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Longevity and sustained performance of rootstocks for Australian vineyards

SARDI has an extensive network of replicated rootstock comparison trials (24+ years in age) distributed across all of South Australia's principal wine growing regions. Many of these sites were assessed within their first ten years and now have historical data sets available for studies of longevity and stability of rootstock performance over time. This factsheet seeks to summarise the key findings from revisiting these trials now that vines are in their third and fourth decades of production.

Why investigate the performance of older rootstock trials?

More than a quarter of vineyards in SA's major wine regions are grafted to rootstocks. For regions such as the Riverland, grafted vines represent 50% of plantings (Vinehealth Australia, 2016). For new vineyards, the proportion of grafted vines is considerably higher. Decisions on which rootstock genotype to select for new plantings are currently guided by overseas research or by field trials that were evaluated when the vines were relatively young. Local information about the performance of rootstocks beyond their first 10 years is scarce.

Since 2010, SARDI has been revisiting some of its mature rootstock trials to:

- Investigate the aging effect on sustained rootstock performance
- Test drought tolerance and salt exclusion characteristics of mature grafted vines
- Evaluate vine health and whether longevity is dependent upon rootstock

Yield of grafted vines can change with age:

Rootstock comparison trials across multiple districts have seen changes in the yield rankings of mature vines as compared to those measured when the vines were young.

At a Shiraz rootstock trial at Coonawarra, yields were measured when the vines were between three and six years of age and then again at 24 and 25 years of age. When young, the yields of Shiraz on own roots and grafted to a range of rootstock genotypes were very similar, excepting those grafted to Petit Verdot which were lower.

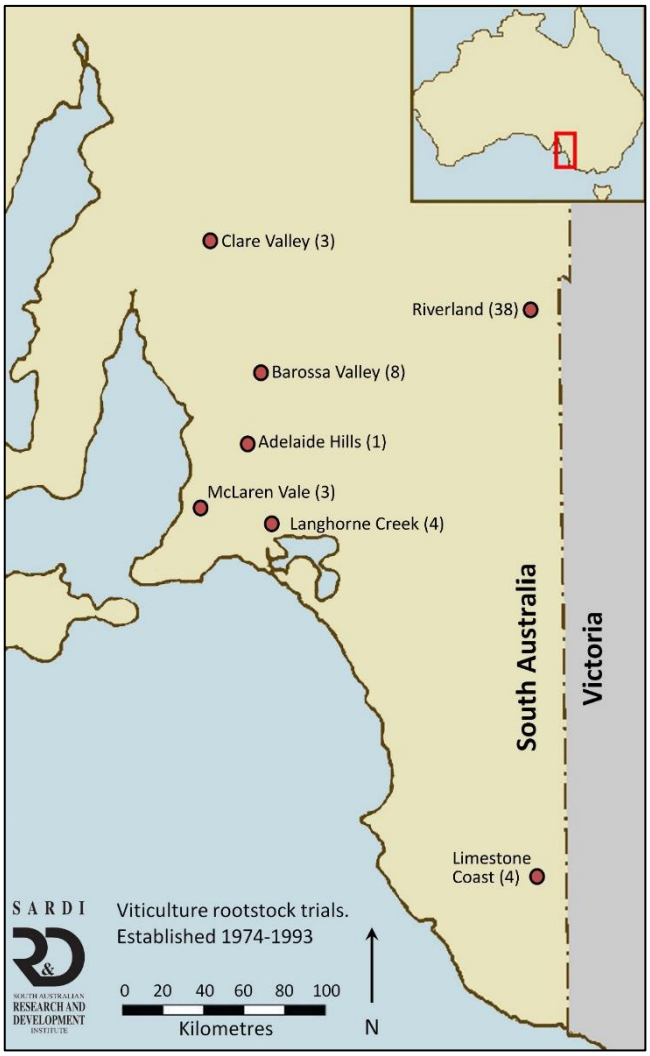

Figure 1. SARDI's rootstock comparison trials across SA's wine production regions. Established 1974-1993

Over time, the picture changed, Figure 2. At 24 and 25 years of age, the yields of vines on Teleki 5C (8344), 101-14, Teleki 5C (8343), 420A, 1616 and Petit Verdot were less than those on own roots and Teleki 5C (A6V18).

