Technical Note

ARC TRAINING CENTRE FOR INNOVATIVE WINE PRODUCTION

Genetic Basis of Salt Exclusion in Grapevine

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Background and Aims

Excessive soil salinity is an environmental constraint with the potential to impact viticulture. Salt-affected grapevines exhibit decreased yields and negative attributes in grape juice. As climate change drives the expansion of salt-affected areas, research efforts are needed to protect future grape and wine production.

The implementation of salt-excluding rootstocks can mitigate many of the negative effects of salinity in grapevines, so this project aimed to identify the genetic information that characterise salt-excluding rootstocks. This genetic information can be incorporated into breeding programs to produce future generations of salt-excluding rootstocks in combination with other traits of viticultural interest.

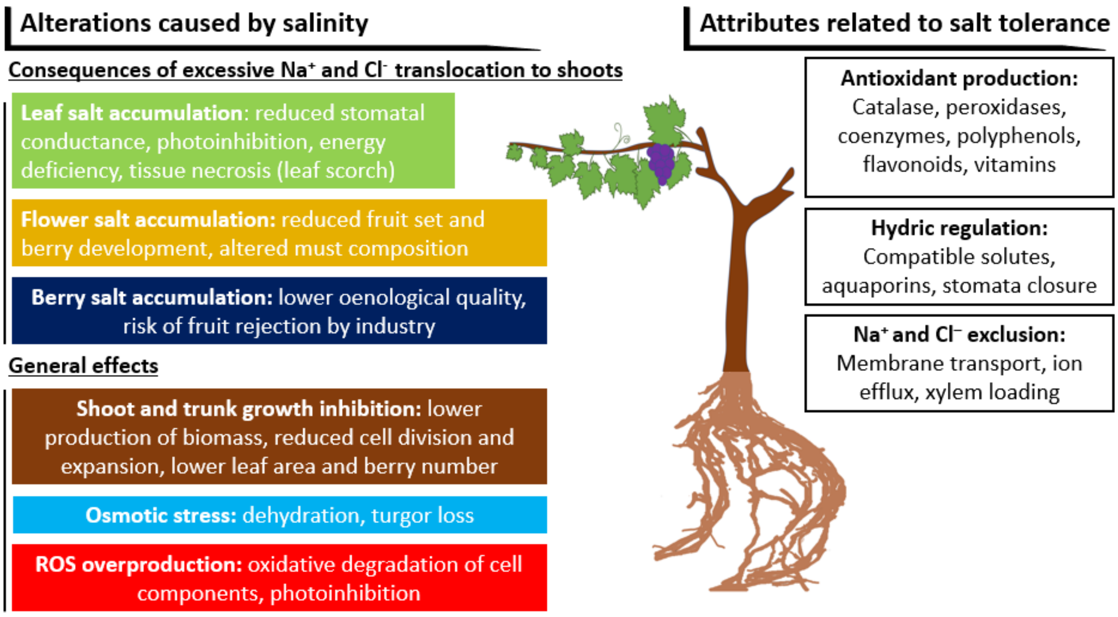

Figure 1. Salt stress involves a complex combination of damaging effects on the grapevine (left panel).
However multiple biological attributes are known to favour salt tolerance (right panel).
Our research on genetic basis for these attributes, especially on ion exclusion, can help breeding salt tolerant varieties.

Key outcomes

- We documented the entire genetic sequence of salt-excluding varieties 140 Ruggeri and Ramsey, as well as the salt-including variety K51-40, through their whole genome assemblies.
- Genomic differences between salt-excluding and salt-including varieties have been identified, revealing genomic components potentially associated with improved salt exclusion. This genomic information can also be utilised to investigate the basis for other distinctive traits (i.e. drought tolerance, pest resistance, vigor).
- We observed differences in gene expression behaviour of salt-excluding and salt-including varieties.

Recommendations

For grapegrowers: Chloride accumulation in leaves and berries is associated with damage in the grapevine and subsequent yield reduction. At levels of soil salinity where own-rooted vines are impacted, damage can be reduced by implementing rootstocks like 140 Ruggeri, Ramsey, Dogridge, Paulsen 1103, Rupestris St. George and Richter 110, which possess higher chloride exclusion capacity (140 Ruggeri being the strongest excluder).

While sodium accumulation is less associated with vine damage, high sodium in berries can result in soapy and salty taste in wine. Rootstocks like 140 Ruggeri and Ramsey are also good sodium excluders, however, some chloride-excluding rootstocks may not confer a similar improvement in sodium exclusion. For instance, Rupestris St. George offers good chloride exclusion but poor sodium exclusion, while K51-40 offers poor chloride exclusion but good sodium exclusion.

The suitability of currently available varieties to different soil and climates can be consulted at the Wine Australia Rootstock selector tool (www.grapevinerootstock.com), where new varieties will be incorporated as they are released in the market.

For breeders and researchers: Genome assisted breeding is becoming more affordable thanks to whole genome assemblies of rootstock genotypes becoming accessible in public repositories and sequencing technologies, and computing resources becoming cheaper and more efficient. The genomes of 140 Ruggeri, Ramsey and K51-40 obtained in this project and their genetic information, not limited to SNPs but also including sequence expansions and rearrangements, can be traced to any offspring produced after them.

What's next?

- **Establish markers for chloride exclusion through genome-wide association.**
- **Design breeding plans implementing genetic markers.**
- **Explore gene-editing options on rootstock genotypes, using their specific genomic sequences.**

Acknowledgments

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