HORTSCIENCE 34(4):622–624. 1999.

Performance of 'Valencia' Orange on 21 Rootstocks in Central Florida

H.K. Wutscher and K.D. Bowman
U.S. Department of Agriculture, Agricultural Research Service, U.S. Horticultural Research Laboratory, 2120 Camden Road, Orlando, FL 32803

Additional index words. survival, growth, yield, *Citrus sinensis*, *Citrus* sp., tree size, fruit size, peel color, juice content, soluble solids

***Abstract*. Twenty-one selections consisting of 13 numbered hybrids, one ornamental, and seven named cultivars were tested as rootstocks for 'Valencia' orange, *Citrus sinensis* L. Osbeck. The test included six, four-tree replications in randomized complete blocks on sandy soil typical of the center of the Florida peninsula. Trees propagated on Vangasay lemon, HRS 812 (Sunki x Benecke trifoliate orange), and HRS 942 (Sunki x Flying Dragon trifoliate orange) produced more fruit than trees on the other 18 rootstocks in the test. Trees on 10 rootstocks, including the widely used commercial rootstocks, Swingle citrumelo and Carrizo citrange, were intermediate in cumulative fruit production. Trees on five rootstocks, including Sun Chu Sha , Gou Tou #1, and Tachibana, had low yields and trees on HRS 939 (Flying Dragon trifoliate orange x Nakorn pummelo) and sour orange #2 were extremely dwarfed and were minimally productive because of tristeza virus disease. Four-year cumulative fruit production ranged from 52 to 317 kg per tree. Fruit from trees on HRS 954 and HRS 952 (Pearl tangelo x Flying Dragon trifoliate orange) had the highest, and fruit from trees on Vangasay and Gou Tou #1 had the lowest total soluble solids concentration.**

Changes in disease pressure, climatic factors, and management practices create a demand for new citrus rootstocks. The freezes of the 1980s resulted in a wave of 'Hamlin' sweet orange planting because this early cultivar can be harvested before the onset of cold temperatures. Citrus blight and tristeza virus disease forced abandonment of traditional rootstocks and brought on a series of rootstock tests in search of suitable replacements (Castle et al., 1988, 1989; Wutscher and Bistline, 1988; Wutscher and Hill, 1995; Youtsey and Lee, 1995). The 'Hamlin' glut, because of widespread planting and warmer winters, brought on a change in planting patterns, with three times as many of the higher-quality 'Valencia' planted than 'Hamlin.' This, in turn, created more interest in rootstocks for 'Valencia' orange (Castle et al., 1993; Hutchison et al., 1992). The aim is to find rootstocks on which trees with small canopies produce large quantities of high quality fruit. Resistance to tristeza virus disease and phytophthora foot and root rot are essential and can usually be determined by greenhouse tests or observed on young trees. Citrus blight, because it rarely appears in trees younger than 5 years of age, requires longer-term observations. The present test compared trees on the commercially used rootstocks Swingle citrumelo, Carrizo citrange, Sunki and Sun Chu Sha mandarin, and sour orange with 13 experimental, mostly new hybrid rootstocks and two importations from the Far East (Gou Tou #1 and Tachibana).

Received for publication 14 Sept. 1998. Accepted for publication 22 Dec. 1998. Mention of a trademark, warranty, proprietary product, or vendor does not constitute a guarantee by the U.S. Dept. of Agriculture and does not imply its approval to the exclusion of other products or vendors that may also be suitable. We thank Fred Bistline and Linda Russo, who made possible the establishment of the test, and Patrick and Ray Bentley, who provided grove care and harvesting crews, making it possible to collect data. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

