LINKING WITHIN-VINEYARD SHARPSHOOTER MANAGEMENT TO PIERCE'S DISEASE SPREAD

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ABSTRACT
Pierce's disease (PD) management in southern California vineyards hinges on chemical control of populations of the vector, the invasive glassy-winged sharpshooter (GWSS) residing in citrus. Growers also frequently apply systemic insecticides in vineyards, but the efficacy of these treatments for disease management is not known. We are conducting a series of surveys in treated and untreated vineyards in Temecula Valley to determine the relative economic value of within-vineyard chemical control for PD management. Thus far the results from preliminary surveys suggest that although PD prevalence varies greatly among vineyards, those that were regularly treated with systemic insecticide tend to have lower prevalence than fields that were intermittently treated or untreated. These surveys will be continued over the next few years to evaluate the relative importance of vector pressure and chemical control for disease spread. Ultimately, survey data will be used to quantify rates of secondary spread and the spatial distribution of *Xylella fastidiosa* strains, which is needed for drawing inferences regarding GWSS movement and pathogen sources.

LAYPERSON SUMMARY
One of the main tools for dealing with the glassy-winged sharpshooter (GWSS) in southern California and the southern San Joaquin vineyards is the application of insecticides. Systemic insecticides (imidacloprid) are regularly applied to citrus, which is a preferred plant type for GWSS, to reduce insect abundance before they move into vineyards. These treatment programs have been successful, reducing GWSS populations to a fraction of what they once were. Grape growers frequently use systemic insecticides in vineyards as well to reduce further the threat of GWSS spreading Pierce's disease among vines. However, no measurements have been made about whether these costly insecticide treatments are effective at curbing disease spread. We are conducting a series of disease surveys in Temecula Valley to understand whether chemical control of GWSS in vineyards is justified. Results from preliminary surveys indicate that the frequency of disease in vineyards varies greatly, but generally fields that are treated regularly tend to have less diseased vines than those that are not treated. We will continue these disease surveys over the next few years to more fully evaluate this question.

INTRODUCTION
Chemical control of insect vectors plays a crucial role in many disease mitigation programs. This is true not only for the management of mosquito-borne diseases of humans, such as malaria and dengue fever, but also for limiting disease epidemics in a wide range of agricultural crops. In southern California vineyards chemical control at both the area-wide and local scales may affect the severity of Pierce's disease (PD), by reducing the density or activity of the primary vector, the glassy-winged sharpshooter (GWSS; *Homalodisca vitripennis*; Castle et al. 2005).

The bacterial pathogen *Xylella fastidiosa (Xf)* is endemic to the Americas, and is widespread throughout the western and southeastern U.S. This xylem-limited bacterium is pathogenic to a wide variety of plants, including several important crop, native, ornamental, and weedy species (Purcell 1997). In the Western U.S. the most economically significant host is grapevine, in which *Xf* causes PD. Multiplication of the bacterium in vines plugs xylem vessels, which precipitates leaf scorch symptoms and typically kills susceptible vines within a few years (Purcell 1997).

Xf can be spread by several species of xylem sap-feeding insects, the most important being the sharpshooter leafhoppers (Severin 1949). Historically PD prevalence has been moderate, with a pattern that is consistent with primary spread into vineyards from adjacent riparian habitats by the native blue-green sharpshooter (*Graphocephala atropunctata*). However, beginning in the late 1990s severe outbreaks occurred in southern California and the southern San Joaquin Valley that are attributable to the recent establishment of the GWSS. This invasive sharpshooter is not inherently more efficient at transmitting the pathogen than are native sharpshooters (Almeida and Purcell 2003). Instead its threat as a vector appears to stem from a combination of ability to achieve extremely high densities (Blua et al. 1999) and promote vine-to-vine (i.e. secondary) disease spread (Almeida et al. 2005).

