

# St. Helena Rootstock Survey Trial

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## St. Helena Rootstock Survey Trial - Description

**HISTORY:** The St. Helena Project was spear-headed by the late Hall of Fame Citrus Grower/Researcher Orie N. Lee. Mr. Lee made significant financial and intellectual contributions to the project. He found and purchased the property (19.9 acres on St. Helena Rd., east of Dundee), had the old trees cleared, fixed the well twice, provided a back-up diesel generator, and had a protective structure built over the well pump. Since this time (2008), the Lee Family has been leasing the property to the Citrus Research and Education Foundation (CREF) for \$1/year. Profits from harvested fruit have gone 100% back to the CREF to support research grove care.

The original idea for the project was to test new sweet orange selections that had potential to improve juice products. However, as HLB spread across the state, the objective changed to evaluating as many new rootstock candidates as possible to identify those that could impart HLB tolerance. The UF/CREC Citrus Improvement Team (Grosser, Gmitter and Castle) then gathered the available rootstocks (propagations from both seed and cuttings) including many diploid and tetraploid selections from the UF/CREC breeding program along with selections from the Sicilian (Reforgio-Recuperato) and Argentinian (Foguet) rootstock breeding programs. Vernia and Valquarius, mid-season processing oranges that generally can be harvested beginning mid-January with Valencia quality, were chosen as the scions for the project.

## St. Helena Rootstock Survey Trial - Description

**PLANTING AND TREE CARE:** The first set of trees was planted in 2008 [about 12 acres] in 4-tree rectangular plots. Trees were planted in one of 3 sections with a different spacing in each section: [1] 9 x 20 [for dwarf-sized trees]; [2] 12 x 20; and [3] 15 x 25 ft. Rootstocks were chosen for a particular section based on a predicted/expected size. There were uneven numbers of 4-tree plots for each rootstock selection.

HLB was first observed in the trial 6 months after the initial planting. The trial has had strong HLB pressure during its entire life as there was an unsprayed block of K-earlies adjacent to the trial block on the east side and, later, a top-worked block on the south side that was a major psyllid attractant.

A second major set of trees was planted in 2010. There were two subsequent plantings, but they were devastated by freezes primarily because the irrigation well volume was not sufficient to provide cold-protection via microjets to the entire trial. As a result, CRDF funded the installation of a larger well that now provides cold protection for the entire trial.

Cultural care of the trial is provided by the CREC Grove Care Team managed by Troy Gainey.

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**NUTRITION:** The nutrition/irrigation program was designed to minimize any stress on the trees and, thereby, allow maximum expression of HLB tolerance. The trees at the beginning were fertilized with a Harrell's nursery mix of controlled release fertilizer [CRF] applied about every 6 months.

Initially, trees were irrigated 3 times per week, but that schedule was later changed to a daily irrigation regime with shorter application intervals.

In cooperation with Harrell's, who supplied their products at no cost, the CRF was modified to enhance the micronutrient content. The first change was to use a CRF mix that contained calcium nitrate and boron (not included in the nursery mix). Next, the revised mix contained elevated micronutrients, some provided in the TigerSul® form. In January 2018, the CRF mix was modified to increase the nutrients again, especially magnesium and manganese (see the 14-3-11 label). A noticeable improvement in tree appearance was observed. Over the 2017-18 and 2018-19 seasons, the trees received supplemental soluble dry fertilizer via broadcasting.

# St. Helena Rootstock Survey Trial - Description

**DATA COLLECTION:** Yield has been measured annually in boxes/tree and fruit quality samples of about 50 fruit/plot have been collected since 2011. An effort was made to obtain data from a minimum of one 4-tree plot for each scion/rootstock combination each season and from two plots per combination when possible. Tree canopy size was also measured and used to predict the optimum tree spacing for each combination. Measured yield and fruit quality data were combined to estimate the pounds-solids that could be produced for each scion/rootstock combination if trees were planted at their optimum spacing.

**COMMENTS:** HLB quickly moved into this trial and initially appeared among the trees on the standard commercial rootstocks. The older, established trees have been 100% infected for several years.

The 2017-18 season was below average with low yields and reduced juice quality across the entire trial possibly because of Hurricane Irma and a significant delay in one of the CRF applications. However, in the 2018-19 season there was a 62% increase in yield and a 20% increase in juice quality across the entire trial.

Although many rootstocks showed a good recovery in the 2018-19 season, there are a few rootstocks that have performed well during the entire life of the trial.

# St. Helena Rootstock Survey Trial

- Location: Dundee, Polk county
- Scion: Vernia & Valquarius
- Rootstocks: large collection of new diploid and tetraploid rootstocks
- Date Planted: 2008 & 2010
- Design: According to the number of trees available
  - Replications: variable per rootstock
  - Plot size: 4-tree rectangular plots
  - Spacing: 9 x 20; 12 x 20; 15 x 25 ft.
- Data:
  - Yield and juice quality: 9 seasons, 2010/11 to 2018/19
  - Tree size: 2019
  - % of tree survival: 2018/19
  - CRF Fertilizer formulation
- Trial status: **ACTIVE.**

Table 1. St. Helena Rootstock Survey Trial – Rootstock parentage and 2018/19 survival of trees planted in 2008, sorted by survival, %

Scion[s]	Rootstock	Rootstock Parentage	Ploidy	No. trees planted	No. survived	Survival**, %
Valq	FG 1702	TBD*	2x	2	2	100
Valq	FG 1707	TBD	2x	3	3	100
Valq	FG 1709	TBD	2x	4	4	100
Valq	UFR 13: FG 1731	putative C. ichangensis/Poncirus hybrid	2x	4	4	100
Valq	UFR 14: FG 1733	putative pummelo/mandarin hybrid	2x	5	5	100
Valq	FG 1792	TBD	2x	2	2	100
Valq/Vernia	Volk	Volkamer lemon	2x	20	20	100
Valq/Vernia	UFR 4: Orange 19	[Nova + HBPummelo] x [Cleopatra + Argentine trifoliolate orange]	4x	124	120	97
Valq/Vernia	Kuharske	Carrizo open-pollinated zygotic	2x	22	21	95
Valq/Vernia	Orange 1804	Cleopatra x trifoliolate orange (Arg.)	2x	19	18	95
Valq/Vernia	UFR 5: White 4	[Nova + HBPummelo] x [Succari + Argentine trifoliolate orange]	4x	74	70	95
Valq/Vernia	Orange 21	[Nova + HBPummelo] x [Cleopatra + Argentine trifoliolate orange]	4x	46	43	93
Valq/Vernia	Orange 16	[Nova + HBPummelo] x [Cleopatra + Argentine trifoliolate orange]	4x	25	23	92
Valq/Vernia	UFR 2: Orange 4	[Nova + HBPummelo] x [Cleopatra + Argentine trifoliolate orange]	4x	50	46	92
Valq	681G26F4P2	C. latipes x trifoliolate orange (Sic.)	2x	12	11	92
Vernia	Yellow 1800	Grapefruit x trifoliolate orange (Arg.)	2x	12	11	92
Valq/Vernia	Cleo+CZO	Cleopatra + Carrizo	4x	164	150	91
Valq/Vernia	UFR 1: Orange 3	[Nova + HBPummelo] x [Cleopatra + Argentine trifoliolate orange]	4x	62	56	90
Valq	681G26F2P12	C. latipes x trifoliolate orange (Sic.)	2x	10	9	90
Valq/Vernia	Aqua 1803	Cleopatra x trifoliolate orange (Arg.)	4x	19	17	89

(\*) To be determined

(\*\*) **Caveat:** Many trees of both scions that were lost during the trial were removed early only because of poor condition at planting. Thus, the tree survival results may be somewhat unrepresentative of true performance.