Materials and Methods

Seed for the 21 rootstocks (Table 1) in this trial were obtained from the germplasm collection and the test plots at the U.S. Dept. of Agriculture (USDA) Foundation Farm near Leesburg, Fla. The seeds were planted in a seedbed in 1989, the seedlings were transplanted into a nursery in 1990 and budded with the virus-free registered clone 1-18-38 of 'Valencia.' While still in the nursery, the trees were apparently infected with tristeza virus. In May 1991, they were dug and planted bare-rooted in a commercial grove at 5.5 × 2.4 m spacing near Lynchburg in Polk County in central Florida. The soil at the gently sloping test site was Candler fine sand (Hyperthermic uncoated Typic Quartzipsamments) with pH and extractable nutrients determined at the beginning and the end of the experiment (Table 2). There were six, four-tree plots on each rootstock in a randomized complete-block design, with guard rows on two sides of the planting. The trees received standard commercial care; irrigation was by overhead sprinklers.

The trees were hedged on alternate sides in 1996 and 1997. The fruit was harvested in late March or early April by picking all four trees

Table 1. Rootstocks tested with 'Valencia' orange scion in central Florida.

Code no.	Rootstock/Cultivar	Botanical name
HRS 811	Smooth Flat Seville x Swingle citrumelo	*Citrus* hybrid x (*Citrus paradisi* MacF. x *Poncirus trifoliata* L. Raf.)
HRS 812	Sunki x Benecke trifoliate orange	*Citrus reticulata* L. Blanco x *P. trifoliata*
HRS 827	Rangpur x Swingle trifoliate orange	*C. reticulata* hybrid x *P. trifoliata*
HRS 849	Smooth Flat Seville x Argentine trifoliate orange	(*C.* hybrid x *P. trifoliata*)
HRS 877	King x Rubidoux trifoliate orange	(*C. sinensis* L. Osbeck x *C. reticulata*) x *P. trifoliata*
HRS 934	Minneola x Trifoliate orange	(*C. paradisi* x *C. reticulata*) x *P. trifoliata*
HRS 935	Cleopatra x Troyer	*C. reticulata* x (*C. sinensis* x *P. trifoliata*)
HRS 937	Sunki x Flying dragon trifoliate orange	*C. reticulata* x *P. trifoliata*
HRS 939	Flying Dragon trif. or. x Nakorn pummelo	*P. trifoliata* x *Citrus maxima* Burm. Merrill
HRS 941	Sunki x Flying Dragon trif. orange	*C. reticulata* x *P. trifoliata*
HRS 942	Sunki x Flying Dragon trif. orange	*C. reticulata* x *P. trifoliata*
HRS 952	Pearl tangelo x Flying Dragon trif. orange	(*C. paradisi* x *C. reticulata*) x *P. trifoliata*
HRS 954	Pearl tangelo x Flying Dragon trif. orange	(*C. paradisi* x *C. reticulata*) x *P. trifoliata*
	Carrizo citrange	*C. sinensis* x *P. trifoliata*
	Gou Tou #1	*Citrus* hybrid
	Sour orange #2	*C. aurantium* L.
	Sun Chu Sha mandarin	*C. reticulata*
	Sunki mandarin	*C. reticulata*
	Swingle citrumelo	*C. paradisi* x *P. trifoliata*
	Tachibana	*C. reticulata*
	Vangasay lemon	*C. limon* (L.) Burm.f.

Table 2. Soil analysis before and after the experiment.

	Element (μg·g^{-1})[z]								
pH[y]	P	K	Ca	Mg	Na	Fe	Mn	Zn	Cu
				April 1991					
6.4	451	19	1282	78	12	25	10	18	30
				May 1998					
7.0	505	56	1415	68	16	19	9	24	34

[z]Mehlich I extraction.
[y]pH, 1 soil : 1 water, means of four samples (0–30 cm).

in each replication into a 10-box (408 kg) bin and measuring the contents with a calibrated stick inserted through the center of a bar across the bin (Wutscher and Hill, 1995; Youtsey and Lee, 1995). Missing and replacement trees were excluded. Three to five days before each harvest, two 30-fruit samples, each from three replications, were collected for fruit quality analysis. Fruit weight, diameter, rind thickness, and peel color were determined, the latter by comparison with a color chart in USDA Technical Bulletin 753 (Harding et al., 1940). The juice was extracted with an electric reamer that extracts 5% to 10% less juice than commercial juice extractors (Wutscher and Hill, 1995).

