

The logo consists of the letters 'UF' in white, bold, sans-serif font, set against a solid orange square background.

University of Florida, Institute of Food and Agricultural Sciences

How to use the new Florida Citrus Rootstock Selection Guide?

Rhuanito “Johnny” Ferrarezi, Ph.D.
Assistant Professor of Citrus Horticulture

Email: rferrarezi@ufl.edu

(772) 577-7376 office / (706) 201-4909 cell

Ferrarezi Citrus Horticulture Lab Social Media

Facebook: @IRRECCitrushortlab

Twitter: @IRRECCitrusHort

Instagram: IRRECCitrusHort

FL CRSG, 4th edition by
Drs. Bill Castle, Kim
Bowman, Jude Grosser,
Johnny Ferrarezi, Steve
Futch and Steve Rogers

The logo features the text 'UNIVERSITY of FLORIDA' in blue, with 'INDIAN RIVER' in a larger, bold blue font below it. Underneath, 'Research and Education Center' is written in a smaller, italicized blue font. The entire logo is set against a white background with a blue border.

UF | UNIVERSITY of
FLORIDA
INDIAN RIVER
*Research and
Education Center*

HISTORY

Florida Citrus Rootstock Selection Guide, 3rd Edition¹

William S. Castle, Kim D. Bowman, Jude W. Grosser, Stephen H. Futch, and James H. Graham²

This 3rd edition of the Florida Citrus Rootstock Selection Guide is a revision of the 2006 publication. The guide is a convenient, easy-to-use reference to 20 characteristics of 45 rootstocks. Of those, 12 are time-honored commercial rootstocks (highlighted in blue), which are the most reliably characterized. The next 12 rootstocks are minor commercial ones (highlighted in green) that are less frequently used today in Florida but may have been prominent at one time. The third group consists of the most recently released 21 rootstocks (highlighted in yellow) for which there is limited commercial experience.

Much within the Florida citrus industry has changed since the discovery and spread of the presumed bacterial-caused disease, Huanglongbing (HLB). Rootstocks were not initially part of the discussion related to managing HLB, but that, too, has changed, particularly given the accumulating evidence that trees on various rootstocks may differ in the incidence or tolerance of the disease. Therefore, the authors have prepared this timely and necessary update of the former editions and considerably expanded the list of rootstocks to include many that have not yet undergone the usual extensive field evaluation in Florida. These new rootstocks offer improvements of many meaningful traits that appear essential to the future of our citrus industry, among them tree size control, high yield and juice quality, and possible HLB tolerance.

The authors wish to gratefully acknowledge the following colleagues who contributed significantly to the first two editions of this publication: Dr. Alfred H. Krezdorn

(deceased), Dr. David P. H. Tucker, and Mr. Charles O. Youtsey.

Note: Print the Rootstock table on 11" x 17" (tabloid size) paper.

Interactive Web Version

The revised Florida Citrus Rootstock Selection Guide is also available on the UF/IFAS Citrus Research and Education Center website (frootstockselectionguide.org). Interested parties are strongly encouraged to visit the website because the version posted there offers a considerably expanded opportunity to interact with the rootstock information. The Selection Guide is supported by 105 downloadable citations related to each rootstock and trait. Furthermore, users of the website version can query the tabulated and background information via customized searches. Users can search for answers to specific questions.

2015

1. This document is HS1260, one of a series of the Horticultural Sciences Department, UF/IFAS Extension. Print version published 2006. Revised May 2015. Visit the EDIS website at <http://edis.ifas.ufl.edu>.

2. William S. Castle, professor emeritus, Horticultural Sciences Department, Citrus Research and Education Center; Kim D. Bowman, research geneticist (plants), United States Department of Agriculture, Agricultural Research Service, Ft. Pierce, FL, 34945; Jude W. Grosser, professor, Horticultural Sciences Department, Citrus REC; Stephen H. Futch, Extension agent IV, Citrus Research and Education Center; and James H. Graham, Soil and Water Science Department, Citrus REC; UF/IFAS Extension, Gainesville, FL 32611.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. For more information on obtaining other UF/IFAS Extension publications, contact your county's UF/IFAS Extension office.

U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.



**45
rootstocks**



**20 hort
traits**



**3
editions**

About the FL CRSG



100 pubs



**Expert
System
(A.I.)**



**1,316,662
visitors
2015-2019**

THE NEW, 4TH EDITION

Florida Citrus Rootstock Selection Guide, 4th Edition¹

William S. Castle, Kim D. Bowman, Jude W. Grosser, Rhuanito S. Ferrarezi, Stephen H. Futch, and Steve Rogers²

Preface

First published in 1989 as *Rootstocks for Florida Citrus*, the work of Dr. William Castle and his colleagues remains relevant 30 years later. The purpose of the Florida Citrus Rootstock Selection Guide (FLCRSG) is to provide timely and useful citrus rootstock information to help Florida citrus growers make well-grounded, practical decisions. New problems with abiotic factors, pathogens, and diseases make the FLCRSG a standard document for the Florida citrus industry. Initially published as a book, it was integrated into an informative wheel and is now a web-based expert system with an interactive table. Originally, 12 rootstocks were assessed, and now that number has increased to 48.

The 3rd edition of this guide was published in 2016. The authors have prepared this 4th edition by adding three rootstocks (US Super Sours) that have not yet undergone the usual extensive field evaluation in Florida, as well as by updating the information on the UFR series. These new rootstocks offer improvements regarding HLB tolerance and several other meaningful traits, such as tree size, high yield and juice quality that appear essential to the future of our citrus industry.