Citrus trees themselves are not susceptible to the strains of *Xf* found in the U.S. (though strains found in Brazil have caused significant economic losses to their citrus industry – Purcell 1997). None-the-less citrus plantings figure prominently in the epidemiology of *Xylella* diseases in California. Many portions of southern California and the southern San Joaquin Valley have vineyards in close proximity to citrus groves (Sisterson et al. 2008). This is important because citrus is a preferred habitat for the GWSS at key times of the year, allowing this vector to achieve very high densities (Blua et al. 2001). High vector populations then disperse seasonally out of citrus into nearby vineyards, resulting in clear gradients of PD prevalence (i.e. proportion of infected plants) as a function of proximity to citrus (Perring et al. 2001).

Given the importance of citrus in PD epidemiology, citrus groves have been the focus of area-wide chemical control programs, initiated in the Temecula and Coachella Valleys in the early 2000s and shortly afterward in Kern and Tulare Counties (Sisterson et al. 2008). The southern California programs use targeted application of systemic insecticides, such as imidacloprid, to limit GWSS populations residing within citrus. Census data in citrus show substantial year to year variation in GWSS abundance that may stem from incomplete application, the use of less effect organically-derived insecticides, or inadequate irrigation to facilitate uptake - which makes the consistent management of sharpshooter populations a challenge (Toscano and Gispert 2009). None-the-less trap counts have been, overall, much reduced compared to pre-area-wide counts. The effect of chemical control can be seen clearly in early insect surveys which found significantly fewer GWSS in treated relative to untreated citrus and in vineyards bordering treated versus untreated groves (R. Redak and N. Toscano, unpublished data). Thus, these area-wide control programs have been considered successful in southern California (Toscano and Gispert 2009), and the swift implementation of an area-wide management program in Kern County has been credited with limiting the severity of PD outbreaks (Sisterson et al. 2008).

Research into imidacloprid uptake by grape also has been initiated, and target concentrations high enough to suppress GWSS activity (approx. 10 μg/L of xylem sap) can be achieved and will endure for several weeks in mature vines (Byrne and Toscano 2006). This information coupled with the success of area-wide programs in citrus appears to have led to relatively widespread adoption by grape growers of imidacloprid application in vineyards to reduce further exposure to *Xf*. In Temecula Valley, for example, it is estimated that 70% of vineyards use imidacloprid, at an approximate cost of $150-200 per acre (N. Toscano, personal communication). Yet consistent treatment of vineyards with systemic insecticides is neither universal, nor have there been any measures of how effective these costly treatments are at reducing PD incidence.

We are studying the epidemiological significance of chemical control in vineyards, via a multi-year series of field surveys in Temecula Valley. This work will address gaps in empirically-derived observations regarding the cascading effects of vineyard imidacloprid applications on GWSS abundance and, ultimately, PD severity.

OBJECTIVES

The overall goal of this project is to understand **does within-vineyard sharpshooter chemical control reduce vector pressure and PD spread?**

This project was initiated this summer. We are currently in the middle of the first of three seasons of Fall disease surveys. Over the next two additional seasons we will continue these surveys and collect additional data on vector abundance, imidacloprid concentrations, and *Xf* genotype distribution.

RESULTS AND DISCUSSION

In the Fall of 2009 we conducted a pilot survey of some Temecula vineyards. These surveys relied on visual PD symptoms for five pairs of regularly treated and untreated vineyards, plus a 6th unpaired treated vineyard. Disease prevalence varied greatly among fields, ranging from 0 to 22%, with lower overall prevalence in treated compared to untreated fields (**Figure 1**). For all five pairs, the untreated field had equal or higher (by up to 20%) prevalence, with four of the six treated fields having no apparent infected vines.

This summer we interviewed several vineyard owners and vineyard managers in the Temecula region to identify vineyards with a range of imidacloprid treatment histories. Of the 88 distinct properties for which we acquired information 66 were treated regularly with imidacloprid, 14 were treated intermittently, and eight properties were not treated with imidacloprid for at least the last four years. These treatment histories will be verified this Fall and next Spring by sampling plant tissue and quantifying imidacloprid concentration. In September we began the first of three years of disease surveys in a collection of these Temecula vineyards. For each vineyard we noted the proportion of vines showing PD symptoms and we collected plant tissue samples which are being cultured, to verify infection in putatively symptomatic vines, and ELISA, to estimate latent (i.e. non-symptomatic) infections. Thus far, we have results of just the visual symptoms from 14 vineyards. The results from these preliminary data support the pilot study. Although PD prevalence varies greatly among vineyards, those that were treated consistently with systemic insecticide tend to have lower prevalence than fields that were intermittently treated or were untreated (**Figure 2**).

