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Breeding Muscadine and Southern Bunch Grapes

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Abstract

Muscadine and bunch grape breeding has a long history in the southern US. After several attempts at growing non-adapted bunch grapes in several southern locations, breeding programs were begun in the late 1800s and into the 1900s to improve muscadine and bunch grape cultivars. Major advances in these programs include perfect-flowered, large-fruited, high-quality muscadines. Bunch grape cultivar improvements include Pierce's disease resistant bunch grapes, and adapted seedless cultivars for the Upper South. Breeding program reductions in recent years will greatly limit subsequent progress in the development of additional improved muscadine and southern-adapted bunch grapes.

History

The muscadine grape (*Vitis rotundifolia* Michx.) is indigenous to the southeastern United States. Its range extends along the Atlantic coast from southern Virginia to central Florida, then west along the Gulf coast to eastern Texas. The northernmost boundary of the range approximates 35° north latitude. This region corresponds to the area where Pierce's disease (caused by the bacterium *Xyella fastidiosa* Wells et al.) is widespread.

Sir Walter Raleigh is reported to have found an abundance of muscadines upon landing on Roanoke Island in 1584. These grapes in their wild state grow in forests across the south, usually being found along the water courses. Frequently, they climb to the top of tall trees or trail over smaller trees and shrubs. They have been called "bullace," "bullis," "bullet", muscadine, and other less common names. The quality of the wild grapes varies greatly due to their high acid content and low soluble solids. The skin is usually thick and tough. Bunches may vary from a single berry up to 20 or more berries per cluster.

The oldest and most famous muscadine cultivar is 'Scuppernong.' It was the first native grape to be brought into cultivation. Some confusion exists concerning the exact origin of 'Scuppernong,' but it is generally believed to have been discovered growing wild in Tyrrell County, N.C. Credit for naming the 'Scuppernong' is given to Dr. Calvin Jones, editor of a Raleigh, N.C. newspaper in 1810, The 'Scuppernong' differs from most wild muscadines by having light colored fruit. In fact, light fruit color has been so identified with the 'Scuppernong' that all light colored muscadines are sometimes erroneously called "Scuppernongs."

Early attempts at establishing a southern wine industry by introducing some of the famous European grapes (*V. vinifera* L.) failed. These cultivars were destroyed by the grape phylloxera (*Dactylosphaira vitifolii* Shimer) which is native to North America. Although experimentation with imported cultivars continued, none of the foreign grapes proved successful in the eastern part of the United States and hopes for a wine industry were unrealized.

The need to diversify agriculture in the cotton belt prior to the Civil War led to renewed interest in the development of commercial vineyards and wine-making in the southeast. As early as 1809 extensive plantings were made in the south using native muscadine grapes and their natural hybrids. Some vineyards were as large as several hundred acres each by the 1850s. The fruit was processed into wine and shipped to the more highly populated areas of the Northeast. The post-war conditions in the South and the establishment of the California wine industry resulted in a decline in this activity which ended during the prohibition era of the 1920s.

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The *Muscadinia* subgenus of *Vitis* includes two species, *V. munsoniana* Simp., and *V. rotundifolia. V. munsoniana,* or "mustang" grape, is found in the southernmost part of the native muscadine region. In the late 1800s, Mr. Thomas V. Munson of Dennison, Tex. did extensive work in crossing *V. rotundifolia* and *V. munsoniana.* Among the cultivars released from these hybrids were 'LaSalle,' 'San Jacinto,' 'San Monta,' 'Labama,' and 'San Melaska.' The 'Yuga' cultivar released by the Georgia Experiment Station in 1934 resulted from a cross between 'San Monta' and 'White Male,' a wild, non-bearing, *V. rotundifolia* selection. A cross between 'Yuga' and 'White Male' resulted in the 'Higgins' cultivar released in 1955. 'Higgins' is apparently the source of large fruit size, in current muscadine cultivars. Thus, the early hybridization' of Munson has contributed significantly to the development of muscadine grape cultivars.

