Available online: www.notulaebotanicae.ro
Print ISSN 0255-965X; Electronic 1842-4309
Not Bot Horti Agrobo, 2019, 47(3):1001-1004. DOI:10.15835/nbha47311452
Note

A New Measurement Model to Estimate the Intensity of Acrotony on the Latent Buds of Grapevine Canes (*Vitis vinifera* L.)

Ioannis DASKALAKIS*, Katerina BINIARI

*Agricultural University of Athens, School of Agriculture, Engineering and Environmental Sciences, Department of Crop Science, Laboratory of Viticulture, Iera Odos 75, 118 55, Athens, Greece; john-daskalakis@hotmail.com (*corresponding author); kbiniari@aua.gr*

Abstract

In warm regions, such as in southern Greece, the climate change can lead to prolonged dormancy as well as to problems in bud dormancy (delay in breaking time, reduce the rate of budbreak, intensity of the phenomenon of acrotony, grapevine bud fall, disorders in bloom with intense blossom dropping, etc.), with a significant impact on the production of the vines. In these areas, it is necessary to apply chemical substances in order to break the dormancy and advance budbreak, especially when it comes to new table grape varieties, most of which are seedless. Another phenomenon which is observed on grapevines and is directly associated with budbreak is acrotony, where the apical buds of the cane break first compared to the middle and basal ones. Acrotony can constitute a problem because it can cause irregular grape ripening, different timing of various activities in the vineyard, which brings about higher cultivation costs. In this research, a new method to measure and evaluate the acrotony and its intensity on the latent buds of grapevine canes was described. The results of two chemical substances applied on table grape variety 'Prime'® in order to advance budbreak were presented.

Keywords: acrotony; budbreak; bud dormancy; grapevines; *Vitis vinifera* L.

Introduction

The knowledge of growth stages for the grapevine, as with all crop plants, is necessary for the communication of cultural information, for decisions on establishment and cultural operations, and for use by researchers when conducting grapevine-related experiments (Coombe, 1995). To date, three descriptive systems have been developed for grapevines: (a) Baggiolini (1952), (b) Eichhorn and Lorenz (1977) and (c) the BBCH system which was developed as a model for the European Union and adapted for the grapevine by Lorenz *et al.* (1995).

One of the most important growth stages in grapevine is budbreak, and more specifically the start of budbreak which is directly correlated to bud dormancy. Irregular and non-uniform budbreak in grapevines, mainly in regions with mild winters, often creates significant economic and viticultural problems (i.e. disorders in bloom with intense blossom dropping, etc.). Thus, research on bud dormancy is of more than scientific interest, particularly since it is a problem common to many temperate horticultural crops grown in warm regions. Dormancy in grapevines has been first reviewed by Bugnon and Bessis (1968). Although there have been many research studies dealing with bud dormancy, this phenomenon has not been completely understood yet. The stages of dormancy are generally distinct, from the onset of pre-dormancy to the gradual development of dormancy and to the following release to post-dormancy leading to growth resumption. Dormancy can have three causes according to Lang *et al.* (1987): (i) an endogenous signal within the affected structure (endodormancy), (ii) a biochemical signal originating in a structure other than the affected structure (paradormancy), (iii) environmental factors which affect the entire plant metabolism (ecodormancy). Decreasing photoperiod and temperatures during the fall can induce grape bud endodormancy (ED) (Lang *et al.*, 1987; Lavee and May, 1997). Further development of the bud through the dormancy cycle requires exposure to adequate chilling temperatures, which ultimately lead to ED release (Lavee and May, 1997; Dokoozlian, 1999). Although the chilling requirements of the grape bud are low compared to other temperate woody perennials, they must be fulfilled to allow proper budbreak. At the same time, maximum budbreak rates improve with increased chilling exposure (Dokoozlian *et al.*, 1995; Lavee and May, 1997; Dokoozlian, 1999). In warm winter regions, where chilling requirements are often insufficient, prolonged ED is a major obstacle to the commercial production of table grapes (Shulman *et al.*, 1983; Saure, 1985).

Acrotony is an endogenous (genetic) property of the vine, which refers to priority in the budbreak of the buds of the top part of the cane (Deloire, 2009; Stavrakakis, 2013).

