

# Rootstocks and Vine Performance

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## Topics

- Purpose and benefits of rootstocks
- Vitis species
- Primary Rootstocks
- Rootstocks and soil maladies
- Rootstock influence on fruit/wine cropping and quality
- Challenges ahead

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## History, purpose and benefits

- Described by Roman author Columela 70 AD →
- Phylloxera destroyed European vineyards second half of 19<sup>th</sup> century. By 1890, killed 70-90 % of vineyards on own rooted Vinifera varieties.
- T.V.Munson from North Texas, restored European vineyards by introducing rootstock plants, native to Texas and Missouri of *V. Rupestris*, *V. Riparia*, *V. Champini*, *V. Cinerea* and *V. Candicans*.
- The French government honored him with the Chevalier du Merite Agricole of the French Legion of Honor for his contributions.



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Cab Franc  
Union -----

SO-4

## Rootstocks

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## Purpose

Provide a better root system which enables

1. Superior root anchorage
  2. Efficient water uptake
  3. Efficient mineral nutrient uptake
  4. Synthesis of plant growth hormones
  5. Storage of carbohydrates and amino acids
- The above leads to increased cold tolerance!
  - The above are direct effects !!

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## Benefits of rootstocks

1. Rootstocks can also help scion varieties contend with soil stresses such as alkalinity, drought, chlorides, potassium, and nitrogen.
2. Rootstocks can be selected which aid vines in absorbing important ions and minerals.
3. Rootstocks can also have negative or positive influences on canopy vigor and yield.
4. In some cases rootstocks can over-invigorate a vine causing shading and fruit quality problems.
5. The viticulturist must select the right rootstock to match the soil conditions.
6. On some sites, increased vigor, influenced by rootstock choice maybe a positive.

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## Indirect effects !!

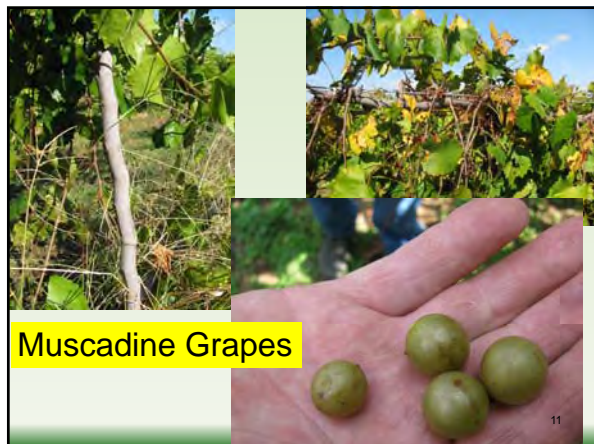
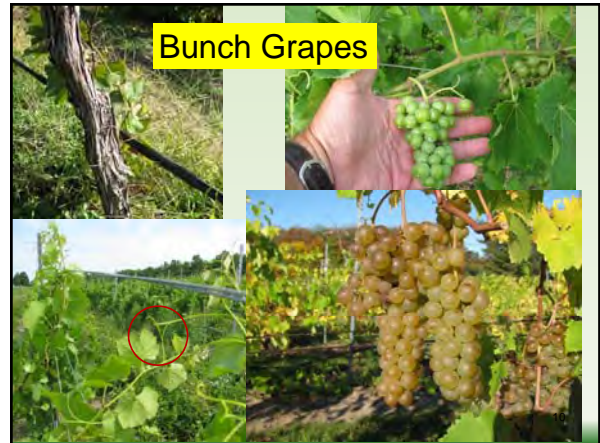
- Vine size modification:
- Small vine size
  - Reduced internal canopy shading
  - Optimal cane distribution
  - More canes with good cold hardiness
- Large vine size
  - More canopy shading and inhibit light penetration
  - Cane distribution altered
  - More canes with poor maturation/cold hardiness

