Selecting and breeding new grape varieties

Harold P. Olmo

The first crosses to produce new grape varieties were made in 1931, 2 years after the University began the breeding project. During the past 50 years, over 300,000 vines of known parentage have been grown to the fruiting stage. The first new varieties were introduced in 1946.

The objectives of geneticist E.B. Babcock and viticulturist F.T. Bioletti were to study the nature and causes of seedlessness and to create new seedless varieties. Only one seedless variety of commercial value was obtained from 1,000 seedlings fruited in the first planting, all involving varietal combinations of seeded and seedless. This was Canner Seedless, whose berries release readily from the stems and process better in canning than the standard Thompson Seedless.

After Prohibition was repealed in 1933, interest developed in improving wine varieties. Support for such a project increased rapidly with the first concept of mechanical harvesting in 1952, as a result of which varieties with long-stemmed clusters adapted to the machine method were developed. But in the interim, the machine method changed and the new varieties were never introduced.

To improve the quality of our standard red table wines making up the bulk of the wine industry, we used the variety long judged to give the best quality in California, the Cabernet-Sauvignon. Inbreeding cultivated varieties was not productive. Top-crossing unrelated lines more effectively maintained vigor and fruitfulness; related lines have been combined only to concentrate certain characters, such as complex flavors.

We have selected varieties to improve brandy quality, and during the last decade researchers have been working on earlier maturing raisin varieties that will escape damage from early fall rains.

Obtacles overcome

To prevent contamination from outside wind-borne pollen or pollen from anther fragments, pollen-sterile female vine selections are maintained as breeding material. Several crosses can be made easily, because the vine can be caged or bagged before blossom and the pollen introduced with a syringe.

Storage experiments demonstrated that grape pollen remains viable for several seasons at low humidity and low temperature. Seed germination in many *Vitis vinifera* varieties is very low because of inherent defects in the developing ovule. Since germination was found to be controlled by the maternal parent, crosses are made by using the variety with the highest viability as the mother whenever possible.

Stratification of the seed in a sand-peat moss mix outdoors for about eight weeks during winter aids germination more effectively than the use of controlled temperatures. The seed can be planted directly in the greenhouse bench, and 8- to 10-inch seedlings are transplanted directly in the vineyard with a vegetable transplanter 2 feet apart in the row. Most seedling vines bear the first crop in the third year. The vine receives its permanent number, and the annual plantings are color-coded. Data on vine and fruit characters are noted for two to three years.

Selections are completed when the vines have finished three fruiting cycles. For wine varieties, small-scale winemaking methods to accommodate 5-pound samples were developed.

Outstanding vines from the seedling block at Davis are grafted onto certified rootstock plantings in three or more trial blocks in different climatic zones or viticultural regions of the state. Selections are evaluated at annual grower and wine industry meetings. Varieties of commercial merit are patented, named, and released under University license to commercial nurseries, which produce vines under the certification program.

Confused nomenclature of the grape has plagued investigations from the beginning. In 1890, Hilgard mentioned soliciting fruit of Pinot noir from growers, and "fully eight different varieties came to hand." Most of the time devoted to variety improvement after 1933 had to be diverted to identification. White Zinfandel of the Napa Valley was verified as Chenin blanc and Barbero and Winkler of the Lodi district proved to be Colombard. Because Colombard was already in use for another variety in the Napa Valley, we had to adopt the name French Colombard.

Many less important varieties have yet to be verified by comparison with European counterparts. The development of more objective methods of identifying fruit samples resulted in the comparison of seed characteristics and more recently that of isozyme banding patterns.

Cytogenetics

Ordinary cells of cultivated grape varieties have 38 chromosomes. Since the late 1920s both spontaneous and induced tetraploids (76 chromosomes) have been obtained in most of our standard grape varieties.

The possibility of producing seedless varieties by using triploids (57 chromosomes) with poor fertility of pollen and egg cells was not practical because of irregular berry set and great size variability. However, triploids are extremely vigorous and may prove useful as rootstocks for infertile and difficult soils. Use of vines with more than 76 chromosomes has not been promising because of an imbalance in growth and yield. The production of haploid plants (19 chromosomes) would be a great aid in genetic analysis and breeding but remains elusive.

Researchers became interested in doubling the chromosome number to 76 to produce much larger cells, and hence berries, especially in table grapes. However, deriving the original chromosome sets from the same species often resulted in a poor, fragile growth habit and poorly developed clusters. Using different species, as in crossing an American wild type with the cultivated *vinifera*, gave a much better balanced growth and fruiting when doubling occurred. We bred the first tetraploid of this type crossing tetraploid Campbell Early with tetraploid Niagara to produce the Niabell and Early Niabell.

The native *Muscadinia rotundifolia* or muscadine grape of the humid southeastern United States is highly resistant or immune to most diseases and insects that plague the introduced *vinifera*. Why not introduce these "protective genes" into *vinifera*? Renewing a program started in South Carolina during the Civil War, we

Grape Varieties Introduced by the University of California

Year—table grapes	Year—wine grapes	Year—special-use grapes
1946 Perlette	1948 Ruby Cabernet	1946 Canner Seedless
1946 Delight	1948 Emerald Riesling	1946 Scarlet
1946 Beauty Seedless	1958 Rubired	1958 Niabell
1954 Queen	1958 Calzin	1958 Early Niabell
1958 Early Muscat	1958 Royalty	
1958 July Muscat	1958 Flora	
1958 Gold	1958 Helena	
1968 Emerald Seedless	1973 Carnelian*	
1968 Ruby Seedless	1975 Centurion†	
	1975 Carmine‡	

*U.S. Plant Patent 3625; September 24, 1974.
†U.S. Plant Patent 3870; April 20, 1976.
‡U.S. Plant Patent 3929; June 29, 1976.

crossed *rotundifolia* with *vinifera* pollen, without results. Using the Hunisa and Almeria, male-sterile varieties, with several male *rotundifolia*, we obtained several hundred very vigorous, but completely unfruitful, hybrids.

