Citrus Collection for Research

citrus relatives, species, varieties, strains, and hybrids provide materials for research on problems of citriculture

W. P. Bitters

Plant source materials for research on citrus problems are available—in one of the world's most extensive citrus variety collections—at the Citrus Experiment Station at Riverside.

In the collection, there are citrus fruits —including relatives—of unusual shapes, sizes, colors, and tastes, growing on trees with varying heights, forms, and foliage characters.

As shown in the lower illustration on the next page, citrus fruit ranges in size from the shaddock—*Citrus grandis*—which may be as large as a person's head and weigh many pounds, to the Chinese box orange—*Severinia*—as small as a pea and weighing only a fraction of an ounce.

Most citrus fruits are round or slightly flattened or elongated in shape, but those of the orange jessamine—*Murraya*—and the finger limes — *Microcitrus* — are greatly elongated and banana-shaped in appearance. Others—such as *C. macroptera*—are conspicuously necked at the stem end and shaped like pears. Some are prominently creased and wrinkled like *C. hystrix* and the Moroccan rough lemon. Fruits of most citrus occur as a single specimen, but that of the Wampee grows in a cymose cluster like a bunch of grapes.

Peel colors range from the bright red of the *Murraya*, through the orange and yellow colors of the standard orange and lemon varieties, to the greenish yellow of the limes, the brown of the Wampee, and the dark blue of the *Severinia*.

The color of the pulp varies as well, and there are several selections of pink-pulped lemons. One of these has in addition a variegated—mottled green and yellow—fruit and attractive green and white variegated leaves, as illustrated in the upper photograph on the next page.

There are many pink-pulped grapefruit and shaddocks. While most fruits

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sunlight struck any part of the structure. A good turf was located adjacent to the north.

Comparisons of the temperatures recorded at Site *A*, on August 31; Site *B*, on September 25; and Site *C*, on August 10 are given in the graph on page 10 because conditions of wind, temperatures, and humidity were approximately equal. However, the summer of 1954 was unusually cool and maximum temperatures were considerably below those of normal years.

More important than the 20F temperature differential between bare ground and shade is the resulting delaying action of the morning heating and hastening of the afternoon cooling. Under the fig trees—Site *C*—the morning temperature reached 75F, three and one-half hours later than when the trailer was located in the sun—Site *A*. It cooled down to 75 F in the afternoon, two and three-quarters hours earlier than in the open. In addition, the temperature remained over 75F during the hot noon period only five hours in comparison to the eleven and one-half hours at Site *A*—the bare ground check location.

The effect of afternoon shade from the eucalyptus trees—Site *B*—was striking, as indicated by the readings of roof temperatures. The trailer received direct sun until 12 noon; then as the shade began to cover the roof, a 35F drop in roof temperatures occurred in an hour's time after arrival of the shadow. The interior heating continued to rise but began to level off two hours later.

Although the coolest condition existed beneath the fig tree foliage—Site *C*—there was inadequate light inside for reading and close work. However, this is attributed largely to the smallness of window area.

From the results of these tests, it would appear that the best planting for living shade would be high-branching deciduous trees—relatively close to the house

