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STORAGE REQUIREMENTS OF THE 'NOVA', 'PAGE', AND 'ROBINSON' CITRUS CULTIVARS

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Abstract. **Storage tests were conducted intermittently from 1971 through 1979 on fruits of the 'Nova' tangelo, 'Page' hybrid, and 'Robinson' tangerine to establish the optimum conditions for extending the life of the fruit during as well as after (shelf life) storage. Preliminary tests were run at 34°, 40°, 45° and 50°F (1°, 4°, 7° and 10°C); however, decay was excessive at 45° and 50°. Consequently, the main effort was to compare 34° and 40°. All 3 cultivars stored better at 40° than at 34°, as indicated by brightness of fruit. During storage at 34° and 40°, decay and chilling injury were negligible and nonexistent, respectively. Storage at 34° and 40° resulted in no significant difference in decay during either storage or the subsequent 1-week holding period at 70° (21°C). 'Page' hybrid fruit could be stored for 3 weeks followed by 1 week at 70° with little decay. 'Nova' tangelo and especially 'Robinson' tangerine performed poorly during the tests.**

In Florida, fruits of 'Nova' tangelo (*Citrus reticulata* Blanco X (*C. paradisi* Macf. X *C. reticulata*)), 'Page' hybrid ((*C. paradisi* X *C. reticulata*) X *C. reticulata*), and 'Robinson' tangerine (*C. reticulata* X (*C. paradisi* X *C. reticulata*)) are used predominantly for the fresh market and usually attain minimum maturity during October and November. Because these cultivars mature early in the Florida citrus season, there is little need for extended storage; however, brief periods of storage may be desirable during transit or for the holiday trade. The purpose of our study was to determine the optimum fruit storage conditions for these cultivars.

'Nova' tangelo, 'Page' hybrid, and 'Robinson' tangerine are cultivars which were released by the U.S. Department of Agriculture approximately 2 decades ago (1, 2, 3, 4). The older, bearing trees of these cultviars now produce more representative fruits than younger trees, and now lend themselves to meaningful storage studies.

The relationship of apparent external fruit maturity of these cultivars, expressed by picking date and degreening time in ethylene, to the incidence of certain decays has been shown (5). The relationship indicates that these hybrid citrus fruits should not be harvested before the latter part of October, or at such time when extended degreening would not be required; otherwise, excessive decay could result regardless of any postharvest fungicidal treatment.

Materials and Methods

The source of most fruits was the U.S. Department of Agriculture research farm near Leesburg, Florida. Other sources were commercial groves in Orange and Lake counties ('Nova' tangelo, 1977, and 'Robinson' tangerine, 1979, from Orange County and 'Robinson' tangerine, 1971, from Lake County). The 3 cultivars were tested intermittently from 1971 through 1979. They were grown on Carrizo citrange (*Poncirus trifoliata* (L.) Raf. X *C. sinensis* (L.) Osbeck), Cleopatra mandarin (*C. reticulata* Blanco), rough lemon (*C. limon* (L.) Burm. f. and sour orange (*C. aurantium* L.) rootstocks; however, fruits of 'Robinson' tangerine grown on sour orange rootstock were not selected.

Immediately after harvest, the fruits were transported to the U.S. Horticultural Research Laboratory at Orlando, where they were run through the various packinghouse treatments, including the ethylene chamber if necessary, until sufficiently degreened for marketing. Fruits to be degreened were subjected to ca. 5 ppm ethylene at 85°F (29°C) and 90% relative humidity. The 'Nova' tangelo and the 'Page' hybrid fruits required degreening from 0 to 24 hr, but the 'Robinson' tangerine required from 0 to 48 hr.

Fruits were then washed, sprayed with a fungicide, dried, graded and waxed with a solvent-type commercial wax. The fungicide was 1,000 ppm thiabendazole (TBZ), in all but the 1979 tests, which were conducted with 600 ppm benomyl. Fruits were divided into replicated lots for storage at different temperatures and 90-95% relative humidity. Lot size was 100 fruits or more, and lots were kept separated according to source and rootstock.

Preliminary tests. These tests were conducted during 1971 to establish parameters for future or main tests. A relatively wide range of storage periods and temperatures were used with holding periods at 70°F after storage. Temperatures and storage periods tested were 34°, 40°, 45° and 50° for 2, 4, 6, and 8 weeks; and holding periods were 1 and 2 weeks at 70°. Throughout all tests rind-chilling injury and the type and amount of decay that followed were evaluated and recorded. Decayed fruit was discarded at each inspection and data were not tabulated cumulatively. Firmness, as assessed manually, flavor, and appearance of the fruit were assessed but were not given numerical values. Statistical analysis for least significant difference was made between storage at 34° and 40° for each storage period by using the *t* test.

Results and Discussion

Preliminary tests. All cultivars stored at 45° and 50° decayed excessively, especially during the first week of holding at 70°F; therefore, these storage temperatures were not used in subsequent tests. Decay also precluded further tests involving storage periods of 6 and 8 weeks, as well as the second week of holding at 70°. For example, 'Nova' tangelos that had been stored for 2 weeks at 45° had 8% decay during the 1 week of holding at 70°. After 1 week at 70°, 'Page' hybrid had 25 and 32% decay when stored for 6 and 8 weeks, respectively at 45°; the same fruits held 2 weeks at 70° had 32% and 37° decay. The 'Robinson' tangerine stored for 6 weeks at 34° had 49% decay after 1 week of holding at 70°. On the other hand, and regardless of cultivar, little decay (less than 2%) developed during actual storage at 34° and 40° for 8 weeks, and less than 5% developed during the same period at 45° and 50°.