Florida Citrus Rootstock Selection Guide, 4th Edition

This updated 4th edition of the Florida Citrus Rootstock Selection Guide is a revision of the 2016 publication. The guide is a convenient, easy-to-use reference to 21 characteristics of 48 rootstocks. Of those, 12 are time-honored commercial rootstocks (highlighted in blue), which are the most reliably characterized. The next 13 rootstocks (highlighted in green) are minor commercial ones that are less frequently used today in Florida but may have been prominent at one time. The third group (highlighted in yellow) consists of the most recently released 23 rootstocks for which there is limited commercial experience.

Much has changed within the Florida citrus industry since the discovery and spread of the presumed bacteria-caused disease huanglongbing (HLB). Rootstocks were not initially part of the discussion related to managing HLB, but that too has changed, particularly given the accumulating evidence that trees on various rootstocks may differ in the incidence or tolerance of the disease. Therefore, the authors have prepared this timely and necessary update of the former editions and expanded the list of rootstocks to include three new rootstocks (US Super Sours) that have not yet undergone the usual extensive field evaluation in Florida. These new rootstocks offer improvements of many meaningful traits that appear essential to the future of our

citrus industry, among them tree size, high yield and juice quality, and possible HLB tolerance.

The authors wish to gratefully acknowledge the following colleagues who contributed significantly to the first three editions of this publication: Dr. James H. Graham, Dr. Alfred H. Krezdorn (deceased), Dr. David P. H. Tucker, and Mr. Charles O. Youtsey (deceased).

Funding for this guide was provided by the Citrus Research and Development Foundation Inc., CRDF project 18-13 and the USDA National Institute of Food and Agriculture, USDA-NIFA-CDRE project 2018-70016-27453.

Note: Print the Rootstock table on 11" x 17" paper.

Interactive Web Version

The revised FLCRSG is also available at <http://flcrsg.com> and https://crec.ifas.ufl.edu/extension/citrus_rootstock. Interested parties are strongly encouraged to visit the website because the version posted there offers a considerably expanded opportunity to interact with the rootstock information. The Selection Guide is supported by over 100 downloadable citations related to each rootstock and trait. Furthermore, users of the website version can query the tabulated and background information via customized searches. Users can search for answers to specific questions.

2019

1. This document is SP248, one of a series of the Horticultural Sciences Department, UF/IFAS Extension. Original publication date May 2015. Revised May 2015, January 2016 and December 2019. Visit the EDIS website at <https://edis.ifas.ufl.edu> for the currently supported version of this publication.

2. William S. Castle, professor emeritus, Horticultural Sciences Department, UF/IFAS Citrus Research and Education Center; Kim D. Bowman, research plant geneticist, United States Department of Agriculture, Agricultural Research Service; Jude W. Grosser, professor, Horticultural Sciences Department, UF/IFAS Citrus REC; Rhuanito S. Ferrarezi, assistant professor, Horticultural Sciences Department, UF/IFAS Indian River REC; Stephen H. Futch, Extension agent emeritus, UF/IFAS Citrus REC; and Steve Rogers, Ecostat, LLC; UF/IFAS Extension, Gainesville, FL 32611.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. For more information on obtaining other UF/IFAS Extension publications, contact your county's UF/IFAS Extension office. U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating, Nick T. Place, dean for UF/IFAS Extension.

How to Use the Rootstock Selection Guide

[1] General

The rootstock information provided is a broad-based compilation of Florida information collected from field trials and commercial situations. The information is general in nature as it represents essentially “average” rootstock behavior across a range of conditions related mostly to scion variety and site conditions.

The quality of information varies due primarily to the time period of evaluation. Thus, the rootstocks have been grouped accordingly into three categories: 1) **MOST USED**, which are commercial rootstocks with a long history of use and are the ones for which the descriptions are the most reliable (highlighted in blue); 2) **MINOR USE** rootstocks, which are ones that have been in minor commercial use for a while and others that were prominent at one time but whose importance has faded as newer rootstocks were introduced and adopted commercially (highlighted in green). The information presented for most of the rootstocks in this category is reliable but is sometimes not as fully developed as with the most used commercial rootstocks; and 3) **RECENTLY RELEASED** rootstocks, which were more recently created in breeding programs and have been under evaluation in Florida for only a few years (highlighted in yellow), eventually selected from field trials and small commercial cooperative trials. Recently released rootstocks have limited commercial experience.

It is also important to note that in rating rootstocks, the differences for a stated factor are sometimes based on a quasi-qualitative comparison and in other cases a more quantitative basis. **Tree height**, for example, is essentially a

relative rating based on the standard of comparison: a tree on a rootstock rated as “Large” would be equivalent in height to a mature tree on rough lemon rootstock. On the other hand, a rootstock’s rating regarding citrus nematode or *Phytophthora* tolerance is fundamentally based on quantitative screening trials plus commercial experience.

[2] Year of First Commercial Availability

The year of first commercial availability is when the rootstock first appeared in the nursery use records of the Florida Department of Agriculture & Consumer Services, Division of Plant Industry, Bureau of Citrus Budwood Registration.

Information on rootstock use can be found in the annual reports of the Bureau available at this site: <http://www.freshfromflorida.com/Divisions-Offices/Plant-Industry/Bureaus-and-Services/Bureau-of-Budwood-Registration>.

[3] Horticultural Traits

Seed germination. Germination is the growth of a seed into a young plant or a seedling. This parameter is important for plant propagation in the nursery. Some rootstocks, like Rusk Citrange and 1584, have a high seed germination rate (80%–90%) but usually produce fruit with few to no seeds.

