Management of Traditional and Alternative Rootstocks, and Use With Table Grapes in Chile

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History

± 1860s: Phylloxera→Europe→damage

1870s debates

Cause or result of damage

Control

• Insecticides
• Hybrid direct producers
• Rootstocks

Breeding and use of resistant rootstocks

Durability of strong resistance

Failure of American Vitis x V. vinifera hybrids

Christy Campbell
The botanist and the vintner: How wine was saved for the world; Phylloxera

George Ordish
The Great Wine Blight
Nodosities on primary roots

Leaf galls

1st instars (crawlers)

Adult & eggs
Traps

Emergence
• 1-2 quart plastic bowls coated with sticky tape nor sticky coatings
• Bands on trunk

Aerial
• Sticky panel
Introduction of Phylloxera into California

- 1873 - Phylloxera identified killing vines
- 1880s - Phylloxera Board initiated as part of California State Viticultural Board
- 1881 - First warnings of dangers associated with uncontrolled importations from Europe and Eastern USA
- 1900s - Rootstock experimentation begins with varieties brought from France
Harry Jacob

- UC Davis rootstock and propagation began in 1925
- Tested a broad set of rootstocks on 99 sites in 17 counties - many were sites from Hussmann and Bioletti
Lloyd Lider

- Lider replaced Jacob and wrote up these long-term rootstock trials; emphasis on phylloxera (1958) and nematodes (1960)
- Concluded AXR#1 was well-suited to many sites and provided a general solution with good yields and quality
- “It is understood that in very dry, shallow soils and in areas where phylloxera can be serious they (AXR#1) may do poorly or even fail.”
- And it did between 1985 and 1995
Nematodes

- Many types are adapted to grapevines:
- *Meloidogyne* spp. Root-knot nematodes
- *Xiphinema index* and other dagger nematode species
  - Virus vectors and produce severe damage
- *Mesocrictonema xenoplex* – Ring nematodes
- *Tylenchulus semipenetrans* – Citrus nematodes
- *Pratylenchus vulnus* – Lesion nematode
Nematodes

- They feed from within the root (endoparasitic) and from the outside of the roots (epiparasitic)
- Root tips are the primary feeding target
- Like phylloxera the damage is chronic and they enable soil borne fungi to get inside the roots resulting in decay
How Do Nematodes Damage Vines?

- Ectoparasitic (dagger, ring) feeding/galling causes less severe root loss than does endoparasitic (root-knot, citrus) feeding
- Symptoms are water stress, nutrient uptake problems, crop decline ... much like phylloxera.
Why Worry About Nematodes?

- Serious replant consideration
- Loss of nematicides and fumigants
- Evolution of aggressive nematode strains
- Specific resistance in current rootstocks
- Unable to rotate vineyards - although can and should rotate rootstock use
- Spread on root systems and equipment
- Often associated with sandy soils, but the connection is agricultural
Rootstock Use in 1990

- 3309C, 110R, 5C, and St. George in the Coastal Valleys
- Freedom in the Central Valley
- O39-16 for fanleaf degeneration sites
- Virus induced graft incompatibility recognized
Rootstock Use in 2017

- Primary rootstocks for Coastal Valleys - 101-14Mgt, 1103P, 3309C, 420A Mgt
- Central Valley - Freedom, 1103P, Ramsey (interest in less vigorous rootstocks)
- O39-16 for fanleaf degeneration
How to Choose a Rootstock

- Hard to make the perfect choice / Avoid making a bad choice
- Want an inverse relationship between soil (water holding capacity/depth/fertility) and rootstock vigor.
- Production factors include:
  - table grapes vs. wine grapes
  - climate and affect on fruit quality
  - marketing fruit or wine
  - tons per acre required
Other Rootstock Issues

• Replant vs. new site (grapes following grapes)
• Virus induced incompatibility
  – Important/critical to use certified stock and scion
  – Desired clones are may not be certified
• Vigor induction, drought tolerance, maturity acceleration
• Availability
**Vitis riparia**

- From Rocky Mtns to Atlantic Ocean, from Canada to Texas
- Riparian habitats — alluvial soil, climbs in trees and shrubs
- Shallow roots, low vigor, hastens maturity
- Resists phylloxera, susceptible to lime, easy to propagate
- Riparia Gloire used in French hybrids
**Vitis rupestris**

- Texas to Tennessee, relatively rare now
- Shrubby, rarely climbs, found in rocky creek beds
- Deep roots induce vigor, but not very drought tolerant on shallow soils
- Resists phylloxera, variable nematode resistance, variable lime tolerance, easy to propagate
- St. George – virus tolerant, nematode susceptible; used in French hybrids
**Vitis berlandieri**