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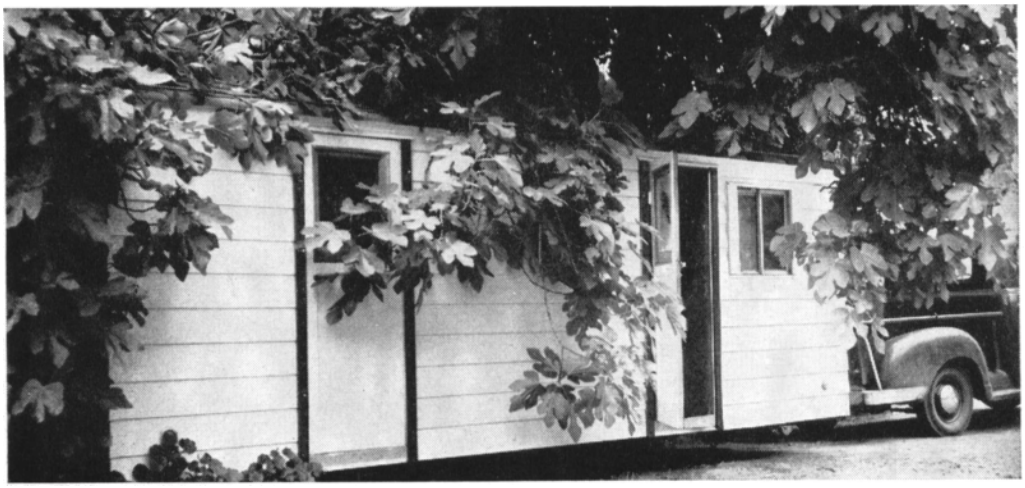
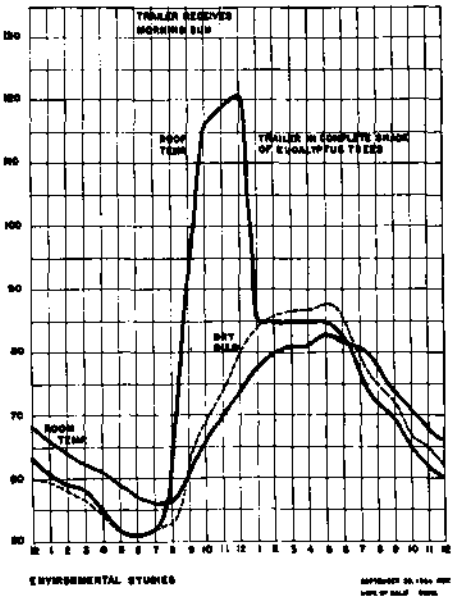
Site C. Northern exposure of front of unit under fig tree where foliage provided shade during entire day.



Effect of afternoon shade is shown in the roof temperature readings where unit is located east of eucalyptus group.



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have a yellowish or orange pulp, some such as *C. hystrix*, have a green color and others, such as the Torocco orange, are a deep red.

There are many mandarins with thin rinds that are easy to remove and at the other extreme are fruits that are nearly all rind. Citrons, for example, may have a rind 2″ thick that can be used to make candied citron peel.

The little kumquat, unlike most citrus, has an edible rind and the fruit is eaten in its entirety. Fruits like *Afraegle* and *Aeglopsis* are hard shelled and have a rind like that of a dried gourd.

There are sweet limes, lemons, mandarins, and oranges. Some fruits are highly aromatic and are frequently used as sachets. Others may be dried and used as condiments.

Most citrus trees are evergreen, but the trifoliate orange—a near-citrus relative—sheds its leaves during the winter time, as do many of its hybrids. In the spring the flowers appear on these varieties before the new leaves are in evidence.

Citrus leaves vary tremendously in size. They may range from ¼″ to ⅜″ in width and 1″ in length on the finger lime—*Microcitrus australasica*—to 4″ or 5″ in width and 8″ or 10″ in length on some of the larger shaddocks. Most varieties have a simple, single leaf which may be long and narrow, such as on the desert lime—*Eremocitrus*—and willow leaf varieties. Leaves of other varieties are compound and may be clover-shaped as in the trifoliate orange or may be even more complex as on *Murraya*, *Hesperethusa*, and others. Many varieties have variegated leaves characterized by different intensity of green areas in the leaf and light areas devoid of chlorophyll.

The shape and size of the trees also vary markedly. A few are inherently slow-growing dwarf trees such as the kumquats; others may be stunted by growing on dwarfing types of rootstocks. A range from bushes to vigorous trees is thus possible. Certain varieties are sprawling in character; others are quite erect and columnar. There is a citrus type for nearly every need of the landscape gardener.

