EPIDEMIOLOGY OF PIERCE'S DISEASE IN THE COACHELLA VALLEY

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Reporting Period: The results reported here are from work conducted from May 1, 2001 through September 30, 2003.

ABSTRACT
In 2001, no Pierce's disease (PD) was detected in the Coachella Valley. However in June 2002, one diseased grapevine was found in each of two adjacent vineyards. A subsequent census of those vineyards revealed the presence of 13 infected vines. Each of the infections was confirmed with ELISA and bacterial culturing, and PCR was used to confirm the presence of the grape strain of *Xylella fastidiosa* (i.e. Pierce's disease). Surveys in June 2003 identified two additional fields with infected vines, bringing the total number of locations in the valley to three.

Yellow sticky traps have been used to show the seasonal trend of glassy-winged sharpshooter (GWSS) adults. Average counts in the summer of 2002 were higher than in the summer of 2001. Similarly, winter traps in 2003 showed higher densities than winter traps in 2002, suggesting an increasing GWSS population density throughout the valley. However, spring and summer 2003 traps were nearly zero at all locations, indicating successful control of GWSS by the CDFA sponsored vector control program implemented by the Riverside County Agricultural Commissioner's office. Through this study, traps adjacent to citrus groves caught more GWSS than traps not near citrus, however fewer than 35 percent of the traps near citrus caught GWSS on any given week. GWSS count data were managed in a GIS format and this enabled us to place relative importance to citrus groves based on various densities of GWSS caught near the groves. This information could be used to target sites for vector reduction treatments.

INTRODUCTION
Pierce's disease (PD) has been in California for over 100 years (Purcell 1981), but the recent introduction of the glassy-winged sharpshooter (GWSS), *Homalodisca coagulata,* into the state (Sorenson and Gill 1996) has radically changed the epidemiology of this devastating disease. Since 1994, at least 1,500 vineyard acres have been lost to the disease in California, and in the Temecula Valley alone, losses have been estimated at $13 million (Wine Institute 2001). The California grape industry is estimated to contribute $33 billion to the state economy (Wine Institute 2001), and GWSS transmission of PD threatens to destroy one of the state's most valuable commodities.

The rapid losses caused by GWSS-transmitted PD in Temecula suggest that areas where GWSS becomes established experience rapid PD spread and vine decline. We conducted a PD survey of eight vineyards in Temecula and found plant decline or death from PD ranging from 51–87% (Perring et al. 2001). The most plausible explanation for the swiftness and severity of the PD epidemic in Temecula is the unique epidemiology created when GWSS is introduced into an area with endemic PD sources (Purcell and Saunders 1999). In Temecula, the epidemic has mimicked that of grape growing regions in the U.S. where GWSS is endemic. In the southeastern U.S., GWSS-transmitted PD is the major factor limiting grape production (Purcell 1981).

The table grape industry in the Coachella Valley is represented by 10,465 acres of producing vines, which generated grapes valued at $108.5 million in 2001 (Riverside County Agricultural Commissioner, 2001). Pierce's disease (PD) was identified in the Valley in 1983 (Goheen 1984), but until the arrival of the glassy-winged sharpshooter in the early 1990's (Blua et al. 1999), PD was of little concern. In May 2001, we began a study in this desert valley, with the goal of discovering characteristics unique to GWSS-vectored PD epidemics.

OBJECTIVES
The goal of our epidemiological studies in the Coachella Valley is to describe the epidemiology of PD when the primary vector is GWSS, and to use this information to design management strategies to reduce disease spread.
Three objectives are pertinent to this report:
1. Determine the incidence and distribution of PD in the Coachella Valley.
2. Describe the spatial and temporal abundance of GWSS in the Coachella Valley.
3. Determine the relationship of citrus to the abundance of GWSS in vineyards.

