The role of diaphragm as a natural resistance to the necrosis produced by pruning cuts

Sourced from the research article “Pruning cuts affect wood necrosis but not the percentage of budburst or shoot development on spur pruned vines for different grapevine varieties” (Vitis, 2021).

Long before the scientific method was created, vine pruning was established as an art as early as at the beginning of the Christian era. Pruning is a way of reducing the vegetative part of the vine in order to limit its natural growth, and thus improve yield and grape quality by controlling the number of latent buds that are left per vine. Today, Virgilio and Plinyo instructions are still being followed for pruning, with the exception of some small empirical changes, which were introduced in the 19th century by Jules Guyot. This report aims to evaluate the effect of pruning cuts on wood necrosis behaviour, and to determine the effect of pruning on shoot development on different grape varieties.

Pruning and plant physiology

Pruning requires cuts to be made to the woody structures of vines, which will inevitably result in a wound of varying size, depending on that of the removed structure. Vines are able to produce a gummy sap substance and form tyloses that obturate the conductive vessels of the vine in response to wounding or damage. Pruning cuts result in the exposure of the vascular system to the environment, leading to natural dehydration and the death of the cells adjacent to the cut zones; desiccation cones are then generated by the vine which seal the injury and act as a protective barrier between the vine vascular system and the environment. This phenomenon results in the production of necrotic wood near the pruning cuts, leading to potentially harmful effects for the vines, such as the partial obstruction of the vascular system. These negative effects will depend on the diameter of the removed structure, its location in the plant, the proximity in which the pruning cuts are made into lignified shoots and the age of the removed wood structure during pruning.

Materials and methods

A first experiment was carried out on spur-pruned Cabernet Sauvignon vines that were randomly selected from a replanting vineyard, and subsequently uprooted from the ground using a backhoe. The chosen vines were dissected on a carpenter’s bench using a reciprocating saw in order to obtain one-year-old spurs (non-permanent structures), arms more than two-years-old, trunks and whole vine (permanent structures). Longitudinal cuts were made in order to quantify the percentage of necrosis in permanent and non-permanent structures with respect to their corresponding living wood area. Visual scoring of the shoot growth the following season was classified according to one of three categories: 1) completely developed, 2) partially developed, and 3) not at all developed. The statistical analysis was performed using a Kruskal-Wallis test rank (no-parametric data) by Statgraphics Centurion XVI.1 (Virginia, USA). Differences between samples were compared using the LSD test at 95 % probability level.

Figure 1. Study of necrosis in non-permanent structures**, arms*, trunk* and whole vine*, using ImageJ.
Results and discussion

First experiment

The necrotic wood area in non-permanent structures was found to be unrelated to the diameter of the pruning wound (Figure 3). In addition, a strong relationship was found between the necrotic wood area and the presence of a node in these structures (Figure 3). Hidalgo (1991) explained that necrosis begins with the dehydration of the cells involved in the wound and continues with the necrosis of the adjacent tissue due to its lack of functionality. This could demonstrate the participation of the diaphragm in the necrotic limitation. Thus, resistance to necrosis penetration can be offered by living tissues, which react by depositing polyphenols and other substances around the wound, and/or producing a callus able to seal the injury.

Hidalgo (1991) and Aliqú et al. (2010) mentioned that the diaphragm directly participates in the limitation of dehydration after the pruning cut is made. This characteristic could be due to the structure of the diaphragm, which is made up of hard, thickened pith cells with sclerified cell walls, as well as its specific position within the node, which is in an intermediate zone, achieving a segmentation between the organs. This structure may be part of a natural defense mechanism against wounding or a defense mechanism triggered by pruning, allowing the vine to reduce the damage caused by cuts. Simonit and Sirch (2013) pointed out the importance of performing pruning cuts only on non-permanent wood structures; this could be due to the fact that these structures contain nodes and diaphragms which limit wood necrosis in the permanent structures of the vines such as arms, canes or trunk. A high percentage and variability of necrosis was found mainly in arms compared to trunks (Figure 3), probably due to the fact that in the arms a greater number of cuts are made in comparison to those performed in trunks. Our results support the recommendation of Simonit and Sirch (2013), who reported that the best way to remove a shoot or spur is to perform the pruning cuts over the basal bud to avoid the necrosis penetrating the permanent wood structures on which the removed structure was supported.

Second experiment

According to our results, in Grenache, Cabernet Franc and Malbec vines a high percentage (> 70 %) (data not shown) of the buds tend to develop after pruning, regardless of the distance above the node of the pruning cut. Furthermore, there were no statistical differences between the treatments, regardless of the cultivar. In this respect, our results do not match those of Hidalgo (1991) and Aliqú et al. (2010), who stated that the pruning distance should be at least 2 to 3 cm above the node to avoid the necrosis penetrating the permanent wood structures.

Conclusion

The necrosis produced from a pruning wound in non-permanent structures of Cabernet Sauvignon vines had a strong relationship with the presence of a node. The arms showed a higher percentage and variability of wood necrosis than the trunks. Regardless of where the pruning cut was performed, the shoot development percentage was not affected in Grenache, Cabernet Franc and Malbec vines. Therefore, it is possible that the diaphragm may produce an effective natural resistance to the necrosis produced by pruning cuts.

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1 Faúndez-López, P., Delorenzo-Arancibia, J., Gutiérrez-Gamboa, G., & Moreno-Simunovic, Y. (2021). Pruning cuts affect wood necrosis but not the percentage of budburst or shoot development on spur pruned vines for different grapevine varieties. Vitis, 60, 137-141.
2 Hidalgo, L. (1991). Vine pruning. (4th Ed). Madrid. Ediciones Mundo-Prensa. Madrid, Spain.
3 Aliqú, G., Catania, A., & Agudo, G. (2010). Vine pruning. Estación Experimental Agropecuaria Mendoza. Instituto Nacional de Tecnología Agropecuaria (INTA). Mendoza, Argentina.
4 Keller, M. (2020). The science of grapevines: Anatomy and physiology. (3rd Ed). Elsevier Inc. Oxford.
5 Simonit, M., & Sirch, P. (2013). Il Metodo Simonit & Sirch Preparatori d’Uva. Scuola Italiana Di Potatura Della Vite. Venecia, Italy.