Citrus Research and
Development Foundation, Inc.

NOTICE OF A MEETING
OF THE
CITRUS RESEARCH AND DEVELOPMENT FOUNDATION
SELECT COMMITTEE ON PLANT IMPROVEMENT
Wednesday, December 2, 2020 – 9:00 am EST

TIME AND PLACE OF MEETING

A TELECONFERENCE meeting of the Select Committee on Plant Improvement of the Citrus Research and Development Foundation, Inc. will be held on **Wednesday, December 2, 2020 at 9:00 am EST.** This meeting is accessible via Zoom Video Conferencing. To join Zoom Meeting visit https://ufl.zoom.us/j/96076167423 and enter the Meeting ID: 960 7616 7423 or by dialing 646-558-8656 and entering participant access code/Meeting ID 960 7616 7423 when prompted.

To avoid interruptions/distractions during the call, please be mindful of the following:

- When speaking, please say your name so that the minutes can be properly captured.
- Please mute your line whenever you are not speaking to prevent background noise from disrupting the meeting and ensure the best sound quality during the call.
- If you have any problems during your call, please text Audrey Nowicki at 412-554-5143 or Deidra Whatley at 863-412-1071, to try to help resolve the problem immediately.

Pursuant to the provisions of the Americans with Disabilities Act, any person requiring special accommodations to participate in this meeting is asked to advise the Foundation at least 72 hours in advance by contacting Deidra Whatley by phone at (863) 956-8817 or by email at d.whatley@citrusrdf.org.

CITRUS RESEARCH AND DEVELOPMENT FOUNDATION
SELECT COMMITTEE ON PLANT IMPROVEMENT
Wednesday, December 2, 2020 – 9:00 am EST

AGENDA

A. Call to Order

B. Roll Call/Determination of Quorum

C. Plant Breeder Goals for the Committee

D. Review and discussion of rootstock recommendations from field trial template data summary

1. UF-IFAS Recommended Rootstocks *
2. USDA Recommended Rootstocks *
    a. Rootstock ranking with narrative *
3. Staff Recommendation *

E. Review and discussion of evaluation criteria and phase definitions of the plant breeding pipeline *

F. Other Business

G. Public Comments

H. Adjournment

* Materials

UF-IFAS Gmitter-Grosser - nominated rootstocks (11-23-2020)

Rootstock	Scion	County	Trial name	Availability	Planting Date	Trees per Replication	Number of Replications	Canopy Volume (M^3) *	average tree diameter	predicted optimum trees/acre	PCR_Ct *	Average Yield per Tree (Kg) *	Average boxes/tree past 2 seasons
Cleo+Carrizo	Vernia	Polk	St. Helena	seed/TC	Apr-08	4	2		8.6	256		73.48	1.8
Blue 1	Vernia	Polk	St. Helena	seed	Apr-08	4	2		10.5	209		91.85	2.25
Orange 1804	Vernia	Polk	St. Helena	seed Argentia	Apr-08	4	2		10.5	182	32	116.35	2.85
Aqua 1803	Vernia	Polk	St. Helena	seed Argentia	Apr-08	4	2		9.7	226	31.5	87.8	2.15
UFR-5	OLL-8	Osceola	Orie Lee	seed	Jun-13	2	1					89.8	2.2
Orange 14	OLL-8	Osceola	Orie Lee	seed	Jun-13	2	1					98	2.4
Orange 16	OLL-8	Osceola	Orie Lee	seed	Jun-13	2	1					72.5	1.8
UFR-1	OLL-8	Osceola	Orie Lee	seed	Jun-13	2	1					77.6	1.9
UFR-10	Marsh gft	Indian River	IR	TC	Mar-07	6	3					102.1	2.5
UFR-9	Marsh gft	Indian River	IR	TC	Mar-07	6	3					89.8	2.2

UF-IFAS Gmitter-Grosser - nominated rootstocks (11-23-2020)

Rootstock	Scion	Average Annual Yield per Plot (Kg)*	Average Cumulative Yield per Plot (Kg)	Yield Efficiency Kg/Cubic Meter *	Annual Pound Solids per Acre average last 2 seasons	Projected Cumulative Pound Solids Per Acre	Fruit Size (g) *	Annual Brix*	Annual Acid *	Annual Ratio *	Annual Pound Solids per Box average of last two seasons *
Cleo+Carrizo	Vernia	293.9			3115	21,214					6.8
Blue 1	Vernia	367.4			2,940	20,579					6.3
Orange 1804	Vernia	465.4			3,380	20,503					6.45
Aqua 1803	Vernia	351.1			3,191	19,863					6.5
UFR-5	OLL-8	179.6						12.2			6.9
Orange 14	OLL-8	196						11.3			6.3
Orange 16	OLL-8	145						11.9			6.8
UFR-1	OLL-8	155						12.3			6.85
UFR-10	Marsh gft	612.6									4.1
UFR-9	Marsh gft	539									4.1

USDA-Bowman - nominated rootstocks (11-23-2020)

Rootstock	Scion	County	Trial name	Availability	Planting Date	Trees per Replication	Number of Replications
US-1282	Hamlin	St Lucie	USDA Picos 2000	no MTA - no seed	2000	1	7
US-1282	Valencia	Hendry	USDA LaBelle 2016	no MTA - no seed	2016	1	5
US-1282	Valencia	St Lucie	Picos 2017 MAC	no MTA - seed available	2017	3	6
US-1283	Hamlin	St Lucie	USDA Picos 2000	no MTA - seed available	2000	1	7
US-1283	Hamlin	Lake	USDA Conserv 2002	no MTA - seed available	2002	2	6
US-1283	Valencia	St Lucie	Picos 2017 MAC	no MTA - seed available	2017	3	7
US-1516	Valencia	Polk	USDA Lake Wales 2008	no MTA - seed available	2008	3	7
US-1516	Hamlin	Lake	USDA WF 2015	no MTA - seed available	2015	1	8
US-1516	Valencia	St Lucie	USDA Picos 2016	no MTA - seed available	2016	1	12
US-1516	Valencia	St Lucie	USDA Picos 2017-5	no MTA - seed available	2017	1	12
US-SS3	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1	10
US-SS3	Hamlin	Lake	USDA WF 2015		2015	1	8
US-SS3	Hamlin	Lake	USDA WF 2015b7		2015	1	8
US-2111	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1	11
US-2111	Valencia	St Lucie	USDA Picos 2015	need MTA - no seed	2015	1	12
US-2111	Hamlin	Lake	USDA WF 2015	need MTA - no seed	2015	1	8
US-2111	Valencia	Hendry	USDA LaBelle 2016	need MTA - no seed	2016	1	5
US-1688	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1	11
US-1688	Valencia	Hendry	USDA LaBelle 2014 V	need MTA - no seed	2014	2	3
US-1281	Hamlin	St Lucie	USDA Picos 2000	no MTA - no seed	2000	1	7
US-1281	Hamlin	Lake	USDA Conserv 2006	no MTA - no seed	2006	1	
US-1281	Valencia	Hendry	USDA LaBelle 2016	no MTA - no seed	2016	1	5
US-1281	Valencia	St Lucie	Picos 2017 MAC	no MTA - seed available	2017	2	6
US-1279	Hamlin	St Lucie	USDA Picos 2000	no MTA - no seed	2000	1	7
US-1279	Hamlin	Lake	USDA Conserv 2006	no MTA - no seed	2006	1	
US-SS1	Hamlin	Lake	USDA WF 2011	no MTA - no seed	2011	1	5
US-SS1	Valencia	St Lucie	USDA Picos 2014		2014	1	9
US-2109	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1	8
US-2109	Hamlin	Lake	USDA WF 2015	need MTA - no seed	2015	1	8
US-2109	Hamlin	Lake	USDA WF 2015b7		2015	1	8
US-1694	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1	10
US-1694	Valencia	Hendry	USDA LaBelle 2014 V	need MTA - no seed	2014	2	3
US-1694	Valencia	St Lucie	USDA Picos 2017	need MTA - no seed	2017	1	12
US-1284	Hamlin	St Lucie	USDA Picos 2000	no MTA - seed available	2000	1	7
US-SS2	Hamlin	Lake	USDA WF 2011	no MTA - no seed	2011	1	5
US-1649	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1	10
US-1649	Hamlin	Lake	USDA WF 2015	need MTA - no seed	2015	1	8
US-1649	Valencia	St Lucie	USDA Picos 2017	need MTA - no seed	2017	1	12
US-2338	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1	8
US-2338	Valencia	Hendry	USDA LaBelle 2016	need MTA - no seed	2016	1	5
US-1672	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1	10
US-1709	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1	10

USDA-Bowman - nominated rootstocks (11-23-2020)

