Coonawarra Rootstock Trial Results

2015/16 Season

Suzanne McLoughlin, Technical Manager
Rootstocks – a background

- Rootstocks traditionally used to manipulate vine performance

- Common historic and now current drivers for rootstock adoption are wide ranging:
  - Phylloxera
  - Nematodes
  - Salt tolerance
  - Water-use efficiency and drought tolerance
  - Reduced vigour to counter the negative impacts of high vigour on berry composition
  - Reduced potassium uptake to counter the impact of high berry potassium on pH

- 3 rootstocks used in this trial were bred by CSIRO as low-med vigour rootstocks with reduced potassium uptake and released in 2009 – M5498, M6262 and M5512

- This trial and others are continuing to improve our understanding of the attributes rootstocks can convey to scions and the environments and purposes for which they are therefore best suited
### Background

**Objectives**
- Compare performance of low-mod vigour rootstocks on principle soil type, ‘Terra Rossa’ and scion variety for Coonawarra - Cabernet Sauvignon

**Outcomes**
- Provide grapegrowers and winemakers in LSC with detailed knowledge on the performance of different rootstocks grafted to Cabernet Sauvignon clone CW44
- Enhance awareness of ability of rootstocks to reflect desired quality and style of the region compared to own roots
- Assist growers in choosing rootstocks

### Planting material

**Planting**
- 110 Richter
- Ramsey
- 1103 Paulsen
- Börner*
- 140 Ruggeri
- Own Roots
- M6262
- M5489
- M5512

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*German-bred rootstock with low lime resistance, touted as immune to phylloxera but does support some root feeding in Australia

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Vinehealth Australia
Safeguarding our wine industry
Despite looking to compare the performance of low-mod vigour rootstocks in this trial, the rootstocks chosen are of wide-ranging vigours.

Site characteristics and the scion can play role in moderating these ratings.

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Börner</td>
<td></td>
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<tr>
<td>140 Ruggeri</td>
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<tr>
<td>1103 Paulson</td>
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<td></td>
<td></td>
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<tr>
<td>Ramsey</td>
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<tr>
<td>110 Richter</td>
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<tr>
<td>Merbein 5512</td>
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<td>Merbein 5489</td>
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<td>Merbein 6262</td>
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</table>

Source: Wine Australia Grapevine Rootstock Selector 2016
Phylloxera resistance ratings

- Research from Dr Kevin Powell showed resistance ratings of 7 rootstocks plus own roots to 6 endemic phylloxera strains
- Considerable variance
- *Schwarzmann not included in current trial

<table>
<thead>
<tr>
<th>Endemic phylloxera strains</th>
<th>G1</th>
<th>G4</th>
<th>G7</th>
<th>G19</th>
<th>G20</th>
<th>G30</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vitis vinifera (own roots)</strong></td>
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<tr>
<td>Ramsay</td>
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<tr>
<td>Schwarzmann*</td>
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<tr>
<td>5BB Kober</td>
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<td>110 Richter</td>
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<tr>
<td>1103 Paulsen</td>
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<tr>
<td>140 Ruggeri</td>
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<tr>
<td>Börner</td>
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</tr>
</tbody>
</table>

-susceptible  tolerant  resistant

Powell, K. (2009), Sustainable phylloxera management – Phase II. Final report to Grape and Wine Research and Development Corporation. Project number DPI 06/02.

Definitions – tolerance vs resistance

- Phylloxera tolerant rootstocks are those on which phylloxera can feed, reproduce and cause root galling (nodosities)
- Phylloxera resistant grapevines are those on which phylloxera cannot develop to the adult stage so there is no egg production and no gall production
### Trial location and layout
- Located on TWE Alexander vineyard
- Vine spacing 2m x row spacing 3.35m
- North-south row direction
- Randomised, replicated trial of 7 rows plus additional 27 rows, planted as whole rows per rootstock
- EM 38 (electromagnetic induction instrument) was used to identify soil management zones which could relate to yield. In Coonawarra, EM38 readings generally determine depth to limestone or the relative soil moisture holding capacity.
- To see whether this variability might affected rootstock performance, rootstocks were planted equally across these variable areas, categorised as L, M, H.

