How to Select Rootstocks

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California Grape Rootstock Improvement Commission /
California Grape Rootstock Research Foundation
CDFA NT, FT, GV Improvement Advisory Board
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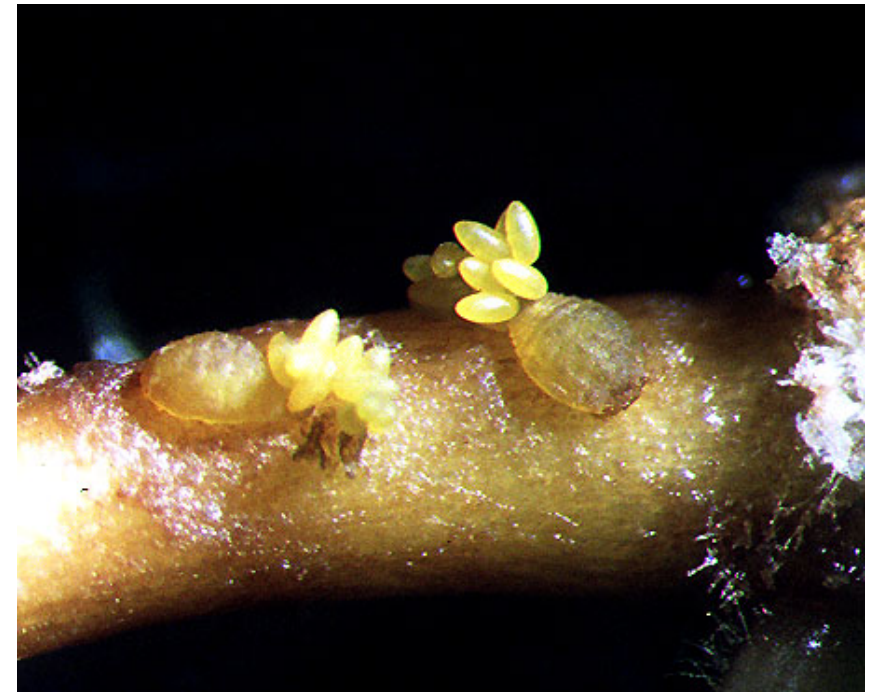
Phylloxera



- North American insect
- Imported to France in 1850s
- Initiated rootstock breeding - most rootstocks are >100yrs old
- Phylloxera spread most readily on plant materials, and blown as crawlers and winged forms
- Feed on leaves of rootstocks and roots of vinifera

Phylloxera

- Feed on root tips and mature roots (nodosities vs. tuberosities). All (?) rootstocks support root tip feeding.
- Kill vines by creating wounds that are attacked by opportunistic saprophytes.

Rootstock Origin

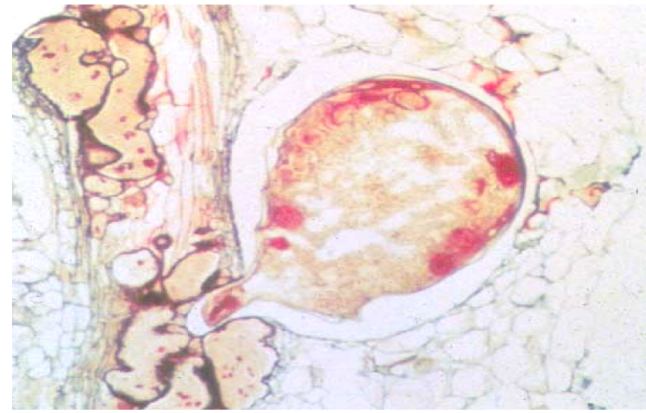
- First developed to address grape phylloxera, most in the 1880s and 1890s
- French scientists came to the US to collect *Vitis* species resistant to phylloxera – T.V. Munson helped
- Took back cuttings of many, but only *V. riparia* and *V. rupestris* rooted well from dormant cuttings
- Later added *V. berlandieri* for lime tolerance

Why worry about phylloxera? —

Is resistance durable? How does it function?

Meloidogyne spp. - Root-knot Nematodes

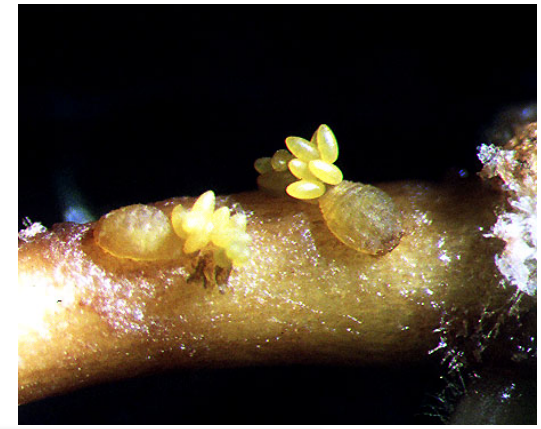
- Endoparasitic - attack at root tip and feeds from within the root
- Galls crack with age, allow entry of fungi and bacteria
- Galls form sequentially, when upper galls decay large portions of the root system are lost
- Vines decline due to lack of water and nutrients.



