

Research Progress Report
Southern Region Small Fruit Consortium

Title: A preliminary survey of bacterial leaf scorch of blueberry in Georgia

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Institutions: University of Georgia

Investigators: **Phillip M. Brannen**
Extension Plant Pathologist - Fruits
University of Georgia
Athens, GA 30602
Phone: (706) 542-1250
FAX: (706) 542-4102
Email: pbrannen@uga.edu

C.J. Chang
University of Georgia
Dept. of Plant Pathology
244 Redding Bldg., UGA Griffin Campus
Griffin, GA 30223
Phone: (770)412-4015
Email: cchang1@uga.edu

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Objectives: The overall objective of this study was to determine the prevalence of the bacterial leaf scorch pathogen, *Xylella fastidiosa*, in Georgia's major blueberry production region. Field surveys of southern highbush blueberry plantings would allow us to establish the current baseline distribution of this disease and its epidemic range.

Justification: Relative to total sales, blueberries have quickly grown to be the number one fruit commodity in the state of Georgia, surpassing even peaches. Recently, a new disease has been identified in the Georgia blueberry production region. This disease has been named bacterial leaf scorch, and it is caused by the xylem-inhabiting bacterium *Xylella fastidiosa*. To date, the disease has been predominantly a problem of southern highbush blueberry varieties.

The initial symptom is a marginal leaf scorch (Figure 1), which unfortunately is similar to that observed with extreme drought or some root rots. Sometimes the scorched leaf area is bordered by a darker band between the healthy and scorched tissue. This leaf symptom can be uniformly distributed throughout the plant, but in the early stages, scorching may be limited to individual stems or perhaps one side of the plant – indicating that only a partial xylem blockage has occurred which may be limited to one cane or one stem. Eventually, leaf drop occurs, and young twigs/stems may take on a yellow appearance. After leaf drop, the plant eventually dies.

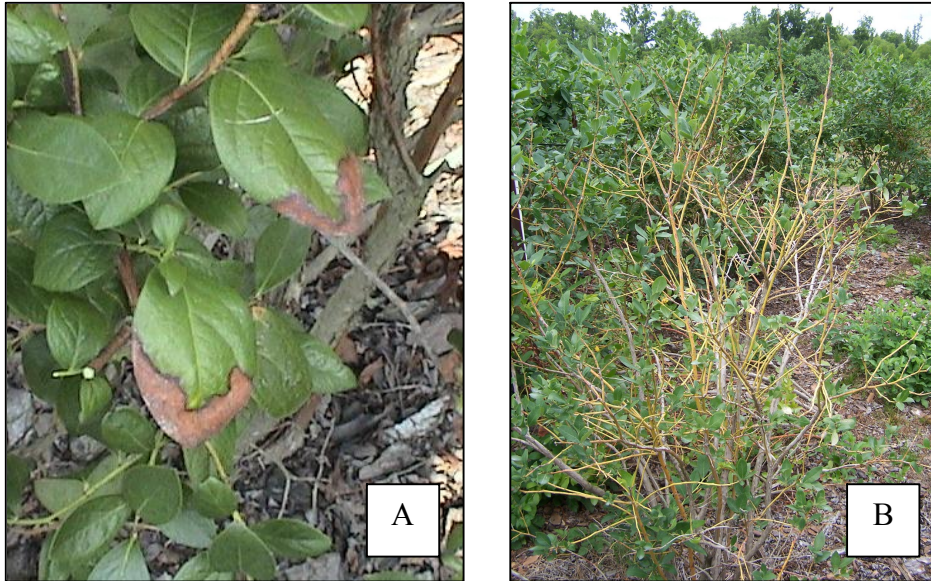


Figure 1. (A) Scorch symptoms (late summer) observed on leaves infected with *Xylella fastidiosa*. In some cases, the marginal leaf burn is very distinct and is surrounded by a dark line of demarcation between green and dead tissue. (B) The symptom observed here is the best indicator that the plants are actually dying of bacterial scorch, as opposed to root rot, anthracnose, fertilizer salt or chemical injury, or drought stress, any of which can mimic leaf symptoms of bacterial scorch. Prior to complete plant death, all leaves abscise (fall off), and the remaining stems take on a yellow “skeletal” appearance. The root system and stems do not show any obvious lesions or dieback symptoms, and the plant will generally appear healthy, with the exception of complete defoliation.