### Trial details
- 9 treatments (8 rootstocks + control)
- 3 vigour areas (L/M/H)
- 3 replicates of each vigour area
- 81 plots randomly located
- 6 vines (2 panels) per plot
- 486 trial vines over the 7 rows
- 9 sample vines per rootstock
- 81 sample vines across the trial area
### Measurements

**Maturity sampling**
- Weekly 12-bunch samples collected for each rootstock x vigour category
- Analysed for total soluble solids (Baume), pH, titratable acidity
- Rootstocks harvested when reached 13.8-14.3

**Harvest sampling**
- Once target Baume reached:
  - Duplicate 12 bunch samples collected for each rootstock x vigour category
    - 100 berries subsampled from each duplicate, combined and frozen for colour
    - Remainder of bunches processed for maturity analysis
  - 20 bunch samples collected for each rootstock including bunches across different vigour zones for salt testing
  - Yield collected for each sample vine
    - Bunch number counted and weight of all bunches recorded
Measurements

Pruning

• For each marked sample vine the following measurements were taken:
  • Trunk circumference
  • Bud number retained
  • Cane number
  • Total cane weight
  • Buds pruned back to target across all rootstocks
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Results

- No measurements differed in significance based on the EM38 vigour zones
- Rootstock played a significant role in affecting the vast majority of yield and vigour components in both years

<table>
<thead>
<tr>
<th>Measure</th>
<th>2016</th>
<th>2015</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rootstock</td>
<td>EM38</td>
<td>Interaction</td>
</tr>
<tr>
<td>Yield/vine</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Bunch number</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Buds/vine</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Cane weight</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Trunk circumference</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Yield/Bud</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Bunch number/Bud</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Bunch weight</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Yield/Cane</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Yield/Trunk circumference</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
</tbody>
</table>

Green squares = significance

- Indicator that rootstock likely impacted berry number per bunch and berry weight and therefore collection started for vintage 2017
Buds per vine

- Minimal effect of rootstock on bud number retained at pruning
- Bud numbers brought back to consistent level across rootstock treatments each season so bud number cannot be implicated in yield differences between rootstocks
- Bud numbers lower in 2016 than 2015

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>2016</th>
<th>2015</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merbein 5512</td>
<td>45 a</td>
<td>68.2 a</td>
<td>56.6 a</td>
</tr>
<tr>
<td>Merbein 5489</td>
<td>45.1 a</td>
<td>68.0 a</td>
<td>56.6 a</td>
</tr>
<tr>
<td>1103 Paulsen</td>
<td>44.2 ab</td>
<td>63.6 b</td>
<td>53.9 b</td>
</tr>
<tr>
<td>Börner</td>
<td>44.1 ab</td>
<td>63.1 b</td>
<td>53.6 bc</td>
</tr>
<tr>
<td>Ramsey</td>
<td>43.4 b</td>
<td>61.1 bc</td>
<td>52.3 bc</td>
</tr>
<tr>
<td>110 Richter</td>
<td>43.8 ab</td>
<td>60.7 bc</td>
<td>52.2 bc</td>
</tr>
<tr>
<td>Own Roots</td>
<td>43 b</td>
<td>60.4 bc</td>
<td>51.7 bc</td>
</tr>
<tr>
<td>140 Ruggeri</td>
<td>42.9 b</td>
<td>59.7 bc</td>
<td>51.3 c</td>
</tr>
<tr>
<td>Merbein 6262</td>
<td>43.8 b</td>
<td>58.7 c</td>
<td>51.2 c</td>
</tr>
<tr>
<td><strong>Standard error</strong></td>
<td><strong>1.5</strong></td>
<td><strong>4.1</strong></td>
<td><strong>2.4</strong></td>
</tr>
</tbody>
</table>

Different letters in each column indicate significance at 95% level

Bunches per vine

- Little consistency in relative order of rootstocks with highest or lowest bunch number across seasons
  - Own roots consistently lower bunches
- Generally higher bunches per vine in 2016 than 2015 despite lower bud numbers -> reflection of seasonal fruitfulness

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>2016</th>
<th>2015</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramsey</td>
<td>125 d</td>
<td>149 a</td>
<td>137 a</td>
</tr>
<tr>
<td>Merbein 5512</td>
<td>138 bc</td>
<td>129 b</td>
<td>134 a</td>
</tr>
<tr>
<td>110 Richter</td>
<td>154 a</td>
<td>109 cd</td>
<td>131 ab</td>
</tr>
<tr>
<td>1103 Paulsen</td>
<td>148 ab</td>
<td>113 cd</td>
<td>130 ab</td>
</tr>
<tr>
<td>140 Ruggeri</td>
<td>136 c</td>
<td>120 bc</td>
<td>128 ab</td>
</tr>
<tr>
<td>Merbein 5489</td>
<td>125 d</td>
<td>118 bcd</td>
<td>122 b</td>
</tr>
<tr>
<td>Börner</td>
<td>113 e</td>
<td>112 cd</td>
<td>113 bc</td>
</tr>
<tr>
<td>Merbein 6262</td>
<td>107 e</td>
<td>118 bcd</td>
<td>113 bc</td>
</tr>
<tr>
<td>Own Roots</td>
<td>113 e</td>
<td>106 d</td>
<td>109 c</td>
</tr>
<tr>
<td><strong>Standard error</strong></td>
<td><strong>10</strong></td>
<td><strong>13</strong></td>
<td><strong>9</strong></td>
</tr>
</tbody>
</table>