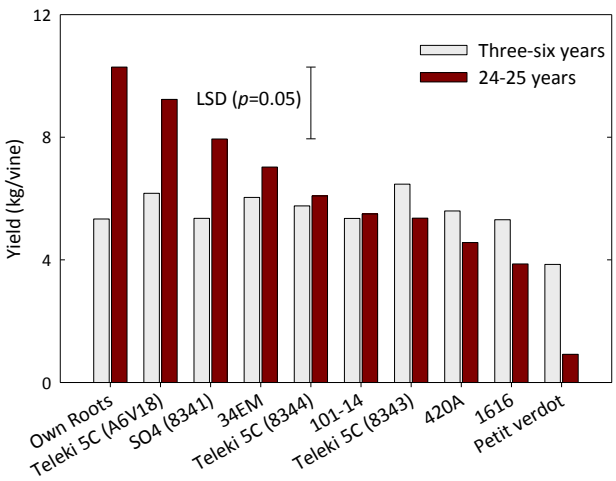

Figure 2. Rootstock effect on the yield of Coonawarra Shiraz vines aged 3-6 and 24-25 years.

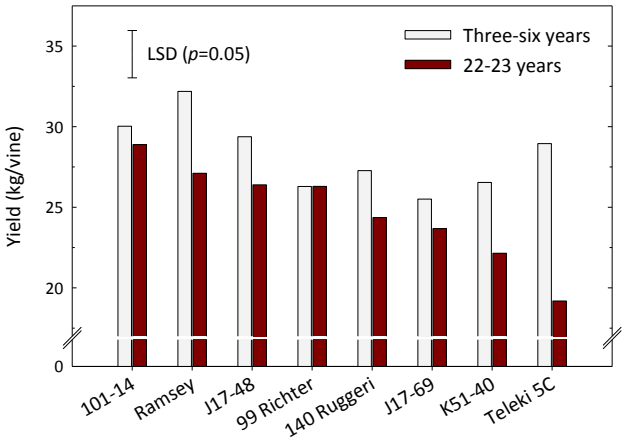

Figure 3. Rootstock effect on the yield of Riverland Cabernet Sauvignon vines aged 4-6 and 22-23 years.

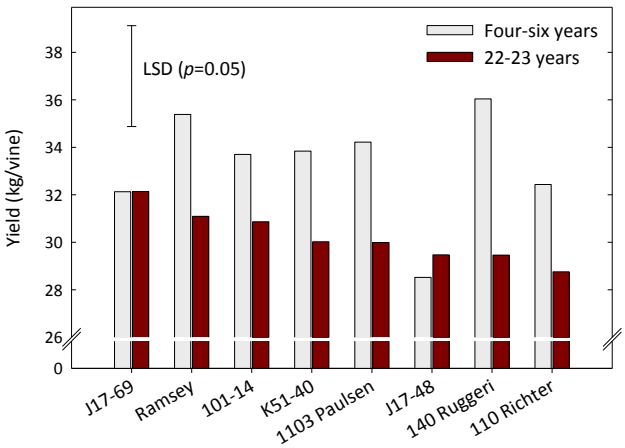

Figure 4. Rootstock effect on yield of Riverland Shiraz vines aged 3-6 and 22-23 years.

At a Riverland Cabernet Sauvignon rootstock trial, yields measured at three to six years of age were compared with those measured at 22 and 23 years of age, Figure 3. Whilst yields were stable for many rootstock genotypes, vines grafted to Ramsey and K51-40 reduced and yield from vines grafted to Teleki 5C almost halved.