Main tests. 'Nova' tangelos had no decay during 4 weeks of storage; however, during the 1-week holding period at 70°F, decay became apparent (Table 1). At the end of 1 week's holding period, no significant difference existed in amount of decay between 34° and 40° for each storage period, but decay was appreciable in fruits from 4 weeks

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Table 1. Decay of 'Nova,' 'Page,' and 'Robinson' citrus fruit on removal from storage and after holding for 1 week.

Storage temperature (°F)	Weeks in storage 1	2	3	4	Holding for 1 week at 70°F; Weeks in storage 1	2	3	4
	(%)				(%)			
Nova[z]								
34	0	0	0	0	0	7	10	26
40	0	0	0	0	1	3	4	14
Page[y]								
34	0	0	0	0	0	0	0	23
40	0	0	0	1	0	0	0	18
Robinson[x]								
34	0	0	0	1	8	13	21	40
40	0	0	0	1	6	10	13	23

[z]Each value for 'Nova' represents a total of 825 fruits picked on December 16, 1971; December 13, 1972; November 28, 1973; November 25, 1977; and November 19, 1979.
[y]Each value for 'Page' represents a total of 1,370 fruits picked on December 13, 1971; December 13, 1972; November 28, 1973; November 4, 1974; and November 19, 1979.
[x]Each value for 'Robinson' represents a total of 500 fruits picked on November 24, 1971; November 1, 1973; November 25, 1977; and November 24, 1979.

of storage. Peel color was brighter in fruits that had been stored for 4 weeks at 40° than at 34°.

Decay of 'Page' hybrid was negligible during 4 weeks of storage, and none was present in fruits stored for 1, 2, and 3 weeks and then held for 1 week at 70°F (Table 1). Fruits stored for 4 weeks had 18% or more decay after 1 week at 70°. Little or no difference in decay incidence and peel color were observed between fruits from 34° and 40° storage.

Decay of 'Robinson' tangerine was negligible during 4 weeks of storage; the incidence was 6% or more after 1 week at 70°F, regardless of storage temperature (Table 1). Fruits stored for 2 weeks or longer showed more than 10% decay during the 1-week holding period at 70°. The incidences of decay at 34° and 40° were not significantly different. Peel color was noticeably brighter in fruit from 40° than from 34° after 2 weeks in storage.

In conclusion, all 3 cultivars had a low incidence of decay, or none during storage at 34° and 40°F for the 1- to 4-week storage period. The following week, decay was prevalent during the holding period. The predominant decay, throughout the studies was *Penicillium digitatum* Sacc. (green mold rot). Generally, fruits from the 40° storage had a brighter peel color than those from 34°; and for this reason, 40° was more desirable as a storage temperature. The lack of bright color, especially in 'Nova' tangelo and 'Robinson' tangerine stored at 34°, was possibly a manifestation of chilling injury, although typical chilling injury symptoms were not observed. Differences in rootstock had no apparent effect on the storage characteristics of the fruits, although it was not unusual to find granulation and mediocre quality, including a watery flavor, in fruit from trees grown on rough lemon rootstock. No differences in fruit firmness could be detected.

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EFFECT OF STORAGE TEMPERATURE ON COLOR AND INCIDENCE OF DECAY OF TOMATOES UNDER SIMULATED EXPORT CONDITIONS

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Abstract. **Vine-ripened tomatoes and ethylene-treated mature-green tomatoes were divided into breakers, turners, and pinks and held under laboratory conditions to simulate export from Florida to European markets. Four storage temperatures (7.2°, 10.0°, 12.8°, and 15.6°C) for 14 days plus holding for 5 additional days at 15.6° were evaluated. Tomatoes stored at 7.2° and 10° developed slight to moderate chilling injury, and moderate to severe incidence of alternaria rot. Tomatoes stored at 15.6° were softer than tomatoes stored at 12.8°. Breakers and turners generally had less decay than pinks after 2 weeks at specific storage temperatures and 5 additional days at 15.6°. Test results indicate that uniformly colored tomatoes can be delivered to European markets with minimal decay if 1) late pickings are not included in the shipments, 2) grading is stringent to remove field-incurred defects and handling injuries incurred during harvesting and packing, and 3) uniformly colored tomatoes are selected at packing.**

For the past 10 years, shippers and receivers have been interested in exporting Florida tomatoes to Europe. This past season, 1979-80, there were 4 known van container shipments of Florida tomatoes to Europe. However, many shipments in the past have not been successful. The biggest problem with most tomato shipments has been the lack of uniform color upon arrival in Europe; excessive decay upon arrival has also been a problem. Many of these shipments were of ethylene-treated (ET), mature-green tomatoes, generally sizes 7 x 7 and 7 x 8. The most successful tomato shipments have been of vine-ripened fruit or larger-sized, mature-green tomatoes that had been treated with ethylene. Many European receivers have indicated that they would import larger quantities if tomatoes arrived in good condition with consistent quality and uniform color.

Recommendations for the transit and storage of ET