As mentioned, this is a new disease. Spread may be contained, but there is no reason to think that this pathogen will not spread throughout the region. With the severe losses incurred in sites where observed, it is essential that we follow this pathogen's progress over time. In addition, a survey will help us to further determine potential means of spread, to include propagation. It would also develop information relative potential resistance among cultivars observed in the field.

Methodologies: In 2008, UGA extension specialists, researchers, and county agents initiated a survey to determine the prevalence of bacterial leaf scorch in Georgia’s major blueberry production region, as well as whether or not resistance is likely found among some southern highbush cultivars. In late August, September, and October, county agents from major blueberry production counties helped to visually identify bacterial leaf scorch based upon symptoms. Counties surveyed were Appling, Pierce, Ware, Colquitt, Brantley, Bacon, Clinch, and Berrien, and a total of 45 sites were reviewed; at all sites, multiple ratings were conducted for different cultivars and cultivars of different ages, as available. Samples were taken for confirmation through use of ELISA, and an estimate of disease incidence was determined for each cultivar (% symptomatic plants). For each site, GPS coordinates were recorded to develop a map of the epidemic range. Data analysis included descriptive statistics (means of disease incidence by cultivar). Correlation analysis was utilized to determine the relation between different cultivars and years since field establishment.

Results and Conclusions: All surveyed counties had at least one site that had bacterial leaf scorch. A total of 45 sites were reviewed; most sites (71%) were positive for the presence of bacterial leaf scorch, though the degree of incidence and severity (observation only; data not collected) varied, largely based on the age of the planting. It can now be firmly concluded that bacterial leaf scorch is found wherever

susceptible southern highbush blueberry cultivars are grown in the state. All *Xylella*-negative sites were 3rd leaf or less in established field age, though some first year plantings did have significant disease incidence; we can therefore conclude that early plantings can be rapidly infected (possibly infected through propagation), but generally, the disease incidence and severity increases with time, as expected with an insect-vectorized disease. For each site, GPS coordinates were recorded to develop a map of the epidemic range (Figure 2).

