MONITORING AND CONTROL MEASURES FOR PIERCE'S DISEASE IN KERN COUNTY, AND EPIDEMIOLOGICAL ASSESSMENTS OF PIERCE'S DISEASE

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ABSTRACT
Vineyards in seven grape production areas of Kern County's area wide management project for 2002-2003 were surveyed for PD. Incidence of Pierce's disease (PD) in the highly affected areas (General Beale and North) peaked in 2002, and declined in 2003. Treatments to reduce glassy-winged sharpshooter (GWSS) and identify and remove PD infected vines each year were associated with these dramatic reductions. A representative General Beale vineyard is mapped for years 2001 – 2003. An epidemiology data processing center was established at Center for the Assessment and Monitoring of Forest and Environmental Resources (CAMFER) at University of California, Berkeley.

INTRODUCTION:
These two projects have complimentary objectives and methods, and were thus pursued and are being reported here cooperatively. This combination of people and resources has resulted in synergistic efficiency.

The epidemiology of Pierce's disease (PD) changed dramatically in California with the arrival of the glassy-winged sharpshooter (GWSS) about 15 years ago. Before that time the disease caused losses, but the damage accumulated gradually resulting in the loss of a small percentage of vines. With the arrival of the GWSS, however, PD spread has increased logarithmically, such that entire vineyards were destroyed in as little as 3 to 5 years. In Kern County where the disease was previously inconsequential, PD may now threaten more than 88,000 acres of grape production. To cope with this development there have been extensive field studies to determine effective methods to control the insect vector, the GWSS. However, our understanding of how to control the disease (goal of project 1) and the characterization of the changes in the epidemiology of PD when the causal bacterium is transmitted by GWSS (goal of project 2) has been based on limited field data.

The cooperative area-wide pest management of the GWSS project has defined seven distinct grape growing areas in Kern County. These areas represent various "stages" in the PD epidemic, ranging from the General Beale area--where GWSS was first observed in 1997 and where the epidemic occurred first and has been most severe--to the Highway 65-Delano area where GWSS was first observed in 2002 and where there is still very little PD. This variation among growing areas in combination with the significant accumulation of field data about these areas makes Kern County an ideal area to locate epidemiological projects. Extensive data have been obtained about GWSS populations and the effectiveness of various treatments in controlling GWSS. These two projects are obtaining data about the incidence of PD over time in each area, and the control measures and possible epidemiological factors that may affect the epidemic.

OBJECTIVES
Project 1: Monitoring and Control Measures For Pierce's Disease In Kern County.

1. Determine changes in the incidence of PD over time in seven distinct grape-growing areas in Kern County.
2. Develop PD monitoring and management techniques and strategies for use by growers to reduce risk and damage. Update and provide educational materials to assist vineyard managers, pest control advisors, other researchers and government agencies involved in advising growers in the area-wide pest management of the GWSS project.

Project 2: Epidemiological assessments of Pierce's Disease.
Evaluate the importance of epidemiological factors such as GWSS population size, vine age, cultivar susceptibility, control practices, and GWSS control treatments in vineyards, and nearby GWSS hosts or habitat.
Create a central data processing facility at the Center for the Assessment and Monitoring of Forest and Environmental Resources (CAMFER) on the University of California, Berkeley campus to compile the data from this project in a GIS format. Share the resulting data, maps, and information with collaborating plant pathologists, statistical analysts, agricultural economists, and other legitimate researchers.

RESULTS AND CONCLUSIONS

Vineyards were monitored by visually inspecting each vine for PD symptoms and collecting and testing (by ELISA) samples from symptomatic vines. Tables 2 and 3 summarize the results for the 7 grape growing areas in Kern County. About 5% of Kern county's grape production acreage was monitored. The General Beale, north, central, south, and west areas have had GWSS since about 1997. In the General Beale and north areas the GWSS populations reached very high numbers in 2000-2001 (see Figure. 1), and the south, central, and west areas have had much lower but persistent populations. GWSS was detected in 2002 in the Hwy 65-Delano area. More than 10 vineyards in the General Beale area and more than two vineyards in the north area were severely impacted by PD in 2001 and 2002, with infection rates between 2% to more than 50%. Many of these were not included in this survey because sampling and testing the high number of infected vines would require more resources than was available. However Figure. 2 presents the progression of the epidemic in a representative Redglobe vineyard. The high infection rate in 2002 probably represents infections that were established in 2000 and 2001. The dramatic reduction apparent in 2003 is associated with a management program of area-wide GWSS reduction combined with roguing PD vines and replanting. This project also demonstrated that monitoring vineyards for PD, testing, removing infected vines, and replanting is very inexpensive when PD incidence is low, in the order of less than $5 per acre per year.