Total soluble solids (TSS) were measured with a refractometer, total acids by titration with 0.1560 N NaOH, and juice color with a chromameter (model CE 200, Minolta Camera Co., Osaka, Japan). The data were analyzed by analysis of variance and the means were separated by Duncan's multiple range test.

Results and Discussion

The most productive trees in the test were on Vangasay lemon, HRS 812 (Sunki x Benecke trifoliate orange) and HRS 942 (Sunki x Flying Dragon) (Table 3). The performance of the trees on Vangasay was typical for lemon rootstocks; they were large and highly productive, but the fruit quality was poor (Tables 3 and 4). The trees on HRS 812 (Sunki x Benecke trifoliate) were medium-sized and produced well both in terms of yield/tree and TSS/tree. The latter is an all-important characteristic in Florida, where 90% of the orange production is processed and where growers are paid for the quantity of solids delivered rather than for the quantity of fruit. There are favorable reports on this rootstock from Israel, where trees on it grew well on high pH soils under desert conditions, (Levy, 1997) and from Brazil (Pompeu et al., 1997). It performed poorly in Peru (K. Bederski, personal communication) but performed well in small plantings in other areas in Florida (M. Irey, personal communication). Trees on HRS 942, one of three Sunki x Flying Dragon hybrids in the test, produced as much fruit and solids as the larger trees on Vangasay and HRS 812. With further testing, it could emerge as the most promising rootstock in the test.

The concentrations of soil nutrients changed little during the experiment (Table 2). The trees on most rootstocks (Table 3) grew well and the maximum loss of trees 7 years after planting was 17% (Table 3); no trees were lost on eight of the 21 rootstocks in the test. Because the trees had been hedged, making tree volume meaningless, size of the 8-year-old trees was expressed as tree height and trunk cross-sectional area. Trees on HRS 942 (Sunki x Flying Dragon) produced as much fruit as trees on Vangasay lemon, which had a trunk cross-sectional area twice as large (Table 3). Trees on four rootstocks, HRS 954 (Pearl x Flying Dragon), HRS 811 (Smooth Flat Seville x Swingle citrumelo), HRS 939 (Flying Dragon x Nakorn pummelo), and on sour orange #2 were distinctly smaller than those on all other rootstocks, apparently because of a severe strain of tristeza virus endemic in the area. Although the trees on sour orange #2 were severely dwarfed and produced very little fruit, only one of the 24 trees died. The tristeza susceptibility of sour orange rootstocks is well known (Costa et al., 1954), but the severity of symptoms varies with the severity of the strain of this virus. Trees on HRS 939 were slightly affected in an area where a milder tristeza strain had only moderately affected trees on sour orange #2 (Wutscher and Hill, 1995); in the present test, they were almost as dwarfed and unproductive as trees on sour orange #2, indicating a more virulent strain of the virus.

Of the five commercially used rootstocks in the test, Swingle citrumelo, Carrizo citrange, and Sun Chu Sha had no tree losses; two trees on Sunki and one tree on sour orange #2 were lost. Trees on the commercial rootstocks were not as productive as trees on several of the new rootstocks. Trees on Vangasay, HRS 812 and HRS 942 out-produced trees on Swingle citrumelo (Table 3), currently the most widely planted rootstock in Florida (Castle et al., 1988). Trees on Carrizo ranked lowest in the group of intermediately producing trees. Unexpectedly, trees on Sun Chu Sha were transitional between intermediate and low productivity; in an earlier test such trees had outproduced trees on Vangasay and Carrizo (Hutchison et al., 1992). Its performance in this test was similar to that in Texas (Wutscher and Dube, 1977; Wutscher and Shull, 1976). Gou Tou #1, an introduction from China via Australia, which has been suggested as a possible replacement for sour orange (Castle et al., 1992, 1993; Garnsey, 1992) performed poorly, only slightly better than the tristeza-affected trees, and was difficult to handle in the nursery. Trees on the two Pearl tangelo hybrids, HRS 952 and HRS 954, were medium to low fruit producers, but had the highest TSS (Table 4), a trait that could be useful in breeding new rootstocks. There were no differences in rind thickness (4 mm) and juice color number (37.3–37.9) among fruit of trees on the rootstocks in this trial.

