as shown in the photographs. Lateral and taproots are generally severed during the digging operation, reducing the root systems to an area approx 10 inches (25.4 cm) to each side of the plant and 12 inches (30.5 cm) deep as outlined by the dashed line in Figs. 1-3. Differences that do remain are probably less meaningful because field experience suggests that trees on most of these stocks can be transplanted with minimum difficulty. Active, growing feeder roots are usually considered primarily responsible for supporting a tree during the reestablishment period. It appears that each root system is adequately supplied within the outlined area; however, some transplanting difficulties have been encountered with Carrizo and Trifoliate orange. Trees on other stocks e.g. *C. macrophylla,* seem to lack feeder roots but apparently are able to rapidly regenerate new roots and resume growth. Also, these results are representative of trees raised in deep sands. Nursery trees raised in other soil types or in containers may have *entirely* different root systems.

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THE PERFORMANCE OF 'ROBINSON' AND 'PAGE' CITRUS HYBRIDS ON 10 ROOTSTOCKS

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Abstract. **'Robinson' trees on Estes rough lemon (RL) rootstock were larger and produced more fruit than trees on 9 other rootstocks tested. However, these fruit had the lowest total soluble solids (TSS), acids, and juice content (46%). 'Robinson' on Orlando (ORL), Cleopatra (CLEO), and Troyer (TROY) produced nearly as much fruit, which was higher in TSS and juice content than those on RL. The percentage of large-size 'Robinson' fruit was greatest when trees were on TROY rootstock. Rusk (RSK) induced early production of 'Robinson' fruit with high TSS, but fruit yield was among the lowest for any rootstock. 'Page' trees on Sanguine sweet orange (SANG) rootstock produced the most fruit, followed by trees on RL and CLEO. 'Page' trees on Carrizo (CAR) produced the largest fruit, followed closely by those on MIL. 'Page' fruit from trees on these rootstocks had similar juice content, but those on RL had the lowest TSS.**

'Robinson' (*Citrus reticulata Blanco* X (*C. paradisi* Macf. X *C. reticulata*)) and 'Page' ((*C. paradisi* X *C. reticulata*) X *C. reticulata*) are citrus hybrids released as new cultivars in 1959 and 1963, respectively (3, 4). Information on the performance of these cultivars on various rootstocks was not available at the time of their release, and no results have been published to date. Trees destined for the first rootstock experiment with these scions were destroyed in the nursery during the 1962 Florida freeze. Most of the commercial 'Robinson' and 'Page' trees were established during the early to mid-1960's. Rootstocks used for these cultivars were selected on the basis of the observed performance of similar scions, such as tangerines and tangelos.

This report contains information on the performance of 'Robinson' and 'Page' in a scion-rootstock experiment during the period 1968-1976.

Materials and Methods

Nursery trees of 10 scions (all mandarin or mandarin hybrids) on 10 different rootstocks were planted on Astatula fine sand in 1965, near Leesburg, Florida. Trees were spaced 4.5 x 5.4 m in 4 randomized blocks with 3-tree plots. The planting received excellent care and all cultivars were vigorous and fruitful. Fertilization, irrigation, and other operations were carried out uniformly. During the early years of the experiment, it became apparent that insufficient labor was available to obtain all the information desired from the experiment. Consequently, complete data on fruit yield and quality were not obtained annually. Also, data were later restricted to 2 of the 4 blocks. For these reasons, most of the data were not subjected to statistical analysis. Fruit quality data were determined by standard methods. This report includes only data on 'Robinson' and 'Page'.

