Annual report to the Almond Board of California for the project entitled:

Surveys for almond leaf scorch in Kern County, CA, and implications on pruning as a tool for management

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Introduction

Since the introduction of glassy-winged sharpshooter (GWSS) into California, considerable attention has been devoted to diseases spread by the bacterium *Xylella fastidiosa* (Xf). The strain of this bacterium which causes almond leaf scorch was first observed in Riverside County around 1930. It did not, however, appear in almond production areas of the lower San Joaquin Valley until 1994 when Sandy Purcell found roadside trees affected b y the disease in Tulare County. In 1996 two Sonora trees were found infected in Kern County, followed by trees in 18 different orchards by the end of 2003. The recognition of the disease in Kern County at about the same time that the potential new vector, glassy-winged sharpshooter, was arriving and spreading was very disconcerting to many almond growers due to the potential of this disease to significantly impact almond production in Kern County as well as statewide.

There is currently very little known about almond leaf scorch compared to other diseases caused by Xf such as Pierce's disease of grapes and citrus variegated chlorosis. This includes information on the identification, biology and management of the vector as well as details on how the disease affects the tree and how it could potentially be managed. For example, the only recommendation currently available for managing the disease once a tree becomes infected is to get a chainsaw. This recommendation will stand until more research-based information on the biology of the vector or disease epidemiology can lead to more preventative or at least less drastic management options.

The purpose of this project was twofold. First, we wanted to survey Kern County for incidence of almond leaf scorch disease. Surveys are an important way to identify trends in infection such as varieties affected, locations of infected orchards and their relationship to each other, as well as severity of infection. Surveys for the disease were also necessary to provide research locations for the second purpose of the project: to determine if localized pruning could be used to remove almond leaf scorch from infected trees as an alternative to removal of the entire tree.

Objectives

1. Conduct surveys in Kern County to determine the locations of blocks with trees expressing symptoms of almond leaf scorch.
2. From these blocks, identify 2-3 that have a high incidence of trees expressing early symptoms of almond leaf scorch.

3. Evaluate pruning as a means for removal of almond leaf scorch

Methods and results

1. Conduct surveys in Kern County to determine the locations of blocks with trees expressing symptoms of almond leaf scorch.

Surveys were conducted during fall 2003 and 2004 to identify almond orchards with trees expressing almond leaf scorch symptoms. This was accomplished by direct contact with growers from areas across Kern County. Growers were educated on symptoms of almond leaf scorch through a series of field meetings, personal communications, and newsletter articles. Growers and PCAs were asked to report any suspected infestations to the Kern County UCCE office. Upon contact with the UCCE office visits were made to the field to validate the presence or absence of almond leaf scorch. Visual symptomology on trees was validated as almond leaf scorch by evaluation through ELISA.

By the end of 2003, we identified a total of 23 orchards in Kern County with at least one tree showing symptoms and testing positive for almond leaf scorch (Fig. 1). Infested orchards ranged from the Wheeler Ridge area in the south up to the border with Tulare County in the north. The greatest concentration of orchards with infested trees was in the Rosedale area in the vicinity of Highway 58 (Rosedale Highway) and Highway 33 (Enos Ln.).

The locations of each of the 23 orchards with at least one infested tree as well as the varieties affected and not affected in each orchard is shown in Table 1. Sonora was by far the most severely affected almond variety. It was present in 21 of the 23 almond leaf scorch orchards; and had at least one symptomatic tree in 20 of those 21 orchards (95.2%). Sonora also typically had the highest percentage of trees infested at any single location. The highest rate of infection for any variety at any location was approximately 4.1% for Sonora at site 23.. In most cases the percentage of trees affected ranged from a few to a few dozen trees per block, and the majority of infected trees were at the edges of the orchard.

The second most affected variety was Nonpareil. Nonpareil was present in 22 of the 23 orchards; however, symptomatic trees were only found in 7 of those orchards (31.8%). So despite the fact that it was the second most common variety to express symptoms, the percentage of orchards with at least one infested tree was reduced by two thirds compared to Sonora. One could also argue that this percentage reduction compared to Sonora is actually higher since the number of Nonpareil trees in some of the orchards is twice that of Sonora.