All PD survey data from this project has been compiled in GIS and database formats by CAMFER at University of California, Berkeley. This is the second in a projected five year project. In addition to the vineyards shown in tables 2 and 3, about 3000 additional acres in Kern and Tulare counties have been monitored. The data and the information from GWSS trapping surveys are being added to the data set at CAMFER. The resulting data, maps, and information will be made available to other scientists, government, and industry people involved in the management of PD in California.

A profile was created for each vineyard and the variables recorded include: GPS coordinates, cultivar, vine age/plant date, row and vine spacing, pruning and trellising system, weed index, proximity to other host crops of GWSS, and confirmed presence of *Xylella fastidiosa,* pesticide use information when available, and presence and population levels of GWSS. Fifteen cultivars of varying ages were examined during the project to correlate respective tolerances to PD (Table 1.). Analysis of temporal and spatial PD patterns and comparisons among the vineyards over time should lead to better models of PD epidemiology, a with quantitative estimates of how epidemiological variables, such as the incidence of PD combined with sampled populations of GWSS affect the further spread of PD. This understanding should lead to better control and management practices.

Table 1. Cultivars monitored in 2002-2003 for Pierce's disease.
Vine susceptibility: 1=most tolerant, 2=less susceptible, 3=most susceptible, NA=unknown.

Green		Red		Purple/Black	
Calmeria	3	Christmas Rose	NA	Autumn Royal	NA
French Colombard	2	Crimson Seedless	2	Black Emerald	NA
Jade Seedless	3	Flame Seedless	2	Fantasy Seedless	NA
Muscat	NA	Redglobe	3		
Perlette	NA	Ruby Seedless	2		
Thompson Seedless	1				
Superior Seedless	NA				

Table 2. Summary of the Monitoring for Pierce's disease in 2002.

Areas surveyed for PD	Number of vineyards	Number of acres/ Number of vines	Number of vines tested	Number of PD + vines Number PD+ vines per 1000
General Beale Pilot Area	41	849 ac 450991v.	2095	1238 PD+ * 2.75 +v./1000
North: Edison/Bena	7	159 ac 80769v.	159	116 1.44
South A: Arvin	21	304 ac 154208v.	46	9 0.058
South B: Arvin	28	261 ac 131247v.	74	7 0.053
Central: Arvin	5	55 ac 32631v.	5	0 0.0
West: Hwy 166	32	797 ac 375671v.	57	6 0.016
Hwy 65 and Delano	83	1636ac 790181v.	243	0 0
Total	216	4060ac 2015698v.	2543	1376 0.68

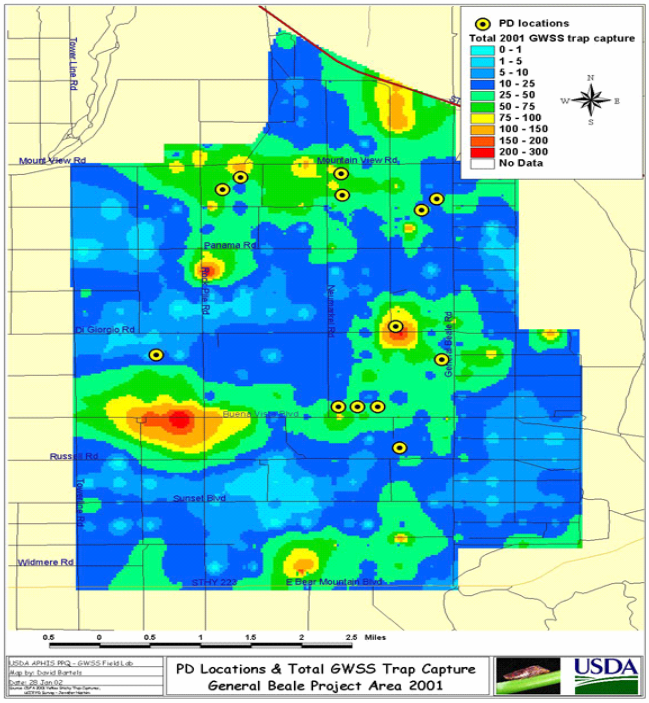
* 98.8% (1224 of 1238) of the PD positive vines in the General Beale area were in 2 out of 6 varieties, Redglobe and Crimson, on 113.4 acres and 40 acres respectively.

Table 3. Summary of the Pierce's disease survey effort in Kern County in 2003.