RESULTS AND CONCLUSIONS

Results

***PD incidence and distribution*:** For the past three grape growing seasons, we have surveyed the Coachella Valley in search for PD. In 2001, we visually inspected 300 plants in each of 25 vineyards and all vines in a 60-acre vineyard proximal to an area that had PD in 1983. We collected 233 suspected samples and analyzed them with ELISA. None of these plants were positive for *X. fastidiosa*. In 2002, we visually sampled 300 plants in each of 25 vineyards, and visually inspected 35,000 vines randomly distributed throughout the Valley. We analyzed (by ELISA) 268 plants from this survey and found 13 vines with *X. fastidiosa*. Bacteria were confirmed in these plants with selective-media plating and PCR, amplifying for PD-specific DNA. This was the first post-GWSS PD finds in the Valley. This past summer (2003) we visually inspected an estimated 616,400 vines and 478 vines with suspected PD were subjected to ELISA. Five of these 478 vines were positive for PD. Four of these vines were at one field site and the fifth vine was at another site. This brings the number of fields at which PD has been detected in the Coachella Valley to three (Figure 1). We are in the process of characterizing these three fields to determine the extent and patterns of infection in them.

***Spatial and temporal abundance of GWSS*:** We used yellow sticky traps distributed uniformly at one-mile intervals throughout the Coachella Valley to monitor the seasonal cycle of adult sharpshooter activity. GWSS catches rose into the summer of 2001, declined in late July, peaked again in mid-August, and then declined into the fall and winter (Figure 2). Numbers were extremely low until a period of increased activity, presumably by overwintering adults, in January and February 2002, after which counts declined again until May 2002. Average counts in the summer of 2002 were higher than in 2001, suggesting an increasing trend of GWSS numbers in the Coachella Valley. GWSS adult catches in the fall of 2002 were very low (similar to fall 2001) until January 2003. At this time there was a peak in adult activity that was greater than trap catch densities at the same time of the year in 2002. In February 2003, the Riverside County Agricultural Commissioner's Office, with support from CDFA, initiated a GWSS reduction program by treating citrus in the Coachella Valley. From our trapping data, this action appears to have reduced GWSS adults to a very low level that has been maintained this year (Figure 2).

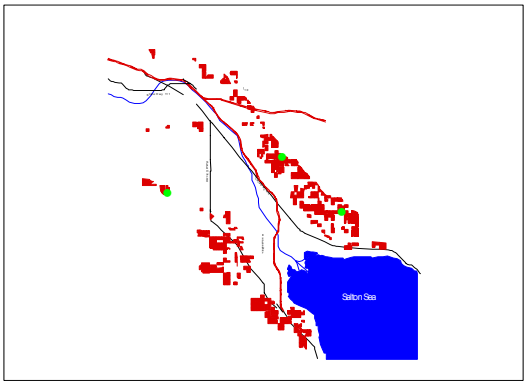


Figure 1. Vineyards (red) and sites (green) inCoachella at which PD has been found.

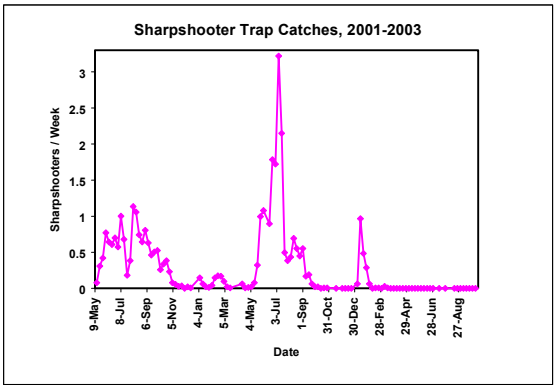
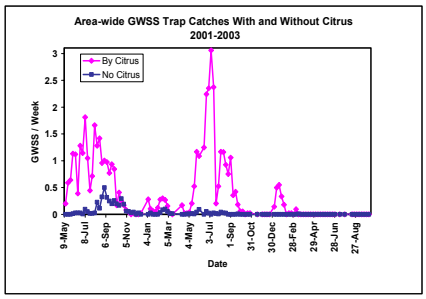
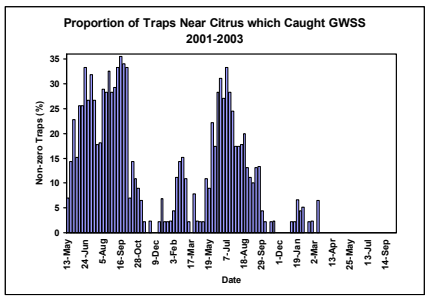


