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# JUICE QUALITY FROM YOUNG TREES OF 6 VALENCIA CLONES ON 16 ROOTSTOCKS IN THE IMMOKALEE FOUNDATION GROVE

ROBERT E. ROUSE
*University of Florida, IFAS*
*Southwest Florida Research and Education Center*
*P. O. Drawer 5127*
*Immokalee, FL 33934*

CHARLES O. YOUTSEY
*FDACS, Division of Plant Industry*
*Citrus Budwood Registration Bureau*
*3027 Lake Alfred Road*
*Winter Haven, FL 33881*

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*Abstract.* **Juice quality of 4-year-old 'Valencia' sweet orange (*C. sinensis* (L.) Osbeck) for nucellar seedling clones VS-F-55-28-X-E, VS-SPB-1-14-19-X-E, and old-line clones V-10-12-7-X-E, V-51-3-3(STG-64G-4)-X-E, and 'Rohde Red Valencia' RRV-472-3-26(STG-31-18)-X-E, RRV-472-11-43(STG-19-2)-X-E were compared for percentage juice per fruit, °Brix, acid, Brix/acid ratio, pound solids per standard 90-lb-field box, and juice color score. Rootstocks were sour orange, Smooth Flat Seville, Cleopatra mandarin, Sun Chu Sha, calamandarin, Valencia seedling, P. trifoliate × Ridge pineapple 1573-26, Duncan grapefruit, Carrizo, Benton and C-35 citranges, Swingle and F-80-18 citrumelos, Rangpur lime × Troyer citrange, *P. trifoliata*, and Vangasay lemon. Trees were planted 15 × 22 ft on typical Immokalee fine sand in 2 row beds typical of southwest Florida flatwoods groves. Juice was extracted using an industry standard FMC® machine. Clone V-10-12-7 had the highest juice content which was significant only from VS-SPB-1-14-19. RRV-472-11-43 had significantly less acid than the other clones and with RRV-472-3-26 had lower °Brix than VS-SPB-1-14-19, V-10-12-7, and V-51-3-3. VS-SPB-1-14-19 had the highest ratio and RRV-472-3-26 the lowest ratio. Pound soluble solids per box were lowest for RRV-472-3-26 and were not different among the nucellar and old-line clones. Juice color score was highest for the 2 'Rohde Red Valencia' clones and lowest for V-10-12-7. Rootstock affected all juice quality factors except juice color score.**

Thirty two percent of the orange trees in Florida are 3-years-old or younger and classified as nonbearing (Florida Agricultural Statistics Service, 1992). Young trees are being heavily fertilized for fast growth to develop bearing structure. Nutrition affects fruit quality and a recent survey has shown leaf N levels were above the optimal range in 70% of samples tested (Tucker, et al., 1990). Juice quality from fruit of young trees is an important economic factor in an industry that sells its fruit based on the juice sugar content and processes over 90% of its oranges.

Florida orange juice quality standards require a minimum color score of 36 to qualify as Grade A (Stewart, 1980). Juice of the late-season 'Valencia', which has the highest color of the oranges used for processing, is blended with the early-maturing varieties to meet juice quality standards. Better juice color of the 'Valencia' clone means less juice needed for blending to attain the desired color. 'Rohde Red Valencia' is a clone that has been selected for its high juice color score, but information is not available comparing juice color among 'Rohde Red Valencia' selections or with other 'Valencia' clones.

## Materials and Methods

Field-grown nursery trees were planted in April and June, 1989 in a 20 acre citrus budwood foundation grove at the Southwest Florida Research and Education Center at Immokalee. Trees were planted 15 × 22 ft on 2-row beds typical of flatwoods citrus plantings with each row of 66 trees being a single scion cultivar. Each scion was budded on 22 different rootstocks, and each rootstock repeated 3 times in each row.

