Alternatives to Rootstock Propagation by Seed – What can we expect?

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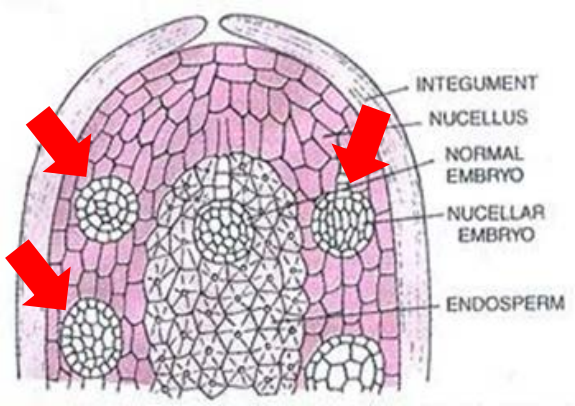
Florida Citrus Growers' Institute
Avon Park, 3 April 2018

UF IFAS
UNIVERSITY of FLORIDA

Seed propagation

Nucellar embryony
genetically identical embryos develop from the nucellar tissue



Why change?

- Many see source trees are located outside and are exposed to diseases.
- Demand for seed for the most popular rootstocks exceeds the available supply.
- No seed source trees for many of the newest rootstock varieties.

Rootstock breeding programs

UF/IFAS breeding program

UFR-1, UFR-2, UFR-3, UFR-4, UFR-5, UFR-6, UFR-7, UFR-8, UFR-9, UFR-10, UFR-11, UFR-12, UFR-14, UFR-15, UFR-16, UFR-17, …

New Varieties Development
NVDMC
& Management Corporation

UF IFAS
UNIVERSITY of FLORIDA

USDA breeding program

US-802, US-812, US-897, US-942, US-1279, US-1281, US-1282, US-1283, US-1284, US-1516, …

USDA

Alternatives to seed propagation

- Cuttings propagation
- Tissue culture propagation

Like seed propagation, both methods will produce **genetically uniform** plants.

Cuttings propagation

- Typically, single node stem cuttings are used (certified disease-free).
- Basal ends are treated with root-stimulating hormones.
- Cuttings are placed in potting medium under high moisture conditions.
- Young plant will develop and roots begin to grow within a few weeks.

Tissue culture (TC) propagation

- Starting material: nucellar embryos or buds from disease-free, true-to-type plants (DPI).
- Placed on agar nutrient medium and sub-cultured to generate multiple shoot clusters.
- Single shoots are separated and pre-rooted on agar-nutrient medium or directly rooted in potting medium.

Photo credit: Beth Lamb, Phil Rucks Nursery

TC propagation

Advantages of TC propagation

- Rapid propagation of large numbers of plants.
- Plants can be propagated year-round without seasonal restrictions.
- Plants are very uniform and pathogen-free.

Major propagation tool for many fruit and nut tree rootstocks (apple, pear, cherry, peach, almond, etc.)

Root system differences

Tap root system

Adventitious-type root system

Nursery performance

- Inferior root system
- Excessive sprouting
- Bud take
- Epigenetic effects
- Rootstock effects
- Higher costs

Field performance

- Early year survival
- Susceptibility to uprooting
- Water and nutrient uptake

New budwood report information

ADAM H. PUTNAM
COMMISSIONER

Florida Department of Agriculture and Consumer Services
Division of Plant Industry

SOURCE TREE BUD CUTTING REPORT

Section 581.031 (3), F.S. / Rules 5B-62.005, .011(3), .012(1)(3)(7), .016, .017(1)(2)(5), .019(3), F.A.C.
Bureau of Citrus Budwood Registration, 3027 Lake Alfred Road, Winter Haven, FL 33881-1438 / PH: (863) 298-3041 FAX: (863) 298-3050

Source Record	Source Tree Information				Budding Record (Fill out at time of budding)						
	Scion		Increase	B/W Cutting			Rootstock Information			Location of Use		Trees Produced
Variety – Clone	Location	ID #	BCR #	# Buds	✓ Rebuds	✓ Topwork	Rootstock	✓ Rooted Cutting ✓ Tissue Culture ✓ Seedling		Block/House	Row/Bench	# Budded

No	Rootstock	2017 Propagations
1	Swingle	582,591
2	X-639	400,536
3	Kuharske	397,555
4	Sour orange	396,911
5	US-942	363,812
6	US-802	298,019
7	US-897	274,433
8	UFR-04	150,429
9	US-942-Tissue culture	119,204
10	US-812	110,274
25	US-897-Tissue culture	6,580
27	US-802-Tissue culture	6,179
28	US-812-Tissue culture	4,733
30	UFR-04-Tissue culture	4,452

ROOT SYSTEMS OF VARIOUS CITRUS ROOTSTOCKS

1945

E. M. SAVAGE, WILLIAM C. COOPER and R. B. PIPER
Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils and Agricultural Engineering, U. S. Dept. of Agriculture, Orlando

INTRODUCTION

Fifteen species and varieties of citrus are now being tested by this station for their value

darin, Morton citrange, Rusk citrange, sweet lime, calamondin, and yuzu (kansu). This paper presents results of a study of the root

Proc. Fla. State Hort. Soc. 89:11-14. 1976.

FIELD PERFORMANCE OF SEVERAL COMMON CITRUS SCIONS ON 'MILAM' ROOTSTOCK[1]

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Additional index words. sweet orange, grapefruit, blight, stem-pitting, burrowing nematode.

the history of the site was obtained from individual co-operators and commercial nursery records.

Measurements were made of tree size and spacing. Fruit samples were collected from each planting for standard analyses. Leaf samples, collected in August, were analyzed for N, P, K, Mg, and Ca (1). Fruit yield was determined by comparing harvest records with three count or by measurement in the plots during commercial harvest. Approx 10%

Proc. Fla. State Hort. Soc. 90:39-44. 1977.

ROOT SYSTEM CHARACTERISTICS OF CITRUS NURSERY TREES[1]

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cm) rows and budded with 'Valencia' (*Citrus sinensis* (L.) Osb.) scion in March, 1976. The trees received commercial care with irrigation provided by a permanent overhead system. Cuttings of the scion were rooted in the greenhouse, established in pots, and set in the nursery in June, 1976.