Areas surveyed for PD	Number of vineyards	Number of acres	Number of vines tested	Number of PD + vines Number PD+ vines per 1000
General Beale Pilot Area	41	849	326	188 PD+* 0.42 +v./1000
North: Edison/Bena	7	159	108	82 1.03
South A: Arvin	21	304	28	2 0.013
South B: Arvin	28	261	36	9 0.069
Central: Arvin	5	55	5	0 0.0
West: Hwy 166	32	797	99	22 0.065
Hwy 65 and Delano	83	1636	127	3 0.0038
Total	208	3958.63	729	306 0.152

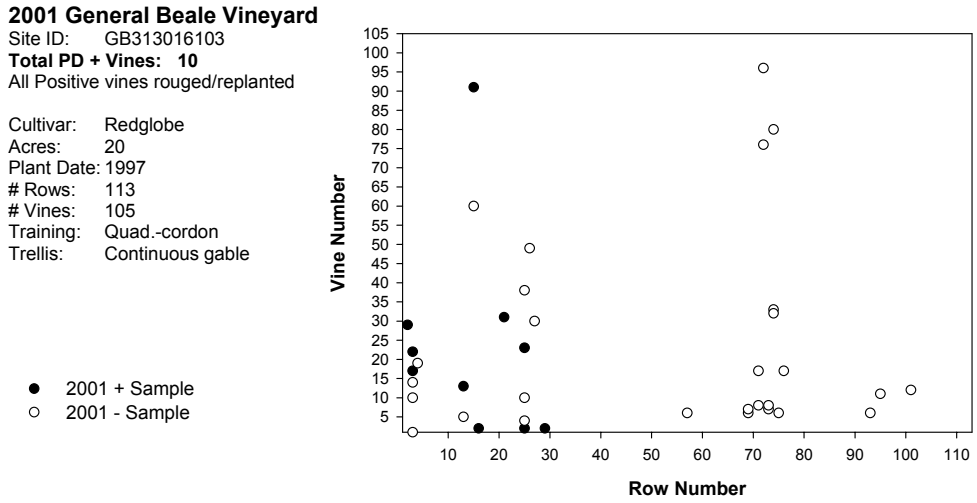
* 96.8% (182 of 188) of the PD positive vines in the General Beale area were in the same 153.4 acres of Redglobe and Crimson as in 2002.

Figure 1. PD locations* and total GWSS trap captures in the General Beale Pilot Project area in 2001.



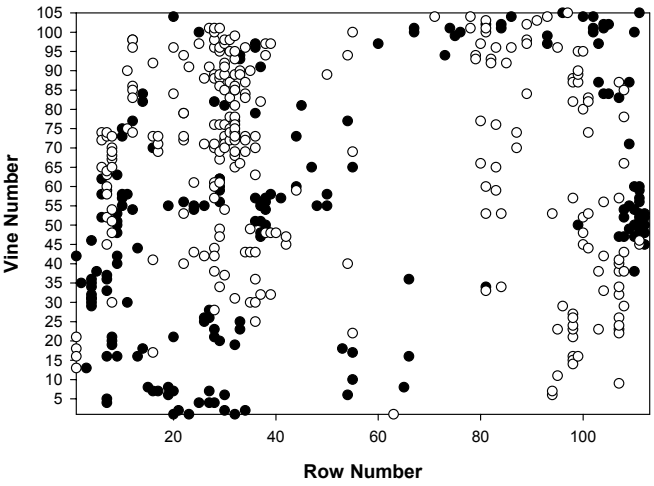
* PD locations are where PD vines were observed but not in all cases mapped nor the incidence quantified.

Figure 2. Three years results of vineyard survey in General Beale area.



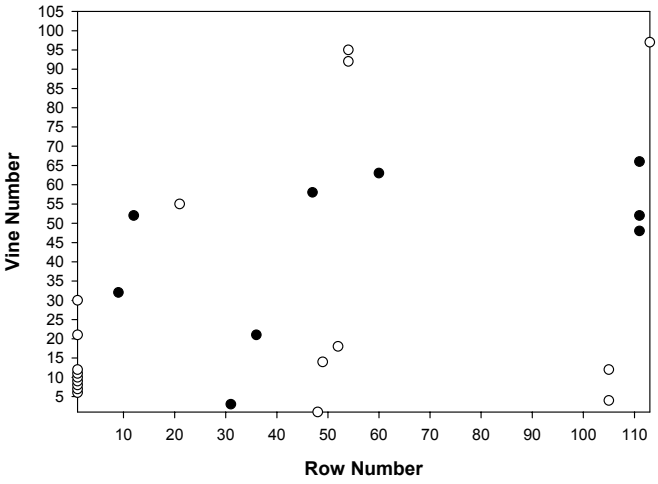
2002 General Beale Vineyard
Site ID: GB313016103
Total PD + Vines: 184
All Positive vines rogued/replanted

Cultivar: Redglobe
Acres: 20
Plant Date: 1997
Rows: 113
Vines: 105



2003 General Beale Vineyard
Site ID: GB313016103
Total PD + Vines: 9
All Positive vines rogued/replanted

Cultivar: Redglobe
Acres: 20
Plant Date: 1997
Rows: 113
Vines: 105



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