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Review Paper

Effective Heat Summation of Grape Cultivars in Response to Phenological Stages in Malatya Ecology

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Abstract

In this study, phenological stages and effective heat summation (EHS) requirements of ten grape cultivars (Banazkara, Köhnü, Kureyş, Tahannebi, Öküzgözü, Ağın Beyazı, Barış, Hatun Parmağı, Italia, and Horoz Karası) grown in Apricot Research Institute Battalgazi Campus Collection Vineyard in Malatya which is one of the important wine growing provinces of Türkiye were determined in the vegetation period of 2021. A double T support system was used and a bilateral cordon training system was formed on the trunk of 80 cm height for the grapevines on the 110 R rootstock by applying a planting density of 3.5 x 2 m in the eight-year-old collection vineyard. For each cultivar, EHS values were recorded with a daily temperature recorder (HOBO) in the stages from the bud break to full bloom, the full bloom to veraison, the veraison to ripening, and from the bud break to maturity. As a result of this study, the EHS values of the cultivars were determined between 1583.5-2113.5 degree days (DD) after the calculation performed by using the average temperature values in Malatya. The lowest EHS requirement was determined as 1583.5 DD in 'Tahannebi', while the highest EHS value was determined in 'Ağın Beyazı' with 2113.5 DD.

Introduction

Effective Heat Summation (EHS) is a widely used criterion for expressing the viticulture potential in a given area or analyzing the required heat sums in phenological stages until maturity (Kunter et al. 2017). Many studies (Işık et al. 2001; Öztürk et al. 2001; Kök and Çelik, 2003; Çelik et al., 2005; Cangi et al., 2008; Gazioğlu-Şensoy et al., 2009; Sağlam et al., 2009; Kaya and Özdemir, 2015; Söğüt and Özdemir, 2015; Toprak-Özcan and Kesgin, 2016; Bekar and Cangi, 2017; Kunter et al., 2017; Küsmüş, 2016; Aktürk and Uzun, 2019; Ünal, 2019; Aktürk and Uzun, 2020; Ateş and Uysal 2020; Kaya-Demirkeser and Kamiloglu 2020; Gönen, 2021; Uyak et al., 2022; Ünal ve Sezgin, 2022) have been conducted to determine the EHS requirements of cultivars in numerous ecologies. All these studies have aimed to understand the local adaptation possibilities of grape cultivars. Additionally, it is important to update the regional EHS requirements of grape cultivars when discussing the impact of climate change on viticulture.

Malatya is an important viticulture province with worthy local grapevine genetic resources and creative uses of grapes such as drying of grapes on vines in Türkiye viticulture. The climate of Malatya is predominantly continental, however, there are microclimate areas that show Mediterranean climate characteristics around the large dam reservoir. For this reason, although it is geographically located in the Eastern Anatolia Region, the climate is considered to be more moderate than other eastern provinces. Summers are long and hot; the winters are relatively warm. Rainfall is

generally concentrated in the spring and winter seasons, while the summer season decreases to a minimum. According to the average of many years (1929-2021), the annual average temperature is 14.3 ºC, the highest temperature is 42.7 ºC, the lowest temperature is -22.2 ºC and the annual precipitation is 365.8 mm (MGM, 2022).

The intense damage of phylloxera and migration from rural areas cause to decrease in vineyard areas. Viticulture is concentrated in Akçadağ, Arapkir, Arguvan, Battalgazi, Darende, Doğanşehir, Doğanyol, Hekimhan, Kale, Kuluncak, Pötürge, Yazıhan, Yeşilyurt and the central districts. In these areas, table and wine grape cultivars, and seeded dried grapes are grown successfully. According to the statistics of 2021, a total of 19.304 tons of grape (TSE, 2021) was obtained from these areas of approximately 36.348 decare.

In this study, it is aimed to determine the EHS values of grape cultivars grown in Malatya Apricot Research Institute in the Battalgazi Campus Collection Vineyard and to obtain findings that can be used to assess the suitability and sustainability of grape cultivars.

Material and Methods

The study was conducted in the Malatya Apricot Research Institute Battalgazi Campus Collection Vineyard (38°27'30.73"N latitude and 38°21'18.60"E longitude and 728 m altitude) in the vegetation period of 2021. The grape cultivars 'Banazkara', 'Köhnü', 'Kureyş', 'Tahannebi', 'Öküzgözü', 'Ağın Beyazı', 'Barış', 'Hatun Parmağı', 'Italia' and 'Horoz Karası' grafted to 110R rootstock were used. The collection vineyard was established at a planting density of 3.5 x 2 m and the vines were trained in the form of a bilateral cordon with a double T-wire training system on the stem of 80 cm height. Irrigation was carried out with a drip irrigation system.

The soil characteristics of the collection vineyard are loamy, non-saline, and moderately alkaline. The lime rate, pH, and organic matter amount of the soil are 5.7%, 7.84, and 1.24%, respectively (Table 1).

Table 1. Soil characteristics of the collection vineyard

	Amount	Status
Potassium (K_2O) kg/da	119.86	High
Phosphorus (P_2O_5) kg/da	10.39	Sufficient
Lime (%)	5.7	Moderately limey
Organic Matter (%)	1.24	Low
Total Salt (%)	0.0404	Non-saline
pH	7.84	Moderately alkaline
Saturation (%)	46.42	Loamy

In the study, the criteria of OIV (2009) are considered for recording budburst, full bloom, veraison, and maturity.