Table 1 (cont'd). St. Helena Rootstock Survey Trial – Rootstock parentage and 2018/19 survival of trees planted in 2008, sorted by survival, %

Scion[s]	Rootstock	Rootstock Parentage	Ploidy	No. trees planted	No. survived	Survival**, %
Valq/Vernia	Orange 2	[Nova + HBPummelo] x [Cleopatra + Argentine trifoliate orange]	4x	55	49	89
Valq/Vernia	Wgft+50-7	White grapefruit + trifoliate orange	4x	89	79	89
Valq/Vernia	UFR 3: Orange 15	[Nova + HBPummelo] x [Cleopatra + Argentine trifoliate orange]	4x	43	38	88
Valq/Vernia	SO+CZO	Sour orange + Carrizo	4x	267	235	88
Vernia	Orange 1	[Nova + HBPummelo] x [Cleopatra + Argentine trifoliate orange]	4x	25	22	88
Valq/Vernia	Orange 18	[Nova + HBPummelo] x [Cleopatra + Argentine trifoliate orange]	4x	25	22	88
Valq/Vernia	UFR 6: Chang+50-7	Changsha mandarin + trifoliate orange 50-7	4x	56	49	88
Valq/Vernia	Orange 14	[Nova + HBPummelo] x [Cleopatra + Argentine trifoliate orange]	4x	46	40	87
Valq	681G26F4P6	C. latipes x trifoliate orange (Sic.)	2x	13	11	85
Valq/Vernia	Blue 1	[Nova + HBPummelo] x [sour orange + Palestine sweet lime]	2x	60	50	83
Valq/Vernia	Chang+Bent	Changsha mandarin + Benton citrange	4x	18	15	83
Valq/Vernia	Cleo	Cleopatra mandarin	2x	18	15	83
Valq/Vernia	SO+50-7	Sour orange + trifoliate orange 50-7	4x	41	34	83
Valq/Vernia	Orange 13	[Nova + HBPummelo] x [Cleopatra + Argentine trifoliate orange]	4x	52	42	81
Valq/Vernia	White 1805	Ruby blood orange x Barnes trifoliate orange (Arg.)	2x	20	16	80
Valq/Vernia	Amb+HBJL-2B	C. amblycarpa + HBJL-2B pummelo	4x	28	22	79
Valq	681G26F6P20	C. latipes x trifoliate orange (Sic.)	2x	19	15	79
Valq/Vernia	Purple 4	[Nova + HBPummelo] x [Cleopatra + sour orange]	2x	77	59	77
Valq/Vernia	Rough lemon	Rough lemon	2x	17	13	76
Valq/Vernia	White 1801	Ruby blood orange x Barnes trifoliate orange (Arg.)	2x	12	9	75

(\*) To be determined

(\*\*) **Caveat:** Many trees of both scions that were lost during the trial were removed early only because of poor condition at planting. Thus, the tree survival results may be somewhat unrepresentative of true performance.



Table 1 (cont'd). St. Helena Rootstock Survey Trial – Rootstock parentage and 2018-19 survival of trees planted in 2008, sorted by survival, %

Scion[s]	Rootstock	Rootstock Parentage	Ploidy	No. trees planted	No. survived	Survival**, %
Valq/Vernia	Green 7	[Nova + HBPummelo] x [sour orange + Carrizo]	4x	47	35	74
Valq/Vernia	MG-11	Hirado Buntan pummelo - zygotic from open pollination	2x	39	28	72
Valq/Vernia	Swingle	White grapefruit x trifoliate orange	2x	22	15	68
Valq/Vernia	Blue 9	[Nova + HBPummelo] x [sour orange + Palestine sweet lime]	2x	35	23	66
Valq/Vernia	Pink 1802	Cleopatra x Swingle citrumelo (Arg.)	2x	19	12	63
Valq/Vernia	Blue 4	[Nova + HBPummelo] x [sour orange + Palestine sweet lime]	2x	45	27	60
Valq	FG 1793	TBD*	2x	5	3	60
Valq/Vernia	Blue 2	[Nova + HBPummelo] x [sour orange + Palestine sweet lime]	2x	32	19	59
Valq/Vernia	Purple 2	[Nova + HBPummelo] x [Cleopatra + sour orange]	4x	22	12	55
Valq	SO+RPxSH99-5	Sour orange + rangpur, open pollinated	4x	17	8	47
Valq/Vernia	Amb+HBJL-1	C. amblycarpa + HBJL-1 pummelo	4x	16	7	44
Valq/Vernia	69LTxamF14P37	C. latipes x sour orange (Sic.)	2x	7	3	43
Valq/Vernia	Blue 3	[Nova + HBPummelo] x [sour orange + Palestine sweet lime]	2x	53	19	36

(\*) To be determined

(\*\*) **Caveat:** Many trees of both scions that were lost during the trial were removed early only because of poor condition at planting. Thus, the tree survival results may be somewhat unrepresentative of true performance.

Table 2. St. Helena Rootstock Survey Trial – 2018/19 Valquarius tree size, spacing and HLB status, for trees planted in 2008, sorted by tree height and tree width.

Rootstock	Tree height* [ft.]	Tree width* [ft.]	Actual spacing [trees/acre]	Optimum no. trees/acre**	HLB diagnosis***	Ct value
Orange 1804	9.0	11.9	12 x 20 [182]	184	No HLB found	32
FG 1707	8.7	10.2	12 x 20 [182]	213	No HLB found	32
Volk	8.5	12.7	15 x 25 [116]	171	Questionable	31
UFR 1: Orange 3	8.3	9.4	9 x 20 [242]	235	Questionable	30
FG 1793	8.2	10.9	12 x 20 [182]	202	No HLB found	33
Amb+HBJL-2B	8.2	10.5	12 x 20 [182]	208	Questionable	30
681G26F4P6	8.2	10.6	12 x 20 [182]	207	HLB positive	30
White 1805	8.0	11.5	12 x 20 [182]	192	HLB positive	28
UFR 5: White 4	7.9	9.7	12 x 20 [182]	226	HLB positive	28
Blue 4	7.8	9.9	9 x 20 [242]	229	HLB positive	28
681G26F4P2	7.8	9.8	12 x 20 [182]	225	Questionable	30
Swingle	7.7	12.0	15 x 25 [116]	182	HLB positive	29
Cleo	7.7	11.7	15 x 25 [116]	186	No HLB found	32
Kuharske	7.7	11.0	15 x 25 [116]	198	HLB positive	28
UFR 14: FG 1733	7.7	10.4	12 x 20 [182]	212	HLB positive	27
MG-11	7.7	9.5	12 x 20 [182]	230	HLB positive	29
UFR 2: Orange 4	7.7	10.9	12 x 20 [182]	203	Questionable	30
UFR 4: Orange 19	7.5	10.2	12 x 20 [182]	213	HLB positive	29
FG 1792	7.5	8.5	12 x 20 [182]	257	HLB positive	27
Blue 1	7.4	8.9	9 x 20 [242]	248	HLB positive	29
Purple 2	7.4	8.7	9 x 20 [242]	249	HLB positive	29
681G26F6P20	7.3	9.9	12 x 20 [182]	221	HLB positive	27
Cleo+CZO	7.2	9.9	9 x 20 [242]	221	No HLB found	32
Rough lemon	7.2	9.9	15 x 25 [116]	221	Questionable	31
69LTXamF14P37	7.2	9.7	12 x 20 [182]	224	HLB positive	28

(\*) Measured.