Six 'Valencia' scion clones on 16 different rootstocks were selected for juice quality analysis. The clones were nucellar seedlings VS-F-55-28-X-E and VS-SPB-1-14-19-X-E, old-line V-10-12-7-X-E and V-51-3-3(STG-64G-4)-X-E, and 'Rohde Red Valencia' RRV-472-3-26(STG-31-18)-X-E and RRV-472-11-43(STG-19-2)-X-E. Rootstocks were Cleopatra and Sun Chu Sha mandarins, calamandarin, sour orange, Smooth Flat Seville, Swingle and F80-18 citrumelos, Carrizo, Benton and C-35 citranges, *Poncirus trifoliata*, the interspecific hybrid Ridge Pineapple × *P. trifoliata* (1573-26), Rangpur lime × Troyer citrange, Valencia seedling, Duncan grapefruit, and Vangasay lemon. Carrizo citrange trees were planted in June 1990 and were 3-years-old at time of harvest.

A 40-lb-fruit sample (approximately 100 fruit) was taken from each 'Valencia' clone on each rootstock on May 6, 1993. Juice from each sample was obtained using an FMC® model 091-B standard state juice extractor (Food Machinery Corporation, Lakeland, FL). Juice was analyzed for maturity factors of percentage juice per fruit on a weight basis, total soluble solids (TSS) as °Brix, titratable acid, and juice color score using a HunterLab® D45-2 Citrus Colorimeter (Hunter Assoc., Fairfax, VA). Calculations were made to obtain TSS (°Brix) to acid ratio, and pound solids per box based on the standard 90-lb-field box.

Grove cultural practices since the time of planting have followed University of Florida, IFAS standard recommendations. Cultural management has included application of fertilizer with micro-elements applied as a dry formulation and as fertigation, chemical weed control, and irrigation by micro-sprinklers.

Statistical analysis was performed on the juice data using the SAS General Linear Models Procedure (GLM) with LSD calculated to separate means. Means for juice quality are reported for the individual 'Valencia' scions. Means for juice quality factors comparing rootstocks are averaged across all 6 'Valencia' clones.

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## Results and Discussion

Generally there were no differences in percentage juice per fruit among the standard old-line and nucellar, or 'Rohde Red Valencia' clones (Table 1). The only difference found was between old-line V-10-12-7 with the highest juice content of 60.2% and nucellar VS-SPB-1-14-19 with the lowest at 57.9%.

Percentage acid was significantly lower for RRV-472-11-43 than the other 'Valencia' clones, including RRV-472-3-26. This difference among 'Rohde Red Valencia' clones may be of importance if future annual data shows this to be consistent.

The 2 'Rohde Red Valencia' clones as a group had lower Brix than the old-line or nucellar clones. The old-line clones and nucellar VS-SPB-1-14-19 had the highest TSS. RRV-472-3-26 was lowest although not significantly lower than the other 'Rohde Red Valencia' clone.

'Rohde Red Valencia' selection RRV-472-3-26 had the lowest Brix/acid ratio with 18.5. 'Rohde Red Valencia' selection RRV-472-11-43 had comparable ratio to the old-line and nucellar clones. This was due primarily to the low acid content. Nucellar VS-SPB-1-14-19 had the highest ratio with 21.4.

Calculated TSS per box were highest with old-line and nucellar clones and lower with 'Rohde Red Valencia'. Mean TSS/box for old-line and nucellar clones was 6.5 compared to 5.9 for the 'Rohde Red Valencia'. Old-line V-10-12-7 and nucellar VS-F-55-28 had the highest TSS per box. Old-line V-51-3-3, nucellar VS-SPB-1-14-19, and RRV-472-11-43 were intermediate, and only RRV-472-11-43 was significantly lower than the highest old-line and nucellar clones.

Juice color was highest from 'Rohde Red Valencia' clones by more than one color score number (Table 1). Mean color score for old-line and nucellar clones was 37.9 and 37.7, respectively. 'Rohde Red Valencia' mean juice color score was 39.1. There was significant difference between the 2 'Rohde Red Valencia' clones. Clone RRV-472-11-43 at 39.5 was almost one color score number higher than RRV-472-3-26 at 38.8, which was one color score number higher than the mean of the old-line and nucellar clones at 37.8 (Table 2). Old-line V-10-12-7 had the lowest color score of 37.4.

