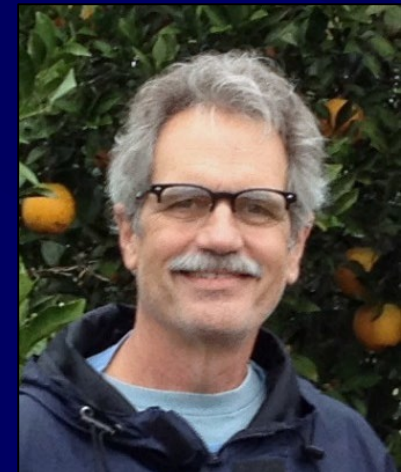


USDA Citrus Rootstocks 2020 January Update



Kim D. Bowman
USDA, ARS, Ft. Pierce



Greg McCollum
USDA, ARS, Ft. Pierce

USDA, ARS Breeding CRIS

CRDF Grants

Florida Citrus Research Foundation

HLB-MAC Grants

NIFA SCRI Grant

CRB Grant

FDACS - DPI

Grower-Cooperators

**Scientist cooperators, post docs, graduate students,
technicians, farm and greenhouse staff**






Approach

- ❑ Sexual hybridization using elite resistant and tolerant parents to develop superior rootstocks
- ❑ Greenhouse and short-term testing of rootstocks
- ❑ Long-term field testing of rootstocks
- ❑ Release superior new rootstock cultivars for commercial use
 - ❑ 13 new rootstocks released from 2001-2018

USDA Rootstocks Released 2001 to 2018

<u>Rootstock</u>	<u>Parentage</u>	<u>Release</u>
US-812	Sunki × <i>P. trifoliata</i>	2001
US-802	<i>Citrus maxima</i> × <i>P. trifoliata</i>	2007
US-897	Cleopatra × <i>P. trifoliata</i>	2007
US-942	Sunki × <i>P. trifoliata</i>	2010
US-1279	Changsha × <i>P. trifoliata</i>	2014
US-1281	Cleopatra × <i>P. trifoliata</i>	2014
US-1282	Cleopatra × <i>P. trifoliata</i>	2014
US-1283	Ninkat × <i>P. trifoliata</i>	2014
US-1284	Ninkat × <i>P. trifoliata</i>	2014
US-1516	<i>C. maxima</i> × <i>P. trifoliata</i>	2015
US SuperSour 1	<i>C. maxima</i> × Cleopatra	2018
US SuperSour 2	<i>P. trifoliata</i> × (sour orange × <i>ichangensis</i>)	2018
US SuperSour 3	Sunki × (<i>C. maxima</i> × <i>P. trifoliata</i>)	2018

Impact: Florida FDACS Report July 2018 - June 2019

	<i>Rootstock</i>	<i>Total propagations</i>
 1	US-942	881,045
 2	Swingle	650,879
3	Kuharske	582,319
4	X639	577,528
5	Sour orange	407,950
 6	US-802	259,654
7	Volkamer	146,738
 8	US-812	126,052
 9	US-897	99,256
10	Rough lemon	51,729

**Large scale commercial use of
rootstocks is based on outstanding
performance over multiple years
in field trials
and in grower plantings.**

USDA-Wheeler Valencia Trial – Lake Wales

<i>Rootstock</i>	<i>2012</i>	<i>2013</i>	<i>2014</i>	<i>2015</i>	<i>Total lbs/tree</i>
US-942	95	148	146	115	500
US-1516	71	132	119	143	465
US-896	79	141	134	97	452
US-1503	64	104	132	134	434
Swingle	60	104	110	123	397
US-802	60	130	104	95	388
Kuharske	71	99	104	93	366
US-812	77	104	77	97	357
Cleopatra	35	75	112	126	348
Kinkoji	42	86	84	75	287

**Results from replicated field trials
are the key to understanding
relative value of different rootstocks**

**By putting together information from
multiple trials and in different
locations, we can make good inferences
of broad field performance . . .**

