DELAYING GRAPEVINE BUDBREAK AND/OR PHENOLOGICAL STAGES IS NOT JUST A MATTER OF PRUNING DATES

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Abstract:

Context and purpose of the study
In the current climatic context, with milder winters leading to earlier budburst in most wine regions, vines are exposed to the risk of spring frosts for a longer period. Depending on the year, frost can lead to yield losses of between 20 and 100 %, jeopardizing the economic survival of wine estates. In addition, by destroying young shoots, spring frosts can impact the following season's production, by reducing the number of canes available for pruning, for example. Late pruning is one method to combat spring frosts.

Material and methods
Experiments were conducted at Montpellier SupAgro-INRA campus (southern France; 43°38N, 3°53E) experimental vineyard. 20 year old Syrah grafted on SO4 were used for the experiment. The vines were Lyre trained and spur pruned. The vines were drip irrigated and fertigation was managed according to vine needs. For the delayed pruning experiment, pruning was carried out by hand according to the grapevine physiological stage as opposed to calendar date. Pre and post budbreak pruning were trialed. For pre budbreak pruning the following stages were considered: endodormancy, ecodormancy and the grapevine bleeding period. For post bud break cane pruning, the pruning dates were chosen according to the concept of acrotony on the winter cane and according to the phyllochron. Berry fresh mass and cane fresh mass and sugar concentration were analysed.

Results
Pre-budburst: The most effective period for pruning to delay budburst is during the bleeding phase. Clearly, this raises the question of feasibility related to the size of vineyard to be pruned and the logistics in terms of labor. In this respect, mechanical pruning can be an advantage, with its speedier implementation allowing for late pruning.
Post-budburst : The pruning period will depend on the "grape variety × climate" interaction versus early or late grape varieties and cool or warm climate applying the concepts of acrotony, considering the phyllochron and the carbon reserves of the vine. Adjustment by wine region and by family of grape varieties is necessary, depending on how early budburst occurs for them. Recommendations are provided following on our study using Syrah as a model under Mediterranean climatic conditions.

Keywords: Grapevine, delayed pruning, acrotony, phyllochron, sugar reserve.

Introduction

Late pruning to delay budbreak is a technique described by Ravaz (1912). We are in 2023 and in the current climatic context, with milder winters leading to earlier budburst in most wine regions, vines are exposed to the risk of spring frosts for a longer period. Depending on the year, frost can lead to yield losses of between 20 and 100 %, jeopardizing the economic survival of wine estates. In addition, by destroying young shoots, spring frosts can impact the following season's production, by reducing the number of canes available for pruning, for example. Late pruning is one method to combat spring frosts.

It is important to be aware of some underlying physiological principles to properly apply late pruning to delay either only budbreak and/or to delay budbreak and the other key phenological stages: flowering, the onset of veraison, ripening and the harvest date.

In this regard, two important pruning stages should be considered: i) pre budbreak; and ii) post budbreak.

This study presents some results on the effects of delayed pruning (pre budbreak and post budbreak) of Syrah in a Mediterranean climate on berry fresh mass and cane fresh mass and sugar content and provide a few practical recommendations for the growers.

Material and methods

Plant material and growing conditions: Experiments were conducted at Montpellier SupAgro-INRA campus (southern France; 43°38N, 3°53E) experimental vineyard. 20 year old Syrah grafted on SO4 were used for the experiment. The vines were Lyre trained and spur pruned. The vines were drip irrigated and fertigation was managed according to vine needs. For the experimentation on delayed pruning, pruning was carried out by hand according to phenological stage and not only according to calendar date. Pre and post budbreak pruning were assessed. The pre budbreak pruning stages implemented included: endodormancy, ecodormancy and the grapevine bleeding period. For post bud break cane pruning, the pruning dates were reasoned/chosen according to the concept of acrotony on the winter cane and according to the phyllochrone.

Phenological stage: endodormancy was assumed to be released early in January 2022 (more than 8 days with mean air temperature below 8°C) (Pellegrino et al., 2020). Based on weekly observations of 120 plants, vine bleeding started the last week of March and mid-budburst defined as the timing when 50% of buds had reached the stage EL–4 from Eichhorn & Lorenz scale occurred the 10 of April. Five pruning stages were imposed (i) during the endodormancy period (21/12/2021), (ii) at the beginning of budburst (01/04/2022) and at three dates post-budbreak: 12/04/2022, 20/04/2022 and 05/05/2022 pruning dates. Figure 2 is showing an example of primary shoot development on unpruned canes for the 20th April pruning date.