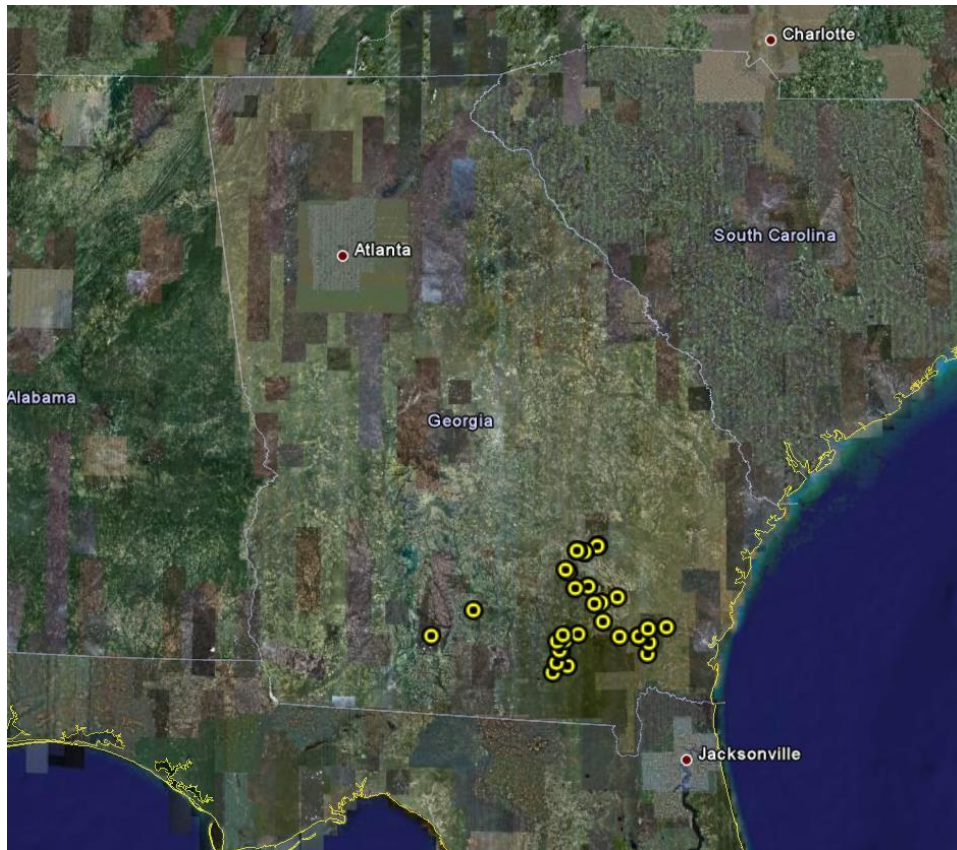


Figure 2. Blueberry survey locations with confirmed *Xylella fastidiosa* infections (bacterial leaf scorch). Symptomatic plants were confirmed through ELISA (map developed through use of Google Earth).

The most valuable information derived from this survey is the determination of the degree of susceptibility of various cultivars. Initially, it does appear that resistance or tolerance does exist among some cultivars. An example data set from Colquitt County is given below (Figure 3). This planting was in its 7th leaf, and because of bacterial leaf scorch, much of the site will soon be replanted. The planting was intermixed (no solid cultivar blocks), so ‘FL 86-19’ (V1) was interspersed or near all other cultivars. Results from this site indicate that ‘FL 86-19,’ ‘Star,’ and ‘O’Neal’ are susceptible, with ‘FL 86-19’ being particularly susceptible; all three had a high incidence of infection, and infected plants were generally near death.

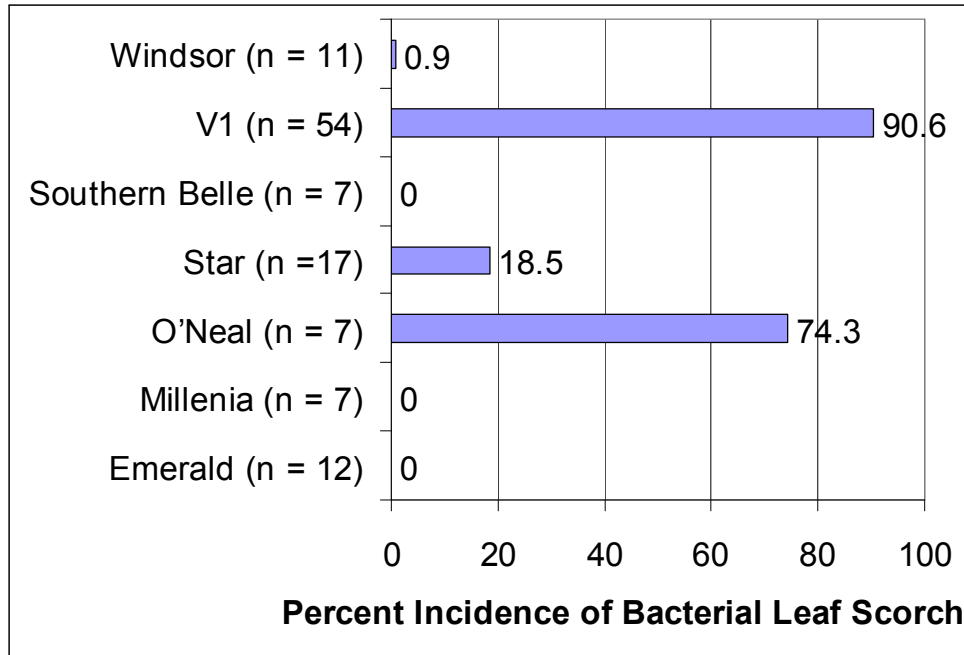


Figure 3. Incidence of diseased plants by cultivar from one 7th leaf producer site in Colquitt County. The number of rows surveyed (*n*) is shown in parentheses next to the cultivar name.