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## General Botany

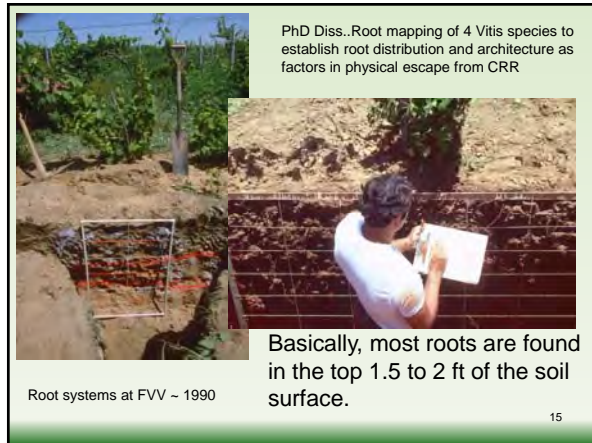
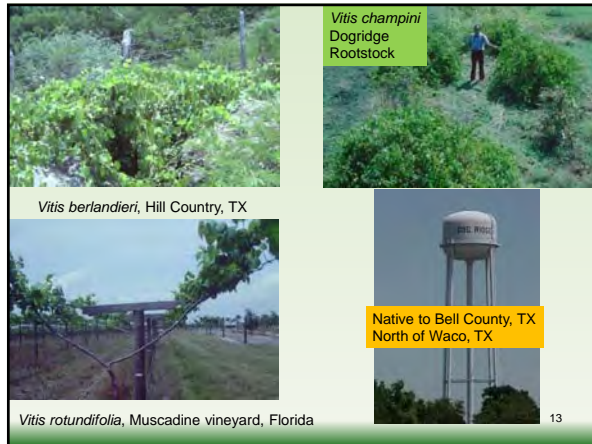
- Grapes belong to the Vitaceae family.
- Genus *Vitis*, with over 50 species is broadly distributed, largely between 25° and 50° N latitude in eastern Asia, Europe, the Middle East, and North America.
- The Euvitis is divided into two primary groups;
  1. Bunch Grapes and 2. Muscadines
    1. *Vitis vinifera*, the European grape, and *V. labrusca*, the Concord grape, Etc.
      - \* Tendrils are mostly forked, bark is "exfoliating" or shreds, bark without lenticels and nodes with a diaphragm.
    2. *Vitis rotundifolia*, native to S. Eastern U.S.
      - \* Tendrils are simple, bark is tight, "non-exfoliating", bark with lenticels and nodes without a diaphragm.

Bailey, L. 1949. Manual of Cultivated Plants. MacMillan Pub, NY.1116<sub>8</sub> pgs.



- The origin of *Vitis vinifera* is likely the Caucasus mountains in eastern Europe. Not native to NA.
- Other species are native to North America.
- The list is long, depending on the "ampelographer" or taxonomist. Some examples:
  - *Vitis riparia* (Michigan and midwest) used and sourced in developing rootstocks and scion varieties (Super Hardy Hybrids from MN)
  - *Vitis labruscana* (Atlantic coast) Concord, Niagara, Delaware, etc.
  - *Vitis rotundifolia* (Southeast) a.k.a., Muscadine, not a bunch grape. Wine, juice and jams.
  - *Vitis rupestris* (Texas) rootstock
  - *Vitis berlandieri* (Texas) rootstock
  - *Vitis champini* (Texas) rootstock
  - *Vitis candicans* (Texas) rootstock
  - *Vitis lincecumii* (Texas) rootstock
  - *Vitis cinerea* (Texas) rootstock
  - *Vitis californica* (California)

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### Vitis species / rootstocks

- Initial breeding programs began in Europe with the focus on resistance to Phylloxera, drought (irrigation not allowed in most appellations) and calcareous soils.
- Breeding programs at UC Davis and Geneva focused on resistance to Phylloxera, nematodes, canopy vigor control, etc.
- Initial rootstocks were seedling selections of *V. Riparia*, *V. Rupestris*, *V. Berlandieri* and *V. Champini*.
- Breeding programs focused on hybridizing to combine genotypic characteristics to satisfy needs.