Rootstock	Scion	Trees per acre	Is the nominated rootstock a part of a MAC trial? (indicate MAC trial by name)	Canopy Volume (M^3) *	PCR_Ct *	Canopy health (5 is best)	Tree Survival (%)	Number of harvests measured
US-1282	Hamlin	182		3.91	24.7		100	8
US-1282	Valencia	182					100	1
US-1282	Valencia	283	Picos, Graves 1, Becks, Parker	1.63		4.3		
US-1283	Hamlin	182		4.13	25.1		100	8
US-1283	Hamlin	121					100	10
US-1283	Valencia	283	Picos, Deseret 1	1.86		4.4	100	
US-1516	Valencia	120	Graves 1, Parker, Bentley II	6.28	27		100	4
US-1516	Hamlin	243					100	3
US-1516	Valencia	283		1.2		3.8	100	1
US-1516	Valencia	283		1.0		4.0		
US-SS3	Valencia	259		2.63		4.0	100	3
US-SS3	Hamlin	243				3.0	100	3
US-SS3	Hamlin	251					100	1
US-2111	Valencia	259		2.34		4.3	100	3
US-2111	Valencia	259		1.33		3.5	100	2
US-2111	Hamlin	243				3.4	100	3
US-2111	Valencia	182					100	1
US-1688	Valencia	259		3.52		4.9	92	3
US-1688	Valencia	174					100	2
US-1281	Hamlin	182		3.00	24.7		100	8
US-1281	Hamlin	121						4
US-1281	Valencia	182					100	1
US-1281	Valencia	283	Picos, Graves 1, Bentley 1, Parker	1.67		3.7	100	
US-1279	Hamlin	182		4.03	25.1		100	8
US-1279	Hamlin	121						4
US-SS1	Hamlin	182						3
US-SS1	Valencia	259		2.38		4.2	90	3
US-2109	Valencia	259		2.32		3.9	100	3
US-2109	Hamlin	243				3.2	100	3
US-2109	Hamlin	251					100	1
US-1694	Valencia	259		2.43		4.4	100	3
US-1694	Valencia	174					67	2
US-1694	Valencia	259		1.1		4.0	100	
US-1284	Hamlin	182		5.28	24.5		100	8
US-SS2	Hamlin	182						3
US-1649	Valencia	259	Bentley II	2.30		4.3	91	3
US-1649	Hamlin	243				3.3	100	3
US-1649	Valencia	259		0.7		3.5	100	
US-2338	Valencia	259		2.33		4.5	100	3
US-2338	Valencia	182					100	1
US-1672	Valencia	259		2.83		4.6	100	3
US-1709	Valencia	259		2.82		5.0	100	3

USDA-Bowman - nominated rootstocks (11-23-2020)

Rootstock	Scion	Average Annual Yield per Tree (Kg) *	Average Cumulative yield per tree (Kg)	Average Annual Yield per Acre (Kg)	Average Cumulative yield per acre (Kg)	Average Annual Yield per Plot (Kg)*	Average Cumulative Yield per Plot (Kg)	Yield Efficiency Kg/Cubic Meter *	Annual Pound Solids per Acre *
US-1282	Hamlin	51	374	9,282	68,068				885
US-1282	Valencia	11.7	11.7	2,129	2,129				
US-1282	Valencia								
US-1283	Hamlin	42	348	7,644	63,336				708
US-1283	Hamlin	111	524	13,431	63,404				1143
US-1283	Valencia								
US-1516	Valencia	65	211	7,800	25,320	195	633	10.35	885
US-1516	Hamlin	11.3	17.8	2,746	4,325				
US-1516	Valencia	1.2	1.2	340	340				
US-1516	Valencia								
US-SS3	Valencia	11.4	31.8	2,953	8,236			4.33	317
US-SS3	Hamlin	9.6	14.6	2,333	3,548				
US-SS3	Hamlin	2.4	2.4	602	602				
US-2111	Valencia	14.2	30.9	3,652	8,003			6.07	386
US-2111	Valencia	8.6	15.0	2,227	3,885				
US-2111	Hamlin	8.9	16.2	2,163	3,937				
US-2111	Valencia	11.3	11.3	2057	2057				
US-1688	Valencia	15.6	37.9	4,040	9,816			4.43	388
US-1688	Valencia	20.0	35.5	3,480	6,177				
US-1281	Hamlin	38	319	6,916	58,058				678
US-1281	Hamlin	74	153	8,954	18,513				
US-1281	Valencia	12.6	12.6	2293	2293				
US-1281	Valencia								
US-1279	Hamlin	45	330	8,190	60,060				793
US-1279	Hamlin	55	123	6,655	14,883				
US-SS1	Hamlin	23	33	4,186	6,006				438
US-SS1	Valencia	8.6	20.5	2,227	5,310			3.61	213
US-2109	Valencia	8.5	29.6	2,202	7,666			3.66	229
US-2109	Hamlin	9.8	16.3	2,381	3,961				
US-2109	Hamlin	3.0	3.0	753	753				
US-1694	Valencia	12.7	27.3	3,289	7,071			5.23	324
US-1694	Valencia	18.2	29.5	3,167	5,133				
US-1694	Valencia								
US-1284	Hamlin	47	353	8,554	64,246				826
US-SS2	Hamlin	35	46	6,370	8,372				680
US-1649	Valencia	13.8	29.8	3,574	7,718			6.00	333
US-1649	Hamlin	6.7	14.4	1,628	3,499				
US-1649	Valencia								
US-2338	Valencia	15.8	33.3	4,092	8,625			6.78	398
US-2338	Valencia	14.7	14.7	2,675	2,675				
US-1672	Valencia	14.7	33.0	3,807	8,547			5.19	356
US-1709	Valencia	14.3	30.0	3,704	7,770			5.07	354

USDA-Bowman - nominated rootstocks (11-23-2020)

Rootstock	Scion	Cumulative Pound Solids Per Acre	Fruit Size (g) *	Annual Brix*	Annual Acid *	Annual Ratio *	Percent juice	Annual Pound Solids per Box *
US-1282	Hamlin	6,489	194	8.67	0.61	14.2		3.90
US-1282	Valencia							
US-1282	Valencia							
US-1283	Hamlin	5,868	190	8.43	0.62	13.6		3.79
US-1283	Hamlin	5,394		7.74	0.73	10.8		3.48
US-1283	Valencia							
US-1516	Valencia	2,872	212	9.41	0.76	12.5	54.8	4.64
US-1516	Hamlin							
US-1516	Valencia							
US-1516	Valencia							
US-SS3	Valencia	886	160	9.14	0.76	12.0	53.5	4.40
US-SS3	Hamlin							
US-SS3	Hamlin							
US-2111	Valencia	845	180	8.61	0.72	12.0	55.8	4.32
US-2111	Valencia		227					
US-2111	Hamlin							
US-2111	Valencia							
US-1688	Valencia	943	175	8.20	0.70	11.7	53.2	3.93
US-1688	Valencia		210					
US-1281	Hamlin	5,691	190	8.90	0.62	14.4		4.01
US-1281	Hamlin							
US-1281	Valencia							
US-1281	Valencia							
US-1279	Hamlin	5,814	193	8.80	0.62	14.1		3.96
US-1279	Hamlin							
US-SS1	Hamlin	628	141	9.7	0.63	15.3	49.0	4.28
US-SS1	Valencia	509	197	8.13	0.71	11.5	53.6	3.92
US-2109	Valencia	798	183	8.74	0.74	11.8	54.2	4.26
US-2109	Hamlin							
US-2109	Hamlin							
US-1694	Valencia	697	196	8.20	0.75	10.9	54.6	4.03
US-1694	Valencia							
US-1694	Valencia							
US-1284	Hamlin	6,203	185	8.77	0.65	13.4		3.95
US-SS2	Hamlin	894	151	9.9	0.63	15.8	49.0	4.37
US-1649	Valencia	719	188	8.13	0.69	11.8	52.1	3.81
US-1649	Hamlin							
US-1649	Valencia							
US-2338	Valencia	839	195	8.08	0.66	12.2	54.7	3.98
US-2338	Valencia							
US-1672	Valencia	800	169	8.14	0.72	11.3	52.3	3.83
US-1709	Valencia	743	168	8.17	0.70	11.7	53.2	3.91

USDA Rootstocks - Ranking for potential use in stage 3 trials

Kim.Bowman@usda.gov

Rank	Rootstock	USDA Status	DPI Status	Narrative on rootstock performance in replicated sweet orange trials
1	US-1282	Released	Available	US-1282 had superior yields in two multiyear trials severely affected by HLB; looking good in one younger trial; fruit is high solids.
2	US-1283	Released	Available	US-1283 had superior yields in two multiyear trials severely affected by HLB; looking good in one younger trial; fruit is medium solids.
3	US-1516	Released	Available	US-1516 had superior yields in two multiyear trials severely affected by HLB; looking good in one younger trial; fruit is medium solids.
4	US-SS3	Released	Available	US-SuperSour 3 had superior yields in two multiyear trials severely affected by HLB; looking good in one younger trial; fruit is high solids.
5	US-2111	Need MTA	Finished	US-2111 had superior yields in two multiyear trials severely affected by HLB; looking good in two younger trials; fruit is high solids.
6	US-1688	Need MTA	Finished	US-1688 had superior yields in two multiyear trials severely affected by HLB; fruit is high solids.
7	US-1281	Released	Available	US-1281 had superior yields in two multiyear trials severely affected by HLB; looking good in two younger trials; fruit is high solids.
8	US-1279	Released	Available	US-1279 had superior yields in two multiyear trials severely affected by HLB; fruit is high solids.
9	US-SS1	Released	Available	US-SuperSour 1 had medium yields in two multiyear trials severely affected by HLB; fruit is high solids.
10	US-2109	Need MTA	Finished	US-2109 had superior yields in two multiyear trials severely affected by HLB; looking good in one younger trial; fruit is high solids.
11	US-1694	Need MTA	Finished	US-1694 had superior yields in two multiyear trials severely affected by HLB; looking good in one younger trial; fruit is high solids.
12	US-1284	Released	Available	US-1284 had superior yield in one multiyear trial severely affected by HLB; fruit is high solids.
13	US-SS2	Released	Available	US-Supersour 2 had superior yield in one multiyear trial severely affected by HLB; fruit is high solids.
14	US-1649	Need MTA	Finished	US-1649 had superior yield in one multiyear trial severely affected by HLB; looking good in two younger trials; fruit is high solids.
15	US-2338	Need MTA	Finished	US-2338 had superior yield in one multiyear trial severely affected by HLB; looking good in one younger trial; fruit is high solids.
16	US-1672	Need MTA	Finished	US-1672 had superior yield in one multiyear trial severely affected by HLB; fruit is high solids.
17	US-1709	Need MTA	Finished	US-1709 had superior yield in one multiyear trial severely affected by HLB; fruit is high solids.