Berry analyses: single berry fresh mass of a population of 30 to 100 berries for each pruning date was carried out pre veraison and during veraison to assess the difference in berry development as a result of the pruning date treatments.

Cane sugar analyses: 10 winter canes were sampled from 10 vines for each pruning date. Total sugars were solubilized from those winter canes, previously dried and crushed, with DMSO and HCl by incubation at 60°C; pH of the extracts was then adjusted between 4 and 5 using NaOH. Soluble sugars were directly extracted with DMSO by incubation at 60°C. Analysis were conducted using the Biosentec Starch kit : Starch hydrolysis with Amyloglucosidase at pH 4,5 was followed by glucose measurement at 340nm with a Beckman Coulter AU5800 chemistry analyzer. Starch was obtained by calculating the difference between total and soluble sugars.

Statistics: Cane pruning fresh mass and individual berry fresh mass were analyzed with an ANOVA a followed by a Tukey test (p-value < 0.05) to test the effects of pruning date (0.05 significance level). Graphical processing and statistical tests were performed using R Studio software.

Results and discussion

A/ Pre-budburst pruning

Pre-budburst pruning has been considered in relation to two key stages of the vine's winter resting period: endodormancy (linked to physiological limitations) and ecodormancy (linked to climatic limitations). Ecodormancy is divided into two physiological substages: before and during bleeding of the vine (Pellegrino et al., 2020; Lang et al., 1987). Pruning before bleeding had no impact on phenological development. However, pruning from the onset of bleeding delayed budburst, but without shifts in the timing of subsequent phenological stages. According to our results with Syrah (Mediterranean climate), the delay in budburst was approximately 6 days when pruning was done at the beginning of budburst (01/04/2022) (to be adjusted for other grape varieties and climates).

B/ **Post-budburst pruning**

To practice post-budburst pruning, i.e. beyond mid-budburst (when 30-50 % of the latent buds have burst on winter canes not yet pruned, stage EL-4 on the Eichhorn & Lorenz scale), it is important to understand certain concepts related to the development and functioning of the vine, such as acrotony and the dynamics of changes in the carbon reserves of the canes, trunk and roots.

Acrotony: on a vertically positioned winter cane, the top buds will develop first, inhibiting the development of latent buds at the base. Acrotony thus permits post-budburst pruning of the vine. Our results demonstrate that at least 8 to 10 latent buds are required on a cane in case of pre-pruning, for acrotony to be effective.

Vine reserves: the carbon reserves (starch, soluble sugars) and nitrogen reserves (amino acids and proteins) stored in the perennial organs (roots, trunk, canes) are utilized at bud burst to allow the growth of the young shoots (Bates et al., 2002).
Justification of post-budburst pruning should be based on the pool of carbon reserves established the previous year and the quantity of carbon allocated to new shoots (Netzer et al., 2022; Frioni et al., 2019). In this respect, the phyllochron (thermal time between the sequential emergence of leaves) can be used as an indicator of the post-budburst level of depletion of carbon reserves. Surprisingly our results showed little difference in cane total sugar content (figure 1) irrespective of the pruning dates prior to budbreak and before mid-April which for the considered year corresponded to a certain number of developed primary shoots on the unpruned winter canes (figure 2). On the contrary late post budbreak pruning from 20/04/2022 did strongly affect the vine vigour as demonstrated by the fresh mass of the winter canes (figure 3).

Late post bud break pruning clearly delayed budbreak of the basal buds of the canes (i.e. due to the acrotony) and the other phenological stages including véraison (figure 4). Practically speaking, the method should be calibrated according to the interaction between grape variety × climate × soil.

What to take away about late pruning of the vine?

Pruning before budbreak (northern hemisphere)

- Pruning during **endodormancy** (generally from November to January, knowing that it takes around 8-10 days at average daily temperatures of ≤ +8°C to release winter dormancy. The dormant buds of the grapevine enter dormancy from July-August for the lignified part of the shoots): **does not delay budbreak**.
- Pruning during **ecodormancy** (post-endodormancy, generally from January to March): **does not delay budbreak**.
- Pruning during **ecodormancy** at the time of **vine bleeding** (resumption of root system activity): **delays budbreak by 6 to 8 days** depending on the grapevine-environment interaction.

