Size and growth habits of

Trifoliate Orange

selections

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Among the characteristics of trifoliate orange—*Poncirus trifoliata*—rootstock for citrus is its supposed dwarfing effect on tree size. However, many of the Valencia, Washington Navel, and grapefruit trees budded on trifoliate orange rootstock are large and productive. Frequently, the trees that exhibit varying degrees of dwarfness are immediately adjacent to large trees.

Unsuckered trifoliate seedlings. *Left*—large-flowered group; *right*—small-flowered group.

Growth characteristics of seedlings from 36 trifoliate selections were studied, to gain information on the nature of the variability in size of trees grafted on trifoliate orange rootstocks.

Seeds for most of the tests were obtained from the progeny of selections originally made in 1945 from various citrus-producing areas of California. At that time, cuttings of trifoliate rootstock suckers were taken from trees showing no symptoms of exocortis or psorosis viruses: 12 from under Valencia scions; four from under Washington Navel scions; and nine from under grapefruit scions. Three rooted cuttings of each selection were planted in the field for production of seed.

Seeds of other trifoliate selections, in which behavior as rootstocks is not yet known, were obtained from Riverside, from various parts of the United States, and from South America, and seedlings were propagated for seed production.

When the rooted cuttings of the original trifoliate selections attained bearing age, the floral characteristics provided a division into two distinct groups.

The flowers of some of the selections are 3.0 cm—centimeters—to 4.0 cm in diameter, with the petals turned up to give the flower a slightly cupped appearance. Individual petals are constricted at the base and rolled upward along the edges, producing a narrow appearance. Trifoliate selections possessing flowers with these characteristics are classed as small-flowered. Flowers of the other selections are 5.5 cm to 6.5 cm in diameter. The petals remain in a horizontal position and exhibit no tendency toward cupping. They are less constricted at the base than the petals of the small-flowered selections and show little tendency to roll upward along the edges. Trifoliate selections in this group are classed as large-flowered.

Floral measurements of small-flowered and large-flowered trifoliate selections were taken from a random choice of selections in each group. Floral measurements were quite uniform, and in only one instance—Barnes—was there doubt as to the group in which an individual selection belonged. Petal staminody—change of petal into stamen—was not apparent in any trifoliate selection.

In the experimental planting at Los Angeles, the small-flowered trifoliate selections have consistently matured their fruit about one month earlier than the large-flowered selections. Also, stem cuttings from small-flowered selections produced roots more readily than stem cuttings from large-flowered plants. These distinguishing characteristics firmly establish that genetically different strains of trifoliate orange do exist.

Trifoliate seeds for the experimental work were extracted in the fall from mature fruit, treated with 50% Arasan—Thiram—dust and stored in polyethylene bags at 40° F. Following a two-month storage, 200 seeds of each selection were planted in flats. Five months later, when the seedlings were 8″ in height, the 20 largest seedlings of each selection were transferred to nursery rows and planted in a randomized block, with four replications of five seedlings each. Standard nursery practices were employed throughout the two-year period of the experiment. Suckers were removed from the lower trunks of the seedlings at frequent intervals, so as to obtain a single trunk to a height of 15″.

Average Top Weights of One-Year-Old Unsuckered Trifoliate Orange Seedlings*

Large-flowered group		Small-flowered group	
Selection	Fresh weight, grams	Selection	Fresh weight, grams
Christian	26.0	Taylor	27.7
K 55-1	24.4	Jacobsen	26.9
K 25-4	22.7	Ronnse	26.7
R 12-2	26.5	Davis A	26.5
U.S.D.A.	20.5	R 21-3	26.2
Towne F	19.3	R 22-2	24.3
K 5-5	19.3	Davis B	23.5
Yamaguchi	19.3	Simmons	23.2
K 28-3	19.1	Barnes	23.0
K-Medium	18.6	English Small	21.5
Webber Fawcett	18.5	Rubidoux	19.9
Towne G	18.0	English Large	16.7
Benecke	17.9	CES Diploid	13.9
K 15-3	16.8		
K 8-5	16.8		
R 7-5	16.7		
Pomeroy	16.3		
R 5-2	16.3		
K 60-2	15.7		
Argentina	14.9		
Average	19.2		23.1
LSD at 5%, 5.2			

* Tops severed from roots at ground level. Weights taken in spring prior to leafing out.