Received: 12 Dec 2018. Received in revised form: 15 May 2019. Accepted: 02 Jul 2019. Published online: 10 Jul 2019.

Acrotony is different from apical dominance in the sense that it concerns the winter cane. On a long winter cane, the top buds will develop first, and their growth will inhibit the development of the buds situated underneath. This principle should be borne in mind when pruning canes and when selecting a pruning system that will influence the shape of the canopy. Also, the time of pruning is equally important to the selection of the appropriate pruning system, since early or late pruning can result in early or late budbreak respectively. Intense acrotony can result in a non-uniform budbreak and shoot growth as well as in irregular grape ripening. The inhibition of the budbreak of the buds of the base part of the cane is more intense in warm climates (Stavrakakis, 2013).

The aim of this research note is to provide a novel approach to measure and evaluate the phenomenon of acrotony in grapevine variety 'Prime'®, after the application of two substances which advance budbreak, with different concentrations and on different dates.

Materials and Methods

Plant material and experimental design

'Prime'® (*Vitis vinifera* L.) is a white table grape variety and is considered as one of the most early-matured grapevine varieties worldwide. Vines of this variety were located in a vineyard in Corinth (altitude 10m, gradient 2%), northeastern Peloponnese, Greece. The ten-year-old vines were all grafted on rootstock 1103 Paulsen; were bilateral cordon-trained (bilateral Royat) at 2.2 m × 1.2 m intervals; and were cane-pruned to 10-node canes per arm. Each vine consisted of four (4) arms, therefore each vine had four (4) canes in total. The usual viticultural techniques were applied, i.e., fertilization using 11-15-15 NPK at a dose 250 g/vine; canopy management techniques (shoot thinning, topping; girdling); and irrigation. All vines studied were grown in the same area and under the same conditions.

Two substances to advance budbreak of table grape variety 'Prime'® were applied and evaluated under the form of solutions. Three (3) solutions were applied on three (3) different dates (15/12/2015, 15/01/2016, 15/02/2016) of a specific time period, more specifically from 15 December 2015, when the first spraying took place, until 2 April 2016, when all measurements took place at the same time for all treatments (Table 1). For the needs of the experiment, the research made use of a Randomized Complete Block Design. Three groups/replications (3 vines per group) per treatment took place. Treatments were performed with a knapsack sprayer. The substances used were Theocooper and Theocal. Theocopper contains 10% sugars, 10% amino acids, 12% urea, 1.4% potassium on organic form, 12% nitrogen on organic form and 3.5% organic matter. Theocal contains 30% calcium, 35% organic matter with pH: 7.1.

The three (3) solutions were:

(i) a mixture containing 10 mL Theocopper and 1 g Theocal per Liter [Solution A]
(ii) a mixture containing 20 mL Theocopper and 1 g Theocal per Liter [Solution B]
(iii) with water (control treatment) [Control]

In total, eighty-one (81) vines were used and each vine had four 10-node canes. The growth stage of 3.240 latent buds was recorded on the same day, as mentioned above, namely on 2nd April 2016. It should be noted that the control vines in the different treatments (Control 1, 2, and 3) are not the same, since they were pruned on different dates, meaning that they were pruned immediately after the sprayings had taken place.

Acrotony evaluation and measurement

The growth stage of each bud was measured according to the scale of Baillod and Baggiolini (1993) when all buds have broken out. It should be noted that, in order to measure acrotony, the bud growth stage was used instead of the shoot length because shoot length is affected by many factors, such as the variety, fertilization, water availability etc. Next, for each vine, the average growth stage of the buds of each position was calculated. More specifically, the following process was followed:

(i) The letters of the scale described by Baillod and Baggiolini (1993) were mapped to a scaler (for example a:1, b:2, c:3 etc.) (Fig. 1).
(ii) The growth stages of the buds of each position of the four (4) canes were measured.
(iii) For each vine, the average growth stage of the buds of each position was calculated (i.e. the average growth stage of the first buds, the average growth stage of the second buds, the average growth stage of the third buds etc.).

Next, the position of the bud on the cane was placed on the x-axis of an axes system and the growth stage of each bud per position was placed on the y-axis of the axes system (Fig. 2a). The points measured in the axes system created a line which is described by a linear equation of the form $y = ax+b$, where 'a' is the slope of the line, taking values between zero and one (Fig. 2b).