In the fall of 1952, there were 1,544 trees in the Riverside collection representing 713 different accession sources. This does not include newly developed hybrids that are not yet released for commercial propagation. Over the past thirty years, 733 other accessions were eliminated by natural hazards of frost and disease and because of undesirable fruit types and characters. A summary of present accessions reveals the following number of varieties:

87 sweet oranges
30 Valencia oranges
55 navel oranges
10 red-pigmented oranges
21 citrons
13 mandarin limes
12 acid (Mexican) and seedless (Tahiti) limes
9 sweet limes
53 shaddocks
43 sour oranges
12 Bittersweet, chinotto, Boquet, sour orange types
58 grapefruit (light pulp)
9 grapefruit (pink pulp)
32 mandarins
15 satsumas
36 tangelos
7 tangors
15 kumquat, kumquat hybrids
6 Calamondin, Calamondin hybrids
7 trifoliate oranges
16 citranges
12 other trifoliate hybrids
14 Ichang, Ichang hybrids
90 lemon, lemon-like types
42 miscellaneous, citrus species—citrus relatives.

Recently — by agreement of the Plant Exploration and Introduction Division of the U.S. D.A. Bureau of Plant Industry, the California State Department of Agriculture Bureau of Plant Quarantine, and the University of California—the prohibi-

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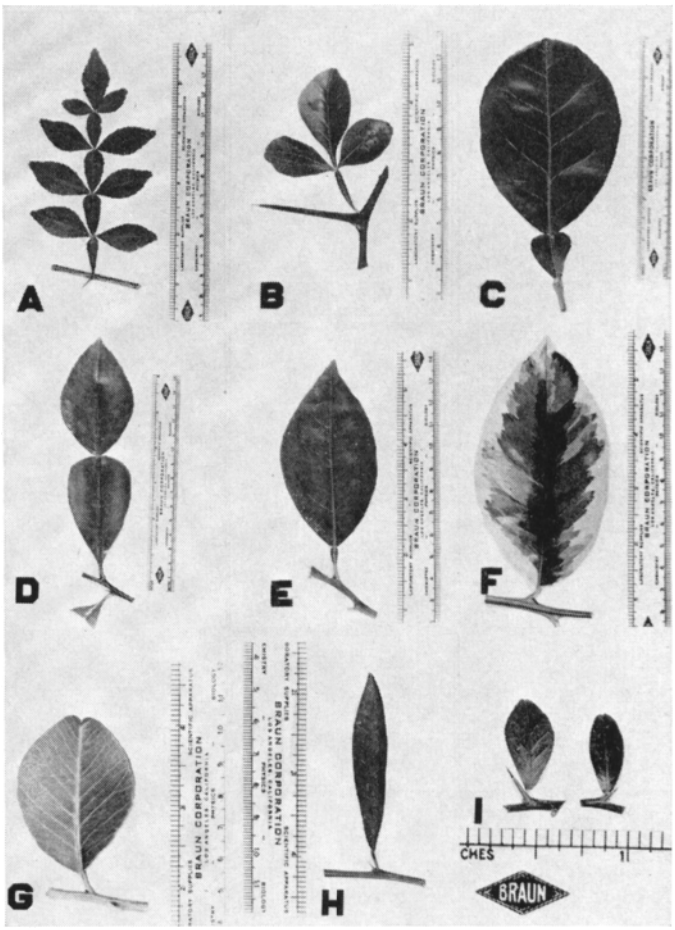
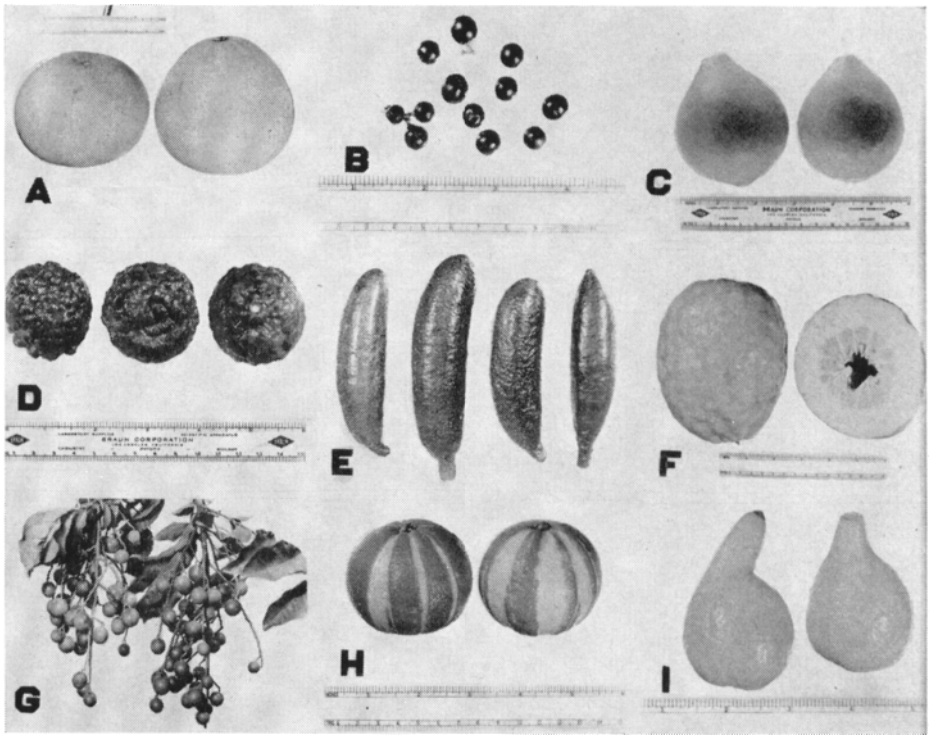