At Los Angeles, where relatively low summer temperatures prevail, seedlings of large-flowered trifoliate selections were, without exception, more vigorous than seedlings of the small-flowered group. The large-flowered selections possessed trunk diameters at budding height—8″ above the ground—of from 1.40 cm to 1.62 cm and top weights from 210 grams to 285 grams. Seedlings of the small-flowered selections showed a wider range of growth. Except for the two very small selections, English Small and CES Diploid, the average trunk di-

ameter in the small-flowered group was 1.06 cm and the average top weight was 120 grams.

Vigor of seedlings within the large-flowered group was quite uniform at Los Angeles, suggesting that the large-flowered selections may comprise a single strain. Within the small-flowered group, the selections English Small and CES Diploid appeared sufficiently different in vigor from the remaining selections to suggest that the small-flowered group is composed of two or more strains. However, preliminary observations suggest that relative vigor among the selections may be different in areas where summer temperatures are higher.

A second line of experimentation seems to indicate that seedlings of the large-flowered group, when used as rootstocks, impart greater vigor to the grafted trees than selections from the small-flowered group. In the oldest experiment, five-year-old Frost nucellar Washington Navel orange trees grafted on large-flowered Christian trifoliate rootstock are approximately 20% larger than Washington Navel trees grafted on the small-flowered Rubidoux trifoliate.

During the first growing season, seedlings of the small-flowered group required more frequent suckering than seedlings of the large-flowered group. In a second experiment, none of the seedlings was suckered. After one growing season, the fresh weights of the tops of undisturbed seedlings indicated only slight differences in vigor among the selections. Apparently nursery management practices may modify the relative vigor of trifoliate selections.

There was a conspicuous difference in the growth habits of typical unsuckered seedlings from the two groups. Without exception, seedlings of the small-flowered group showed a bushy habit of growth with multiple trunks, and seedlings of the large-flowered group showed an upright habit of growth with a single trunk. Seedlings with the bushy-multiple trunk habit of growth require frequent suckering to obtain a single trunk suitable for budding, whereas seedlings with the upright-single trunk habit of growth are easier to handle and require little, if any, labor to obtain a single trunk for budding.

Trifoliate seedlings are susceptible to lime-induced chlorosis. Uniform seedlings from each of the 36 selections were transplanted from the germinating flat to 6″ pots containing a mixture of 50% clay loam and 50% 20-mesh calcium carbonate. Immediately after transplanting, the new growth on seedlings from each selection developed severe symptoms of lime chlorosis, and very little new growth developed after the initial flush. After one year, the control seedlings—in 50% clay loam mixed with 50% 20-mesh silica sand—were more than twice as large as seedlings growing in the calcium carbonate mixture. Not one of the 36 trifoliate selections under study was resistant or tolerant to high lime soil.

A quite distinct type of chlorosis—the causes of which are at present unknown—may develop on leaf and stem tissues of trifoliate orange. Once developed, the symptoms persist and may remain throughout the life of the tissue. Affected leaves show irregular green spots surrounded by chlorotic tissue, and terminal growth is markedly diminished when a seedling develops the disorder.

The nature of this disorder is not established. Severe symptoms have been observed on two-year-old trifoliate scions grafted on Rough-lemon rootstock, indicating that the trifoliate root system is not a prerequisite for the disorder. Other citrus scions grafted on trifoliate rootstock do not show the disorder. Concentrations of minerals were found to be similar in the normal and the affected trifoliate leaves and were within the range considered satisfactory for plant growth. The minerals measured were nitrogen, phosphorus, potassium, calcium, magnesium, manganese, and iron.

Results of numerous experiments undertaken to study this form of chlorosis indicate that the disorder appears only in seedlings growing under environmental conditions which favor rapid, succulent growth. Factors favoring the development of the symptoms include heavy nitrogen fertilization, root temperatures of 80°F to 90°F, and air temperatures of 90°F to 105°F.

Repeated experiments have demonstrated that trifoliate selections within the large-flowered group are more susceptible to the new type of chlorosis than are selections within the small-flowered group. Hence, under conditions conducive to the disorder, seedlings of the small-flowered group may outgrow seedlings of the large-flowered group—another illustration which shows that nursery management practices may modify the relative vigor of trifoliate selections.

Experiments are under way to determine if dwarfing of the original trees was due to genetic variability of the trifoliate rootstock or to a possible virus infection.

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