Growth and Survival of Grapevine Rootstocks Infected with Grapevine Leafroll and Vitiviruses

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Newly replanted grape (*Vitis vinifera*) vineyards in California in the 1990s were observed failing with disease symptoms characteristic of virus infection. This epidemic occurred during a planting cycle which involved a dramatic change in rootstock genotypes. Disease was associated with vineyards using certified rootstock field grafted with scion buds from apparently healthy commercial vineyards. We hypothesized that virus infections which were latent in vines growing on their own roots or grafted to V. hybrid 'AXR-1' caused the severe disease on the alternative rootstocks coming into common use. This phenomena has been widely referred to as the latent virus problem in California (Golino, 1993). Since diagnosis of grapevine virus infections can be complex, grapevine accessions were taken from vineyards showing typical symptoms of the phenomena and propagated into a permanent collection. These accessions have been analyzed for infection with grapevine viruses using traditional woody and herbaceous indexing, ELISA tests, and RT-PCR tests. All accessions were indexed on the rootstock 'Freedom' which was associated with severe latent virus problems early in the epidemic.

A cause-and-effect relationship has been confirmed between the presence of certain viruses in propagating stock and the decline of young vines. A total of 36 virus accessions have been indexed on Freedom. In 18 cases, severe latent virus effects on Freedom rootstock were observed. In all but one case, when 'Freedom' was severely affected both GLRaV-2 and GVB were present in the virus accession. In the single exception, the vitiviruses GVA and GVC were both present; possibly contributing the same disease factor as GVB (Golino et al., 2000, Golino et al., 2002). Conversely, all of the virus accessions that did not cause a severe reaction on Freedom tested negative for GLRaV-2 + GVB.

We demonstrated that the combination of GLRaV-2 and GVB leads to severe stunting on Freedom rootstock. We named this phenomena virus-induced rootstock decline (VIRD). VIRD is highly correlated with the presence of both GLRaV-2 and GVB, which may be acting synergistically. It is important to note that this effect is independent of any rootstock/scion relationship or incompatibility as has been observed in other disease cases. Although rootstock/scion interaction may be involved in this and other virus disease syndromes, in this case, severe effects of virus can be noted on the rootstock alone.

Tests were conducted to compare the relative resistance of popular grapevine rootstocks to both the single viruses and mixed infections which caused VIRD on 'Freedom.' Selected established virus sources, extensively indexed by multiple techniques (Golino, 1992), were grafted to each of 22 grape varieties (largely rootstock cultivars) including 101-14 Mgt, 110R, 1103P, Kober 5BB, 3309C, 140Ru, Teleki 5C, 420A Mgt, Ramsey, Riperia Gloire, 1613C, 1616C, Schwarzmann, SO4, 44-53 Malague, Dog Ridge, AXR, St. George, Chardonnay, Cabernet Franc, Freedom and Harmony. 40 plants were budded per treatment per cultivar and planted in 5 randomized blocks with 8 plants/block for a total of 240 plants/ variety and 5,280 total plants. Virus treatments included: non-grafted control, grafted healthy control, LR 101 (GLRV-3), LR 102 (GLRaV-1, GLRV-2, GVB), LR 109 (GFkV, GLRaV-2, GLRaV-3, GVC), and CB 100 (GLRaV-2,GVB). LR 102, LR 109, and CB 100 have been demonstrated to cause severe VIRD. Tests were also conducted on selected rootstocks to investigate the effects of additional virus sources on growth and survival.

Graft inoculations were accomplished by chip budding two dormant buds from virus-infected source plants into green growing rootstocks produced in our greenhouses. The inoculation buds were allowed to callus and take for several weeks before planting. About 2 months after inoculation, bud take was observed and the inoculum buds removed. Plants for which neither inoculum bud healed were removed from the data analysis. Data taken on these blocks over the next 2 years included: survival, symptoms, trunk diameter, length of the longest shoot in early spring, and dormant pruning weight. Grafts were observed for necrosis and abnormalities.

Varieties were grouped into three categories according to size differences between the healthy and virus-inoculated plants of each variety. AXR was clearly unaffected by any of the inoculated viruses (Fig 1). There was no significant difference between healthy and virus-inoculated plants in 2 of 3 years data of length of the longest shoot nor in 2 years of pruning weight data. Shoot length in year 2 ranged from 90 to 100% of healthy; pruning weight in year 2 ranged from 89 to 121% of healthy. Survival was 100% over all

3 years of the study. Selected plants tested positive for virus using ELISA and PCR, providing evidence that AXR, while infected with virus, did not suffer any detectable effects of the virus. Other varieties that were relatively resistant to the inoculated viruses included Ramsey, St. George, 110R and 3309C. In these rootstocks no significant difference was observed between healthy control and virus-inoculated plants in the length of the longest shoot in early spring (Fig 1), nor in dormant pruning weight.

Varieties with a medium level of resistance to the inoculated viruses included: Cabernet Franc, Chardonnay, Kober 5BB, Riperia Gloire, Oppenheimer SO4, Teleki 5C, 101-14 Mgt, 1103P, 140Ruggeri, and 1616C. Size of virus-inoculated treatments in these varieties was significantly different as compared to healthy control. In most rootstock/virus combinations, the virus-inoculated plants were approximately 70 to 80% of the size of healthy. However, more severe stunting was observed in 1103P and SO4 inoculated with CB100 (57 and 60% of healthy, respectively) and in 44-53 Malague inoculated with LR102

Varieties that were very susceptible to the inoculated viruses included: Harmony, Freedom, Schwarzmann, 1613C, 44-53 Malague, and 420A. Virus treatment was highly significant. In these varieties virus-inoculated plants were severely and dramatically stunted, and often were 50% or less of the size of the healthy control.

This data provides clear support for our original hypothesis that virus problems became more evident when growers changed from AXR to new rootstocks because scions grafted to AXR can be symptomless carriers of viruses. When scion wood was taken from a vineyard that had been doing well on AXR and grafted to a different rootstock, virus disease caused decline in growth and productivity.

It also provides supporting evidence for our hypotheses that rootstock response to virus infection depends on the rootstock genotype and the virus type. Rootstocks differ widely in virus susceptibility and rootstock growth and survival is affected by virus infection. No graft union is necessary for detrimental virus effects to appear, although graft union symptoms may be a symptom of rootstock decline.

References

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Figure one. Average length of longest shoots in spring, 2 years after inoculation with selected virus isolates, expressed as a percent of healthy; H = healthy control, NG = not grafted control.