At a Riverland Shiraz rootstock trial, yields measured at four to six years of age were compared with those measured at 22 and 23 years of age, Figure 4. Whilst average yields changed little over time, some grafted vines demonstrated a significant reduction in their yield potential, albeit at levels in excess of 28 kg/vine. Most notable yield reductions were Shiraz grafted to 140 Ruggeri and Ramsey, reducing by 18% and 12% respectively. Vines grafted to J17-69 and J17-48 displayed stable yields across the three decade assessment period, Figure 4.

Ramsey and 110 Richter show signs of drought tolerance:

At a Chardonnay rootstock trial in the Riverland, measurements of vegetative growth and inflorescence number were collected during a period of 100% irrigation allocation (2004 – age 11 years). These same measures were repeated towards the end of the Millennium Drought, following two years of near zero irrigation (2010 – age 17 years).

Rootstock genotypes that had high inflorescence counts under non-stressed conditions did not necessarily perform well under stressed conditions. For example, vines grafted to either Ramsey or 110 Richter retained fruitful healthy canopies that were more tolerant of the 98% reduction in irrigation than those on 1103 Paulsen and K51-40, many of which collapsed through water stress, Table 1. Vines grafted to 140 Ruggeri retained reasonable vigour but their inflorescence counts were low.

Rootstocks such as Ramsey and 110 Richter, that can tolerate high levels of water stress, may be relevant to irrigators considering a strategy of vineyard "mothballing" to sustain their operations through future droughts.

Table 1. Effect of two seasons of lethal water stress on canopy growth and mortality of Riverland Chardonnay grafted to eight rootstock genotypes. Grid cell size on photo backdrop = 0.5m x 0.35m

Rootstock	Canopy following two seasons of lethal water stress	Mortality (%)
Ramsey		**0 [a]**
140 Ruggeri		**0 [a]**
110 Richter		**10 [ab]**
1103 Paulsen		**20 [ab]**
K51-40		**30 [ab]**
101-14		**40 [ab]**
J17-69		**40 [ab]**
J17-48		**60 [b]**

Values followed by same letter are not significantly different (*P*=0.05)

Reduced incidence of bunch stem necrosis on vines grafted to Ramsey:

During the 2015 vintage, Cabernet Sauvignon vines in Langhorne Creek were subjected to elevated levels of bunch stem necrosis (BSN), Figure 5. Yield assessment protocols were modified to account for shrivelled bunches and investigate the influence of rootstock on the incidence and severity of BSN. BSN affected 38% of bunches on own rooted vines as compared to 12.5% of bunches on vines grafted to Ramsey, Table 2.

Whilst high vigour vines, such as those grown on Ramsey, are reported to be more susceptible to BSN than low vigour vines, this was not the case at this trial.

Figure 5. BSN at a Cabernet Sauvignon rootstock trial in Langhorne Creek, age 33 yrs. Ramsey rootstock (L) and own rooted vines (R)

Table 2. Rootstock effect on deliverable yields from a BSN affected Cabernet Sauvignon vineyard in Langhorne Creek (2015)

Rootstock	Total bunch count (n/vine)	BSN incidence (%)	Deliverable fruit (kg/vine)
Own roots	88.0 [a]	38.1 [a]	2.8 [a]
Schwarzmann	98.1 [ab]	37.4 [a]	3.8 [ab]
5C Teleki	107.4 [abc]	35.6 [a]	5.0 [b]
110 Richter	122.9 [c]	25.1 [ab]	7.3 [c]
Ramsey	109.4 [bc]	**12.5 [b]**	7.4 [c]
LSD (*P*=0.05)	20.2	17.6	1.9

Different superscript within columns indicates significant difference between means

Salt exclusion by mature grafted vines:

At a 38 year old Colombard trial in the Riverland, the salt excluding properties of some rootstocks persisted longer than others. Schwarzmann, 140 Ruggeri, 110 Richter and others had lower chloride concentrations at age 38 compared to their first assessment at four to six years. Through the same period, vines grafted to K51-40 and Teleki type rootstocks increased their chloride uptake. In their fourth decade they presented juice concentrations at two to five times those measured in other grafted vines, Figure 6. Sodium concentrations reduced significantly across the four decades with only those vines grafted to Harmony expressing high juice concentrations.