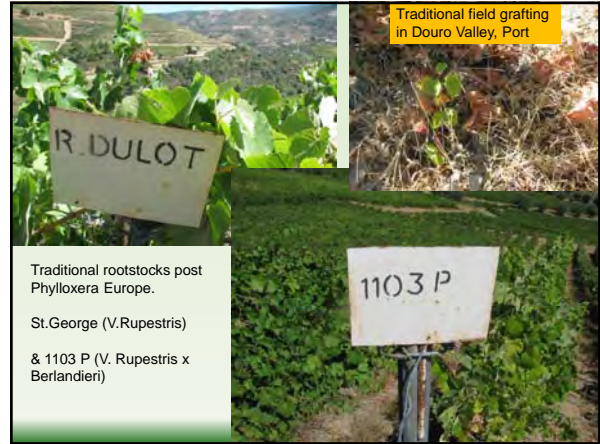
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### Insect Pests; Phylloxera, *Viteus vitifoliae* Fitch

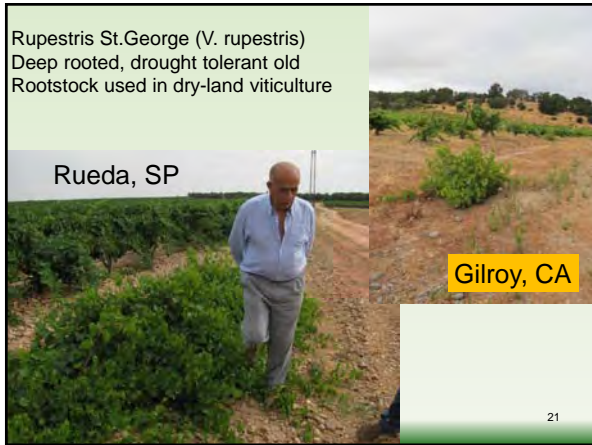
- Phylloxera
  - Destroyed 67-90% Vineyards in France
  - 1860s-1900
  - Now use resistant rootstocks

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Traditional rootstocks post Phylloxera Europe.  
St. George (V. Rupestris)  
& 1103 P (V. Rupestris x Berlandieri)

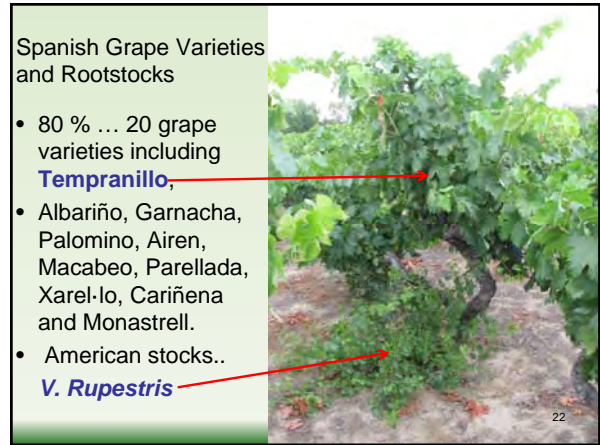


Rupestris St. George (V. rupestris)  
Deep rooted, drought tolerant old  
Rootstock used in dry-land viticulture

Rueda, SP

Gilroy, CA

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Spanish Grape Varieties and Rootstocks

- 80 % ... 20 grape varieties including **Tempranillo**,
- Albariño, Garnacha, Palomino, Airen, Macabeo, Parellada, Xarel-lo, Cariñena and Monastrell.
- American stocks.. **V. Rupestris**

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*The first rootstocks...../ species*

- *Vitis vinifera* (own roots)
  - Grows well in high pH soils
  - Highly susceptible to Phylloxera and nematodes.
- *Vitis riparia* “riverbank” grape
  - Likes soils with good soil moisture
  - Does not like high pH / calcareous soils
  - Resistant to Phylloxera, Propagates easily
- *Vitis rupestris* (St. George or Rupestris du Lot)
  - Likes soils with good moisture
  - Does not like high pH / calcareous soils
  - Resists Phylloxera, Propagates easily
- *Vitis berlandieri*
  - Handles high pH / calcareous soils
  - Resists Phylloxera, Does not propagate easily