Citrus Research and Development Foundation, Inc.

MEMORANDUM

To: Member of the CRDF Select Committee on Plant Improvement
From: Rick Dantzler
RE: Staff Recommendations for the CRDF Phase III Field Trial
Date: November 25, 2020

Note: Sorting through the data provided by the plant breeders has been difficult. Each has his or her own way of working material through the plant breeding pipeline and there is not a standard way of measuring relevant growing characteristics of each cultivar. The difficulties of comparing the cultivars has reinforced my belief that it is imperative that uniformity be brought to our plant breeding efforts or the frustration growers have felt when trying to analyze data to make planting decisions will continue.

Please pardon the dictum, but I'm told that nearly every other crop in commercial production has a standardized method for plant evaluation, which includes clearly defined objectives and measurements for advancing new plant material from the point of creation to the point of release to the industry. Citrus has unique challenges, certainly, but some level of standardization is crucial.

I am sure that you will have comments on these recommendations. It is entirely possible that we missed something in our analysis, but please know that many hours from several persons went into trying to compare the nominations from the breeders.

While we have tried to fairly present the most worthy nominations, with so little data accompanying some of the them and because the breeding efforts have been so varying it is my belief that we should not take final action on the recommendations at the December 2nd meeting. Instead, I suggest that we only discuss them and wait until the next meeting (sometime in January) before taking final action. While I had hoped we would have these recommendations in time for board action in December, we must get it right since making the proper selections is the lynchpin for the success of the trial. CRDF staff will take the comments from the breeders and committee members at the December 2nd meeting and prepare a list for your consideration and vote in January.

Note: Staff is aware that there are Lykes Brothers' small plot trials underway that are an excellent source of quality data on rootstock performance. Top performers are being evaluated and will be ready for your consideration at the meeting in January.

700 Experiment Station Rd. • Lake Alfred, FL 33850 • Phone: (863) 956-5894

Rootstock Nominations for CRDF Phase 3 Field Trials:

1. US-1282
    a. Yes – calculated boxes per acre is 227. This value come from a 20-year-old trial in St. Lucie County. The solids per box is 3.9 with Hamlin as the scion. Solids will likely increase with scions that produce better quality fruit. Tree survivability is 100% at 3 separate locations.
2. US-1283
    a. Yes – calculated boxes per acre is 329. This value comes from an 18-year-old trial in Lake County. The solids per box is 3.48 with Hamlin as the scion. Solids will likely increase with scion that produce better quality fruit. Tree survivability is 100% at 3 separate locations.
3. US-1516
    a. Yes – calculated boxes per acre is 190. This value comes from a 12-year-old trial in Polk County. The solids per box is 4.64 with Valencia as the scion. Tree survivability is 100% at 3 separate locations.
4. US-SS3
    a. No – the calculation of boxes per acre is low for this rootstock in 3 trial locations. The highest calculated boxes per acre value is 72. This value comes from a 6-year-old trial in St. Lucie County. Two 5-year-old trials in Lake County had lower boxes per acre, 57 and 14. Pound solids were 4.4 per box.
5. US-2111
    a. No – the calculation of boxes per acre is low for this rootstock in 4 trial locations. The highest calculated boxes per acre value is 90. This value comes from a 6-year-old trial in St. Lucie County. Two 5-year-old trials in Lake County and St. Lucie County had lower boxes per acre, 54 and 52. The final trial site is 4 years old and in Hendry County. This trial had the lowest boxes per acre at 50. Pound solids were 4.3 per box.
6. US-1688
    a. No – the calculation of boxes per acre is low for this rootstock in 2 trial locations. The highest calculated boxes per acre value is 98. This value comes from a 6-year-old trial in St. Lucie County. Another 6-year-old trial in Hendry County had lower boxes per acre, 85. Pound solids were 3.9 per box.
7. US-1281
    a. Yes – calculated boxes per acre is 219. This value comes from a 14-year-old trial in Lake County. The solids per box is 4.01 with Hamlin as the scion. Tree survivability is 100% at 3 separate locations.
8. US-1279
    a. Yes – calculated boxes per acre is 200. This value comes from a 20-year-old trial in St. Lucie County. The solids per box is 3.96 with Hamlin as the scion. Tree survivability is 100% at 2 separate locations.
9. US-SS1
    a. No – the calculation of boxes per acre is low for this rootstock in 2 trial locations. The highest calculated boxes per acre value is 102. This value comes from a 9-year-old trial in Lake County. A 6-year-old trial in St. Lucie County had lower boxes per acre, 54. Pound solids were 4.2 and 3.92 per box respectfully for each trial.
10. US-2109

a. No – the calculation of boxes per acre is low for this rootstock in 3 trial locations. The highest calculated boxes per acre value is 58. This value comes from a 5-year-old trial in Lake County with Hamlin as the scion. A 6-year-old trial in St. Lucie County had lower boxes per acre, 53. A 5-year-old trial, with Hamlin as the scion, had the lowest calculated boxes per acre, 18. Pound solids were 4.26 per box.

11. US-1694
    a. No – the calculation of boxes per acre is low for this rootstock in 2 of 3 trial locations. The highest calculated boxes per acre value is 80. This value comes from a 6-year-old trial in St. Lucie County with Valencia as the scion. A 6-year-old trial with Valencia as the scion in Hendry County had lower boxes per acre, 77. A 3-year-old trial, with Valencia as the scion, has not had harvest data collected to date. Pound solids were 4.03 per box.
12. US-1284
    a. Yes – calculated boxes per acre is 209. This value comes from a 20-year-old trial in St. Lucie County. The solids per box is 3.95 with Hamlin as the scion. This rootstock is only present in one trial location in St. Lucie County. Tree survivability is 100%.
13. US-SS2
    a. Yes – calculated boxes per acre is 156. This value comes from a 9-year-old trial in Lake County. The solids per box is 4.37 with Hamlin as the scion. This rootstock is only present in one trial location in Lake County. Tree survivability is not reported.
14. US-1649
    a. No – the calculation of boxes per acre is low for this rootstock in 2 of 3 trial locations. The highest calculated boxes per acre value is 87. This value comes from a 6-year-old trial in St. Lucie County with Valencia as the scion. A 5-year-old trial is Lake County had lower boxes per acre, 40. A 3-year-old trial, with Valencia as the scion, has had no harvest data collected to date. Pound solids were 3.81 per box.
15. US-2338
    a. No – the calculation of boxes per acre is low for this rootstock in 2 trial locations. The highest calculated boxes per acre value is 100. This value comes from a 6-year-old trial in St. Lucie County with Valencia as the scion. A 4-year-old trial in Lake County had the lower boxes per acre, 65. Pound solids were 3.98 per box.
16. US-1672
    a. No – the calculation of boxes per acre is low for this rootstock in a single trial. The calculated boxes per acre value is 93. This value comes from a 6-year-old trial in St. Lucie County with Valencia as the scion. Pound solids were 3.83 per box.
17. US-1709
    a. No – the calculation of boxes per acre is low for this rootstock in a single trial. The calculated boxes per acre value is 90. This value comes from a 6-year-old trial in St. Lucie County with Valencia as the scion. Pound solids were 3.91 per box.
18. Cleo + Carrizo
    a. No – Data values presented are from only 8 trees. For confidence in selecting this rootstock, more trees of this genotype are needed. The data values presented are encouraging, but additional plantings for this rootstock in various locations would greatly enhance the confidence in the data.

19. Blue 1
    a. No – Data values presented are from only 8 trees. For confidence in selecting this rootstock, more trees of this genotype are needed. The data values presented are encouraging, but additional plantings for this rootstock in various locations would greatly enhance the confidence in the data.

20. Orange 1804
    a. No – We don't expect seed to be available until July 2021. DPI will then need to screen seed for seed-borne pathogens after the seed is delivered from Argentina.

21. Aqua 1803
    a. No – We don't expect seed to available until July 2021. DPI will then need to screen seed for seed-borne pathogens after the seed is delivered from Argentina.

