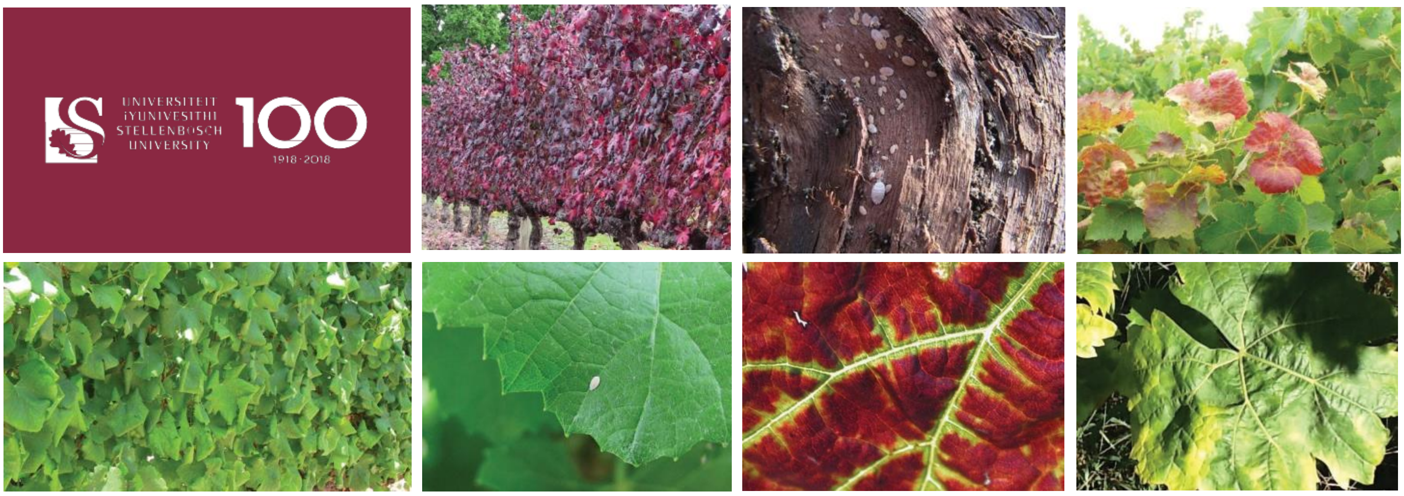

LEAFROLL CONTROL STRATEGY

7. ALTERNATE CONTROL STRATEGIES FOR LEAFROLL DISEASE

7.1 Breeding for resistance to leafroll disease

Besides the control of leafroll disease advocated in these fact sheets (vector control and leafroll infected vine removal) this disease could theoretically be controlled by using resistant *Vitis* plants.

The rationale behind the support for the current control method rather than attempts to obtain resistant cultivars is as follows;

No *Vitis vinifera* cultivar is currently known to have either tolerance (virus infects the plant but does not cause a disease) or immunity (virus is unable to infect the plant) to grapevine leafroll-associated virus 3 (GLRaV-3) the prime cause of leafroll disease in South Africa. Because of this a traditional breeding program to introgress this trait into the commercial cultivars cannot be attempted.

While rootstocks, which are often *Vitis* of a different species e.g. *Vitis berlandieri* or *V. riparia* do show an apparent tolerance to GLRaV-3 (Fig. 1), it would take decades of backcrossing of these cultivars to a desired parental *V. vinifera* parent to assess and obtain all the desired traits of the *V. vinifera* parent along with the tolerance to GLRaV-3 (Fig. 2). This would have to be done for each *V. vinifera* cultivar. Clonal properties of the final cultivar developed would also have to be re-assessed.

Figure 1: No symptoms displayed by R99 rootstock here even though scion shows severe leafroll infection. (Image: Kirsti Snyders, University of Pretoria)

Utilization of resistance to GLRaV-3 is not performed anywhere currently.

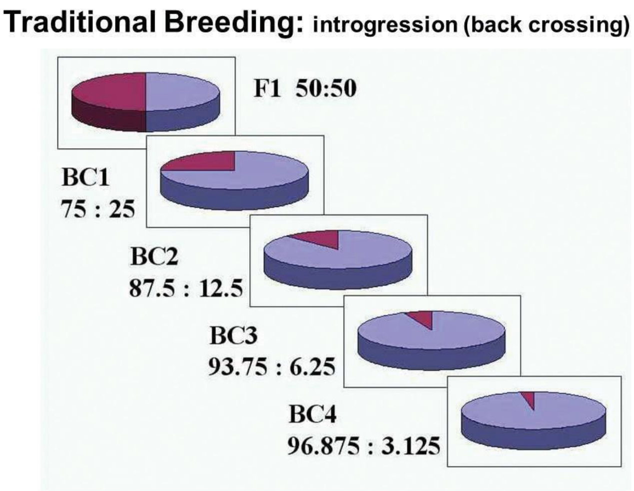

Figure 2: Diagram showing the percentage of desirable traits obtained in some progeny with every new backcross conducted. For example the burgundy colored portion represents leafroll resistance from an American Vitis rootstock, while purple represents the desirable traits of a Vitis vinifera. (Image: D. Francis, Ohio State University)