Xiphinema index - Dagger Nematode

- Nematode vector of grapevine fanleaf virus (GFLV) - widespread and introduced
- Ectoparasitic - probes and feeds behind the root tip inducing galls
- Root tips die from repeated feeding and damage, and new roots form above the feeding point
- Rarely seen without fanleaf degeneration - causes severe crop loss

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

George Hussmann

- USDA rootstock trials.
- Tested 102 rootstocks in plots located across Calif.
- First report in 1915
- 1930 focused on: AXR#1, AXR#2, 1202C, Lenoir, St. George, Riparia Gloire, 420A Mgt, 161-49C, 3306C, 3309C, 1616C, 1613C, Dog Ridge and Salt Creek (Ramsey)

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
- Focused on Riparia Gloire, St. George, 3306C, 3309C, 44R, 99R, 110R, 420A Mgt, 5A, 8B, AXR#1, 1202C, 93-5C, Ponzo XX, 41B, Lenoir, 1616C, 1613C, Dog Ridge and Salt Creek (Ramsey)

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.”

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:

  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 may not be certified
- Availability

Six years in old rocky terraces without top-growth and 60 days in the bag

Vitis riparia

- US 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

Vitis rupestris

- Texas to Tennessee, relatively rare now
- Shrubby, rarely climbs found in rocky creeks
- 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

Vitis berlandieri

- Texas on limestone soils
  V. cinerea var. *helleri*
- Found on deeper soils
  between ridges, climbs
  fences, shrubs and trees
- Deep rooted, some drought tolerance
- Variable phylloxera resistance, good lime tolerance, hard to propagate

Vitis champinii

- Texas, eastern Edwards Plateau, limestone soils
- Natural hybrid of *V. candicans* x *V. rupestris* (*V. monticola, V. berlandieri*)
- Deep roots, induces high vigor, resists nematodes, moderate phylloxera resistance, relatively difficult to propagate
- Ramsey and Dog Ridge

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

Muscadinia rotundifolia

- Southern United States, sub-tropical to tropical, genetically distinct from *Vitis*
- Sandy, acidic soils, high rainfall, short to tall vine
- Very resistant to nematodes, phylloxera, fungi, bacteria
- Will not root from dormant cuttings, long cycle of growth

V. riparia x *V. rupestris*

- 101-14 Mgt, Schwarzmann, 3309C
- Both relatively shallow roots, induce low to moderate vigor
- 101-14 Mgt poorly adapted to cracking clay soils
- 3309C relatively low vigor
- Neither would be classified as drought or salt adapted

1616C

- *V. solonis* x *V. riparia*
- Good phylloxera resistance, good nematode resistance
- Relatively shallow rooted, induces low to moderate vigor in scions
- Tolerant of wet, water-logged soils

V. berlandieri x *V. riparia*

- Relatively shallow root systems, induce a range of vigor levels
- 5BB, 5C = SO4, 420A Mgt, 161-49C
- 5C poorly adapted to drought, deficit irrigation, and cracking clay soils
- 420A very *V. berlandieri*-like – late season growth, hard to graft/propagate

V. berlandieri x *V. rupestris*

- 1103P and 110R
- Relatively deep root systems avoid drought
- Can induce excess vigor with high spring rainfall and deep soils
- 140Ru is higher vigor, excellent salt tolerance
- 1103P is reported to be moderately tolerant of saline soil, 110R less so

V. champinii rootstocks

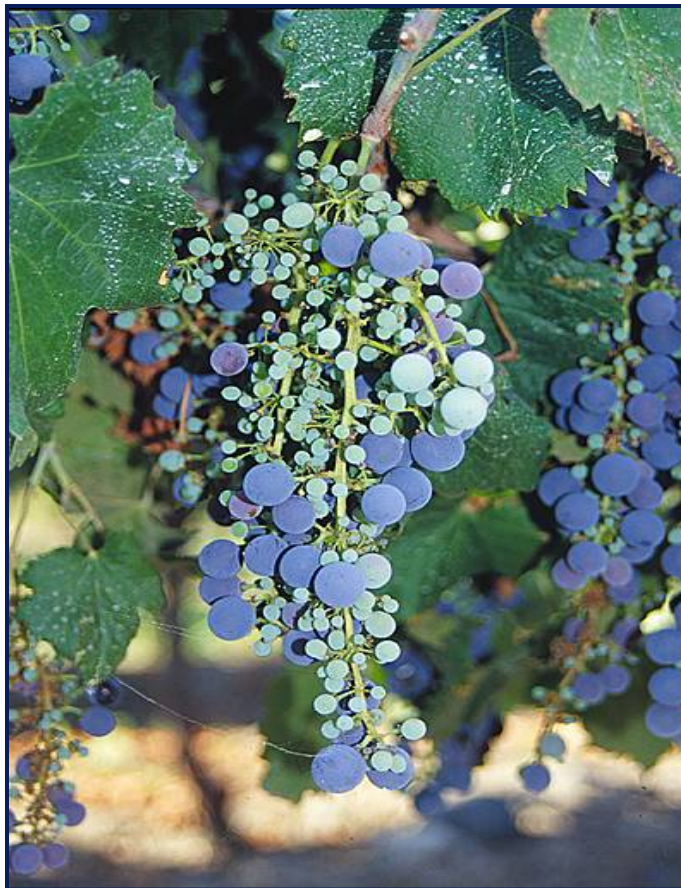
- Ramsey and Dog Ridge – Munson selections for fruiting varieties
- Deep roots, very high vigor —sandy, infertile soils
- Moderately difficult to propagate
- Moderate phylloxera resistance, strong nematode resistance
- Can delay maturity, reduce color, increase K in juice
- Harmony and Freedom for nematodes