22. UFR-5
    a. Yes - It should be noted that data was only for trees at the Orie Lee planting. Nevertheless, this rootstock has been selected by independent growers and is included in a CRAFT Cycle 2 application. The Tropicana research planting in Lake Alfred has UFR 5 budded with Hamlin and an OLL variety. It is reported that these trees are cropping extremely well and additional analysis is forthcoming. UFR 5 is being evaluated in a small-plot trial project hosted by Lykes Brothers and is preforming well. The scion used for this nomination is OLL-8. Calculated boxes per acre is 550. Pound solids per box is 6.9, the highest value for this category from the 30 nominated rootstocks. The data presented is for 2 trees of the indicated rootstock/scion combination. Given this interest and early encouraging performance, staff is recommending it for inclusion in the trial.

23. Orange 14
    a. Yes - The data provided with the template is only for trees at the Orie Lee planting. Nevertheless, this rootstock has been selected by independent growers and is included in a CRAFT Cycle 2 application. The Tropicana research planting in Lake Alfred has Orange 14 budded with OLL 10. It is reported these trees are cropping extremely well and additional analysis is forthcoming. Orange 14 is being evaluated in a small plot trial project hosted by Lykes Brothers and is preforming well. The scion used for this nomination is OLL-8. Calculated boxes per acre is 600, the highest value for this category from the 30 nominated rootstocks. Pound solids per box is 6.3. The data presented is for 2 trees of the indicated rootstock scion combination. Given the interest and early encouraging performance, staff is recommending it for inclusion in the trial.

24. Orange 16
    a. No – the data values presented are from only 2 trees. For confidence in selecting this rootstock, more trees of this genotype are needed. The data values presented are encouraging, but additional plantings for this rootstock in various locations would greatly enhance the confidence in the data.

25. UFR-1
    a. No – the data values presented are from only 2 trees. For confidence in selecting this rootstock, more trees of this genotype are needed. The data values presented are encouraging, but additional plantings for this rootstock in various locations would greatly enhance the confidence in the data. However, this rootstock is being evaluated at the Lykes Brothers trial so more data will be forthcoming.

26. UFR-10
    a. Possible – Yield is 562 calculated boxes per acre with Marsh Grapefruit as the scion. If the data values provided are correct, this would indicate extremely good performance for a very HLB susceptible scion. This data comes from a 13-year-old trial in Indian River County. The trial design allows for evaluation of 18 trees (3 replications of 6 trees per replication). More data from other plantings would be helpful.

27. UFR-9
    a. Possible – Yield is 495 calculated boxes per acre with Marsh Grapefruit as the scion. If the data values provided are correct, this would indicate extremely good performance for a very HLB susceptible scion. This data comes from a 13-year-old trial in Indian River County. The trial design allows for evaluation of 18 trees (3 replications of 6 trees per replication). More data from other plantings would be helpful.

28. A+Volk x Orange 19-11-8
    a. No – No data provided.

29. S10xS15-12-25
    a. No – No data provided.

30. LB8-9 (SugarBelle)xS13-15-16
    a. Yes – While data is lacking, the logic is sound. We know LB8-9 preforms well as a scion. The concept that tolerance could be imparted to a scion when using LB8-9 as a rootstock parent is worth exploring. There are 50+ trees planted at the USDA Picos farm. All trees are reported to be in excellent condition.

Rootstock Development – Stage I – III

Please note, this draft document is a work in progress. It is intended to stimulate discussion on how Stage I - III trials should be conducted. This document has not been reviewed, approved, or should not be considered as a consensus of the industry or research community on how to conduct field trials.

In creating a development plan for plant improvement, one must be prepared to adjust or modify as needed to meet the changing needs of the industry, environmental conditions, markets, and pest pressure in the ever-changing Florida citrus industry. To achieve multiple goals in plant improvement, replicated field trials are conducted to evaluate horticultural traits, pest and disease tolerance/resistance, regional sites adaptability, selection of appropriate rootstock/scion combinations and to optimize planting density to maximize profitability. We will refer to these trials in three basic stages: Stage I, II and III.

Breeders have numerous areas where parent material is housed and will be used to create new crosses. Having sufficient sources and numbers of parent material is essential to any successful plant breeding program.

Prior to Stage I field trials, the plant breeder must select parents, make new hybrids, grow out hybrids, conduct pre-screening and testing to identify selected new rootstocks, and then propagate trees on the new rootstocks to be included in Stage I trials. From pre-Stage I and through Stage I, the plant breeder is in complete control of the process and has autonomy to make all crosses, select hybrids, and conduct trials to best make use of resources to achieve the project goals. Crosses may come from a variety of sources, including but not limited to traditional plant breeding, to laboratory procedures to create new plant material, irradiation and other techniques. However, throughout this process, breeders should be in dialog with producers to make sure they are breeding plants that meet the needs of the citrus industry for both fresh and processed markets.

In the UF program prior to field trials, new rootstock selections are subjected to a comprehensive study to determine their ability to survive in harsh conditions which include calcareous soil, high pH, salinity, and two species of phytophthora. Seedlings that remain vigorous and dark green after the study will be moved to additional trials based upon their superior performance in harsh conditions.

Newly created plant material is first tested with only a few trees and later tested with an increasing number of selections that appear to be promising. Currently, a lot of early selection work for rootstocks is being conducted at Orie Lee's property near St. Cloud. The Orie Lee site is comprised mainly of oranges, and those selections that appear promising are shared with the processing industry representative.

UF plant breeders also conduct numerous early work trials at the USDA Picos Farm location in Ft. Pierce.

Work being conducted with triploid material is conducted mostly on properties owned or managed by the CREC. Study sites include the large MAC planting located north of the CREC main campus at the end of Experiment Station Road and the new study site located just south of Eagle Lake. The CREC MAC site has approximately 70 combinations with 40-50 trees per plot. The Saint Helena site is currently being replanted whereby plant material that is not promising is being removed and new selections are being incorporated into that site to allow for larger field testing. Studies are also underway with cooperating

growers (Lykes, Cutrale, etc.). Some other study sites may be a single row or a bed of multiple rootstocks. While these sites provide valuable data, they may not be a formalized trial that will produce data that is replicated, or the data received may not be of sufficient quality to allow it to be published in a peer reviewed journal, but it is still data that has value and serves the industry with additional generalized performance information.

Fast Track with the New Variety Development Foundation also serves as a valuable method to get new varieties into the hands of growers more rapidly than a standard breeding program may have previously allowed.

UF is also involved in a tri-state cooperative program whereby early Valencia (EV), Rio grapefruit, multiple orange selections, lemon, Murcott and Tango are being evaluated. This tri-state program is cooperative funded via Texas Citrus Mutual, California Citrus Research Board, and others.

In the USDA rootstock program, about 80% of researcher time is devoted to Stage I and 20% to Stage II. The USDA rootstock program generally does not conduct extensive Stage III trials. The focus on in Stage I and II trials allows the researcher to maximize resources for creating promising new rootstocks and to efficiently identify those that appear to be the most promising for future trials and to be released to the industry after adequate testing. The analysis of results from well-designed and successfully-completed Stage I and Stage II trials should provide clear information about relative potential of new rootstocks and be suitable for making decisions about small-scale commercial use of the new rootstocks. Major early testing of new plant material selections is being conducted at the USDA Picos Farm location in Ft. Pierce.

Plant material from both programs (UF and USDA) are also being incorporated into planting sites at the MAC trial location in Eagle Lake, Pantuso Citrus as well at other sites around the state.

An effective way to showcase some new varieties is to offer various fruit displays over the production season at grower events (Florida Citrus Show) and various research and education centers.

For a more comprehensive review of the citrus improvement program, please see the article "Comprehensive Citrus Genetic Improvement Program (Chapter 1) authored by Gmitter, Grosser, Castle and Moore. While this document is 10-15 years old, it can serve as a basis for plant improvement. This document is also being rewritten to update the article to include how HLB has impacted the plant breeding process.

Results from multiple trials are currently available on websites hosted by both UF (https://crec.ifas.ufl.edu/citrus-research/rootstock-trials/) and USDA (https://citrusrootstocks.org/).

Trial Experimental Design:

- All trials should have an experimental design (randomized or randomized block design) that maximizes statistical analysis.
- Actual design will depend on space available (both length and width of the area) for the trial but should contain a minimum of 6 replications and preferable multiple tree replications, when and where possible.
- Trees in a given trial should come from the same nursery source and planted at the same time to avoid trail variability.

- The trial area should have a uniform soil type and irrigation system. When possible, trial area should avoid rows adjacent to drainage ditches or canals where the soil may be different than the remainder of the block, and plant border trees at the end of the rows.

