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THE PERFORMANCE OF 'NOVA' AND 'ORLANDO' TANGELOS ON 10 ROOTSTOCKS

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Abstract. 'Nova' and 'Orlando' tangelos were evaluated on 10 rootstocks during 1968-1976. 'Nova' and 'Orlando' tangelos propagated on rough lemon rootstock produced the largest trees. The highest yields were 'Nova' on rough lemon and 'Orlando' on Troyer rootstocks. The highest total soluble solids were produced by 'Nova' on sour orange and 'Orlando' on Rusk citrange. The lowest total acids and juice content were produced by 'Nova' and 'Orlando' tangelos on rough lemon rootstock. Petal drop information indicated that 'Orlando' tangelo is an effective pollinizer for 'Nova'. For all characteristics evaluated, 'Nova' and 'Orlando' trees on Troyer citrange, Carrizo citrange and Cleopatra mandarin produced good yields of high-quality fruit.

'Nova' tangelo (*Citrus reticulata* Blanco X (*C. paradisi* Macf. X *C. reticulata*)) and 'Orlando' tangelo (*C. paradisi* X *C. reticulata*) are citrus hybrids released as cultivars in 1964 and 1931, respectively (3, 6). Information of their performance on different rootstocks was not available when these cultivars were released. Therefore, rootstocks for these cultivars were chosen on the basis of observations in commercial mandarin orchards. Subsequently, rootstock information for 'Nova' and 'Orlando' has been summarized by Krezdorn (2) and Robinson (4).

This report presents information on the performance of 'Nova' and 'Orlando' tangelos over the period 1968-1976.

Materials and Methods

Nursery trees of 10 mandarin or mandarin hybrid scions, propagated on 10 rootstocks, were planted in an Astatula fine sand soil in 1965 near Leesburg, Florida. Trees were spaced 4.5 m x 5.4 m in 4 randomized blocks with 3-tree plots. The experimental planting was given commercial grove maintenance. Data were not collected from all scions, rootstocks, and replications every year. This report includes only petal drop, tree size, fruit quality, and fruit production data from 'Nova' and 'Orlando' trees. The extent of petal drop was visually estimated per 3-tree plot with 4 replications. Trunk circumference was measured 20 cm above ground level, fruit quality was determined by standard methods, and fruit production was expressed as 90 lb (40.8 kg) field boxes.

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The rootstocks were Carrizo (CAR), Rusk (RSK), and Troyer (TROY) citranges (*C. sinensis* (L.) Osbeck X *Poncirus trifoliata* (L.) Raf.); Estes rough lemon (RL) (*C. limon* (L.) Burm. f.); Milam (MIL) (rough lemon hybrid?); Seville sour orange (SO) (*C. aurantium* L.); Cleopatra mandarin (CLEO) (*C. reticulata*); Large Flower trifoliolate orange (LETO) (*P. trifoliata*); Orlando tangelo (ORL); and Sanguine Grosse Ronde sweet orange (SANG) (*C. sinensis*).

Results and Discussion

The time of bloom indicated by percentage petal drop in 1969 and 1971 is shown in Table 1. In 1969, the amount of bloom of 'Nova' on all rootstocks was more advanced than that of 'Orlando'. In 1971, 'Nova' and 'Orlando' initiated bloom at approximately the same time. However, their bloom periods overlapped sufficiently for adequate cross-pollination. These data agree with a previous report on pollinizer requirements (1). The influence of rootstock on petal drop is somewhat variable, however, for both dates and scions; trees on RSK and LFTO bloomed later than the other rootstocks. If 'Orlando' is used as pollinizer for 'Nova', both cultivars should be on the same rootstock to eliminate the possible rootstock effect on bloom date.

Table 1. Percentage petal drop of 'Nova' and 'Orlando' tangelos on 10 rootstocks.

Rootstock	Avg. % petal drop			
	Nova		Orlando	
	Apr. 11 1969	Mar. 31 1971	Apr. 11 1969	Mar. 31 1971
SO	99a*	19bcd	86a	35ab
CLEO	98a	10d	75ab	38ab
SANG	98a	9d	75ab	18abc
TROY	98a	40a	78a	34ab
MIL	95a	14cd	74ab	18abc
CAR	94ab	25bc	90a	33ab
RL	94ab	30ab	61ab	40a
ORL	94ab	31ab	67ab	40a
RSK	85bc	15cd	61ab	8c
LFTO	84c	8d	45b	15bc

*Means followed by the same letter are not significantly different at the .05 confidence level

The largest trees were 'Nova' and 'Orlando' on RL (Table 2). The smallest trees were on RSK and LFTO.

