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VITES QUALITAS

SUSTAINABILITY AND COMPETITIVENESS OF VITICULTURE IN THE POCTEFA TERRITORY

INCREASING GRAPEVINE LONGEVITY AND HEALTH THROUGH THE EVALUATION AND TRANSFER OF PLANT PRODUCTION AND PRUNING PRACTICES

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State of the art - Grafting

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SUMMARY

The VITES QUALITAS project has begun to study of the quality of grafted grapevines in order to better understand the relationship that may exist between the reduction of vineyard longevity, which has been observed since the beginning of the 20th century, and the cultural practices used currently. In order to contextualize the research done in this area of study, this document analyzes the status quo of the knowledge generated about the biochemical and structural process during grafting, the evaluation techniques currently used in nurseries to evaluate the quality of the plant, and the main techniques used in plant production today, analyzing which alternatives may be interesting for the future in the sector.

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1. INTRODUCTION

Since the arrival of Phylloxera in Europe at the end of the 19th century, viticulture cannot be done without the use of grafting. Thanks to this technique, we obtain plants that are formed by the union of two individuals: an American varieties/species, which will be in charge of producing the Phylloxera-tolerant root system, and a variety of *Vitis vinifera* that will produce the fruit.

The production process of grafted plants is generally carried out in specific grapevine nurseries, without, until relatively recently, much scientific attention having been paid to the production process in the nursery or to the quality of the plants. However, since the beginning of the century we are seeing a serious decrease in the longevity of vineyards, associated with an increase in the incidence of wood diseases caused by fungi, and although there are many factors involved in this problem, one of them could be related to the quality of the planting material coming from the nurseries.

Although grafting is a widely used practice worldwide, both in herbaceous and woody crops, achieving quality plants is not a simple task since grafting involves a very complex biochemical and structural process: initial wound response, callus formation, creation of a continuous cambium and establishment of a functional vascular system between the two individuals. This complexity requires the process to be carried out properly, which depends on multiple factors: wood quality (hydration, reserves, presence of pathogens), hygiene in mother fields and nursery, proper calibration of material, preservation of material under optimal conditions, etc. In addition, practically all the knowledge that nurserymen have has been acquired empirically with the experience gained during decades of work.

In terms of research, very few studies have analyzed the underlying mechanisms during graft union. Therefore, it is complicated to define which factors favor successful graft union to produce quality plants that will survive several decades in the field.

2. WHAT DO WE CONSIDER A "QUALITY PLANT"?

A solid graft, a uniform callus, aligned vascular vessels, a vigorous bud and a sufficient number of roots would be some of the elements indicating that the graft union is almost perfect. However, in the field, it appears that all of these elements are not always present and are often difficult to assess. Several visual indicators can help us identify poor quality grafts, such as a bud that fails to initiate growth, a callus that develops only on one side of the graft, or an insufficient number of roots.

As for objective quality assessment, there are no standardized procedures. Normally, the only quality test carried out at the end of the rooting stage in the nursery is the so-called "thumb" test, which allows the resistance of the union to be evaluated by pressing on the area of the graft. Plants that resist this test should be kept and marketed, while the rest should be discarded. However, to test all the plants produced in a nursery one by one is a costly job, which is not always done. Moreover, it is difficult to know what is happening at the graft interface without breaking the plant. In this regard, there are some studies whose objective has been to evaluate graft quality in an objective way. For example, Milien et al. (2012) used 3D images obtained by X-ray tomography to assess vascular connections in the graft area in plants of different quality. Similarly, Spilmont & Carrere (2019) used the same type of images to demonstrate the presence of more or less significant necrosis in plants (Figure 1). Finally, Pisciotta et al. (2017) studied the possibility of the

use of thermographic, mechanical and electrical measurements to assess graft quality, concluding that only the first type of analysis allowed it. Following this line, the research group of the Public University of Navarra partner of Vites Qualitas has evaluated during the last years, and within the Vit-Foot and Vit-Feet projects, the possibility of using hydraulic conductivity measurements in the graft area to distinguish between good and poor quality grafts. With all this, the Vites Qualitas project will deepen the application of imaging techniques obtained by X-ray tomography and hydraulic conductivity to further test their suitability as indicators of quality of graft-plants in grapevine.

In parallel, studies have been carried out for several years to find molecular markers at an early stage of grafting (Errea 1998, Pina et al. 2017). The identification of these molecules present during an incompatibility, whether of mechanical or biological origin, makes it possible to detect less compatible combinations and to improve grafted plants produced in grapevine nurseries.