Data collected should include:

- Tree size
    - Measure trunk diameter at 5 cm above the bud union and measure the same location every year. These measurements should be perpendicular directions and use the average of the two measurements in data analysis. Trunk cross sectional area can be calculated using the formula [π x (diameter/2)^2]. This data is important in Stage I and II trials but may not be necessary in Stage III trials.
    - Measure tree height to the top of the average canopy height and avoid any vigorous shoots that extend significantly beyond the top of the canopy.
    - Canopy diameter measured parallel and perpendicular to the row.
- Calculate canopy area and/or volume from the tree height and diameter measurements.
- Calculate standard canopy volume using the formula: [(diameter parallel to row x diameter perpendicular to row) x height/4], modified from Wutscher and Hill (1995).
- If nutrition is part of the study, determine leaf macro and micronutrient concentrations annually based upon IFAS recommendations, which is 4-6-month-old foliage collected in July-August.
- Report percentage of dead trees periodically. Dead trees should be excluded from further ratings and analysis.
- Since all areas in Florida have endemic HLB, conduct foliar disease ratings two times per year in the summer and winter using a scale from 1-5, with 1 = no foliar disease symptoms, 2 = foliar symptoms on less than 25% of leaves, 3 = 25-50% of leaves with symptoms, 4 = 50-75% of leaves with symptoms, 5 = greater than 75% of leaves with symptoms. The rating should be done using UF IFAS Disease Index (DI) Rating Method by B. Page and S. Slinski, April 2016. Conduct ratings the same time each year is preferable. Currently not all rating numbering systems are the same between researchers, and a standardized numbering system should be adopted.
- PCR tissue analysis should be conducted by collecting the leaves from the most recently matured new flush and use petiole/midribs for CLas detection. Depending on tree size, collect one or more leaves randomly from each of the four cardinal directions. The same lab should be used over the life of the trial to minimize any difference in laboratory procedures that may impact reported results.
- Once trees reach maturity, collect fruit yield and quality assessment data for each season. Conduct yield and fruit quality assessment at dates that are standard harvest time for that cultivar, or harvest times that are proposed for new cultivars. Report date of assessment.
    - Yield – assess directly by weighing fruits per replicate. Report as fruit weight per experimental unit. Alternatively, yield can be measured as boxes of fruit per tree.
    - Fruit weight – determine from random subsample of fruits from each tree, or group, depending on what is practical.
    - Fruit size – determine from subsample of fruits from each tree or group depending on what is practical for the situation. Measure the horizontal or vertical diameter (as appropriate) of the subsample of fruit collected for determination of fruit weight.

- Fruit quality – depending on the type for fruit and trial purpose, determine percent juice, brix, acid, brix/acid ratio, pound solids, external color, and juice color from subsample of fruits according to standard laboratory methods.
- Sampling time will vary based on scion variety maturity and other factors. Select item that is most appropriate for the scion variety under evaluation.
- Where possible, assess percentage of visually abnormal greening-affected fruit per tree.
- Assess pre-harvest fruit drop. Report as percent drop from fruit number data.

Stage I

Stage I is the first stage where replicated field trials with the new rootstocks are conducted. In many cases, the rootstock plants in USDA and UF Stage I will be grown from cuttings. The reason to use cuttings is to shorten the time needed to generate plants from new hybrids. Waiting for the newly created hybrids to fruit and produce seeds would typically add an additional 6 to 12 years to the process. In addition, uniform seed propagation can only be obtained from a small portion of citrus genetic material. Although propagation of citrus rootstocks by seed is a good convenience, it is now quite practical to propagate citrus rootstocks on a commercial scale by cuttings or tissue culture. Expanding the diversity of candidate rootstocks being tested to include those that do not produce apomictic seeds will greatly increase the opportunity to find the one rootstock that has the ideal combination of disease tolerance along with favorable effects on yield, fruit quality, and tree size.

USDA Stage I trials are usually a single tree or several tree replications and with 8-12 replications per selection and planted as a randomized block design. Within a given Stage I trial, 30-80 new rootstocks, along with commercial standards, are included to provide for sufficient statistical analysis and is an economical use of field space. Trees for USDA Stage I trials are always propagated in the USDA citrus nursery in Ft. Pierce because of the complexity of coordinating propagation of so many different rootstocks and propagation types. A typical Stage I trial occupies 2-3 acres of space. UF trials may use a different number of trees and replications as well as where the trees are produced.

Stage I trials are usually conducted long enough to produce 4 to 5 harvest seasons which makes these trials at least 6 to 8 years in duration. The 4 to 5 harvest seasons will allow sufficient data to create peer reviewed publications and good confidence in the results. In some cases, Stage I trials may last longer than the 6-8 years depending on the ability to collect sufficient data for the decision making.

In recent years, new releases are made at the end of Stage I trials. Historically, releases were not made from Stage I trials as longer-term Stage II trials generated more data allowing the researcher to have greater confidence in potential releases. However, today growers feel they cannot wait longer to receive new plant material and are willing to accept new releases with fewer years of data.

Data collected in Stage I includes: tree survival, crop size (amount of fruit per tree), fruit quality, tree size, tree rating, and HLB status.

Most USDA Stage I trials use Valencia or Hamlin sweet orange scion. Stage I usually has 3 or 4 industry standard rootstocks, and most likely will include: Swingle, sour orange, and Cleo.

From Stage I trials, the researcher can make decisions as to what to include in future Stage II trials.

Stage II

Rootstocks in Stage II trials are selected from the best performing selections from Stage I trials. Stage II trials usually contain fewer rootstocks per trial as compared to Stage I, more trees per replication and more industry standard rootstocks for comparison. Typical Stage II trials contain 10-25 different rootstocks, and with 12-24 trees per rootstock, planted as 6-8 replication of 2-4 trees in a randomized block design. Often Stage II trials make use of a scion different than used in the Stage I trial(s). Trees for USDA Stage II trials are usually propagated in the USDA citrus nursery in Ft. Pierce because of the complexity of coordinating propagation of different rootstock and propagation types. A Stage II trial typically occupies 1-3 acres. The types of data collected form Stage II trials is usually the same as collected in Stage I trials.

Rootstocks and scions used in Stage II trials should be selected based upon outstanding performance in Stage I trials. Selection of trial plant material should be done in consultation with both growers, industry (packing and processing) and breeders to ensure industry needs are being fully investigated. Plant material for Stage II trials need to be based upon previously determined selection criteria that Stage I trials provide.

Stage II trials should include both UF and USDA rootstocks to allow for comparisons between both agencies and to better inform growers of full rootstock options.

Stage III

Stage III trials are usually left up to the industry to do these larger type field trials, although UF and USDA are supportive of the idea and willing to participate by providing rootstocks, scions, experimental design and interpretation of results. Stage III trials will usually have larger plot size and include multiple scion and rootstocks.

Stage III trials should include the “winners” from multiple trials and programs. In many of the large-scale field trials, only a subset of the trees in a given replication are evaluated for data collection, whereas, in the earlier Stage I and II trials, all trees are usually evaluated and are used for data collection.

Just like in Stage II trials, trials should include both UF and USDA rootstocks to allow a full comparison of all rootstock options.

It was also stated that it is difficult to include plant material from other sources (California, Spain, Argentina, Brazil, etc.) in early Stage I or II trials due to limited space and time. Additionally, plant material from other regions can be difficult to obtain quickly enough to get them through the cleanup process to be included in trials or into some nursery production systems. Nevertheless, these are, potentially, exceptional rootstocks, so it would benefit the industry if a more effective system for testing these materials could be devised.

Nomination	classificaiton	Rootstock	Scion	County	Trial name	Availability	Planting Date
1	nomination	**Cleo+Carrizo**	Vernia	Polk	St. Helena	seed/TC	Apr-08
	control	Cleo	Vernia	Polk	St. Helena		Apr-08
2	nomination	**Blue 1**	Vernia	Polk	St. Helena	seed	Apr-08
	control	Cleo	Vernia	Polk	St. Helena		Apr-08
3	nomination	**Orange 1804**	Vernia	Polk	St. Helena	seed	Apr-08
	control	Cleo	Vernia	Polk	St. Helena		Apr-08
4	nomination	**Aqua 1803**	Vernia	Polk	St. Helena	seed	Apr-08
	control	Cleo	Vernia	Polk	St. Helena		Apr-08
5	nomination	**UFR-5**	OLL-8	Osceola	Orie Lee	seed	Jun-13
	control	Swingle	OLL-8				Jun-13
6	nomination	**Orange 14**	OLL-8	Osceola	Orie Lee	seed	Jun-13
	control	Swingle	OLL-8				Jun-13
7	nomination	**Orange 16**	OLL-8	Osceola	Orie Lee	seed	Jun-13
	control	Swingle	OLL-8				Jun-13
8	nomination	**UFR-1**	OLL-8	Osceola	Orie Lee	seed	Jun-13
	control	Swingle	OLL-8				Jun-13
9	nomination	**UFR-10**	Marsh gft	Indian River	IR	TC	Mar-07
	control	C-22	Marsh gft				
10	nomination	**UFR-9**	Marsh gft	Indian River	IR	TC	Mar-07
	control	C-22	Marsh gft				

Nomination	Trees per Replication	Number of Replications	Canopy Volume (M^3) *	average tree diameter	predicted optimum trees/acre	PCR_ Ct *	Average Yield per Tree (Kg) *	Average Yield per Tree (Boxes) *
1	4	2		8.6	256		73.48	1.80026
	4	2		10.4	211		67.36	1.65032
2	4	2		10.5	209		91.85	2.250325
	4	2		10.4	211		67.4	1.6513
3	4	2		10.5	182	32	116.35	2.850575
	4	2		10.4	211		67.4	1.6513
4	4	2		9.7	226	31.5	87.8	2.1511
	4	2		10.4	211		67.4	1.6513
5	2	1					89.8	2.2001
	2	1					40.8	0.9996
6	2	1					98	2.401
	2	1					40.8	0.9996
7	2	1					72.5	1.77625
	2	1					40.8	0.9996
8	2	1					77.6	1.9012
	2	1					40.8	0.9996
9	6	3					102.1	2.50145
	6	3					83.7	2.05065
10	6	3					89.8	2.2001
	6	3					83.7	2.05065