At other Riverland sites, Teleki 5C and K51-40 were consistently amongst the most susceptible to expressing higher concentrations of both sodium and chloride in plant tissue and juice sampled at harvest.

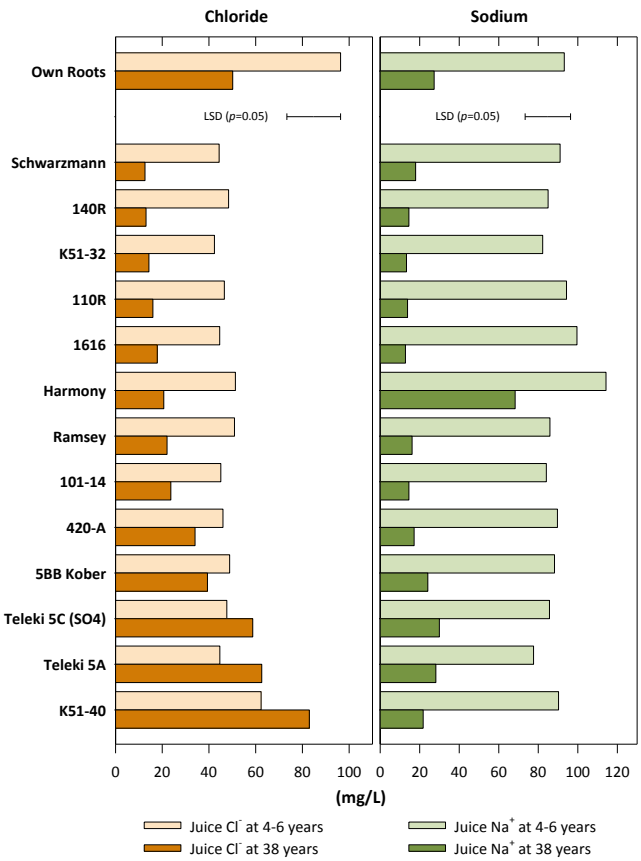

Figure 6. The effect of rootstock genotype and vine age on the juice concentrations of chloride (L) and sodium (R) Riverland Colombard aged 4-6 and 38 years. LSD bars represent difference between rootstocks across four decades (*P*=0.05).

Vine health and rootstock longevity:

In the spring of 2016, a survey of vine survival and cordon dieback was conducted across multiple rootstock trials within the Riverland and Langhorne Creek irrigation districts. Rootstock incompatibility was not an issue and most trial sites had zero or very few missing vines. Those sites that did present significant missing vines were comprised of rootstocks no longer used on a commercial scale (e.g. 3309 and R.St.George).

Riverland rootstock trials showed minor cordon dieback but with no notable trunk or foliar disease symptoms. Where present, dieback tended to be equivalent across rootstock genotype and was concentrated along the lower cordon, most likely due to shading. Rootstock trials located in Langhorne Creek presented a higher proportion of dead cordon, most likely associated with trunk diseases such as Eutypa dieback. An example of cordon dieback in relation to historic yields at a 24 year old Langhorne Creek Shiraz rootstock trial is presented in Figure 7. At this site, vines grafted to 140 Ruggeri and 99 Richter had significantly lower incidence of dieback relative to own rooted vines and those grafted to 110 Richter. As expected, the higher yielding rootstock combinations were those that presented with the lowest incidence of cordon dieback.

SARDI pathologists are currently integrating rootstock genotype as a variable of interest in their Eutypa dieback investigations.