The losses on the various rootstocks were mostly due to phytophthora foot rot caused

Table 3. Tree size and yield after the first four harvests (1995–98) of 'Valencia' orange trees on 21 rootstocks in central Florida.

Rootstock		Survival (%)	Tree ht (m)	TCA[z] (cm^2)	Yield/tree (kg) 1995	1996	1997	1998	Cumulative Yield 1995–98 (kg/tree)	kg SS[y] produced
	Vangasay Lemon	100	3.9 a[x]	161.2 a	54.4 a	51.0 b	119.5 a	92.3 a–d	317.3 a	15.6 ab
HRS 812	Sunki x Benecke Trif.	100	3.5 cd	100.2 e	39.8 b–d	63.8 a	88.8 b	113.3 a	305.7 a	17.7 a
HRS 942	Sunki x Flying Dragon Trif.	96	3.1 fg	82.0 f–h	44.2 a–c	64.2 a	82.9 b–d	99.5 ab	290.9 a	17.5 a
HRS 934	Minneola x Trif.	96	3.7 bc	122.0 cd	30.9 c–g	35.2 c–e	79.1 b–e	99.8 ab	244.9 b	14.1 bc
HRS 935	Cleopatra x Troyer	96	3.8 ab	131.8 bc	26.8 d–j	35.1 c–e	78.5 b–e	100.1 ab	240.4 b	13.9 bc
HRS 941	Sunki x Flying Dragon Trif.	100	2.6 i	72.2 hi	45.1 ab	50.2 b	60.7 e–h	84.2 b–f	240.1 b	13.0 b–d
	Swingle Citrumelo	100	3.2 e–g	81.3 gh	38.0 b–e	39.4 b–d	75.1 b–e	87.2 b–e	239.7 b	13.7 bc
HRS 827	Rangpur x Swingle Trif	100	3.5 d	117.6 d	27.6 d–i	35.2 c–e	84.7 bc	87.2 b–e	234.7 b	13.9 bc
HRS 849	Smooth Flat Seville x Argentine Trif.	92	2.9 h	64.1 i	35.4 b–f	45.1 bc	65.7 c–f	84.3 b–f	230.6 b	13.9 bc
HRS 952	Pearl Tangelo x Flying Dr. Trif.	96	3.1 e–g	69.1 hi	32.0 b–f	49.3 b	55.1 f–h	83.9 b–f	220.4 bc	14.0 bc
	Sunki Mandarin	92	3.6 b–d	138.3 b	31.5 b–f	32.7 c–f	78.2 b–e	75.3 c–g	217.8 bc	13.1 b–d
HRS 877	King Mand x Rubidoux Trif.	87	3.3 e	95.8 ef	27.2 d–i	25.7 e–g	67.2 c–f	96.9 a–c	217.0 bc	12.0 c–e
	Carrizo Citrange	100	3.5 cd	114.8 d	25.2 d–j	29.2 d–f	75.3 b–e	86.3 b–e	216.0 bc	11.9 c–e
	Sun Chu Sha Mandarin	100	3.6 cd	135.2 bc	28.9 d–h	28.5 d–f	66.3 c–g	60.3 g	184.0 cd	10.8 d–f
HRS 937	Sunki x Flying Dragon	100	2.7 i	58.7 ij	28.1 d–h	24.2 e–g	48.9 g–i	71.0 d–g	172.2 de	10.0 ef
	Gou Tou #1	96	3.2 ef	93.5 e–g	12.9 jk	15.5 g	73.0 b–e	63.8 fg	165.1 de	8.5 f
	Tachibana	83	3.0 gh	89.7 e–g	16.3 h–k	21.4 fg	54.1 f–h	68.4 e–g	160.3 de	9.6 ef
HRS 954	Pearl Tangelo x Flying Dr. Trif.	83	2.4 j	46.1 j	21.4 f–j	24.5 e–g	34.2 ij	56.2 g	136.3 ef	8.9 f
HRS 811	Smooth Flat Seville x Swingle Citr.	87	2.6 i	48.6 j	17.0 g–k	14.5 g	43.7 hi	36.1 h	111.3 f	6.0 g
HRS 939	Flying Dragon x Nakorn Pumm.	88	1.8 k	31.2 k	13.6 i–k	2.0 h	25.9 j	23.7 h	65.3 g	3.8 gh
	Sour Orange #2	96	1.8 k	30.4 k	7.1 k	3.1 h	19.9 j	22.1 h	52.2 g	2.9 h
Mean		95	3.1	89.7	28.7	32.8	65.6	75.8	203.0	11.7

