UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service
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NOTICE TO FRUIT GROWERS AND NURSERYMEN RELATIVE TO THE NAMING AND RELEASE OF THE US-897 CITRUS ROOTSTOCK

The Agricultural Research Service, U.S. Department of Agriculture hereby releases to nurserymen and growers the US-897 citrus rootstock. This rootstock selection originated from a cross of Cleopatra mandarin (Citrus reticulata) × Flying Dragon Trifoliate Orange (Poncirus trifoliata) made by Dr. Herb Barrett (deceased) of the USDA, ARS, USHRL, Florida. Field testing of US-897 was planned and conducted by Drs. Don Hutchison, Heinz Wutscher, and Kim Bowman (all of USHRL, Florida) in collaboration with or support from industry partners, including Florida Citrus Research Foundation, Florida Citrus Production Research Advisory Council, Mr. Orie Lee, Becker Groves, Bentley Bros., Florida Research Center for Agricultural Sustainability (Vero Beach), and University of Florida. During field testing, this hybrid rootstock was identified by code numbers FF5-8-119, HRS-897, or US-897. In all field evaluations, US-897 rootstock produced dwarf trees that had good fruit productivity on a canopy volume basis and yielded good fruit quality. The major positive attributes of this new rootstock are resistance or tolerance to citrus tristeza virus, Phytophthora palmivora, and Diaprepes root weevil, dwarfing effect on scion tree size, induction of high fruit quality, induction of good productivity per canopy volume on grafted scions, and ease of seed propagation. A notable negative of this rootstock may be a relatively high rate of tree loss after ten years of age to citrus blight or a similar disease.

US-897 rootstock has been field tested at several locations and with several different scions. The longest and most studied field test involving this rootstock is a replicated cooperative trial in Osceola County (Florida). In this trial with cooperator Mr. Orie Lee, 'Hamlin' sweet orange trees on US-897 were compared with a similar number of trees on 15 other rootstocks through the first 18 years after field planting. Fruit production of 'Hamlin' on US-897 was measured through the first seven harvest seasons and found to be low on a per tree basis (Table 1). However, trees on US-897 were much smaller in size than trees on most other rootstocks, so on a canopy volume basis (yield efficiency), productivity of US-897 was very good (Table 2). Fruit quality characteristics of 'Hamlin' on US-897 were evaluated periodically over an 18-year period and found to be good. Soluble solids concentration and brix/acid ratio of fruit from trees on US-897 was similar to or better than those on Swingle citrumelo, and significantly better than the quality of fruit produced on some other rootstocks (Tables 3 and 4). Fruit produced on trees with US-897 rootstock was similar in size and juice color to that produced on Swingle (Tables 5 and 6). Evaluation of tree survival at 8 and 17 years of age indicated that US-897 had excellent survival at 8 years, but only 67% survival at 17 years (Table 7). This rootstock appeared to induce only moderate cold hardiness in the trees during the Florida freeze of December 1989.

Growth and production on a canopy volume basis, and survival of trees on US-897 rootstock have also been good in other trials, including a 'Marsh' grapefruit trial in Martin County, a 'Valencia' sweet orange trial on a high pH site in St. Lucie County, and a 'Hamlin' trial in Lake County. A 'Valencia trial in Hardee County duplicated the findings from the trial in Osceola

County: US-897 rootstock produced dwarf trees that yielded well on a tree-size basis and with high soluble solids fruit (Table 8). The fruit quality testing in these other trials has consistently indicated that soluble solids concentration of fruit on US-897 rootstock are similar to or better than those on many other rootstocks, like Swingle and Carrizo, including situations where it is used with grapefruit scions (Table 9).

Preliminary test data suggests that US-897 is resistant or field tolerant to some common citrus disease and pest problems in Florida, including citrus tristeza virus (CTV), citrus nematode (Tylenchulus semipenetrans), Phytophthora nicotianae and Phytophthora palmivora foot and root rot, and Diaprepes root weevil. During field evaluation at the Florida Research Center for Agricultural Sustainability (Vero Beach), grapefruit trees on US-897 rootstock that were exposed to severe infestation with Diaprepes root weevil, Phytophthora palmivora, and P. nicotianae grew exceptionally well, while trees on other common rootstocks like Swingle and Carrizo declined or died (Table 10). Some trees on US-897 have been observed with symptoms of a citrus blight-like decline, and this appeared to be the principle cause of the 33% tree loss after 17 years in the Osceola County trial. In comparison to other rootstocks, US-897 appears to be moderately susceptible to this type of decline, although the first trees were not lost until after the trees were over 9 years old. Observations on soil adaptation, insect, nematode, and disease resistance will need to be confirmed by more widespread and long-term studies in the field environment.

