

Chart I: Rootstock-Scion Combinations

(C = Compatible I = Incompatible U – Uncertain because observed less than 10 years — = No information)

Rootstock	Kumquat	Navel Orange	Valencia Orange	Grapefruit	Mandarin ¹	Lisbon ² Lemon	Eureka ³ Lemon	Meyer Lemon
Lemon types								
Macrophylla	—	—	C	C	—	I ³	I ³	C
Rough lemon	—	C	C	C	C	C	I	—
Volkameriana ⁴	—	U	C	C	U ⁵	C	C	—
Yuma ponderosa ⁴	—	U	C	—	U	C	C	C
Mandarin types								
Cleopatra mandarin ⁶	—	C	C	C	C	I	I	—
Rangpur ⁴	—	C	C	C	U	C	C	—
Orange types								
Taiwanica	—	U	C	C	U	— ⁷	— ⁷	—
Sour orange	I ⁸	C	C	C	C	C	I	—
Sweet orange	—	C	C	C	C	C	C	—
Trifoliolate orange	C ⁹	C ¹⁰	C	C	C ¹¹	C	I	—
Trifoliolate hybrids								
C-35 citrange	—	C	C	U	C	C	—	—
C-32 citrange	—	C	C	U	C	C	—	—
Carrizo citrange	—	C	C	C	C ¹¹	C	I	—
Troyer citrange	—	C	C	C	C ¹¹	C	I	—
Swingle	—	C	C	C	U	C	I	I

1. Compatibility of mandarins varies with cultivar.
2. See Chart II.
3. Rootstock necrosis often develops.
4. Information presented is based on limited observations.
5. With Satsumas this combination develops a bud union overgrowth.
6. Especially good for cultivars with larger fruit sizes; Temple, Nova, Murcott, Orlando tangelo, and grapefruit.
7. Bud unions weak, often break.
8. Slow-growing, unhealthy-looking combination.
9. Good production with this combination.
10. With some scions, particularly Frost nucellar navel, trifoliates decline after 20 years due to bud union abnormalities. Rich 16-6, an experimental trifoliolate, does not display this decline.
11. Sometimes a short-lived combination.

Chart II: Lemon Compatibility Status

(C = Compatible I = Incompatible U – Uncertain because observed less than 10 years — = No information)

Rootstock	Eurekas, all	Limoneira 8A	Monroe	Prior	Strong
Lemon types					
Macrophylla (Alamow)	I (5-12)	I (16-21)	I (15)	—	I (15)
Rough lemon	I (11)	C (20)	—	—	—
Volkameriana	—	C (20)	—	—	—
Yuma ponderosa	C(20)	C (20)	C (20)	C (20)	C (20)
Mandarin types					
Rangpur	—	C (20)	—	—	—
Orange types					
Taiwanica	—	—	—	—	—
Sour orange	I (12-15)	C (20)	I (12-15) ³	C (20)	C (20)
Sweet orange	C (20)	C (20)	C (20)	C (20)	C (20)
Trifoliolate orange	I (4)	C (20)	—	—	C (20)
Trifoliolate hybrids					
Troyer citrange	I (2-8)	C (20)	C (20)	C (20)	—
Swingle	—	C ⁴	—	—	—

SOURCE: Schneider and Sakovich 1984, and additional information.

1. "C (20)" is used to indicate freedom from necrotic tissue at the bud union of trees more than 20 years old.
2. Following "I" the numbers indicate the age in years when delayed incompatibilities were first observed.
3. Trees affected were on Seville bitter orange in the 1940 strain plot at Riverside, CRC project 1134 (1951-1954). However, 25-year-old Ledig and Monroe Lisbons on Bradbury sour oranges at Limoneira appeared to be free of sour orange rootstock necrosis.
4. The oldest trees sampled were less than 20 years old.

Chart III: Disease, Virus, and Nematode Susceptibility

Rootstock	Phytophthora ¹			Citrus nematode ²	Controlled by budwood certification			
	Root rot	Gummosis	Armilliaria		Tristeza ³	Exocortis	Cachexia	Woody Gall
Lemon types								
Macrophylla	tolerant ⁴	tolerant	susceptible	susceptible	susceptible	tolerant	susceptible	tolerant
Rough lemon	susceptible ⁵	susceptible	susceptible	susceptible	tolerant	(?) ⁶	tolerant	(?)
Volkameriana	susceptible	susceptible	— ⁷	—	tolerant	tolerant	—	susceptible
Yuma ponderosa	tolerant	susceptible	—	susceptible	tolerant	—	—	—
Mandarin types								
Cleopatra mandarin	susceptible	susceptible	—	susceptible	tolerant	tolerant	(?)	tolerant
Rangpur	susceptible	susceptible	susceptible	susceptible	tolerant	susceptible	susceptible	—
Orange types								
Taiwanica	susceptible	tolerant	—	susceptible	susceptible	tolerant	—	—
Sour orange	intermediate	tolerant	susceptible	susceptible	susceptible	tolerant	tolerant	tolerant
Sweet orange	susceptible	susceptible	—	susceptible	tolerant	tolerant	tolerant	tolerant
Trifoliolate orange	tolerant	tolerant	—	tolerant	tolerant	susceptible	tolerant	—
Trifoliolate hybrids								
C-35 citrange	tolerant	tolerant	—	tolerant	tolerant	—	—	—
C-32 citrange	tolerant	tolerant	—	susceptible	tolerant	—	—	—
Carrizo citrange	intermediate	tolerant	susceptible	susceptible	tolerant	tolerant ⁴	tolerant	tolerant
Troyer citrange	intermediate	tolerant	susceptible	susceptible	tolerant	tolerant ⁴	tolerant	tolerant
Swingle	tolerant	tolerant	—	tolerant	tolerant	tolerant	tolerant	—

1. Root rot and gummosis are caused by both *Phytophthora citrophthora* and *P. parasitica*. Root rot is caused by *P. parasitica* in summer and *P. citrophthora* in winter. Susceptibility to the two pathogens varies among rootstocks, but within a rootstock responses are similar.
2. (*Tylenchulus semipenetrans*) Biotypes 1,2,3 (McCarty et al. 1979).
3. Widespread and naturally transmitted in southern California, consequently not controlled by budwood there.
4. Produces some dwarfing, but no cracking or scaling.
5. Variation among cultivars.
6. Contradictory evidence.
7. No information available.

