How to use the new Florida Citrus Rootstock Selection Guide?

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FL CRSG, 4th edition by Drs. Bill Castle, Kim Bowman, Jude Grosser, Johnny Ferrarezi, Steve Futch and Steve Rogers
HISTORY
1989

ROOTSTOCK FOR FLORIDA CITRUS (SP 42)

William S. Castle, D.P.H. Tucker, A.H. Krezdorn, C.O. Youtsey publish the 1st edition of “Rootstocks for Florida Citrus”. Originally, there were 12 rootstocks discussed at length.

1993

ROOTSTOCKS FOR FLORIDA CITRUS 2ND EDITION (SP 42)

William S. Castle, D.P.H. Tucker, A.H. Krezdorn, C.O. Youtsey publish the 2nd edition of “Rootstocks for Florida Citrus”, were 7 new rootstocks were added to the 2nd edition.

1998

THE FLORIDA CITRUS ROOTSTOCK SELECTION GUIDE (SP 248)

From laminated spreadsheets to a useful informative wheel for growers.

2006

FLORIDA CITRUS ROOTSTOCK SELECTION GUIDE (SP 248)

This updated wheel added additional rootstocks and was further developed in 2015 into a web-based expert system designed for growers.
Florida Citrus Rootstock Selection Guide, 3rd Edition
William S. Castle, Kim D. Bowman, Jude W. Grosser, Stephen H. Futch, and James H. Graham

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 24 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. Kreuzer (deceased), Dr. David P. H. Tucker, and Mr. Charles O. Youse.

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 (3trootstockselectionguide.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 305-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

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About the FL CRSG

- 45 rootstocks
- 20 hort traits
- 3 editions
- 100 pubs
- Expert System (A.I.)
- 1,316,662 visitors 2015-2019
THE NEW, 4TH EDITION

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

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 web 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.

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 these, 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 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. Kreuzdorn (deceased), Dr. David P. H. Tucker, and Mr. Charles O. Younset (deceased).

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

Interactive Web Version
The revised FLRCSG is also available at http://flrcsg.com and https://cecs.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.

1. This document is SP248, one of a series of the Horticultural Sciences Department, UF/IFAS Extension. Original publication date May 2015. Revised May 2019, January 2016 and December 2019. Visit the EXIT website at https://exit.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 pathologist, U.S. Department of Agriculture, Agricultural Research Service; Jude W. Grosser, professor, Horticultural Sciences Department; Rhiunato S. Ferrarezi, assistant professor, Horticultural Sciences Department; Stephen H. Futch, Extension agent emeritus; Steve Rogers, Extension agent emeritus; IFAS Citrus REC, and Steve Rogers, Extension agent emeritus; UF/IFAS Extension, Gainesville, FL, 32611.

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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. Rootstocks listed 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; and 3) NEWER rootstocks that have been introduced and adopted commercially (highlighted in green). The information presented for 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 for 1-2 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/Bureau-of-Service/ 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. Seedling survival of rootstocks in Florida ranges from 80-90%.

Seedling uniformity. This variable indicates the percentage of true-to-type seedlings. Most citrus rootstocks produce polyembryonic seed that yields true-type to product 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. Some rootstocks like Smooth Flate Scville produce less seeds, however, some rootstocks may be highly productive, so be sure to check the seedling type.

Tree size. Tree size refers to the size of the canopy of a tree. The rating indicates 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 Cl-23 citrus 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 potential of the 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 does not take into consideration bearing habits of different scion/rootstock combinations vary. For example, some are more precocious (early bearing) than others. Combining rootstocks for effects on tree yield should consider canopy size. Small trees usually produce less fruit per tree than larger trees. In general, 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 small 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.


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 pH. High pH would be detrimental to citrus. Newer rootstocks are more resistant to this issue. Various rootstocks have good tolerance for high pH irrigation water.

Clay soil. Soils are rated based on their ability to store water and nutrients. Clay soils are generally unsuitable for Swingle citrange, Carriazo citrange, and other citrus, but may be a better option for rootstocks.

Salt tolerance. Rootstocks vary in their tolerance to salt stress and water stress and have been under various conditions for a long time. Various rootstocks have demonstrated good tolerance to salt stress.

Additional Comments

Incompatibility. There are a few situations where a scion/rootstock combination, like Murcott budded to Carriazo citrange or Swingle citrange, will not grow due to a lack of incompatibility that manifests itself at the bud union. Other problematic combinations were described by Carney and others and are listed in the citations on the interactive website.

WARNING! Mandarins are perhaps the most sensitive scions to incompatibility, especially with trifoliate 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.
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 FLCRSG
- Updated literature review articles
- Webpage has a substantially modernized appearance and new address: flcrsg.com
How the Expert System Works?
The Expert System

The expert system complements the static rootstock table:

Its essence is a **series of questions asked in the form of a short interview** to identify a user’s specific set of circumstances. The system can reason through answers to select the best rootstock and:

- provide a **measure of confidence that certain rootstocks are good matches** for their site
- easily **test different rootstock planting scenarios**
- provide a **“second opinion” regarding initial rootstock choices**
- provide **rootstock suggestions and options** growers may not have considered
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)
The Expert System step-by-step

- Landing page available at flcrsg.com > Expert System

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).

**EXAMPLE**

- The expert system does not keep or archive information provided by users (users can print a copy of the report).
Recommendations Based on the Florida Citrus Rootstock Selection Guide Using a Web-server Application of Artificial Intelligence

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ADDITIONAL INDEX WORDS: artificial intelligence, software as a service, SAAS, DataTables, Metronic, Apache Tomcat, Apple, Mac OS X, Twitter Bootstrap, expert system, decision support, Essys 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 Essys 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
HANDS ON DEMONSTRATION USING YOUR OWN MOBILE DEVICE
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).

https://programs.ifas.ufl.edu/scion-guide

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