Seedling uniformity. This variable indicates the percentage of true-to-type seedlings. Most common citrus rootstocks produce polyembryonic seed that yields true-to-type plants, that is, seedlings that are the same type of plant as the original plant. However, a few rootstocks will differ based on the parental pedigree used for crossings. Rootstocks like Smooth Flat Seville produce lots of seeds, but the seeds do not germinate well, and the seedlings are highly variable, with 50% or more discarded as off-types. UFR-3, UFR-15, and

UFR-16 present 80%–90% germination, but seedlings are also highly variable.

Tree size. Tree size refers to the size of the canopy of a mature tree. The ratings indicate relative tree vigor. A tree on a selected rootstock would be rated large [Lg] if it was comparable in vigor and size to one on Cleopatra mandarin or rough lemon, i.e., perhaps 14–20 ft tall. A small tree [Sm] would be less than 8 ft tall at maturity, and an intermediate tree [I] would be like one on C-35 citrange and range in height from 8 to 14 ft tall.

Suggested in-row spacing. This is the appropriate spacing without excessive crowding given the expected vigor and growth to maturity of common commercial scion varieties. Spacing would change according to the selected scion/rootstock combination. Between-row spacing would be dictated mostly by cultural and harvesting machinery used.

Yield/tree. This term is related to the amount of fruit on an individual mature tree at a recommended spacing but recognizing that the bearing habits of different scion-rootstock combinations vary. For example, some are more precocious (early bearing) than others. Comparisons of rootstocks for effects on tree yield should consider canopy size. Small trees usually produce less fruit per tree than larger trees, but the smaller trees can be planted at higher densities.

Yield/acre. Yield per tree times the number of trees per acre will ultimately determine the yield per acre. Generally, the relationship between these two variables (yield per tree and yield per acre) is directly proportional. However, there are situations where a tree has only intermediate yield per tree because of a smaller canopy but yield per acre is high because more trees of smaller stature can be planted per acre.

Juice quality. Brix/acid ratio rating has been determined from juice samples

from various rootstock and scion combinations and compared to industry averages.

Fruit size. Refers to a relative rating based on US market size standards.

[4] Tolerances

Salinity. Salty waters in Florida containing high levels of NaCl are problematic because rootstocks vary in their absorbance and translocation of the Na⁺ and Cl⁻ ions. This rating indicates how much a given rootstock can tolerate high-salinity irrigation water.

High pH. Rootstocks vary in their tolerance of calcareous soils mostly because of the CaCO₃ in the soil and/or the irrigation water. Such conditions commonly lead to calcium-induced Fe chlorosis. New evidence suggested that HLB-affected trees may also suffer stresses related to high bicarbonate in the irrigation water.

Clay soil. Refers to soils with horizons containing >20% clay or loamy materials, and especially soils where such horizons are close to the soil surface. These soils are generally unsuitable for Swingle citrumelo, Carrizo citrange, and other citrumelo, citrange, and trifoliolate orange rootstocks.

Wet soil (flooding). Wet soils are poorly drained, chronically wet, or subject to extended periods of flooding. For additional soils information, see *Field Guide to Soil Identification for Florida’s Citrus-Growing Regions*, SP 362 (<http://ifasbooks.ifas.ufl.edu/p-266-field-guide-to-soil-identification-for-floridas-citrus-growing-regions.aspx>).

Drought. With the advent of generally practiced irrigation, drought is no longer considered an important rootstock factor.

Freezes. The threat of a seriously damaging cold event remains. Few stressful

freeze events have occurred since the 1980s. Thus, the tolerance of many of the minor and recently released rootstocks has not been adequately determined.

[5] Diseases and Pests

HLB (Huanglongbing) incidence. Observations are accumulating that the incidence of HLB is less among trees on some rootstocks, especially new rootstocks included in various field trials. This rating reflects those observations; however, the ratings are quite tentative and subject to change. The interpretation of the observations is speculative and highly subject to revision over time. Survey results from a grower-scale observation of HLB incidence among commercial scions and rootstocks are available by visiting http://www.crec.ifas.ufl.edu/extension/pdf/hlb_scion_survey.pdf.

Blight. As with HLB, rootstock tolerance to blight, a disorder of unknown cause, is based on field observation in research trials and commercial groves. It is a combined rating for overall incidence and rate and time to first losses. Thus, Cleopatra mandarin is rated “S-T” because while the incidence of blight is low among young trees, substantial losses can occur when the trees reach 12 to 15 years of age.

Phytophthora nicotianae ratings are a combination of foot- and root-rot tolerances that are similar within a rootstock, but may differ; for example, sour orange has good foot-rot tolerance but mediocre root-rot tolerance.

P. palmivora/Diaprepes weevil complex. Rootstocks vary in their tolerance to *P. nicotianae* and *P. palmivora*, but when *P. palmivora* is present, it is not ordinarily problematic unless *Diaprepes* weevils are also present (*Phytophthora/Diaprepes* Complex). Most rootstocks are susceptible to this complex, but the ratings may vary depending on soil type.

Burrowing nematodes. All rootstocks are susceptible except for selections of Carrizo citrange, Ridge Pineapple sweet orange, Milam lemon, and Kuharske citrange.

Citrus nematodes. Trifoliolate orange has tolerance to citrus nematodes. That trait is inherited by many of its hybrids including Swingle citrumelo. **Sting nematode** is a pest in some instances, especially in soils with high sand content. There are no known tolerant rootstocks.

Xyloporosis and Exocortis. These virus and viroid diseases, respectively, can be problematic for trees on certain rootstocks. However, they have been virtually eliminated from Florida because of clean budwood programs. Therefore, they are not included in this guide.

Tristeza. This disease is caused by an aphid-transmitted virus. Rating rootstocks is a bit complicated because there are strains and mixtures of strains of this virus that cause symptoms ranging from very mild effects to tree decline.