Six trees of each rootstock and 6 rooted cuttings were selected in February, 1977 for study of their root systems. The excavations were approx 40 to 48 inches (101.6 x 121.9 cm) in width and 24 inches (61 cm) deep. Adjacent trees were also removed when necessary in order to retrieve inter-

Collaborators

Dr. Kim Bowman

Dr. Mireia Bordas

Beth Lamb
Philip Rucks

Nate Jameson
Anna Jameson

Joby Sherrod
Larry Black

Plant material

Rootstock	Parentage
Cleopatra	*Citrus reticulata*
Swingle	*C. paradisi* x *Poncirus trifoliata*
US-1516	*C. grandis* x *P. trifoliata*
US-802	*C. grandis* x *P. trifoliata*
US-812	*C. reticulata* x *P. trifoliata*
US-897	*C. reticulata* x *P. trifoliata*
US-942	*C. reticulata* x *P. trifoliata*
X-639	*C. reticulata* x *P. trifoliata*

Objectives

Short-term (nursery)

- Effect of propagation method on plant traits during the nursery stage:
  - Biomass distribution
  - Root architecture
  - Effects on grafting

Long-term (field)

- Evaluate root structure, survival, and field performance during the early years and throughout the productive years.

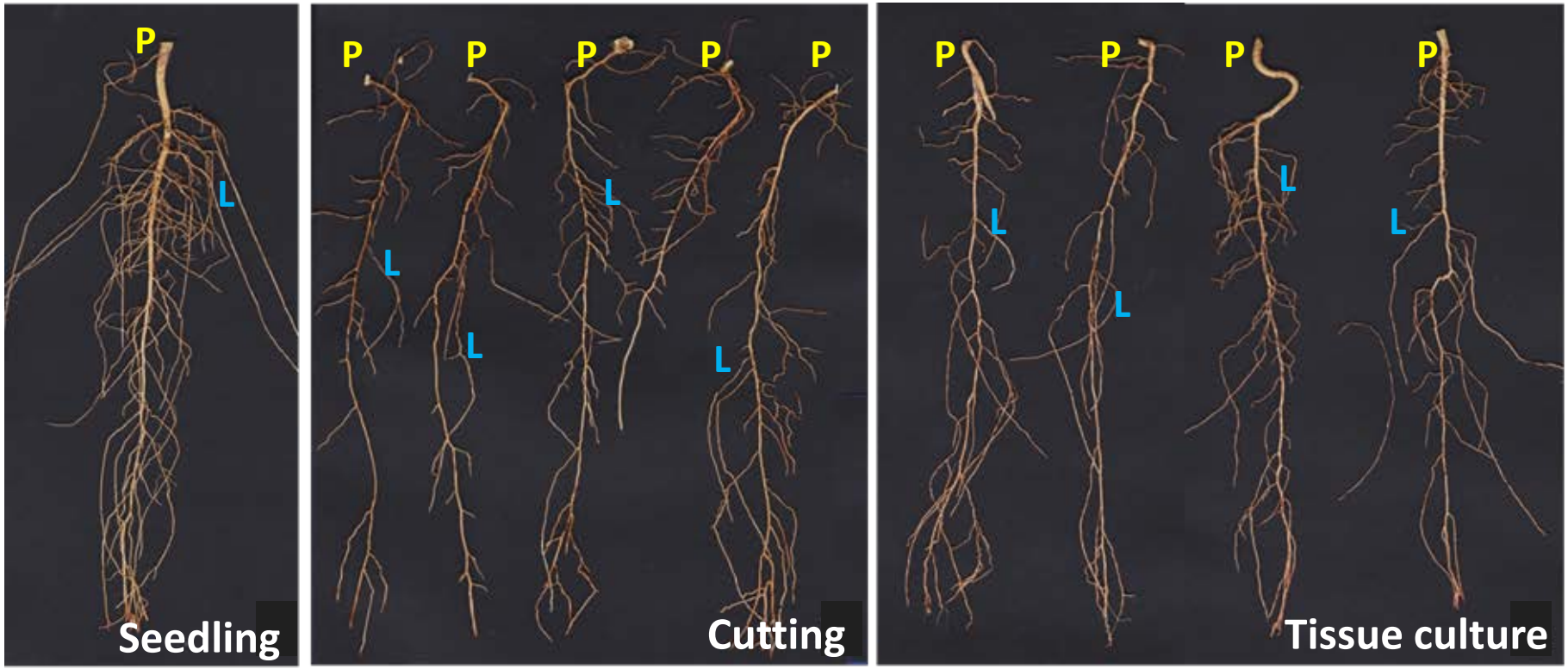
Nursery stage

Non-grafted young rootstocks plants

Grafted field-ready plants (Valencia)

Root architecture

Young non grafted plants



Traits assessed:

- Number of primary roots (P)
- Number of lateral roots (L)
- Specific root length (m/g)

Root architecture

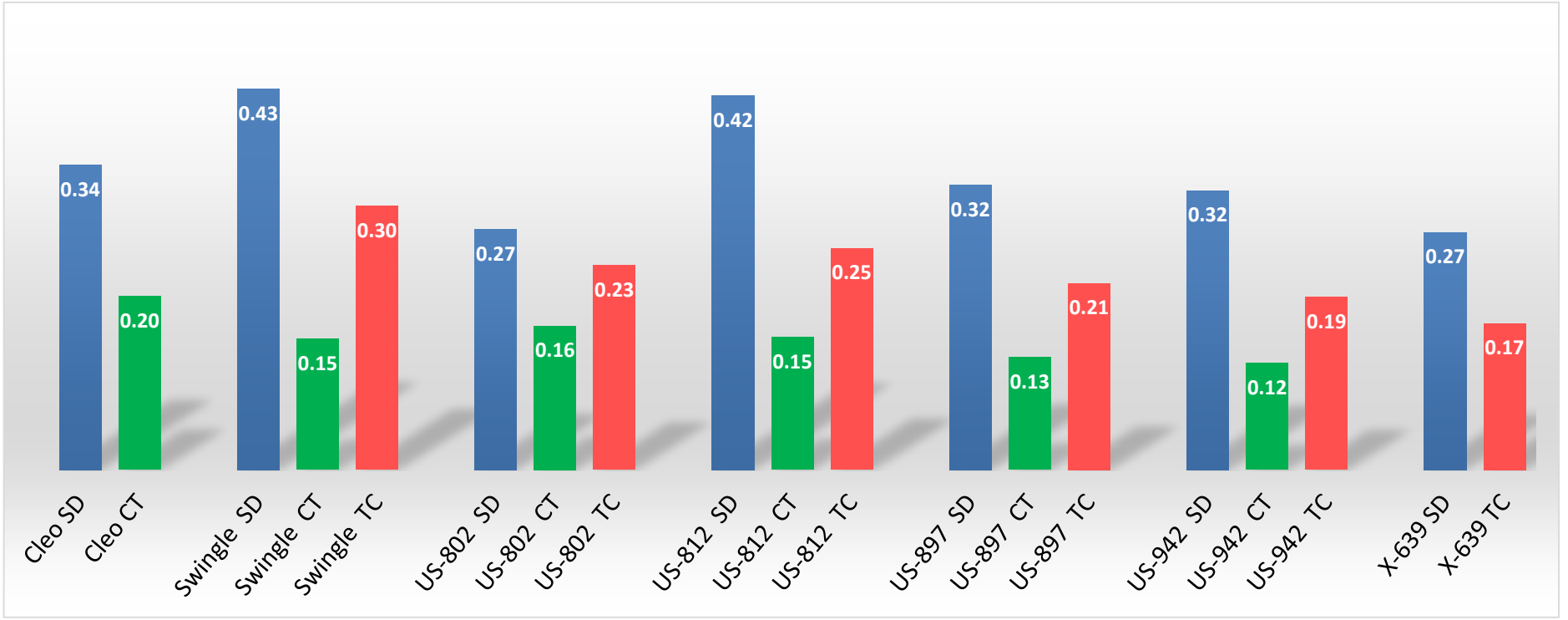
- Seed propagated rootstocks produced mostly one well-defined taproot.
- TC plants and cuttings produced many primary/ adventitious roots (4-8).
- TC plants and cuttings produced a considerably larger number of lateral roots (82-138) than seedlings (62).
- TC plants and cuttings had a higher specific root length (m/g) than seedlings.

