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Blueberry Breeding for the Southern United States

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Abstract

The USDA blueberry breeding program was initiated in 1910 by Dr. F. V. Coville and has been continuous since that time. Plant breeders Drs. G. M. Darrow, D. H. Scott, J. N. Moore and I have worked with state agricultural experiment stations (SAES) and private growers to develop the majority of cultivars presently grown for commercial production. In the South, major cooperators with the USDA include SAES in Arkansas, North Carolina, Georgia, and Texas. Recently the USDA Small Fruits Station at Poplarville, Miss. has been instrumental in blueberry cultivar development for the South. Rabbiteye (*Vaccinium ashei* Reade) blueberry cultivars make up the majority of blueberry acreage grown in the South. A new type of blueberry, the southern highbush (SHB), has been developed by intraspecific hybridization with various *Vaccinium* species. Late-blooming SHB cultivars have been developed that offer better protection from spring frosts and ripen earlier than the earliest rabbiteye blueberry. Genes required to meet future needs reside within native *Vaccinium* species. Progress has been made in plant adaptation, disease resistance, fruit quality, and season of ripening. There remains a need for greater plant vigor, insect resistance and consistent production.

The USDA blueberry breeding program has been a cooperative effort from its inception; started by Dr. Frederick V. Coville (USDA Division of Plant Exploration and Introduction, Washington, D.C.), who made crosses among native plants selected from the wild because of superior fruit size. Seedlings from these crosses were grown by Miss Elizabeth C. White of New Lisbon, N.J. Upon retirement, Dr. Coville was replaced by Dr. George M. Darrow, who greatly extended the cooperative nature of the blueberry breeding program. Dr. Donald H. Scott assumed the blueberry breeding program when Dr. Darrow retired. In 1961, Dr. James N. Moore was hired by USDA-ARS at Beltsville, Md., to take over the blueberry breeding duties. Dr. Moore stayed until the end of 1963 then returned to the University of Arkansas to become a successful fruit breeder.

I took over the USDA-ARS blueberry breeding at Beltsville in 1964 and continued this work until retirement in 1988. In the early years of the USDA blueberry program, private growers in several northern states were selected to grow seedlings produced by USDA, for example, Mr. Arthur Elliott in Michigan, Mr. Sayre Rose in Connecticut, Mr. Herbert Alexander in Massachusetts, Mr. William Darrow in Vermont, and the Galletta Brothers, Atlantic Blueberry Company, Hammonton, New Jersey. Selections were evaluated by USDA breeders and the propagation rights of released cultivars were retained by the grower. One example of the success of these cooperative programs came from Mr. Elliott's farm with the release of 'Spartan' and 'Elliott.' 'Elliott' remains one the most widely planted cultivars, due chiefly to its extremely late-ripening fruit. From that productive joint USDA-private growers partnership came many of the well-known highbush blueberry (*V. corymbosum* L.) cvs, Earliblue, Collins, Bluetta, Blueray, Bluecrop, Darrow, and later Duke, Toro, Nelson, Bluegold, and Sierra.

In the South, the USDA-ARS has cooperated with scientists from state land-grant universities in the blueberry breeding program. Dr. Darrow established cooperative blueberry breeding with Mr. Emmett Morrow, North Carolina State University and rabbiteye blueberry breeding with Mr. Otis Woodard of the University of Georgia Coastal Plain Experiment Station at Tifton in 1940. Dr. Tom Brightwell was hired as the blueberry breeder shortly thereafter and many good cultivars came from the joint USDA-University of Georgia efforts. Two cvs., Woodard

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and Tifblue, put the rabbiteye blueberry industry on a solid footing and these cultivars remained the backbone of the industry for many years. 'Climax' was the final release prior to Dr. Brightwell's retirement. Later, 'Brightwell' was named in recognition of his great contribution to rabbiteye blueberry breeding. The cvs. Climax, Tifblue, and Brightwell along with the 'Premier' and 'Powderblue' are currently recommended for commercial production. The latter two cultivars were released from the USDA-North Carolina State University program under the direction of Dr. Gene Galletta who replaced Mr. Morrow. The principal breeding aim at North Carolina was early ripening highbush blueberries with resistance to cane canker, caused by *Botryospheria corticis* (Demaree & Wilcox) Arx & Muller, a very prevalent and devastating disease. Dr. Galletta transferred to USDA, Beltsville, in 1977 and was replaced by Dr. James Ballington. Dr. Ballington has collected many native populations of *Vaccinium,* and has used this valuable germplasm for breeding purposes. He has also released several fine blueberry cultivars.

