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Low-chill Highbush Blueberries

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The low-chill highbush blueberry cultivars (Table 1) have been developed using highbush selections from New Jersey and Michigan along with sources of low-latitude adaptation from Florida, Georgia, and North Carolina, most important of which are *Vaccinium darrowi* (diploid), *V. ashei* (hexaploid), and southern forms of *V. corymbosum* (tetraploid). So far, all the cultivars have been tetraploid.

Experience in North Carolina and Arkansas indicates that the southern limits of adaptation of traditional northern highbush cultivars comes close to or overlaps the northern limit of adaptation of the rabbiteye blueberry. Thus, the reason for developing and growing southern highbush cultivars is not so much to expand the geographical limits of blueberry production as it is to exploit the advantages of the highbush blueberry. The most important advantage is a short bloom-to-ripening interval, which results in early fruit ripening. In north Florida, for example, the earliest-ripening southern highbush cultivars ('Sharpblue' and 'Flordablue') normally ripen about 4 weeks before the earliest rabbiteye cultivars ('Climax' and 'Beckyblue'). The same interval exists between early-ripening northern highbush cultivars and early rabbiteyes in eastern North Carolina.

In the fresh produce business, season of harvest is often the paramount factor that determines whether or not a particular crop is profitable in a particular area. Starting in the mid 1920's, blueberry growers from New Jersey made trial plantings of New Jersey highbush cultivars in coastal North Carolina in an effort to extend the blueberry harvest season (6). By the mid 1930's it became obvious that highbush blueberries could be grown and fruited reliably in southeastern North Carolina and that ripening was about four weeks earlier than in New Jersey (6). Additional plantings were quickly established, and by 1965 there were 4000 acres of northern highbush blueberries under cultivation in southeastern North Carolina (4). The normal start of the harvest season for this acreage is around May 15, with most of the production coming between June 1 and 20. Highbush acreage that was later planted in northwest Arkansas normally starts ripening about a week later than the North Carolina acreage. Early-ripening rabbiteye cultivars normally begin to ripen about May 20 in north Florida and June 1 in south Georgia, but the combination of small acreages and a series of years with severe spring freezes has limited production.

Early attempts to grow highbush blueberries south of North Carolina met with little success due to problems with chilling requirement (3). Coville (2) had discovered before 1916 that the northern highbush blueberry would not break bud normally in the spring if kept in a heated greenhouse throughout the winter. Darrow (3) reported in 1942 that tests in Florida with the highbush blueberry had consistently resulted in failure of the plants to grow. In a controlled chilling test,

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Darrow (3) found that the 13 highbush cultivars tested required 800 to 1060 hours below 45°F (7°C) for good growth, whereas the one rabbiteye cultivar tested ('Pecan') required only 250 hours. Darrow (3) suggested that it should be possible to obtain hybrids fully adapted to the short cold period in Florida since other species of blueberry that cross with the highbush are native in north Florida.

The first improved low-chill highbush cultivars were developed in Florida by Sharpe and Sherman (8, 9, 10). This breeding program began in 1948 with a survey of native blueberries in the state that had lower chilling requirements than *V. ashei* (7). The lowbush diploid evergreen species, *V. darrowi,* from the central Florida peninsula was selected as the most useful species for breeding. *V. darrowi* was crossed with both rabbiteye and northern highbush selections, and the resulting hybrids formed the foundation population from which the Florida highbush cultivars were developed. The primary purpose of this breeding program initially was not to develop earlier-ripening blueberries, but to obtain cultivars that could be grown farther south in Florida than the rabbiteye (7).

In addition to the Florida program, other low-chill highbush breeding programs have been conducted in conjunction with the USDA in North Carolina, Georgia, and Mississippi. The first cultivars from these programs were released in 1986 and 1987.

Current Status of the Low-chill Highbush Industry

The low-chill highbush blueberry industry is still in its infancy in most areas, although Florida has over 300 acres as of 1989 and about 500 acres of 'Sharpblue' have been planted on the central east coast of Australia. Georgia has about 40 acres of low-chill highbush as of 1989, and acreage of 'Georgiagem' (1) appears ready to increase fairly rapidly as nursery supplies increase and Georgia rabbiteye growers plant 'Georgiagem' to obtain early fruit. Florida, Georgia, South Carolina, Alabama, Mississippi, Louisiana, and Texas appear to be the states most likely to benefit from the low-chill cultivars.

