Petit rappel utile sur le greffage de la vigne

A brief review on grapevine grafting

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Why graft a vine (*Vitis vinifera* L.) and how to study the grafting zones

Grafting is the process of physically connecting two genotypes to achieve a plant that produces above ground the canopy and fruit (cultivars of *Vitis vinifera* L., called scion) and below ground a root system from bred *Vitis* species (*Vitis berlandieri*, *riparia*, *rupestris*) referred as the rootstock. The root system genotype must be resistant or tolerant to pathogens and insects such as Phylloxera, and abiotic stressors such as drought, salinity or calcium (chalk).

The rootstock will control the vegetative expression of the vine including the vigour and canopy size. The architecture and vigour of the root system will depend mainly on soil structure (affecting root system morphology), depth and composition (minerals and water holding capacity) and management factors such as nutrient application and irrigation.

The main grafting methods used for the grapevine are:

- Omega graft (mechanized technique used by most nurseries)
- Cleft graft (not currently practised by nurseries; however could be used for direct hand grafting in the field)
- T-bud, chip bud and bark grafts (hand grafting used in the vineyard)
- A new grafting technic has been implemented by the Italian nursery Vivaï Cooperativi Rauscedo - VCR (Frioul, Italy), which is called “Mortaise” or mortise grafting (Figure 1), because according to VCR it allows better contacts between cambiums and thus insures better technical success.

Grafting in the vineyard can take several months to complete, with the work beginning in June-July in the southern hemisphere and February/April in northern hemisphere.

Figure 2 shows examples of a cleft graft (a, b), omega graft (d, e) and the associated cross sections (c, f). Histology is useful for visualising the junction between the rootstock and scion and to assess potential issues with grafting incompatibility.

Successful grafting in plants requires the development of a functional vascular system between the scion and the rootstock. Understanding the spatial organisation of the graft interface is important for the evaluation of new rootstock genotypes and for the development of new grafting technologies. The graft interface was previously studied using 2D classical sectioning with conventional microscopy. However by employing micro CT, a more comprehensive visualisation of the graft-zone is possible and provides a better understanding of how grafting disorders occur. An anatomical digital map of the sample is created upon scanning. Multiple 2D slices of the scanned area can be made in any direction, at any time. A living sample can

be scanned multiple times to study the development of the graft region over time. Unlike classical histology, X-ray tomography is none destructive so it can be used to image intact live plants. This method may also be used to follow the kinetics of tissue development at the graft interface using reduced doses of X-ray (X-rays can in some cases damage the cells). With the X-ray tomography, we were able to identify the main important tissues such as the pith, xylem and phloem vessels and the necrotic tissues (cf. figures 3 and 4).

Figure 3 shows an omega graft zone of Pinot gris on 110 Richter in longitudinal view: (a) is a healthy plant with good vascular continuality and no grafting disorder symptoms; (b) is a plant with poor vascular continuity and classical symptoms of graft incompatibility. The causes of graft incompatibility-disorders are numerous: genotype, viruses, poor grafting conditions in nurseries and desiccation. The type of graft appears to have little influence on the overall success of the union.

In Figure 4 we illustrate the difference between a good (A) and a bad graft (B) several months after grafting. In the “good graft”, the tissues were continuously produced and the density of wood is very homogeneous. It is difficult to identify the interface between the rootstock and the scion. Many vessels, produced after grafting, are organized in a compact mass (C).
By contrast, in the “bad graft”, the wood appears heterogeneous: the dark grey, less dense tissues are necrotic wood. The contact area between the two partners is also limited and very few vessels were produced resulting in a limited connection between the rootstock and scion (D).

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Figure 1 : Example of mortise grafting (greffe en mortaise) developed by the nursery Rauscedo and which is mechanised. This type of graft allows to increase the contact area at the grafting zone level between the scion and the rootstock (La Vigne, 2016).