By considering the phenological stages of the cultivars, EHS requirements between the bud break and full bloom, full bloom and veraison, veraison and maturity stages were determined according to the EHS Winkler Index (Winkler et al. 1974). The obtained data are expressed as degree days (DD). Daily average temperature values obtained from a daily temperature recording instrument (HOBO) were used to calculate the EHS requirement.

Results and Discussion

Phenological stages

According to the phenological stages, the earliest budburst was recorded in 'Tahannebi' (03 April) while the latest was in 'Italia' (21 April). For the full bloom, the earliest one is 'Hatun Parmağı' (May 19) while the latest one is 'Italia' (June 1). The earliest one is 'Tahannebi' (July 17) for veraison while the latest is 'Köhnü' (August 29). The earliest maturity was observed in 'Tahannebi' (August 10) while the latest one was in 'Italia' (September 28) cultivars (Table 2).

The knowledge of the phenological stages of grape cultivars in a given ecology is useful in terms of increasing the effectiveness of cultural processes, especially disease and pest management, guiding the labor requirements and marketing (Aktürk and Uzun, 2019). Küsmüş (2016) determined the total EHS among the phenological stages, budburst to maturity in 17 grape cultivars grown in Malatya (center and

Table 2. Phenological stages of the grape cultivars

	Phenological Observations			
	Bud Break	Full Bloom	Veraison	Maturity
'Banazkara'	17 April	30 May	17 August	19 September
'Kureyş'	15 April	24 May	26 July	29August
'Köhnü'	10 April	23 May	29 August	14 September
'Tahannebi'	3 April	23 May	17 July	10 August
'Öküzgözü'	18 April	24 May	15 August	17 September
'Ağın Beyazı'	11 April	28 May	24 August	27 September
'Barış'	10 April	22 May	25 July	17 August
'Hatun Parmağı'	9 April	19 May	19July	14 August
'Italia'	21 April	1 Jun	27 August	28 September
'Horoz Karası'	15 April	28 May	26 July	19 August

Akçadağ) ecology in 2015. Seven of these grape cultivars (Banazkara, Tahannebi, Kureyş, Öküzgözü, Barış, Köhnü and Italia) repetitive in our study. However, our results were different from the results of Küsmüş (2016), which referred to a difference of up to around 30 days in terms of phenological stages. This difference could be attributed to the source of the measurement of temperature data or the different interpretations of phenological observation dates. As mentioned in the literature review (Winkler et al., 1974; Cangi et al., 2008; Cangi et al., 2011; Kaya and Özdemir, 2015) phenological stages of grapes may be different for years depending on the cultivar, ecology, and cultural practices. However, this variation might be occurring within acceptable limits in the same area and ecology.

Effective Heat Summation (EHS)

EHS values of grape cultivars are presented in Table 3. Although the values vary according to phenological stages and cultivars, the EHS value between bud break and full bloom was observed between 307.9 DD (Hatun Parmağı) and 436.1 DD (Banazkara). Likely, the EHS request between the full bloom-veraison stage was found between 732.2 DD (Köhnü) and 1174.8 DD (Banazkara). Minimum and maximum EHS values between the veraison-maturity stage were recorded as 403.9 DD in 'Hatun Parmağı' and 518.9 DD in 'Köhnü'. Similarly, EHS values between bud break - maturity stage ranged from 1583.5 DD (Barış and Tahannebi) to 2113.5 DD (Ağın Beyazı).

Table 3. EHS values (DD) of grape cultivars between phenological stages

Cultivars / Phenological Stages	Bud break – Full Bloom	Full Bloom – Veraison	Veraison - Maturity	Bud break - Maturity
'Banazkara'	436.1	1174.8	410.1	2021.0
'Kureyş'	361.9	1015.8	273.6	1651.3
'Köhnü'	354.1	732.2	518.9	1605.2
'Tahannebi'	370.3	847.8	365.4	1583.5
'Öküzgözü'	343.8	1231.4	400.9	1976.1
'Ağın Beyazı'	415.1	1271.0	427.4	2113.5
'Barış'	345.0	969.8	269.1	1583.9
'Hatun Parmağı'	307.9	902.9	403.9	1614.7
'Italia'	431.0	977.4	416.9	1825.3
'Horoz Karası'	415.1	966.4	273.6	1655.1

Conclusion

In this study, based on the computation using the average temperature, the EHS values of the cultivars were determined between 1583.5-2113.5 DD in Malatya province. Thus, it can be stated that the ecology of Malatya is broadly suitable for viticulture. 'Banazkara', 'Kureyş', 'Köhnü', 'Tahannebi', 'Öküzgözü', 'Ağın Beyazı', 'Hatun Parmağı' and 'Horoz Karası' grape cultivars are convenient for Malatya ecology. It can also be noted that 'Italia' and 'Barış' cultivars are suitable for the province. However, further research and experiments are strongly recommended to determine the phenology and EHS requirements by making adaptation studies of marketable grape cultivars in the future.

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Conflicts of Interest

We declare no conflict of interest.

Author Contribution

All authors designed the study. A.K. was responsible for the performance of the research and collection. N.K. and B.K. interpreted the results and wrote the manuscript. All authors have read and agreed to the published version of the manuscript.

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