The disease susceptibility of individual cultivars can be compared by averaging all data points without regard to plant age, but more useful information can be derived by developing trend lines for cultivars over time (Figure 4). For example, the epidemic for ‘FL 86-19’ is shown to develop more rapidly over time than that of ‘Star,’ though both are susceptible cultivars. One can further predict that ~75% of ‘FL 86-19’ plants will be infected and showing symptoms within 10 years of planting, whereas ~30% of ‘Star’ plants will be diseased within the same timeframe. This is an important distinction, as use of insecticides (vector management) and reduction of plant stress (cultural practices such as fertility and irrigation) may further decrease the rate of epidemic development in ‘Star,’ increasing the productive life of a planting over time. This should be the topic of additional research in the future. Also, ‘FL86-19’ should probably not be planted near cultivars such as ‘Star,’ as the ‘FL86-19’ may further increase the epidemic development in ‘Star.’ It is highly questionable as to whether planting of ‘FL 86-19’ should be continued.

‘Windsor’ plants were confirmed to have the disease as well, but disease incidence was minimal (<1%). At this site, no ‘Emerald,’ ‘Millennia,’ or ‘Southern Belle’ plants had any symptoms of disease. More detailed research will be needed to confirm this, but for now, the results are consistent across locations (Table 1). Additional sites give strong evidence that ‘V5’ and ‘Jewel’ can be added to the list of resistant cultivars, though the limited number of sites with these cultivars makes extrapolation somewhat dangerous.

Of major concern, the ‘Rebel’ cultivar, a new release, may be susceptible to this disease as well (Table 1). In the future, new varieties need to be screened for resistance to bacterial leaf scorch, either in the greenhouse, field, or likely both. Screening methods need to be developed to compare cultivars as they are being developed. To date, cultivar screening test sites in Georgia have not shown evidence of bacterial leaf scorch, and likewise, it has not been prevalent in Florida screening sites (Paul Lyrene; *personal communication*). Testing new varieties in the presence of highly susceptible, diseased cultivars, such as ‘FL 86-19,’ will likely provide valuable information relative resistance. Injection of the *X. fastidiosa* bacterium (greenhouse or field) into the xylem of new cultivars may also provide a screening

method, but if vectored by insects as anticipated, field trials may be more accurate as to susceptibility. Again, a combination of screening techniques may be required to determine true disease susceptibility.

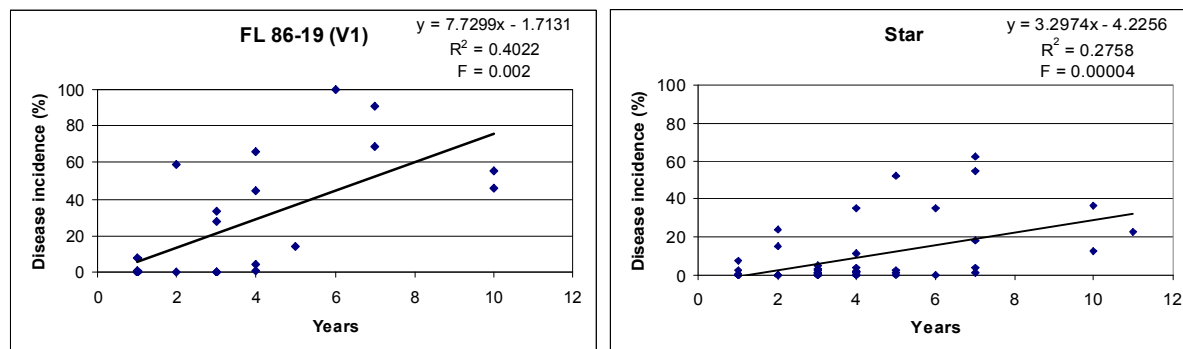


Figure 4. Disease incidence (%) of bacterial leaf scorch observed on cultivars ‘FL 86-19’ (‘V1’) and ‘Star’ over time (years in the field). Both ‘FL 86-19’ and ‘Star’ are susceptible cultivars, but ‘FL 86-19’ is clearly more susceptible to disease development and spread than the ‘Star’ cultivar. Based on the trend lines projected through use of survey data, ~75% of any ‘FL 86-19’ planting would be infected and showing symptoms by the tenth year in the field, versus ~30% of a comparable ‘Star’ planting. This is a significant difference, and good management practices (i.e. stress reduction, leaf hopper management, etc.) may possibly further reduce the rate of epidemic development.