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**Hybrids and breeding**

- Riparia X Rupestris
  - Couderc 3309, C.3306, 101-14
  - Don't handle high lime soils well but drought
- Riparia X Berlandieri
  - SO4, Teleki 5C, Kober 5BB, 420 A Mgt
  - Moderate vigor, Phyllox resist., resist lime
- Berlandieri X Rupestris
  - 110 R, 140 Ru, 1103 P
  - High vigor, resist lime & Phyllox
- Champini and hybrids
  - Dogridge, Salt Creek, Ramsey
  - Hybrids... Freedom (Armillaria resistnt & Harmony)
  - High vigor in good soils

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### Important rootstocks

- Teleki 5A, 5BB\*, 5C and SO-4\* (Berlandieri X Rupestris)
- Riparia Gloire\* (V. Riparia)
- Rupestris St. George (V. Rupestris)
- C.3306, C. 3309, 101-14 (V.Riparia X Rupestris)
- C. 1613 (Othello X V. Solonis)
- Continue to evaluate new rootstock candidates
  - Learn from the lessen of AXR#1... avoid stocks with Vinifera parentage (susceptible to Type B Phylloxera)
  - Perhaps look at new rootstocks like the 039-16 hybrid of V. Rotundifolia X Vinifera. Dagger nematode resistant, but not cold hardy.

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TABLE 3

The most important cultural aptitudes of commercially cultivated rootstocks. Summarised after Branas (1974), Cosmo *et al.* (1958), Galet (1971), Mottard *et al.* (1963), Pátena (1972), Pongrácz (1978), and Ribereau-Gayon & Peynaud (1971)

rootstock	vigour of grafted vine	vegetative cycle	propagation by			affinity with <i>V. vinifera</i>
			cutting (rooting)	bench grafting	field grafting	
Rupestris du Lot	xxxx	long	xxx	xxx	xxx	xxxx
Riparia Gloire	xx	short	xxx	xxx	xxx	xx
99 Richter	xxxx	medium	xxxx	xxxx	xxxx	xxxx
110 Richter	xxx	very long	xxx	xxx	xxx	xxxx
140 Ruggeri	xxxx	very long	xxx	xxx	xxx	xxxx
105 Paulsen	xxx	long	xxx	xxx	xxx	xxxx
SO 4	xx	medium	xx	xx	xx	xxx
5 BB Teleki	xx	medium	xx	xx	xx	x
420 A Mgt	xx	long	xx	xx	xxx	xx
44-53 Malgûe	xxx	medium	xxxx	xxxx	xxxx	xxxx
3509 Couderc	xx	medium	xxx	xx	xxx	xx
101-14 Mgt	xx	short	xxx	xx	xx	xx
196-17 Castel	xxx	medium	xxx	xxx	xxx	xxx
41 B Mgt	xx	short	x	xx	xxx	xxx
333 FM	x	medium	x	xx	xxx	xxx
Salt Creek	xxxx	very long	x	xx	xx	x

- Advanced Maturity: some rootstocks have shorter or longer growth cycle than that of the scion variety
- i.e. a short growth cycle rootstock can advance the maturity of the scion variety
- Short growth cycle rootstock also can enhance the cold acclimation of the vine
- So, this kind of characteristic in rootstocks would be desirable for a cool climate, like Michigan

G. S. Howell

Miller, D. P., G. S. Howell and R. K. Striegler. 1988a. Cane and bud hardiness of selected grapevine rootstocks. *Am. J. Enol. Vitic.* 39:55-59.

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### Most Commonly Used in Michigan

- C. 3309
  - Moderate vigor, resistant to Phylloxera but not nematodes.
- 101-14
  - Similar vigor to C.3309 but Australian work demonstrates general nematode resistance + Phylloxera

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### Nematodes

- Nematodes can debilitate vine vigor, and thus productivity, by alarming levels.
- Dagger nematode, is a vector for “fan leaf virus” which also can weaken vines even further.
- Coarse, droughty soils, which do not support Phylloxera colonies do attract nematode populations (sandy soils in particular).
- Therefore, rootstocks are selected in Australia with nematode resistance as most important and resistance to Phylloxera secondary.