(\*\*) Calculated using measured width and hypothetical 20 ft. between all rows.

(\*\*\*) Southern Gardens diagnostic lab, PCR analysis of 4-tree composite sample.

Table 2 (cont'd). St. Helena Rootstock Survey Trial – 2018/19 Valquarius tree size, spacing and HLB status, for trees planted in 2008, sorted by tree height and tree width.

Rootstock	Tree height* [ft.]	Tree width* [ft.]	Actual spacing [trees/acre]	Optimum no. trees/acre**	HLB diagnosis***	Ct value
UFR 13: FG 1731	7.2	9.5	12 x 20 [182]	230	HLB positive	30
Pink 1802	7.2	9.1	12 x 20 [182]	243	[not sampled]	
Aqua 1803	7.1	9.4	12 x 20 [182]	236	HLB positive	27
681G26F2P12	7.1	8.4	12 x 20 [182]	261	Questionable	30
UFR 6: Chang+50-7	7.1	7.2	9 x 20 [242]	301	No HLB found	32
Orange 13	7.1	9.6	12 x 20 [182]	230	HLB positive	29
Orange 16	7.0	8.8	12 x 20 [182]	248	HLB positive	30
FG 1709	7.0	8.4	12 x 20 [182]	261	HLB positive	27
UFR 3: Orange 15	6.9	9.5	12 x 20 [182]	230	HLB positive	28
Blue 2	6.9	8.7	9 x 20 [242]	250	HLB positive	27
White 1801	6.7	9.5	12 x 20 [182]	230	HLB positive	28
FG 1702	6.7	8.5	12 x 20 [182]	257	HLB positive	29
Green 7	6.7	8.5	12 x 20 [182]	259	Questionable	32
Blue 9	6.7	8.4	9 x 20 [242]	264	HLB positive	28
SO+50-7	6.7	6.9	9 x 20 [242]	317	HLB positive	28
Blue 3	6.6	7.2	9 x 20 [242]	301	HLB positive	28
Wgft+50-7	6.5	7.6	12 x 20 [182]	290	No HLB found	36
Orange 18	6.4	7.0	12 x 20 [182]	315	HLB positive	28
Chang+Bent	6.4	7.6	9 x 20 [242]	288	HLB positive	29
SO+CZO	6.3	8.1	12 x 20 [182]	272	HLB positive	29
Amb+HBJL-1	6.2	8.5	12 x 20 [182]	257	No HLB found	32
Purple 4	6.2	7.6	9 x 20 [242]	289	HLB positive	29
Orange 21	5.9	8.7	12 x 20 [182]	252	HLB positive	29
Orange 14	5.7	8.3	12 x 20 [182]	264	HLB positive	29
SO+RPxSH99-5	5.7	5.7	9 x 20 [242]	391	Questionable	30

(\*) Measured.

(\*\*) Calculated using measured width and hypothetical 20 ft. between all rows.

(\*\*\*) Southern Gardens diagnostic lab, PCR analysis of 4-tree composite sample.

Table 3. St. Helena Rootstock Survey Trial – 2018/19 Vernia tree size, spacing and HLB status, for trees planted in 2008, sorted by tree height and tree width.

Rootstock	Tree height* [ft.]	Tree width* [ft.]	Actual spacing [trees/acre]	Optimum no. trees/acre**	HLB diagnosis***	Ct value
Orange 1804	9.2	10.5	12 x 20 [182]	208	HLB positive	26
Volk	9.1	12.1	15 x 25 [116]	180	HLB positive	28
Blue 1	9.0	10.5	9 x 20 [242]	209	HLB positive	28
MG-11	8.7	10.7	12 x 20 [182]	206	Questionable	30
Purple 2	8.6	8.9	9 x 20 [242]	250	HLB positive	29
UFR 4: Orange 19	8.3	9.7	12 x 20 [182]	226	HLB positive	26
Yellow 1800	8.1	9.5	12 x 20 [182]	230	HLB positive	27
Cleo+CZO	8.1	8.6	9 x 20 [242]	256	HLB positive	29
Cleo	8.0	10.4	15 x 25 [116]	211	HLB positive	30
UFR 5: White 4	8.0	9.8	12 x 20 [182]	224	HLB positive	28
Purple 4	7.9	9.2	9 x 20 [242]	246	Questionable	30
Blue 9	7.9	8.9	9 x 20 [242]	249	Questionable	30
Kuharske	7.9	11.6	15 x 25 [116]	190	Questionable	32
Aqua 1803	7.9	9.7	12 x 20 [182]	226	No HLB found	32
Wgft+50-7	7.9	8.7	9 x 20 [242]	250	HLB positive	30
White 1805	7.9	7.7	12 x 20 [182]	282	No HLB found	33
UFR 1: Orange 3	7.7	9.7	12 x 20 [182]	227	HLB positive	30
Swingle	7.6	10.0	15 x 25 [116]	219	HLB positive	30
Orange 13	7.6	8.9	12 x 20 [182]	246	HLB positive	30
UFR 6: Chang+ 50-7	7.6	7.9	9 x 20 [242]	277	No HLB found	32

(\*) Measured.

(\*\*) Calculated using measured width and hypothetical 20 ft. between all rows.

(\*\*\*) Southern Garden diagnostic lab, PCR analysis of 4-tree composite sample.

Table 3 (cont'd). St. Helena Rootstock Survey Trial – 2018/19 Vernia tree size, spacing and HLB status, for trees planted in 2008, sorted by tree height and tree width.

Rootstock	Tree height* [ft.]	Tree width* [ft.]	Actual spacing [trees/acre]	Optimum trees/acre**	HLB diagnosis***	Ct value
Orange 2	7.5	11.0	12 x 20 [182]	198	Questionable	30
Blue 4	7.5	7.6	9 x 20 [242]	289	HLB positive	30
Blue 2	7.4	7.8	9 x 20 [242]	279	HLB positive	30
Chang+Bent	7.4	9.3	9 x 20 [242]	240	Questionable	32
Rough lemon	7.3	10.5	15 x 25 [116]	208	Questionable	30
White 1801	7.3	10.0	12 x 20 [182]	218	HLB positive	26
Orange 21	7.3	9.0	12 x 20 [182]	246	Questionable	31
SO+RPxSH99-5	7.3	7.8	9 x 20 [242]	282	HLB positive	28
Blue 3	7.2	7.2	9 x 20 [242]	320	HLB positive	27
UFR 3: Orange 15	7.0	9.4	12 x 20 [182]	233	HLB positive	30
Green 7	7.0	9.3	12 x 20 [182]	235	HLB positive	28
Orange 1	7.0	8.7	12 x 20 [182]	256	HLB positive	27
SO+CZO	7.0	8.4	9 x 20 [242]	261	HLB positive	29
Orange 18	6.9	8.4	12 x 20 [182]	261	Questionable	31
UFR 2: Orange 4	6.8	8.7	12 x 20 [182]	254	Questionable	31
Orange 14	6.6	8.4	12 x 20 [182]	279	No HLB found	34
Amb+HBJL-2B	6.5	8.0	12 x 20 [182]	273	HLB positive	28
SO+50-7	6.5	7.9	9 x 20 [242]	281	HLB positive	27
Pink 1802	6.4	7.6	12 x 20 [182]	290	HLB positive	29

(\*) Measured.