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

Results and Discussion

The influence of rootstock on time of bloom during 2 seasons is shown in Table 1. Data on the performance of 'Orlando' tangelo are included, because 'Orlando' is commonly used as a pollenizer for 'Robinson' and 'Page'. Significant differences in the percentage of petal drop were found only for 'Robinson' in 1969 and 'Orlando' in 1969 and 1971. The trees were young, and their annual or biennial bloom patterns may not have been stabilized. 'Page'

[1]The authors express their appreciation to W. R. Conybear and R. Fenton for their assistance in the collection and analysis of data.

and 'Orlando' trees initiated bloom slightly earlier than 'Robinson' each year. However, the bloom periods overlapped enough (data not shown) for adequate cross-pollination. This supports the limited information on pollenizers previously reported (1). 'Robinson' trees on RSK, LFTO, TROY, and CAR rootstocks bloomed later than any others in 1969, but in 1971 there were no significant differences. 'Page' trees bloomed at the same time, regardless of rootstock. 'Orlando' trees on LFTO bloomed late in 1969. 'Orlando' trees on RSK, LFTO, SANG, and MIL were late blooming in 1971. The trees in this experiment always had adequate soil moisture as rainfall or supplemental irrigation, and it is possible that this condition may have resulted in less rootstock influence on bloom date.

Table 1. The influence of rootstock on time of bloom of 'Robinson', 'Page', and 'Orlando' trees.[z]

Rootstock	Robinson Avg % petal drop		Page Avg % petal drop		Orlando Avg % petal drop	
	Apr 11 1969	Mar 31 1971	Apr 11 1969	Mar 31 1971	Apr 11 1969	Mar 31 1971
CAR	13 b[y]	20 a	86 a	40 a	90 a	33 ab
CLEO	46 a	24 a	91 a	33 a	75 ab	38 ab
RSK	1 b	5 a	91 a	45 a	61 ab	8 c
TROY	4 b	23 a	83 a	49 a	78 a	34 ab
ORL	40 ab	16 a	76 a	40 a	67 ab	43 a
RL	34 ab	10 a	86 a	40 a	61 ab	40 a
LFTO	17 b	15 a	90 a	33 a	45 b	15 bc
SO	41 ab	28 a	98 a	16 a	86 a	35 ab
MIL	39 ab	20 a	75 a	19 a	74 ab	18 abc
SANG	65 a	19 a	93 a	38 a	75 ab	18 abc

[z]The extent of petal drop was visually estimated per 3-tree plot with 4 replications. Data on 'Orlando' tangelo were added, because 'Orlando' is commonly used as a pollenizer for 'Robinson' and 'Page'.
[y]Mean separation within columns by Duncan's multiple range test, 5% level.

Table 2 shows the influence of rootstock on trunk circumference of 'Robinson' and 'Page' trees. Trunk circumference was used as a measure of tree size because the trees were hedged on 2 sides in 1975. The smaller trees in the experiment escaped hedging, because their canopies did not extend far enough into the hedged middles to contact the hedging machine. 'Robinson' and 'Page' trees on RSK and LFTO were the smallest by the end of the test period. 'Robinson' trees on RL and ORL were among the largest in 1976. By 1976, 'Page' trees on SANG, RL, MIL, and CLEO were the largest. When the trees were 11 years old

Table 2. The influence of rootstock on the average trunk circumference of 'Robinson' and 'Page' trees.[z]

Rootstock	Robinson		Page	
	1966[y]	1976[x]	1966[y]	1976[x]
SANG	5.3 bc[w]	50.4 ab	5.5-c	67.0 a
RL	7.7 a	55.9 a	7.6 a	66.0 a
MIL	5.6 bc	50.2 ab	7.5 a	66.0 ab
CLEO	6.0 bc	48.6 ab	6.7 ab	62.8 ab
ORL	6.1 bc	54.7 a	6.2 bc	58.1 ab
CAR	5.3 bc	43.1 bc	6.0 bc	57.2 ab
SO	5.1 c	46.0 ab	5.5 c	56.7 ab
TROY	6.7 ab	46.8 ab	6.2 bc	51.8 bc
RSK	5.9 bc	35.3 cd	7.1 ab	43.8 c
LFTO	3.7 d	32.9 d	4.1 d	43.4 c

[z]Circumference in centimeters about 20 cm above bud union.
[y]Average of 12 trees, 1 year after transplanting.
[x]Average of 6 trees, 11 years after transplanting.
[w]Mean separation within columns by Duncan's multiple range test, 5% level.