[z]TCA = trunk cross-sectional area.
[y]SS = soluble solids.
[x]Mean separation within columns by Duncan's multiple range test at $P \leq 0.05$.

Table 4. Fruit quality analysis of 'Valencia' orange on 21 rootstocks in Central Florida. (Means for four harvests, 1995–98.)

	Rootstock	Fruit diam (cm)	Fruit wt (g)	Peel color[z]	Juice content (%)	Total soluble solids (TSS) (%)	Total acids (TA) (%)	TSS : TA ratio
	Vangasay Lemon	7.7 ab[y]	239 ab	8.8 cd	50.9 a–c	9.4 d	0.71 c–e	13.3 b–d
HRS 812	Sunki x Benecke Trif.	7.7 ab	245 ab	9.2 a–d	53.8 ab	10.5 bc	0.78 b–d	13.5 b–d
HRS 942	Sunki x Flying Dragon	7.1 ab	242 ab	9.3 a–c	54.2 ab	10.8 bc	0.78 b–d	13.9 a–d
HRS 934	Minneola x Trif	7.8 ab	251 ab	9.3 a–c	53.6 a–c	10.6 bc	0.75 b–e	14.1 a–d
HRS 935	Cleopatra x Troyer	7.8 ab	254 ab	9.2 a–d	52.5 a–c	10.5 bc	0.74 b–e	14.3 a–c
HRS 941	Sunki x Flying Dragon	7.9 ab	255 ab	9.3 a–c	49.2 c	10.5 bc	0.77 b–d	13.8 a–d
	Swingle Citrumelo	7.8 ab	244 ab	8.8 cd	51.8 a–c	10.5 bc	0.77 b–d	13.6 a–d
HRS 827	Rangpur x Swingle Trif	7.7 ab	238 ab	9.4 ab	54.7 a	10.6 bc	0.77 b–d	13.8 a–d
HRS 849	Smooth Flat Seville x Argentine	7.7 ab	243 ab	9.3 a–c	54.2 ab	11.0 bc	0.79 bc	13.9 a–d
HRS 952	Pearl Tangelo x Flying Dragon	7.5 ab	230 ab	9.6 a	55.3 a	11.5 ab	0.79 bc	14.5 ab
	Sunki Mandarin	7.8 ab	247 ab	9.4 ab	55.3 a	10.5 bc	0.81 b	13.0 d
HRS 877	King Mandarin x Rubidoux Trif	7.8 ab	244 ab	9.2 a–d	51.5 a–c	10.2 cd	0.72 c–e	14.3 a–c
	Carrizo Citrange	7.8 ab	252 ab	9.0 b–d	52.5 a–c	10.2 cd	0.74 b–e	13.8 a–d
	Sun Chu Sha Mandarin	7.7 ab	237 ab	9.3 a–c	54.2 ab	10.6 bc	0.77 b–d	14.0 a–d
HRS 937	Sunki x Flying Dragon	7.8 ab	254 ab	9.3 a–c	50.3 bc	11.0 bc	0.79 bc	14.0 a–d
	Gou Tou #1	7.9 ab	250 ab	8.9 cd	52.1 a–c	9.5 d	0.70 de	13.5 b–d
	Tachibana	7.6 ab	226 ab	9.3 a–c	54.1 ab	10.5 bc	0.76 b–e	13.9 a–d
HRS 954	Pearl Tangelo x Flying Dragon	7.3 b	209 b	9.4 ab	53.3 a–c	11.9 a	0.92 a	13.1 cd
HRS 811	Smooth Flat Seville x Swingle	8.0 a	266 a	9.4 ab	51.5 a–c	10.0 cd	0.68 e	14.8 a
HRS 939	Flying Dragon x Nakorn	7.4 b	217 ab	9.1 a–d	50.2 bc	10.6 bc	0.79 bc	13.7 a–d
	Sour Orange	7.6 ab	229 ab	9.1 a–d	50.2 bc	10.6 bc	0.75 b–e	14.2 a–d
Experiment mean		7.7	241.5	9.2	52.6	10.5	0.77	13.9