Additional Comments

Incompatibility. There are just a few situations where a scion/rootstock combination, like Murcott budded to Carrizo citrange or Swingle citrumelo, declines from an apparent incompatibility that manifests itself at the bud union. Other problematic combinations were described by Garnsey et al. and are listed in the citations on the interactive website.

WARNING! Mandarins are perhaps the most sensitive scions to incompatibility, especially with trifoliolate orange-hybrid rootstocks. Nursery managers and growers should be alert to the fact that new releases of mandarin scion types have generally not been tested for compatibility with a broad range of rootstocks.

Rootstocks	Year of first avail.	Horticultural traits								Tolerances						Diseases and pests						
		Seed germination*	Seedling uniformity	Tree size	Spacing	Yield per tree	Yield per acre	Juice quality	Fruit size	Salinity	High pH	Clay soil	Wet soil	Drought	Freeze	HLB incidence	Blight	Phytophthora	<i>P. palmivora</i> weevil complex	Burrowing nematode	Citrus nematode	Tristeza
C-35 citrange	1994	80%-90%	80%-90%	I	8-10	I	I-H	H/I	I	[P-I]	P	[P]	[I]				T+	[S]	[S]	R	T	
Carrizo citrange	1932	>90%	90%	Lg	8-12	H	I-H	I-H/I	I-Lg	P	P	P	I	G	G	I-H	I	I	[S]	[S]	S	T
Cleopatra mandarin	1932	>90%	99%	Lg	8-15	L-I	I	H/H	Sm	G	I	G	P	I-G	G	L	S-T	S	[S]	S	S	T
Kuharske citrange	1932	80%-90%	80%-90%	Lg	8-12	[H]	I-H	I/I	L/Lg	[P-I]	[P]			[G]	[G]		I	[S]	[R]	S	[T]	
Sour orange	Long established	>90%	91%	I-Lg	8-12	I-H	I-H	H+/H	I	G	G	G	G+	I	G	L	T+	T	T	S	S	S
Swingle citrumelo	1974	>90%	95%	I	8-12	I	I	I/I	I	P	P	P	[G]	P-I	G	I	T	T+	S	[S]	R	T
US-802	2007	>90%	98%	Lg	12-14	H	I	L-I/I	Lg		[I]	[G]	[I]		G	L	T	T	T			T
US-812	2001	>90%	96%	I	10-12	H	H	H/H	I		G	[I]	[I]		[G]	I	T+	T	[S]			T+
US-897	2007	>90%	98%	Sm	8-10	L	H	H/H	Sm-I		[I]	[G]	[I]		I	I	T	T				T
US-942	2010	>90%	96%	Sm-I	8-10	H	H	H/H	I		[G]	[G]	[G]	[G]	[G]	L	T+	T				T+
Volkamer lemon	1970	>90%	98%	Lg	12-15	H	I-H	L/L	Lg	I	T	I	I-G	G	P		S	T	[S]	S	S	T
x-639	1994	80%-90%	80%-90%	Lg	8-12	I	I-H	H/H	I	G	[I]	[G]	[G]	[G]	[I-G]	L		T	[S]	[S]		T
Benton citrange	1986	>90%	98%	Lg	8-12	H		H/I	I-Lg	P-I	P	[P]	[I]	G	G		T	[S]				T
Flying Dragon TF	1978	80%-90%	80%-90%	Sm	5-7	L-I	H	H/H	Sm-I	P	P	G	I	P	G		P	T	[I]	S	R	T
Goutou	1994	80%-90%	80%-90%	I	8-10	[L-I]	[I]	L-I/L	Lg		[I]	G	[G]				S	[S]	[S]			T+
Kinkoji	1986	80%-90%	86%	I	8-10	[I]	I	L-I/L	I		[I]	[G]	[G]				T	[S]	[S]			T
Rough lemon	Long established	80%-90%	80%-90%	Lg	10-15	H	I-H	L/L	Lg	I	G	I	I	G	P		S	S	S	S	S	T
Rusk citrange	1969	80%-90%**	80%-90%	Sm-I	6-8	I	I-H	H+/I	I	P	P	P	P	[P]	P-I		[I]	T	[S]	S	S	T
Shekwasha mandarin	1986	80%-90%	80%-90%	I-Lg	8-15	L-I	I	I/H	Sm	[I]	G+	[G]	P	I-G	G		S	[S]	S	S	S	T
Smooth Flat Seville	1988	10%-49%	41%	I	8-12	L-I	I	L-I/I	I-Lg	[I]	G	[G]	I	[G]	[I]		[T]	S	[S]	[S]		[T]
Sun Chu Sha mandarin	1988	80%-90%	80%-90%	Lg	8-12	L-I	I	H/H	Sm	[I]	I+	G	P	[I-G]	[G]		S	[S]	S	S	S	T
Sweet orange	Long established	80%-90%	80%-90%	Lg	10-12	I	I	I/I	I-Lg	I	I	I	P	P	I		T+	S+	[S]	S	S	T
Trifoliolate orange	Long established	80%-90%	80%-90%	Sm	6-8	L-I	H	H/H	Sm-I	P-	P-	G	G	P	I-G		[S]	T+	[S]	S	R	T+
US-852	1999	50%-79%	40%-60%	I	8-10	H	H	H/H	I		[I]	[I]			G	I	T	T	[S]			T
1584	2004	80%-90%**	80%-90%	I	8-12	H		I-H/I	I	[I]		G	T				I	[S]			T	T
C-22 Bitters	2009	80%-90%	80%-90%	Sm-I	6-8	[I]	[I]	H/I	I		G+						I	[I]			S	I
C-54 Carpenter	2009	80%-90%	80%-90%	I	8	[H]	[H]	H/I	I		I						I	[L]			G	I
C-57 Furr	2009	80%-90%	80%-90%	I	8	[H]	[H]	H/I	I		I						G	[L]			G	I
C-146	2009	80%-90%	80%-90%	I	8	[H]	[H]	H/I	I									[L]			[G]	[I]
US-896	2015	>90%	97%	Sm-I	8-10	H	H	H/H	I-Lg						I	I	T	T	[S]			T
US-1279	2014	>90%	<5%	Sm-I	8-10	H	H	I/H	I-Lg							L	T	T	[I]			T
US-1281	2014	>90%	<5%	Sm-I	8-10	H	H	H/H	I-Lg							L	T	T	[I]			T
US-1282	2014	>90%	<5%	Sm-I	8-10	H	H	H/H	I-Lg							L	T	T	[I]			T
US-1283	2014	>90%	96%	Sm-I	8-10	H	H	H/H	I-Lg							L	T	T	[I]			T
US-1284	2014	>90%	95%	I	10-12	H	H	I/I	I-Lg							L	T	T	[I]			T
US-1516	2015	80%-90%	73%	I-Lg	10-14	H	H	L-I/I	I-Lg							L	T	T	[I]			T
UFR-1	2015	80%-90%	80%-90%	I	8-10	H	H	I/H	I	[G]	G	G			I	L	[I]	T	T			[T]
UFR-2	2015	80%-90%	80%-90%	I	8-10	I/H	I/H	I/I	I	[G]					I	L	[I]	T	[I]			[T]
UFR-3	2015	80%-90%	10%-49%***	I	8-10	H	H	I/I	I	[I]					I	L	[I]	T	[I]			[T]
UFR-4	2015	80%-90%	80%-90%	I	10	H	H	I/H	I	G	G	G			I	L	[I]	T	T			[T]
UFR-5	2015	80%-90%	80%-90%	I	8-10	H	H	H/I	I-Lg	[I]	G				I	L-I		T	T			[T]
UFR-6	2015	80%-90%	80%-90%	Sm	6-8	H	H	H	Sm-I	[I]					G	I	[I]	T				T
UFR-15	2015	80%-90%	10%-49%***	Lg	12	[I]	[I-H]	I/I	Lg	[G]	[G]	[G]			I	[G]	T					
UFR-16	2015	80%-90%	10%-49%***	I/Lg	10-12	[I]	[I-H]	I/I	I	[G]	[G]	[G]			I	[G]	T		[I]			
UFR-17	2015	80%-90%	80%-90%	Sm-I	8-10	[H]	H	I/I	I	[I]	[G]		[G]		G	I	[G]	T	[I]			
US Super Sour 1	2018	>90%	<5%	Sm-I	8-12	[H]	I/I	I-H/I-H	I-Lg							L	T					[T]
US Super Sour 2	2018			Sm-I	8-12	H	H	I/I	I							L	T					[T]
US Super Sour 3	2018			Sm-I	8-12	H	H	I/I	I							L	T					[T]

