

is medium in size with light red skin and yellow flesh. Fruit firmness and fruit retention are poor to fair. It produced an 80% crop following the 1993 freeze and an 85% following the 1996 freeze. Flowers appear to be pollen sterile, but it is very precocious and set heavy crops in both test orchards.

Turnage 88 selection is an upright, vigorous tree that blooms in early to mid March and ripens its fruit in mid May. The fruit is medium in size with light red skin and yellow flesh. Fruit firmness and retention are poor to fair. Turnage 88 was slow to come into heavy bearing, but since 1994 it has shown outstanding cropping ability. It was the highest yielding selection in the orchard at Attapulugus following the 1996 freeze, producing 41.2 lbs. (18.7 kg).

Pest Problems. A number of insect and disease problems were noted during the study. Since the orchards received pesticide applications during the post bloom period, plum curculio [*Conotrachelus nenuphar* (Herbst)] and apple maggot [*Rhagoletis pomonella* (Walsh)] were not a significant problem. Several scale insects have required treatment with dormant oil. Quince rust (*Gymnosporangium clavipes* Cke. & Pk.) has been a major problem in some commercial orchards, especially where cedar trees are located nearby. However, it has only been a minor problem in the two test orchards in this study. The fungicide myclobutanil (Nova) is pending registration for use on mayhaws to control rust. In 1997 a foliage and flower blight(s) were noted on several orchards in the state including Attapulugus. Samples from Attapulugus have been tentatively identified as *Monilinia johnsonii* (Dr. Warren Copes, personal communication). This disease is potentially very serious and reduced the crop at Attapulugus by approximately one-half in 1997. This blight or a similar disease caused a near 100% crop loss in a Thomas Co., Ga. orchard in 1997. Leaf spots can partially defoliate mayhaw trees prematurely in September, but have not required treatment to date. A few herbicides such as glyphosate (Roundup) are labeled for use on mayhaws and can be used for weed control after the root suckers have been removed.

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Proc. Fla. State Hort. Soc. 110:171-174. 1997.

HIGHBUSH BLUEBERRY VARIETIES FOR FLORIDA

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Abstract. Many southern highbush blueberry varieties (*Vaccinium corymbosum* L.) have been tested in Florida. The best of these allow blueberries to be harvested from early April through May. Early blueberries are not an easy crop to grow in Florida. Good site selection and intensive management are necessary for good results. Breeding cultivars that not only grow and survive well but also produce high yields of high-quality fruit suitable for early shipments requires many years of hybridization and evaluation. The varieties now available to growers in Florida all have strengths and weaknesses that must be considered by growers interested in producing this crop.

Two classes of blueberries are grown in Florida, rabbiteye and highbush (Williamson and Lyrene, 1995). Rabbiteye varieties are domesticated forms of *Vaccinium ashei* Reade, a vigorous, late-ripening species native in north Florida, southeast Georgia, and south Alabama. Southern highbush varieties are

hybrids of *V. corymbosum* L., from New Jersey, with *V. darrowi* Camp, an evergreen, short-statured, stoloniferous blueberry native in the Florida peninsula as far south as Lake Placid.

The breeding of low-chill highbush blueberries that could be grown in Florida was begun in 1950 by Ralph Sharpe (Sharpe, 1954; Sharpe and Darrow, 1959; Sharpe and Sherman, 1971). Programs to develop highbush varieties for other areas of the southeastern U.S. were later begun in Mississippi and in Georgia in conjunction with the U.S. Department of Agriculture (Draper, 1997). The long-term breeding program at North Carolina State University has also produced a few highbush varieties that can be grown in the colder areas of North Florida.

The first highbush blueberry varieties that could be grown in Florida were 'Sharpblue' and 'Flordablue', released from the University of Florida breeding program in 1977. These and subsequent varieties presented two marketing opportunities: pick-your-own marketing in the Florida peninsula and worldwide fresh-fruit marketing a month earlier in the year than had been possible with highbush blueberries in North Carolina or with rabbiteye varieties from north Florida (Lyrene, 1989; Lyrene and Sherman, 1984 and 1988).