7.2 Transgenic resistance

To overcome the length of time required by traditional breeding to produce GLRaV-3 resistant vines, various transgenic approaches could be utilized to achieve this, including using parts of the virus itself (pathogen derived resistance), or resistance genes obtained from *Vitis* rootstocks.

Besides the social-political difficulties in obtaining markets for transgenic products, various technical aspects also make this approach a long term one. These hurdles include: 1) each potentially GLRaV-3 resistant *Vitis* clone developed only replaces one susceptible cultivar or possible clone of that cultivar, *i.e.* for each existing commonly cultivated cultivar (or possibly even clone of a cultivar) a resistant equivalent will need to be produced. If this cannot be done an interim period in the industry of some resistant and some susceptible vines will exist. To protect the susceptible cultivars in such a scenario the resistant cultivars must rather be immune (no virus replication or infection allowed) than tolerant (allow virus to replicate in them but do not show symptoms), as tolerant vines will make control of leafroll spread to susceptible vines extremely difficult. This is similar to the white-berried cultivars, where GLRaV-3 infection takes place currently but where symptoms are not visually observed and hence cannot be removed without laboratory tests for the virus. 2) The resistance will have to be directed and effective against all variants of GLRaV-3 occurring in South Africa. 3) The gene causing resistance in rootstocks must be identified and must be a single gene conferring this and not a combination of multiple genes as it is very difficult to produce transgenic plants having multiple introduced genes. The basis of resistance in rootstocks is currently not known. 4) The current insertion of the gene conferring GLRaV-3 resistance by transgenic means is not very precise and such a gene (or multiple copies of it) can be placed within the *Vitis* genome at places where it alters some of the natural functions of the *Vitis* plant and hence all transgenic plants need to be rigorously evaluated, up to wine-making, to ensure they do not have any impaired functions, a very long process. 5) Transgenic *Vitis* plants would be derived from extremely limited numbers of individuals and hence the genetic base of transgenic crops is extremely low, making them vulnerable to various adverse conditions. Ideally then the desirable transgenic trait (GLRaV-3 resistance) needs to be introgressed into genetically more diversified *Vitis* clones, and 6) as with all forms of resistance to pathogens, this effectively selects for GLRaV-3 variants which overcome the resistance, which inevitably results in a race of having to breed resistance against emerging resistance-breaking viruses.

7.3 Cross protection with mild strains of GLRaV-3

Cross protection is when a mild strain of a virus is used to protect a plant against the effects of a more severe virus.

To affect cross protection against GLRaV-3, all individual vines will have to be pre-immunized (inoculated) with a mild strain of GLRaV-3.

While theoretically possible (this approach is used to protect citrus trees against citrus tristeza virus, CTV), cross protection against GLRaV-3 will be difficult to develop and implement for the following reasons;

1) Cross protection tends to be a very specific strategy, with mild forms of specific strains of CTV only being able to protect against other forms of the same strain, and therefore it is likely that mild strains of all variants of GLRaV-3 will have to be found and isolated on their own. The biological properties of variants of GLRaV-3 are not yet known, and the existence of mild strains unproven. It will take a number of years to determine the pathogenicity of pure sources of each variant on all of the most commonly grown grapevine cultivars.

2) All pre-immunized vines would be infected with GLRaV-3 and hence producers requiring leafroll-free vines would be at risk from high inoculum levels in pre-immunized, protected vines.

3) Inoculation of even mild forms of GLRaV-3, are likely to exact some yield or quality losses in pre-immunized vines (by analogy with CTV in citrus).

4) Pre-immunizing populations of GLRaV-3 may undergo genetic drift or mutations with time resulting in potentially more severe forms of GLRaV-3 overcoming the cross protection.

5) Cross protection therefore is also an extremely long-term approach to controlling leafroll in South Africa.

7.4 Conclusion

Control of virus spread by roguing and vector control has been demonstrated to be very effective at controlling leafroll, and hence while some projects in the alternative control approaches have been funded by Winetech, these are not considered applicable to the South African industry in the short term.

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