Peach and nectarine cultivars and selections mostly developed in the last 10 yr are promising for supporting commercial production in central and north central Florida (100-350 chill units) and in north Florida (350-650 chill units) as well as other areas around the world with similar low winter chilling climates (Table 3). The selections described in Table 3 were chosen because they possess characteristics most acceptable in U. S. markets and because they ripen in Florida between late April and the start of the rainy season in early June.

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BREEDING EARLY-RIPENING BLUEBERRIES FOR FLORIDA[1]

P. M. Lyrene and W. B. Sherman
Fruit Crops Department, IFAS,
University of Florida,
Gainesville, Florida 32611

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Abstract. **The early-season fresh blueberry market appears to offer the greatest potential profits for Florida growers, especially as blueberry plantings increase in other states in the southeastern U.S. To take full advantage of Florida's potential for producing early blueberries, cultivars are needed that are specifically selected to flower early, ripen as quickly as possible after flowering, and fruit well after mild winters. The University of Florida breeding program is attempting to meet the needs of the Florida blueberry industry by developing earlier-ripening rabbiteye blueberry (Vaccinium ashei Reade) cultivars, rabbiteye cultivars that will fruit reliably south of Ocala, and vigorous, well-adapted highbush (V. corymbosum L.) cultivars.**

Approximately 3000 acres of rabbiteye blueberries were cultivated in north Florida in 1928. These plantations were established by digging wild rabbiteye blueberry bushes from the river swamps of west Florida and transplanting them to upland sites (4, 7, 15). Although these plants usually grew well, the unimproved rabbiteyes were highly variable in productivity, time of ripening, and fruit quality. Low quality, lack of handling and marketing expertise, and the advent of the economic depression resulted in the early demise of Florida's first blueberry industry.

During the past 20 yr, blueberries have again been planted in Florida, this time with improved cultivars. Current state acreage is approaching 1000 acres. This paper attempts to evaluate the potential for growth of the Florida blueberry industry and to describe how new blueberry cultivars could facilitate this growth.

If blueberry cultivation is to be successful in Florida, growers must be able to obtain high yields, and they must be able to market the crop at profitable prices. Blueberry markets can be divided broadly into 2 types: fresh and processed. Worldwide, about 30% of the total annual blueberry production goes to the fresh and 70% to the processed market. Processed blueberries can be stored for several years. This makes early, midseason, and late blueberries about equal in value for processing. On the other hand, fresh blueberries must be marketed quickly, usually within 2 weeks after harvest. Thus, the market requires an orderly supply of fresh blueberries throughout the season. Underproduction during one part of the season results in high prices, while overproduction results in low, usually unprofitable, prices.

At present, the first fresh blueberries produced in commercial volumes in North America are available about May 20 and come from southeastern North Carolina (18, 23). This production area is near the Atlantic coastline where the climate is considerably moderated by the waters of the Gulf Stream, which make the season substantially earlier than it would otherwise be at that latitude. The North Carolina blueberry industry was started primarily to produce early, fresh blueberries that could be marketed before harvest of the large New Jersey crop (1, 18). This has led North Carolina growers to select early-ripening cultivars for planting. These cultivars also flower early and in many years yields are reduced by spring freezes. Total producing acreage in North Carolina is about 3100 acres (21) and production averages about 6 million lb. per year.

The next major production area is New Jersey, which begins to harvest about June 15 with about 8000 acres and production of about 26 million lb. Perkins (23) found that of the blueberries marketed fresh from the U.S. and Canada in a typical year, only 7% were marketed in May, compared to 24% in June, 40% in July, and 26% in September. As might be predicted from these statistics, prices for fresh blueberries are typically quite high before May 20, fall somewhat by June 1, and then decline substantially after June 15.

Florida's best market opportunities for fresh blueberries lie with early-season production because competition from established production areas farther north reduces prices for late-season production.