Since 1983, when the first highbush blueberries were shipped from Florida, interest in the crop has remained high, but expansion of the acreage has been slow due to produc-

tion problems, which included birds that devour the fruit, freezes after flowering, high-pH irrigation water, diseases, insects, and lack of experience with production of the crop in Florida. The available varieties have also been a limiting factor. Some have not been well adapted to the climate, some have been excessively susceptible to diseases, mites, and insects, and some have had berry quality problems. During the last decade, much progress has been made with highbush blueberries in Florida. Growers have begun using nets to exclude birds, overhead irrigation to protect against freezes, fertigation to correct water-quality problems, pruning, fungicides and improved soil texture and drainage to reduce diseases. The Florida breeding program has continued to develop and test new varieties, and blueberry selections from other states are continually being tested. Annual production of highbush blueberries in Florida now exceeds 1,000,000 pounds per year, and far greater volumes of blueberries could be marketed during Florida's production season if they were available. However, production costs in Florida are high. Higher yields per acre and lower production costs will be necessary if the crop is to reach its full potential in Florida. Both improved cultivars and better cultural methods will contribute to this development. The Florida breeding program has dozens of selections in advanced stages of testing, and it is expected that many new varieties will be released during the next 10 to 15 years. Some of these, after they have been proved in grower fields, will probably be much more productive than the varieties available today.

This paper describes the highbush varieties currently available for Florida. This information was gathered during the past 20 years at the University of Florida Horticultural Unit in Gainesville and from many grower farms in Florida. Less is known about the newer cultivars.

Table 1 lists the varieties discussed in the paper. The varieties are arranged in order from those being used most in new plantings in Florida to those being used least. The varieties are highly responsive to environment, and the characteristics listed in the table describe plants on good soil and good cultural conditions. The chilling requirements given in the table are based principally on how completely and vigorously

the flower buds break dormancy in the field at Gainesville. Varieties that have vigorous, uniform budbreak even after the mildest winters in Gainesville were assigned a 200 hour chill requirement. Varieties that have uniform and vigorous budbreak only after the very coldest winters in Gainesville were assigned a 500 hour chill requirement. These numbers are arbitrary but conform to the system that has been traditionally used with deciduous fruit in areas farther north. There is evidence that blueberries taken far enough south in Florida, for example Immokalee (Reeder et al., 1994) may not enter deep dormancy in many years, and therefore may suffer less from lack of chilling than they do farther north in Florida. Some varieties, by avoiding dormancy in south Florida, may grow adequately even though they receive far less than their designated chill hours.

Bloom date and fruit ripening dates vary widely from year to year and from location to location depending on winter and spring weather. In Gainesville, Sharpblue, an early flowering variety averages full bloom in mid-February, and Magnolia, a late variety, about a month later. The range in ripening dates is similar between the early and the late-ripening varieties listed in the table. The first 20% of the crop is normally ripe on 'Star' in Gainesville by April 20, compared to about May 15 for 'Magnolia.'

Some blueberry varieties set too many flower buds. If the flower number is not reduced by pruning or spring freezes, the plant may set more fruit than it can size and sweeten; overfruiting plants also lose vigor and become more susceptible to disease. Thus, high or low flower bud number, while important in knowing how to manage a variety, is not inherently a good or bad feature. Both very high and very low flower bud production can be problematic.

Early leafing refers to the ability of the plant to break a large number of vegetative buds at the same time it flowers. Varieties that have a tendency to flower long before they leaf in the spring, for example 'Misty', 'Wannabe', and 'Marimba' are very difficult to manage.

"Ease of postharvest management" refers to a number of berry features that affect how easily the berry can be packed and how well it holds up when shipped. Various problems can

Table 1. Highbush blueberry varieties adapted to various parts of Florida.