According to the literature, the plant response to grafting is comparable to that to a wound, given the involvement of genes associated with healing processes (Cookson et al. 2013). Subsequently, secondary metabolites are synthesized in the graft zone, playing a crucial role for a successful union due to their antifungal and antioxidant properties (Canas et al. 2015, Assunção et al. 2016, 2019, Pina et al. 2017, Prodhomme et al. 2019).

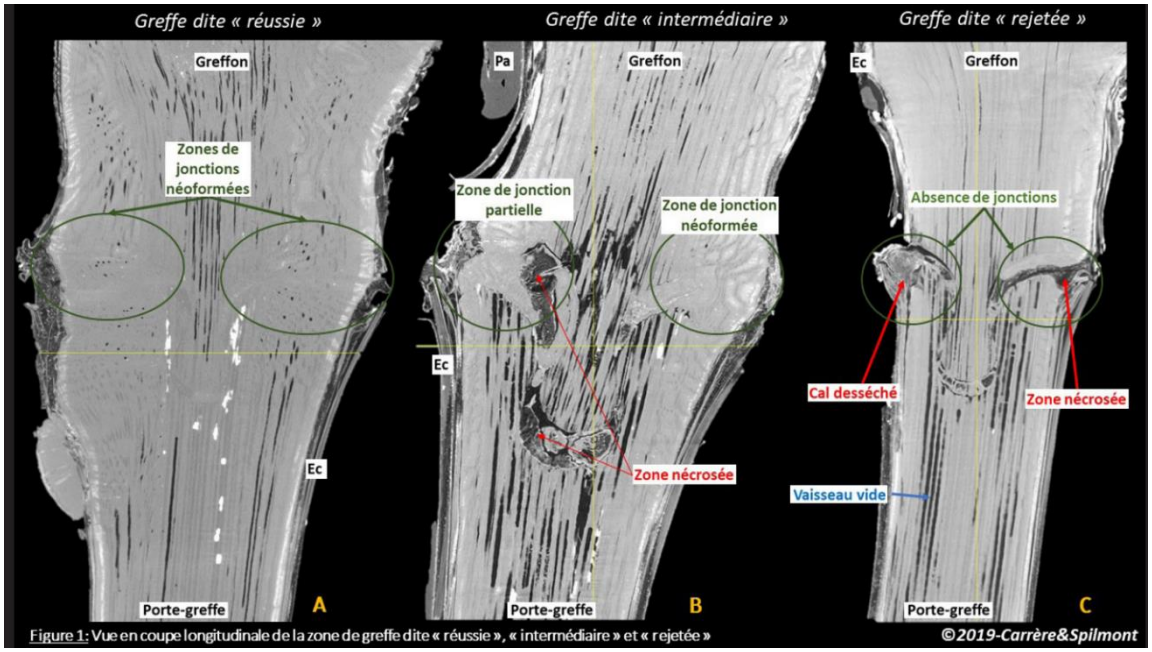

Figure 1: Longitudinal section view of the graft area known as "successful", "intermediate" and "rejected" (Spilmont & Carrere 2019).

3. ALTERNATIVE TYPES OF GRAFTING TO OMEGA

Omega grafting is currently the most widely practiced grafting method worldwide. It is a grafting done in the nursery "in the workshop", and its popularity is mainly due to its ease of mechanical processing, which makes it possible to produce a large number of plants at a relatively low cost each season. This is its strength, but it also has a downside, which is that if not enough attention is paid to the process, we can produce poorly calibrated plants. In addition to Omega grafting, there are other grafting techniques that were and/or are used within the sector in other times or countries, which could be interesting alternatives. On this subject there are some works carried out in different universities in Turkey in which they evaluate different aspects related to the type of grafting: Sabir & Kara (2010) and Sabir (2011) from Selcuk University Faculty of Agriculture, Department of Horticulture (Konya, Turkey); Çelik & Odabas (1999), Çelik (2000) and Çelik & Boz (2003) from University of Ondokuz Mayis, Department of Horticulture (Samsun, Turkey); and Çelik (2018) from Namik Kemal University, Agricultural Faculty, Department of Horticulture (Tekirdağ, Turkey). For their part, Mary et al. (2017) evaluated the impact of grafting type on the expression of foliar symptoms of Esca, observing higher symptoms in mechanically grafted plants in nursery (omega and whip and tongue grafting) compared to those grafted directly in the field (full-cleft grafting), although the results should be considered as preliminary mainly due to the large age difference of the plants evaluated in the study.

Within the Vites Qualitas project, the potential of 3 alternative grafting types to Omega (English, cleft and V) and their incidence on the presence of wood fungi and on the quality of vascular connections between scion and rootstock are being evaluated, with the final objective of obtaining knowledge to help produce higher quality plants. This task also continues one of the research lines initiated within the Vit-Foot and Vit-Feet projects with promising results (Marín et al. 2018).

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