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Regrafting and curettage of esca-affected vines: useful control techniques but difficult to implement

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Grapevine trunk diseases affect 13 % of French vineyards and esca has become more prevalent in recent decades[1]. Fussler *et al.* (2008)[2] reported that an average of 3.25 % of vines are affected by esca. Management of these vines, considered unproductive, often consists in cutting off the symptomatic arm or uprooting the vine. In this competitive environment, it is difficult for a newly planted vine to grow and return to production. Regeneration of diseased vines thus seems an interesting alternative approach to controlling esca.

Esca leaf symptoms (Grapevine Leaf Stripe Disease, GLSD) are associated with the presence of necroses developing in the old wood of the vine. Several necroses have been identified and linked to different pathogens[3 4 5]. Although the pathogens are present from the time the plant is grafted in the nursery[6], any wounds encourage penetration of these fungi into the wood. However, the mechanisms leading to the expression of GLSD are still poorly understood, though it has been postulated that toxins are responsible[7]. The link between GLSD and the degree of necrosis – including that of the "amadou" type, a soft white wood rot caused by the fungus *Formitiporia mediterranea* – has been demonstrated[8 9]. Hence, rather than replacing vines showing symptoms of GLSD, there has been a revival of interest in vine regeneration techniques. In our study, "chip bud" regrafting and curettage were studied on plots of Cabernet Sauvignon, a grape variety susceptible to esca, planted with 15- to 20-year-old vines, the age of full leaf expression[2]. Direct and indirect mortality rate, percentage re-expression of esca and return to production were quantified.

Curettage, a technique that kills more than half the vines

Curettage was performed by a specialist service provider using a chainsaw in spring 2015 and 2016, under hot and dry conditions, on a plot planted in 1998 in the Médoc. In 2015, the service provider selected 124 vines from among those diagnosed with GLSD in previous years. The experiment was repeated in 2016 with a further 98 vines in the same plot, i.e. a total of 222 vines over 2 years. The status of the selected vines ranged from mild expression on one arm of the vine in one year only up to strong expression over consecutive years. Curettage was not performed on vines previously diagnosed with apoplexy. Of the vines on which curettage was attempted, nearly 57 % did not survive (Figure 1). It is a delicate operation, and if there is a lot of necrotic tissue to remove in the heart of the vine, its removal often leads to death of the plant. 11 % of the vines died in the following 3 years, increasing the mortality rate to 62 %. Esca symptoms re-appeared in 16.7 % of the vines that survived curettage (Figure 1). By comparison, the rate of re-appearance of GLSD in the rest of the plot over the same years was 18.8 % with a mortality rate of 19.2 %[10].

Regardless of the year of curettage, the failure rate is high and the percentage of re-appearance of disease is of the same order of magnitude as for the rest of the plot. This rate is all the more disappointing given that some of vines selected for curettage were only mildly affected by esca and it was not performed on apoplectic vines.

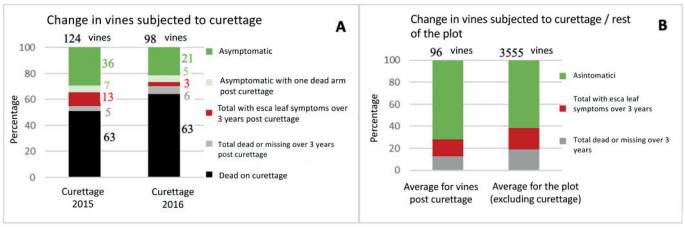


FIGURE 1. Change in vine status over 3 years. A: State of the vines 3 years after curettage (2018 for curettage in 2015 and 2019 for curettage in 2016). The bar charts show the cumulative percentage for the different states of the vines after curettage for each of the two years and the number of vines in each category appear on the right. B: Change in vine status post-curettage compared with the rest of the plot. The bar charts show the cumulative percentage for the different states of the vines.

Re-grafting, mixed results in a difficult year

Regeneration by "chip bud" regrafting on the rootstock was carried out in spring 2013, on all vines diagnosed with the chronic and apoplectic form of GLSD on 2 plots located in the Médoc, 18 and 28 years old respectively, with a total of 648 vines. The climatic conditions in 2013 were unfavorable for regrafting (a cold and wet spring) and several of the regrafted vines were apoplectic. The cumulative failure rate between immediate failure and failure within 3 years of regrafting was 40 to 50 %. The percentage of vines that survived regrafting and then showed esca symptoms at least once within 3 years of grafting was 12.6 %, none of which were initially apoplectic (Figure 2). By comparison, over the same period, the rate of re-appearance of GLSD in both plots was 18.7 % on average with a mortality rate of 5.3 %[10].

The failure rate was high in both plots, but lower than for curettage. Percentage re-appearance was high, but lower than the rate of new appearance in the plots concerned.

Rapid return to production

The crop weight per vine was measured on 30 to 60 vines for each experimental protocol (47 on average) in the 3 plots. It is compared with the year's crop weight from asymptomatic (As) vines that showed no symptoms of GLSD between 2011 and 2019 (Figure 3).