**and the places where a rootstock can
be successfully used. Or not!**

Active Replicated USDA rootstock trials
= 26

USDA Trial ID	Scion	Date planted	Location	Number rootstocks (replications)
WFF 2011	Hamlin	2011	Groveland, Lake Co., FL	40 (10)
WFF 2012	Hamlin	2012	Groveland, Lake Co., FL	37 (10)
La Belle 2014 M	Murcott	2014	La Belle, Hendry Co., FL	9 (3)
Ft Meade 2014	Valencia	2014	Ft. Meade, Polk Co., FL	24 (7)
WFF 2014 HB	Pummelo	2014	Groveland, Lake Co., FL	9 (14)
Picos 2014	Valencia	2014	Ft. Pierce, St. Lucie Co., FL	51 (12)
La Belle 2014 V	Valencia	2014	La Belle, Hendry Co., FL	55 (3)
Picos 2015	Valencia	2015	Ft. Pierce, St. Lucie Co., FL	47 (12)
WFF 2015	Hamlin	2015	Groveland, Lake Co., FL	48 (8)
WFF 2015 7	Hamlin	2015	Groveland, Lake Co., FL	15 (8)
Picos 2016	Valencia	2016	Ft. Pierce, St. Lucie Co., FL	59 (12)
La Belle 2016	Valencia	2016	La Belle, Hendry Co., FL	69 (7)
WFF 2017	Hamlin	2017	Groveland, Lake Co., FL	41 (8)
Picos 2017	Valencia	2017	Ft. Pierce, St. Lucie Co., FL	50 (12)
Picos 2017 5	Valencia	2017	Ft. Pierce, St. Lucie Co., FL	58 (12)
WFF 2018	Hamlin	May 2018	Groveland, Lake Co., FL	34 (8)
Picos 2018 MF	Minnie	Oct 2018	Ft. Pierce, St. Lucie Co., FL	6 (5)
Picos 2018 B	Bingo	Oct 2018	Ft. Pierce, St. Lucie Co., FL	15 (7)
WFF 2018 B	Bingo	Oct 2018	Groveland, Lake Co., FL	13 (6)
WFF 2018 SB	Sugar Belle	Oct 2018	Groveland, Lake Co., FL	13 (8)
La Belle 2018 SB	Sugar Belle	Nov 2018	La Belle, Hendry Co., FL	10 (7)
Picos 2018 BL	Bearrs	Nov 2018	Ft. Pierce, St. Lucie Co., FL	11 (6)
Picos 2019 SR	Star Ruby	Apr 2019	Ft. Pierce, St. Lucie Co., FL	12 (7)
Picos 2019 V	Valencia	Nov 2019	Ft. Pierce, St. Lucie Co., FL	12 (5)
WFF 2019	Hamlin	Dec 2019	Groveland, Lake Co., FL	50 (7)
Picos 2020	Valencia	Apr 2020	Ft. Pierce, St. Lucie Co., FL	55 (12)

**In addition,
there are many other cooperative
rootstock trials, where I am
working with UF scientists to
compare USDA and UF rootstocks**

Some of the USDA trials are to determine which of the currently available rootstocks are best for each scion and location . . .

Ft. Pierce Bingo Rootstock Trial

Bowman Trial ID: Picos 2018 B

Scion: Bingo Planted: Oct 2018

Location: St. Lucie County, Florida

Design: 15 rootstocks; RCB; 7 reps

Spacing: 7 ft. x 24 ft.



Ft. Pierce Bingo Rootstock Trial

Bowman Trial ID: Picos 2018 B

Rootstock	6 months shoots with dieback (%)	12 months shoots with dieback (%)	12 months total shoots	Trees with catastrophic dieback (%)	Scion TCSA increase 0- 12 months (%)
US-897	1.7	0.1	209	0	2317 a
US-852	0.3	1.2	166	0	2022 ab
US-942	1.3	1.1	208	0	1910 a-c
Swingle	1.0	1.8	158	0	1850 bc
US-896	1.2	2.0	193	0	1831 bc
US-812	0.9	0.6	162	0	1726 bc
US-1516	7.8	9.0	186	7	1612 b-d
Yamaguchi TO	17.3	0.0	107	16	1502 c-e
US-802	0.4	1.8	205	0	1483 c-e
Carrizo	5.2	5.4	124	0	1264 d-f
Flying Dragon TO	2.2	0.4	115	0	1256 d-f
Sour orange	1.9	2.4	132	0	1183 d-f
Ridge	7.0	4.0	121	0	1127 ef
Cleopatra	1.0	10.2	133	7	973 f

Ft. Pierce Bearss Lemon Rootstock Trial

Bowman Trial ID: Picos 2018 BL

Scion: Bearss Lemon Planted: Nov 2018

Location: St. Lucie County, Florida

Design: 11 rootstocks; RCB; 6 reps

Spacing: 7 ft. x 22 ft.