Pruning after budbreak (northern hemisphere)
There are three ways to do this in the field:

- Use 10 pre-budbreak pruned vines in endodormancy or ecodormancy but before bleeding as a reference point, and then prune post-budbreak to a maximum of 30-50% of the budbreak of these pre-pruned reference vines. Depending on the grapevine-environment interaction, the budbreak date of the latent buds at the base of the shoots can be delayed by 8 to 12 days.
- Pruning after the post-budbreak frost period has passed (already used in the field but risky if frost is very late because if pruning is too late, it can delay other phenological stages and result in fertility/yield losses) mainly due to the exhaustion of the carbon reserves (but not only!) of the perennial parts of the vine following the development of the late pruned primary shoots.
- Prune when the first 2 or 3 primary shoots emerging from the apex of the post-budbreak shoots have reached an average of 3-5 unfolded leaves. Depending on the grapevine-environment interaction, the budbreak date of the latent buds at the base of the shoots can be delayed by 8 to 12 days.
- To promote strong acrotony, it is recommended to leave between 8 and 10 latent buds on the cane and to leave the cane (shoot) in a vertical position.

Practical constraints (northern hemisphere)

- Logistics (organization of pruning work according to vineyard surface area) and associated costs; except for mechanical pruning
- Prediction of the start of bleeding according to grapevine-environment interactions
- Prediction of bleeding duration according to grapevine-environment interactions
- Prediction of budbreak date according to grapevine-environment interactions
- Prediction of probabilities of spring frost dates, intensity, and duration.

Conclusion and perspectives

Based on our experiments performed on cv. Syrah in South of France over four years (2019-2023), we have shown that budbreak can be postponed by pre-budbreak pruning implemented during the grapevine bleeding period (and not before).
Early post budbreak pruning can delay the emergence of the more basal buds and late post budbreak pruning will delay later phenological stages such as flowering, veraison and ripening/harvest date. However while applying late post budbreak pruning there is a high risk of yield loss and strong decrease in vine vigour even over two consecutive years. In that regards it is recommended to calibrate early and late post budbreak pruning according to the interaction genotype x environment considering the phyllochron and the utilisation of the vine carbohydrate reserves (canes, trunks and roots) for the growth of young primary shoots which have emerged before late pruning (Deloire & Pellegrino, 2022; Gatti et al., 2016).

In summary, delaying phenological development is not only a matter of pruning date but also has to be calibrated on a case by case basis (site x genotype) in relation to the targeted practical goals: what phenological stage to delay and for how long? What will be the consequences on vine vegetative expression, vigour and yield?

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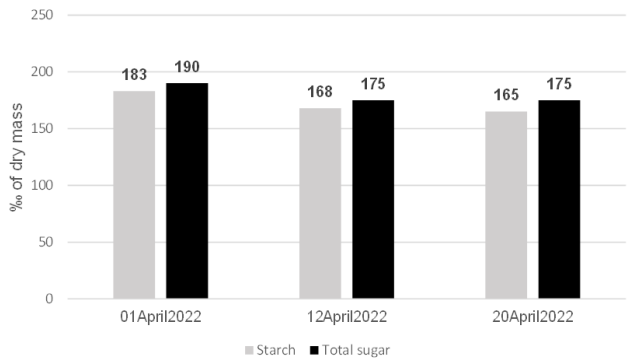

Figure 1: Winter cane starch and total sugar at three post budbreak pruning dates. Little differences are shown in terms of sugar concentration.

Figure 2 : Example of vines before and after the pruning date of 20th April 2022: (a) Vines pruned on 20/04/2022 (yellow arrow) and before pruning (blue arrow); (b) Example of an unpruned winter cane on 04 April; (c) The young primary shoots bore between 3 to 12 leaves, depending on their position on the unpruned winter cane (20/04/2022).