(1976), those on ORL, CAR, TROY, and SO were intermediate in size.

The influence of rootstock on yield and size of 'Robinson' fruit is shown in Table 3. In 1968, when the trees were 3 years old, trees on RSK rootstock were the most precocious, followed by those on RL, TROY, and CAR. Trees on MIL, SANG and ORL were the least precocious. The 3-year average fruit yields show that 'Robinson' trees on RL, ORL and CLEO rootstocks were the most productive. Trees on SO, RSK, MIL and LFTO were the least productive during the 3 seasons. Trees on SANG, TROY and CAR were intermediate in fruit production. It is interesting that 'Robinson' trees on RSK produced about the same amount of fruit per tree at all 3 harvests and their yield did not increase with age.

Table 3. The influence of rootstock on yield and size of 'Robinson' fruit.

Rootstock	Avg no. fruit per tree 1968	Avg boxes fruit per tree[z]	3-yr avg fruit diam (cm)	Avg fruit size (%)[y]	
				5.7 cm diam or larger[w]	6.9 cm diam or larger[v]
RL	132 b[x]	2.5 a	6.58 b	97 ab	29 a
ORL	26 d	2.3 ab	6.55 b	97 a	23 a
CLEO	67 cd	2.1 ab	6.50 c	92 bd	24 a
TROY	116 bc	1.8 bc	6.63 a	100 a	46 a
SANG	23 d	1.8 bc	6.65 a	98 a	33 a
CAR	102 bc	1.7 bc	6.48 cd	89 cd	24 a
MIL	39 d	1.5 c	6.55 b	97 ab	27 a
SO	75 bcd	1.3 c	6.55 b	88 d	20 a
RSK	219 a	1.3 c	6.48 cd	95 ab	25 a
LFTO	71 cd	1.2 c	6.45 d	96 ab	25 a

[z]One box is 90 lb or 40.8 kg, average yield for 1972, 1974 and 1976.
[y]Average of 200 fruit per rootstock for each of 2 years.
[x]Mean separation within columns by Duncan's multiple range test, 5% level.
[w]Minimum diam of market size 210 tangerines is 5.7 cm.
[v]Minimum diam of market size 120 tangerines is 6.9 cm.

The average fruit diam (Table 3) did not differ appreciably between trees on different rootstocks, but those from trees on SANG and TROY were the largest. The smallest fruit came from trees on RSK and LFTO. Because 'Robinson' is marketed in Florida as a tangerine and fruit size can have a profound effect on market value, the percentages of fruit attaining 2 important market sizes are listed in Table 3. Size 210 (5.7 cm) is often the minimum market size in Florida, whereas size 120 (6.9 cm) is a desirable market size.

All or nearly all of the fruit from trees on TROY, SANG, RL, ORL, and MIL were 5.7 cm or larger. Trees on CAR, SO, CLEO, RSK, and LFTO had 4-12% fruit that were smaller than 5.7 cm in diam. Nearly one-half of the fruit from trees on TROY were 6.9 cm (size 120) or larger. The next largest percentages of size 120 or larger fruit came from trees on SANG, RL, and MIL, although the differences were not statistically significant. Approximately one-fourth of the fruit from trees on other rootstocks were 6.9 cm or larger.

Table 4 shows the influence of rootstock on quality of 'Robinson' and 'Page' fruit. 'Robinson' fruit from trees on MIL and RL rootstocks were the lowest in total soluble solids (TSS). The Florida market standards for tangerines shipped before November 15 require a minimum of 9.00% TSS. Therefore, fruit from trees on RL (Oct. 26, 1971 and Oct. 13, 1976) could not be shipped on those dates, while all others could.

'Robinson' fruit varied little in acid content but those from trees on RL and MIL were lowest, with levels lower

Table 4. The influence of rootstock on quality of 'Robinson' and 'Page' fruit.