(\*\*) Calculated using measured width and hypothetical 20 ft. between all rows.

(\*\*\*) Southern Garden diagnostic lab, PCR analysis of 4-tree composite sample.

Table 4. St. Helena Rootstock Survey Trial – 2018/19 Valquarius yield, estimated cumulative yield and PS for trees planted in 2008, sorted by estimated cumulative PS/acre.

Rootstock	PS/box	Boxes/tree	Optimum no. trees/acre*	Estimated PS/acre [increase 2017-18 to 2018-19, %]	Estimated boxes/acre [increase 2017-18 to 2018-19, %]	Estimated Cum PS/acre 2010-11 to 2018-19
UFR 13: FG 1731	6.7	1.1	230	1652 [89]	247 [56]	17535
UFR 1: Orange 3	6.5	1.8	235	2699 [113]	417 [101]	16549
Orange 13	6.6	2.0	230	2973 [103]	451 [73]	16407
White 1805	6.1	2.9	192	3401 [176]	559 [146]	15839
681G26F4P6	6.2	2.2	207	2858 [62]	463 [46]	15580
UFR 14: FG 1733	6.2	1.9	212	2529 [163]	410 [109]	15152
Amb+HBJL-2B	6.4	2.3	208	3074 [224]	483 [177]	15134
Aqua 1803	6.2	2.2	236	3146 [160]	511 [125]	14713
Cleo+CZO	5.8	1.1	221	1368 [56]	234 [51]	14643
Orange 14	6.9	0.9	264	1554 [133]	227 [102]	14481
FG 1707	6.8	1.9	213	2808 [73]	412 [46]	14226
UFR 6: Chang+ 50-7	6.8	1.2	301	2390 [96]	350 [81]	14183
SO+50-7	6.5	1.0	317	2101 [90]	325 [72]	14030
FG 1793	6.2	3.0	202	3711 [178]	601 [160]	14021
Purple 2	6.4	1.0	249	1654 [27]	259 [15]	13961
UFR 5: White 4	6.6	1.4	226	2012 [56]	307 [33]	13906
MG-11	6.0	2.1	230	2836 [110]	477 [69]	13888
Blue 9	6.4	1.1	264	1882 [69]	293 [58]	13884
Kuharske	6.2	2.8	198	3475 [121]	561 [95]	13842
Blue 2	6.7	0.9	250	1479 [-21]	221 [-30]	13481
Swingle	6.3	1.8	182	2008 [34]	321 [17]	13461
UFR 3: Orange 15	5.9	1.7	230	2225 [65]	379 [40]	13433
Orange 1804	5.9	3.2	184	3523 [109]	597 [85]	13289
FG 1709	6.5	1.1	261	1833 [37]	281 [27]	13266
681G26F6P20	6.3	1.6	221	2265 [91]	358 [64]	13151

(\*) Calculated using measured width and hypothetical 20 ft. between all rows.

Table 4 (cont'd). St. Helena Rootstock Survey Trial – 2018/19 Valquarius yield, estimated cumulative yield and PS estimates for trees planted in 2008, sorted by estimated cumulative PS/acre

Rootstock	PS/box	Boxes/tree	Optimum no. trees/acre*	Estimated PS/acre increase 2017-18 to 2018-19 [%]	Estimated boxes/acre [increase 2017-18 to 2018-19, %]	Estimated Cum PS/acre 2010-11 to 2018-19
Amb+HBJL-1	6.6	1.1	257	1858 [114]	282 [88]	13001
UFR 2: Orange 4	6.2	1.8	203	2272 [82]	369 [59]	12943
Pink 1802	6.4	1.8	243	2832 [71]	443 [51]	12942
FG 1792	6.7	1.2	257	1967 [5]	295 [-9]	12941
Blue 4	5.8	1.8	229	2466 [144]	423 [136]	12742
Volk	5.8	2.6	171	2539 [84]	441 [47]	12692
SO+CZO	6.7	0.9	272	1707 [53]	256 [27]	12611
681G26F2P12	6.6	1.3	261	2175 [57]	328 [35]	12530
681G26F4P2	6.1	1.8	225	2428 [176]	396 [130]	12479
Orange 16	5.3	1.9	248	2430 [117]	460 [106]	12182
Purple 4	6.9	0.6	289	1127 [-6]	164 [-18]	12016
Blue 1	6.6	1.1	248	1856 [106]	282 [62]	11377
Green 7	6.1	1.2	259	1835 [30]	301 [16]	11203
Wgft+50-7	6.3	0.9	290	1725 [55]	273 [37]	11019
Orange 21	6.1	1.4	252	2093 [77]	343 [56]	10715
FG 1702	6.6	1.2	257	1943 [46]	295 [31]	10670
SO+RPxSH99-5	6.9	1.1	391	2912 [105]	421 [81]	10637
Orange 18	6.3	1.2	315	2371 [60]	374 [45]	10422
UFR 4: Orange 19	6.1	1.8	213	2312 [134]	378 [94]	10334
Chang+Bent	6.7	0.3	288	557 [-39]	83 [-45]	10245
Rough lemon	5.9	1.5	221	1902 [163]	325 [102]	9849
Cleo	6.0	1.5	186	1621 [165]	269 [111]	9444
White 1801	6.5	1.6	230	2345 [233]	362 [174]	9416
Blue 3	6.9	0.3	301	677 [-50]	98 [-59]	9346
69LTXamF14P37	6.0	1.1	224	1475 [125]	246 [101]	8630

(\*) Calculated using measured width and hypothetical 20 ft. between all rows.



Table 5. St. Helena Rootstock Survey Trial – 2018/19 Vernia Yield, estimated cumulative yield and PS estimates for trees planted in 2008, sorted by estimated cumulative PS/acre

Rootstock	PS/box	Boxes/tree	Optimum no. trees/acre*	Estimated PS/acre [increase 2017-18 to 2018-19, %]	Estimated boxes/acre [increase 2017-18 to 2018-19, %]	Estimated Cum PS/acre 2010-11 to 2018-19
Cleo+CZO	6.9	1.8	256	3136 [65]	454 [40]	18128
Blue 1	6.5	2.5	209	3346 [201]	512 [156]	18051
Purple 2	6.1	2.0	250	3026 [29]	494 [8]	17565
Aqua 1803	6.6	2.2	226	3363 [130]	508 [85]	16844
Chang+Bent	6.7	1.2	240	1905 [23]	284 [12]	16601
Orange 1804	6.5	2.9	208	3906 [147]	604 [112]	16464
Wgft+50-7	6.7	1.9	250	3079 [115]	463 [118]	16356
Blue 2	7.0	1.1	279	2159 [73]	309 [62]	15995
Amb+HBJL-2B	6.7	1.3	273	2369 [144]	355 [159]	15820
MG-11	6.8	2.3	206	3209 [91]	473 [54]	15719
Purple 4	7.5	1.1	246	1952 [45]	261 [12]	15145
UFR 4: Orange 19	6.4	1.9	226	2773 [150]	433 [105]	14762
Volk	5.6	3.5	180	3548 [115]	637 [94]	14525
Orange 14	6.8	1.1	279	2090 [99]	306 [53]	14390
Orange 21	6.6	1.9	246	3099 [101]	470 [61]	14131
Blue 4	6.5	1.0	289	1855 [69]	287 [56]	13919
Orange 18	6.7	1.5	261	2612 [62]	390 [51]	13863
White 1805	6.9	1.4	282	2776 [95]	402 [64]	13778
UFR 6: Chang+ 50-7	7.3	1.4	277	2841 [221]	388 [136]	13665
Yellow 1800	6.5	2.4	230	3580 [134]	548 [117]	13477

(\*) Calculated using measured width and hypothetical 20 ft. between all rows.