[z]Peel color according to color tables in Harding et al. (1940); color range from A = 1 (completely green) to L = 12 (dark red).
[y]Mean separation within columns by Duncan's multiple range test at $P \leq 0.05$.

by *Phytophthora nicotianae* B. deHaan. Tachibana, a small-fruited Japanese ornamental mandarin, performed poorly as a rootstock, as it did in similar tests conducted in Texas (Wutscher et al., 1975; Wutscher and Shull, 1973). Likewise Sunki also performed poorly (Wutscher and Bistline, 1988; Wutscher and Shull, 1975). At the end of the observation period, three trees showed symptoms of citrus blight (a tree decline of unknown cause), which were confirmed by wood analysis (Wutscher et al., 1977) and water injection into the trunk (Lee et al., 1984), including one tree each on Vangasay, HRS 812 (Sunki x Benecke trifoliate), and HRS 877 (King x Rubidoux trifoliate orange). Longer-term observations are needed to draw definite conclusions concerning the resistance of the currently studied rootstocks to citrus blight. Of the three best-performing rootstocks in the test, trees on Vangasay have a track record of being cold-tender and blight-susceptible, and of producing low quality fruit (Hutchison et al., 1992; Wutscher and Hill, 1995; Wutscher and Shull, 1975). The rootstocks of the other highest-producing trees, HRS 812 and HRS 942, are clearly worthy of further testing. The excellent performance of HRS 812 under a wide range of conditions (Levy 1997; Pompeu et al., 1997; Irey, personal communication) and of HRS 942, with heavy production of high-quality fruit on small trees, makes them outstanding candidates for commercial-scale testing. The test results also eliminate the hybrids HRS937, HRS 954, HRS 811, and HRS 939 and the introductions Gou Tou #1 and Tachibana as rootstocks for 'Valencia' orange (Table 3).

Literature Cited

Castle, W.S., R.R. Pelosi, C.O. Youtsey, F.G. Gmitter, Jr., R.F. Lee, C.A. Powell, and X. Hu. 1992. Rootstocks similar to sour orange for Florida citrus trees. Proc. Fla. State Hort. Soc. 105:56–60.

Castle, W.S., D.P.H. Tucker, A.H. Krezdorn, and C.O. Youtsey. 1989. Rootstocks for Florida citrus. Univ. of Florida, Coop. Ext. Serv. Publ. SP42.