Vines post curettage (without new GLSD) showed good yields, between 61 and 80 % of the crop weight of an As vine, in the year following curettage (Figure 3A). In comparison, vines newly planted in the plot in 2015 and 2016 produced only 18 % of the crop weight of an As vine after 3 to 4 years.

Regrafted vines also showed a quicker return to production that newly planted vines. In plot 2, the crop weight of the rearafted vines

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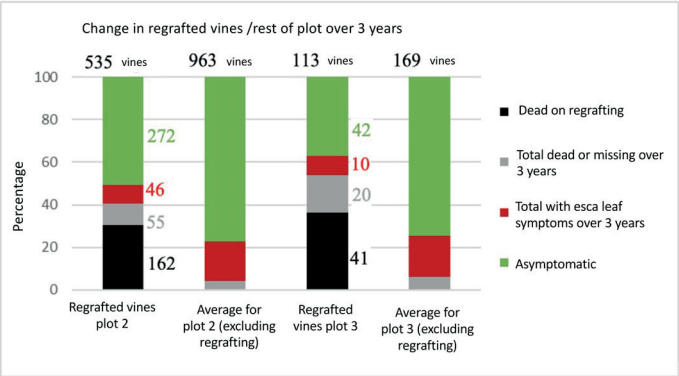


FIGURE 2. Change in status over 3 years of regrafted vines compared with vines that showed esca leaf symptoms at least once between 2011 and 2013. The bar charts show the cumulative percentage for the different states of the vines between 2014 and 2016 for each of the two plots. The number of vines in each category appear on the right for the regrafted vines.

increased from 57 % of that of an As vine two years after regrafting to 94 % in the third year. Return to production was more gradual in plot 3, increasing from 40 % two years after regrafting to 100 % after 5 years. At the same time, new vines in plot 2, planted one year after the regrafting year (Co14), produced only 6% of the crop weight of an As vine two years after planting, and their production increased slowly to reach 28 % after 5 years. In plot 3, the production of new vines planted in the year of regrafting (Co13) was better, with 19 % of the crop weight of an As vine two years after planting and increasing to 85 % after 5 years, but this remains lower than the crop weight for regrafted plants (Figure 3B and 3C).

Promising techniques but difficult to implement

In combating esca, winegrowers are often hesitant about what actions to take to prolong the life of the vines and maintain their production. Evaluation of regeneration techniques such as curettage or regrafting has demonstrated that it is possible to contain the spread of the disease and limit esca leaf symptoms, considered detrimental to grape yield and quality. In addition, a recent study showed that the quality of grapes from vines post curettage was just as good as from healthy vines[11]. However, these techniques are complex and, even when performed by specialists, the failure rate remains high at the time of implementation, especially for curettage. Other studies show lower mortality rates, either because only the mortality rate of vines that survived the operation was monitored, or because the conditions were more favorable (lower age and/or necrosis rate of the vines undergoing curettage, more favorable weather conditions, etc.).

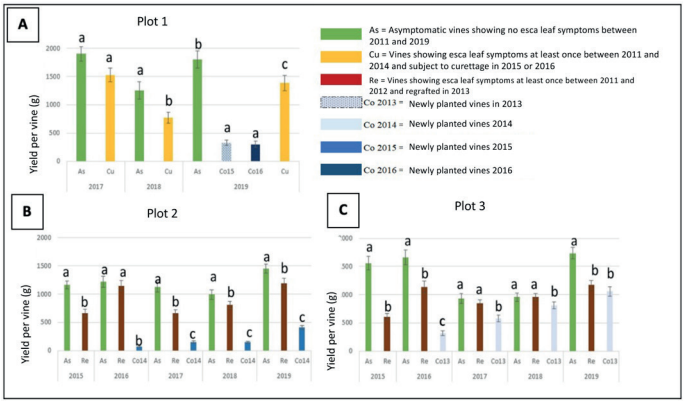


FIGURE 3. Change in the production of vines previously diagnosed with esca after curettage (plot 1), regrafting (plots 2 and 3) or with newly planted vines (plots 1, 2 and 3) compared with asymptomatic vines (no esca leaf symptoms between 2011 and 2019) in the 5 years following these technical operations. The bar charts show the average yield per vine and the error bars show the standard deviation. The letters indicate significant differences between the experimental protocols for each year (Tukey's range test, P <0.05).

In addition, these techniques must be carried out during periods of peak activity in the vineyard. The cost per vine is higher for curettage than for regrafting, but regrafting requires more upkeep during the growing season. On the other hand, once the vines have started to grow again, they return to production quickly, which could make these techniques more interesting than interplanting with new vines in certain situations. An economic study of the plots where it is preferable to choose regeneration should be carried out. Indeed, contrary to popular belief, the loss of yield from esca-affected vines is far from total and these techniques are time-consuming and costly to implement[10]. Their adaptation may therefore depend on the rate of vines affected on the plot and the value of the wines it produces. ■

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