Table 5 (cont'd). St. Helena Rootstock Survey Trial – 2018/19 Vernia Yield, estimated cumulative yield and PS estimates for trees planted in 2008, sorted by estimated cumulative PS/acre

Rootstock	PS/box	Boxes/tree	Optimum no. trees/acre*	Estimated PS/acre [increase 2017-18 to 2018-19, %]	Estimated boxes/acre [increase 2017-18 to 2018-19, %]	Estimated Cum PS/acre 2010-11 to 2018-19
Blue 9	7.1	1.0	249	1712 [42]	240 [31]	13445
Orange 2	6.9	0.9	198	1230 [-1]	179 [-12]	13403
UFR 5: White 4	6.9	1.4	224	2234 [186]	322 [100]	13135
Kuharske	6.9	2.6	190	3371 [96]	487 [68]	13080
SO+50-7	7.1	0.8	281	1567 [57]	221 [40]	13015
Swingle	6.7	1.8	219	2653 [126]	398 [98]	12640
UFR 1: Orange 3	6.8	1.6	227	2434 [117]	360 [78]	12617
Blue 3	6.7	0.9	320	2020 [168]	301 [146]	12584
Green 7	7.1	1.2	235	1995 [75]	281 [51]	12362
Orange 13	6.9	1.4	246	2339 [98]	341 [69]	12204
Orange 1	7.0	1.5	256	2607 [178]	375 [137]	12189
SO+CZO	7.3	1.0	261	1974 [178]	272 [120]	11216
UFR 3: Orange 15	NA	1.0	233	NA [NA]	233 [20]	10596
White 1801	6.6	1.4	218	2017 [69]	306 [27]	10302
UFR 2: Orange 4	6.7	1.1	254	1901 [105]	282 [76]	10100
SO+RPxSH99-5	7.1	0.4	282	796 [-32]	113 [-41]	9417
Cleo	5.6	1.7	211	1972 [91]	350 [103]	9102
Pink 1802	6.9	1.1	290	2101 [130]	305 [111]	8089
Rough lemon	6.3	1.2	208	1513 [43]	239 [14]	6801

(\*) Calculated using measured width and hypothetical 20 ft. between all rows.

Fig. 1. St. Helena Rootstock Survey Trial – 9-year estimated cumulative PS/acre for Valquarius trees planted in 2008; 9 seasons, 2010/11 to 2018/19.

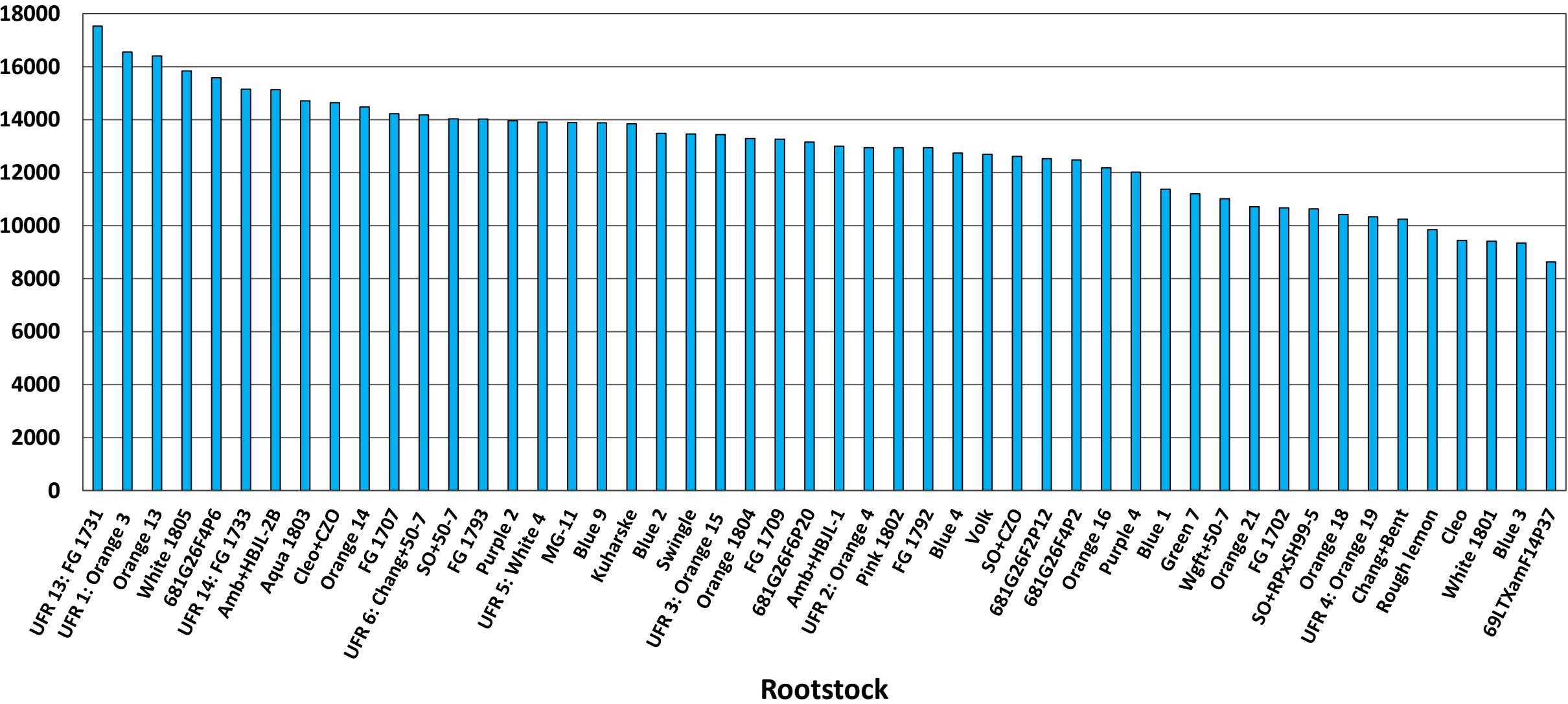


Fig. 2. St. Helena Rootstock Survey Trial – 9-year estimated cumulative PS/acre for Vernia trees planted in 2008; 9 seasons, 2010/11 to 2018/19.