Rootstock effect

Young non grafted plants

Root to shoot ratio

Young non grafted plants



Significant differences between plants propagated by seed, cuttings, and TC.

What does this mean?

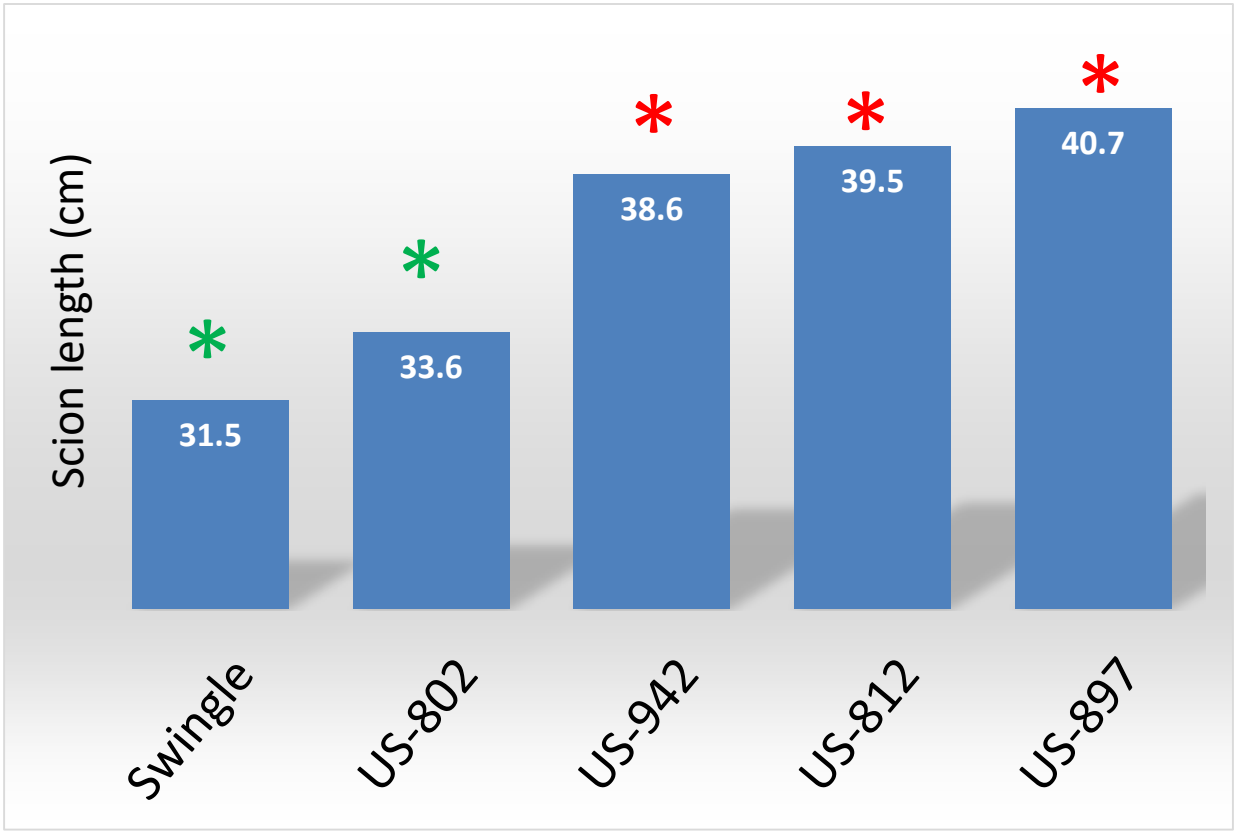
- Plants with a higher specific root length and smaller root to shoot ratio are generally considered very efficient in taking up nutrients and water.

→ Commercial nurseries may have to adjust their management practices based on the method by which rootstock liners are produced.

Effect on grafting (Valencia)

- Bud survival was not affected by propagation method.
- Grafted shoot growth was not different on seed propagated rootstocks compared with TC propagated rootstocks.
- But, grafted shoot length was lower on cuttings.

Grafted shoot length (Valencia)