Breeding Cultivars for Early-ripening in Florida: General Considerations

Two main components determine the ripening date of a blueberry cultivar: time of flowering and interval from flowering to ripening. Both components are affected

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by climate and cultivar (10). Open blueberry flowers are killed by temperatures below −2°C, so a blueberry cultivar would be maladapted to an area in which it flowered before the average date of the last killing frost. Examination of frost data for a number of sites in Florida clearly reveals a problem in trying to develop cultivars that flower shortly after the mean date of the last killing frost: these dates vary enormously within short distances depending on local topography and proximity to the Gulf and the Atlantic. For example, Palatka, Gainesville, and Archer, at nearly the same latitude in the north Florida peninsula, have average last-killing frost dates of February 2, February 22, and March 7, respectively (22). To get the earliest possible yields, a grower would have to be located in an area not prone to late frost and must use cultivars that flower early and yield well in warm areas. Clearly, cultivars developed for colder regions will not maximize early-season production.

The second component of ripening time, bloom-to-ripening interval, does not require such specific local adaptation as flowering time. For the early-ripening highbush cultivars grown in North Carolina, New Jersey, and Michigan, this interval can be as short as 50 days. For 17 rabbiteye cultivars and advanced selections tested at Gainesville for 4 yr, the average interval ranged from 62 days for F80-150 to 94 days for Southland (Lyrene, unpublished data). Certain wild rabbiteye selections from west Florida require over 180 days to ripen. Clearly, variation is sufficient to allow the development of cultivars to span a long production season.

Two main types of blueberries can be grown commercially in Florida—highbush (based on tetraploid *V. corymbosum*) and rabbiteye (based on hexaploid *V. ashei*) (5, 12, 14, 26). Although the berries can be marketed interchangeably, it is convenient to think of them as 2 different groups because they do not hybridize well and because they have somewhat different cultural requirements and limitations. The blueberry breeding program at the University of Florida is using 3 different strategies to develop cultivars that will allow growers to take full advantage of early season fresh blueberry production made possible by Florida's low latitude and long growing season. These 3 strategies are discussed below.

Breeding Early-ripening Rabbiteye Cultivars

Rabbiteye blueberries have always been considered late ripening compared to highbush (6, 24). In the Florida panhandle west of the Appalachicola River and in adjacent areas of south Alabama, where the main concentration of wild rabbiteyes is located, the average ripening date for plants in their native habitats is in August in most years. By contrast, the much-smaller populations of wild rabbiteyes in northeast Florida and southwest Georgia are substantially earlier (1). The cultivated rabbiteye germplasm now being used in breeding traces back largely to 4 clones (8, 11). Three of these ('Ethel', 'Clara', 'Myers') are from the southeast-Georgia-northeast Florida area and the fourth ('Black Giant') is from west Florida, near Crestview. The first rabbiteye improvement program was cooperative between the U.S.D.A. in Beltsville, Maryland, the North Carolina Agricultural Experiment Station, and the University of Georgia station at Tifton (6). The first breeders considered earliness an important selection criterion, and the pedigrees of current cultivars reflect heavy use in breeding of the earlier-ripening germplasm from the eastern part of the range of rabbiteye blueberry and less use of the relatively late western germplasm. The earliest-ripening of the modern rabbiteye cultivars, 'Climax', 'Aliceblue', 'Beckyblue', and 'Premier', ripen 1 to 2 weeks before 'Clara', 'Myers', and 'Ethel' and 3 to 4 weeks before 'Black Giant' (Lyrene, unpublished observations).

Three approaches are available by which earlier rabbiteye cultivars can be bred. The one which will give the fastest payoff is recurrent selection for earliness within the present cultivated rabbiteye gene pool. This method involves the intercrossing of the earliest-ripening rabbiteye cultivars and breeding lines available, the growing of large seedling populations, and the selection from these populations of the earliest-ripening segregates for use as parents to produce still-earlier seedling populations. Ripening dates at Gainesville for several test selections developed by this method are compared with the ripening dates of various rabbiteye cultivars in Table 1.