The Georgia Experiment Station was established in 1889 and Bulletin 28 on Grape Culture was issued in 1895. A subsequent bulletin in 1901 reported on an experimental vineyard originally planted in 1894 which included over 300 cultivars, excluding the native species. An extensive muscadine breeding program has been conducted at the Georgia Experiment Station since 1909 and has resulted in more than 30 cultivars. There was a proliferation of cultivars developed in the late 1920s and early 1930s. Of those produced during this period, 'Creek' and 'Hunt' are the only two still propagated. Other important cultivars from Georgia include 'Higgins' and 'Cowart' released by Mr. B. O. Fry. Contributions to the study of muscadines were made by Dr. H. P. Stuckey, Mr. M. M. Murphy, Jr., Dr. F. F. Cowart, and Mr. Fry. Through their efforts, the quality of the muscadine fruit was improved and the berry size was greatly increased.

North Carolina also has a long history of grape research dating back to 1908 with the work of Mr. F. C. Reimer and Mr. L. R. Detjen. One of their most significant contributions was the self-fertile muscadine. Functionally hermaphroditic muscadine grape flowers were first reported by them in 1910. This new flower type was of interest to breeders because it eliminated the need for non-fruitful pollinizers. At Detjen's departure, breeding work was continued by Dr. C. T. Dearing who named and released many of the first perfect-flowered cultivars. Dearing overlapped with the next breeder, Prof. Carlos Williams. Both Dearing and Williams placed emphasis on increased productivity and perfect flowers. None of Dearing's cultivars are of current importance, however, 'Magnolia' released by Williams remains quite important as a wine cultivar. All the previous North Carolina breeders had joint appointments with the USDA. After the death of Williams in 1961, the USDA withdrew funding for its portion of the grape work in North Carolina. In 1966, North Carolina State University resumed the breeding program under the guidance of Dr. W. B. Nesbitt. Besides 'Magnolia,' other important cultivars released from North Carolina include: 'Topsail,' and 'Tarheel.'

The first attempt at growing grapes in Florida was made over 300 years ago by the early Spanish, French, and English settlers intending to develop a wine industry. They brought with them many European cultivars; however, diseases and insects attacked these grapes and this early venture was soon discouraged. In the late 1800s another attempt was made to grow grapes using *V. labrusca* L. or American bunch grapes. This effort also failed due to climatic conditions and diseases. This second failure of the grape plantings led the USDA to make its first investigations on growing grapes in Florida. In 1899 an experimental vineyard was established on a private estate near Gainesville, Fla. where European, native bunch (several wild *Vitis* species), and muscadine grapes were tested. Meanwhile, Munson had been using native grapes in obtaining new cultivars adapted

to the environment of Texas. Munson's success stimulated private viticulturists in Florida to begin breeding with native Florida species. In 1927, Dr. Charles Demko began hybridizing American cultivars with Florida native grapes. He developed three cultivars: 'Dunstan,' 'Taylor,' and 'Florida Concord,' but none persisted. In 1945 at the University of Florida Watermelon Investigations Laboratory at Leesburg, Fla., L. H. Stover crossed the native 'Pixiola' (*V. simpsoni* Munson) with 'Golden Muscat' which gave rise to 'Lake Emerald.' Subsequent breeding by Stover led to the release of three other bunch grapes: 'Blue Lake,' 'Norris,' and 'Stover.' All four cultivars were resistant to Pierce's disease.

Still other muscadine breeding was done at the United States Horticultural Field Station, Meridian, Miss. Mr. N. H. Loomis worked there from 1941 until the Station was closed in 1965. His primary objective was the improvement of fruit quality in muscadines. Cultivars released from there include 'Magoon,' 'Southland,' 'Chief,' and 'Bountiful.' The cross that eventually resulted in the 'Loomis' cultivar was also made at that station.