Footnotes: *Seed germination in the first year under appropriate storage conditions; **Produces few seeds; ***Seedlings are highly variable.

Key to Symbols

Blue—Commercial; Green—Minor Commercial; Yellow—Recently Released

G—Good, P—Poor, H—High, I—Intermediate, L—Low, Lg—Large, R—Resistant, S—Susceptible, Sm—Small, T—Tolerant, Blank space—Rating unknown or undetermined, []—Any symbol in brackets indicates a probable or expected rating, +/- Relative ranking, UFR—University of Florida Rootstock, and US—USDA.

NEW,
UPDATED
INFO FROM
FIELD

What is new in the 4th edition?

- [Updated info about the UFR Series in the Rootstock Data Table](#)
- 3 new rootstocks (US Super Sours 1, 2, 3)
- New info on Seed germination and Seedling uniformity
- Additional [authors and contributors](#)
- New section [History of the FLCRSRG](#)
- Updated [literature review](#) articles
- Webpage has a substantially modernized appearance and new address: flcrsg.com



Florida Citrus Rootstock Selection Guide, 4th Edition

New, Updated 4th Edition

The 4th edition has updated literature review articles, 3 new rootstocks (US Super Sours 1, 2 and 3), [updated info about the UFR Series in the Rootstock Data Table](#), additional [authors and contributors](#), and a new section with the [History of the FLCRSRG](#).

The revised FLCRSRG is also available as an Interactive Web version called Expert System. This system emulates a human expert by systematically sorting information you provide, then determining the best possible recommendation for the given rootstock. The FLCRSRG system will use the traits about the rootstocks, and utilize data that can provide facts that you tell it to deduce the best recommendations for your circumstance. The Expert System will ask you a series of questions about your location, horticultural needs and pest management requirements. It will compare across all the rootstocks for those that rate highest on the most traits, then provide you a list of its top five recommendations.

[Link to Expert System](#)

Rootstock Data Table

This data table is a convenient, easy-to-use reference to 21 characteristics of 48 rootstocks.

[Learn More](#)

Printable, Revised EDIS publication

The document #SP248 (Florida Citrus Rootstock Selection Guide, 4th Edition, by Drs. Castle, Bowman, Grosser, Ferrarezi, Futch, and Rogers) is an extension publication of the Horticultural Sciences Department, UF/IFAS Extension.

[Learn More](#)

Bibliography

Over 100 peer-reviewed publications about citrus rootstocks (mainly from Florida's research and extension system).

[Learn More](#)

Rootstock Field Data

For additional information, visit the UF/IFAS CREC website, Plant Improvement Rootstock Field Data, where the results of individual trials are presented.

[Learn More](#)

History

30 years of the Florida Rootstock Selection Guide.

[Learn More](#)

Credits

These individuals developed or contributed to the rootstock selection guide.