Variety	Location and year of release ^a	Chill requirement (hours) ^b	Best adapted at or north of	Bloom date ^c	Ripe date ^c	Flowerbud abundance	Early leafing ability	Berry size	Ease of postharvest management ^d	Growth and survival of the plants ^e	Use in new plantings in Florida ^f
Sharpblue	FL-1976	200	Sebring	1	2	Medium	High	Large	3-4	2	1
Star*	FL-1995	400	Gainesville	3	1	Low	High	Very large	1	2	1
Misty	FL-1990	300	Orlando	2	2	Very high	Very low	Large	1	2-4	1
Gulf Coast	MS-1987	200	Sebring	1	2	Medium	High	Large	4	2	1-2
Southmoon*	FL-1995	400	Gainesville	3	4	Medium	Medium	Large	1	2	2
Wannabe	FL-	500	Lake City	4	2-4	Medium	Very low	Large	2	2-4	3
Flordablue	FL-1976	300	Orlando	1	2	Medium	Medium	Large	3	4	4
Marimba*	FL-1992	400	Gainesville	3	3	Very high	Low	Medium	2	3	4
Avonblue	FL-1977	400	Gainesville	3	3-4	Very high	Medium	Large	1	3	4
O'Neal	NC-1987	500	Lake City	1-4	1-3	Low	Low	Large	1	3	3
Georgia Gem	GA-1987	500	Lake City	3	4	Low	Medium	Large	2	3-4	4
Magnolia	MS-1994	500	Lake City	4	4	Medium	Medium	Large	1	2	4
Jubilee	MS-1994	500	Lake City	4	4	Medium	Medium	Large	2	2	4

^aFlorida, Georgia, North Carolina, Mississippi. Varieties marked * are patented and require a license for propagation.

^bEstimated based on flower budbreak in Gainesville over many years.

^cBloom date and ripening date: 1 = very early; 4 = Late. Late - ripening varieties are normally finished ripening by May 20 in Gainesville.

^d1 = Packs and ships well; 4 = difficult to pack and ship.

^e1 = High growth and survival; 4 = Low.

^f1 = Very often planted; 2 = often planted; 3 = occasionally planted; 4 = seldom planted.

detract from postharvest handling ease. With 'Sharpblue', for example, the dried corolla frequently remains attached to the ripe fruit and must be manually removed before packing. The second half of the 'Sharpblue' harvest tends to have many small berries; these make a very uneven pack if mixed with large berries. During hot or rainy weather, the berries of some varieties tend to become soft. Plants that leaf poorly, such as 'Wannabe', may have uneven pigmentation in the ripening berries. The berries may remain pink or green on one side even when ripe. 'Gulf Coast' is hard to pack because the pedicel remains on many of the berries when they are harvested instead of remaining on the plant.

"Growth and survival of the plants" also encompasses many different potential problems. Phytophthora root rot (*Phytophthora cinnamomi* Rands), stem blight (*Botryosphaeria dothidia*), stem canker (*B. corticis*), a number of different leaf-spotting fungi, a tendency to over fruit and not leaf strongly in the spring, and inherently low vigor can all contribute to poor growth and survival.

"Use in new plantings" estimates the extent to which growers are expected to use the cultivars in new plantings over the next few years. 'Star' and 'Southmoon' are new releases for which plant availability is still limited, and their rating in the table is based on projected use and not on current plantings.

Most or all of the southern highbush varieties described below require cross pollination for maximum earliness, fruit size and fruit quality. Although some will produce acceptable crops in solid blocks, it is much better in most cases to plant alternating rows of varieties that flower at about the same time.

Description of Individual Cultivars

'Sharpblue', the most successful of the three highbush blueberry varieties released from the Florida breeding program in 1976 and 1977, became the foundation on which the Florida highbush blueberry industry was begun. 'Sharpblue' combined a vigorous bush that leafs well in the spring and has a very low chill requirement with a berry that ripens early, has good size and excellent flavor. 'Sharpblue' normally maintains a good balance between flower buds and vegetative buds, and is thus easy to prune. 'Sharpblue' is moderately resistant to phytophthora root rot and stem blight. 'Sharpblue' requires cross pollination for greatest earliness, yield, and fruit quality. Problems with propagation and survival of 'Sharpblue', the cultivar released with 'Sharpblue' for cross pollination, led to the planting of many pure stands of 'Sharpblue' until other cultivars became available. These plantings showed clearly the lower performance of solid-block plantings. Principal problems with 'Sharpblue' include susceptibility to various foliar fungus diseases, limited resistance to phytophthora root rot and stem blight, and several berry quality problems. There is some tendency for the skin to tear when the berry is picked. In some fields, the dried corolla tends to remain on the berry through harvest. This may be increased by lack of cross pollination and Botrytis flower blight during bloom. In north Florida, cold weather before Christmas followed by warm weather in late December and early January can cause 'Sharpblue' flowers to advance too early and be highly vulnerable to freezes from late January through late March. 'Sharpblue' often has a long fruiting season, and even though the first berries of the spring are early

and large, berries in the second half of the crop may be much smaller and ripen after peak markets have past. 'Sharpblue' is easy to propagate and grows well in a nursery. Although 'Sharpblue' has various deficiencies, it has been a hard variety to replace. After 20 years it is still being widely planted in Florida as well as in Australia and in other low-chill production areas.