Hybrids between bunch grapes and muscadines have been of interest for over 100 years with the primary objective being to combine fruit quality or bunch grapes with disease resistance of muscadines. Hybridization has been difficult because the species have different chromosome numbers and the seedlings are mostly sterile. Dr. Robert T. Dunstan, a private breeder from Greensboro, N.C., and later Alachua, ,Fla., did considerable work with hybridization of *Euvitis* x *V. rotundifolia.* His DRX-55, an ovule-fertile, pollen-sterile backcross of *Euvitis* x *V. rotundifolia,* became a bridge between the species thus more readily allowing interspecific crosses. He developed the 'Aurelia,' and 'Carolina Black Rose' cultivars of bunch grape using muscadine in their parentage

With the decade of the 1960s, a new generation of grape breeders began working in the southeastern United States. Dr. James Moore initiated a grape breeding program emphasizing bunch grapes at the University of Arkansas. Some of the grape material that he used early in his breeding program included Dunstan's *Euvitis* x *V. rotundifolia* hybrids. Dr. John Mortensen succeeded Stover in Florida and continued to breed for vigorous, long-lived vines with resistance to diseases (especially Pierces's disease), uniformly ripening berries, and productivity. As previously mentioned, Nesbitt was hired to fill a new grape position at North Carolina State University. He resumed the muscadine breeding program and increased the breeding effort in bunch grapes. He gathered a large amount of material for evaluation and began to make crosses with the better adapted clones. Upon Fry's retirement, I assumed responsibility for the grape breeding program at the Georgia Experiment Station. Emphasis was placed on the improvement of fruit quality in muscadines and increased shelf life through selection for dry stem scars and better disease resistance. The interspecific hybrid breeding was continued and expanded to include more species. Meanwhile, Fry joined Ison's Vineyard at Brooks, Ga. and started a private breeding program in muscadines.

The next two decades brought a progression of grape cultivars from the southeast. Arkansas released several bunch grape cultivars, including 'Venus,' 'Reliance,' 'Mars,' 'Saturn,' and 'Sunbelt,' which were all *Euvitis* hybrids derived from *V. labrusca* and *V. vinifera.* Florida released 'Liberty' bunch grape, 'Welder' muscadine and jointly released 'Dixie' muscadine with North Carolina. North Carolina released 'Carlos,' 'Sterling,' 'Noble' and 'Regale' muscadine cultivars. Following Nesbitt's death in 1983, 'Nesbitt' muscadine was released by Dr. Ron Goldy who followed Nesbitt at North Carolina State. Georgia released 'Fry,' 'Jumbo,' 'Pride,' 'Summit,' and 'Triumph' muscadine cultivars. Fry de-

veloped numerous muscadine cultivars, some of which were patented,, and these were released through Ison's Vineyard.

In the early 1980s, there was a resurgence of interest in grape production in Florida and the State Legislature appropriated funds to establish new grape research programs at Florida A & M University, Tallahassee and the University of Florida. A breeding program was initiated at Florida A & M and a biotechnology laboratory was established at the Watermelon and Grape Investigations Laboratory.

Current Situation

Grape breeding programs are a long-term commitment and fiscal constraints have resulted in breeding programs being curtailed at some southern universities. With the departure of Goldy at North Carolina State, the grape breeding program was discontinued. However, Mr. Jeff Bloodworth, a former graduate student of Nesbitt, has established a private program utilizing some of Nesbitt's breeding material. He is funded in part by the North Carolina Department of Agriculture and continues an active breeding program. Similarly, Florida's breeding program was deactivated when Mortensen retired. The University of Florida continues to evaluate some of the breeding lines and have released 'Alachua,' 'Southern Home,' and 'Florida Fry' cultivars of muscadines. Dr. Dennis Gray leads the biotechnology research at the Central Florida Research and Education Center (formerly the Watermelon and Grape Investigations Laboratory) and Dr. Jiang Lu continues the grape breeding program at Florida A & M. With my impending retirement at Georgia and the hiring freeze now in place, the future of the grape breeding program there is uncertain. Also, the death of Mr. Bill Ison of Ison's Vineyard has placed their breeding effort in jeopardy. The breeding program which Dr. Booker T. Whatley led at Tuskegee Institute for a number of years has been discontinued.