In these hybrids with 39 chromosomes, 20 from *rotundifolia* and 19 from *vinifera*, it was found that, on the average, only 13 chromosomes of *rotundifolia* paired or were similar to those of *vinifera*; the remaining 13 were without mates. The best explanation seemed to be that the 13 single chromosomes consisted of a set of 6 plus a set of 7 that were derived from other as yet unknown progenitors.

The use of certain *vinifera* parents in the cross broke the deadlock, and a few viable seeds were obtained. It was then possible to continue crossing to *vinifera*. If a hybrid had a preponderance of *rotundifolia* chromosomes, the cross with *vinifera* pollen was ineffective. On the other hand, any combination of *vinifera-rotundifolia*, like *rotundifolia* itself, would succeed on *vinifera*.

Beginning in 1971, after three successive backcrosses to *vinifera* wine grapes, we made wines from several *vinifera-rotundifolia* hybrids. A few were of better than average quality. These and similar selections are being screened for resistance to diseases and insects in cooperation with a number of experiment stations.

Clonal selection

The concept of clonal selection (propagating from superior mother vines) was applied to grapes by Bioletti, who made progeny tests of low- and high-yielding vines of Muscat of Alexandria. His publication of the results in 1926 discredited the idea of improving varieties by selecting from the most productive vines.

Nonetheless, the study of distinct mutations discovered in California varieties reopened the issue. An unfruitful but extremely vigorous sport of Thompson Seedless was unwittingly being increased, because cuttings were gathered for propagation in the winter, and the vigorous vines yielded the most cuttings. Clonal selection became widely practiced in establishing new University plantings for resumption of wine studies.

The first comprehensive clonal experiment was set up in Napa County in 1939 with Cabernet-Sauvignon. Of 40 original mother vines, after 15 consecutive years of yield records and wine analyses, differences were readily apparent. This work was later extended to Gewürztraminer and Riesling.

The most significant results have been obtained with Chardonnay. Clonal selection beginning in 1951 raised yield from an average ½ ton to 6 tons per acre without any loss of wine quality. California acreage of the variety increased from less than 100 acres to over 13,486 acres, and Chardonnay is now one of the most popular premium white varieties.

Clonal selection of the Emperor table grape revealed that the light berry color of White Emperor is of virus origin, transmitted by grafting to the rootstock Couderc 1613, a symptomless carrier.

Practically all the new vineyards established are made up of the most desirable clones. Many growers now do clonal selection in their own vineyards.

Acceptance of new varieties

Growers accepted the first introductions of new grape varieties with some trepidation, but this attitude has changed remarkably in recent years. For example, acceptance of Ruby Cabernet, now a leading variety, took more than 20 years. Newly introduced varieties now reach the 2,000-acre mark in 2 to 3 years.

In 1967 less than 0.1 percent of new wine grape acreage planted for the year were new varieties. By 1969 this increased to 4.1 percent, and in 1975 the new plantings consisted of 32.7 percent University varieties. New varieties in response to the consumer shift to white wines will soon be introduced. Future work in variety improvement must concentrate on developing vines better adapted to mechanical culture, especially harvesting and pruning.

Many table grape varieties have compact clusters that require expensive hand thinning of the berries in the early growth stages. The use of gibberellin to increase berry size accentuates the problem. A self-thinning seedless grape is now being introduced and is the largest seedless variety of commercial promise.

The first new seedless grapes introduced in 1946—Perlette, Delight, and Beauty Seedless—are in great demand as early-season fruit. Perlette has been most successful, gradually replacing Thompson Seedless in the early desert regions. It is the most important variety in northern India and is of increasing importance in Israel. However, its excessively compact cluster is a serious defect. Irradiation has been used to produce a poorer flower set, but the Loose Perlette has not been completely successful. Two additional seedless varieties were introduced in 1968, and others are now being patented. The belief that all table grapes should be seedless is now well on the way to reality.

Disease and insect resistance

Powdery mildew is the most widespread, persistent fungus disease that attacks the grapevine worldwide. Many American hybrids derive some resistance from an original native species, such as the *Vitis labrusca* of northeastern United States and *V. riparia*. Selection for tolerance to the disease was accomplished in the new varieties Rubired and Royalty, used extensively to add color to some red wines and for food coloring.

Some of the first-generation hybrids of *vinifera* x *rotundifolia* are immune to phylloxera and have good grafting affinity with *vinifera* varieties. In a 30-year project to combine phylloxera and nematode resistance in the same stock using hybrid combinations of *Vitis champini*, *V. rupestris*, and *V. riparia*, advanced selections have been made and field trials conducted. Material is also being screened for resistance to *Xiphenema index*, a nematode vector of the fan-leaf virus complex. Screening of grape species and varieties for resistance to the bacteria that cause Pierce's disease began in 1938 on the U.C., Los Angeles, campus, where a leafhopper vector was abundant, and the disease existed in epidemic form. Selection is continuing to combine good fruit quality with resistance in later backcross generations to *vinifera*.

The grapevine is a potential source of synthetic fuel as ethyl alcohol. Some of the newer wine varieties produce 15 tons per acre with a sugar content of 25 percent, and selections could be made for even higher sugar yields.

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