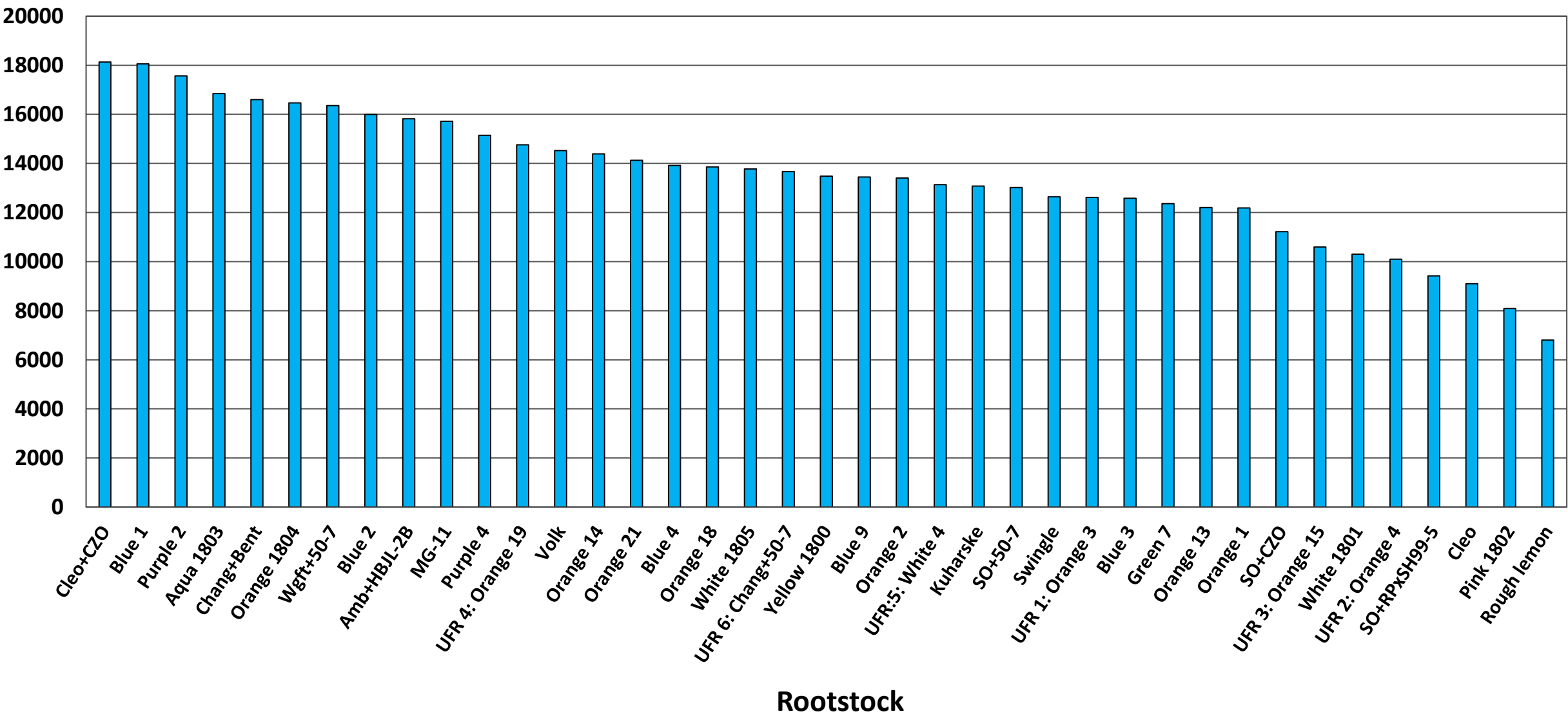


Fig. 3. St. Helena Rootstock Survey Trial – 2018/19 % of tree survival for Valquarius and Vernia trees planted in 2008.

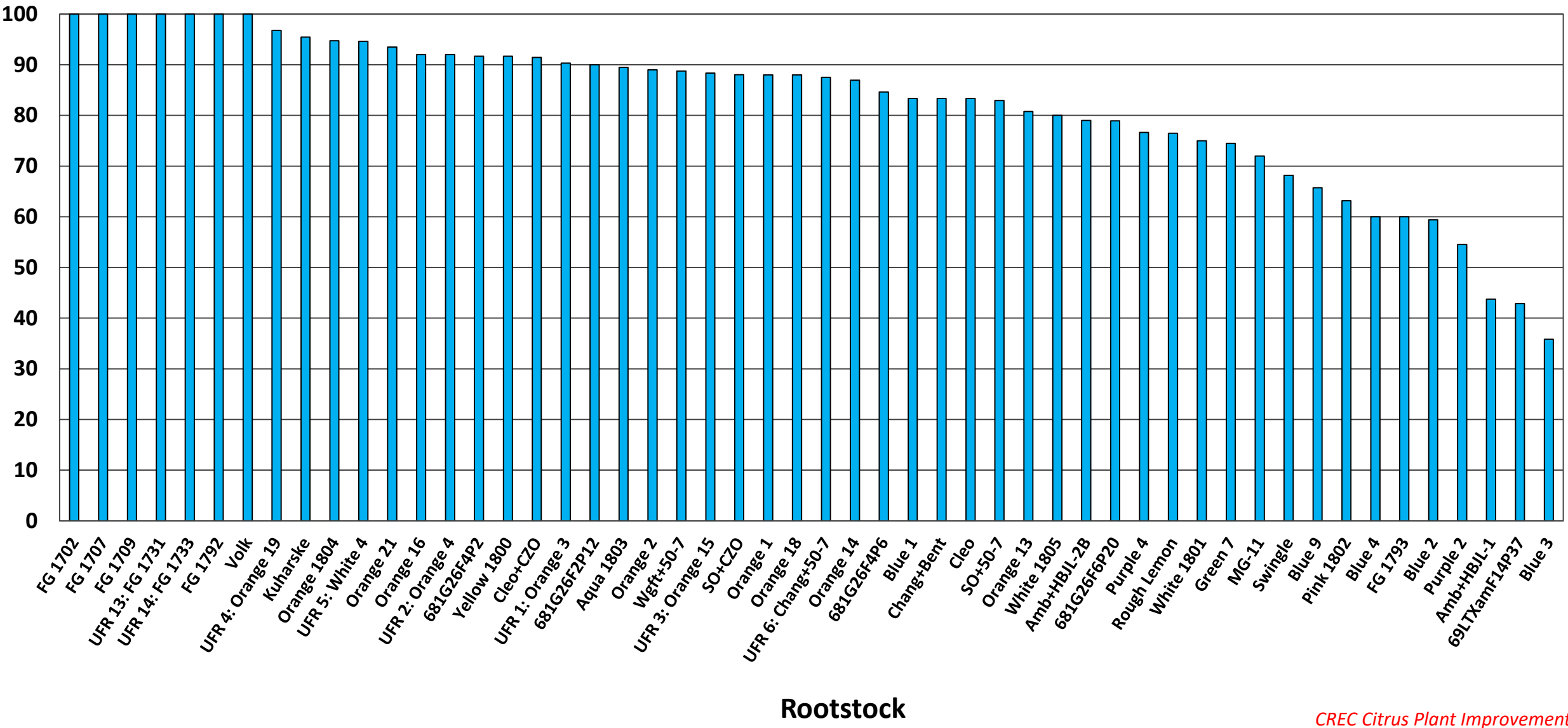


Table 6. St. Helena Rootstock Survey Trial – Rootstock parentage and 2018/19 survival of trees planted in 2010, sorted by survival, %

Scion	Rootstock	Rootstock Parentage	Ploidy	No. trees planted	No. trees survived	Survival**, %
Valq/Vernia	UFR 17: Green 2	[Nova + HBPummelo] x [sour orange + Carrizo]	4x	17	17	100
Vernia	SR+SH-99-11	Sour orange + rangpur, open pollinated	4x	5	5	100
Valq/Vernia	UFR 16: 46x31-02-13	Hirado Buntan (HB) pummelo x Shekwasha	2x	9	9	100
Valq/Vernia	6058-2071-01-02	[Sour orange + rangpur] x [Cleopatra + Argentine trifoliolate orange]	4x	24	23	96
Vernia	6058x6056-002	[Sour orange + rangpur] x [sour orange + Palestine sweet lime]	4x	20	18	90
Valq/Vernia	Nova+7-2-99-2	Nova + pummelo 7-2-99-2	4x	42	36	86
Valq/Vernia	White 1	[Nova + HBPummelo] x [Succari + Argentine trifoliolate orange]	4x	24	20	83
Vernia	46x31-02-S3	Hirado Buntan (HB) pummelo x Shekwasha, salinity tolerant	2x	11	9	82
Vernia	SO+RPxSH99-4	Sour orange + rangpur, open pollinated	4x	14	11	79
Vernia	A-Mac	Tetraploid Macrophylla, Amblycarpa cytoplasm	4x	19	14	74
Valq/Vernia	Nova+7-3-99-1	Nova + 7-3-99-1 pummelo	4x	14	10	71
Vernia	Amb+Volk	Tetraploid Volkameriana, Amblycarpa cytoplasm	4x	42	28	67
Vernia	N+HBP-SS-9	Nova + HBPummelo, open pollinated	4x	30	19	63
Vernia	46x31-02-S9	Hirado Buntan (HB) pummelo x Shekwasha, salinity tolerant	2x	12	6	50
Valq/Vernia	Amb + 5-1-99-2	C. amblycarpa + 5-1-99-2 pummelo	4x	15	6	40
Valq/Vernia	Wmur+HBJL-7	W. Murcott + HBJL-7 pummelo	4x	28	7	25