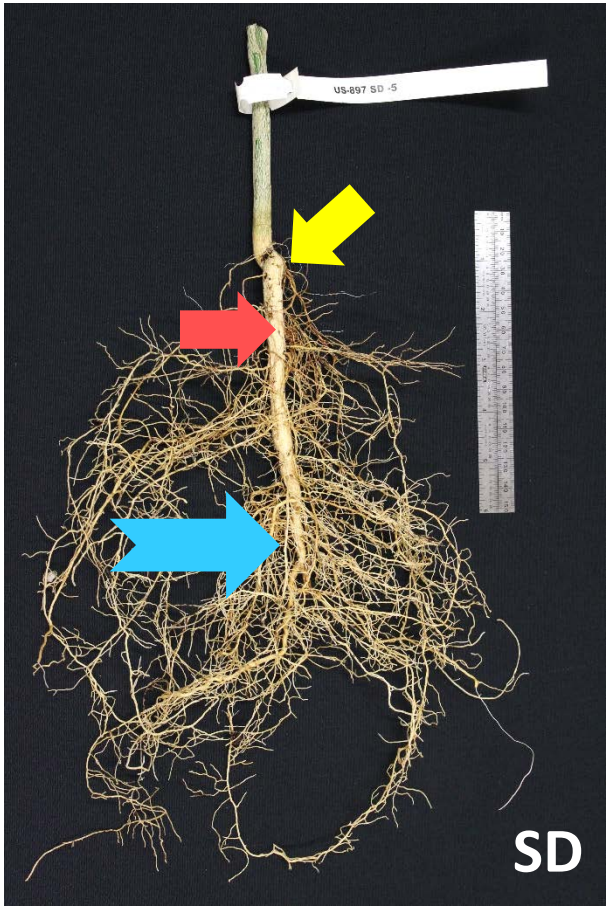


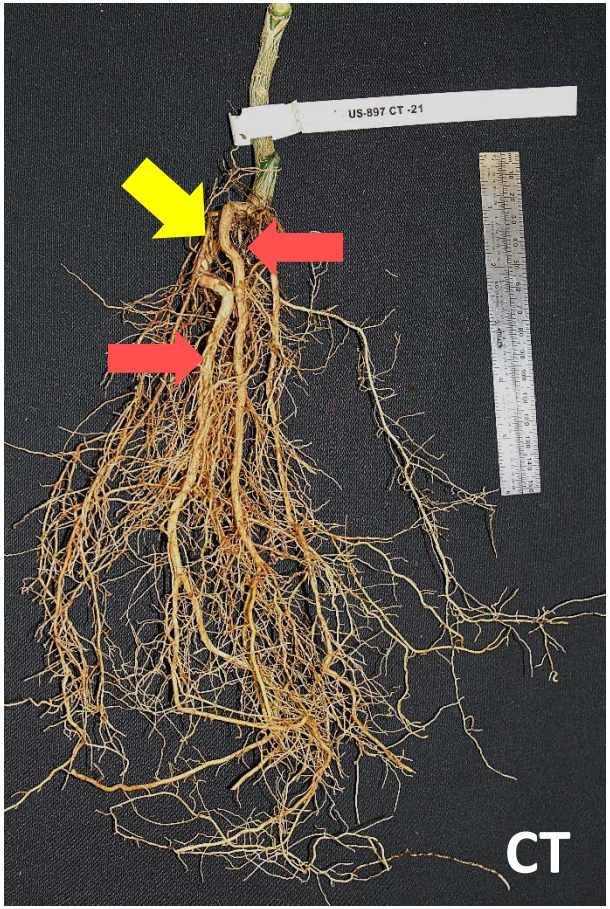
→ Rootstock effect

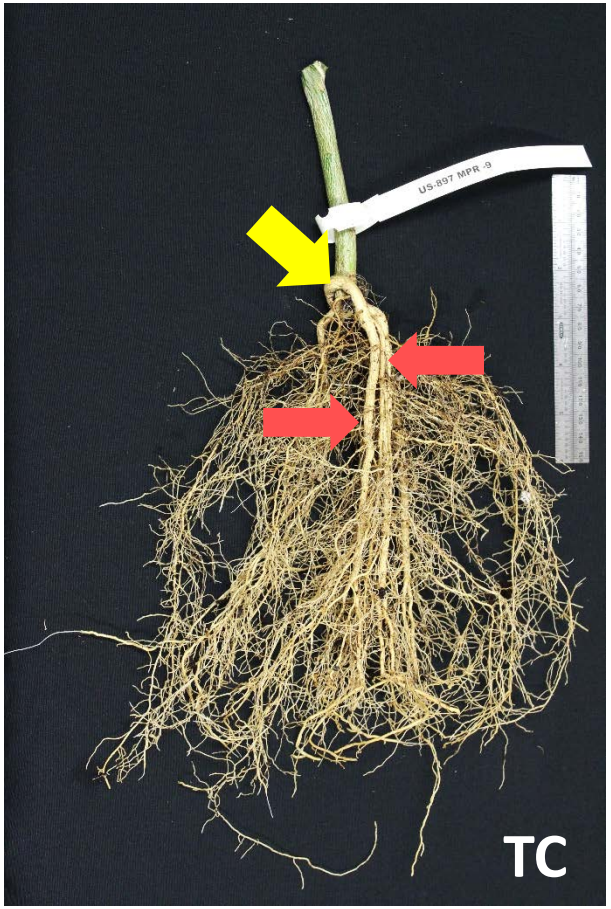
Field-ready Valencia trees

Bud date: April 2017 – Analysis: Nov 2017

Field-ready Valencia trees