Ft. Pierce Bearss Lemon Rootstock Trial

Bowman Trial ID: Picos 2018 BL

Rootstock	Tree survival (%)	Canopy volume (cu ft)	Tree height (ft)	Scion trunk dia (mm)	Scion/Rootstock ratio
Volkamer	100	24 a	5.6	36	0.86
US-897	100	19 b	5.1	30	0.75
US-802	100	19 b	5.2	30	0.70
US-942	100	18 b	5.1	31	0.80
US-1516	92	18 b	5.1	29	0.75
US-812	100	17 b	5.2	30	0.75
Sour orange	100	17 b	5.0	30	0.83
US-852	100	16 b	5.2	30	0.83
Swingle	92	16 b	5.0	28	0.66
US-896	100	16 b	4.9	29	0.83
Cleopatra	100	14 b	5.1	28	0.90

Ft. Pierce Star Ruby Rootstock Trial

Bowman Trial ID: Picos 2019 SR

Scion: Star Ruby grapefruit

Planted: Apr 2019

Location: St. Lucie County, Florida

Design: 12 rootstocks; RCB; 7 reps

Spacing: 7 ft. x 24 ft.



Ft. Pierce Star Ruby Rootstock Trial

Bowman Trial ID: Picos 2019 SR

Rootstock	2020 Survival (%)	2020 Scion trunk diameter (mm)	2020 Rootstock trunk diameter (mm)	2020 Scion/Rootstock Ratio
Carrizo	93	23	30	78
Cleopatra	86	23	27	86
Volkamer	93	23	28	82
US-942	93	22	27	79
US-896	100	22	26	83
Sour orange	100	21	24	88
US-897	100	20	27	74
US-852	100	19	24	80
US-812	100	19	25	74
US-1516	92	19	27	69
US-802	93	18	28	66
Swingle	85	15	24	63
<i>ANOVA</i>		<i>p<0.0001</i>	<i>p=0.006</i>	<i>p<0.001</i>

Many of the active USDA rootstock trials are focused on selecting the best of the new SuperSour hybrids

Following is information from one trial

Ft. Pierce Valencia Rootstock Trial – 2019 Summary

Bowman Trial ID: Picos 2014

Scion: Valencia 1-14-19

Planted: Nov 2014

Location: St. Lucie County, Florida

Design: 52 rootstocks; RCB; 12 reps

Spacing: 7 ft. x 24 ft.



Partial results 2019

Ft. Pierce Valencia rootstock trial

Bowman Trial ID:
Picos 2014

Focus on evaluation of SuperSour rootstocks

Rootstock	2019 Survival (%)	2019 Feb Canopy health (1-5)	2018 Yield per tree (lbs)	2019 Yield per tree (lbs)	Cumulative Yield per tree (lbs)	2019 Yield efficiency (kg fruit/m ²)
US-2349	100	4.3	11.7	39.9	51.6	5.44
US-1688	92	3.8	12.1	36.8	48.9	4.89
US-2301	100	3.5	25.8	21.8	47.6	3.58
US-2109	100	3.2	16.1	30.4	46.5	6.18
US-2152 (SS3)	100	3.7	14.3	30.9	45.2	5.34
US-2336	90	3.1	14.8	26.9	41.7	5.66
US-1672	100	3.8	18.3	21.8	40.1	3.37
US-2338	100	3.5	13.0	25.8	38.8	5.13
US-1680	89	2.9	11.7	25.8	37.5	4.25
US-2111	100	3.5	10.6	26.2	36.8	5.34
US-2293	100	3.1	14.3	21.4	35.7	4.95
US-1649	91	3.1	12.8	22.7	35.5	4.83
US-1709	100	3.9	9.9	24.5	34.6	3.98
US-1673	100	3.2	18.7	15.2	34.0	3.04
US-1676	70	2.1	17.2	16.1	33.3	4.11
US-1678	100	2.9	13.9	17.9	31.7	3.97
US-1694	100	3.2	14.1	17.4	31.5	3.18
US-1653	90	2.9	11.7	19.0	30.6	3.06
US-2280	100	2.9	14.8	15.9	30.6	4.89
US-2137	100	3.3	13.0	17.2	30.2	4.23
US-2104	100	3.0	14.3	15.2	29.5	4.80
US-1681	100	3.3	13.0	16.5	29.5	4.73
US-2257	100	2.8	12.1	17.0	28.9	4.26
Swingle	100	3.3	12.1	20.5	28.9	3.76
US-2132	100	3.0	13.4	15.2	28.7	3.18
US-2250	100	2.7	14.3	13.4	28.0	4.09
US-2234	100	3.2	15.0	12.8	27.8	4.31
US-1687	90	3.2	6.0	21.2	27.1	2.74
US-1691	90	3.0	9.9	15.9	25.8	3.04
US-2136	89	2.6	12.6	13.0	25.6	5.25
US-2343	92	2.5	12.6	12.1	24.9	4.09
US-2106	100	3.2	9.7	14.3	24.0	3.76
US-2143	100	3.1	6.2	17.0	22.9	4.70
US-1679	100	2.8	12.6	9.5	22.0	5.17
Sour orange	100	2.9	8.6	12.1	20.7	1.94
US-2158	100	2.8	7.9	12.3	20.3	3.28
US-2135	91	3.1	5.1	13.9	19.4	4.09
US-1701	100	3.2	8.4	10.1	18.5	3.03
US-1790	100	2.9	6.4	11.9	18.3	2.71
US-2272	100	3.2	6.8	11.0	17.9	3.34
US-2153	100	2.9	11.5	5.5	17.0	3.28
US-2173	100	2.7	7.7	8.8	16.5	2.51
US-2102	100	2.6	11.7	4.6	16.3	2.31
US-2214	100	2.8	5.3	11.0	16.3	4.09
US-2156	100	2.8	11.0	5.1	16.1	2.33
US-2240	91	2.6	8.8	7.5	16.1	3.36
Ridge	58	1.3	7.1	7.1	14.3	1.90
US-2123	91	2.3	6.6	7.3	13.9	3.21
US-2107	100	2.3	5.1	8.6	13.7	2.84
US-2229	64	2.0	4.9	6.4	11.9	2.80
Cleopatra	100	2.6	4.4	5.5	9.9	1.15
US-1103	100	1.8	1.8	0.9	2.6	0.93