Table 1. Date of spraying, treatments and composition of the solutions applied

Date of spraying	Treatment	Composition
15/12/2015	Control 1	H_20
	Treatment A1	Solution A
	Treatment B1	Solution B
15/01/2016	Control 2	H_20
	Treatment A2	Solution A
	Treatment B2	Solution B
15/02/2016	Control 3	H_20
	Treatment A3	Solution A
	Treatment B3	Solution B

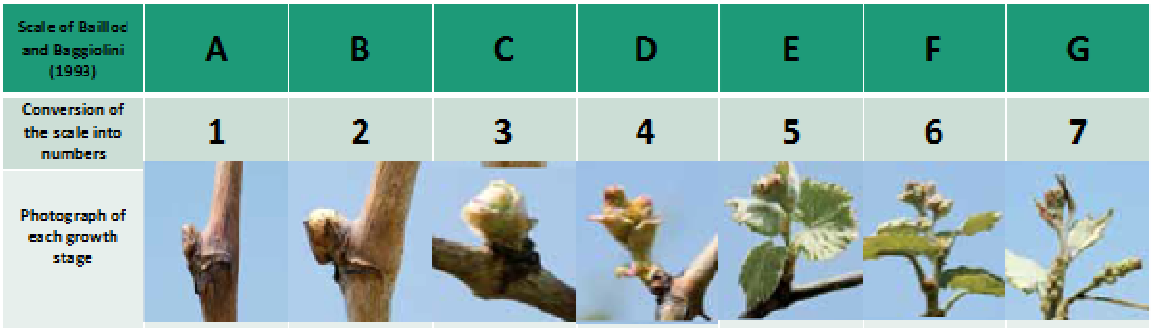

Fig. 1. Mapping of the letters of the Baillod and Baggiolini scale to a scaler (Photographs by Stavrakakis, 2013)

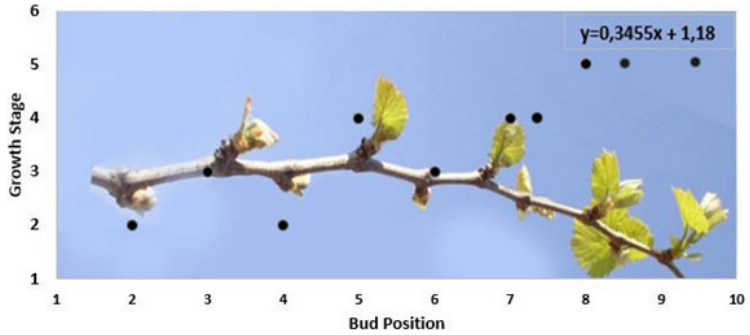

Fig. 2a. Mapping of a cane's bud position and growth stage of each bud per position on an axes system

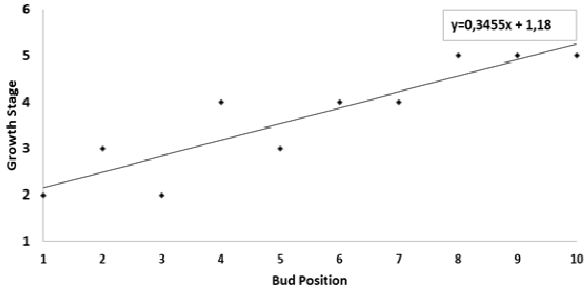

Fig. 2b. Bud position on the cane and growth stage of each bud per position on an axes system. The points measured created a line which is described by a linear equation of the form $y = ax+b$, where a is the slope of the line

Less intensity of acrotony can result in a more uniform budbreak and shoot growth as well as in more regular grape ripening.

Data analysis

The experiment was designed and implemented following the tenets of the Randomized Complete Block Design. The significance of the results was tested by means of one-way analysis of Variance (ANOVA) and the means of the treatments were compared using the Tukey's range test at $P \leq 0.05$ (JMP v. 10 statistical software, SAS Institute Inc., Cary, NC, USA). Last, the Standard Error (SE) of the mean of each treatment was also calculated.

Results and Discussion

The ANOVA results presented in Table 2 revealed that vines of grapevine cultivar 'Prime'® treated with Treatment B1 and B2 had significantly lower intensity of acrotony compared to control vines.