I transferred in April 1965, from the USDA-ARS Tung Laboratory, Bogalusa, La. to the USDA-ARS Small Fruits Investigations Laboratory at Beltsville, headed by Dr. Scott. A vacancy in blueberry breeding had been created by Dr. Moore's decision to return to his home state. Dr. Scott, a premier fruit breeder, introduced me to the blueberry, and trained me in fruit breeding for 10 years until he retired. Dr. Moore's decision to return to Arkansas proved to be a fine career choice for both of us. At that time Florida had the only SHB breeding work, headed by Mr. Ralph Sharpe, but no cultivars had yet been released. In the late 1800s Florida had a rabbiteye blueberry industry based on plants selected from the wild and transplanted for establishment of commercial plantings. The fruit, usually small and dark, was shipped by train to northern markets. This enterprise failed when the fruit could not compete in the markets with fruit from improved highbush blueberry cultivars which ripened at the same time. The goal of the Florida breeding program was to originate low-chill highbush cultivars so growers could produce fruit earlier than other production areas.

There remained in my mind the great potential of having highbush blueberries adapted to Gulf Coast region because few small fruits other than strawberries were grown commercially in that area. Dr. Scott encouraged me in this idea and I started developing the necessary germplasm. I obtained some improved low-chill highbush selections from Mr. Sharpe and also started sifting through several *Vaccinium* species native to the southern US. From these species, our primary goal was to obtain an adapted tetraploid plant that was low-chilling, disease resistant, heat tolerant, and with improved soil adaptation. It later became obvious that late blooming was required in order to escape late spring frosts common in this region.

Blueberry crosses were made and seed germinated at Beltsville, but a location in the Gulf Coast region was needed for growing the hybrid seedlings. We approached Dr. James M. Spiers, head of the USDA-ARS Research Station at Poplarville, Miss. about a cooperative blueberry program. After some deliberation he agreed to switch from forage work to a blueberry research ventured. He is now acknowledged for his experience and understanding of blueberry culture and continues to play an important part in the blueberry breeding program. The first blueberry seedlings arrived in Poplarville in 1971, beginning a productive research endeavor that has been a source of mutual satisfaction. Dr. Creighton Gupton came to Poplarville in 1980 and has made important contributions. He conceived the idea of the Southern Regional Testing Program, which has been very valuable.

Cooperative blueberry breeding was subsequently established at Overton, Tex. with Dr. John Lipe. Dr. Lipe transferred to another location in Texas and was replaced by Dr. Don Cawthon who left after

a brief stay and Dr. Kim Patten filled the vacancy. After working several years in Texas, Dr. Patten went to the Pacific Northwest to work on cranberries, and Dr. Jeff Baker now has responsibility for blueberry selection testing. Much of the credit for holding the program in Texas together during all the interim periods goes to Mrs. Elizabeth Neuendorff, taken early in life by cancer. Liz was a devoted fan of the blueberry.

In the late 1970s Dr. James Moore at the University of Arkansas had a graduate student, John Clark, who needed *Vaccinium* germplasm for a Ph.D. dissertation. He wanted to breed blueberries resistant to Phytophthora root rot which was becoming a serious problem in Arkansas. That began the work to develop cultivars for the mid South with improved adaptation and consistent annual production. From this work sprang 'Ozarkblue.' Now that Dr. Moore is retired, Dr. Clark will carry on the blueberry breeding duties.

To obtain the needed adaptive characters in a southern blueberry, we looked to native southern species *V. darrowi* Camp, *V. myrsinites* Lam., *V. elliottii* Chapman, *V. constablaei* Gray, and *V. ashei.* Though these species range from diploid to hexaploid chromosome numbers, our objective was to end with tetraploid hybrids that could be crossed with *V. corymbosum* to take advantage of its 50-year improvement in fruit quality. To obtain tetraploid germplasm we used the following procedure: chromosome doubling of diploid with colchicine, crossing diploids x tetraploids looking. for unreduced gamete production in the diploid, and making diploid x hexaploid crosses hoping for tetraploid seedlings.

The most successful technique proved to be crossing of diploid x tetraploid genotypes. A Florida selection of *V. darrowii,* Fla. 4b, crossed with 'Bluecrop,' produced tetraploid hybrids that in one backcross generation provided selections with commercial qualities for the southern areas. From one of the F_1 hybrids, US75, sprang the cvs. Gulfcoast, Cooper, Georgiagem, Cape Fear, and Blue Ridge.