[Learn More](#)

Project sponsors



This work is supported by the Citrus Research and Development Foundation Inc., CRDF project 18-13 and the USDA National Institute of Food and Agriculture, USDA-NIFA-CDRE project 2018-70016-27453.

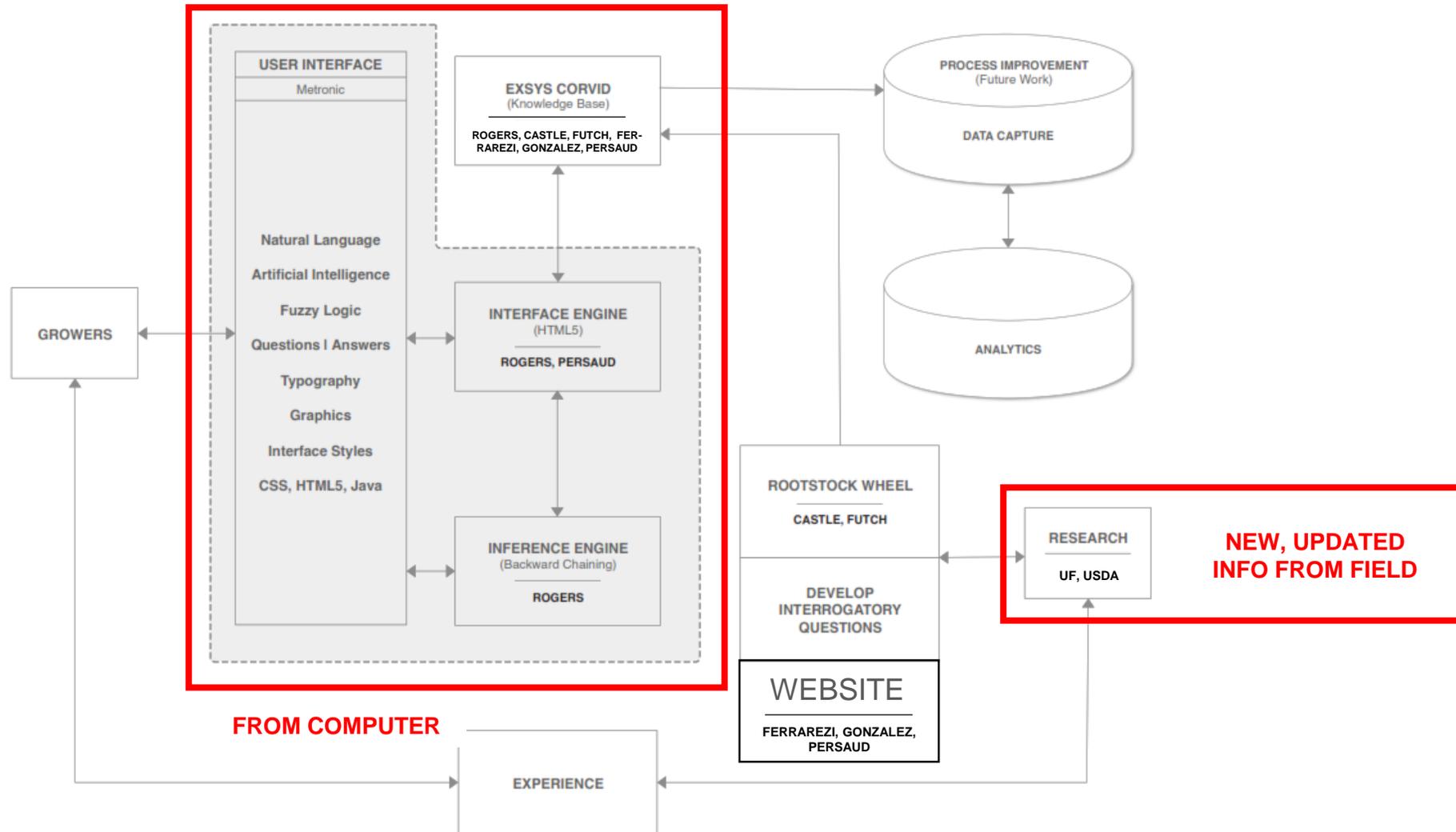
HOW THE EXPERT SYSTEM WORKS?

The Expert System

Why did we take this particular web application approach to the matter of rootstock selection?

- Available online at flcrsg.com > Expert System
- Rapid adaptation and deployment
- Non-algorithmic programming
- Unbiased
- Weighed condition (Sour high fruit/juice quality but susceptible to CTV)
- Similar to human interaction
- Backward chaining (continuously check rules IF... THEN)

Expert System Architecture



The Expert System step-by-step

- Landing page available at flcrsg.com > Expert System

Expert System for the Florida Citrus Rootstock Selection Guide, 4th Edition

Florida Citrus Rootstock Selection Guide. I don't replace the guide, but rather am intended to be used alongside it. I will interview you and can reason through your information to hone in on your best rootstock options. Over time, I'll know more about you and can provide more information. Here are the ways I can help you:

- Provide a measure of confidence that a rootstock is suitable
- Easily test different rootstock planting scenarios
- Serve as a "second opinion" if you already selected your rootstock
- Provide rootstock suggestions you may have overlooked
- Help you get started with a new selection that considers the latest rootstocks

My analysis will provide a report that gives you a ranked list of rootstocks that ON AVERAGE are top candidates for you to consider in your situation. Please be sure to read the disclaimer below before proceeding.

What is the name of the site for which you'd like me to do an analysis?

What rootstock traits do you want to consider today for the Lab location? You may want to consider a little more information about each group you choose.