(\*) To be determined

(\*\*) **Caveat:** Many trees of both scions that were lost during the trial were removed early only because of poor condition at planting. Thus, the tree survival results may be somewhat unrepresentative of true performance.

Table 7. St. Helena Rootstock Survey Trial – 2018/19 Valquarius or Vernia tree size, spacing and HLB status, of trees planted in 2010, sorted by tree height and tree width.

Scion	Rootstock	Tree height* [ft.]	Tree width* [ft.]	Optimum trees/acre**	HLB diagnosis***	Ct value
Valquarius	White 1	8.5	11.5	190	Questionable	30.1
Vernia	UFR 16: 46x31-02-13	8.3	9.5	230	HLB positive	27.4
Vernia	46x31-02-S3	8.0	8.8	251	HLB positive	27.5
Vernia	6058x6056-002	7.8	10.2	215	HLB positive	29.1
Vernia	UFR 17: Green 2	7.7	10.6	208	Questionable	30.3
Vernia	SO+RPxSH99-4	7.3	8.3	271	HLB positive	27.1
Vernia	46x31-02-S9	7.3	9.8	224	HLB positive	28.3
Valquarius	6058x2071-01-02	7.1	8.0	277	Questionable	30.9
Vernia	Nova+7-3-99-1	7.0	10.0	219	HLB positive	29.2
Vernia	46x31-02-9	7.0	9.2	240	No HLB found	32.6
Vernia	A-Mac	6.8	9.0	244	Questionable	31.0
Vernia	N+HBP-SS-9	6.8	8.2	270	Questionable	30.0
Vernia	Amb+Volk	6.7	9.1	240	Questionable	31.3
Vernia	Nova+7-2-99-2	6.6	8.5	261	Questionable	30.2
Valquarius	SO+RPxSH99-4	6.5	7.3	304	not sampled	
Vernia	Amb + 5-1-99-2	6.5	7.3	301	HLB positive	28.5
Vernia	6058x2071-01-02	6.5	7.1	315	No HLB found	34.0
Vernia	SR+SH-99-11	6.5	6.5	336	HLB positive	29.7
Vernia	Wmur+HBIL-7	6.3	9.3	236	HLB positive	28.3

(\*) Measured

(\*\*) Calculated using measured width and hypothetical 20 ft. between all rows

(\*\*\*) Southern Gardens diagnostic lab, PCR analysis of 4-tree composite sample

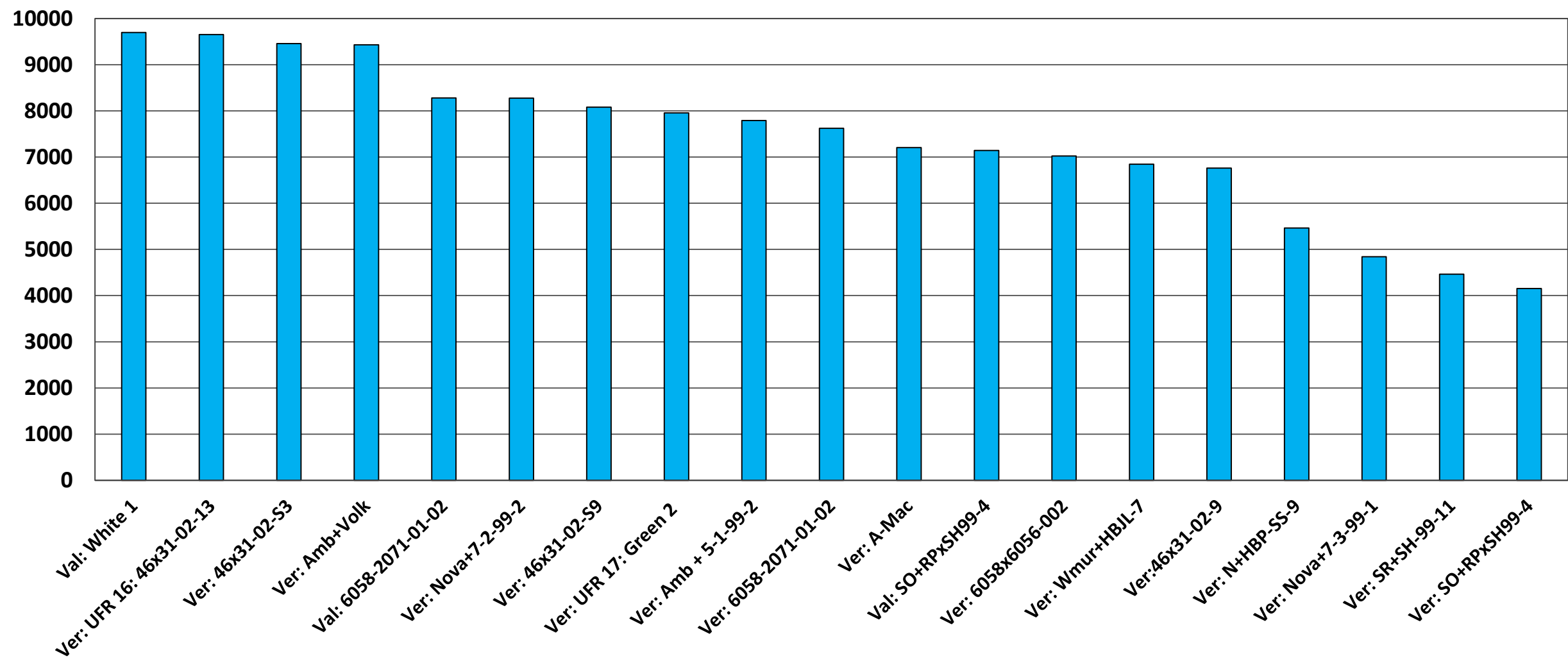


Table 8. St. Helena Rootstock Survey Trial – 2018/19 Valquarius or Vernia Yield, estimated cumulative yield and PS estimates for trees planted in 2010, sorted by estimated cumulative PS/acre.