Several unexpected developments occurred in the crosses of species of differing ploidy levels. One result of these crosses was that diploid seedlings were produced in diploid x tetraploid crosses. Another finding was that in diploid x hexaploid crosses, occasional diploid but mostly pentaploid seedlings resulted. Also, in hexaploid x diploid crosses, offspring were pentaploids due to unreduced gametes in the diploid.

The *V. myrsinites* hybrid seedling populations did not segregate for plant height. They were productive and well adapted to southern environments, but were too short in stature to be easily machine harvested. We learned that a species difficult to cross with *V. corymbosum,* such as *V. elliottii,* could be crossed with *V. darrowi* Fla. 4b, and the F_1 hybrids could then be crossed to. *V. corymbosum. V. constablaei* has contributed earlier ripening without causing earlier flowering to the *V. ashei* germplasm and that should soon be seen in commercial cultivars.

From interspecific hybridization there came an unexpected increase in fruit quality (scar, firmness, good flavor retention), along with wider soil and climatic adaptation and increased productivity. We should try harder to incorporate *V. ashei* germplasm into future SHB cutivars because of its plant vigor. Many of the progenies of this cross were sterile, but a few crosses produced fully fertile hybrids. These were usually vigorous plants, with good fruit and small scars, but had somewhat dark fruit. One of these F1 selections, MS149, selected at the Poplarville Station has recently been released as "Pearl River.'

The other cvs. recently released from the Poplarville Station, 'Magnolia' and 'Jubilee,' are superior to 'Gulfcoast' and 'Cooper' in fruit quality and consistent yearly production. As spring frosts became more frequent it became apparent that late flowering and early ripening, a difficult combination to obtain, were needed. We now have breeding selections that have good fruit quality and are con-

sistently productive due mainly to later flowering.

Most SHB cultivars and selections could use more plant vigor. Disease resistance is good, but insect resistance is needed, for especially blueberry gall midge (*Dasineura oxycoccana* Johnson) and cranberry fruit worm (*Acrobasis vaccinii* Riley). Marketing windows dictate some of the breeding goals. Since SHB fruit is grown for the early markets, early ripening coupled with late flowering are needed plant characteristics. In other words, a short interval between rather late flowering and fruit ripening would facilitate early ripening and reduce the risks of late spring frosts. Those areas with very low chilling, such as central Florida, need cultivars adapted to that environment. We currently do not have a simple, short test to determine chilling requirements of the blueberry selections. Such a test would facilitate the breeding for low-chilling types.

I believe that all the genes needed to obtain the blueberry cultivars for the differing environments within the southern US are existent. They are in the vast treasure of native *Vaccinium* species and cultivated germplasm. It is up to the breeder to learn what is needed by growers, the markets, and consumers and then systematically search for it.

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Small Fruit Breeding for the Southern United States: Strawberries

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Abstract

This review briefly summarizes the development of the strawberry (*Fragaria x ananassa* Duchesne) industries of the southern United States during the twentieth century, their problems, major cultivars, and breeding programs. The breeding objectives, contributions, and personnel of the several state and federal improvement programs are presented in more detail. Some ideas are offered about the future of the southern strawberry industries, and how the objectives of the fewer remaining breeding programs may have to be altered to accommodate the new and continuing problems of the growing and consuming public.

Historical

While all of the southern United States did and do produce strawberries, major commercial centers during the first half of the twentieth century were Louisiana, Florida, Tennessee, Missouri, Arkansas, Alabama, Kentucky, and Virginia. Maryland, Delaware, Texas, and Mississippi had smaller industries (2). 'Klondike,' Missionary,' 'Aroma,' 'Chesapeake,' 'Parsons,' 'Joe,' and 'Gandy' were the principal southern cultivars of 1900 to 1940, with 'Blakemore' and 'Tennessee Beauty' becoming important in the 1930s and 1940s (1). 'Klonmore' and 'Massey' began to be grown in the 1940s; 'Florida Ninety,' 'Albritton,' 'Armore,' 'Pocahontas,' and 'Dixieland' in the 1950s. 'Blakemore' and 'Tennessee Beauty' continued to be important cultivars into the 1970s. By the 1960s 'Headliner' and 'Dabreak' were commonly grown in Louisiana.

Traditionally, almost all of the strawberries grown in the South have been intended for the fresh fruit shipping trade. The later season crops might be offered to local markets and limited processing outlets in some years. Strawberry culture in the early season and some second early crop districts of the South was annual cul-

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