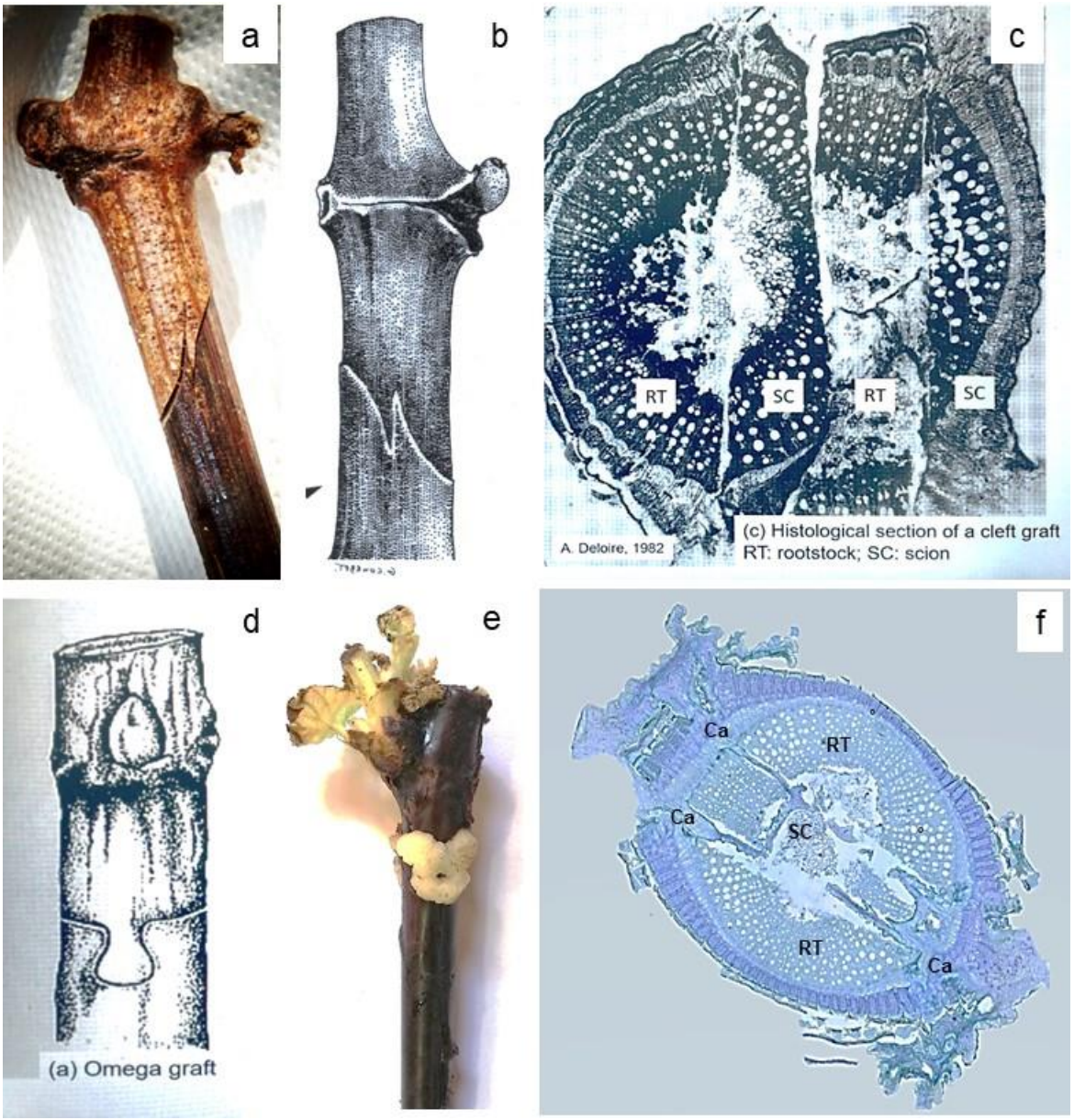

Figure 2: Examples of cleft (a, b, c) and omega (d, e, f) grafts: schemes, photos and histological sections across graft union

Histological analyses allow observing how the junction is achieved through the callusing process. In the Omega graft (d, e) colored by Toluidine blue (f), callus (Ca) development between the scion (SC) and the rootstock (RT) 6 weeks post-grafting (From A.S. Spilmont, IFV)