Rootstock influence on juice quality across all 'Valencia' scion clones was minimal and generally what might be expected of young trees (Table 2). Juice quality from trees on Cleopatra mandarin and Sun Chu Sha were comparable for young trees in the first production year. Smooth Flat Seville and sour orange used as rootstocks produced similar juice quality as did Swingle citrumelo, Carrizo, Benton, and C-35 citranges with 'Valencia' scions.

Table 1. Comparison of mean[z] juice quality of 6 'Valencia' scion clones in the Immokalee Foundation Grove. Juice analysis from fruit harvested May 6, 1993.

| Scion clone | Juice/frt (%) | Acid (%) | TSS (°Brix) | Ratio (TSS/acid) | TSS/box (lbs) | Juice color no. |
|---|---|---|---|---|---|---|
| V-10-12-7 | 60.2 a[y] | 0.60 a | 12.4 ab | 20.5 b | 6.7 a | 37.4 d |
| V-51-3-3 | 58.2 ab | 0.59 a | 12.0 bc | 20.4 b | 6.3 ab | 38.0 c |
| VS-F-55-28 | 60.0 ab | 0.59 a | 11.6 cd | 19.8 b | 6.7 a | 37.9 c |
| VS-SPB-1-14-19 | 57.9 b | 0.60 a | 12.8 a | 21.4 a | 6.3 ab | 38.0 c |
| RRV-472-3-26 | 58.4 ab | 0.59 a | 10.9 e | 18.5 e | 5.8 c | 38.8 b |
| RRV-472-11-43 | 59.4 ab | 0.55 b | 11.2 de | 20.3 b | 6.0 bc | 39.5 a |

[z]Means are summed across all rootstocks.
[y]Mean separation in columns by LSD, 5%.

Table 2. Comparison of mean[z] juice quality of 6 'Valencia' scion clones by rootstock in the Immokalee Foundation Grove. Juice analysis from fruit harvested May 6, 1993.

| Rootstock | Juice/frt (%) | Acid (%) | TSS (°Brix) | Ratio (TSS/acid) | TSS/box (lbs) | Juice color no. |
|---|---|---|---|---|---|---|
| Cleopatra mandarin | 61.4 a[y] | 0.61 abc | 11.9 b | 19.6 b | 6.6 ab | 38.3 a |
| Sun Chu Sha mandarin | 61.2 a | 0.64 a | 12.6 ab | 19.7 b | 6.9 a | 38.2 a |
| Calamandarin | 60.3 abc | 0.61 abc | 11.8 b | 19.5 b | 6.4 ab | 38.1 a |
| Sour orange | 59.7 abc | 0.58 bcd | 11.7 b | 20.3 ab | 6.3 ab | 38.6 a |
| Smooth Flat Seville | 59.4 abc | 0.60 a-d | 12.2 ab | 20.4 ab | 6.5 ab | 38.2 a |
| Swingle citrumelo | 59.3 abc | 0.59 bcd | 11.7 b | 20.0 ab | 6.2 b | 38.5 a |
| F80-18 citrumelo | 60.4 ab | 0.59 bcd | 11.8 b | 20.0 ab | 6.4 ab | 38.2 a |
| Carrizo citrange[x] | 59.3 abc | 0.59 bcd | 11.8 b | 20.1 ab | 6.4 ab | 37.7 a |
| Benton citrange | 59.9 abc | 0.60 a-d | 11.9 b | 20.0 ab | 6.4 ab | 38.6 a |
| C-35 citrange | 58.2 bcd | 0.56 de | 11.5 bc | 20.7 ab | 6.1 bc | 38.3 a |
| *Poncirus trifoliata* | 59.0 abc | 0.64 a | 12.4 ab | 19.3 b | 6.6 ab | 38.6 a |
| Ridge pineapple × *P. trif.* (1573-26) | 56.0 d | 0.62 ab | 13.1 a | 21.1 ab | 6.6 ab | 38.2 a |
| Rangpur × Troyer | 57.5 cd | 0.52 e | 10.6 c | 20.7 ab | 5.5 cd | 38.2 a |
| Valencia seedling | 59.9 abc | 0.56 de | 12.1 ab | 21.6 a | 6.5 ab | 37.7 a |
| Duncan grapefruit | 60.5 ab | 0.60 a-d | 11.6 bc | 19.5 b | 6.3 ab | 38.4 a |
| Vangasay lemon | 52.2 e | 0.52 e | 10.5 c | 20.1 ab | 5.0 d | 37.6 a |

[z]Means for all 6 'Valencia' clones are summed by rootstocks.
[y]Mean separation in columns by LSD, 5%.
[x]Carrizo citrange trees 3-years-old at harvest.