There are some bright spots in the southeast concerning grape breeding. The University of Arkansas has assured the continuation of their program with the assignment of Dr. John Clark to follow Jim-Moore. This effort will continue to emphasize seedless table grapes adapted to the Upper South. Louisiana State University initiated a grape program a number of years ago at Hammond, La. Many cultivars have been evaluated for adaptation to southern climates and the program continues under the direction of Dr. Roy Constantin. The USDA has established a grape research program at the USDA-ARS Small Fruits Laboratory at Poplarville, Miss. with Dr. C. L. Gupton in charge of grape breeding and germplasm evaluation.

Future Outlook

The future expansion of the grape industry in the southeast depends on the development of new cultivars that are resistant to Pierce's disease and adapted to our climatic conditions. There is a great diversity of genetic material in *Vitis* and further progress can be expected. An immediate need is the development of seedless muscadines. There is one seedless muscadine cultivar ('Fry Seedless') but it is parthenocarpic and not useful for breeding purposes. Current breeding in Georgia and Florida has the objective of transferring seedlessness into *V. rotundifolia* by conventional methods. Transfer of genes for seedlessness from other grape species is being attempted using interspecific hybrids as a bridge. Another possibility is the direct transfer of seedless genes using biotechnology.

A primary limitation for expansion of the muscadine industry is not a breeding problem at all. It is a marketing problem. Developing major markets outside the southeast is imperative. This may take an educational program that is regional in scope. It should include fresh fruit marketing and developing markets for processed muscadine grape products such as jams, jellies, preserves, and juice. Other

opportunities exist in expanding the market for muscadine wine.

Bunch grape breeding in Arkansas should continue to yield new seedless table grape cultivars adapted to the Upper South. These new cultivars will be valuable to the areas of the region in which Pierce's disease does not occcur.

Biotechnology promises new dimensions to compliment conventional breeding programs and further improvement of muscadine and bunch grapes appears on the horizon.

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Blackberries and Raspberries in the Southern United States: Yesterday, Today, and Tomorrow

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Abstract

Blackberries have long been a popular fruit in southern U.S., and they are widely grown there, with excellent potential for expanded production. Raspberries are also well-liked, but not widely grown, due to lack of adapted cultivars. Great progress has been made, particularly in the past four decades, in improving blackberry cultivars for the South, but little effort has been given to raspberry improvement. Germplasm exists within *Rubus* to provide great advances in conventional cultivar improvement in both subgenera and for creating new types of fruits through interspecific hybridization. Germplasm and breeding strategies will be discussed that would result in new cultivars to serve as the foundation on which to build much expanded blackberry and raspberry industries in southern United States.

Blackberries (including dewberries) have long been a favorite fruit in the southern United States. Generations of southerners have harvested fruits from the abundance of wild plants found growing along fencerows and in fields in the South. Even today, it is common to see cars parked along roadsides with people harvesting blackberries nearby.

The love for raspberries among native southerners did not develop as rapidly as it did for blackberries, due to lack of familiarity since native stands of raspberry did not exist. However, raspberries were commonly grown in southern gardens in the 19th century, and the in-migration of northerners into the South in the second half of the 20th century has stimulated a great interest in commercial culture of red raspberries in southern growing areas.

Blackberries and raspberries are classified taxonomically in the genus *Rubus* (Tourn.) L. Blackberries are in the subgenus *Rubus* (formerly *Eubatus*) (1) while raspberries are placed in the subgenus *Idaeobatus*. Both subgenera are very diverse and taxonomically very complex, containing hundreds of species. It has been estimated that the genus *Rubus* contains as many as 740 separate species (7). This tremendous diversity makes classification difficult but provides great genetic variability for use, in improving cultivars through breeding. Several excellent reviews have been published on the breeding and development of blackberries and raspberries, including the use of *Rubus* species in cultivar improvement (7, 10, 14, 15, 26).

Yesterday

Blackberries

Interest in the cultivation of blackberries was slow to develop in the U.S., probably due to the ready availability of wild fruits and to the aggressiveness and thorny nature of the plants (23). However, in the 19th century, blackberry enthusiasts

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