ANOVA

$p < 0.0001$

$p < 0.0001$

$p < 0.001$

$p < 0.001$

$p < 0.0001$

Ft. Pierce Valencia Rootstock Trial – 2019 Summary

Bowman Trial ID: Picos 2014

2019 Top Ten

plus Sour orange

Rootstock	2019 Feb Canopy health (1-5)	2018 Yield per tree (lbs)	2019 Yield per tree (lbs)	Cumulative Yield per tree (lbs)	2019 Yield efficiency (kg fruit/m ³)
US-2349	4.3	11.7	39.9	51.6	5.44
US-1688	3.8	12.1	36.8	48.9	4.89
US-2301	3.5	25.8	21.8	47.6	3.58
US-2109	3.2	16.1	30.4	46.5	6.18
US-2152 (SS3)	3.7	14.3	30.9	45.2	5.34
US-2336	3.1	14.8	26.9	41.7	5.66
US-1672	3.8	18.3	21.8	40.1	3.37
US-2338	3.5	13.0	25.8	38.8	5.13
US-1680	2.9	11.7	25.8	37.5	4.25
US-2111	3.5	10.6	26.2	36.8	5.34
Sour orange	2.9	8.6	12.1	20.7	1.94

Partial results 2019

Ft. Pierce Valencia rootstock trial

Bowman Trial ID:
Picos 2014

Tree size and Fruit quality

Rootstock	Canopy volume (ft ³)	Brix (%)	Acid (%)	Brix/Acid Ratio	Juice color (CN)	Fruit weight (g)
US-2136	33.5	9.5	0.74	12.8	37.4	182
US-2123	36.0	9.2	0.88	10.6	37.2	167
US-2153	25.1	9.2	0.77	12.1	37.5	177
US-2156	37.4	9.2	0.81	11.3	37.3	151
US-2257	60.4	9.1	0.75	12.5	36.9	169
US-2152 (SS3)	92.9	9.1	0.76	12.0	37.0	160
US-2280	51.6	9.1	0.80	11.6	37.0	175
US-2343	59.3	9.0	0.77	11.7	37.0	165
US-2132	75.2	8.9	0.85	10.7	37.2	168
US-2229	34.6	8.9	0.74	12.2	37.0	160
US-1103	10.9	8.9	0.90	9.9	36.9	162
US-2102	31.1	8.8	0.78	11.5	36.9	154
US-2143	59.7	8.8	0.74	12.1	37.1	169
US-2272	53.0	8.8	0.75	11.8	37.0	174
US-2107	46.6	8.8	0.73	12.1	37.1	160
US-1790	65.0	8.7	0.73	12.1	37.0	164
US-2109	81.9	8.7	0.74	11.8	37.1	183
US-1701	56.2	8.7	0.73	12.0	36.9	172
US-2135	54.7	8.7	0.80	10.9	37.1	180
US-2173	59.0	8.6	0.86	10.6	36.8	146
US-2104	55.1	8.6	0.76	11.4	37.1	172
US-1676	72.0	8.6	0.78	11.2	36.9	166
US-2111	82.6	8.6	0.72	12.0	37.0	180
US-2137	66.0	8.6	0.76	11.3	37.2	183
US-2158	52.6	8.6	0.75	11.6	36.8	154
US-1673	74.5	8.5	0.75	11.5	37.1	174
US-2349	123.6	8.5	0.70	12.2	37.5	205
US-2293	72.7	8.5	0.73	11.8	36.8	179
US-2250	52.3	8.5	0.78	11.1	36.9	153
Swingle	84.4	8.5	0.70	12.2	37.1	166
US-1653	87.6	8.4	0.76	11.1	37.0	178
US-2106	62.9	8.4	0.77	11.1	36.9	158
US-1687	111.6	8.4	0.68	12.5	37.1	180
US-2240	34.3	8.3	0.73	11.6	37.3	164
US-1681	52.3	8.3	0.72	11.7	36.7	182