Table 1. Date of 50% fruit ripening for some early-ripening rabbiteye cultivars and test selections at the University of Florida Horticultural Unit, Gainesville, Florida.

Clone	Date of 50% ripening: 1981	1982	1983	1984	Average
F 81-31[z]	—	—	May 24	May 20	—
F 80-150[z]	May 21	May 9	May 28	May 22	May 20.0
F 80-141[z]	May 24	May 10	May 30	May 29	May 23.2
Aliceblue[y]	May 28	May 22	June 4	June 2	May 29.5
Beckyblue[y]	May 28	May 26	June 4	June 5	June 0.2
Climax[y]	June 3	May 25	June 11	June 9	June 4.2
Chaucer	June 8	May 30	June 8	June 7	June 5.5
Bonita	—	May 29	June 15	June 6	—
Woodard	June 4	June 5	June 16	June 14	June 9.8
Bluebelle	June 12	June 19	June 20	June 24	June 18.8
Tifblue	June 16	June 10	June 26	June 24	June 19.0
Choice	June 16	June 15	July 1	June 25	June 21.8

[z]Early rabbiteye test selections developed by recurrent selection.
[y]Earliest ripening available rabbiteye cultivars.

A problem being encountered with recurrent selection as outlined above is inbreeding depression (9). Recurrent selection among the progeny of only 4 original clones necessarily leads to crosses between near relatives, and in rabbiteye blueberries, this leads to considerable reductions in vigor. This problem has necessitated a second approach to the breeding of earlier-ripening rabbiteyes—the collection and use in breeding of additional early-ripening wild rabbiteyes. This project is relatively new, and the wild clones for use are only now being identified and collected. West Florida seems to have little to offer with respect to early-ripening rabbiteye germplasm, and efforts are being concentrated in the eastern races of wild rabbiteyes (2). This project will entail the crossing of selected wild rabbiteyes with the earliest-ripening rabbiteye cultivars, and the initiation of recurrent selection using a number of early F_1 plants. Cultivars from these crosses will probably not be available for 15 years unless F_1 populations contain cultivar-class seedlings.

A third possible way to develop early-ripening rabbiteye cultivars is through the use of *V. constablaei*, a wild blueberry native to the tops and upper slopes of the highest mountain peaks in western North Carolina and eastern Tennessee (3). Although this species is unadapted to the coastal plain, it has 3 characteristics that make it extremely valuable in breeding rabbiteyes. First, it has high berry quality including some unique flavor components not found in rabbiteyes. Second it has the same chromosome number as and crosses readily with rabbiteyes. The hybrids are vigorous and fertile, both in the F_1 and in backcross generations. Third, some *V. constablaei* plants ripen in as little as 49 days after flowering (20), an apparent adaptation to the short growing season in their native habitats.

V. ashei x *V. constablaei* hybrids produced by Arlen Draper of U.S.D.A., Beltsville, Maryland, and others produced and selected by James Ballington at the University of North Carolina, Raleigh, have been crossed with Florida rabbiteye cultivars. The backcross-1 populations contain some plants that ripen before the earliest rabbiteyes.

Breeding Rabbiteye Cultivars that Fruit Well After Mild Winters

Of the many species of blueberries native in eastern North America, the rabbiteye is the most productive and easiest to cultivate in northern Florida. Unfortunately, present rabbiteye cultivars have a definite chilling requirement, which is manifested in areas south of Ocala, not so much by reduced vigor as by reduced yields (13). Following a winter that provides fewer than 300 chilling hours, the cultivar Tifblue, for example, typically flowers heavily, but fewer than 20% of the flowers form berries (13). The same cultivar, after receiving 800 hr of chilling, may set 75% of its flowers (19). The exact cause of this problem is unknown, but repeated observations in north Florida have shown that 1) the colder the winter, the better the fruit set the following spring and 2) cultivars vary in the amount of cold needed to induce full berry set. This second observation suggests the possibility of breeding cultivars that yield well after mild winters. Highbush blueberry cultivars could provide genes for resistance to mild-winter-induced fruit drop, for they appear to set fruit well even when inadequate chilling delays their foliation in the spring. At least 50% of the winters at the University of Florida Horticultural Unit are sufficiently cold to induce good fruit set on most rabbiteye cultivars. Thus, efficient selection for low chilling requirement will require the assistance of growers in milder areas of the state. Rabbiteye cultivars that flower early and set well after mild winters could allow areas such as Tampa and Daytona Beach to produce rabbiteye blueberries early in the season.

