

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service
Washington, D.C.

RELEASE OF US-1282, Citrus Rootstock

The Agricultural Research Service, U.S. Department of Agriculture hereby releases to nurserymen and growers the US-1282 citrus rootstock. This rootstock selection originated from a 1995 cross of Cleopatra mandarin (*Citrus reticulata*) × Gotha Road #6 Trifoliate Orange (*Poncirus trifoliata*) made at the A.H. Whitmore Foundation Farm by Dr. Kim D. Bowman of the USDA, ARS, USHRL, Florida. Field testing of US-1282 was planned and conducted by Dr. Kim Bowman, in collaboration with or support from industry partners, including Florida Citrus Research Foundation, Florida Citrus Production Research Advisory Council, Florida Citrus Research and Development Foundation, and Mid-Florida Citrus Foundation. Dr. Greg McCollum (also of USDA, ARS, USHRL) collaborated in the evaluation of fruit quality from field trials. During field testing, this hybrid rootstock was identified by code numbers BS95-V5-78 or US-1282. The major positive attributes of this new rootstock are induction of superior fruit productivity and fruit quality on sweet orange trees grown in the Florida flatwoods and infected with *Candidatus Liberibacter asiaticus* (Las), the causal agent of huanglongbing (HLB). This rootstock is being released for commercial use in Florida because of the urgent need for new citrus rootstocks that have improved tolerance to HLB.

Field testing of the US-1282 rootstock has been primarily at one location with 'Hamlin' sweet orange scion. This field test is a replicated trial in St. Lucie County Florida at the USHRL research farm in Ft. Pierce. The site is typical Florida flatwoods with a soil characterized as Riviera fine sand, and trees were planted in double row beds at 3.0 m x 7.6 m spacing and irrigated by microjet. In this trial, seven 'Hamlin' sweet orange trees on US-1282 were compared with a similar number of trees on 25 other rootstocks planted in 2000 and using a randomized complete block statistical design. Trees in this trial were damaged by hurricanes Frances and Jeanne in 2004, and both HLB and citrus canker (*Xanthomonas citri* subsp. *citri*) began to affect the trees in 2007-8. Fruit production of 'Hamlin' on US-1282 in this trial was first measured in the 2006 and 2007 harvest seasons, before HLB symptoms were widespread. During the 2006 and 2007 seasons, fruit production on US-1282 was found to be significantly higher than production of trees on Swingle, the most common rootstock used in Florida. In the following years, Las spread rapidly throughout the trial, and overall tree health declined. From 2008 to 2012, cropping on all rootstocks declined from the pre-HLB yields, but cropping on Swingle rootstock suffered more dramatically than cropping on US-1282 and some other rootstocks. During this period, trees on US-1282 yielded more fruit than any other rootstock. The average fruit production during this period on US-1282 was measured at 3.1 times the fruit production on Swingle. As a result of increased application of plant nutrients, overall tree health in the trial improved during 2012-14. In the 2013 harvest season, trees on US-1282 produced 63 kg fruit per tree, or about 78 percent of the annual crop produced on those trees during the 2006 and 2007 seasons (before HLB impact). In comparison, trees on Swingle rootstock in the 2013 harvest season continued a very low fruit production, yielding 19 kg fruit per tree, or about 17 percent the annual crop produced on those trees during the 2006 and 2007 seasons. The significantly higher fruit production of trees on US-1282 than trees on Swingle following tree infection with Las, and also following the implementation of an improved nutritional program, indicates a greater tolerance of US-1282 to HLB disease.

Fruit quality was assessed on samples from the replicated trial at the USHRL farm in St. Lucie County just before harvest in December 2012 and 2013. Fruit weight from trees on US-1282 rootstock was 161 g and significantly higher than the 115 g fruit on Swingle in 2012. During the 2013 season, fruit from trees on US-1282 were again numerically heavier than fruit on Swingle, but differences among the rootstocks were not significant. During both the 2012 and 2013 seasons, fruit total soluble solids were numerically higher for trees on US-1282 than for trees on Swingle, but only in 2013 were these differences statistically significant. During both the 2012 and 2013 seasons, TSS:acid ratios were significantly higher for trees on US-1282 than for trees on Swingle. Significant differences among the rootstocks for other fruit quality traits, such as juice color, were not observed. Three characteristics of fruit quality, fruit size, TSS, and TSS:acid ratio, were significantly better for trees on US-1282 in comparison to trees on Swingle.

Canopy size was measured on the trees in the replicated trial at the USHRL farm in St. Lucie County in August 2014. Canopy height and width were not significantly different for trees on US-1282 and Swingle. However, calculation of canopy area and canopy volume showed that canopy size was significantly larger for trees on US-1282. To assess whether measured differences in performance of 'Hamlin' trees on US-1282 and Swingle rootstocks were due to differences in infection rate with Las or bacterial titer in plant tissues, trees were tested by canopy sampling and PCR in August 2014. All trees on all rootstocks in the trial were observed to be PCR positive for Las at that time. The amount of Las (Las genome copy number per gram of plant tissue) detected in random leaf samples from the canopy of trees on US-1282 and Swingle were similar and not significantly different. It can be inferred that improved yield and other traits of trees on US-1282 in comparison with Swingle were not because of an induction of increased resistance to Las infection or reduced Las growth in the scion tissues, but rather to an increased tolerance of the tree to HLB following Las infection. The results from the trial suggest that US-1282 is clearly superior to Swingle rootstock for use on a Florida flatwoods site with HLB. Further definition of the advantages and faults of US-1282 rootstock will be resolved through additional field testing.

