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Part 1: Is there a correlation between the diameter of the pruning wound and the length of the desiccation cone?

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While pruning is an age-old and essential practice for managing yields and keeping vines in production for as long as possible, many questions remain unanswered about its role in vine physiology, particularly with regard to the formation of the desiccation cone that results from the pruning wound. To "respect the sap flow", it is recommended to avoid pruning too short and to leave a chicot, a piece of wood between the cut and the base of the removed shoot. In practice, it is generally accepted that the length of this chicot should be equivalent to its diameter, as the depth of necrosis corresponds to the diameter of the pruning wound, and it can be removed the following year. But is this really the case? By observing the stages and mechanisms of desiccation cone formation, this study aims to verify whether there is a real correlation between the diameter of the pruning wound and the depth of desiccation. This study covered 4 parameters: pruning quality, cultivar, age of the vine, and vintage.

Recap on the importance of pruning and the goals of the study

Work carried out over the last few years has clearly shown that pruning systems that preserve sap flow limit dieback and the development of grapevine trunk diseases such as esca[1 2]. The establishment of deep desiccation cones leading to the formation of dead wood in the perennial parts of the vine is one of the most likely hypotheses to explain changes in sap flow linked to dieback[3].

When woody structures are removed, the formation of a desiccation zone called a "desiccation cone" is inevitable, and it enables the plant to limit penetration by pathogens. However, this systematically creates a dead wood zone which, depending on its diameter, depth and position, can lead to changes in sap flow[4]. Recent work[5] has shown that preserving the diaphragm by leaving a "chicot" when cutting is an effective way of limiting the deep establishment of the necrosis zone, and that in the case of mutilating pruning, the dead wood zone resulting from scarring can have a major impact on the vascular tissue.

Nevertheless, in current pruning practice, it is generally accepted that the diameter of the cut corresponds to the depth of the desiccation zone, and the pruner is generally instructed to leave a "chicot" of a length equivalent to the diameter of the cut wood. Yet research into the importance of the diaphragm[3 5] would seem to contradict this, suggesting that there is no direct relationship, as the diaphragm acts as a "physical barrier" to limit deep desiccation.

The aim of this part of the study is to verify whether there is a real correlation between the diameter of the pruning wound and the speed of progression, in order to propose the most appropriate pruning instructions for the proper functioning of the plant.

Pruning quality, diameter of the cut and depth of necrosis

In this study, two pruning protocols were compared: "virtuous" pruning, with a chicot left at an internode, and "mutilating" pruning, with a mutilating cut and without leaving the diaphragm in place (Figure 1).



FIGURE 1. Two pruning methods: virtuous (V+) and mutilating (V-).

At 4 and 8 months after pruning, the chicots and the wood zones close to the mutilating cut were sampled for quantification of the necrosis zone by image analysis using ImageJ software. The depth of each necrosis was measured and compared with the diameter of the pruning wound.

For this analysis, 200 measurements were made from trials with 3 cultivars (Ugni blanc, Sauvignon blanc and Cabernet-Sauvignon). Samples were taken in 2014 and 2015 for the Sauvignon blanc and Cabernet-Sauvignon plots (Cadillac, Gironde), and in 2019, 2020 and 2021 for the Ugni blanc plots (Saint-Preuil and Juillac-le-Coq, Charente) of different ages (2015, 2006). For this part of the study, only the results after 4 months of pruning are shown, as no difference was observed between 4 and 8 months.

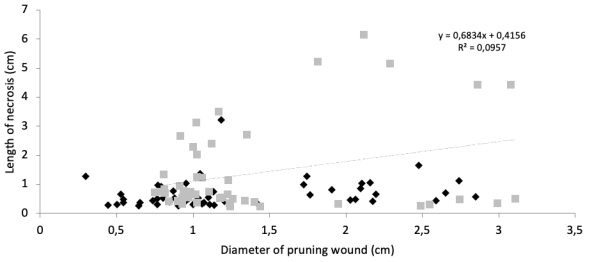


FIGURE 2. Correlation between observed necrosis lengths and the pruning wound diameter as a function of pruning type, virtuous V+ (grey) and mutilating V- (black). The full set of points represents measurements for all 3 cultivars.