US-897 produces apomictic seed by nucellar polyembryony and is thus very easy to propagate uniformly by seed. Nursery studies have indicated that US-897 produces vigorous and true to type seedlings at a frequency similar to or better than that of most other commercial rootstocks (Table 11). US-897 has not been tested for response to viroid diseases, but is expected to be sensitive to exocortis infection and only scion sources free of viroid diseases should be used for propagations with this rootstock.

Source plant material for US-897 has been tested and found free of CTV. Source plant material for US-897 has been entered into testing and is expected to be free of citrus viroids and psorosis. Once testing is completed, budwood for source trees of US-897 will be distributed by the Florida Bureau of Citrus Budwood Registration, 3027 Lake Alfred Road (Highway 17), Winter Haven, Florida 33881. Limited quantities of seed will be distributed by the Florida Citrus Research Foundation (A.H. Whitmore Foundation Farm, 23402 USDA Road, Groveland, Florida 34736) and the Southwest Florida Research and Education Foundation (2686 State Road 29 N., Immokalee, FL 34142). Small quantities of US-897 plant material for professional research and additional information may be obtained from Kim D. Bowman, USDA, ARS, USHRL, 2001 South Rock Road, Ft. Pierce, Florida 34945. Genetic material of this release will be deposited in the National Plant Germplasm System where it will be available for research purposes, including development and commercialization of new cultivars. Appropriate recognition should be made if this germplasm contributes to the development of a new breeding line or cultivar.

Deputy Administrator, Crop Production and Protection
Agricultural Research Service, U.S. Department of Agriculture

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Date

Table 1. Fruit yield of 'Hamlin' sweet orange on US-897 and selected rootstocks in cooperative trial with Mr. Orie Lee in Osceola County. Eighteen trees on each rootstock were planted in 1986. Soil is Myakka fine sand at pH 5.5; tree spacing is 4.2 x 6.6 m. Yearly average yield is for years 8, 9, and 10.

	Fruit yield per tree (kg)				
Rootstock	Year 4-7	Year 8	Year 9	Year 10	Yearly Ave.
US-802	781 a	364	303	348	338 a
US-852	769 a	307	258	307	291 ab
Swingle	597 c	250	225	270	248 bc
US-801	622 b	237	188	262	229 cd
US-896	536 cd	229	172	237	213 cd
US-897	**462 d**	**168**	**151**	**205**	**175 d**

Mean separations for significant ANOVA within columns were by Duncan's multiple range test at $P<0.05$

Table 2. Tree size and yield efficiency of 'Hamlin' sweet orange on US-897 and selected rootstocks in cooperative trial with Mr. Orie Lee in Osceola County.

Rootstock	Tree height at 8 yrs (m)	Canopy volume at 8 yrs (m^3)	Fruit Yield Efficiency at 8 yrs (kg/m^3)	Tree height at 18 yrs (m)
US-802	4.0 a	17.7 a	13.9 c	6.1 a
Swingle	3.0 b	9.1 c	20.2 b	4.8 b
US-801	2.5 c	6.8 c	25.3 a	4.4 b
US-852	3.0 b	11.4 b	20.7 b	3.7 c
US-896	2.6 c	8.4 c	19.0 b	3.3 c
US-897	**2.4 c**	**6.6 c**	**20.2 b**	**2.7 d**

Mean separations for significant ANOVA within columns were by Duncan's multiple range test at $P<0.05$

Table 3. Fruit total soluble solids at harvest of 'Hamlin' sweet orange on US-897 and selected rootstocks in cooperative trial with Mr. Orie Lee in Osceola County.

	Juice total soluble solids (brix)		
Rootstock	Years 4-7	Years 15-17	Average
US-896	10.1 a	10.7 a	10.4
US-897	**9.4 b**	**10.6 a**	**10.0**
US-852	9.6 b	10.4 ab	10.0
Swingle	9.7 b	10.1 b	9.9
US-801	9.2 c	10.3 ab	9.8
US-802	9.0 c	10.1 b	9.6

Mean separations for significant ANOVA within columns were by Duncan's multiple range test at $P<0.05$

Table 4. Juice brix/acid ratio at harvest of 'Hamlin' sweet orange on US-897 and selected rootstocks in cooperative trial with Mr. Orie Lee in Osceola County.

	Juice brix/acid ratio		
Rootstock	Years 4-7	Years 15-17	Average
US-897	**12.7 b**	**15.1 a**	**13.9**
US-896	12.6 bc	15.1 a	13.8
US-801	13.1 a	14.4 a	13.7
US-852	12.2 bc	15.1 a	13.6
Swingle	12.1 c	13.3 b	12.7
US-802	12.3 bc	13.0 b	12.6

Mean separations for significant ANOVA within columns were by Duncan's multiple range test at $P<0.05$

Table 5. Fruit weight at harvest of 'Hamlin' sweet orange on US-897 and selected rootstocks in cooperative trial with Mr. Orie Lee in Osceola County.

