Citrus germplasm collection is widely used

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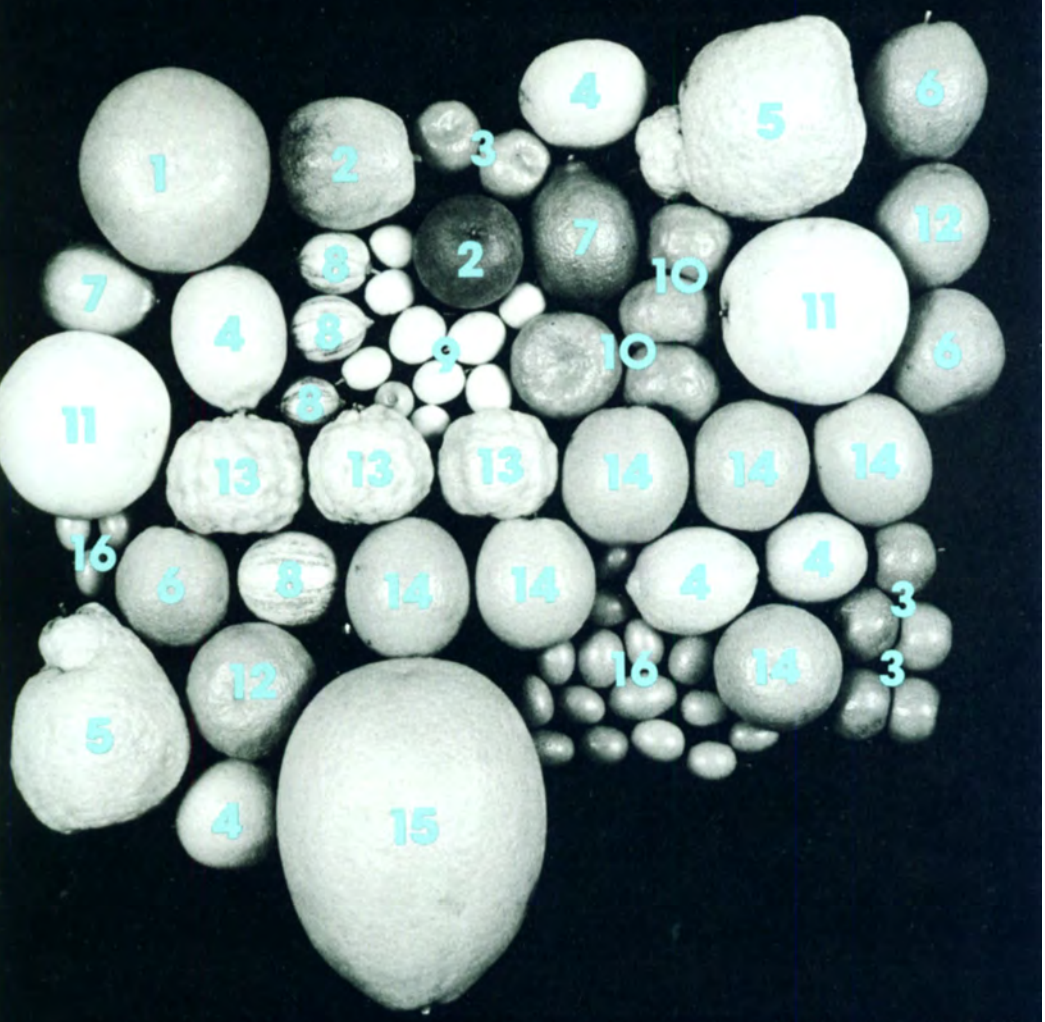

The citrus variety collection at U.C. Riverside is the largest in the world. The color of these fruits is shown in the reproduction of this photograph on the back cover of this issue.

1. Grapefruit
2. Blood orange
3. Unidentified mandarin
4. Lemon
5. Sanbokan
6. Precoce de Valencia
7. Green lemon
8. Variegated lemon
9. Eustis limequat
10. Cleopatra mandarin
11. Grapefruit seedling
12. Doblefina (blood orange)
13. Florida rough lemon
14. Valencia
15. *Citrus grandis* (pummelo)
16. Nagami kumquat

The University of California's citrus variety collection was initiated with the establishment of the Citrus Experiment Station (CES) in 1910, at what is now U C 's Riverside Campus (UCR). The collection, numbering more than 1200 accessions from throughout the world, has been used extensively to solve citrus disease problems, improve varieties, and congregate and preserve valuable germplasm resources.

Identification

Identification of accessions has been a major problem, expecially when materials have been sent to us with incorrect names or vague identification. Careful taxonomic comparisons and some extensive record searches have corrected titles, and only a few identifications still are in doubt or unknown.

The Riverside collection does, however, contain most cultivars of the major citrus species. Twenty-five of the 33 genera in the subfamily Aurantioideae described by W. T. Swingle are represented.