- Texas on limestone soils, *V. cinerea* var. *helleri*
- Found on deeper soils between ridges, climbs on trees
- Deep rooted, some drought tolerance
- Variable phylloxera resistance, good lime tolerance, hard to propagate
- *V. cinerea* used in French hybrids (excellent cluster architecture)
V. riparia

V. rupestris

V. berlandieri
Rootstocks have a very narrow genetic base. Numbers to the right of the dashed lines represent the number of rootstocks in this study derived from the respective accession. The pie chart presents estimated species representation in the hybrid rootstocks.
Vitis candicans / mustangensis

- Texas, Louisiana, NE Mexico
- Very common and very large species
- Major part of landscape from Dallas to Houston
- Resists nematodes and phylloxera, difficult to propagate
- Lots of pollen but limited seed spread (large berries and calcium oxalate)
**Vitis champinii**

- Texas, Edwards Plateau, limestone soils
- Natural hybrid of *V. candicans* x *V. rupestris* (*V. monticola, V. berlandieri*)
- Very limited ... *rupestris* almost extinct, so no chance to remake this natural hybrid
- Deep roots, induces high vigor
- Resists nematodes, moderate resistance to phylloxera, relatively difficult to propagate
Vitis acerifolia

- North Texas to Oklahoma and New Mexico, a southern riparia, a.k.a. solonis and acerifolia
- Sandy to gravelly gullies and ravines
- Deep roots, some drought tolerance
- Variable nematode resistance, resists phylloxera, easy to propagate
Current Table Grape Rootstocks in Chile

- 1103P (Paulsen), Freedom, Harmony and Ramsey
- Deep root systems, larger structural roots, variable nematode and phylloxera resistance, generally high to very high vigor
**V. riparia x V. rupestris**

- Useful on fertile, non-calcareous soils
- Root system spaced evenly in the soil profile
- Nematode resistance varies
- Easy to root and graft, mothervines vary – some with short canes and abundant laterals, others with long canes and few laterals
- But not able to take up enough Fe on calcareous soils
V. berlandieri x V. riparia

- Selected for phylloxera resistance, lime tolerance and moderate vigor
- Generally shallow to moderate rooting depth
- Most derived from the Teleki hybrids - a Hungarian banker / breeder (1880s)
- Many have moderate to good nematode resistance
- Excellent mothervines with long canes, few internodes
- Graft and root moderately well - 420A Mgt difficult
V. berlandieri x V. rupestris

- This group was developed for drought and lime tolerance in warmer, drier parts of Europe
- Have deeper root systems to avoid drought
- Limited nematode resistance, good phylloxera resistance
- Most are shrubby mothervines and produce short canes and many laterals
- Some are more difficult to root and graft
1103P

- Relatively high vigor; >110R and <140Ru
- Moderate to poor nematode resistance, and moderate to poor salt tolerance
- Widely used in California because it roots and grafts well, and produces more graftable canes
- Adaptable, but better on low vigor sites or large canopy trellis and spacing systems
**V. champinii - Based Rootstocks**

- A natural hybrid of *V. candicans* x *V. rupestris*
- “champinioid”
- Very vigorous
- Drought tolerant due to deep root system
- Broad nematode resistance; does not tolerate fanleaf degeneration
- Often more difficult to propagate
Freedom & Harmony

- Freedom has greater vigor and easily propagated, high K uptake
- Not phylloxera resistant - have *vinifera* in their parentage; damaging aggressive root-knot nematode strains have been selected
- Good for sandy low vigor soils; rotate to other nematode resistant rootstocks
- Freedom is very intolerant of viruses that induce graft failure
Ramsey (Salt Creek)

- Selected by T.V. Munson. Salt Creek is *V. doaniana*.
- Very good nematode, moderate phylloxera resistance, induces very high vigor in scions
- Good for sandy low vigor soils; rotate to other nematode resistant rootstocks
- Moderate salt tolerance, widely used in droughty, saline, shallow soils in Australia
- Dog Ridge is more vigorous (*V. candicans* x *V. berlandieri*)
**V. rupestris**
‘St. George’ / du Lot

- Good phylloxera resistance, susceptible to nematodes, good salt tolerance
- Deep root system, lime sensitive, drought adapted, but grows in creeks
- Tolerant of grape viruses
- High vigor on deep fertile sites can result in problems with flower set
- Roots and grafts well, shrubby with short canes and many laterals
Schwarzmann

- Good phylloxera and nematode resistance
- Moderate vigor, roots and grafts well, mothervine has long canes and few laterals
- Not widely used in California and much like 101-14Mgt in appearance - with a more puckered leaf surface
- Might have better nodosity resistance than 101-14
1616C