Figure 2. Sharpshooter trap catches, 2001-2003.

***Relationship of citrus to the abundance of GWSS in vineyards*:** Numerous studies have shown citrus to be a key host for GWSS and we studied the contribution of citrus proximity to GWSS densities in grapes near citrus. Prior to the vector reduction program in the February 2003, we found that traps adjacent to citrus caught more GWSS than those not adjacent to citrus (Figure 3). However, the presence of citrus did not always result in elevated GWSS catches; fewer than 35 percent of the traps adjacent to citrus caught GWSS on any given week (Figure 4). This indicates that vector control strategies should be targeted at citrus, but all citrus groves in the Coachella Valley do not need treatment at this time. We also conducted extensive studies at 25 citrus/grape interface study sites. At each site, traps were placed in 4 plots: along the citrus border, within the vineyard adjacent to the citrus (designated "Grapes-Near", Figure 5), 500 ft from the citrus (Grapes-Medium), and 1000 ft from the citrus (Grapes-Far). When GWSS were caught (on 31 of 90 weeks, no GWSS were trapped in the Valley), traps near citrus consistently caught the most GWSS than traps within the vineyards, statistically different on 20 weeks ($P<0.05$, Tukey-Kramer). The effect on PD epidemiology of these decreases in GWSS with distance from citrus are not clear, but Perring et al. (2001) showed PD incidence was higher, on average, in vines next to citrus compared to vines distant from citrus. Our Coachella Valley data support the practice of focusing vector control on citrus and grapes immediately adjacent to the citrus. At the same time, the data indicate that area-wide insecticide applications in vineyards that are not close to citrus are unwarranted in the Coachella Valley.





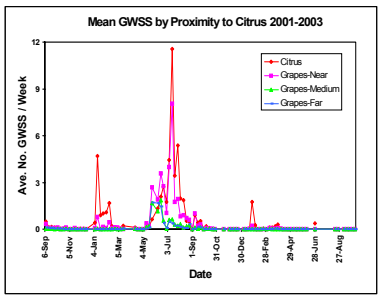


Figure 3 **Figure 4** **Figure 5**

CONCLUSIONS

This year we identified two additional fields in the Coachella Valley with PD, bringing the total to three fields. In each of these fields, many of the vines show severe disease, suggesting they have been infected for some time. Some of the vines show less-severe symptoms that may indicate more recent infections. While we currently have no basis for linking symptom severity to length of infection in mature vines, we are interested in this relationship because it may provide information on primary and secondary spread of PD by GWSS.

Early in our research program, we established a geographic information system (GIS) in which we have managed 90 weeks of data from 156 traps. This provides a powerful tool for data manipulation and allows us to link GWSS densities to spatial information, and use these relationships to identify sites that should be targeted for vector reduction. For example, we can display the traps that have caught more than 0 GWSS per week (or conversely identify traps that have never caught a GWSS) through the course of the study (Figure 6A). Similarly, the GIS can be used to display traps with varying densities of GWSS, (>5, Figure 6B or >20, Figure 6C).