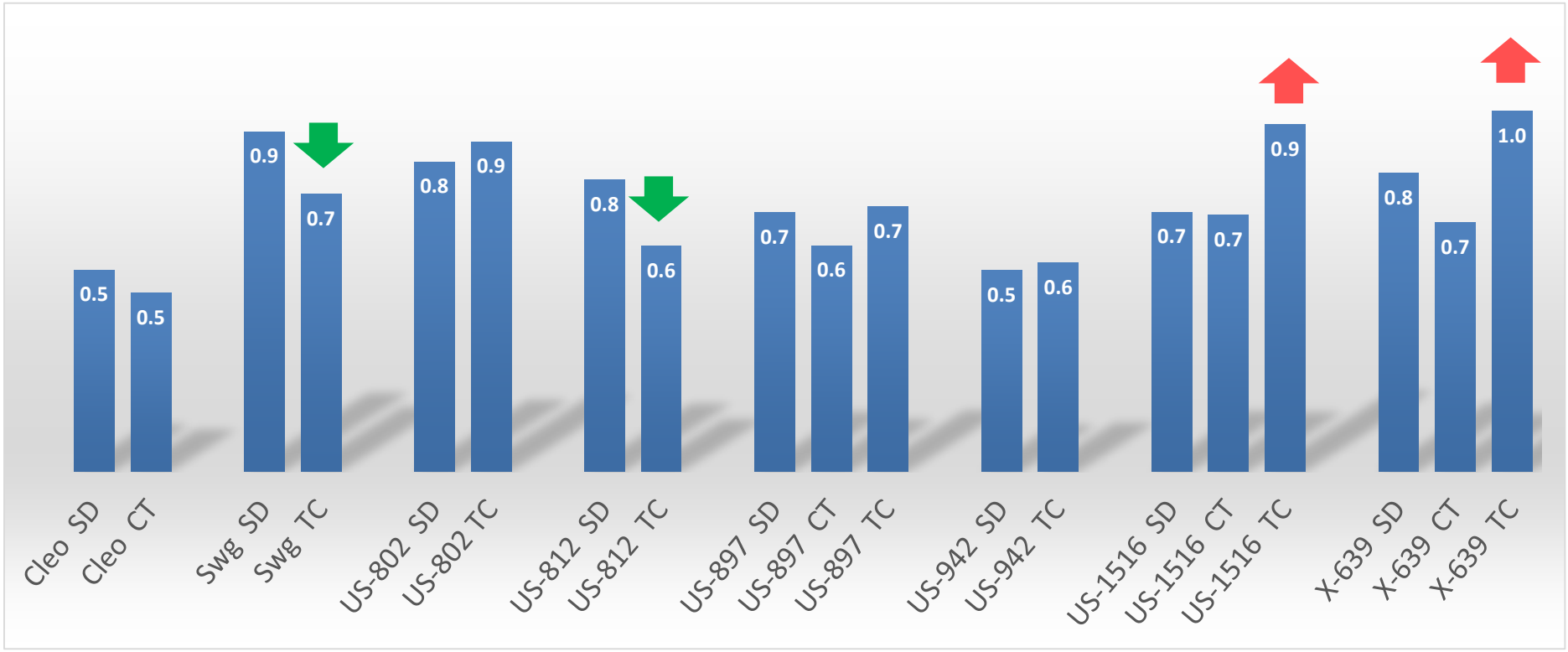




US-897

Root to shoot ratio

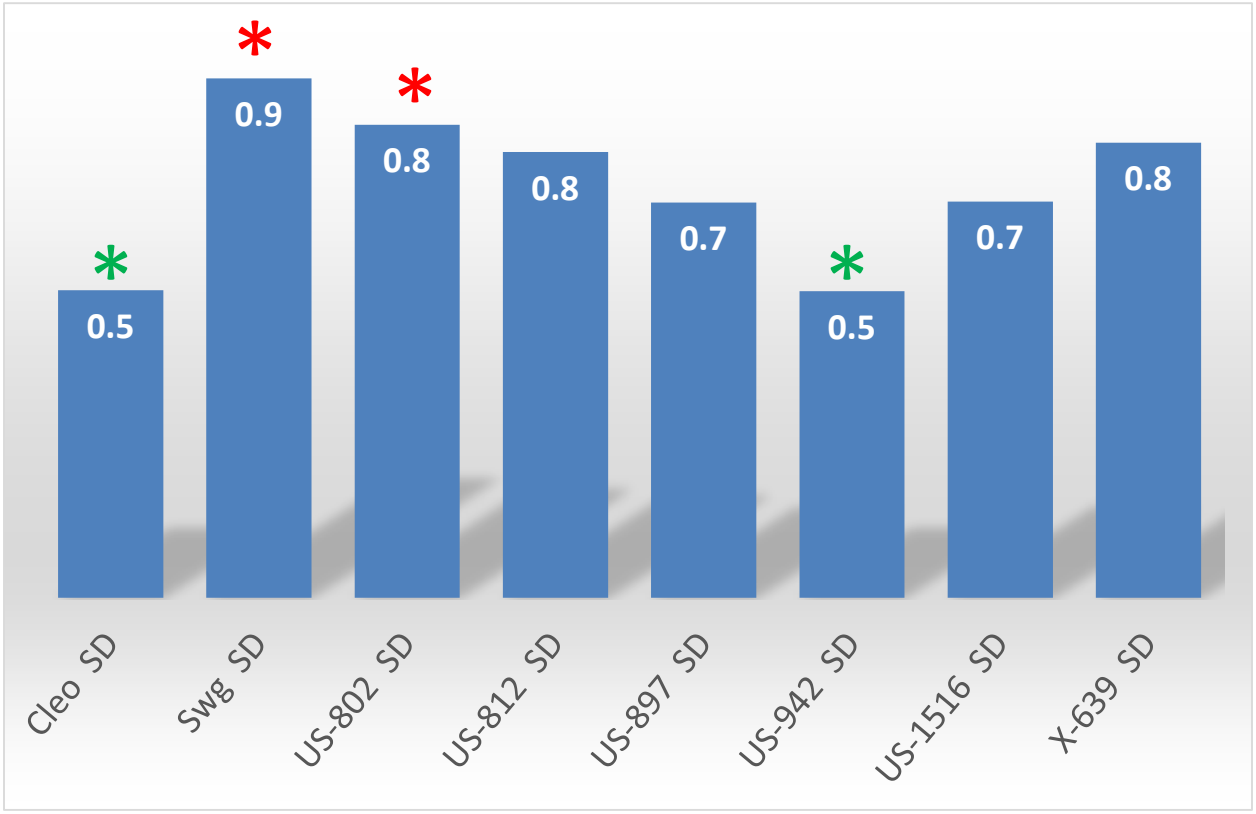
Field-ready Valencia trees



Root to shoot ratio differences are not correlated with the propagation method.