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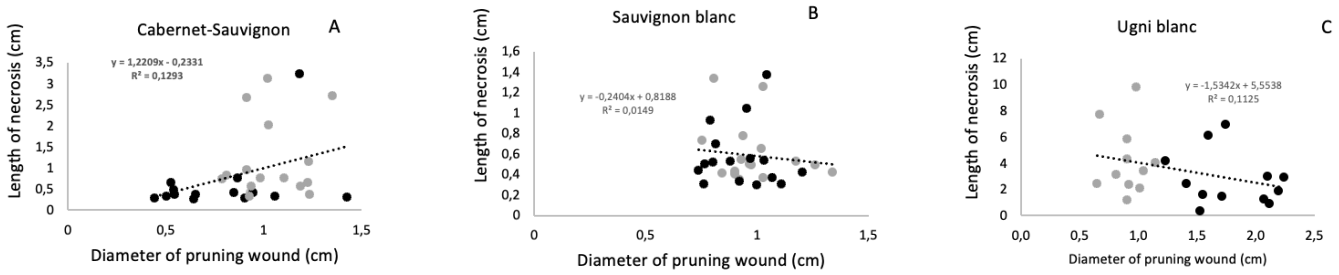


FIGURE 3. Correlation between pruning wound diameter and necrosis lengths for Cabernet-Sauvignon (A), Sauvignon blanc (B) and Ugni blanc (C) according to pruning type, virtuous V+ (grey) and mutilating V- (black) in 2018, 2019 and 2020.

Measurement and comparison of diameter of the cut and depth of necrosis depending on pruning quality

All the measurements made show great variability in the diameter of the pruning wound and the depth of necrosis (Figure 2), regardless of the pruning method. The highly scattered point cloud obtained shows no effect on necrosis depth from pruning quality, and no correlation between necrosis depth and pruning wound diameter.

These results thus confirm that there is no correlation between pruning quality, diameter of the cut and depth of necrosis, whatever the type of pruning, V+ or V-.

Cultivar diameter of the cut and depth of necrosis

At a more detailed level, within the same cultivar, such as Cabernet-Sauvignon (Figure 3A) or Sauvignon blanc (Figure 3B), it was not possible to demonstrate a correlation between the diameter of the pruning wound and the depth of necrosis. However, for Ugni blanc, the pruning quality seems to have an effect on the diameter of the pruning wound, as two sets of points can be differentiated according to the pruning quality (Figure 3C). This effect is independent of the depth of necrosis. We can observe still deeper necrosis in the case of mutilating pruning (V-).

Vine age, diameter of the cut and depth of necrosis

When comparing the establishment of necrosis as a function of the age of the plant, there is still no correlation between pruning wound diameter and necrosis depth. The size of the pruning wound is in no way correlated with the size of the necrosis, regardless of the age of the Ugni blanc plants (personal data). However, when the plots are young (*e.g.* a plot planted in 2015), it is possible to differentiate between the two types of pruning in terms of the diameter of the pruning wound and not the depth (Figure 4A), with mutilating pruning (V-) leading to larger pruning wounds. This effect diminishes as the plot ages (Figure 4B), and it is no longer possible to differentiate between the trials by diameter.

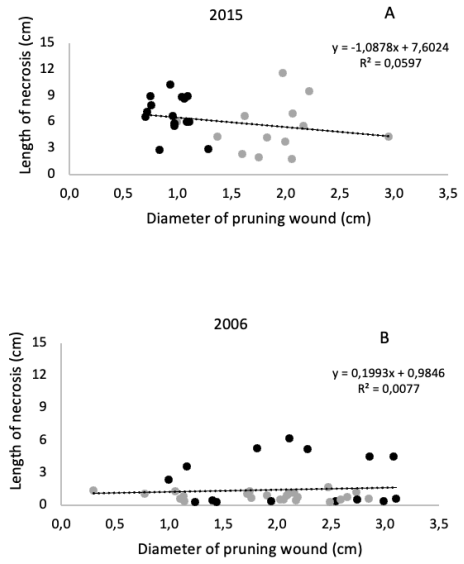


FIGURE 4. Correlation between pruning wound diameter and necrosis lengths for Ugni blanc according to pruning type, virtuous V+ (grey) and mutilating V- (black), for the plot planted in 2015 (A) and the plot planted in 2006 (B).

Conclusion

As already mentioned by Faúndez-López *et al.* (2021)[4] in their study on the role of the diaphragm in providing natural protection against necrosis generated by pruning wounds, the results do not allow for differentiation between cultivars according to pruning quality, or the diameter or depth of necrosis, regardless of the type of pruning, V+ or V-.

Hence, we found no correlation between diameter of pruning wound and depth of necrosis, whatever the quality of pruning, the age of the plant, the cultivar or the vintage.

The generally accepted idea that the depth of necrosis is equivalent to the diameter of the cut thus seems to have no physiological basis. Rather, it is a practical marker for the pruner, who must leave a chicot to minimize desiccation of the vascular system.

The length of the chicot does not necessarily have to correspond to the diameter of the cut, as it is the diaphragm that stops the deep establishment of necrosis. ■

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