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. Boloatti 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After Prohibition was repealed in 1933, interest developed in improving wine varieties.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.

Obstacles 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...
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 Boletti, 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 produced. Selections 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 *Xiphinema 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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