Root to shoot ratio

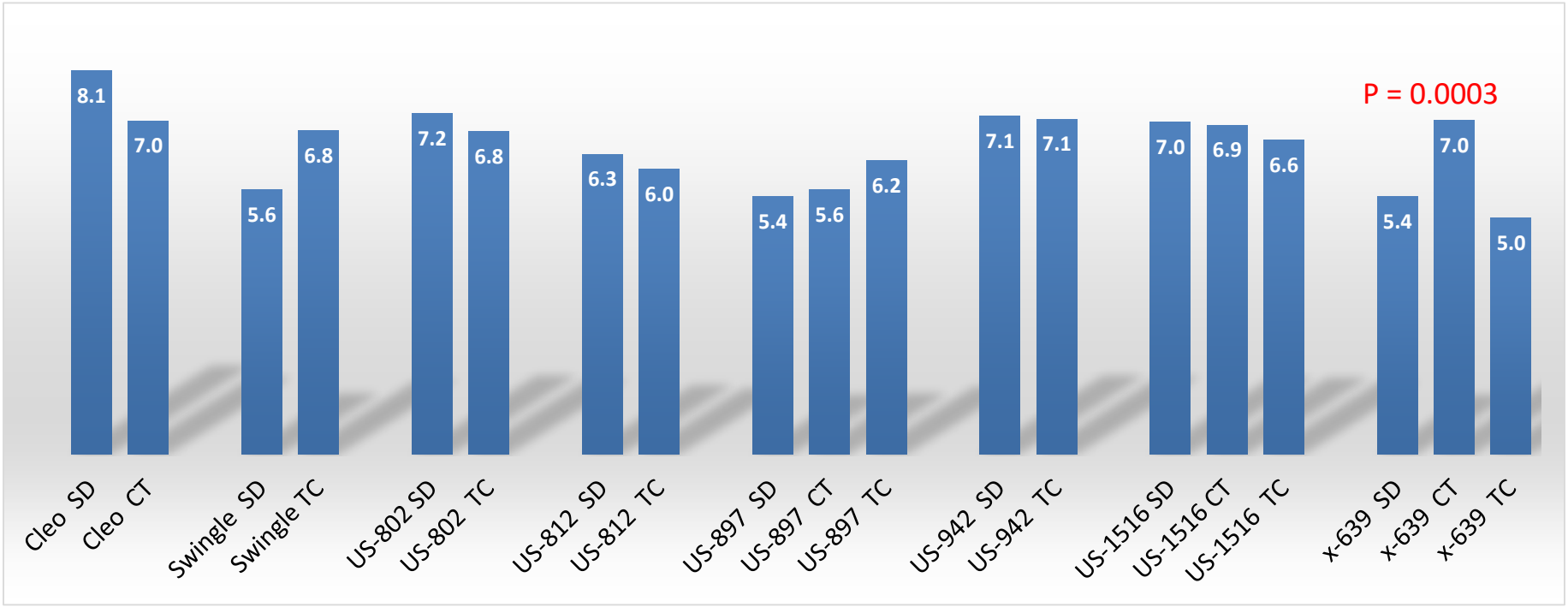
Field-ready Valencia trees



→ Rootstock effect

Scion trunk diameter (mm)

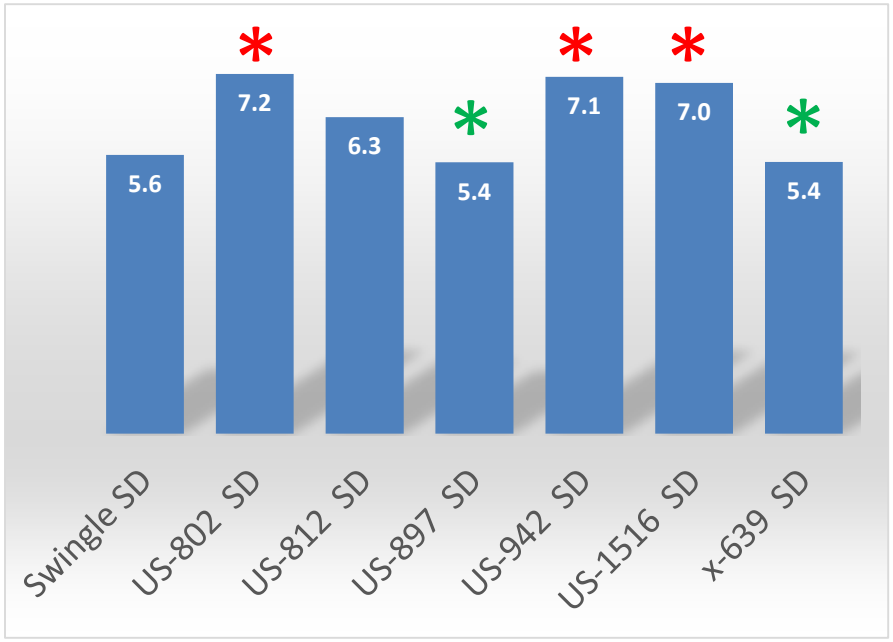
Field-ready Valencia trees

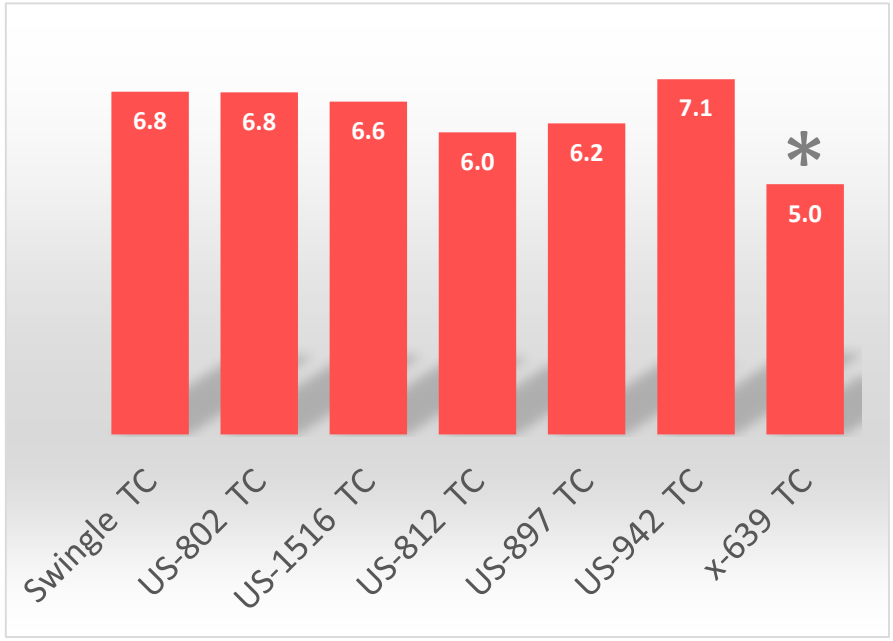


Except for X-639, no trunk diameter differences associated with rootstock propagation method were observed.

Scion trunk diameter (mm)