- Horticultural traits (tree size, spacing, yield and juice quality)
- Tolerance to site conditions (salinity, pH, clay, flood, drought and cold)
- Pest and disease traits (HLB, blight, Phytophthora, nematodes and tristeza)

- **Depending on the selections**, the system asks questions to gather information about the grower's specific situation. **The line of questioning is determined on a case-by-case basis** depending on how the interview develops.
- The system uses its rules to match and score their input with the 1,008 possible factors in the guide.
- **User is presented a report with a ranked list of rootstocks** that ON AVERAGE are top candidates for their situation.
- The rankings are based on a "Selection Score" (**not a statistical value**), referring to a relative ranking of the expert system's confidence suggesting rootstocks suitable for the site situation described during the interview process.

The Expert System step-by-step

- The closer in value the selection score for a rootstock is to 100, the closer the match of that rootstock is for the grower's described situation. Results are **normalized so the maximum value is 100** (making it easy to compare results within and between separate runs).

100%
(good match)

EXAMPLE

- The expert system does not keep or archive information provided by users (users can print a copy of the report).

Florida Citrus Rootstock Selection

crec.ifas.ufl.edu/extension/citrus_rootstock/full-width.html

UFIFAS UNIVERSITY OF FLORIDA

Rootstock Report: Demonstration Purposes Only

THIS INFORMATION IS PROVIDED AS-IS, WITHOUT WARRANTY OF ANY KIND. This web application is a free service. Users of this information assume any and all risks related to its use for any purpose.

Location: Lab

How to Use These Results

The information below is just one of several sources that must be consulted to make an informed rootstock selection. Other sources include the Florida Rootstock Selection Guide, other growers, our reference bibliography and your own experience. Based on your answers to the questions in this interview, here are my suggestions for rootstocks that come closest to meeting your needs.

The term, **Selection Score**, shown in the rankings immediately below the rootstock name is not a statistical value. Instead, it refers to a relative ranking of my confidence that rootstock is suitable **on average** for the conditions you described. The closer in value the Selection Score for a rootstock is to 100.00, the closer the match of that rootstock is for your situation.

IMPORTANT NOTE: Selecting Recently Released rootstocks involves more risk because of less time and scope of evaluation.

You selected a total of 17.00 traits in this session. Here are the selections you made for how to perform this analysis: - Evaluate horticultural traits - Evaluate site tolerances - Evaluate pest and disease traits - Evaluate rootstocks from all release dates - Show all rootstocks, including positively- and negatively-rated ones. Negatively-rated rootstocks are rootstocks that did not meet your minimum criteria

Compare these results to the rootstock selection table at ficsg.com. The colors highlighted in the release category correspond to the same colors in the online rootstock table.

Rootstock Rankings - ordered from top to bottom

The maximum Selection Score for any single rootstock is 100%.

If you don't see any rootstocks in a bullet list in the next section below, it means I'm not sufficiently confident in this instance to make recommendations. You might try clicking the Back button at the bottom right corner of this page to go to the prior screen, then lower the minimum Selection Score which I'll use to revised this report.

- **Sour orange (Commercial)** Best traits: excellent external, internal fruit quality, good tolerance for saline, high pH, clay, wet soils, tolerant of freezes, low incidence of HLB, tolerant of blight, tolerant of *Phytophthora nicotianae*, tolerant of *P. palmivora*, root weevil complex. **Less desirable:** Weaknesses: susceptible to tristeza, susceptible to burrowing nematodes, susceptible to citrus nematodes. [Learn more.](#)
Selection Score = 44%
- **US-942 (Commercial)** Best traits: low incidence of HLB, tolerant of blight, tolerant of *Phytophthora nicotianae*, tolerant of *P. palmivora*, root weevil complex, tristeza, small tree size, high yield/tree, high yield/acre. **Less desirable:** Weaknesses: [Learn more.](#)
Selection Score = 44%
- **Carrizo citrange (Commercial)** Best traits: tolerant of drought, tolerant of freezes, tolerant of tristeza, high yield/acre, high pounds-solids/acre. **Less desirable:** high incidence of HLB, intermediate tolerance of blight, intermediate tolerance of *Phytophthora*

0%
(not a good match)

Want to know more details?

Citrus Section

Proc. Fla. State Hort. Soc. 129:90–94. 2016.



Recommendations Based on the Florida Citrus Rootstock Selection Guide Using a Web-server Application of Artificial Intelligence

STEVEN ROGERS*¹, WILLIAM S. CASTLE², STEPHEN H. FUTCH², AND
ANDREW S. PERSAUD²

¹*Ecostat, Inc., P.O. Box 237, Highland City, FL, 33846*

²*University of Florida/IFAS, Citrus Research and Education Center,
700 Experiment Station Road, Lake Alfred, FL 33850*

ADDITIONAL INDEX WORDS. artificial intelligence, software as a service, SAAS, DataTables, Metronic, Apache Tomcat, Apple, Mac OS X, Twitter Bootstrap, expert system, decision support, Exsys Corvid Core

The Third Edition of the Florida Citrus Rootstock Selection Guide was recently released online. This website is a valuable resource containing updated information on rootstock options. The site is unique in that several technologies there complement the rootstock table, including: 1) an interactive online version of the table; 2) an extensive bibliography containing over 100 rootstock references; and 3) an expert system to help focus on the best rootstock candidates given certain user-selected criteria. The expert system is a backward-chaining platform that interviews users about their planting and site requirements. The system uses artificial intelligence technology to infer the best candidate rootstocks based on those criteria. The results are presented in an ordered list from top to bottom showing rootstocks that might be considered. The expert system is built on the Exsys Corvid® Core for Mac OS® X platform, which has the advantages of providing robust development features at a reasonable cost. This paper presents the expert system, provides details on the development process, and discusses the results of a focus group presentation for real-world user feedback.