Market Window

The primary reason for cultivating low-chill highbush blueberries in the southeastern United States is to extend the season of availability of fresh blueberries into April and the first half of May. It seems unlikely that prices for processed fruit will be high enough to support the establishment of low-chill highbush plantings in the southeastern United States. Until growers have gained experience and until well-adapted, high-yielding cultivars are available, production costs per pound will probably be higher for low-chill highbush blueberries grown in the southeast than for highbush blueberries produced in Michigan, New Jersey, and the Pacific northwest and for late-ripening rabbiteyes from the southeast. The higher market price for fresh berries during the period of low availability early in the season is the primary hope for making low-chill highbush cultivation economically feasible, at least during the costly start-up years.

Blueberries are increasingly being planted in the southern hemisphere, particularly in New Zealand, Australia and Chile. High labor costs and extremely long air-freight distances guarantee that fresh blueberries exported to North America from New Zealand and Australia will sell at very high prices. Because of low labor costs and shorter transport distances, blueberries from Chile could probably be sold at much lower prices in North America if the crop is found to be highly productive in Chile. The primary marketing season for southern hemisphere blueberries is November through early

March. At least for the next decade, the April and May blueberry markets in North America are not likely to be greatly influenced by southern hemisphere production.

Fresh blueberry prices fall rapidly after June 1 due to heavy production from North Carolina and Arkansas highbush and from rabbiteyes from Georgia, Florida, and the lower Gulf coast. The best market for fresh blueberries, therefore, is before June 1 and preferably before May 20.

For several reasons, it is not easy to predict from the scant data available when commercial plantations of low-chill highbush would be likely to ripen in various sections of the country. There is much variation from year to year, from cultivar to cultivar, and from farm to farm. Furthermore, the first few berries may ripen a week or more before a sufficient number are ripe to warrant commercial harvest. Because of these factors the following estimates are generalized and preliminary. They are presented only to facilitate speculations presented later in this paper as to the future of the low-chill highbush industry.

Assume as a reference point that early cultivars of northern highbush normally start to be harvested in large volumes at the southern limit of their range around Wilmington, North Carolina on about May 20. The line along which low-chill highbush cultivars could be commercially harvested on May 10 would probably start at about Charleston, South Carolina and swing southwest to about latitude 32°N which it would follow westward to east Texas. The May 1 first-harvest line might begin at about Jacksonville, Florida, and follow close to latitude 30°N, west to Houston, Texas. An April 20 line might run through the Florida peninsula at about latitude 29°. Sufficient heat units appear to be available to ripen highbush blueberries by April 1 at latitude 27°N, which is the southern limit of where they have been tested in Florida.

A factor that will affect future market windows for low-chill highbush blueberries is the production of early-ripening rabbiteyes. Although early-ripening rabbiteye cultivars tend to be less productive and more subject to spring freeze damage than mid-season to late rabbiteyes, they appear to have the potential to produce berries at lower cost per pound than low-chill highbush, at least in north Florida after May 20. It seems likely that within 10 years rabbiteye or rabbiteye x *V. constablaei* cultivars will be available that ripen 10 days earlier than 'Climax,' 'Premier,' and 'Beckyblue,' currently the earliest cultivars. Such cultivars, if successful, could eventually be grown along the lower Gulf and Atlantic coasts in competition with highbush that ripen after May 10.

The considerations presented above suggest that market forces are favorable at present for the development of the low-chill highbush blueberry industry in the southeastern U.S. In the long term, however, maintenance of a large industry for berries that ripen after May 1 will require relatively low-cost production.

Cultural and Climatic Problems with Highbush Blueberries in Florida

The highbush cultivars 'Sharpblue,' 'Flordablue,' and 'Avonblue' were released in 1976 and 1977, but were not widely planted until after 1983. Of the 300 acres now planted in Florida 'Sharpblue' makes up 250 acres. All the acreage is irrigated, most with solid-set overhead irrigation that can be used for frost protection. Most of the initial acreage was in north Florida from Ocala north through the panhandle, but most new acreage is going in farther south in the peninsula, where growers hope to take advantage of better soils, lower spring frost risk, and potentially earlier harvest seasons.

Several serious problems have hampered production of highbush blueberries in Florida over the past decade. It is estimated that over the past 6 years, growers have lost half the yield potential because of suboptimum soils and water quality, half the remaining yield potential to spring freezes, and half the remaining yield to birds, leaving about one-eighth of the potential yield to be harvested. Some of the more serious problems that have been experienced by Florida highbush growers are discussed below.

Late freezes: The flowers and fruit of 'Sharpblue' and 'Flordablue' are vulnerable for about 9 weeks in Florida, from February 1 to April 1. Many growers use overhead irrigation to reduce freeze losses.