Table 1. Incidence of bacterial leaf scorch observed in southern highbush blueberry plantings and cultivars, based on a disease survey conducted in 2008.

Cultivar	Early disease incidence (%) ^w	n ^x	Late disease incidence (%) ^y	n	Combined disease incidence (%) ^z	n
Bluecrisp	NA	NA	9.6 (0-37.5)	4	9.6 (0-37.5)	4
Emerald	0	20	0.03 (0-0.3)	10	0.01 (0-0.3)	35
Jewel	0	2	0	1	0	3
Millennia	NA	NA	0.1 (0-0.5)	5	0.1 (0-0.5)	5
O’Neal	0.6 (0-1.25)	2	23.1 (0-74.3)	8	18.6 (0-74.3)	10
Rebel	1.8 (0-7.5)	5	15.6 (8.75-22.5)	2	5.7 (0-22.5)	7
Southern Belle	NA	NA	0	4	0	4
Star	2 (0-23.75)	31	15.6 (0-62.5)	23	7.8 (0-62.5)	54
FL 86-19 (V1)	10.7 (0-58.8)	12	49.0 (0.8-100)	10	28.2 (0-100)	22
V5	0	1	0	2	0	3
Windsor	0	1	0.3 (0-0.9)	5	0.2 (0-0.9)	6

^wValues are means and ranges for the category of young plantings (1st through 3rd leaf).

^xNumber of samples.

^yValues are means and ranges for the category of older plantings (≥ 4th leaf).

^zValues are means and ranges across all sites and age categories.

These survey data provide good evidence that the solution to bacterial leaf scorch will likely involve genetic selection of resistant cultivars. If resistance is durable (lasting), then this will be important for the long-term health of the southern highbush industry. We still need to determine better ways of managing

susceptible varieties (i.e. vector management, etc.), especially where they are already planted. However, the long-term solution will likely involve breeding and screening to provide resistant lines.

Impact Statement: Relative to total sales, blueberries have quickly grown to be the number one fruit commodity in the state, surpassing even peaches. Recently, a new disease has been identified in the Georgia blueberry production region. This disease has been named bacterial leaf scorch, and it is caused by the xylem-inhabiting bacterium *Xylella fastidiosa*. To date, the disease has been predominantly a problem of southern highbush blueberry varieties. The initial symptom is a marginal leaf scorch. This leaf symptom can be uniformly distributed throughout the plant, but in the early stages, scorching may be limited to individual stems or perhaps one side of the plant – indicating that only a partial xylem blockage has occurred that may be limited to one cane or one stem. Eventually, leaf drop occurs, and young twigs/stems may take on a yellow appearance. After leaf drop, the plant eventually dies. In 2008, UGA extension specialists, researchers, and county agents initiated a survey to determine the prevalence of bacterial leaf scorch in Georgia’s major blueberry production region, as well as whether or not resistance is present among some southern highbush cultivars. In late August, September, and October, county agents from major blueberry production counties helped to visually identify bacterial leaf scorch based upon symptoms. Samples were taken for confirmation through use of ELISA, and an estimate of disease incidence was collected for each site (% symptomatic plants). For each site, GPS coordinates were recorded to develop a map of the epidemic range. Over time, this regional disease incidence map will serve as a baseline for epidemic observation of spread. Based on the results obtained, the nature of the epidemic may be better understood. The most valuable initial information derived from this survey is the determination of the degree of susceptibility of various cultivars. It does appear that resistance or tolerance does exist among some cultivars, and initial results show that ‘FL 86-19,’ ‘Star,’ and ‘O’Neal’ are susceptible, with ‘FL 86-19’ being particularly susceptible; all three had a high incidence of infection. ‘Windsor,’ ‘Emerald,’ ‘Millennia,’ ‘Southern Belle,’ ‘Jewel,’ and ‘V5’ either had no symptoms or minimal symptoms of disease (<1%). More detailed research will be needed to confirm this, but for now, the results are consistent across locations. These data provide good evidence that the solution to bacterial leaf scorch will likely involve genetic selection of resistant cultivars. If resistance is durable (lasting), then this will be important for the long-term health of the southern highbush industry. We still need to determine better ways of managing susceptible varieties, especially where they are already planted.