Field-ready Valencia trees

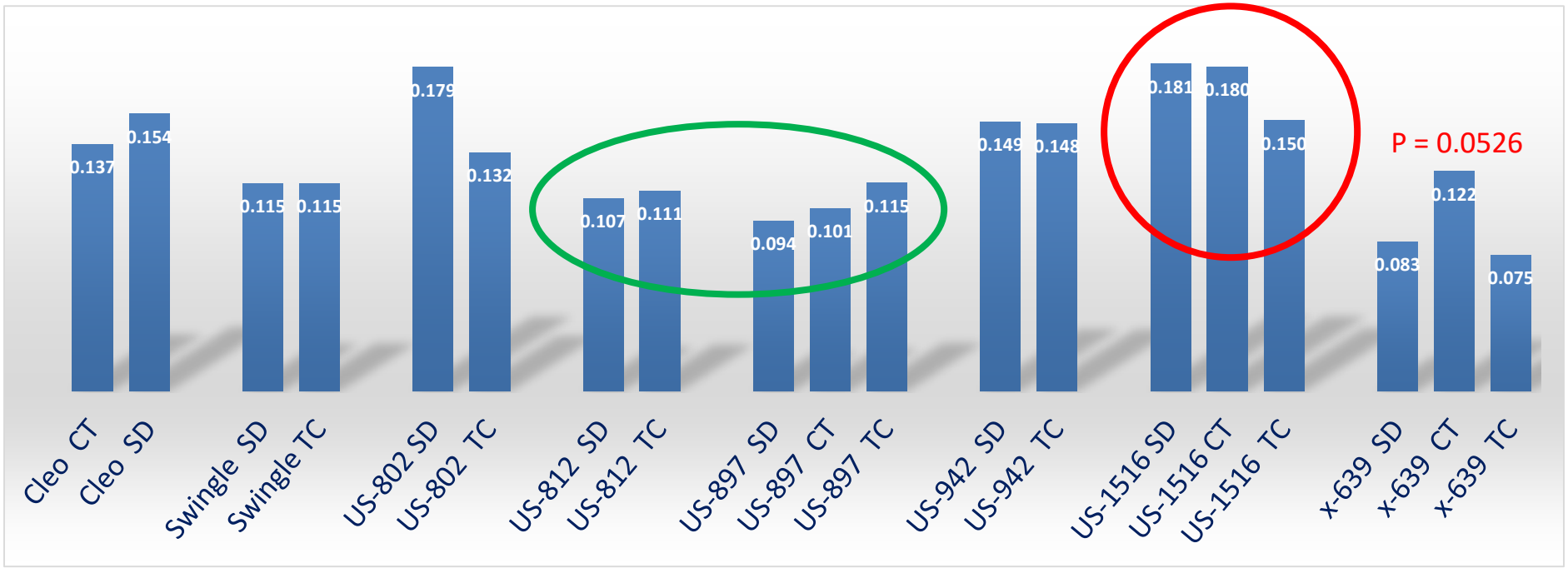




Trunk diameter varied significantly among plants on different rootstocks propagated by **seed**, but not on different rootstocks propagated by **TC**.

Leaf area (cm^2)

Field-ready Valencia trees



Except for X-639, no leaf area differences associated with rootstock propagation method were observed.

But, leaf area varied depending on the rootstock.

Summary

- Differences in root architecture were found among differently propagated plants, but also among different rootstocks.
- In non-grafted plants the root to shoot ratio was lower in cuttings and TC plant than in seedlings.
- The root to shoot ratio was **not different in field-ready grafted plants** on rootstocks propagated by seed, cuttings or TC, but **differed depending on the rootstock**.
- Other plant parameters were also not affected by rootstock propagation method in field-ready plants

What are the possible implications for field performance?