'Star' is a hybrid between FL80-31 and the North Carolina highbush variety 'O'Neal'. 'Star' was released from the Florida breeding program in 1995. It was patented by Florida Foundation Seed Producers, Inc., P.O. Box 309, Greenwood, FL 32443, from which a license must be obtained for propagation. 'Star' is slightly less vigorous than 'Sharpblue'. Its survival in the field is about equal to that of 'Sharpblue'. 'Star' holds its winter dormancy much better than 'Sharpblue', and is much less likely to flower in January and early February. 'Star' has a very short bloom-to-ripe interval, and all of its berries for the year normally can be harvested in a 3-week period, compared to a 6-week harvest for 'Sharpblue'. The two varieties normally begin ripening at about the same time in Gainesville, but 'Star' is finished long before 'Sharpblue'. 'Star' leafs well in Gainesville and in southeast Georgia. South of Ocala, 'Star' is not well adapted. It produces too few flower buds and grows less vigorously than in north Florida. The berry quality of 'Star' is excellent. The berries are large, uniform in size, and have excellent scar and firmness. 'Star' is easy to propagate. In some fields it has shown susceptibility to cane canker (*Botryosphaeria corticis*), but so far has remained productive if propagated by clean softwood cuttings and grown in a good environment. 'Star' is currently a popular variety for new plantings in north Florida and southeastern Georgia.

'Misty' was released in 1992 from the Florida breeding program, but had been widely tested in north and central Florida before its release. It originated as a seedling from the cross FL67-1 × 'Avonblue'. 'Misty' has a low chilling requirement, similar to 'Sharpblue', but has a greater tendency to retain its leaves through the winter, at least on strong, upright shoots. 'Misty' appears superior to 'Sharpblue' in phytophthora root rot resistance. It is a vigorous, upright bush and is easy to propagate by cuttings. The greatest weakness of 'Misty' is its tendency to produce far more flower buds than the plant can support. These flower buds tend to sprout before the leaf buds in the spring, and the resulting flowers and fruit inhibit sprouting of the leaf buds. 'Misty' stems that flower and fruit without leaves are highly susceptible to tip dieback, believed to be caused by *Botryosphaeria dothidia*. This dieback spreads rapidly downward, killing the stem and sometimes the entire plant, especially if the plants are young. The problem can be avoided or minimized by removing flower buds from young plants and by reducing the flowering of bearing plants by pruning in late summer or during the winter. In some environments, evergreen leaves maintained through the fall and winter have been used to support the spring berry crop on 'Misty'. Where this is possible, it reduces problems caused by delayed production of new leaves in the spring.

On 'Misty' plants that are leafy and not overfruiting, berry quality is high. The berries are large, firm, have good color, picking scar, and firmness. 'Misty' is still planted in Florida, often using 'Sharpblue' or 'Star' for cross pollination, by growers who have successfully dealt with the over-fruiting problem.

'Gulf Coast' was released from the U.S. Dept. of Agriculture breeding program in Poplarville, Mississippi in 1987. De-

spite being bred far to the north, the variety has grown and fruited well in Florida. If it loses its leaves by Christmas, which is normal in Florida, it appears to have about the same chilling requirement as 'Sharpblue', with which it has been widely planted for cross-pollination in central Florida. 'Gulf Coast' normally flowers and ripens at the same time as 'Sharpblue'. The berries are large and of good flavor. The main problem with 'Gulf Coast' has been that the pedicels remain attached to many of the berries after harvest. These are difficult to remove and cause much trouble in the packing house.

'Southmoon' was released from the Florida breeding program in 1995 and patented by Florida Foundation Seed Producers, Inc., from which a license must be obtained for propagation. 'Southmoon' is an upright bush with excellent berry quality. It is adapted in Florida from Gainesville north and in southeastern Georgia. 'Southmoon' flowers at the same time as 'Star', with which it can be planted for cross pollination. The harvest season is about 10 days later than for 'Sharpblue'. Harvest is normally complete by May 20 in Gainesville.