VR O39-16

- *V. vinifera* x *M. rotundifolia*, bred by Olmo, and selected for fanleaf resistance by Lider and Goheen
- Good resistance to *Xiphinema index*, induces tolerance to fanleaf, poor resistance to root-knot nematodes
- Half *V. vinifera*, but phylloxera resistant for 30 yrs
- Very deep roots, induces high vigor in scions, not strong on sandy soils… drought / root-knot?

Fanleaf Degeneration

- Disease complex caused by GFLV and vectored by the dagger nematode, *Xiphinema index*
- One rootstock alternative exists - O39-16 - *vinifera* x *rotundifolia* and *rotundifolia* is the key.
- But phylloxera, root-knot nematode and excessive vigor concerns.



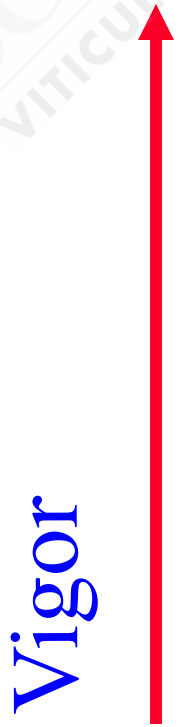
Which rootstock to choose?

- *riparia* based – shallow roots, water sensitive, low vigor, early maturity:
  - 5C, 101-14, 16161C (3309C)
- *rupestris* based – broadly distributed roots, relatively drought tolerant, moderate to high vigor, midseason maturity:
  - St. George, 1103P, AXR#1 (3309C)

Which rootstock to choose?

- *berlandieri* based – deeper roots, drought tolerant, higher vigor, delayed maturity:
  - 110R, 140Ru (420A, 5BB)
- *champinii* based – deeper roots, drought tolerant, salt tolerance, but variable in hybrids
  - Dog Ridge, Ramsey (Salt Creek)
  - Freedom, Harmony, GRNs
- Site trumps all… soil depth, rainfall, soil texture, water table

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

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 rotate rootstock use
- Spread on root systems and equipment
- Major portion of Walker breeding program

New Rootstock Releases

- Resist 3 strains of root-knot including two that feed on Harmony and Freedom, and *Xiphinema index*.
- Resist all the above in one inoculum
- Resist all the above at high soil temperatures
- And …

GRN Rootstock Summary

	Citrus Nematode	Ring Nematode	Phylloxera Nodosities	Lesion/Pin Nematode
GRN-1	R	R	HR	MR/MR
GRN-2	MS	MS	HR	MRMR
GRN-3	MR(R)	MR	R	R/MR
GRN-4	MR(R)	MR	R	MR/MS
GRN-5	MR(R)	MR(R)	MS	MR/MR

They all resist all 3 strains of root-knot, *X. index*, these combined, and at high temperatures

GRN Parentages

- GRN-1 = 8909-05 *rupestris* x *rotundifolia* 'Cowart'
- GRN-2 = 9363-16 (*rufotomentosa* x (Dog Ridge x Riparia Gloire)) x Riparia Gloire
- GRN-3 = 9365-43 (*rufotomentosa* x (Dog Ridge x Riparia Gloire)) x *champinii* c9038
- GRN-4 = 9365-85 (*rufotomentosa* x (Dog Ridge x Riparia Gloire)) x *champinii* c9038
- GRN-5 = 9407-14 (Ramsey x Riparia Gloire) x *champinii* c9021
- Released in 2009

Establishing Vineyards on Rootstocks

- Plant high quality plants properly
- Utilize certified / virus-free plant materials
- If not available, use rootstock/scion combinations that have performed well
- Establish the root system first - do not stress
- Avoid overcropping stress in the first fruiting year

Roots at base of rootstock are severely “J’ed”. Additional roots branching from above, but remaining horizontal.


Thanks!