Yield and fruit size of 'Nova' are shown in Table 3. In 1968, the most productive trees were on RSK and RL, while trees on ORL were the least productive. In 1976, trees on TROY and CAR were the most productive followed by trees on ORL, SANG, LFTO, RL, and CLEO. The least productive trees were on MIL, SO, and RSK. Four-year total fruit yields were highest on TROY followed by those

Table 2. Tree size of 'Nova' and 'Orlando' tangelos on 10 rootstocks.

Rootstock	Avg. trunk circumference (cm)			
	Nova		Orlando	
	1966 ^a	1976 ^b	1966 ^a	1976 ^b
RL	8.5 a ^x	59.0 a	9.6 a	65.4 a
CLEO	8.0 ab	56.2 a	6.7 cd	53.9 ab
RSK	7.4 ab	40.0 bc	8.3 abc	38.7 cd
MIL	7.3 abc	53.1 a	8.6 ab	56.9 ab
ORL	6.8 bcd	53.8 a	6.1 de	47.6 bc
TROY	6.5 bcde	49.8 ab	7.7 bc	40.6 cd
SANG	5.7 cdef	53.1 a	6.9 cd	54.2 ab
CAR	5.6 def	46.7 abc	6.8 cd	46.8 bc
SO	5.0 ef	47.7 abc	7.3 bcd	50.5 bc
LFTO	4.5 f	37.3 c	5.1 e	34.6 d

^aAverage of 12 trees.

^bAverage of 6 trees.

^xMeans followed by the same letter are not significant at the 0.05 confidence level.

trees on RL, CLEO, MIL, CAR, ORL, SANG, and LFTO. Trees on RSK and SO were the least productive. The fruit yield data in this experiment indicated that alternate bearing is not a serious problem for 'Nova' tangelo. Trees on TROY, RL, MIL, and SANG produced the largest fruit. Trees on ORL, CAR, and CLEO yielded intermediate-sized fruit, while the smallest fruit was produced by trees on LFTO, SO, and RSK. Trees on TROY, RL, and MIL had the highest percentage of fruits 6.9 cm or larger and trees on RSK produced the lowest percentage of larger fruit.

Table 3. Fruit yield and fruit diameter of 'Nova' tangelo on 10 rootstocks.

Rootstock	Avg. no. fruit per tree ^a	Avg boxes fruit per tree ^b					Avg fruit diam (cm) ^c	Avg fruit size 6.9 cm ^w or larger (%) ^v
		1972 1973 1974 1976				4-year total		
		1968	1972	1973	1974			
TROY	67	2.5	3.0	2.1	5.3	12.9 a	7.4	96
RL	84	4.2	3.7	0.3	4.3	12.5 ab	7.6	97
CLEO	53	2.5	3.0	2.8	4.1	12.4 ab	7.3	90
MIL	45	2.8	2.9	2.7	3.7	12.1 ab	7.5	97
CAR	47	2.1	3.1	1.7	5.1	12.0 ab	7.3	83
ORL	17	2.4	3.0	1.8	4.7	11.9 ab	7.3	82
SANG	30	1.6	3.1	2.4	4.4	11.5 ab	7.4	92
LFTO	49	1.9	1.9	3.1	4.4	11.3 ab	7.2	78
RSK	73	2.6	2.4	2.3	2.9	10.2 ab	7.2	77
SO	30	1.8	2.3	1.6	3.3	9.0 b	7.2	85
							N.S.	

^aAverage of 12 trees.

^bOne box is 90 lb or 40.8 kg. Average of 6 trees per year.

^cAverage of 200 fruit per rootstock for each of 3 years (1971-1972-1973). ^w6.9 cm corresponds to 120 market size tangelo.

^vMeans followed by the same letter are not significantly different at the .05 confidence level.

Yield and fruit size of 'Orlando' are presented in Table 4. Trees on RL were the most productive bearers in 1968 followed by those on RSK. The least productive trees in 1968 were those on LFTO rootstock. Trees on RL had the highest yields in 1976, followed by trees on MIL. Next in rank were 'Orlando' trees on RL, CAR, CLEO, SANG, SO, and TROY. The least productive trees were on RSK and LFTO. The average fruit diam and percentage fruit 6.9 cm or larger did not appear to be influenced by the rootstocks used in this experiment.

The influence of rootstock on juice content, total soluble solids (TSS), and total acids of 'Nova' and 'Orlando' is shown in Table 5. Fruit of 'Nova' trees on SO had the high-

Table 4. Fruit yield and diameter of 'Orlando' tangelo on 10 rootstocks.