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### Soil Pests Common in Michigan

Common Name	Scientific Name	Rootstocks with Tolerance**
Root Knot	<i>Meloidogyne incognita</i> *	Ramsey, Teleki 5C, 5 BB, Freedom, SO 4
Lesion	<i>Pratylenchus vulnusand P. penetrans</i>	Similar to Root Knot but needs testing in Michigan
Dagger	<i>Xiphinema americanum</i> and <i>X. index</i>	Freedom, Ramsey, 101-14 Mgt, Riparia Gloire
Ring	<i>Mesocriconema (=Criconebella) xenoplax</i>	420A, 101-14 Mgt
Phylloxera	<i>Daktulosphaira vitifoliae</i>	C.3309, 101-14 Mgt, SO 4, Teleki 5C, 5 BB, Riparia Gloire
Armillaria	<i>Armillaria mellea</i>	Freedom

\* Multiple species

\*\* moderate, resistant

[www.ipm.ucdavis.edu/PMG/r302200111.html](http://www.ipm.ucdavis.edu/PMG/r302200111.html)

May, P. 1994. Using rootstocks; The Australian Perspective, WineTitles.

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### Nematode Resistance among grape rootstocks ?

- “No single rootstock is resistant to all root knot nematodes and there are numerous other nematodes of concern. Broadest resistance is present in **Ramsey, Freedom, and several rootstocks in the Teleki series (5C is the only one that has been specifically tested)**. Selection of a rootstock is a risky endeavor because of their excessive or inadequate growth in certain situations and their limited breadth of resistance.”
- <http://www.ipm.ucdavis.edu/PMG/r302200111.htm>

### There is no SILVER bullet

- No one rootstock is best for all sites.
- Rootstock selection is a management tool.
- Don't look to Germany, France, Italy or Spain to provide needed rootstocks for the future.
  - They are looking for combination of Phylloxera resistance, tolerance to calcareous soils and drought (can't irrigate).

### Soils and Roots



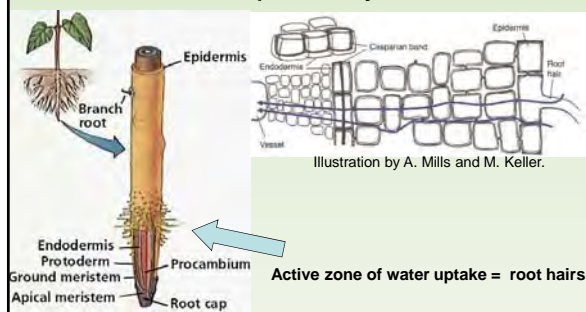
Roots travel a path of least resistance!!!!

Roots will penetrate rock and crevices to develop where good soil moisture conditions exist.



Healthy new roots are the critical functioning Component in water and nutrient uptake

### Water uptake by roots

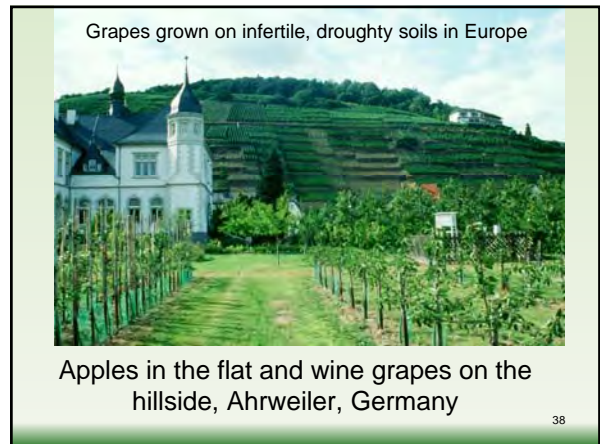


Rootstock trials are important in Europe to find rootstocks resistant to:

1. Phylloxera
2. Calcareous soils
3. Drought



Lime induced chlorosis, Geissenheim, Germany



### Do rootstocks affect wine quality?

- In answering this question.... Must keep all parameters under control...
- Crop load, light penetration, fruit to leaf ratio
- Wine made of Shiraz on 6 stocks showed similar levels of anthocyanins as own roots (Walker, et.al. 2000).

