Etiology of "Rugose Wood Complex".

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Introduction

The rugose wood (RW) complex is one of the major disease complexes affecting grapevines (*Vitis* species) and was reported as early as 1966 (Graniti *et al*., 1966). RW affects grapevines on the woody cylinder causing pitting, grooving and severe aberration of the zone underneath the bark. Today the incidence of this complex is recognized to have a strong economical impact worldwide on the grape industry.

Rupestris stem pitting, LN 33 stem grooving, corky bark and Kober stem grooving are the names of diseases included in the RW complex. Some viruses are shown to be associated with the RW disorders, and the majority of these viruses belong to the family Flexiviridae, in the genera *Vitivirus* or *Foveavirus.* RW is usually transmitted in the vineyards via grafting and propagation of infected material, but some of them can also be spread in the fields by mealybugs. The viruses associated with the RW are: *Grapevine virus* A (GVA) associated with Kober stem grooving (Garau *et al.,* 1994), *Grapevine virus* B (GVB) associated with Corky bark (Bonavia *et al.,* 1996), both in the genus *Vitivirus*; and *Rupestris stem pitting associated virus* (RSPaV) associated with rupestris stem pitting (Zhang *et al.,* 1998), belonging to the genus *Foveavirus*. Another Vitivirus named *Grapevine virus D* (GVD) (Abou-Ghanem, *et al*.,1997) was detected in a vine showing corky rugose wood symptoms, but its role in the RW is still unclear. The RW disorders can be recognized by indexing. Rupestris stem pitting is biologically indexed on *Vitis rupestris,* cv. St. George rootstock, where it causes pitting extending downward in a line from the point of inoculation. The typical symptoms of Corky bark are grooving and pitting on the woody cylinder of *V. rupestris* and LN 33 (Courdec 1613 x Thompson seedless) (Martelli, 1993). Kober stem grooving is indicated by a marked grooving on Kober 5BB (*V. berlandieri* x *V. riparia*) stems, but it is asymptomatic on *V. rupestris* and LN 33 (Martelli, 1993).

Even though Vitiviruses are known to be involved in the rugose wood complex, yet their etiology is not completely known. Each of the viruses associated with RW seems to have an influence on the severity of the diseases, depending on the virus species or their combination. Furthermore, symptom expression on different grapevines may depend on the scion, the rootstock, or their combination.

The objective of this research project was to clarify some of the unknown aspects of the RW complex. More specifically, it was designed to determine the effects of multiple virus infection associated with RW on different indicators including symptom development and expression. With this objective in mind, an experimental trial was designed and healthy indicator grapevines were inoculated with single or combinations of known sources of Vitiviruses and RSPaV.

Materials and Methods

Canes from healthy indicator hosts Kober 5BB, LN33, and *V. rupestris* cv. St. George were collected in November 2004. During the month of May 2004, each of these rootstocks was grafted by chip budding with three buds per grapevine, in single, double, and triple virus inoculation-combinations, with 15 replicates per treatment. Viruses inoculated were GVA, GVB, GVD and RSPaV.

At the end of August 2006, grapevines grafted in 2004 were topped off and sampled. The following day, plants were cut at the base, their bark was removed and symptom development was evaluated. The scale used for the evaluation of the symptoms ranged from 0 to 5, where 0 indicated "no symptoms" and 5 indicated "dead". The diameter of the trunks was also measured at about 10 cm above the soil level. Statistical analysis of the field trial data was performed.

Results and Discussion

Our analysis showed that virus inoculation treatments did not have the same effect on all three rootstocks. The most notable exception was treatment GVB/GVD/RSPaV that caused the greatest reduction in diameter on all the rootstocks. In general, the average diameter appeared to be more

affected by combinations of viruses, and the presence of GVB generally caused both more severe symptoms and a reduction in growth. Nevertheless, we could not see any correlation between a particular virus combination and the severity of the effects on all the grapevines. In particular, treatments GVB/GVD and GVB/GVD/RSPaV impaired the growth of LN33 rootstocks, GVA/GVB/RSPaV, GVB/GVD/RSPaV and GVA/GVB impaired the growth of Kober 5BB rootstocks, and the GVB/GVD/RSPaV treatment impaired the growth of St. George rootstocks.

In regards to symptomology, LN33 showed symptoms when it was grafted with RSPaV or GVD, Kober 5BB did not show any symptoms when inoculated with two different strains of GVA. However, St. George showed symptoms when inoculated not only with RSPaV, but also with GVB. Growth and symptoms did not show any significant correlation, and only LN33 plants infected with GVB showed such extensive necrosis to predict a complete vine decline a few years after planting. In conclusion, it seems that the use of indicators for virus detection is not always a reliable way to verify the presence of viruses and other testing procedures should be available to complement the test.

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