Rootstock	Robinson			Page		
	Avg % TSS[z]	Avg % acids[z]	Avg % juice[z]	Avg % TSS[x]	Avg % acids[x]	Avg % juice[x]
RSK	10.99 a[y]	0.86 a	50 ab	11.63 a	0.77 a	57.0 a
SO	10.64 a	0.78 bc	53 a	10.97 b	0.74 a	58.0 a
CLEO	10.58 ab	0.83 ab	52 a	10.96 b	0.72 a	57.0 a
LFTO	10.46 ab	0.78 bc	47 bc	10.35 c	0.75 a	57.0 a
CAR	10.42 ab	0.76 cd	51 ab	10.42 bc	0.73 a	56.0 a
TROY	10.35 ab	0.76 cd	51 ab	10.48 bc	0.74 a	56.0 a
ORL	10.33 ab	0.75 cd	51 ab	10.54 bc	0.76 a	57.0 a
SANG	10.17 ab	0.77 bcd	50 ab	10.65 bc	0.72 a	56.0 a
MIL	9.74 bc	0.73 cd	48 abc	10.50 bc	0.73 a	56.0 a
RL	9.22 c	0.71 d	45 c	9.80 d	0.75 a	56.0 a

[z]3-year average, 1971, 1972 and 1976.
[y]Mean separation within columns by Duncan's multiple range test, 5% level.
[x]5-year average.

than desirable for best taste. 'Robinson' fruit contain less juice than some tangerines, and low juice content sometimes is a problem. Fruit from trees on SO, CLEO, CAR, TROY, and ORL contained the most juice (Table 4). Fruit from trees on RL and LFTO had the lowest juice content. During some seasons, fruit from trees on these stocks had only 38-41% juice and were "ricy." This observation was also reported by Krezdorn (2). Fruit with low juice content was more prone to show sunburn.

The TSS level in 'Page' fruit was slightly higher than that of 'Robinson' fruit (Table 4). The highest TSS level in 'Page' fruit was found on trees on RSK. The lowest TSS level occurred in fruit from trees on RL. Trees on the other 8 rootstocks were nearly the same in TSS level. The acid and juice contents were not influenced by rootstock. 'Page' fruit contained more juice than 'Robinson' fruit.

Data in Table 5 show the influence of rootstock on yield and size of 'Page' fruit. 'Page' trees on CAR, RSK, TROY, MIL and RL were more precocious in 1968 than trees on other rootstocks. However, in later years, trees on SANG were the most productive. Trees on RL, CLEO, SO, CAR, and TROY were intermediate in fruit production. Trees on ORL, MIL, LFTO, and RSK were the least productive. In 1976, the greatest fruit production of 'Page' was found on the largest trees, except in the case of MIL rootstock, where the trees were large but production was small.

Table 5. The influence of rootstock on yield and size of 'Page' fruit.

Rootstock	Avg no. fruit per tree 1968	Avg boxes fruit per tree[z]	5-year avg fruit wt gm[y]	Avg fruit diam cm 1973	Avg fruit size (%) Nov. 20, 1973	
					6.4 cm diam or larger[x]	6.7 cm diam or larger[x]
SANG	28 bc[w]	2.4 a	132 a	5.94 a	26 de	16 bcd
RL	45 abc	1.9 ab	131 a	5.79 a	21 e	8 e
CLEO	16 c	1.8 ab	137 a	5.97 a	28 cd	16 bcd
SO	27 bc	1.7 ab	131 a	5.89 a	21 e	7 e
CAR	74 a	1.7 ab	140 a	6.25 a	51 a	36 a
TROY	67 a	1.7 ab	130 a	5.94 a	32 bcd	19 b
RSK	70 a	1.6 b	127 a	5.99 a	35 bc	17 bc
LFTO	27 bc	1.4 b	129 a	5.84 a	19 e	9 de
MIL	57 ab	1.3 b	139 a	6.10 a	37 b	23 b
ORL	29 bc	1.3 b	132 a	5.89 a	21 e	10 cde

[z]One box is 90 lb or 40.8 kg, average for 1972, 1973, and 1976.
[y]Average fruit weight for samples harvested in 1969, 1971, 1973, 1974, and 1976.
[x]Average of 100-fruit samples per rootstock from each of two 3-tree plots.
[w]Mean separation within columns by Duncan's multiple range test, 5% level.