Field trial SWFREC – Nov 2017

Monthly root imaging

Image analysis to assess root growth

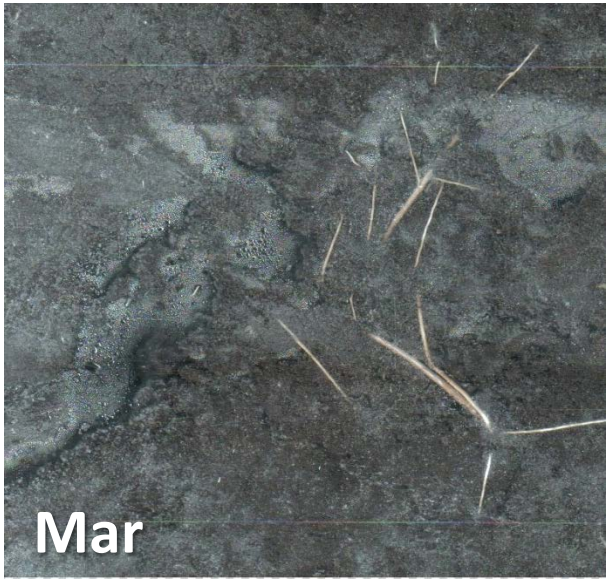
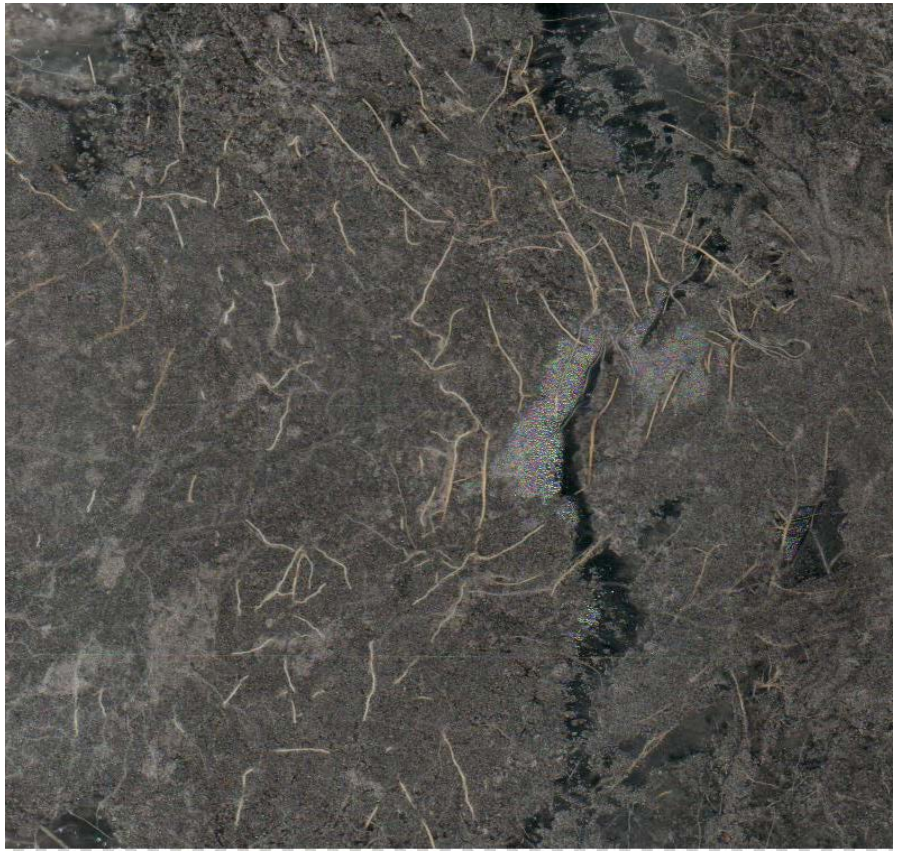
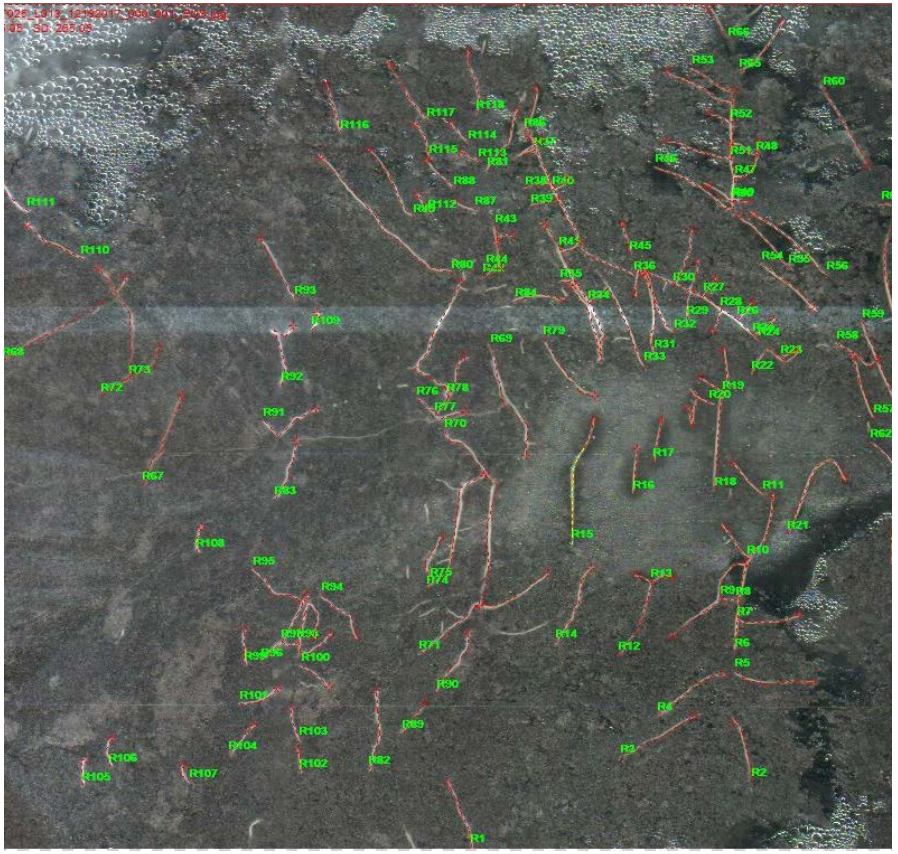
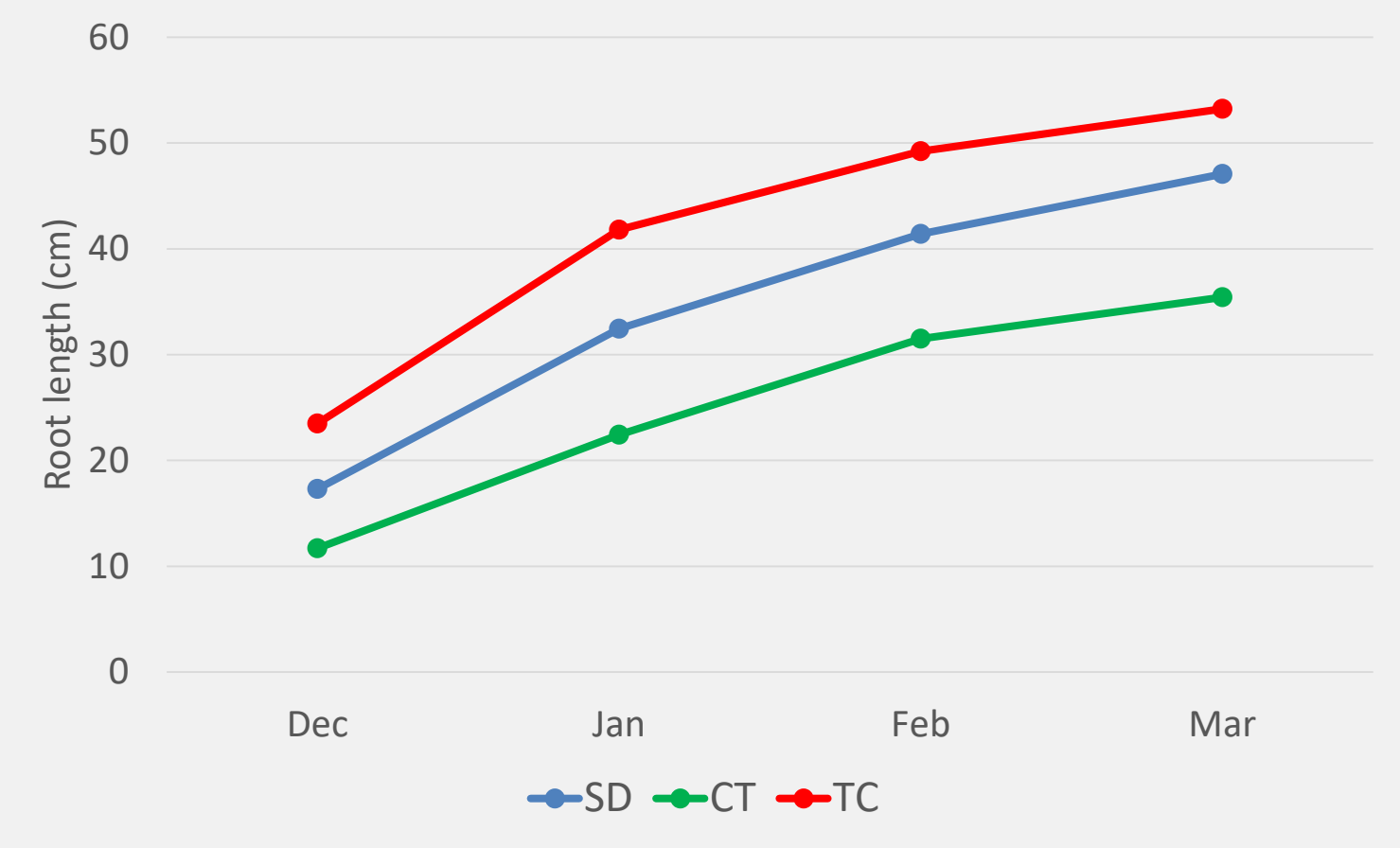


Image analysis to assess root growth





Root growth over 4 months



Average: US-802, US-812, US-897, US-942, US-1516, ~~Swingle~~

What about root anchorage?


East coast

Central Ridge

Photo credit: Chris Oswalt

Conclusions

- The root architecture and anchorage in the upper zone of the soil will be the most critical factor in the susceptibility of citrus trees to wind-induced damage.
- It is expected that rootstock-specific traits will have a larger influence on field performance than the method by which it was propagated.

Thank you

All collaborators & UF/IFAS Citrus Research Initiative

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