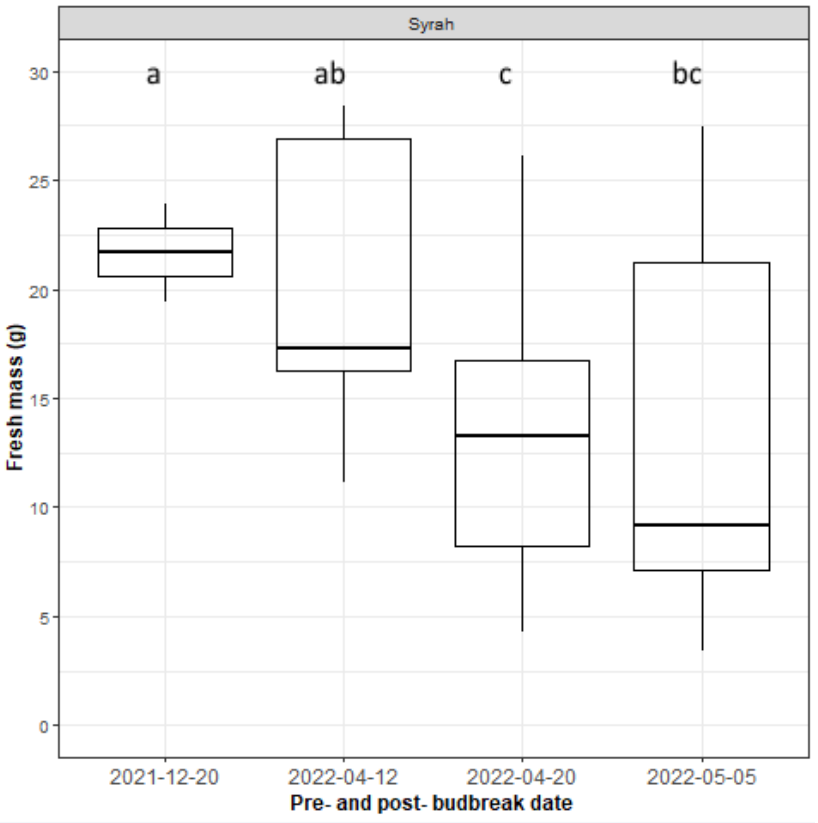

Figure 3: Fresh mass (g) of canes as assessed on the 16 February 2023 following pruning in 2021 and 2022 (pre and post budbreak pruning). Very late pruning post budbreak significantly affected vine vigour.

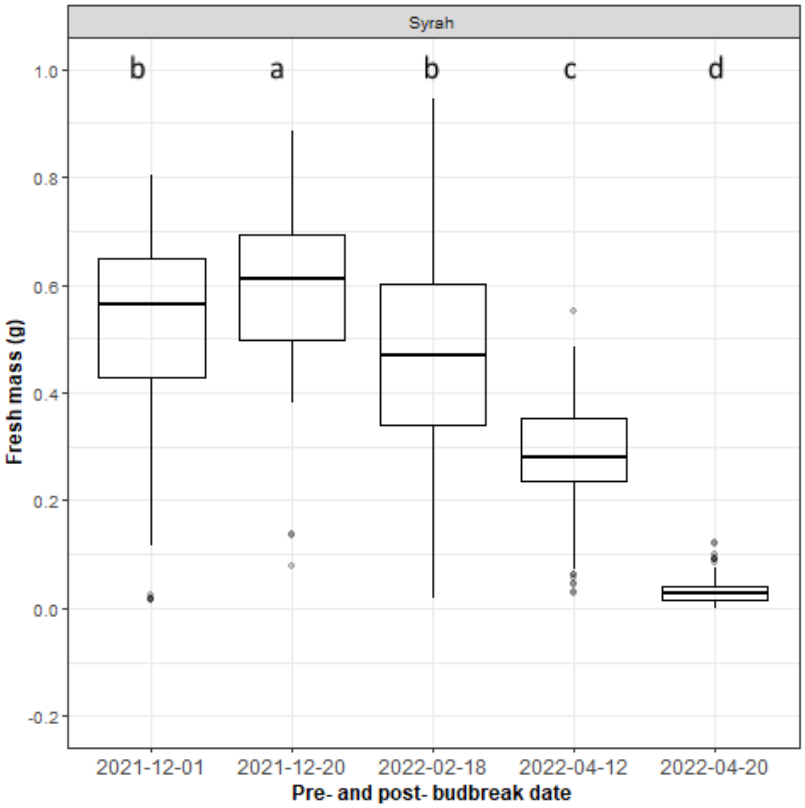

Figure 4: Individual berry fresh mass (g) of 119 single berries. The results showed the effect of pre and post budbreak pruning dates on the development of a population of berries which clearly indicated that late pruning can delay berry growth, veraison and ripening.