

TITLE: Incidence and Distribution of Bacterial Leaf Scorch of Hardwoods in the North Central and Plains States

LOCATION: MI, WI, MN, IA, IN, IL, MO, KS, NE, SD, ND

DURATION: 3-year project

FUNDING SOURCE: Base EM

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PROJECT OBJECTIVES: 1. Determine the incidence of Bacterial leaf scorch (BLS) in species of *Quercus*, *Acer*, *Platanus*, *Ulmus*, *Morus*, *Tilia* and other hardwoods. 2. Determine the distribution of BLS in the 11 North Central and Plains States. 3. Relate the occurrence of BLS to mapped landscape-scale physiographic, edaphic, and climatic data.

JUSTIFICATION: This project directly addresses many of the emphases of the 2008 Evaluation Monitoring selection criteria as below:

- *Geographic scale:* This project has a broad geographical range as susceptible tree hosts are wide-spread throughout the North Central and Plains States. Additionally, the project will examine natural, rural and urban forests. The pathogen has a broad hardwood host range. Multiple cooperators in the States will be involved with this project.
- *Biological impact/political importance:* Susceptible oak species are a particularly significant component of natural, rural, and urban forests throughout the region, as are *Acer* and *Ulmus* species. BLS is a significant, as yet unknown mortality agent, directly and indirectly causing *Tree Mortality*. More often it decreases vigor and increases susceptibility to drought damage. Thus, it can be a component of widespread oak decline and decline in other species and may result in reduction of timber resources.
- *Drought:* The leaf scorch, early autumn dormancy, and decline symptoms associated with BLS mimic those of drought stress. BLS symptoms increase with moisture stress. We will use detection of the causal agent, *Xylella fastidiosa*, as a method of differentiating the effects of drought stress alone from disease, and will compare the results to the landscape-scale data.
- *Climate change:* Distribution of BLS mapped to the landscape-scale data will provide the basis of predicting expansion of the geographical range for the disease with climate change. Distribution of BLS is considered to be cold-limited and the target tree species are widespread in the mid-west. The consequences of climate change are predicted to affect the mid-west climate with warming and drying.
- *Poor crown condition:* Detection of infection by *X. fastidiosa* may be a critical variable in determining the incidence of oak decline. Uncompacted live crown ratio and percentage crown dieback in trees showing leaf scorch with and without *X. fastidiosa* infection will be compared to clarify the relationship of BLS to crown condition and decline.

- *Insects and diseases*: Documenting the incidence and distribution of BLS will improve understanding of hardwood decline and susceptibility to insects and other diseases. Infection with *X. fastidiosa* is documented as increasing susceptibility of *Ulmus* spp. to Dutch elm disease, increasing dieback in *Platanus* with anthracnose, and causing decline in vigor, and sometimes mortality, in many hardwoods.
- *Validating insect and disease risk models*: Insect and disease risk models could be impacted by the incidence and distribution of BLS. This study should supplement and improve some risk models.

DESCRIPTION:

a. Background: Bacterial leaf scorch of shade trees is the common name for a disease caused by *Xylella fastidiosa*, a xylem-inhabiting bacterium that has fastidious nutritional requirements and is difficult to culture or verify by culturing. The disease affects forest trees (including oak, sycamore, elm, and maple) throughout the eastern and southeastern U.S. as well as in parts of the Midwest. In New Jersey, BLS was first detected in populations of trees in the red oak group in several western counties 20 years ago and since has spread throughout the state, affecting as many as 44% of susceptible oaks in some communities. Diagnosis and detection recently depended on ELISA immunology assays but have just been improved 100-fold in sensitivity with the development of Real-Time PCR methodology (rt-PCR). Population increases of *X. fastidiosa* in vessel elements lead to water stress symptoms, especially chlorosis followed by necrosis of leaf margins and interveinal areas, leaf curling, decreased seed production, delayed budbreak, early autumn dormancy, decline, dieback, and sometimes mortality. Increasing incidence and distribution of BLS combined with drought will increase decline and mortality in susceptible hardwoods. Introduction of exotic leafhopper vectors can increase incidence and distribution of BLS.

b. Methods: Cooperators and volunteers will locate trees showing leaf scorch during August and September. Five living leaves with and without symptoms will be collected from a tree and placed in a self-addressed stamped Tyvek® envelop for shipment. Approximate tree location will be recorded by GPS coordinates or street address. Diameter at breast height will be measured. Condition of the tree crown will be measured as uncompact live crown ratio and percentage of crown dieback. Information will be recorded on or in the envelopes. Leaf samples from a minimum of 100 trees per state (1100 to 2000 trees) will be photographed then processed to extract DNA from xylem tissues using magnetic bead capture microcolumns. Quality of DNA and presence of *X. fastidiosa* will be determined with rt-PCR technology using *X. fastidiosa* specific primers. Three replicates of each sample will be assayed. Positive and negative trees will be mapped for distribution. Climatic (especially isotherm lines), physiographic, and edaphic data will be overlaid on the final maps and correlations examined.

c. Products: This project will produce 1) quantitative assessment of the relationship between infection by *X. fastidiosa*, leaf scorch, and crown condition; 2) maps of states showing incidence and distribution of BLS in select hardwood species; 3) predictive understanding of the relationships between BLS distribution and climatic, physiographic, and edaphic parameters; and 4) a peer-reviewed publication.

d. Schedule of Activities: Year 1- Organize cooperators in spring and summer. Distribute envelopes and instructions. Collect samples in autumn. Process samples, extract and store DNA. Detect pathogen with rt-PCR assays. Year 2- Repeat organization, distribution, collection, sample processing and detection. Map data and overlay maps with landscape-scale data. Year 3- complete synthesis and analysis of data and write a final manuscript.

