Karly Jacobsen, University of Florida, Gainesville, FL, USA
Jillian Stupiansky and Sergei S. Pilyugin, University of Florida, Gainesville, FL, USA

A Host-Vector Model for Citrus Greening with Roguing: Persistence, Transients and Other Behavior

Citrus greening, a bacterial infection of citrus trees, has had a severe impact on the citrus industry of Florida since its first detection in 2005. A recent study estimates that the disease has caused over $3 billion in lost revenue and over 6,000 lost jobs in the state. Citrus greening is also present in Georgia, South Carolina and Louisiana. More significantly, in January 2012 the Texas Department of Agriculture and the USDA confirmed the presence of the disease in Texas, and on March 30, 2012 a grove in California was determined to be positive for citrus greening. Together the industries in Florida, California and Texas comprise about 98% of the citrus production of the United States.

Citrus greening has been impossible to eradicate and very difficult to control. The disease exhibits a latent period which has been observed to last anywhere from 6 months to 6 years. During this time the tree is asymptomatic but can be infectious. The vector for citrus greening is the Asian citrus psyllid; transmission occurs during feeding in the nymphal and adult stages. The psyllids were first discovered in Florida in 2000 and are now well distributed throughout the citrus-growing areas of the state. In addition to those states with citrus greening, Arizona, Hawaii, Mississippi and Alabama are now also home to the insect. Various management methods, with none being overly successful, have been attempted to control the disease. Citrus growers are currently implementing a rogue and replant strategy where infected trees are removed and replaced with new trees. Often, replanted trees quickly become infected; there is the possibility that the soil acts as a reservoir for the disease.

Previously, we developed a model for the population dynamics of citrus greening at the grove-scale, explicitly including both the tree and vector populations. The tree population is divided into susceptible, infectious and asymptomatic, infectious and symptomatic, and removed (considered to be dead) compartments. Roguing of symptomatic and dead trees occurs with a positive probability of the replanted tree directly entering the infectious state. Prior work also included calculation of the basic reproduction number, R_0, and determining a condition for the existence of an endemic equilibrium.

Here we perform further analysis on the model. The relation of R_0 to the extinction and persistence of the disease is discussed. Simulations suggesting additional stability behavior of the endemic equilibrium are included. By allowing for distinct roguing rates of symptomatic and dead trees we determine the effect of roguing strategy on R_0, the transient behavior of the disease, and the equilibrium level of susceptible (productive) trees. Finally we make a biologically relevant modification to the model which yields more complicated dynamics. The existence of two endemic equilibria becomes possible; conditions for such existence are discussed and numerical simulations are shown which indicate further stability results.