One of the weaknesses of 'Page' is small fruit size. A detailed study of 'Page' fruit size was made (Table 5). The greatest 5-year average fruit weight and the diam in 1973 were found on trees with CAR rootstock, but the differences were not statistically significant. Fruit from trees on MIL, RSK, CLEO, TROY, and SANG were nearly as large. It is interesting that fruit from trees on RL were among the smallest average diam. Probably the most common rootstock used for 'Page' trees in commercial plantings is RL. This is due largely to growers commonly planting 'Dancy' tangerines on RL rootstock to obtain large fruit size. Growers are also aware that 'Page' fruit are juicy and contain favorable levels of TSS, even on RL (4). The fruit diam ranking is in nearly the same order as that based on the 5-year average fruit weight, with RL among the poorer rootstocks.

The 'Page' fruit-size study made only in 1973 (Table 5) included calculation of percentages of fruit in 2 size categories. Fifty-one percent of the 'Page' fruit from trees on CAR rootstock were 6.4 cm (2.5 in.) or larger in diam. Approximately one-third of the fruit from trees on MIL, RSK, and TROY were 6.4 cm or larger. One-fourth or less of the fruit from trees on other rootstocks were that large. Obviously, the increase in fruit diam from 6.4 to 6.7 cm made a large change in average fruit sizes. More than one-third of the fruit from 'Page' trees on CAR were 6.7 cm or larger. About one-fourth of the fruit from trees on TROY and MIL were that size. Only 8% of the fruit from trees on RL were 6.7 cm or larger. Although these data are for only one season, this may help to explain why growers have been plagued with small-size 'Page' fruit. A nonsignificant correlation coefficient (.005) showed no relationship between average fruit size and fruit yield in 1973.

Fruit yields were not collected each year; therefore, there is no reliable estimate of possible alternate bearing of 'Page' and 'Robinson' trees. However, 'Robinson' trees produced a light bloom in 1974. Both 'Page' and 'Robinson' had little bloom in 1975 following an unusually mild winter. Many other cultivars failed to bloom in 1975.

Results of this study indicate that there is no single best rootstock for 'Robinson' or 'Page'. The bloom date of 'Page' was not influenced by the rootstock. However, there was some influence on the bloom date of 'Robinson'; trees on RSK, LFTO, TROY, and CAR sometimes bloomed later than trees on other rootstocks.

'Robinson' trees were generally smaller than those of 'Page'. By the end of the test, trees on SANG, RL, and MIL were among the largest, whereas those on RSK and LFTO were the smallest.

Trees on RSK generally began bearing earlier than trees on other rootstocks, but fruit production per tree remained low throughout the test, whereas trees on most stocks increased in production with age. 'Robinson' trees on RL produced the most fruit, but the quality was poor. 'Robinson' trees on TROY produced the highest percentage of large fruit.

Although the TSS of 'Page' fruit from trees on RL was lower than that on other rootstocks, the fruit were of acceptable quality.

In the 1 year of detailed study, 'Page' trees on CAR produced the largest fruit, followed closely by those on MIL. Trees on RL and LFTO rootstock produced the smallest fruit. The ranking of rootstocks was nearly the same when based on 5-year average fruit weight.

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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.

[1]The authors express their appreciation to W. R. Conybear and R. Fenton for their assistance in the collection and analysis of data during the experiment.

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 trifoliate 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.

	Avg. % petal drop			
	Nova		Orlando	
Rootstock	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