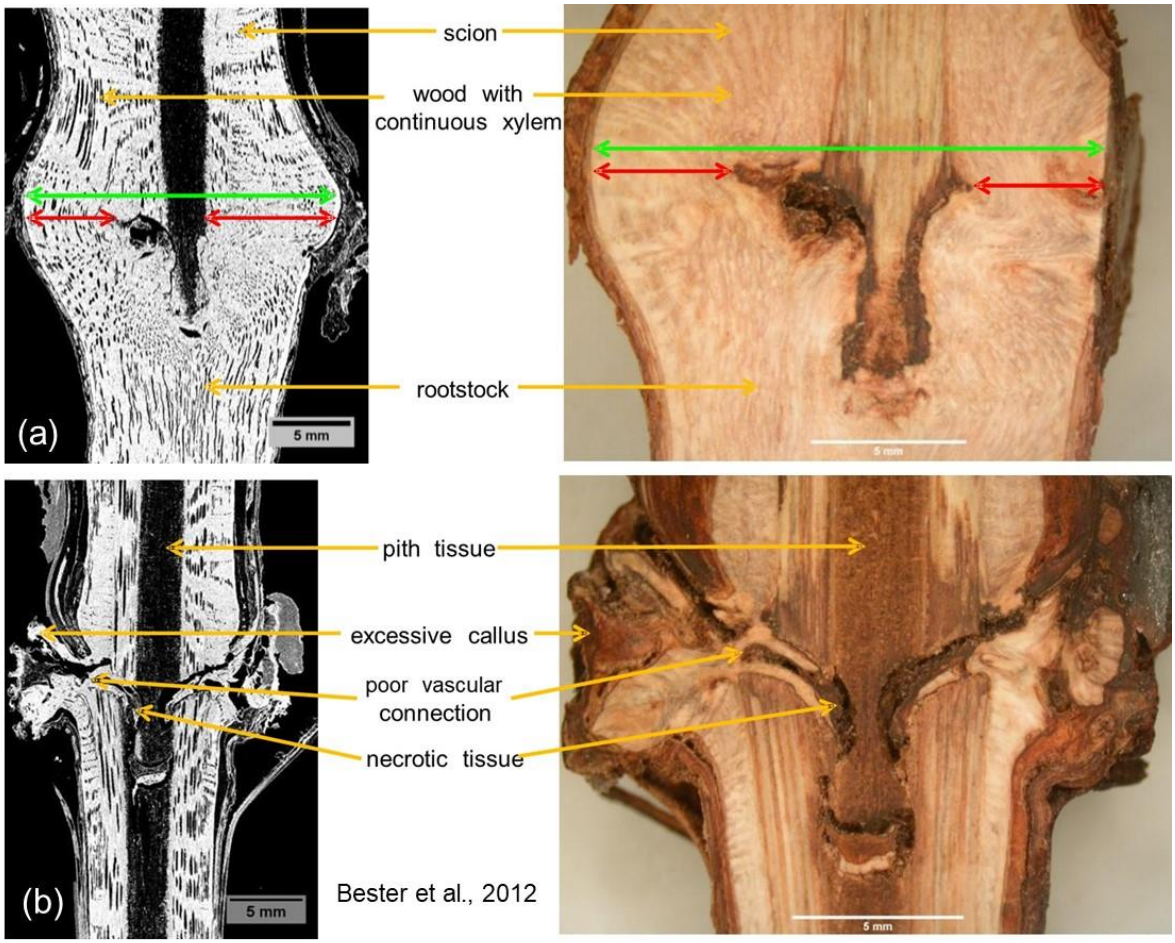

Figure 3: Longitudinal sections and tomography views of Omega graft zones of Pinot gris on 110 Richter: (a) is a healthy plant with good vascular continuity and no grafting disorder symptoms; (b) is a sick plant with poor vascular continuity and classical symptoms of graft incompatibility.