<https://journals.flvc.org/fshs/article/view/106037/101689>

HOW TO USE?

How to use?

Open flcrsg.com > Expert System

Florida Citrus Rootstock Selection Guide, 4th Edition

Florida Citrus Rootstock Selection Guide, 4th Edition

Florida Citrus Rootstock Selection Guide, 4th Edition

New, Updated 4th Edition

The 4th edition has updated literature review articles, 3 new rootstocks (US Super Sours 1, 2 and 3), updated info about the UFR Series in the Rootstock Data Table, additional authors and contributors, and a new section with the History of the FLCRSRG.

The revised FLCRSRG is also available as an interactive Web version called Expert System. This system emulates a human expert by systematically sorting information you provide, then determining the best possible recommendation for the given rootstock. The FLCRSRG system will use the traits about the rootstocks, and utilize data that can provide facts that you tell it to deduce the best recommendations for your circumstance. The Expert System will ask you a series of questions about your location, horticultural needs and pest management requirements. It will compare across all the rootstocks for those that rate highest on the most traits, then provide you a list of its top five recommendations.

[Link to Expert System](#)

Rootstock Data Table
This data table is a convenient, easy-to-use reference to 21 characteristics of 48 rootstocks.
[Learn More](#)

Printable, Revised EDIS publication
The document #SP248 (Florida Citrus Rootstock Selection Guide, 4th Edition, by Drs. Castle, Bowman, Grosse, Ferrarezi, Futch, and Rogers) is an extension publication of the Horticultural Sciences Department, UF/IFAS Extension.
[Learn More](#)

Bibliography
Over 100 peer-reviewed publications about citrus rootstocks (mainly from Florida's research and extension system).
[Learn More](#)

Rootstock Field Data
For additional information, visit the UF/IFAS CREC website, Plant Improvement Rootstock Field Data, where the results of individual trials are presented.
[Learn More](#)

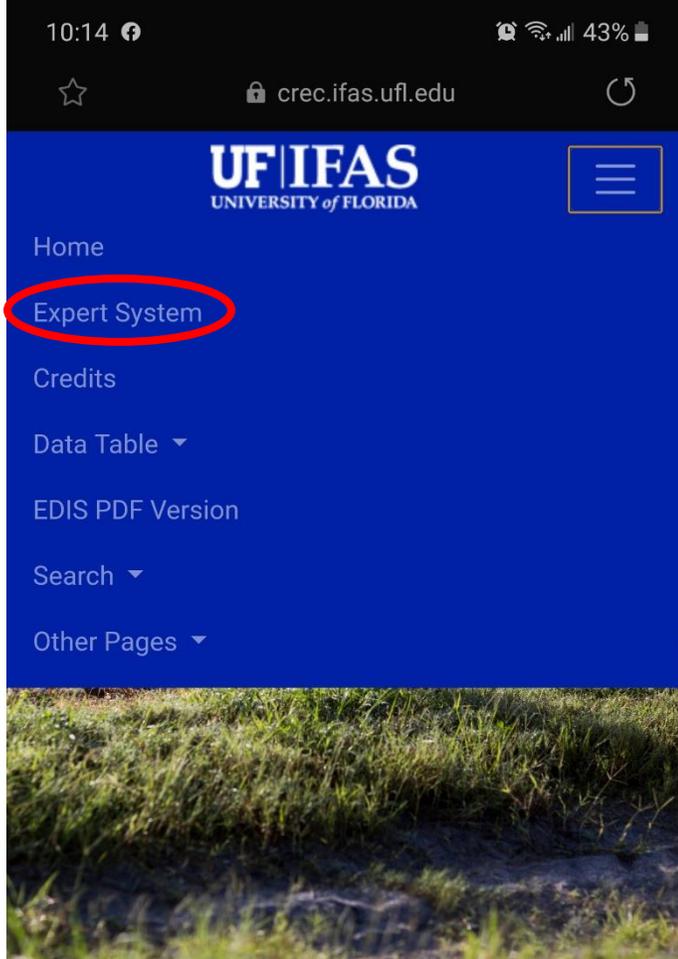
History
30 years of the Florida Rootstock Selection Guide.
[Learn More](#)

Credits
These individuals developed or contributed to the rootstock selection guide.
[Learn More](#)

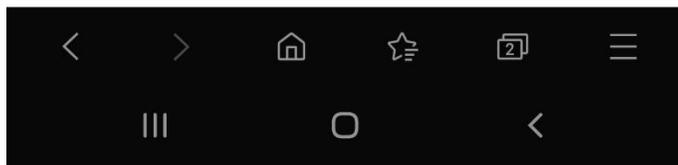
Project sponsors

 Citrus Research and Development Foundation, Inc.  United States Department of Agriculture National Institute of Food and Agriculture

This work is supported by the Citrus Research and Development Foundation Inc., CRDF project 18-13 and the USDA National Institute of Food and Agriculture, USDA-NIFA-CDFE project 2018-70016-27453.



Florida Citrus
Rootstock Selection
Guide, 4th Edition



HANDS ON DEMONSTRATION USING YOUR OWN MOBILE DEVICE

Thanks! Questions?

Rhuanito “Johnny” Ferrarezi, Ph.D.
Assistant Professor of Citrus Horticulture

Email: rferrarezi@ufl.edu
(772) 577-7376 office / (706) 201-4909 cell

Ferrarezi Citrus Horticulture Lab Social Media

Facebook: @IRRECCitrushortlab

Twitter: @IRRECCitrusHort

Instagram: IRRECCitrusHort

FL CRSG, 4th edition by
Drs. Bill Castle, Kim
Bowman, Jude Grosser,
Johnny Ferrarezi, Steve
Futch and Steve Rogers