Castle, W.S., D.P.H. Tucker, A.H. Krezdorn, and C.O. Youtsey. 1993. Rootstocks for Florida citrus. 2nd ed. Univ. of Florida, Coop. Ext. Serv. Publ. SP42.

Castle, W.S., H.K. Wutscher, C.O. Youtsey, and R.R. Pelosi. 1988. Citrumelos as rootstocks for Florida citrus. Proc. Fla. State Hort. Soc. 101:28–33.

Costa, A.S., T.J. Grant, and S. Moreira. 1954. Behavior of various citrus rootstock-scion combinations following inoculation with mild and severe strains of tristeza virus. Proc. Fla. State Hort. Soc. 67:26–30.

Garnsey, S.M. 1992. Tolerance of Gou Tou rootstock to severe exotic isolates of citrus tristeza virus (CTV). Proc. Fla. State Hort. Soc. 105:35–38.

Harding, P.L., J.R. Winston, and D.F. Fisher. 1940. Seasonal changes in Florida oranges. U.S. Dept. Agr. Tech. Bul. 753.

Hutchison, D.J., C.J. Hearn, and F.W. Bistline. 1992. The performance of 'Valencia' orange trees on 21 rootstocks in the Florida flatwoods. Proc. Fla. State Hort. Soc. 105:60–63.

Lee, R.F., L.J. Marais, L.W. Timmer, and J.H. Graham. 1984. Syringe injection of water into the trunk: A rapid diagnostic test for citrus blight. Plant Dis. 6:511–513.

Levy, Y. 1997. The response of different rootstocks to viroid-infected scions. Proc. 5th Intl. Congr. Soc. Citrus Nurserymen. Montpellier, France. (Abstr.)

Pompeu, J., Jr., J.O. deFigueiredo, F.F. Laranjeira, G.W. Müller, and J.T. Sobrinho. 1997. Performance of Valencia sweet orange on trifoliate hybrids in Sao Paulo, Brazil. Proc. 5th Intl. Congr. Soc. Citrus Nurserymen. Montpellier, France. (Abstr.)

Wutscher, H.K. and F.W. Bistline. 1988. Performance of 'Hamlin' orange on 30 citrus rootstocks in southern Florida. J. Amer. Soc. Hort. Sci. 113:493–497.

Wutscher, H.K., M. Cohen, and R.H. Young. 1977. Zinc and water soluble phenolic levels in the wood for diagnosis of citrus blight. Plant Dis. Rptr. 61:572–574.

Wutscher, H.K. and D. Dube. 1977. Performance of young nucellar grapefruit on 20 rootstocks. J. Amer. Soc. Hort. Sci. 102:267–270.

Wutscher, H.K. and L.L. Hill. 1995. Performance of 'Hamlin' orange on 16 rootstocks in east-central Florida. HortScience 30:41–43.

Wutscher, H.K., N.P. Maxwell, and A.V. Shull. 1975. Performance of nucellar grapefruit, *Citrus paradisi* Macf., on 13 rootstocks in south Texas. J. Amer. Soc. Hort. Sci. 100:48–51.

Wutscher, H.K. and A.V. Shull. 1973. The performance of 'Valencia' orange trees on 16 rootstocks in South Texas. Proc. Trop. Reg. Amer. Soc. Hort. Sci. 17:66–73.

Wutscher, H.K. and A.V. Shull. 1975. Yield, fruit quality, growth, and leaf nutrient levels of 14-year-old grapefruit, *Citrus paradisi* Macf., trees on 21 rootstocks. J. Amer. Soc. Hort Sci. 100:290–294.

Wutscher, H.K. and A.V. Shull. 1976. Performance of 'Orlando' tangelo on 16 rootstocks. J. Amer. Soc. Hort. Sci. 101:88–91.

Youtsey, C.O. and O. Lee. 1995. A 6-year comparison between 16 rootstocks budded with 'Hamlin' sweet orange. Proc. Fla. State Hort. Soc. 108:69–73.