	Individual fruit weight (g)		
Rootstock	Years 4-7	Years 15-18	Average
US-801	191 a	160	175
Swingle	174 b	160	167
US-852	172 b	162	167
US-802	169 b	162	165
US-896	174 b	157	165
US-897	**175 b**	**153**	**164**

Mean separations for significant ANOVA within columns were by Duncan's multiple range test at $P<0.05$

Table 6. Juice color at harvest of 'Hamlin' sweet orange on US-897 and selected rootstocks in cooperative trial with Mr. Orie Lee in Osceola County. Values measured as color number (CN) with Greytag MacBeth Color Eye Spectrophotometer.

	Juice color (CN)			
Rootstock	Year 15	Year 16	Year 17	Average
US-802	35.4	35.4	35.4	35.4
US-801	35.7	35.1	35.5	35.4
US-896	35.3	35.0	35.5	35.3
US-852	35.1	35.0	35.7	35.3
US-897	**35.0**	**35.0**	**35.7**	**35.2**
Swingle	35.0	35.0	35.6	35.2

There were no significant ANOVA for juice color within columns.

Table 7. Tree survival and response to 1989 freeze for 'Hamlin' sweet orange on US-897 and selected rootstocks in cooperative trial in Osceola County.

	Freeze damage rating at 3 years (1= no damage)	Tree replacement through 8 years (%)	Tree replacement through 17 years (%)
US-852	1.2	0	6
US-896	2.4	0	6
Swingle	1.8	11	11
US-802	1.1	0	17
US-801	1.1	11	28
US-897	**2.5**	**0**	**33**

Tree replacement and freeze damage rating were not tested by statistical analysis.

Table 8. Yield, tree size, and fruit soluble solids concentration of 'Valencia' sweet orange on US-897 and selected rootstocks in field trial in Hardee County.

Rootstock	Fruit yield (kgs/tree)		Fruit soluble solids at 7 yrs (brix)	Tree height at 7 yrs (m)
Rootstock	Year 5	Year 7		
US-812	26	95 a	11.0 a	2.7 a
Swingle	23	92 a	9.8 b	2.6 a
US-897	**37**	**56 b**	**11.3 a**	**2.2 b**
US-896	17	50 b	11.3 a	2.2 b
Carrizo	28	36 b	10.3 b	2.6 a

Mean separations for significant ANOVA within columns were by Duncan's multiple range test at $P<0.05$

Table 9. Fruit quality at harvest of 4 year old Flame grapefruit trees in St. Lucie County.

Rootstock	Individual fruit weight (g)	Total soluble solids (brix)	Total soluble solids per box (kg)
US-896	254 bc	8.6 a	1.9 a
US-897	**227 c**	**8.5 ab**	**1.9 a**
Swingle	295 ab	8.5 ab	1.8 ab
US-812	279 abc	8.2 ab	1.8 ab
Carrizo	289 ab	8.1 ab	1.7 bc
US-802	321 a	8.0 b	1.6 c

Mean separations for significant ANOVA within columns were by Duncan's multiple range test at $P<0.05$

Table 10. Grapefruit tree size in Indian River County field trial at 3 years old under heavy *Diaprepes* weevil pressure and inoculated with *Phytophthora nicotianae* and *P. palmivora*.

Rootstock	Scion Trunk Cross Sectional Area (mm^2)	Rootstock Trunk Cross Sectional Area (mm^2)
US-802	2284 a	5694 a
US-897	**1912 ab**	**3460 b**
Cleopatra	1897 ab	2732 bc
US-896	1662 b	2031 cd
US-852	1538 b	1683 d
US-812	1523 b	2025 cd
Carrizo	987 c	1395 d
Swingle	880 c	2052 cd

Mean separations for significant ANOVA within columns were by Duncan's multiple range test at $P<0.05$

Table 11. Nursery performance of US-897: Seedling vigor and trueness to type. 'Usable seedlings' is calculated as percent strong seedlings × percent true to type among strong.

Rootstock	Strong seedlings (%)	True to type among strong (%)	Usable seedlings (%)
US-897	**76 a**	**100 a**	**76**
US-802	76 a	90 bc	68
Cleopatra	66 bc	100 a	66
Swingle	65 bc	97 ab	63
Volkamer	58 c	97 ab	56
Kinkoji	63 bc	86 c	54
Smooth Flat Seville	67 b	37 d	25

Mean separations for significant ANOVA within columns were by Duncan's multiple range test at $P<0.05$