Nomination	% increase compared to the standard (Kg)	Average boxes/tree past 2 seasons	Average Annual Yield per Plot (Kg)*	Average Annual Yield per Plot (Boxes)*	% increase compared to the standard (Kg)	Average Cumulative Yield per Plot (Kg)	Yield Efficiency Kg/Cubic Meter *
1	9.085510689	1.8	293.9	7.20055	9.094283593		
		1.65	269.4	6.6003			
2	36.27596439	2.25	367.4	9.0013	36.37713437		
		1.65	269.4	6.6003			
3	72.62611276	2.85	465.4	11.4023	72.75426875		
		1.65	269.4	6.6003			
4	30.26706231	2.15	351.1	8.60195	30.32665182		
		1.65	269.4	6.6003			
5	120.0980392	2.2	179.6	4.4002	120.0980392		
		1	81.6	1.9992			
6	140.1960784	2.4	196	4.802	140.1960784		
		1	81.6	1.9992			
7	77.69607843	1.8	145	3.5525	77.69607843		
		1	81.6	1.9992			
8	90.19607843	1.9	155	3.7975	89.95098039		
		1	81.6	1.9992			
9	21.9832736	2.5	612.6	15.0087	21.9832736		
		2.1	502.2	12.3039			
10	7.287933094	2.2	539	13.2055	7.327757865		
		2.05	502.2	12.3039			

Nomination	Annual Pound Solids per Acre average last 2 seasons	% increase compared to the standard (pound solids per acre)	Projected Cumulative Pound Solids Per Acre	Fruit Size (g) *	AnnualBrix*	Annual Acid *	Annual Ratio *
1	3115	57.16448032	21,214				
	1982		11,089				
2	2,940	48.33501514	20,579				
	1,982		11,089				
3	3,380	70.53481332	20,503				
	1,982		11,089				
4	3,191	60.99899092	19,863				
	1,982		11,089				
5		#DIV/0!			12.2		
					12.2		
6		#DIV/0!			11.3		
					12.2		
7		#DIV/0!			11.9		
					12.2		
8		#DIV/0!			12.3		
					12.2		
9		#DIV/0!					
10		#DIV/0!					

Nomination	Annual Pound Solids per Box average of last two seasons *	% increase compared to the standard (Pound Solids per box)
1	6.8	18.26086957
	5.75	
2	6.3	9.565217391
	5.75	
3	6.45	12.17391304
	5.75	
4	6.5	13.04347826
	5.75	
5	6.9	2.222222222
	6.75	
6	6.3	-6.666666667
	6.75	
7	6.8	0.740740741
	6.75	
8	6.85	1.481481481
	6.75	
9	4.1	-1.204819277
	4.15	
10	4.1	-1.204819277
	4.15	

Breeder Ranking of Nominated Rootstock	classification	Rootstock	Scion	County	Trial name	Availability	Planting Date	Trees per Replication
1	nomination	US-1282	Hamlin	St Lucie	USDA Picos 2000	no MTA - no seed	2000	1
	standard	Swingle	Hamlin	St Lucie	USDA Picos 2000		2000	1
1	nomination	US-1282	Valencia	Hendry	USDA LaBelle 2016	no MTA - no seed	2016	1
	standard	Swingle	Valencia	Hendry	USDA LaBelle 2016		2016	1
1	nomination	US-1282	Valencia	St Lucie	Picos 2017 MAC	no MTA - seed available	2017	3
	standard	Sour orange	Valencia	St Lucie	Picos 2017 MAC		2017	3
2	nomination	US-1283	Hamlin	St Lucie	USDA Picos 2000	no MTA - seed available	2000	1
	standard	Swingle	Hamlin	St Lucie	USDA Picos 2000		2000	1
2	nomination	US-1283	Hamlin	Lake	USDA Conserv 2002	no MTA - seed available	2002	2
	standard	Swingle	Hamlin	Lake	USDA Conserv 2002		2002	2
2	nomination	US-1283	Valencia	St Lucie	Picos 2017 MAC	no MTA - seed available	2017	3
	standard	Sour orange	Valencia	St Lucie	Picos 2017 MAC		2017	3
3	nomination	US-1516	Valencia	Polk	USDA Lake Wales 2008	no MTA - seed available	2008	3
	standard	Swingle	Valencia	Polk	USDA Lake Wales 2008		2008	3
3	nomination	US-1516	Hamlin	Lake	USDA WF 2015	no MTA - seed available	2015	1
	standard	Swingle	Hamlin	Lake	USDA WF 2015		2015	1
3	nomination	US-1516	Valencia	St Lucie	USDA Picos 2016	no MTA - seed available	2016	1
	standard	Sour orange	Valencia	St Lucie	USDA Picos 2016		2016	1
3	nomination	US-1516	Valencia	St Lucie	USDA Picos 2017-5	no MTA - seed available	2017	1
	standard	Sour orange	Valencia	St Lucie	USDA Picos 2017-5		2017	1
4	nomination	US-SS3	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1
	standard	Sour orange	Valencia	St Lucie	USDA Picos 2014		2014	1
4	nomination	US-SS3	Hamlin	Lake	USDA WF 2015		2015	1
	standard	Swingle	Hamlin	Lake	USDA WF 2015		2015	1
4	nomination	US-SS3	Hamlin	Lake	USDA WF 2015b7		2015	1
	standard	Sour orange	Hamlin	Lake	USDA WF 2015b7		2015	1
5	nomination	US-2111	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1
	standard	Sour orange	Valencia	St Lucie	USDA Picos 2014		2014	1

5	nomination	US-2111	Valencia	St Lucie	USDA Picos 2015	need MTA - no seed	2015	1
	standard	Sour orange	Valencia	St Lucie	USDA Picos 2015		2015	1
5	nomination	US-2111	Hamlin	Lake	USDA WF 2015	need MTA - no seed	2015	1
	standard	Swingle	Hamlin	Lake	USDA WF 2015		2015	1
5	nomination	US-2111	Valencia	Hendry	USDA LaBelle 2016	need MTA - no seed	2016	1
	standard	Swingle	Valencia	Hendry	USDA LaBelle 2016		2016	1
6	nomination	US-1688	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1
	standard	Sour orange	Valencia	St Lucie	USDA Picos 2014		2014	1
6	nomination	US-1688	Valencia	Hendry	USDA LaBelle 2014 V	need MTA - no seed	2014	2
	standard	Carrizo	Valencia	Hendry	USDA LaBelle 2014 V		2014	2
7	nomination	US-1281	Hamlin	St Lucie	USDA Picos 2000	no MTA - no seed	2000	1
	standard	Swingle	Hamlin	St Lucie	USDA Picos 2000		2000	1
7	nomination	US-1281	Hamlin	Lake	USDA Conserv 2006	no MTA - no seed	2006	1
	standard	Swingle	Hamlin	Lake	USDA Conserv 2006		2006	1
7	nomination	US-1281	Valencia	Hendry	USDA LaBelle 2016	no MTA - no seed	2016	1
	standard	Swingle	Valencia	Hendry	USDA LaBelle 2016		2016	1
7	nomination	US-1281	Valencia	St Lucie	Picos 2017 MAC	no MTA - seed available	2017	2
	standard	Sour orange	Valencia	St Lucie	Picos 2017 MAC		2017	3
8	nomination	US-1279	Hamlin	St Lucie	USDA Picos 2000	no MTA - no seed	2000	1
	standard	Swingle	Hamlin	St Lucie	USDA Picos 2000		2000	1
8	nomination	US-1279	Hamlin	Lake	USDA Conserv 2006	no MTA - no seed	2006	1
	standard	Swingle	Hamlin	Lake	USDA Conserv 2006		2006	1
9	nomination	US-SS1	Hamlin	Lake	USDA WF 2011	no MTA - no seed	2011	1
	standard	Swingle	Hamlin	Lake	USDA WF 2011		2011	1
9	nomination	US-SS1	Valencia	St Lucie	USDA Picos 2014		2014	1
	standard	Sour orange	Valencia	St Lucie	USDA Picos 2014		2014	1
10	nomination	US-2109	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1
	standard	Sour orange	Valencia	St Lucie	USDA Picos 2014		2014	1
10	nomination	US-2109	Hamlin	Lake	USDA WF 2015	need MTA - no seed	2015	1
	standard	Swingle	Hamlin	Lake	USDA WF 2015		2015	1
10	nomination	US-2109	Hamlin	Lake	USDA WF 2015b7		2015	1
	standard	Sour orange	Hamlin	Lake	USDA WF 2015b7		2015	1
11	nomination	US-1694	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1