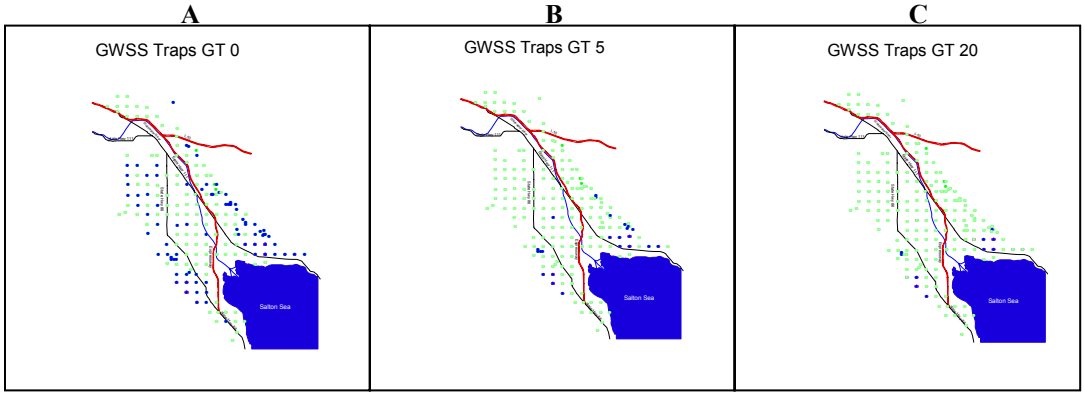


Figure 6. Trap locations (green) and those traps (in blue) that caught greater than (GT) 0 GWSS, GT 5 GWSS, or GT 20 GWSS per week through the course of this study (May 2001 - October 2003).

If we specify a certain distance around each of the traps (we used 500 ft. for this analysis), we can identify citrus blocks near traps with various GWSS densities. From this exercise, we identified the groves within 500 ft. of traps that have caught five or more GWSS/week (Figure 7A) and groves near traps that have caught one or more GWSS/week (Figure 7B) at anytime from May 2001 - October 2003. Using five GWSS/week as a threshold, treatment would be necessary on 4822 acres, while a threshold of one GWSS would result in 8192 acres needing treatment. Depending on resources available for vector reduction, these types of analyses can be extremely useful to prioritize citrus groves for application.

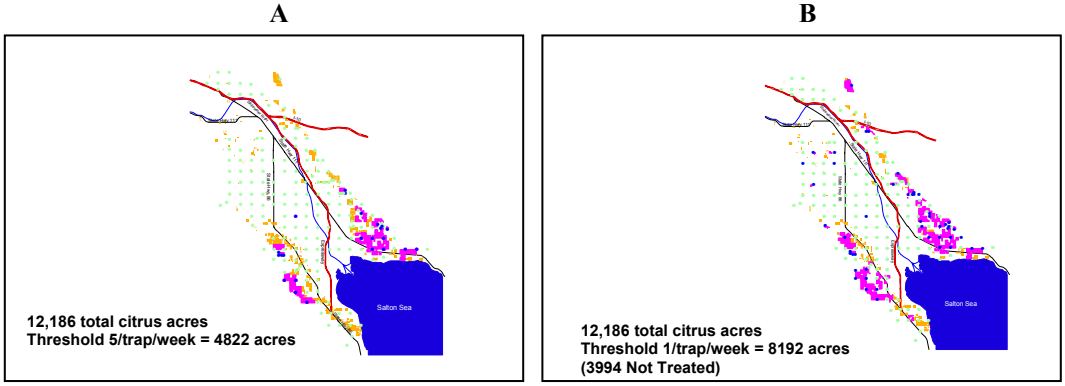


Figure 7. Trap locations (green), citrus groves (orange) and groves within 500 ft. of sticky trap (purple) that caught at least 5 GWSS/week (A) or at least 1 GWSS/week (B) during any week between May 2001 and October 2003.

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FUNDING AGENCIES

Funding for this project was provided by the California Desert Grape Administrative Committee, the University of California Pierce's Disease Grant Program, and the California Department of Food and Agriculture. We acknowledge and appreciate the support we have received.