Fundamentals of Rootstock Use for Table Grapes in Chile

Andrew Walker
awalker@ucdavis.edu
Nodosities on primary roots

Leaf galls

1st instars (crawlers)

Adult & eggs
Nematodes

- Many types are adapted to grapevines:
  - Meloidogyne spp. Root-knot nematodes
  - Xiphinema index and other dagger nematode species
    - Virus vectors
  - Mesocriciconema 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 target
• Like phylloxera the damage is chronic and they enable soil borne fungi to get inside the roots and rot them
• 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
Vitis candicans / mustangensis

- Texas, Louisiana, NE Mexico
- Very common and huge 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
- 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
- Excellent salt tolerance
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
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. 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
- Reported to have moderate nematode resistance, and good salt tolerance, but it survives by producing lots of new roots
1103P

- 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.
- Not doing well in several California trials with nematode complexes and not salt tolerant in greenhouse studies.
**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
- Good salt tolerance, widely used in droughty, saline, shallow soils in Australia
- Dog Ridge is more vigorous (*V. candidans* x *V. berlandieri*)
Alternative Table Grape Rootstocks

• Needs:
  – better, broader nematode resistance
  – drought and salinity tolerance
• Control of vigor and ripening
• Increase fruitfulness, berry size, cluster compactness and size
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
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
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

italics = moderate resistance
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
Replanting Issues

• Status of the site
  – Non-agricultural ("virgin") soil
  – Agricultural uses --- annuals vs perennials
  – Vineyard
Vineyard Site Evaluation

• Reliance on specific sites and their unique attributes
• If the vineyard is in place, evaluate vineyard health
  – Arm and spur caliper, cane and internode length
  – Trunk and cordon development
Vineyard Site Evaluation

• Sampling for soil-borne pests
• Most are in the drip zone or upper soil profile
• Random sampling won’t help – no roots, no pests
• Nematodes rarely problematic in first generation vineyards, but …
Vineyard Site Evaluation

- Soil pits to evaluate soil depth and structure
- Compaction and the degree to which ripping is needed
- Root penetration and root architecture
Replant Disease

- Combined impact of:
  - Adapted nematodes
  - Limited or disrupted mychorrhizal and soil-borne fungi
  - Soil compaction and impact on roots and fungi
    - Anaerobic conditions
  - Depleted soil nutrients and organic matter
Fallow and Crop Rotation

- Key components of agriculture
- Fallow will reduce nematode numbers
- Need to switch hosts or better yet use non-hosts
- Remove roots – kill roots with herbicides?
- Dry down soil – grains work well
- Also increase organic matter and helping with soil structure
Fallow and Crop Rotation

• Given the loss of nematicides and fumigants, fallow and rotation are becoming more important

• Work beginning on host trap plants and systemic pesticides like Movento…
  – Downwardly systemic and can leak into the soil

• But … grape roots live a long time
60 days in the bag
• Vineyards have been removed because of Petri disease and vine decline caused by *Phaeoacremonium spp.* and *Pm. chlamydospora*

• **BLACK GOO … YOUNG VINE DECLINE … PETRI DISEASE**
Fungi Commonly Associated with Vine Decline and Esca in California Grapevines

- **Pc** – *Phaeomoniella chlamydospora* (formerly *Phaeoacremonium chlamydosporum*)
- **Pa** – *Phaeoacremonium aleophilum*
- **Pi** – *Phaeoacremonium inflatipes*
- *Cylindrocarpon destructans* and *C. obtusisporum*
Rootstock Breeding Objectives

- Develop better forms of drought and salinity tolerance
- Combine these tolerances with broad nematode resistance and high levels of phylloxera resistance
- Develop better fanleaf degeneration tolerant rootstocks
- Develop rootstocks with “Red Leaf” virus tolerance
They all resist all 3 strains of root-knot, *X. index*, these combined, and at high temperatures.
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
2014/16 UCD Rootstock Evaluation Trials

- Salt resistant and resistant to HarmA&C – 8
- Improved GRN HarmA&C, Xi, reduced vigor – 5
- PD resistant and resistant to HarmA&C, Xi – 11
- *Rotundifolia* based resistance to ring, fanleaf – 7
- Salt resistant with 101-14 to improve rooting – 2
- Salt resistance from both parents and high vigor – 6
Cabernet Sauvignon grafted to rootstocks and species, 5 gal pots, 75 mM, 5 months