11	standard	Sour orange	Valencia	St Lucie	USDA Picos 2014		2014	1
11	nomination	US-1694	Valencia	Hendry	USDA LaBelle 2014 V	need MTA - no seed	2014	2
	standard	Carrizo	Valencia	Hendry	USDA LaBelle 2014 V		2014	2
11	nomination	US-1694	Valencia	St Lucie	USDA Picos 2017	need MTA - no seed	2017	1
	standard	Sour orange	Valencia	St Lucie	USDA Picos 2017		2017	1
12	nomination	US-1284	Hamlin	St Lucie	USDA Picos 2000	no MTA - seed available	2000	1
	standard	Swingle	Hamlin	St Lucie	USDA Picos 2000		2000	1
13	nomination	US-SS2	Hamlin	Lake	USDA WF 2011	no MTA - no seed	2011	1
	standard	Swingle	Hamlin	Lake	USDA WF 2011		2011	1
14	nomination	US-1649	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1
	standard	Sour orange	Valencia	St Lucie	USDA Picos 2014		2014	1
14	nomination	US-1649	Hamlin	Lake	USDA WF 2015	need MTA - no seed	2015	1
	standard	Swingle	Hamlin	Lake	USDA WF 2015		2015	1
14	nomination	US-1649	Valencia	St Lucie	USDA Picos 2017	need MTA - no seed	2017	1
	standard	Sour orange	Valencia	St Lucie	USDA Picos 2017		2017	1
15	nomination	US-2338	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1
	standard	Sour orange	Valencia	St Lucie	USDA Picos 2014		2014	1
15	nomination	US-2338	Valencia	Hendry	USDA LaBelle 2016	need MTA - no seed	2016	1
	standard	Swingle	Valencia	Hendry	USDA LaBelle 2016		2016	1
16	nomination	US-1672	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1
	standard	Sour orange	Valencia	St Lucie	USDA Picos 2014		2014	1
17	nomination	US-1709	Valencia	St Lucie	USDA Picos 2014	need MTA - no seed	2014	1
	standard	Sour orange	Valencia	St Lucie	USDA Picos 2014		2014	1

Breeder Ranking of Nominated Rootstock	Number of Replications	Trees per acre	Is the nominated rootstock a part of a MAC trial? (indicate MAC trial by name)	Canopy Volume (M^3) *	PCR_ Ct *	Canopy health (5 is best)	Tree Survival (%)	Number of harvests measured
1	7	182		3.91	24.7		100	8
	7	182		2.22	25.1		100	8
1	5	182					100	1
	5	182					100	1
1	6	283	Picos, Graves 1, Becks, Parker	1.63		4.3		
	6	283		1.05		3.9		
2	7	182		4.13	25.1		100	8
	7	182		2.22	25.1		100	8
2	6	121					100	10
	6	121					100	10
2	7	283	Picos, Deseret 1	1.86		4.4	100	
	6	283		1.05		3.9	100	
3	7	120	Graves 1, Parker, Bentley II	6.28	27		100	4
	7	120		4.95	26.8		90	4
3	8	243					100	3
	8	243					100	3
3	12	283		1.2		3.8	100	1
	12	283		0.9		3.0	100	1
3	12	283		1.0		4.0		
	12	283		0.8		3.6		
4	10	259		2.63		4.0	100	3
	15	259		2.59		4.4	100	3
4	8	243				3.0	100	3
	8	243				3.2	100	3
4	8	251					100	1
	8	251					100	1
5	11	259		2.34		4.3	100	3
	15	259		2.59		4.4	100	3

5	12	259		1.33		3.5	100	2
	12	259		1.12		2.8	100	2
5	8	243				3.4	100	3
	8	243				3.2	100	3
5	5	182					100	1
	5	182					100	1
6	11	259		3.52		4.9	92	3
	15	259		2.59		4.4	100	3
6	3	174					100	2
	3	174					100	2
7	7	182		3.00	24.7		100	8
	7	182		2.22	25.1		100	8
7		121						4
		121						4
7	5	182					100	1
	5	182					100	1
7	6	283	Picos, Graves 1, Bentley 1, Parker	1.67		3.7	100	
	6	283		1.05		3.9	100	
8	7	182		4.03	25.1		100	8
	7	182		2.22	25.1		100	8
8		121						4
		121						4
9	5	182						3
	5	182						3
9	9	259		2.38		4.2	90	3
	15	259		2.59		4.4	100	3
10	8	259		2.32		3.9	100	3
	15	259		2.59		4.4	100	3
10	8	243				3.2	100	3
	8	243				3.2	100	3
10	8	251					100	1
	8	251					100	1
11	10	259		2.43		4.4	100	3

11	15	259		2.59		4.4	100	3
11	3	174					67	2
	3	174					100	2
11	12	259		1.1		4.0	100	
	12	259		0.7		3.2	100	
12	7	182		5.28	24.5		100	8
	7	182		2.22	25.1		100	8
13	5	182						3
	5	182						3
14	10	259	Bentley II	2.30		4.3	91	3
	15	259		2.59		4.4	100	3
14	8	243				3.3	100	3
	8	243				3.2	100	3
14	12	259		0.7		3.5	100	
	12	259		0.7		3.2	100	
15	8	259		2.33		4.5	100	3
	15	259		2.59		4.4	100	3
15	5	182					100	1
	5	182					100	1
16	10	259		2.83		4.6	100	3
	15	259		2.59		4.4	100	3
17	10	259		2.82		5.0	100	3
	15	259		2.59		4.4	100	3

Breeder Ranking of Nominated Rootstock	Average Annual Yield per Tree (Kg) *	Average Annual Yield per Tree (Boxes) *	% increase compared to the standard (Kg)	Average Cumulative yield per tree (Kg)	Average Cumulative yield per tree (Boxes)	% increase compared to the standard (Kg)
1	51	1.2495	628.5714286	374	9.163	116.1849711
	7	0.1715		173	4.2385	
1	11.7	0.28665	125	11.7	0.28665	125
	5.2	0.1274		5.2	0.1274	
1		0	#DIV/0!		0	#DIV/0!
		0			0	
2	42	1.029	500	348	8.526	101.1560694
	7	0.1715		173	4.2385	
2	111	2.7195	19.35483871	524	12.838	21.01616628
	93	2.2785		433	10.6085	
2		0	#DIV/0!		0	#DIV/0!
		0			0	
3	65	1.5925	16.07142857	211	5.1695	17.22222222
	56	1.372		180	4.41	
3	11.3	0.27685	22.82608696	17.8	0.4361	33.83458647
	9.2	0.2254		13.3	0.32585	
3	1.2	0.0294	50	1.2	0.0294	50
	0.8	0.0196		0.8	0.0196	
3		0	#DIV/0!		0	#DIV/0!
		0			0	
4	11.4	0.2793	-3.389830508	31.8	0.7791	52.15311005
	11.8	0.2891		20.9	0.51205	
4	9.6	0.2352	4.347826087	14.6	0.3577	9.77443609
	9.2	0.2254		13.3	0.32585	
4	2.4	0.0588	140	2.4	0.0588	140
	1.0	0.0245		1.0	0.0245	
5	14.2	0.3479	20.33898305	30.9	0.75705	47.84688995
	11.8	0.2891		20.9	0.51205	

5	8.6	0.2107	91.11111111	15.0	0.3675	57.89473684
	4.5	0.11025		9.5	0.23275	
5	8.9	0.21805	-3.260869565	16.2	0.3969	21.80451128
	9.2	0.2254		13.3	0.32585	
5	11.3	0.27685	117.3076923	11.3	0.27685	117.3076923
	5.2	0.1274		5.2	0.1274	
6	15.6	0.3822	32.20338983	37.9	0.92855	81.33971292
	11.8	0.2891		20.9	0.51205	
6	20.0	0.49	37.93103448	35.5	0.86975	65.88785047
	14.5	0.35525		21.4	0.5243	
7	38	0.931	442.8571429	319	7.8155	84.39306358
	7	0.1715		173	4.2385	
7	74	1.813	100	153	3.7485	50
	37	0.9065		102	2.499	
7	12.6	0.3087	142.3076923	12.6	0.3087	142.3076923
	5.2	0.1274		5.2	0.1274	
7		0	#DIV/0!		0	#DIV/0!
		0			0	
8	45	1.1025	542.8571429	330	8.085	90.75144509
	7	0.1715		173	4.2385	
8	55	1.3475	48.64864865	123	3.0135	20.58823529
	37	0.9065		102	2.499	
9	23	0.5635	4.545454545	33	0.8085	10
	22	0.539		30	0.735	
9	8.6	0.2107	-27.11864407	20.5	0.50225	-1.913875598
	11.8	0.2891		20.9	0.51205	
10	8.5	0.20825	-27.96610169	29.6	0.7252	41.62679426
	11.8	0.2891		20.9	0.51205	
10	9.8	0.2401	6.52173913	16.3	0.39935	22.55639098
	9.2	0.2254		13.3	0.32585	
10	3.0	0.0735	200	3.0	0.0735	200
	1.0	0.0245		1.0	0.0245	
11	12.7	0.31115	7.627118644	27.3	0.66885	30.62200957

