treatment. Amongst the treatments, the lowest percentage of buds opening was shown at 100 hrs; whilst the highest was recorded at 400 and 500 hrs. The findings indicate that extended chilling duration increased buds breaking percentage (Figure 1).

3.2. Number of days until the first bud breaking

The number of days to the first bud breaking is shown in Figure 2. The findings indicate that there was a significant difference in the number of days to the first bud opening between the chilled treatments and control except for 100 hrs. However, it was declined in longer chilling duration. By increasing the chilling time duration from 100 hrs to 200, 350, and 500 hrs, the number of days to the first bud breaking was reduced (Figure 2).

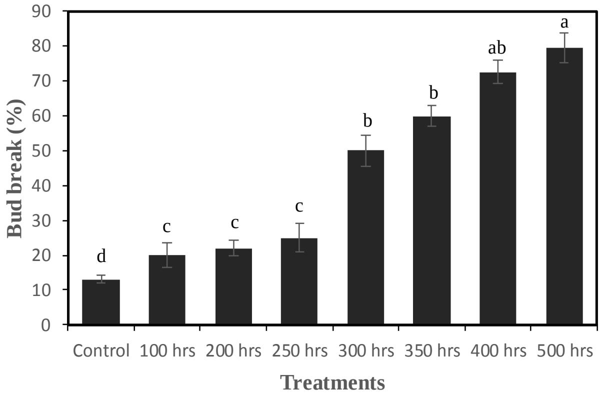

Figure-1.
Effect of chilling duration on bud break percentage in grapevine cv.' Aabjosh'.
Note: Bars with the same letter mean that there was no significant difference between them.

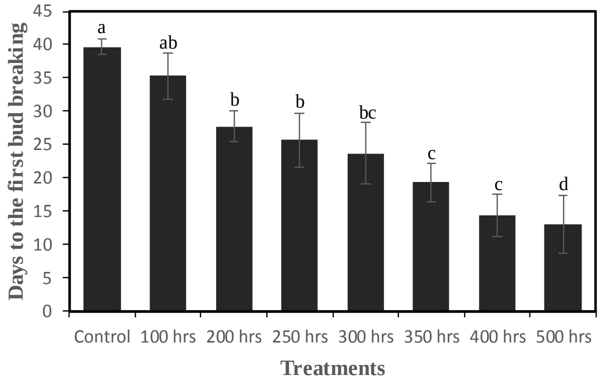

Figure-2.
Effect of chilling duration on number of days to the first bud breaking in grapevine cv.' Aabjosh'.
Note: Bars with the same letter mean that there was no significant difference between them.

3.3. Time to 50% of bud breaking

In terms of the number of days to 50% of bud breaking, there was a significant difference between the control (no chilling) with the 100 hrs, 250 hrs, and 400 hrs treatments. As the chilling duration increased, the number of days to 50% of buds breaking decreased, but no significant differences were found among the chilling treatments such as 100 to 200, 250 to 300, and 400 to 500 hrs (Figure 3).

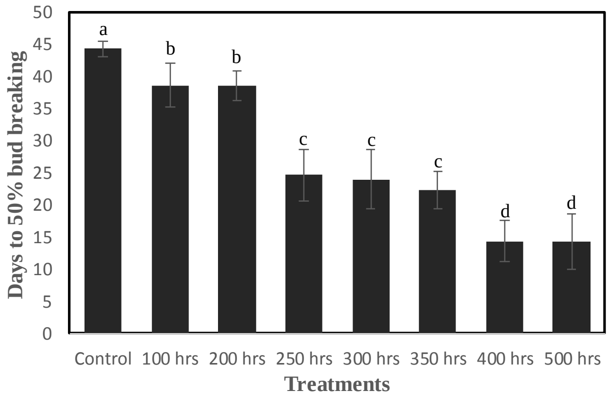

Figure-3.
Effect of chilling duration on the number of days to the 50% bud breaking in grapevine cv.' Aabjosh.
Note: Bars with the same letter mean that there was no significant difference between them.

3.4. Number of days to the last bud breaking

The effect of different levels of chilling on the time interval to the last buds breaking was significant between the control (no chilling) and the 100 hrs, 250 hrs, and 400 hrs treatments. However, the time to the last buds opening was reduced by increasing the cold duration. In the case of total bud breaking, no significant differences were realized in 100 with the control, 200, 250 with 350, and 400 with 500 hrs of cold treatments. (Figure 4).

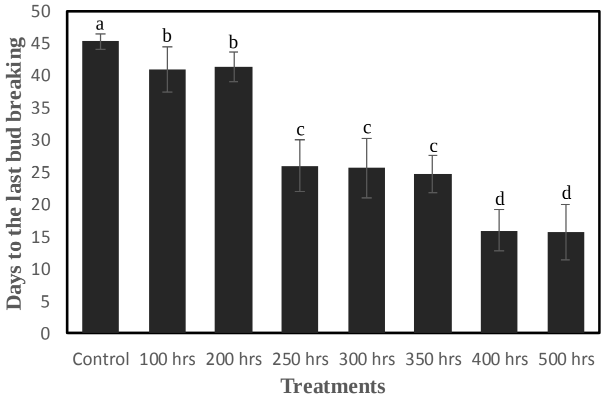

Figure-4.
Effect of chilling duration on the number of days to last bud breaking in grapevine cv.' Aabjosh'.
Note: Bars with the same letter mean that there was no significant difference between them.

4. Discussion

Grapes, like other fruit trees, need a cold period to get out of the dormant stage. Lack of sufficient cold in the period leads to a decrease in the percentage of buds' breaking, irregular budding, and reduction in the quantity and quality of the products [5]. Based on the result of this study, grape buds need a minimum of a cold period for their following normal growth. As far as the uniform rate of buds' breaking increases along with the increasing of cold duration, the less cold duration causes the fragile bud breaking. Regular buds' growth in grapevine has been reported to be between 50 and 400 hrs. It is reported that cold increased the total number of uniform blossoming and accelerated bud breakage [16]. Some buds grow in suitable environmental conditions after pruning due to eco-dormancy without the need for cold. In contrast, buds that need cold for growth may have endo-dormancy [15]. In most studies, the effect of cold on dormancy releasing of deciduous plants such as grapes has been investigated. The cold requirement for dormancy termination and normal bud breaking is considered as an important phenomenon [17, 18]. Besides, a study has also shown that Merlot cultivar needs an average daily temperature below 10 °C at least for 7 days to break bud dormancy [19, 20]. Thus, the results of both studies can be highly consistent with the result of the present study. Based on our result, we observed weak bud breaking where no cold treatment was applied; whilst, via increasing of the cold duration, the number of days to the first bud breaking, the number of days to 50% bud breaking, and the number of days to the last bud breaking were significantly reduced.

5. Conclusion

We observed that 300 hrs of chilling at 5 °C is required for buds to reach a 50% blossoming level, however, 400 hrs of chilling showed more than 80% of buds breakage. Therefore, the minimum of cold is required for an acceptable level of bud breaking and uniform breaking rates; thus, a minimum of 300 hrs of chilling at 5 °C is required for the 50% of bud breaking in the Abjosh grape cultivar. Moreover, with increasing cold duration from 300 to 500 hrs, the buddings increase from 50% to 80%. The results are consistent with the results of Mathiason. However, possible differences can be of the types of buds dormancy that may lie on a branch of the same age and position.
The results obtained in this study enrich the knowledge about the chilling requirement of the Abjosh grape cultivar to be utilized for future researches and will help the growers to select the best climate-adapted cultivars based on their chilling requirements.

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