Leaf types found in citrus species and relatives. *A, Hesperethusa; B,* Trifoliate orange—*Poncirus trifoliate; C,* Shaddock— *Citrus grandis; D, Citrus macroptera; E,* sweet orange—*Citrus sinensis; F,* Variegated lemon—*Citrus limon; G,* Chinese box orange—*Severinia buxifolia; H,* Desert lime—*Eremocitrus hybrid; I,* Finger lime—*Microcitrus australasica.*

**Fruit types found in citrus species and relatives. *A,* Shaddock—*Citrus grandis; B,* Chinese box orange—*Severinia buxifolia; C, Citrus macroptera; D, Citrus hystrix; E,* Finger lime—*Microcitrus australasica; F,* Citron—*Citrus medica; G,* Wampee—*Clausena lansium; H,* Variegated sour orange—*Citrus aurantium; I,* Lemon-lime hybrid.



New Mite Predators

four species from Guatemala show promise in southern California

C. A. Fleschner

The Guatemalan *Stethorus*—a small, black, lady beetle mite predator—is being propagated by the thousand in the insectary at Riverside for release in southern California avocado and citrus groves.

As a result of an exploratory trip through Mexico and Central America during the winter of 1953–54 to study the natural balance of pests of avocado trees in their native habitat, several species of natural enemies controlling mite pests of wild avocado trees were found in the Guatemalan highlands. Although Guatemala is a tropical country, frost may occur in the highlands above 5,000′ during the colder months, so it was thought that beneficial species collected from this area could possibly be established in southern California.

Consequently, after methods were developed for their propagation, nine species of these mite predators were shipped to Riverside in the spring of 1955, and four of these—one cheyletid mite, two typhlodromid mites, and one *Stethorus*—are being propagated. All four are new, undescribed species.

Stethorus, particularly, shows promise. Over 7,000 of this predator have already been released in the southern counties where it is working and reproducing well, although it remains to be seen how satisfactorily it will work through the winter months. Large numbers will be used experimentally in mass liberations at critical times in attempts to prevent the development of injurious plant-feeding mite infestations.

