Using vibrational spectroscopy to phenotype fusiform rust disease resistance in loblolly pine trees

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Abstract

Fusiform rust is a disease caused by the fungal pathogen Cronartium quercuum f. sp. fusiforme (Cqf). It is considered one of the most damaging and economically important diseases for loblolly pine (Pinus taeda L.), causing millions of dollars in damage and loss of products each year. Evaluating trees for disease resistance includes inoculation trials – these trials require artificial inoculation of the pathogen followed by visual inspection for disease incidence. Visual inspection can lead to incorrect classification due to human error or escaped susceptible (i.e. a susceptible individual with no symptoms). Here, we plan to use vibrational spectroscopy tools to improve the accuracy of phenotypic values. Vibrational spectroscopy tools allow for a user to obtain a single, comprehensive reading based on the chemical constituents of sample. Because pine trees mostly rely on chemical-based defenses, the relationship between chemical makeup and resistance is promising. We plan to collect spectra from 40 different loblolly pine families (20 with lower rust incidence and 20 higher rust incidence) over five different progeny test sites in the southeastern US, totaling 400 trees. We will use a handheld near-infrared (NIR) spectrometer for a real-time, in-field reading on phloem and needle tissue. In addition, phloem and needle tissue will be analyzed by a benchtop Fourier-transformed infrared (FT-IR) spectrometer. Using multivariate analyses and machine learning algorithms, spectral readings can be mined for patterns associated with fusiform rust disease resistance or susceptibility, which can be used to predict the phenotype of untested trees. The results of the two tools and two tissue types will be compared to evaluate the best method for identifying phenotype in the system. This chemical fingerprinting and classification approach to phenotyping loblolly pines will provide a more objective, efficient, and more accurate way to identify disease resistance in the field, thereby creating more robust forest stands against fusiform rust.

Using vibrational spectroscopy to phenotype fusiform rust disease resistance in loblolly pine trees

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