'Wannabe' is a variety of unknown origin that was propagated and sold as 'Flordablue' starting about 1980's. It was rather widespread in Florida plantings by 1992, when it was given the name 'Wannabe' to distinguish it from true 'Flordablue'. 'Wannabe' is a vigorous, upright plant with a large berry. In central and north Florida, it appears to have a rather high chilling requirement and often is very late in flowering and in leafing in the spring. It is quite susceptible to phytophthora root rot, and this, along with leafing and flowering problems arising from lack of chilling, have caused it to lose popularity.

'Flordablue' was released with 'Sharpblue' in 1976. Many features of the plant and fruit closely resemble 'Sharpblue', and the two were highly compatible in cross pollination. Because 'Flordablue' was very hard to propagate and was rather susceptible to phytophthora root rot, it was never widely planted for commercial production in Florida.

'Marimba' was released from the Florida breeding program in 1992. It has a small but firm berry that ripens about a week after 'Sharpblue'. It tends to over-fruit in north Florida, is susceptible to phytophthora root rot, and has had leafing problems some springs. Thus, it is not widely planted in Florida.

'Avonblue', (1977), was the third variety released from the Florida program. It has very heavy flower bud production and the plant is rather compact, with short internodes. If grown on excellent blueberry soil and pruned in both summer and winter, 'Avonblue' can produce large berries of excellent quality. Because it is difficult to grow in commercial fields and ripens 10 days later than 'Sharpblue', it has been little planted in recent years in Florida.

'O'Neal' was released from the North Carolina State University breeding program in 1987. It has been planted as an early-ripening variety in southeastern North Carolina and has been tested at various places in north Florida. 'O'Neal' produces a vigorous, upright bush that does not flower excessively. Flowering on 'O'Neal' often begins at the same time as on 'Sharpblue' in Gainesville, but continues for a long time, probably due to lack of chilling. Leafing is usually delayed, probably due to lack of chilling in Gainesville. The plants are susceptible to cane canker in Florida. Although the berries are large and of high quality, the variety does not get enough

chilling to succeed commercially in Gainesville. It could have limited success in the coldest areas of the panhandle, but does not appear to be a high-yielding variety under Florida conditions.

'Georgia Gem' was released in 1987 from the cooperative U.S.D.A. - University of Georgia breeding program at Tifton, Georgia. It was tested at Gainesville for 8 years, where it lacked vigor, earliness, and productivity.

'Magnolia' was released from the U.S.D.A. breeding program in Poplarville, Mississippi in 1994. The variety was selected to flower late and avoid late freezes in Mississippi. After a cold winter in Gainesville, it produced a good crop of high-quality berries, although only the first half of the fruit were ripe by May 20. After mild winters, 'Magnolia' has shown much delay in leafing and flowering in Gainesville, and if it has a place in commercial blueberry production in Florida, it would be in the colder areas of the panhandle.

'Jubilee', which was also released from Poplarville in 1994, is much delayed in leafing and flowering in Gainesville after mild winters and does not appear well adapted to Florida.

Two new varieties, 'Santa Fe' and 'Bluecrisp' have been approved for release from the Florida breeding program and should be available for licensing from Florida Foundation Seed Producers, Inc. in 1998. Both are adapted from Gainesville north into southeast Georgia. 'Santa Fe', which was tested as E-12, is an open-pollinated seedling of 'Avonblue'. It is very vigorous and upright in growth and has had excellent survival in the field. Unfortunately, it has been very difficult to propagate from softwood cuttings, and this will delay its use in commercial production. 'Santa Fe' flowers and ripens with 'Sharpblue'. The berry is slightly smaller than that of 'Sharpblue', but has excellent shipping qualities. The outstanding features of 'Santa Fe' have been its good growth and survival and dependable high yields in tests at Gainesville.

'Bluecrisp', tested as FL84-40 and as 'Crunchyblue', has an extremely firm, almost crunchy berry texture, considered excellent by most people who have eaten the berries. This firm texture makes the berry excellent for shipping. In Gainesville, 'Bluecrisp' flowers about a week later than 'Sharpblue' but ripens at about the same time. 'Bluecrisp' is more susceptible than most Florida varieties to blueberry bud mite (*Aceria vaccinii*). A post-harvest insecticide application may be needed to obtain high yields from 'Bluecrisp'. 'Bluecrisp' propagates readily from softwood cuttings.

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