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**Bunches per bud**
- Marginally significant effect of rootstock on number of bunches per bud
- With more maturity may see this increase?
- 110 Richter, 1103 Paulson and 140 Ruggeri showed highest fruitfulness

**Weight per bunch**
- Large and statistically significant differences in bunch weight between rootstocks in both seasons
- 140 Ruggeri and 1103 Paulsen consistently large bunches; own roots and M6262 consistently small bunches; Börner not following trend

Different letters in each column indicate significance at 95% level
Yield per vine

- Significantly different between rootstocks in each season
- More strongly driven by bunch weight than by bunch number
- 140 Ruggeri and 1103 Paulson consistently highest yielding; own roots and M6262 consistently lowest yielding

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>2016</th>
<th>2015</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>140 Ruggeri</td>
<td>14.68</td>
<td>9.74</td>
<td>12.21</td>
</tr>
<tr>
<td>1103 Paulsen</td>
<td>15.16</td>
<td>8.93</td>
<td>12.04</td>
</tr>
<tr>
<td>Ramsey</td>
<td>12.03</td>
<td>9.90</td>
<td>10.96</td>
</tr>
<tr>
<td>110 Richter</td>
<td>13.57</td>
<td>7.22</td>
<td>10.40</td>
</tr>
<tr>
<td>Merbein 5512</td>
<td>11.73</td>
<td>7.88</td>
<td>9.81</td>
</tr>
<tr>
<td>Merbein 5489</td>
<td>9.98</td>
<td>7.26</td>
<td>8.62</td>
</tr>
<tr>
<td>Börner</td>
<td>7.56</td>
<td>7.84</td>
<td>7.70</td>
</tr>
<tr>
<td>Merbein 6262</td>
<td>6.44</td>
<td>6.51</td>
<td>6.47</td>
</tr>
<tr>
<td>Own Roots</td>
<td>7.07</td>
<td>5.81</td>
<td>6.44</td>
</tr>
<tr>
<td>Standard error</td>
<td>1.06</td>
<td>0.77</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Different letters in each column indicate significance at 95% level

Yield per bud

- Very significant difference across all rootstocks in 2016 yield per bud retained during 2015 pruning
- Efficiency of yield produced highest for 1103 Paulsen and 140 Ruggeri; lowest for Börner, own roots and M6262
- Again driven largely by bunch weight

Different letters in each column indicate significance at 95% level
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**Maturity - Baume**
- No EM38 effects so means presented
- Trend as expected over time
- Despite large and significant yield differences in v16, sugar accumulation curves were relatively similar for all rootstocks
- M5489 showed a faster ripening curve

**Maturity – Titratable Acidity**
- No EM38 effects so means presented
- Trend as expected over time
- Own roots and M6262 showing lowest acids – possibly due to lowest vigour (higher stress?)
Maturity - pH

- No EM38 effects so means presented
- Trend as expected over time
- M5489 showed comparatively low pH at harvest compared to other rootstocks, reflective of its breeding
- Own roots had highest pH compared to other rootstocks
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**Pruning weight**

- Large and statistically significant differences in pruning weight between rootstocks in both seasons
- 140 Ruggeri and 1103 Paulsen consistently large pruning weight; Börner and M6262 consistently small pruning weight

![Pruning weight graph]

- Could these differences be due to trunk circumference?
  - Strong positive relationships between trunk circumference and pruning weight but also seasonal differences
Fruit weight to Pruning weight ratio

- Fruit weight : pruning weight ranged from 3.5 – 6.7 in 2015 and from 7.8-11.2 in 2016 – largely driven by relative yield differences between seasons, but all within ideal range of 5-12.