Chart IV: Responses of Rootstocks to Soil and Climate

(good = best performance acceptable = intermediate poor or unsatisfactory = noneconomic performance — = no information)

Rootstock	Soil factors							Climate
	Chlorides ¹	Boron	Calcareous Soils	Poor Drainage	Sand	Loam	Clay	Cold hardiness
Lemon types								
Macrophylla	acceptable	good	acceptable	(?) ²	good	acceptable	unsatisfactory	
Rough lemon	acceptable	acceptable	(?)	unsatisfactory	good	acceptable	unsatisfactory	unsatisfactory
Volkameriana	acceptable	—	—	—	good	acceptable	—	
Yumaponderosa	—	—	—	poor	—	acceptable	—	—
Mandarin types								
Cleopatra mandarin	good	(?)	good	unsatisfactory	(?)	acceptable	acceptable	
Rangpur	good	acceptable	good	—	acceptable	acceptable	acceptable	
Orange types								
Taiwanica	acceptable	acceptable	acceptable	—	acceptable	acceptable	acceptable	acceptable
Sour orange	acceptable	acceptable	acceptable	acceptable	unsatisfactory ³	acceptable	acceptable	
Sweet orange	(?)	acceptable	poor	unsatisfactory	acceptable	acceptable	acceptable	acceptable
Trifoliolate orange	poor	unsatisfactory	poor	acceptable	unsatisfactory	acceptable	good	good
Trifoliolate hybrids								
C-35 citrange	—	—	—	—	—	—	—	—
C-32 citrange	—	—	—	—	—	—	—	—
Carrizo citrange	unsatisfactory	acceptable	unsatisfactory	unsatisfactory	acceptable	acceptable	acceptable	acceptable ⁴
Troyer citrange	unsatisfactory	acceptable	unsatisfactory	unsatisfactory	acceptable	acceptable	acceptable	acceptable ⁴
Swingle	acceptable	acceptable	unsatisfactory	—	acceptable	acceptable	unsatisfactory	good

1. In soil or irrigation water.
2. Conflicting evidence; extremes of performance have been observed.
3. Poor fruit production.
4. Sweet orange grows well on clay but overirrigation can render it susceptible to *phytophthora*.
5. Troyer and Carrizo are cold hardy during cold weather, but can easily be stimulated to flush by periods of warm weather.

Chart V: Effects of Rootstocks on Horticultural Traits

(High, medium, and low, or large, medium, and small = relative rankings

— = no information)

Rootstock	Tree Characteristics			Peel	Fruit Quality				
	Tree Vigor	Tree Size	Drought Tolerance		TSS	Acid	Juice %	Fruit Size	Yield
Lemon types									
Macrophylla	high	med	—	coarse/ thick	low	low	low	large	high ¹
Rough lemon	high	med	high	coarse/ thick	low	low	low	large	high
Volkameriana	high	med/ large	low ²	coarse/ thick	low	low	low	large	high
Yuma ponderosa	high	large ²	—	coarse/ thick	low	low	low	large	high
Mandarin types									
Cleopatra mandarin	med	large	med/ low	med	med	high	high	small	med ³
Rangpur	var ⁴	var ⁴	high	med	low/ med	low/ med	low/ med	med	high ¹
Orange types									
Taiwanica	med	med	—	—	low	low	low	med	low
Sour orange	med	med	high	smooth/ thin	high ⁵	high ⁵	high ⁵	med ⁶	med ¹
Sweet orange	med	large	low ⁷	—	high	high	high	med/ small	med/ high
	low	var ^{4,8} med/ small	low ⁷	smooth/ thin	high ⁵	high ⁵	high ⁵	small/ med	med
Trifoliolate orange									
Trifoliolate hybrids									
C-35 citrange	low	small ⁹	—	med	high	high	high	med	med
C-32 citrange	high ¹⁰	large	—	med	high	high	high	med	high
Carrizo citrange	med ¹¹	med	med	med ¹²	high	high	high	med	med
Troyer citrange	med	med	med	med ¹²	high ¹³	high	high	med	med
Swingle	low	small ⁹	high	med ¹²	high ¹⁴	high ¹⁴	high ¹⁴	med	med ¹⁴

1. Particularly in early years.

2. Evaluation based on limited or preliminary data.

3. Slow to begin bearing.

4. Conflicting reports; characteristic may depend on scion and location.

5. Good rootstock for cultivars of low internal quality.

6. Not suggested for small-fruited cultivars; sour orange accentuates this characteristic.

7. Sweet orange and trifoliolate are particularly drought sensitive on sandy soils.

8. Varies with soil.

9. Varies with scion.

10. Higher vigor than Troyer.

11. Under some conditions (Florida) displays higher vigor and bears earlier than Troyer.

12. This rootstock exacerbates creasing with a sweet orange scion.

13. Troyer can produce acid fruit in cool areas.

14. In arid climates, produces better yields and higher quality of “Redblush” grapefruit and “Orlando” tangelo than most rootstocks, including sour orange.