Evaluation

General tree and fruit characters of all accessions are noted. The horticultural characteristics of accessions intended for scion use are evaluated more thoroughly. If the accessions have potential rootstock use, seed production and the amount of nucellar embryony (percentage of asexual seedlings) are determined. When possible, potential rootstock accessions undergo screening tests for virus disease resistance, major soil-borne diseases, pests, and nutritional problems. They may also be included in preliminary rootstock trials for evaluation of their effects on the horticultural characters of scion cultivars, and for bud union incompatibilities. Both scion and root stock accessions with specific valuable characters are utilized in breeding programs and desirable progeny from such breeding are added to the collection. Thus, the collection serves to maintain foreign and domestic accessions as foundations for

breeding, and then preserving products of breeding.

The payoff

The value of these endeavors is illustrated by the varied and widespread uses to which the present collection has been put. With the rapid spread of Tristeza disease (Quick Decline) through California orchards in the 1940s, a large-scale screening program for resistance was initiated. Tristeza-infected sweet orange cultivars decline rapidly if on sour orange rootstocks, and finding a substitute rootstock was essential. Tests in the variety collection identified Troyer citrange (Navel orange x *Poncirus trifoliata* [L.] Raf.) as being tolerant to Tristeza as well as to Phytophthora root rot. (Troyer, produced in 1909 by U.S.D.A. breeders seeking cold tolerance, had been added to the CES collection in 1924.) A very large percentage of the California 200,000 acres of plantings made since the early 1950s has been on Troyer citrange. This rootstock has since proved susceptible to Tristeza under some environmental conditions or with more severe disease strains, so the search for outright resistance continues. Meanwhile, preliminary tests indicate several new *Citrus* x *P. trifoliata* hybrids show considerable tolerance to Tristeza and other diseases.

The UCR collection has been an invaluable source of sensitive, rapid indicator clones for virus diseases that are transmitted in symptomless carriers or that, like Cachexia (Xyloporosis), which leads to poor growth in sensitive cultivars, exhibit debilitating effects in the orchard only after several years, when replacement is extremely costly.

In recent screening tests, the 'Parsons's Special' mandarin, acquired in 1914, was found to be a rapid indicator for Cachexia. It provides a positive index in 6 to 7 months, in contrast to the 5 to 6 years needed previously. Similarly, rapid indicators for several other important virus diseases have been found among the accessions.

In the 1940s pummelos (*Citrus grandis* [L. Osbeck]) were used for breeding because of their large fruit size and because they produce only hybrids. One pummelo, CRC2240, with only a trace of acidity, produced early-maturing hybrids when crossed with medium- or late-maturing cultivars. The hybrid pummelo, 'Chandler,' which matures in December in Riverside, is one example. A new early-maturing grapefruit hybrid is showing promise for commercial use.

Although the pummelos had been used because of their large fruit size and because they produce 100 percent hybrids when used as seed parents (most citrus cultivars produce few or none), the unexpected dividend was the simple inheritance of the low acidity (early maturity) of one of the pummelo accessions. Thus, valuable genetic traits are often unsuspected and not detected until crosses are made for some other purpose.

The UCR collection serves as a reservoir of fruit for biochemical investigations and applications. Blood oranges were recently supplied to a commercial firm for research on anthocyanin as a potential natural coloring agent for manufactured beverages. The collection proved to be the only reliable source of anthocyanin-containing citrus in the United States.

The ornamental value of the collection also has been tapped, with some cultivars propagated for landscape purposes.

A variety of teaching needs for UCR and other UC campuses and institutions are met by the citrus collection. Fruits, flowers, and foliage are used regularly in courses on citrus and chemotaxonomy.

Development of the collection

The collection was begun by station staff and U.S. Department of Agriculture explorers and researchers. A surge of collecting was triggered by the spread of Tristeza in the 1940s. Many additional species and genera have been acquired from professional contacts throughout the citrus areas of the United States and the rest of the world. In recent years the collection has expanded steadily. Accessions were obtained from Japan, the Philippine Islands, and Thailand during the 1960s.

Quarantine regulation against the direct importation of citrus budwood slowed acquisitions for many years. Fortunately, many citrus taxa produce apomictic (nucellar) seedlings, making possible the establishment of clones not otherwise available. However, the juvenile, non-fruiting period of seedlings is long, and mutations often occur. Beginning in 1958, a rigorous quarantine, isolation, and indexing program was developed, which permits budwood introductions. A large percentage of these will contain one or more graft-transmissable diseases. But heat treatment and *in vitro* shoot-tip micrografting have made most budwood accessions of the past 15 years free of known transmissable diseases. The disease status of accessions acquired prior to 1960 is largely unknown and a large scale indexing effort would be required to test them.

Future possibilities

The collection could play an even greater role under plans of a National Plant Germplasm Committee, which is expected in the near future to seek funds from Congress for national plant material repositories for fruits and nuts. Included are two proposed major locations for citrus, one in Florida and one in California. A national repository administered at Riverside in conjunction with the large university collection would significantly strengthen the value and usefulness of citrus germplasm resources within the state and nation.

Such an addition could strengthen opportunities for exploration and acquisition in other citrus areas of the world. Many of these areas have been isolated politically and by difficult terrain, climate, and language barriers. Considerable valuable genetic material may be undiscovered or incorrectly identified.

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