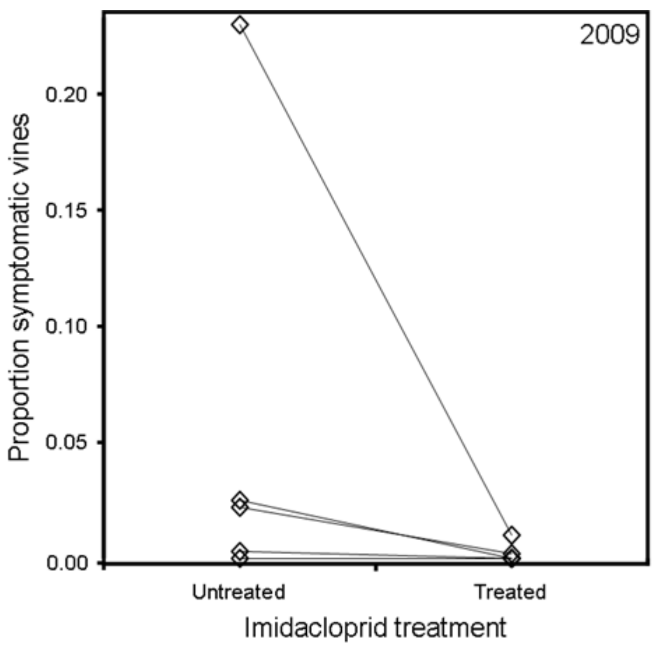

Figure 1. Proportion of plants displaying Pierce's disease symptoms in pairs of imidacloprid treated or untreated vineyards. Observations from Temecula Valley pilot surveys, Fall 2009. Lines connect untreated vineyards with a treated neighboring vineyard. Some data points for the Treated fields overlap (n=6).

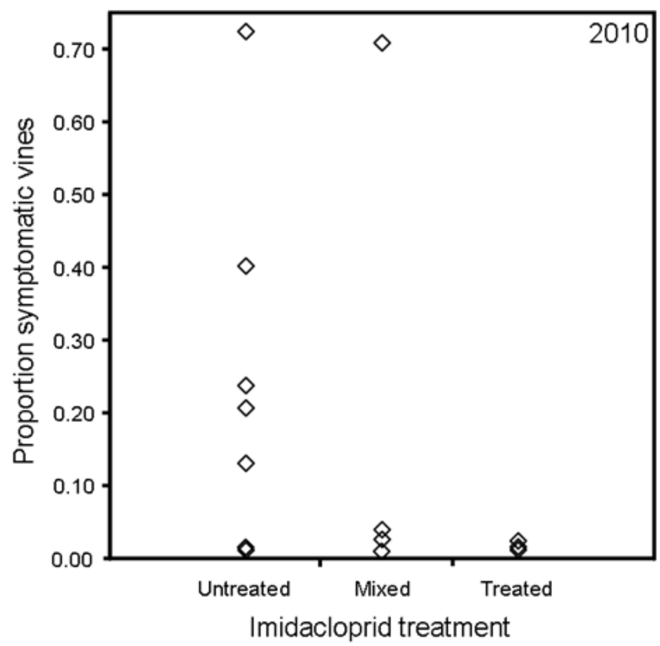

Figure 2. Proportion of plants with Pierce's disease symptoms in fields categorized as being regularly treated with imidacloprid, a mixed treatment history, or never been treated with imidacloprid. Observations from preliminary 2010 surveys in Temecula Valley. Some points overlap (n=7, 4, 3 for Untreated, Mixed and Treated respectively).

CONCLUSIONS

Results so far suggest that within-vineyard sharpshooter chemical control may be effective at reducing disease pressure. However these results should be viewed as preliminary. More complete surveys are needed to estimate the effect of chemical control on vector abundance in vineyards and year-to-year increases in disease (i.e. incidence).

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