US-2214	44.8	8.3	0.69	12.1	37.1	167
US-1679	35.7	8.2	0.68	12.3	36.8	177
Ridge	32.8	8.2	0.59	14.0	36.6	196
US-1678	61.8	8.2	0.65	12.6	37.0	176
US-2336	78.0	8.2	0.64	12.9	36.8	187
US-1694	85.8	8.2	0.75	11.1	37.1	196
US-1688	124.3	8.2	0.70	11.9	37.0	175
US-1709	99.6	8.2	0.70	11.8	36.7	168
US-2234	45.2	8.2	0.75	11.2	37.2	153
US-1672	99.9	8.1	0.72	11.5	37.0	169
US-1691	84.0	8.1	0.71	11.5	37.0	197
US-1649	81.2	8.1	0.69	12.0	36.8	188
US-2338	82.3	8.1	0.66	12.3	37.1	195
US-2301	100.6	7.9	0.73	10.9	36.9	182
US-1680	92.9	7.8	0.68	11.7	36.8	168
Sour orange	96.8	7.7	0.65	12.1	36.6	174
Cleopatra	75.6	7.7	0.72	10.8	36.7	154

ANOVA

$p < 0.001$

$p < 0.0001$

$p < 0.0001$

$P = 0.1009$

$P = 0.0014$

$P = 0.0033$

Ft. Pierce Valencia Rootstock Trial – 2019 Summary

Bowman Trial ID: Picos 2014

2019 Top Ten for Fruit Quality

plus Sour orange

Rootstock	Brix (%)	Acid (%)	Brix/Acid Ratio	Juice color (CN)	Fruit weight (g)
US-2136	9.5	0.74	12.8	37.4	182
US-2123	9.2	0.88	10.6	37.2	167
US-2153	9.2	0.77	12.1	37.5	177
US-2156	9.2	0.81	11.3	37.3	151
US-2257	9.1	0.75	12.5	36.9	169
US-2152 (SS3)	9.1	0.76	12.0	37.0	160
US-2280	9.1	0.80	11.6	37.0	175
US-2343	9.0	0.77	11.7	37.0	165
US-2132	8.9	0.85	10.7	37.2	168
US-2229	8.9	0.74	12.2	37.0	160
Sour orange	7.7	0.65	12.1	36.6	174

Valencia on US SuperSour 3 in Ft. Pierce

- ❑ More than double the yield of trees on Sour orange**
- ❑ 1.4% higher solids than trees on Sour orange**
- ❑ Canopy looks healthier than trees on Sour orange**
- ❑ Yield efficiency is more than double that of trees on Sour orange**

**All the recently released USDA rootstocks have been
planted into additional replicated trials**

<u>Rootstock</u>	<u>Parentage</u>	<u>Release</u>
US-1279	Changsha × <i>P. trifoliata</i>	2014
US-1281	Cleopatra × <i>P. trifoliata</i>	2014
US-1282	Cleopatra × <i>P. trifoliata</i>	2014
US-1283	Ninkat × <i>P. trifoliata</i>	2014
US-1284	Ninkat × <i>P. trifoliata</i>	2014
US-1516	<i>C. maxima</i> × <i>P. trifoliata</i>	2015
US SuperSour 1	<i>C. maxima</i> × Cleopatra	2018
US SuperSour 2	<i>P. trifoliata</i> × (sour orange × ichang)	2018
US SuperSour 3	Sunki × (<i>C. maxima</i> × <i>P. trifoliata</i>)	2018

More results available soon!