Breeding Highbush Blueberries Adapted to Florida

The northern highbush (*V. corymbosum*) is the primary cultivated blueberry of the northern United States, from North Carolina to New Jersey and Michigan, and in the Pacific Northwest. The best highbush cultivars have high fruit quality and a high percent fruit set, and some have a very short period between flowering and ripening. Crosses between northern highbush cultivars and the Florida natives *V. darrowi* Camp and *V. ashei* have given rise to early-ripening cultivars that can be grown in Florida (24, 25, 26). 'Sharpblue', 'Flordablue', and 'Avonblue' have been released from the University of Florida (27). 'Sharpblue' has been the most widely planted of the three. 'Sharpblue' culture in Florida is potentially quite profitable, because it ripens in early May when no other fresh blueberries are available in the northern hemisphere. Despite their early ripening, Florida highbush cultivars have some weaknesses which could be alleviated by breeding. Low vigor compared to rabbiteyes, susceptibility to Phytophthora root rot on certain soils, and a tendency to cease growth and produce flower buds too early in the summer are problems with the southern highbush cultivars. In addition, even though 'Sharpblue' usually ripens 3 weeks before the earliest rabbiteyes, it does not have a particularly short bloom-to-ripe interval compared to highbush cultivars grown farther north.

Several genetic sources of improved vigor, adaptation and earliness are available for breeding southern highbush cultivars (16, 17, 24). Two of the most promising are *V. darrowi* and *V. elliottii* (Chapm.) Small. *V. darrowi* is an evergreen, highly-colonial lowbush species which is common on the dry pine scrublands of peninsular Florida. When crossed with highbush cultivars, *V. darrowi* imparts high vigor and improved adaptation. Two disadvantages of using *V. darrowi* in breeding are the tendency of hybrids to be short-statured and spreading rather than upright in growth, and the fact that *V. darrowi* is relatively late ripening.

V. elliottii is a deciduous blueberry whose range extends from north Florida to Virginia, and west to Texas (3). Characteristics of *V. elliottii* which make it potentially valuable in crossing with highbush cultivars include very early ripening, a desirable growth habit (upright without excessive suckering), and good adaptation to the soils and climate of northern Florida. Because of differences in chromosome number, the initial highbush x *V. elliottii* hybrids have been hard to produce and have been obtained only in small numbers (17). Some of these hybrids, however, have been highly vigorous and quite easy to backcross to highbush cultivars, and the backcross-1 populations have been early ripening and highly vigorous. Large berry size and light blue color are 2 traits that have been hard to recover after crosses with *V. elliottii*.

Conclusions

Even with present cultivars, the Florida blueberry industry has considerable growth potential. Customer-pick production is expanding to satisfy local markets, 'Sharpblue' is increasingly being planted to satisfy the early-May fresh blueberry market, and early rabbiteyes such as 'Climax', 'Aliceblue', 'Beckyblue', and 'Bonita' are being planted to fill the late-May-early June fresh market. In time, however, the Florida blueberry industry will increasingly require earlier-ripening rabbiteye cultivars and more-productive highbush cultivars that will allow growers to take full advantage of the state's warm climate and long growing season.