Rootstock	Avg no. fruit per tree ^a	Avg boxes fruit per tree ^b		Avg fruit diam (cm) ^c	Avg fruit size 6.9 cm or larger (%) ^x	
		1968	1973			1976
		RL	175			3.9 a ^w
MIL	90	3.2 abc	6.5 b	7.4	96	
ORL	82	2.9 abc	5.8 bc	7.4	99	
CAR	111	3.5 ab	5.7 bc	7.2	92	
CLEO	101	2.7 bcd	5.7 bc	7.2	93	
SANG	95	3.4 ab	5.5 bcd	7.2	91	
SO	80	2.3 cd	5.2 bcd	7.4	97	
TROY	105	1.8 de	5.1 cd	7.3	91	
RSK	132	2.7 bcd	4.7 cd	7.4	99	
LFTO	66	1.2 e	4.3 d	7.4	100	
				N.S.		

^aAverage of 12 trees.

^bOne box is 90 lb or 40.8 kg. Average of 6 trees per year.

^cAverage of 200 fruit per rootstock for each of 2 years (1971 and 1973).

^xMeans followed by the same letter are not significantly different at the .05 confidence level.

est TSS, followed by RSK, CLEO, and LFTO. Next in order were trees on CAR, TROY, ORL, SANG, and MIL. Trees on RL had the lowest TSS. For 2 of the 6 years of data reported for TSS, 'Nova' trees on RL failed to meet the minimum percentage TSS (8.5%) required to market Florida tangelos before December 1 (Citrus Fruit Maturity Chart 1974-1975 as compiled by the Florida Department of Agriculture). Total acids of 'Nova' fruit were highest on SO rootstock and lowest on LFTO rootstock. The juice content of 'Nova' fruit was lowest on RL rootstock.

Table 5. Total soluble solids, total acids, and juice content percentage of 'Nova' and 'Orlando' tangelos on 10 rootstocks.

Rootstock	Nova ^a			Orlando ^b		
	Avg % total soluble solids	Avg % acids	Avg % juice	Avg % total soluble solids	Avg % acids	Avg % juice
RSK	10.49 ab	0.80 ab	52.0 a	9.48 a	0.81 a	57.0
CLEO	10.52 bc	0.78 abc	52.0 a	8.93 abc	0.80 ab	56.0
LFTO	10.33 bc	0.75 c	49.0 a	8.86 bc	0.77 abc	55.0
CAR	10.08 bcd	0.78 abc	51.0 a	9.06 abc	0.77 abc	56.0
TROY	10.00 bcd	0.79 abc	50.0 a	9.13 ab	0.78 abc	56.0
ORL	9.96 cd	0.76 bc	50.0 a	8.64 bcd	0.75 bc	56.0
SANG	9.69 d	0.78 abc	48.0 a	8.53 cd	0.75 bc	57.0
MIL	9.65 d	0.76 bc	49.0 a	8.21 de	0.75 bc	57.0
RL	8.95 e	0.77 bc	43.0 b	7.83 e	0.73 c	55.0
						N.S.

^aAverage of 2 replications of 20-fruit samples for 6 years (1969, 1971-1973, 1975-1976).

^bAverage of 2 replications of 20-fruit samples for 3 years (1969, 1971, and 1973).

^xMeans followed by the same letter are not significantly different at the .05 confidence level.

Fruit from 'Orlando' trees on RSK had the highest TSS, followed by trees on TROY and CAR. Next in order were trees on CLEO, LFTO, SO, ORL, and SANG. The lowest TSS were produced by trees on MIL and RL. 'Orlando' fruit on the 10 rootstocks varied little in acid content and juice content; however, it was lowest in both cases on RL.

A winter yellowing of leaves rating was given the trees of this experiment in 1967. The results indicated that 'Orlando' tangelo expressed a higher degree of winter yellowing of leaves than 'Nova' tangelo. Smith (5) in 1975 confirmed these results when he stated that this apparent

deficiency was associated with leaf N levels and that 'Orlando' had significantly lower levels of N in the leaves than 'Nova'. Smith's work was conducted on the same trees utilized in the previously mentioned winter yellowing rating experiment.

Results of this experiment indicate that several rootstocks may satisfactorily be used for 'Nova' and 'Orlando' tangelos. 'Nova' and 'Orlando' trees on TROY, CAR, and CLEO rootstocks produced good yields of high quality fruit. 'Nova' and 'Orlando' trees on MIL and RL produced high yields, but were poor in fruit quality, a factor of prime importance for the fresh fruit market.