Percentage juice per fruit was not significantly different among rootstocks except for the interspecific hybrid Ridge Pineapple × *P. trifoliata* (1573-26), Rangpur × Troyer, and Vangasay lemon which were low. TSS were highest for Ridge Pineapple × *P. trifoliata* (1573-26) and lowest for Rangpur × Troyer, and Vangasay lemon. Ratio of TSS/acid was highest for Valencia seedling rootstock and lowest for Duncan grapefruit rootstock.

Calculated TSS per box was highest from Sun Chu Sha which was significantly higher than Swingle citrumelo, C-35 citrange, Rangpur × Troyer. Vangasay lemon was significantly lower than all rootstocks.

Across all 6 'Valencia' clones there was no difference in juice color score by rootstock in this test. There are few reports of rootstock influence on juice color. Published works from the 1940s indicate no effect (Harding et al., 1940; Miller et al., 1941), although these results are contradicted by more recent works (Foguet et al., 1970; Wutscher & Bistline, 1988). Reported differences seem to occur between extreme juice color scores from a given year and may vary with scion clone and with time of testing, i.e. color improves as the season progresses.

In summary these data from 4-year-old trees favors nucellar VS-SPB-1-14-19 standard 'Valencia' and RRV-472-11-43. Compared to the other 'Valencia' clones RRV-472-11-43 had less acid, low TSS, but acceptable ratio and TSS/box. Old-line clones and VS-SPB-1-14-19 had the highest TSS. VS-SPB-1-14-19 had the highest ratio and RRV-472-3-26 the lowest ratio. The 'Rohde Red Valencia' clones had the highest juice color score and there was no difference in juice color of old-line and nucellar clones. There was a difference in juice color between the 'Rohde Red Valencia' selections. Juice color was highest for RRV-42-11-43. Juice color was not affected by rootstock in this test.


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# IN-VITRO MICROPROPAGATION OF SEEDLESS 'COHEN' CITRANGE


J. W. Grosser and J. L. Chandler
*University of Florida, IFAS*
*Citrus Research and Education Center*
*700 Experiment Station Road, Lake Alfred, FL 33850*

R. R. Pelosi and M. Cohen
*University of Florida, IFAS*
*Agricultural Research and Education Center*
*P. O. Box 248, Fort Pierce, FL 34954*



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*Abstract.* **'Cohen' citrange, produced from a cross made by Dr. Mort Cohen, is a single tree that has remained thrifty in the AREC research plot (Ft. Pierce) for more than 35 yr. Since the tree fruits but never produces seed, it has not been evaluated for use as a commercial rootstock. Due to the thrifty nature and survivability of this tree under challenging conditions, there has been some interest in developing an alternative method of propagating it for evaluation. Undeveloped ovules were removed from mature fruit of 'Cohen' citrange and cultured in-vitro. Somatic embryo proliferation was observed from 3 ovules. These embryos were enlarged and germinated, then transferred to a shoot multiplication medium. The resulting shoots were rooted and transferred to potting soil in a growth chamber. More than 200 plants have been recovered for evaluation. This method of propagation would probably remove some pathogens that might have been in the original tree. More than 24 plants were also recovered from rooted cuttings from the original tree. A comparison of the plants from ovule culture with the rooted cuttings using isozyme analysis showed that they were true-to-type.**


Traditional propagation of citrus rootstocks is by seed, and requires a high level of nucellar polyembryony. This method of propagation precludes the use of genotypes that produce seed primarily of zygotic origin or inadequate


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