- Statistically significant differences in the ratio between rootstocks over both seasons

- Relatively high consistency in order of ratios by rootstock across both seasons, except for 110 Richter and own roots

- These results lead to question of how root architecture affects performance – relatively poorly understood

- Low root to shoot ratio rootstocks - more efficient in supplying water and nutrients to scion for drought tolerance
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- A way of looking at relative vigour of a rootstock
- Definite vigour differences between rootstocks

Interestingly even though the trunks of the Merbein rootstocks still relatively small compared to some other rootstocks, they are actively growing – might impact results over time and therefore important to extend the trial

- Own roots noticeably slow growing compared to rootstocks

Trunk architecture of these vines very related to yield capacity

% increase in trunk circumference 2015 to 2016

Merbein 5489 Merbein 5512 140 Ruggeri 1103 Paulson 110 Richter Merbein 6262 Ramsey Börner Own Roots
Yield per trunk circumference

- Statistically significant differences in yield per trunk circumference between the rootstocks in each season but same relative differences between the rootstocks were not apparent across the seasons

- Trunk circumference increase of ~1cm = ~1kg yield per vine

- Expect Own roots to yield poorly compared to rootstocks over time

Effect of yield on vine growth

- No apparent negative effect of yield on growth of the vine trunk
  - those rootstocks with higher yield did not seem to have a compromised trunk growth rate
  - Indicative of natural capacity differences between rootstocks, not a seasonal-seasonal yield effect

![](chart.png)
<table>
<thead>
<tr>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>•</strong> Trial used range rootstocks of known vigour rating conveyed to scion</td>
</tr>
<tr>
<td><strong>•</strong> Saw significant differences in rootstock responses to yield and growth habit</td>
</tr>
<tr>
<td><strong>•</strong> Börner rated as high vigour (overseas) appears in this trial to be moderated by the calcareous soil or other</td>
</tr>
<tr>
<td><strong>•</strong> Does its potentially lower vigour here perhaps make it a more desirable contender for future planting?</td>
</tr>
<tr>
<td><strong>•</strong> Börner is closest to a phylloxera resistant rootstock we have in Aus but even it has range of tolerance to phylloxera strains</td>
</tr>
<tr>
<td><strong>•</strong> Does confer resistance to G1 and G4 most widely distributed strains</td>
</tr>
<tr>
<td><strong>•</strong> All rootstocks being pruning back annually to similar bud number means differences in yield are rootstock driven</td>
</tr>
<tr>
<td><strong>•</strong> No difference in attributes based on EM 38 vigour areas</td>
</tr>
<tr>
<td><strong>•</strong> Apparent bunch weight differences likely driven by differences in berry number per bunch and berry weight.</td>
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<tr>
<td><strong>•</strong> Important to delve into these for V17 to improve our understanding for implication on wine quality and canopy management</td>
</tr>
</tbody>
</table>
Summary

- General consistency in results with Own roots, Börner and M6262 generally lowest for measured attributes and 110 Richter, 1103 Paulsen and 140 Ruggeri generally highest for measured attributes.

- As expected, rootstocks with high fruitfulness also had higher yield, larger bunches, higher pruning weight, larger trunk circumference.

- Some interesting maturity results with M5489 showing fastest rate of ripening and lowest pH at harvest; whereas Own roots and M6262 showed lowest titratable acidity and Own roots had highest pH at harvest.

- Quite large differences in vine balance between seasons and between rootstocks, led to questions about root architecture and carbohydrate storage.

- Own roots appears slower growing than all rootstocks.
Choosing varieties to make into wine

• Have funding for making 4 rootstocks plus control into wine for vintage 2017

• Rootstock choice based on various factors:
  • Desire to test wine quality for rootstocks we haven’t dealt with before (eg. Börner)
  • Desire to include rootstocks that range in vigour to determine effect on wine quality – are some too vigorous?
  • Desire to include rootstocks displaying positive attributes such as lower pH (eg. M5489)
  • Knowledge of other research results and applicability to the region
    • leading to decision to rootstocks with lower potential to be planted in future eg M6262 due to poor chloride exclusion, 1103 Paulsen due to declining chloride exclusion over time
  • **Own roots, Börner, 140 Ruggeri, 110 Richter, M5489**

• Wine quality reflective of a hands-off approach, not necessarily of managing each rootstock through manipulation, to be the best it can be
Next steps

Field walk
- Field walk and discussion of 2015/16 results
- Collection of 2016/17 data
- Winemaking for V17
- Repeat for 2017/18

Additions for 2016/17 onwards
- Winemaking
- Colour analysis 2015/16 plus 2016/17
- Berry sodium, chloride and potassium
- Berry number per bunch
- Berry weight
- Study into variability patterns in bunch weight, berry number per bunch and berry weight for winemaking treatments

Seeking funding for winemaking for vintage 2018