The results also show that the highest reductions of acrotony were recorded in the case of the first spraying (15.12.2015) with Treatment A1 and Treatment B1, and in the case of the second spraying (15.01.2016) with Treatment B2. Control vines exhibited significant difference in budburst time between buds of the top part of the cane and the buds from the base part of the cane, while vines treated with Treatment A and Treatment B exhibited more uniform budburst.

Table 2. Date of spraying, treatments and intensity of acrotony measured

Date of Spraying	Treatment	Intensity of acrotony
15/12/2015	Control 1	0.56 a ± 0.035
	Treatment A1	0.28 c ± 0.034
	Treatment B1	0.25 c ± 0.033
15/01/2016	Control 2	0.53 a ± 0.017
	Treatment A2	0.38 bc ± 0.021
	Treatment B2	0.28 b ± 0.039
15/02/2016	Control 3	0.51 a ± 0.021
	Treatment A3	0.44 ab ± 0.023
	Treatment B3	0.46 ab ± 0.013

Values are the mean (± SE) of three analyses from three different groups. Values assigned with different letters are significantly different according to Tukey's range test at P≤0.05.

This result suggests that chemical applications indeed mitigate the acrotony in lateral buds of canes.

Conclusions

The methodology followed in order to measure acrotony, namely to measure bud growth stage instead of shoot length, is reliable since with this way, the acrotony of different varieties in different regions and terroirs can be compared, instead of measuring the shoot length. As mentioned earlier, shoot length is significantly affected by the variety, fertilization, water availability and others.

Acknowledgements

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflicts of interest

The authors declare that there are no conflicts of interest related to this article.

References

Baggiolini M (1952). Les stades repères dans le développement annuel de la vigne et leur utilization pratique (in French) [The landmark stages in the annual development of the vine and their practical use]. Revue Romande d'Agriculture, de Viticulture et d'Arboriculture 8:4-6.

Baillod M, Baggiolini M (1993). Les stades repères de la vigne (in French) [The benchmark stages of the vineyard]. Revue Suisse de Viticulture Arboriculture Horticulture 1:7-9.

Bugnon F, Bessis R (1968). Biology de la Vigne (in French) [Biology of the wine]. Masson et Cie. Paris.

Coombe BG (1995). Growth stages of the grapevine: Adoption of a system for identifying grapevine growth stages. Australian Journal of Grape and Wine Research 1(2):100-110.

Deloire A (2009). Grapevine morphology and flowering: Buds of the grapevine primary shoot. Technical Yearbook 2009. Department of Viticulture and Oenology, University of Stellenbosch.

Dokoozlian NK, Williams LE, Neja RA (1995). Chilling exposure and hydrogen cyanamide interact in breaking dormancy of grape buds. HortScience 30(6):1244-1247.

Dokoozlian NK (1999). Chilling temperature and duration interact on the bud break of "perlette" grapevine cuttings. HortScience 34(6):1054-1056.

Eichhorn KW, Lorenz H (1977). Phaenologische Entwick-lungstadien der Rebe (in German) [Phaenological development stages of the vine]. Nachrichtenblatt des Deutschen Pflanzen-schutzdienstes (Braunschweig) 29:119-120.

Lang GA, Early JD, Martin GC, Darnell RL (1987). Endo, para and ecodormancy: physiological terminology and classification for dormancy research. HortScience 22:271-277.

Lavee S, May P (1997). Dormancy of grapevines buds-facts and speculation. Australian Journal of Grape and Wine Research 3(1):31-46.

Lorenz DH, Eichhorn KW, Bleiholder H, Klose R, Meier U, Weber E (1995). Growth stages of the grapevine: Phenological growth stages of the grapevine (*Vitis vinifera* L. ssp. *vinifera*)-Codes and descriptions according to the extended BBCH scale. Australian Journal of Grape and Wine Research 1(2):100-110.

Saure MC (1985). Dormancy release in deciduous fruit trees. Horticultural Reviews 7:239-299.

Shulman Y, Nir G, Lavee S (1983). The effect of cyanamide on the release from dormancy of grapevine buds. Scientia Horticulturae 19(1-2):97-104.

Stavrakakis MN (2013). Viticulture (in Greek). Tropi Publications. Athens.