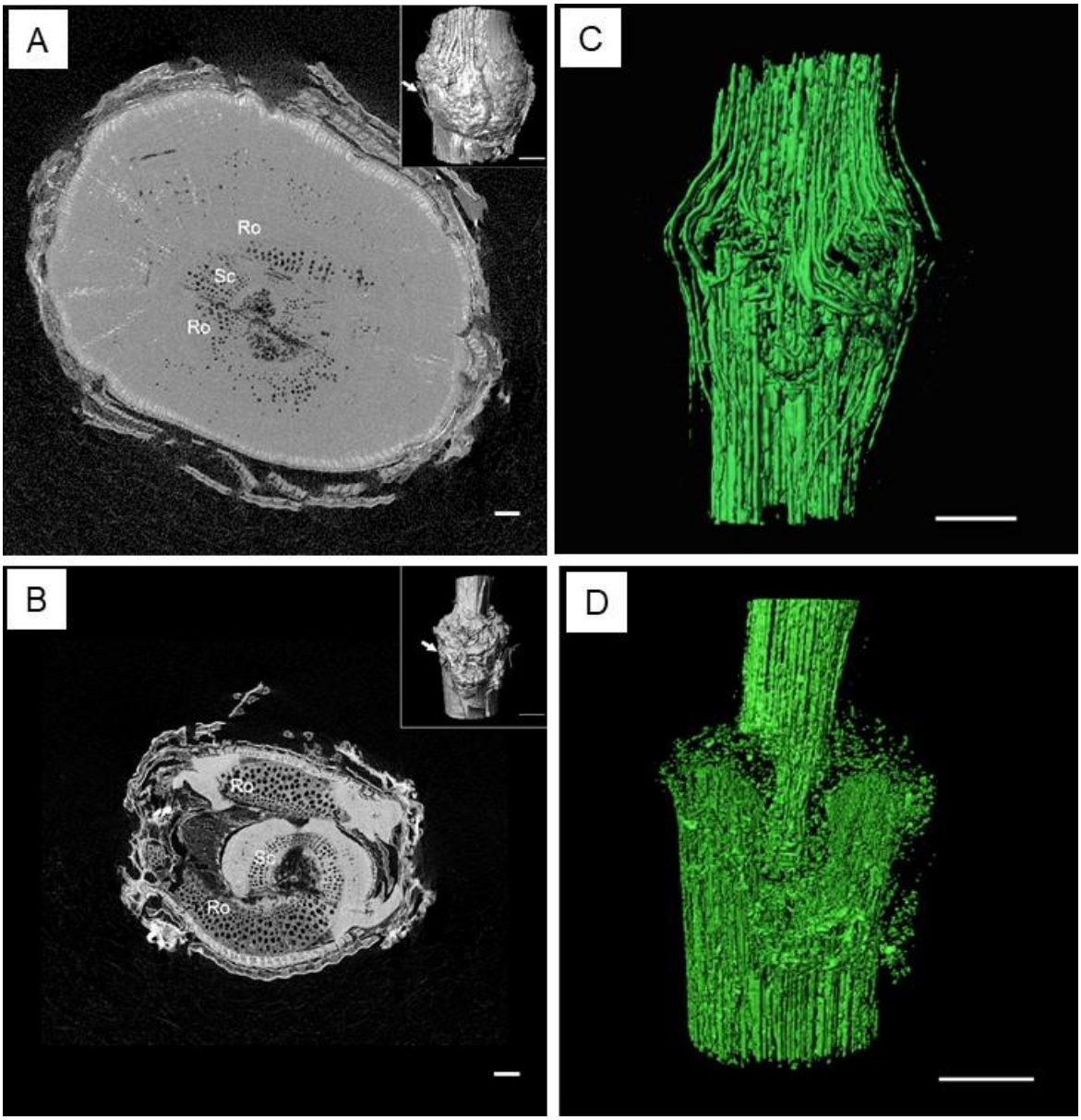

Figure 4: Comparative visualization of a “good graft” (A, C) and a “bad graft” (B, D) 8 months after grafting from the 3D X-ray tomography reconstruction (Milien et al, 2012)

(A) and (B) show virtual transverse sections taken from the grafting zone (see arrows) (ImageJ and Imaris softwares).

(C) and (D) show 3D vasculature obtained after vessel segmentation on the same plants

Ro: rootstock, Sc: Scion