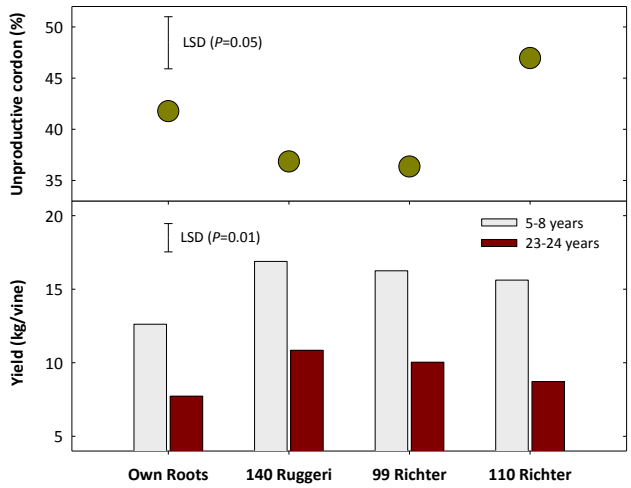

Figure 7. Effect of rootstock on incidence of cordon dieback (at age 24 years) and yield performance across three decades. Langhorne Creek Shiraz.

Summary of rootstock characteristics

There are numerous publications, including online rootstock selection tools that describe the benefits of rootstocks for viticulture. Some of these publications are listed under 'Further Reading' at the end of this document. Table 3 summarises current recommendations for the most commercially applicable rootstocks. It highlights new knowledge produced from SARDI's recent investigations at rootstock comparison trials in their third and fourth decades since planting. Some of the recent learnings agree (green coloured cells) and some conflict (orange coloured cells) with previous recommendations.

Table 3. Summary of published characteristics for phylloxera resistant rootstocks. Cell colour describes level of agreement between published rootstock characteristics and SARDI's observations at its mature rootstock trials (green cells = agree; orange cells = disagree*; clear cells = not assessed).
Final column reflects long-term yield trends in SARDI's mature rootstock trials (measured at 23-38 years)
Table adapted from Nicholas (1997 and 2006) and Dry (2007)

	Tolerance/Resistance					Long-term yield trends
	Drought	Salinity	Vigour	Nematodes	Waterlogging	
Ramsey	●●	●●	H	●●	○	↘
101-14	○	●●	L-M	●●	●	–
Schwarzmann	○	●	L-M	●●	●	↘
3309	○	○	L-M	○	○	↓
Teleki 5C	○	○	M	●	○	↘
110 Richter	●●	●	M	●	●	–
1103 Paulsen	●●	●●	M-H	●	●	–
99 Richter	●	●	M-H	●	○	–
140 Ruggeri	●●	●●	M-H	●●	○	↘
K51-40	○	○	M-H	●●	?	–

Key: ●● Good ● Moderate ○ Poor L=Low M=Medium H=High
– No change ↘ Moderate decline ↓ Severe decline

***Differences between published recommendations and findings from SARDI's mature rootstock trial sites:**

Ramsey
- Whilst salt uptake was not excessive, vines grafted to Ramsey often contained higher concentrations of Na^+ and Cl^- than vines grafted to other rootstocks
- Significant age related yield decline observed at a number of sites

Schwarzmann
- Yield decline is based on one site only. Rootstock not available at other sites

3309
- High mortality and constrained vigour at Langhorne Creek Cabernet Sauvignon

Teleki 5C
- Smaller canopies than vines grafted to other rootstocks
- Significant age related yield decline observed at a number of sites

110 Richter
- Smaller canopies than vines grafted to other rootstocks

1103 Paulsen
- Vegetative decline and yield collapse under severe drought stress

140 Ruggeri
- Retained good vigour under severe drought stress, but yield potential (inflorescence counts) collapsed
- Significant age related yield decline observed at a number of sites

Further reading

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Acknowledgements

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