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Root:1 [THE ORIGINAL UNGRAFTED] Coldwater Valley & Cavallone Valley, Chile

▶ DISCOVER AN ORIGINAL [WATCH STORY]

Character Comes from Your Roots

While most vineyards around the world are planted on grafted rootstock, Root:1 wines are grown on original, ungrafted roots, producing outstanding quality wine with pure fruit flavors and aromas.

<http://root1wine.com/>

Study conducted by Harbertson and Keller "Rootstock Effects on Deficit-Irrigated Winegrapes in a Dry Climate: Grape and Wine Composition"

- Chardonnay, Merlot, and Syrah on five rootstocks (5C, 140Ru, 1103P, 3309C, 101CU and own roots over three yrs.
- Rootstock caused few significant differences in fruit and wine composition.
- All fruit and wine variables measured with the exception of TSS varied significantly with scion.
- Rootstock had no effect on grape anthocyanins and tannins

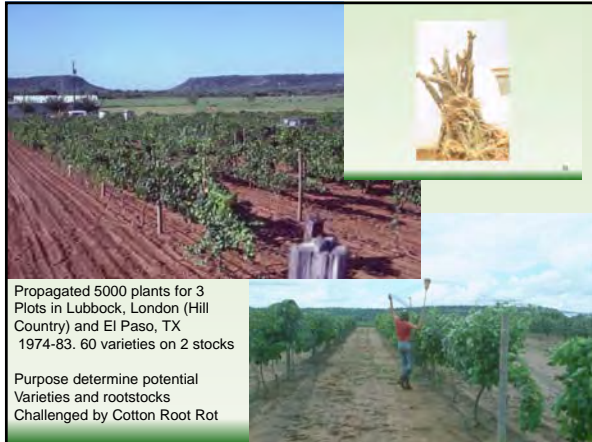
Am. J. Enol. Vitic. 63:1 (2012) 41

Rankings among Vitis species regarding tolerance or susceptibility to Cotton Root Rot (*P. Conioformis*)

Tolerant	Mid Susceptible	Highly Susceptible
Champagne	Aestivalis	Bouquetin
Cardinalis	Arbutus	Yaroslav
Bastardierl	Clares	Balfeano
	Castellana	Blonde
	Linnecourt	
	Monticola	
	Rotundifolia	
	Vulpina	

Field grafting

Rootstock importance/role Resistance to soil pests



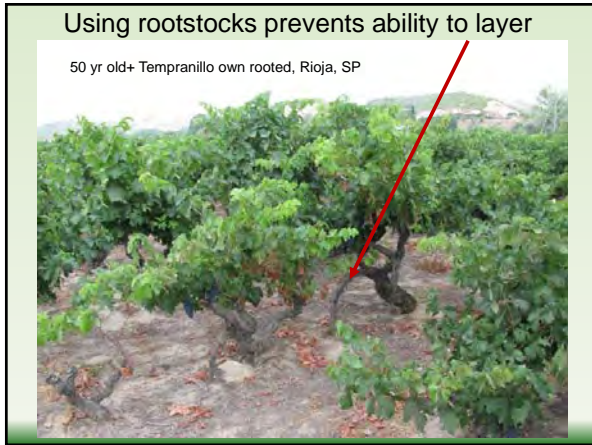
### Effects of rootstocks on wine grape yield, vigor and juice quality

- Studied 39 varieties [Vinifera (19), FH (17) & American] over 9 years on 2 rootstocks (C.1613 and Dogridge) compared to own root.
- Dogridge
  - Vigor ++ 37% / **-- 7 % of varieties**
  - Winter Hardiness ++ 7 % / **-- 22% of varieties**
  - Yield ++ 17% / **-- 32% of varieties**
  - pH **+++ on 50% of varieties**
- C.1613 moderate effects

In summary, we found that variety performance was dependent on combination!

Lipe & Perry, 1988, HortSci, 23:317 321

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### General References

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