11	11.8	0.2891	7.627118644	20.9	0.51205	36.62200957
11	18.2	0.4459	25.51724138	29.5	0.72275	37.85046729
	14.5	0.35525		21.4	0.5243	
11		0	#DIV/0!		0	#DIV/0!
		0			0	
12	47	1.1515	571.4285714	353	8.6485	104.0462428
	7	0.1715		173	4.2385	
13	35	0.8575	59.09090909	46	1.127	53.33333333
	22	0.539		30	0.735	
14	13.8	0.3381	16.94915254	29.8	0.7301	42.58373206
	11.8	0.2891		20.9	0.51205	
14	6.7	0.16415	-27.17391304	14.4	0.3528	8.270676692
	9.2	0.2254		13.3	0.32585	
14		0	#DIV/0!		0	#DIV/0!
		0			0	
15	15.8	0.3871	33.89830508	33.3	0.81585	59.33014354
	11.8	0.2891		20.9	0.51205	
15	14.7	0.36015	182.6923077	14.7	0.36015	182.6923077
	5.2	0.1274		5.2	0.1274	
16	14.7	0.36015	24.57627119	33.0	0.8085	57.89473684
	11.8	0.2891		20.9	0.51205	
17	14.3	0.35035	21.18644068	30.0	0.735	43.54066986
	11.8	0.2891		20.9	0.51205	

Breeder Ranking of Nominated Rootstock	Average Annual Yield per Acre (Kg)	Average Annual Yield per Acre (Boxes)	% increase compared to the standard (Kg)	Average Cumulative yield per acre (Kg)	Average Cumulative yield per acre (Boxes)	% increase compared to the standard (Kg)
1	9,282	227	629	68,068	1,668	116
	1,274	31		31,486	771	
1	2,129	52	125	2,129	52	125
	946	23		946	23	
1		0	#DIV/0!		0	#DIV/0!
		0			0	
2	7,644	187	500	63,336	1,552	101
	1,274	31		31,486	771	
2	13,431	329	19	63,404	1,553	21
	11,253	276		52,393	1,284	
2		0	#DIV/0!		0	#DIV/0!
		0			0	
3	7,800	191	16	25,320	620	17
	6,720	165		21,600	529	
3	2,746	67	23	4,325	106	34
	2,236	55		3,232	79	
3	340	8	50	340	8	50
	226	6		226	6	
3		0	#DIV/0!		0	#DIV/0!
		0			0	
4	2,953	72	-3	8,236	202	52
	3,056	75		5,413	133	
4	2,333	57	4	3,548	87	10
	2,236	55		3,232	79	
4	602	15	140	602	15	140
	251	6		251	6	
5	3,652	89	20	8,003	196	48
	3,056	75		5,413	133	

5	2,227	55	91	3,885	95	58
	1,166	29		2,460	60	
5	2,163	53	-3	3,937	96	22
	2,236	55		3,232	79	
5	2057	50	117	2057	50	117
	946	23		946	23	
6	4,040	99	32	9,816	240	81
	3,056	75		5,413	133	
6	3,480	85	38	6,177	151	66
	2,523	62		3,724	91	
7	6,916	169	443	58,058	1,422	84
	1,274	31		31,486	771	
7	8,954	219	100	18,513	454	50
	4,477	110		12,342	302	
7	2293	56	142	2293	56	142
	946	23		946	23	
7		0	#DIV/0!		0	#DIV/0!
		0			0	
8	8,190	201	543	60,060	1,471	91
	1,274	31		31,486	771	
8	6,655	163	49	14,883	365	21
	4,477	110		12,342	302	
9	4,186	103	5	6,006	147	10
	4,004	98		5,460	134	
9	2,227	55	-27	5,310	130	-2
	3,056	75		5,413	133	
10	2,202	54	-28	7,666	188	42
	3,056	75		5,413	133	
10	2,381	58	6	3,961	97	23
	2,236	55		3,232	79	
10	753	18	200	753	18	200
	251	6		251	6	
11	3,289	81	8	7,071	173	31

11	3,056	75	8	5,413	133	31
11	3,167	78	26	5,133	126	38
	2,523	62		3,724	91	
11		0	#DIV/0!		0	#DIV/0!
		0			0	
12	8,554	210	571	64,246	1,574	104
	1,274	31		31,486	771	
13	6,370	156	59	8,372	205	53
	4,004	98		5,460	134	
14	3,574	88	17	7,718	189	43
	3,056	75		5,413	133	
14	1,628	40	-27	3,499	86	8
	2,236	55		3,232	79	
14		0	#DIV/0!		0	#DIV/0!
		0			0	
15	4,092	100	34	8,625	211	59
	3,056	75		5,413	133	
15	2,675	66	183	2,675	66	183
	946	23		946	23	
16	3,807	93	25	8,547	209	58
	3,056	75		5,413	133	
17	3,704	91	21	7,770	190	44
	3,056	75		5,413	133	

Breeder Ranking of Nominated Rootstock	Average Annual Yield per Plot (Kg)*	Average Annual Yield per Plot (Boxes)*	Average Cumulative Yield per Plot (Kg)	Average Cumulative Yield per Plot (Boxes)	Yield Efficiency Kg/Cubic Meter *	Annual Pound Solids per Acre *	Cumulative Pound Solids Per Acre
1						885	6,489
						119	2,948
1							
1							
2						708	5,868
						119	2,948
2						1143	5,394
						1001	4,662
2							
3	195		633		10.35	885	2,872
	168		540		11.31	765	2,459
3							
3							
3							
4					4.33	317	886
					4.56	272	482
4							
4							
5					6.07	386	845
					4.56	272	482

5							
5							
5							
6					4.43	388	943
					4.56	272	482
6							
7						678	5,691
						119	2,948
7							
7							
7							
8						793	5,814
						119	2,948
8							
9						438	628
						391	533
9					3.61	213	509
					4.56	272	482
10					3.66	229	798
					4.56	272	482
10							
10							
11					5.23	324	697

11					4.56	272	482
11							
11							
12						826	6,203
						119	2,948
13						680	894
						391	533
14					6.00	333	719
					4.56	272	482
14							
14							
15					6.78	398	839
					4.56	272	482
15							
16					5.19	356	800
					4.56	272	482
17					5.07	354	743
					4.56	272	482

Breeder Ranking of Nominated Rootstock	Fruit Size (g) *	Annual Brix*	Annual Acid *	Annual Ratio *	Percent juice	Annual Pound Solids per Box *	% increase compared to the standard (Pound Solids per box)
1	194	8.67	0.61	14.2		3.90	1.82767624
	160	8.51	0.64	13.2		3.83	
1							#DIV/0!
1							#DIV/0!
2	190	8.43	0.62	13.6		3.79	-1.044386423
	160	8.51	0.64	13.2		3.83	
2		7.74	0.73	10.8		3.48	-4.395604396
		8.09	0.80	10.5		3.64	
2							#DIV/0!
3	212	9.41	0.76	12.5	54.8	4.64	-0.429184549
	213	9.19	0.74	12.5	56.3	4.66	
3							#DIV/0!
3							#DIV/0!
3							#DIV/0!
4	160	9.14	0.76	12.0	53.5	4.40	20.87912088
	174	7.74	0.65	11.9	52.3	3.64	
4							#DIV/0!
4							#DIV/0!
5	180	8.61	0.72	12.0	55.8	4.32	18.68131868
	174	7.74	0.65	11.9	52.3	3.64	

5	227						#DIV/0!
	193						
5							#DIV/0!
5							#DIV/0!
6	175	8.20	0.70	11.7	53.2	3.93	7.967032967
	174	7.74	0.65	11.9	52.3	3.64	
6	210						#DIV/0!
	237						
7	190	8.90	0.62	14.4		4.01	4.699738903
	160	8.51	0.64	13.2		3.83	
7							#DIV/0!
7							#DIV/0!
7							#DIV/0!
8	193	8.80	0.62	14.1		3.96	3.394255875
	160	8.51	0.64	13.2		3.83	
8							#DIV/0!
9	141	9.7	0.63	15.3	49.0	4.28	7.268170426
	135	8.7	0.59	14.8	51.0	3.99	
9	197	8.13	0.71	11.5	53.6	3.92	7.692307692
	174	7.74	0.65	11.9	52.3	3.64	
10	183	8.74	0.74	11.8	54.2	4.26	17.03296703
	174	7.74	0.65	11.9	52.3	3.64	
10							#DIV/0!
10							#DIV/0!
11	196	8.20	0.75	10.9	54.6	4.03	10.71428571

11	174	7.74	0.65	11.9	52.3	3.64	10.71428571
11							#DIV/0!
11							#DIV/0!
12	185	8.77	0.65	13.4		3.95	3.133159269
	160	8.51	0.64	13.2		3.83	
13	151	9.9	0.63	15.8	49.0	4.37	9.523809524
	135	8.7	0.59	14.8	51.0	3.99	
14	188	8.13	0.69	11.8	52.1	3.81	4.67032967
	174	7.74	0.65	11.9	52.3	3.64	
14							#DIV/0!
14							#DIV/0!
15	195	8.08	0.66	12.2	54.7	3.98	9.340659341
	174	7.74	0.65	11.9	52.3	3.64	
15							#DIV/0!
16	169	8.14	0.72	11.3	52.3	3.83	5.21978022
	174	7.74	0.65	11.9	52.3	3.64	
17	168	8.17	0.70	11.7	53.2	3.91	7.417582418
	174	7.74	0.65	11.9	52.3	3.64	