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COLD HARDINESS OF ORANGE AND GRAPEFRUIT TREES ON DIFFERENT ROOTSTOCKS DURING THE 1977 FREEZE

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Abstract. Immediately before the severe freeze in January 1977, prevailing cool temp significantly cold hardened citrus trees on different rootstocks. Temp as low as -6.7°C (20 F) killed most of the leaves but not the wood of 2-year-old 'Valencia' orange (*Citrus sinensis* (L.) Osbeck) trees on 12 different rootstocks in a relatively low-ground area. Wood kill was greater in an adjacent planting of Florida red grapefruit (*C. paradisi* Macf.) of the same age and on the same rootstocks. In nearby but separate plantings, freeze kill was slight on 3- to 4-year-old 'Valencia' orange and Florida red grapefruit trees on 4 rootstocks. Near Dade City, 2-year-old 'Hamlin' orange trees on 23 rootstocks had severe leaf kill and slight-to-moderate wood kill. Other observations in different areas showed that mature trees were more cold hardy on sour orange (*C. aurantium* L.) than on Carrizo citrange (*C. sinensis* X *Poncirus trifoliata*) rootstock.

The 1977 freeze in Florida replaces the 1962 freeze as the latest entry in the log of historic Florida freezes. The 1977 freeze is memorable on several accounts. For the first time in this century, freezing temps covered the entire Florida peninsula. Snow fell as far south as the Everglades and ice closed bridges in Tampa. Agricultural losses measured in hundreds of millions of dollars began during the early morning hours of January 18, and continued through the morning of the 20th. Estimated losses were alarming in vegetables, forage, ornamentals, tropical fish, limes, avocados, and citrus. Initial estimates totaled a 30 to 35% production loss in citrus.

Subfreezing and frost conditions the first night were reinforced with freezing temps and snow as early as 8 p.m. the second night; the third night showed minimum temps of -8.9°C (16 F) to -4.4°C (24 F) with 9 or more hr at or below -3.3°C (26 F).

This paper summarizes observations of citrus trees on different rootstocks, with emphasis on young citrus trees.

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The observations are an integral part of our cold-hardiness screening program for citrus rootstock selections (15).

Materials and Methods

Freeze injury surveys were initiated 2 months after the 1977 freeze and continued for 3 months. Sites visited were research plantings near Leesburg, Dade City, Lake Garfield, and commercial groves throughout central and south Florida. Scion types included sweet orange, *Citrus sinensis* (L.) Osbeck cvs. Valencia, Hamlin, Pineapple, and Sanguine; grapefruit, *C. paradisi* cvs. Marsh and Florida red seedless; mandarin types, *C. reticulata* Blanco cvs. Dancy, and assumed mandarin-hybrid type 'Murcott'; hybrids, (*C. paradisi* X *C. reticulata*) X *C. reticulata* cv. Page, and *C. reticulata* X (*C. paradisi* X *C. reticulata* cvs. Robinson, Nova, and Osceola and *C. sinensis* X *C. reticulata* (?) cv. Temple; tangelo types, *C. paradisi* X *C. reticulata* cvs. Orlando and several station-numbered selections. Rootstocks included Chase and Estes rough lemon, *C. limon* Burm. f.; sour orange No. 2, *C. aurantium* L.; trifoliolate orange, *Poncirus trifoliata* Raf., cvs. Davis, Swingle, Rich 22-2, English Large, English Small, Kryder 15-3, Flying Dragon, Rubidoux, Jacobsen, Large flower, Small flower, Chambers, Ronnse, and a tetraploid; Cleopatra mandarin; citrumelos, *C. paradisi* X *P. trifoliata*, cvs. Swingle (CPB-4475) and 4481; citranges, *C. sinensis* X *P. trifoliata*, cvs. Carrizo (diploids and tetraploids), Rusk, Troyer; and Pee Wee hybrid, plus *P. trifoliata* X *C. sinensis* cv. Morton; citrangor, (*C. sinensis* X *P. trifoliata*) X *C. sinensis*; (Temple X Gotha Road trifoliolate orange) X Valencia orange; *Severinia buxifolia*; and open pollinated seedlings of hybrid 61-182-6. Representative samples were 10 trees or more for each scion/rootstock combination. Observations were mostly on young-tree cold hardiness relative to specific scion-rootstock combinations made. Broad standard guidelines and, if needed, more detailed measurements were used to place trees into injury categories. Observations of leaf kill, wood injury, and bark splits on each tree were recorded and prefreeze tree condition, cultural practices, site characteristics, and temps were obtained for each planting site.

Results and Discussion

Citrus trees withstood the 1977 Florida freeze better than one would generally expect from reported minimum temps