INTERIM
PROGRESS REPORT

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CATEGORY	Northeast Regional IPM Competitive Grants Program (RIPM)
PROJECT TITLE	Predicting Inoculum Availability for Peach Scab: Development and Validation of a Forecasting Model
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Summary

This research project investigates the quantitative epidemiology of peach scab, caused by the plant pathogenic fungus *Fusicladosporium carpophilum*. Crop profiles for most northeastern states, including NJ, PA, WV, and New England, list scab as a disease of major importance. Since resistant cultivars are not available and cultural controls alone are inadequate, scab is primarily managed by application of consecutive fungicide sprays. This approach results in unnecessary fungicide applications when environmental conditions are unfavorable and loss of disease control when conditions are highly favorable. The major goal of the proposed project is to develop a forecasting model for predicting inoculum availability for infection. Specifically, sporulation of overwintering twig lesions, the major source of inoculum, will be quantitatively described as a function of temperature. A forecasting model algorithm will be created from this temperature relationship and previously published results. Predictions of this model will be validated. Implementation of the model will allow optimized fungicide application timing, thereby simultaneously reducing the potential for fungicide overuse and the likelihood of yield loss. Improvements in fungicide application efficiency will decrease amount of fungicide in the environment, enhance grower profitability, reduce applicator and field crew pesticide exposure, and decrease risk of pesticide residues on harvested fruit.

Introduction

Importance. Peach scab occurs wherever peaches are grown in warm, humid climates. In the United States, scab is most prevalent and problematic in the eastern half of the country, which has approximately 71,250 bearing acres or 62% of the total U.S. fresh production, with a value of $179 million. Peaches are grown in every state in the Northeast Region, which has 17,539 bearing acres or 25% of the total eastern acreage.

Limited Management Options. There are no scab-resistant peach or nectarine cultivars available for use by commercial growers. Furthermore, pruning out infected twigs, the source of overwintering inoculum, is not a practical means of cultural control. Thus, growers depend entirely on application of fungicides for scab management. The total number of applications usually ranges from 5 to 7 sprays per season, depending on time of harvest and spray interval. This approach only indirectly incorporates knowledge on the biology of the scab pathosystem, and mostly ignores the important effects of environment on epidemic development. Examination of weather records in relation to current knowledge indicates that environment may be a limiting factor during the early-season period. Of particular interest is the combined effect of temperature and relative humidity on sporulation and therefore availability of inoculum for infection.

Improved Efficiency. Implementation of a sporulation-based forecasting model will allow growers to optimize fungicide applications according to the risk of infection. Applications will only be made prior to an infection event (e.g., rainfall) if the risk is high based on inoculum availability. This optimized approach will result in fewer applications when environmental conditions are less favorable to disease development and more appropriately timed applications when conditions are favorable.

Benefits. Improvements in fungicide application efficiency from model usage will result in a number of economic and environmental benefits for the grower and the public in general. Fewer fungicide applications will: (i) improve grower profitability by reducing cost of control; (ii) decrease amount of pesticide [fungicide] in the environment; (iii) reduce exposure of applicator and field crews to the fungicide; and (iv) decrease the risk of pesticide residues on harvested fruit. Accurately timed fungicide applications will improve scab control and reduce yield loss, particularly during periods of erratic weather patterns. Furthermore, fungicide applied according to model predictions will be present at the highest concentration when it is needed the most, thereby providing growers with the greatest return for their investment.

Objectives

The major goal of this project is to create the knowledge base necessary for the initial development of a sporulation-based peach scab forecasting model. Specifically, there are three sequential objectives for the proposed research project:

(1) Quantitatively describe the temperature-sporulation relationship - modeling the quantitative effects of temperature on sporulation over time. Data were generated during 2007 and 2008; see "Progress" below for details.

(2) Validate biological criteria for the model, i.e., the sporulation predictions. A "first level" validation protocol, conducted in incubators, was added to the project to be performed prior to field validation. See "Approach" below for details.

(3) Create model algorithm based on new and currently available information - combine newly developed temperature-sporulation relationship with already published information. Work on this objective to begin after successful sporulation model creation & validation.

Approach

Model development. During the peak sporulation periods in 2007 and 2008, 1-year-old twigs harboring overwintering scab lesions were collected from an experimental non-sprayed 'Redgold' nectarine orchard. With the aid of a stereoscope at low power, the number of lesions on each twig were counted. Ten-twig samples were then washed, dried, and incubated in moist chambers at >95% RH. The moist chambers were placed in incubators maintained at constant temperatures of 5, 10, 15, 20, 25, 30, and 35C for 4, 8, 12, 24, 36, and 72 hours duration. Thus, the experimental design was a 7 × 6 factorial (temperature × duration of high RH) consisting of 42 treatment regimes. An additional treatment at 0-2C was also executed for possible inclusion in model development. To assess sporulation, conidia were washed from the twigs with deionized water using a DeVilbiss atomizer at 5 psi. Spore counts were performed using a hemacytometer under a compound microscope. Given the data collected, the # condia/lesion and # conidia/cm of twig length were calculated as the dependent variables which will define response surfaces with temperature and time as the independent variables.

Validation. A "first level" validation, conducted in incubators, was added to the project to be performed prior to field validation. Infected twigs were placed in incubators at constant temperatures and set durations of high RH not used for model development. In 2007 and 2008, data were collected from six and twelve different combinations of temperature and duration of high RH, respectively. If these independent incubator data successfully validate the model, then "second level" field validations will be conducted during high relative humidity periods which, by default, will have variable temperatures.

Progress

Graphs of either dependent variable over time depict a somewhat sigmoidal increase in sporulation. This growth pattern was evident at most temperatures and more apparent in 2008 than 2007. Sporulation increased more slowly with incubation time in 2007 than in 2008. Nevertheless, in both years maximum sporulation levels were similar at approximately 10,000-11,000 conidia/lesion and 65,000-75,000 conidia/cm twig length.

As would be expected, graphs of either sporulation variable against temperature depict a parabolic or possibly Gaussian relationship for both years. However, optimum sporulation in 2007 appears to be centered between 15 and 20C, while in 2008 the optimum is closer to 20C. In addition, the temperature curves are somewhat broader for 2008, showing greater sporulation for the mid-range of temperatures.

In the months ahead, data from each year will be fit via regression analysis to appropriate mathematical models. The combined data set will also be fit to these models to produce a reduced regression model. Comparison of reduced and full regression models, the latter being separate fits for each year, will be made to determine if the two years are statistically similar to allow pooling of the data. "First level" validation data from each year will be compared to model predictions.