Birds: Crows and cedar waxwings take a heavy toll. The waxwing is particularly troublesome because it is a protected species and it migrates through Florida during the highbush ripening season. It appears that some growers may have to net their fields to protect the crop.

Soils and water: 'Sharpblue,' 'Flordablue,' and 'Avonblue' grow poorly on soils containing less than 2% organic matter unless they are kept mulched with pine bark. This mulch needs to be renewed every 3 years, and it adds to the cost of production. Water from aquifers in many parts of Florida has a pH above 7.5 and contains large quantities of calcium and magnesium carbonates. Although rain provides most of the water needed to grow blueberries in Florida, low-quality irrigation water can cause problems on poorly-buffered soils and with potted plants.

Table 1. Low-chill highbush blueberry cultivars developed for the southeastern United States.

Cultivar	Year released	Released from
Sharpblue	1976	Florida
Flordablue	1976	Florida
Avonblue	1977	Florida
Georgiagem	1986	Georgia, USDA
Cooper	1987	Mississippi, USDA
Gulf Coast	1987	Mississippi, USDA
O'Neal	1987	North Carolina, USDA
Cape Fear	1987	North Carolina, USDA
Blue Ridge	1987	North Carolina, USDA

Cultivars: The first cultivars developed for a new production area are unlikely to be satisfactory in all respects. In Florida, 'Sharpblue' has been far more popular with growers than 'Flordablue' and 'Avonblue,' because it has proved easier to grow. Low chilling requirement has turned out to be only one element needed for good adaptation to the Florida environment. A problem with many low-chill highbush selections in north Florida is that they differentiate flower buds on the new growth that emerges in February and March, and by the time the fruit is harvested in May, they have finished growing for the year. Meanwhile, rabbiteyes continue to grow throughout the summer and differentiate flower buds in the fall. Resistance to many potentially destructive diseases, many of which are worse in warm areas, is also necessary. Potential growers of low-chill highbush blueberries in states other than Florida face the expensive and time-consuming task of determining which of the nine available low-chill cultivars are best suited to their conditions (Table 1).

Chilling problems: Growing a low-chill cultivar does not eliminate problems with chill requirement. Year-to-year variation in the amount of chilling received is high in low-chill zones. In a 10-year period, the number of chill units per dormant season is likely to vary from a low of 150 to a high of 800 units in Gainesville. A 300-unit cultivar may, in some years, be in full bloom by mid-January, making it almost certain to lose its crop to a subsequent freeze, or it may be delayed in leafing and flowering due to insufficient chill.

Leafing problems: Mainland (5) described a condition that sometimes occurs on certain blueberry cultivars in North Carolina in which little or no leaf bud break occurs on fruiting canes. This problem can occur on either rabbiteyes or highbush, but is much more damaging on highbush (5). Mainland reported that temperature during bud break seems to be the critical factor in determining the severity of the problem. Warm temperatures during this time cause flower bud development to begin before leaf bud development. The developing flower buds appear to inhibit development of the leaves. The problem of poor leafing can probably be overcome by cultivar selection, since some cultivars are much more susceptible than others.

Diseases: Phytophthora *(Phytophthora cinnamomi)* root rot is a serious disease on highbush blueberries in Florida, Arkansas, North Carolina, and probably in most other warm areas where blueberries are grown. Cultivars vary in susceptibility, but a blueberry cultivar with total immunity probably does not exist, Cane canker *(Botryosphaeria corticis)* and stem blight *(B. dothedia)* are also potentially devastating diseases for which chemical controls are not available.

Lack of information on growing highbush blueberries: Highbush blueberries are not an easy crop to grow. Growers in new areas are likely to make mistakes until they have gained experience with the crop. The information and assistance growers in new areas are able to obtain from university extension and research personnel is likely to be incomplete and occasionally erroneous until more is learned about growing the new cultivars in the new areas. Experience with rabbiteye blueberries is useful, but highbush have their own particular requirements.

Summary

Low-chill highbush blueberries are a new crop adapted to sections of North Carolina, South Carolina, Georgia, Florida, and west through the Gulf coast states to east Texas. These appear best suited as a fresh-market crop that can be sold before highbush blueberries from North Carolina and Arkansas and rabbiteyes from the Gulf coast states and Georgia. Because of a long market window (April 1 to May 15) during which the fruit can be harvested, Florida appears to have the best chance of developing a sizeable acreage of low-chill highbush. A major challenge to new growers will be the job of sorting out the nine available cultivars to determine which to plant in a particular area. A challenge for research and extension personnel will be to provide growers with accurate information on how to grow the crop.

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