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NECTRIELLA (KUTILAKESA) PIRONII, A PATHOGEN OF FIG PLANTS[1,2]

S. A. Alfieri, Jr., N. E. El-Gholl, and M. L. Campbell
Division of Plant Industry,
Florida Department of Agriculture and Consumer Services,
P. O. Box 1269, Gainesville, FL 32602

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Abstract. **The fungus,** Nectriella (Kutilakesa) pironii **Alfieri & Samuels, causes stem galls and cankers of fig (**Ficus carica **L.) plants. Six cultivars were found to be susceptible to the pathogen.**

Nectriella pironii has been recently described (3) along with its imperfect state *Kutilakesa pironii* Alfieri (1) and reported as a wound pathogen on a number of woody and other ornamental plants (4, 5). The generic name *Kutilakesa* Subram. is reported as a synonym of *Sarcopodium* Ehrenb. ex Schlecht. by Sutton (7).

In 1982, *N. pironii* was isolated from a naturally infected fig plant (*Ficus carica* L. 'Spanish Brown' = ? 'Fico di Spagna' or ? 'Noire de'Espagne') in Gainesville, Florida (6). The fungus was recovered from stem cankers of a relatively young fig plant (1.2 m tall) in close proximity, ca. 2 m, to a *K. pironii*-infected Texas sage plant, *Leucophyllum frutescens* (Berl.) Johnston. Both the perfect state and *Kutilakesa* imperfect state were present on corky callus tissues of the cankers. This appears to be the first report of *K. pironii* occurring on fig.

Because figs are an edible crop of world importance, the purpose of this study was to determine pathogenicity of the fungus on 6 of the more popular cultivars of fig.

Materials and Methods

Six fig cultivars were tested for comparative susceptibility to *Kutilakesa pironii.* They were 'Celeste' = 'Malta', 'Conadria' a selection from 'Adriatic', 'Green Ischia' = 'Verte', 'Kadota', 'Lemon' = 'Blanche', and 'Osborn Prolific' (6). Plants were derived from cuttings, were 14 months old, fairly uniform in stem diameter, and ca. 46 cm in height at the time of inoculation. The inoculum was grown on potato dextrose agar (PDA) (prepared from 200 g of boiled fresh Irish potatoes supplemented with 20 g dextrose, 1 g KH_2PO_4, and 18 g Difco agar, made up to 1 liter with deionized water) for 3 weeks at room temperature 25 ± 2°C) under continuous light (fluorescent light, General Electric F40LW-RS-WMII at approximately 1000 lux).

All cultivars were inoculated via an oblique stem incision approximately 2-3 mm deep and 5-7 mm long made with a sterile scalpel. Two plants per cultivar were inoculated with 10 incisions per plant (5 incisions on the stem up to the first leaf and 5 stem incisions at the leaf axils) with a like number of plants serving as controls. Incisions were inoculated by inserting a 2-mm diameter PDA plug bearing sporodochia of the fungus into the incision. On plants serving as controls, a PDA plug (2-mm diameter) without the fungus was inserted into the incision.

Inoculation without wounding was accomplished by placing a PDA plug (2-mm diameter) bearing sporodochia of the fungus at the leaf axil. Two plants per cultivar were inoculated with 5 sites per plant.

All plants were enclosed in plastic bags which served as moist chambers and placed on a greenhouse bench; ambient temperatures were 30 ± 6°C during day time and 17 ± 5°C at night. The plastic bags were removed after 4 days and observations were made at 3-week intervals for 12 weeks. Gall formation was measured as proliferated, callused tissue at inoculation sites and was substantiated with subsequent re-isolation of the causal pathogen at the end of 12 weeks.

Results and Discussion

All 6 cultivars of fig were susceptible to *Kutilakesa pironii.* Symptom reaction was expressed in the form of galls and cankers from which the pathogen was re-isolated in every instance. The cultivar reaction to incision inoculation of the 6 cultivars of fig showed that all produced galls except 'Conadria', which reacted with the formation of cankers (Table 1). Some differences in host susceptibility were observed with respect to stem gall proliferation (Table 2). 'Kadota' and 'Lemon' produced larger galls.

The fungus was not able to penetrate and infect stem

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