• *V. solonis* x *V. riparia*
• Moderate nematode resistance
• Low vigor – looking worse over time
• Good phylloxera resistance
• Easy to root and propagate and good mothervine growth - long canes and few laterals
• Judged too weak in the past; recent experience - lower pruning weights, but relatively high fruitfulness
Kober 5BB

- Relatively high vigor and deepest roots within this group
- Good nematode resistance - root-knot and dagger
- No fanleaf degeneration tolerance
- Graft over growth may be as pronounced as 5C
- Very intolerant of viruses that cause graft failure
- Very similar in appearance to 5C, but female, leaf edges turn up and red “T”
Börner

- *V. cinerea x V. riparia* produced by Börner and Becker – proprietary
- Very good nematode and phylloxera resistance; fanleaf testing underway
- Relatively hard to root and graft
- Field performance has been inconsistent - on some sites growth is very weak and on others very strong
140Ru

• Highest vigor of group
• Nematode susceptible
• Infrequently used in California, good for shallow, droughty, limestone soils where high vigor is needed.
• Excellent salt tolerance
• Brushy growth with short canes and abundant laterals; roots and grafts like 110R
VR O39-16 & O43-43

• *V. vinifera* x *M. rotundifolia* siblings
• Only sources of tolerance to fanleaf degeneration
• O43-43 susceptible to phylloxera, O39-16 susceptible to root-knot nematodes
• May act as natural nematicides
• High vigor, respond well to deficit irrigation and cover crops; poor growth on limestone soils
• Hard to propagate
Ability to Induce Vigor in Scions

Dog Ridge, Ramsey* (Salt Creek)
Freedom, Harmony
140Ru, O39-16*, 1103P, 110R, St. George
5BB, Börner(?), 101-14Mgt
Schwarzmann, 5C*, SO4, 3309C
44-53Malegue, 1616C, 420AMgt*, 161-49C, Riparia Gloire
Nematode Resistant Rootstocks

Dog Ridge, Ramsey (Salt Creek)
Freedom, Harmony
O39-16*, 1103P
5BBB, 101-14Mgt, Börner?
Schwarzmann, 5C, SO4
1616C

* = not root-knot resistant

italic = moderate resistance
8909-05 UCD GRN-1

- *rupestris x rotundifolia* ‘Cowart’
- Excellent combined resistance, resists ring nematode; phylloxera nodosity rating = 0.59
- Sterile vine, moderately vigorous mothervine, brushy but less so than St. George, deep rooting angles (3.5 mean, 0.83 sd)
- 70% dormant bench graft success, fanleaf tolerance studies underway.
9363-16  UCD GRN-2

- (rufo x (DR x rip)) x rip
- No galls in combined testing; resists lesion nematode; moderate resistance to citrus, but not ring nematodes; phylloxera nodosity rating = 0.89
- Male vine, good cane production, long straight canes, shallow rooting angles (1.65 mean, 0.59 sd)
- Field trials
9365-43 UCD GRN-3

- (rufo x (DR x rip)) x champ c9038
- Excellent in combined testing; resists lesion and citrus nematode; susceptible to ring nematode; phylloxera nodosity rating = 1.86
- Female vine, moderately vigorous mothervine, long straight canes with good internode length, moderately deep rooting angles (2.35 mean, 0.81 sd)
- Field trials
RS-3 & RS-9 (Ramsey x Schwarzmann)

- Bred by David Ramming, selected by Mike McKenry; released in 2003 limited trial data
- RS-3 (1103P+) is more vigorous than RS-9 (101-14Mgt)
- Good nematode resistance RKN and X. index
- Designed to have better nematode and phylloxera resistance than Freedom/Harmony, but less vigor than Ramsey/Dog Ridge
## GRN Rootstock Summary

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<tr>
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<th>Citrus Nematode</th>
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<th>Phylloxera Nodosities</th>
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<td>MR(R)</td>
<td>MR(R)</td>
<td>MS</td>
<td>MR/MR</td>
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They all resist all 3 strains of root-knot, *X. index*, these combined, and at high temperatures.
USDA Rootstock Selections

- 10-17A = Edna (America (sdlg Jaeger 70 (lincecumii × rupestris) × Malaga) × male simpsonii

- 10-23B = V. doaniana

- 6-19B = 10-6B × 9-22C

  10-6B and 9-22C = GA 3-4-5 × Dog Ridge 5
Peter Cousins USDA Rootstocks

- Released in 2010 as alternatives to Freedom
- **Matador** and **Minotaur** – siblings from a cross of 101-14 Mgt x 3-1A (*candicans* x *rupestris*)
- **Kingfisher** – 4-12A (Dog Ridge x *rufotomentosa*) x *V. riparia*
- Resistant to Harmony and Freedom strains of root-knot nematode
- Field testing at UC Kearney Station
More Walker rootstocks to come!