Since *Stethorus* feeds on a wide range of mite species, it may be used in this experimental manner not only on avocado and citrus but on various truck and field crops and other trees. This is also true of the cheyletid mite and the two typhlodromid mites, which—as laboratory studies have shown—will feed on all mite pests of avocado and citrus trees except the citrus bud mite.

Propagation of these beneficial species will be continued until they have been given an opportunity to become established in southern California groves.

C. A. Fleschner is Associate Entomologist, University of California, Riverside.

The above progress report is based on Research Project No. 1495.

FRUIT SIZE

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from each culture were tested in duplicate determinations for their content of calcium, potassium, magnesium, and sodium, the results of which are shown in the larger table. The calcium percentage in the peel was approximately doubled while that of potassium was more than tripled in the extreme. Hoagland's nutrient solution regularly contains 159 ppm of calcium. When the concentration of calcium in the nutrient solution was increased above this strength—as shown in the larger table—the calcium percentage in the peel made its greatest increase. Above a concentration of 237 ppm of calcium in the nutrient, calcium percentage in the peel increased only slightly.

The peel readily absorbed large amounts of potassium when the concentration of potassium in the nutrient solution was increased and that of calcium was simultaneously decreased. In the peel there were very small increases in the percentages of magnesium accompanying the increased calcium and reduced potassium percentages though the magnesium concentrations in the nutrient solutions were similar for all cultures.

Yields and Sizes of Lemon Fruits in the Silver Stage of Maturity Grown on Trees in Soil Cultures That Received Similar Nutrient Solutions Except for the Ratio of Calcium and Potassium

Culture	Calcium	Potassium	No. of fruit	Wt. of fruit grms.	Diameter of fruit ins.
	ppm in nutrient				
1	318	0	12	1134	2.095
2	298	39	23	2335	2.165
3	277	77	15	2400	2.169
4	237	155	13	1503	2.193
5	159	310	18	2027	2.228
6	80	467	19	2227	2.252
7	40	545	11	1299	2.272
8	0	622	8	1100	2.374

In the pulp the calcium percentages, while relatively low in comparison with those of potassium, showed a consistent increase, whereas the magnesium—constant in each nutrient—showed minor increases as calcium in the nutrient was increased and potassium decreased.

Lemon fruit therefore responded very well to changes in the calcium-potassium content in the nutrient solution applied to the soil when the concentration of the applied other nutrient elements was not varied in any of the cultures. The larger table also shows that the calcium and potassium percentages in the dry matter of lemon flowers can be markedly affected by varying the ratio of calcium to potassium in the nutrient applied to soil cultures. The high calcium content of many irrigation waters should make the potassium supply of considerable importance.

A. R. C. Haas is Plant Physiologist, Emeritus, University of California, Riverside.

Joseph N. Brusca is Principal Laboratory Technician, University of California, Riverside.

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tion of importation bud of wood or cuttings was modified, and introduction of citrus budwood from other countries is permissible under quarantine measures.

Quarantine regulations—imposed in the 1930's—prohibited importation of budwood or cuttings from out of state because of the danger of introducing contagious diseases with the incoming material.

Material introduced under current quarantine measures is carefully screened and indexed for various diseases at the U.S.D.A. Plant Industry Station greenhouses at Beltsville, Maryland. Satisfactory material can be released to California where it will again be placed in isolation quarantine greenhouses. The introductions will be budded into various rootstock combinations and into different seedlings to index for miscellaneous virus and other diseases. Material found to be satisfactory will be released from quarantine to governmental agencies for experimental field trials.

The variety orchard provides a wide source of propagating material of miscellaneous varieties and a varied population of genes for breeding studies. Wide use of such trees is made in rootstock tests and in the search for nematode and disease-resistant stocks.

W. P. Bitters is Associate Horticulturist, University of California, Riverside.

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