For field testing, US-1282 was propagated by cuttings. It is anticipated that US-1282 will produce nucellar seed that can be used for uniform nursery propagation, but a mature seed source is not available and nursery performance of seedlings has not been assessed. Source plant material for US-1282 has been tested and found free of Las and CTV. Source plant material for US-1282 has been provided to the Florida Bureau of Citrus Budwood Registration clean budwood program (3027 Lake Alfred Road - Highway 17, Winter Haven, Florida 33881) and will be distributed, following USDA release, according to Florida Department of Agriculture and Consumer Services regulations. Plant tissue for research and additional information on US-1282 may be obtained from Kim D. Bowman, USDA, ARS, USHRL, 2001 South Rock Road, Ft. Pierce, Florida 34945 (kim.bowman@ars.usda.gov). 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.

Signature:



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

Date 9/29/14

Addendum: RELEASE OF THE US-1282, Citrus Rootstock - TABLES
Kim D. Bowman and Greg McCollum

Table 1. Fruit yield of ‘Hamlin’ sweet orange on US-1282 and other rootstocks in comparison with Swingle at a replicated trial in St. Lucie County on flatwoods soil. Yields for 2008-12 are shown as percent of cumulative highest yielding rootstock in the trial.

<u>Rootstock</u>	<u>2006+7</u> <u>(kgs/tree)</u>	<u>2008-12</u> <u>(Percent)</u>	<u>2013</u> <u>(kgs/tree)</u>
US-1283	166 ab	74 a	67 a
US-1282	162 ab	100 a	63 a
US-1284	168 a	78 a	63 a
US-1279	153 abc	71 a	61 a
US-1281	158 abc	72 a	52 a
Swingle	114 c	32 b	19 b
Flying Dragon	57 d	30 b	16 b

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

Table 2. Individual fruit weight (g) in the replicated trial in St. Lucie County. Fruit samples were collected 14 November 2012 and 14 November 2013.

<u>Rootstock</u>	<u>2012</u>	<u>2013</u>	<u>Average</u>
US-1283	153 a	127	140
US-1282	161 a	127	144
US-1284	153 a	126	140
US-1279	159 a	129	144
US-1281	161 a	118	140
Swingle	115 b	112	114
Flying Dragon	151 a	112	132

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

Table 3. Fruit total soluble solids content (brix) in the replicated trial in St. Lucie County. Fruit samples were collected 14 November 2012 and 14 November 2013.

<u>Rootstock</u>	<u>2012</u>	<u>2013</u>	<u>Average</u>
US-1283	7.7 b	8.0 ab	7.8
US-1282	8.0 ab	8.6 a	8.3
US-1284	8.1 ab	8.2 ab	8.2
US-1279	7.9 ab	8.1 ab	8.0
US-1281	8.3 ab	8.5 ab	8.4
Swingle	7.6 b	7.6 b	7.6
Flying Dragon	8.8 a	8.6 a	8.7

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

Table 4. Fruit juice TSS:acid ratio in the replicated trial in St. Lucie County . Fruit samples were collected 14 November 2012 and 14 November 2013.

<u>Rootstock</u>	<u>2012</u>	<u>2013</u>	<u>Average</u>
US-1283	12.8 ab	13.4 ab	13.1
US-1282	14.0 a	14.8 a	14.4
US-1284	12.9 ab	13.1 ab	13.0
US-1279	13.7 a	14.4 a	14.0
US-1281	13.7 a	14.2 a	14.0
Swingle	11.6 b	11.8 b	11.7
Flying Dragon	13.4 a	13.9 ab	13.6

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

Table 5. Fruit juice color (cn) in the replicated trial in St. Lucie County. Fruit samples were collected 14 November 2012 and 14 November 2013.

<u>Rootstock</u>	<u>2012</u>	<u>2013</u>	<u>Average</u>
US-1283	34.7	33.5	34.1
US-1282	35.1	33.7	34.4
US-1284	34.7	33.4	34.0
US-1279	34.8	33.5	34.2
US-1281	34.8	33.5	34.2
Swingle	34.7	33.7	34.2
Flying Dragon	34.7	33.5	34.1

ANOVA within columns were not significant

Table 6. Comparison of tree sizes in the replicated trial in St. Lucie County. Trees were measured in August 2014.

<u>Rootstock</u>	<u>Canopy Height (m)</u>	<u>Canopy Width(m)</u>	<u>Canopy Area (sq m)</u>	<u>Canopy Volume (cu m)</u>
US-1283	2.6 ab	2.5 ab	4.9 ab	4.1 ab
US-1282	2.6 ab	2.4 ab	4.8 ab	3.9 ab
US-1284	2.7 a	2.8 a	6.1 a	5.3 a
US-1279	2.6 ab	2.4 ab	4.9 ab	4.0 ab
US-1281	2.5 b	2.2 bc	3.8 bc	3.0 bc
Swingle	2.4 b	1.9 bcd	2.8 c	2.2 c
Flying Dragon	2.1 c	1.7 d	2.3 c	1.6 c

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

Table 7. Comparison of Las infection and bacterial titers in the replicated trial in St. Lucie County. Trees were sampled randomly across the canopy in August 2014.

<i>Rootstock</i>	<i>N</i>	<i>Las Infected Trees (%)</i>	<i>Average Ct Las</i>	<i>Average Las Copy No. per q</i>
US-1283	7	100	25.1	1,507,681
US-1282	7	100	24.7	2,143,900
US-1284	7	100	24.5	2,432,189
US-1279	7	100	25.1	1,831,557
US-1281	7	100	24.7	2,016,472
Swingle	7	100	25.1	1,584,108
Flying Dragon	6	100	25.1	1,482,230

ANOVA within columns were not significant ($P > 0.8$).