Scion	Rootstock	PS/box	Boxes/tree	Optimum trees/acre*	Estimated PS/acre [increase 2017-18 to 2018-19, %]	Estimated boxes/acre [increase 2017-18 to 2018-19, %]	Estimated Cum PS/acre 2010-11 to 2018-19
Valquarius	White 1	6.2	3.1	190	3630 [240]	588 [214]	9697
Vernia	UFR 16:46x31-02-13	6.4	2.1	230	3070 [72]	477 [55]	9651
Vernia	46x31-02-S3	6.3	1.8	251	2890 [117]	462 [94]	9457
Vernia	Amb+Volk	6.5	1.4	240	2187 [93]	336 [44]	9429
Valquarius	6058x2071-01-02	5.9	1.6	277	2593 [20]	437 [12]	8281
Vernia	Nova+7-2-99-2	6.6	1.5	261	2618 [146]	400 [114]	8273
Vernia	46x31-02-S9	6.9	1.1	224	1664 [-21]	241 [-31]	8080
Vernia	UFR 17:Green 2	6.3	1.8	208	2380 [183]	377 [134]	7957
Vernia	Amb+5-1-99-2	6.5	0.7	301	1272 [16]	196 [2]	7789
Vernia	6058x2071-01-02	6.4	1.1	315	2119 [138]	332 [123]	7620
Vernia	A-Mac	6.2	1.1	244	1682 [-9]	270 [-23]	7203
Valquarius	SO+RPxSH99-4	6.6	0.7	304	1329 [42]	202 [32]	7140
Vernia	6058x6056-002	5.9	1.7	215	2076 [89]	355 [65]	7024
Vernia	Wmur+HBJL-7	6.7	1.0	236	1506 [14]	224 [11]	6843
Vernia	46x31-02-9	6.2	1.1	240	1692 [46]	274 [33]	6762
Vernia	N+HBP-SS-9	6.8	0.6	270	1184 [4]	174 [-5]	5461
Vernia	Nova+7-3-99-1	6.2	1.0	219	1280 [25]	208 [2]	4841
Vernia	SR+SH-99-11	6.6	0.2	336	446 [-18]	67 [-15]	4465
Vernia	SO+RPxSH99-4	6.1	1.0	304	1598 [80]	262 [83]	4153

(\*) Calculated using measured width and hypothetical 20 ft. between all rows

Fig. 4. St. Helena Rootstock Survey Trial – Estimated cumulative PS/acre for Valquarius or Vernia trees planted in 2010, 6 seasons, 2013/14 to 2018/19.



Scion: Rootstock

Fig. 5. St. Helena Rootstock Survey Trial – 2018/19 % of tree survival for Valquarius or Vernia trees planted in 2010.

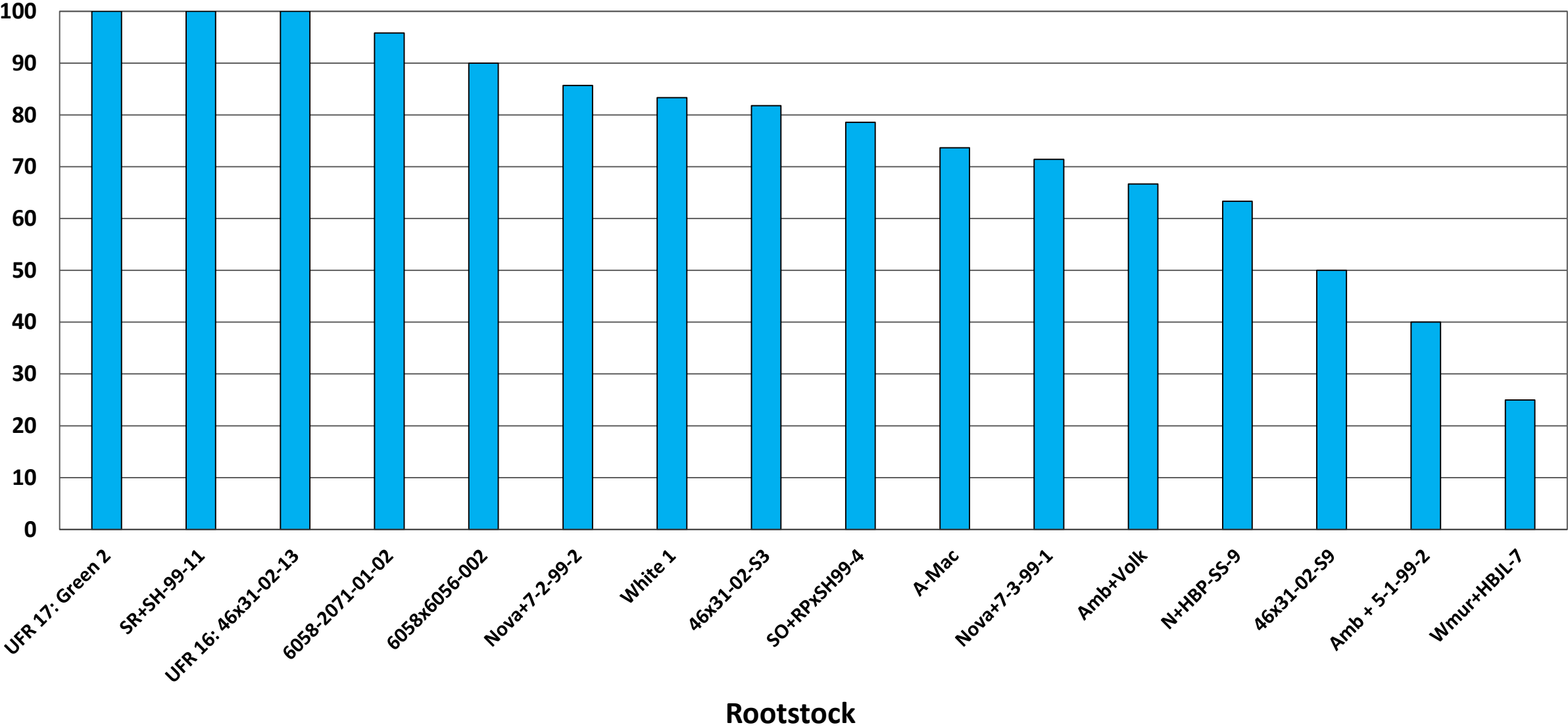


Table 9. St. Helena Rootstock Survey Trial – Harrell’s CRF Fertilizer formulations (utilized in sequence from left to right; of these, 12-3-8, 12-3-9 and 14-3-11 contain TigerSul<sup>®</sup> products).

Component	Formulations (%)				
	16-5-10	13-4-9	12-3-8	12-3-9	14-3-11
<b>Total Nitrogen</b>	16.00	13.00	12.00	12.00	14.00
<b>Nitrate Nitrogen</b>	5.86	7.47	6.94	6.83	5.12
<b>Ammoniacal Nitrogen</b>	6.86	5.00	4.55	4.36	4.50
<b>Urea Nitrogen</b>	3.26	0.53	0.51	0.81	4.38
<b>Available Phosphate</b>	5.00	4.00	3.00	3.00	3.00
<b>Soluble Potash</b>	10.00	9.00	8.00	9.00	11.00
<b>Calcium (Ca)</b>	0.00	4.28	4.53	4.53	1.99
<b>Magnesium (Mg)</b>	1.08	1.12	0.98	0.79	1.37
<b>Copper (Cu)</b>	0.06	0.00	0.04	a.n.p	0.04
<b>Iron (Fe)</b>	0.27	0.95	1.10	1.09	0.60
<b>Manganese (Mn)</b>	0.10	0.16	0.92	0.92	1.65
<b>Molybdenum (Mo)</b>	0.01	0.01	0.01	0.01	0.01
<b>Zinc (Zn)</b>	0.06	0.01	0.71	0.71	0.62
<b>Sulfur</b>	a.n.p*	a.n.p	a.n.p	a.n.p	10.15
<b>Boron (B)</b>	0.00	0.04	0.05	0.07	0.04

(\*) a.n.p - amount not provided