Other varieties with symptomatic trees included Fritz, Butte, Padre and Price. At least one Fritz tree was symptomatic in 3 out of 11 orchards where it was present (27.3%), at least one Butte tree at 1 of the 6 orchards with this variety (16.7%), in at least one tree at 1 of the two locations planted with Padre (50%), and at the only location containing Price (100%).

Varieties that had no trees expressing ALS symptoms despite being in orchards where trees of other varieties were symptomatic included 6 orchards with Carmel and one orchard each with Monterey, Mission and Aldrich.

2. From these blocks, identify 2-3 that have a high incidence of trees expressing early symptoms of almond leaf scorch.

Three almond orchards were identified as expressing some of the highest incidences of almond leaf scorch. These included site 8, 6 and 23 (Table 2). We visited each of these sites in more detail to determine the feasibility to conduct a pruning experiment. Site 8 had a history of almond leaf scorch and the grower had previously removed dozens of trees as well as attempting whole scaffold removal. In nearly all cases trees where entire scaffolds had been removed the trees expressed symptomatic leaves on all remaining scaffolds. Due to the fact that the trees were well over 15 years old and all leaf sampling would have to be done with an extended ladder made this site unfeasible from a research standpoint as well as completely impractical from a grower's perspective.

The size of the trees at the second site (site 6) were ideal for experimentation. However, a quick survey revealed that there were nearly no trees with new infestations throughout the orchard. Additionally, nearly all symptomatic leaves that we found on our initial survey dropped prematurely from the trees before a complete survey could be conducted. This scenario is a very real one that growers would have to face if attempting pruning to remove almond leaf scorch. Surveys would have to be completed very quickly with pruning taking place shortly after, and maybe even before, harvest before symptomatic leaves drop prematurely from the tree.

The third site (site 23) was chosen as the best candidate for a pruning trial. The trees were small enough that foliar symptoms could be rated and collection of leaf samples was practical. We surveyed all of the Sonora trees and rated them on a scale of 0 to 4. A zero rating was given to trees expressing no symptoms, a one was assigned to trees in which only one scaffold in one quartersection of the tree had symptomatic leaves, a two was where symptomatic leaves were in two different quartersections within one half of the tree, a three was three quartersections and a four was assigned if symptomatic leaves were in all four quartersections.

A total of 2,055 almond trees were surveyed for symptoms of almond leaf scorch. Of those, 85 (4.1%) were symptomatic. Of these 85 trees, 76 (89.4%) were given a rating of four, 1 (1.2%) was given a rating of three, 3 (3.5%) were given a rating of two, and 5 (5.8%) had symptomatic leaves on only one scaffold. Numerous other trees had other scorch symptoms that were due to salt burn that were not associated with the almond leaf scorch disease.

3. Evaluate pruning as a means for removal of almond leaf scorch

Due to the very low incidence of new almond leaf scorch infections (5 trees out of an orchard of 2,055 Sonora trees) it was not possible to do pruning experiments. This is unfortunate from a research standpoint, but extremely encouraging for growers in Kern County. It appears that at this site, as well as many of the others, that trees expressing symptoms in 2004, and that did not express symptoms in 2003, are rare. This suggests that disease incidence may be declining instead of spreading exponentially as was feared in the early 2000s when glassy-winged sharpshooter became more widespread in Kern County.

Conclusions

Surveys for almond leaf scorch conducted in Kern County provide an optimistic view to the future of almond leaf scorch. A total of 23 orchards have been identified as having at least one tree with almond leaf scorch; however, no new orchards were found infested in 2004 that were not previously known to be infested in 2003, and newly infected trees in orchards previously known to have infected trees were highly uncommon. In all the surveys, Sonora was the most affected variety, followed by Nonpareil and Fritz. Highest disease incidence was approximately 4.1% for Sonora at site 23 and at most locations ranged from only a few isolated trees to one or a few dozen throughout the entire block.

We were not able to determine the effectiveness of pruning as an alternative to whole tree removal, primarily due to the lack of newly infested trees. Approximately 93% of the trees with the disease expressed symptoms in greater than one half, and in most cases the entire, tree. Other impediments to the practical use of pruning by a grower were identified as difficulties in sampling related to tree size, premature leaf drop, difficulty of recognition of symptoms (especially where large amounts of salt burn is present), and time required for sampling and laboratory work to validate almond leaf scorch infection in a tree.

Acknowledgements

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Figure 1. Kern County map showing locations of almond orchards with at least one tree testing positive for almond leaf scorch, 2004.

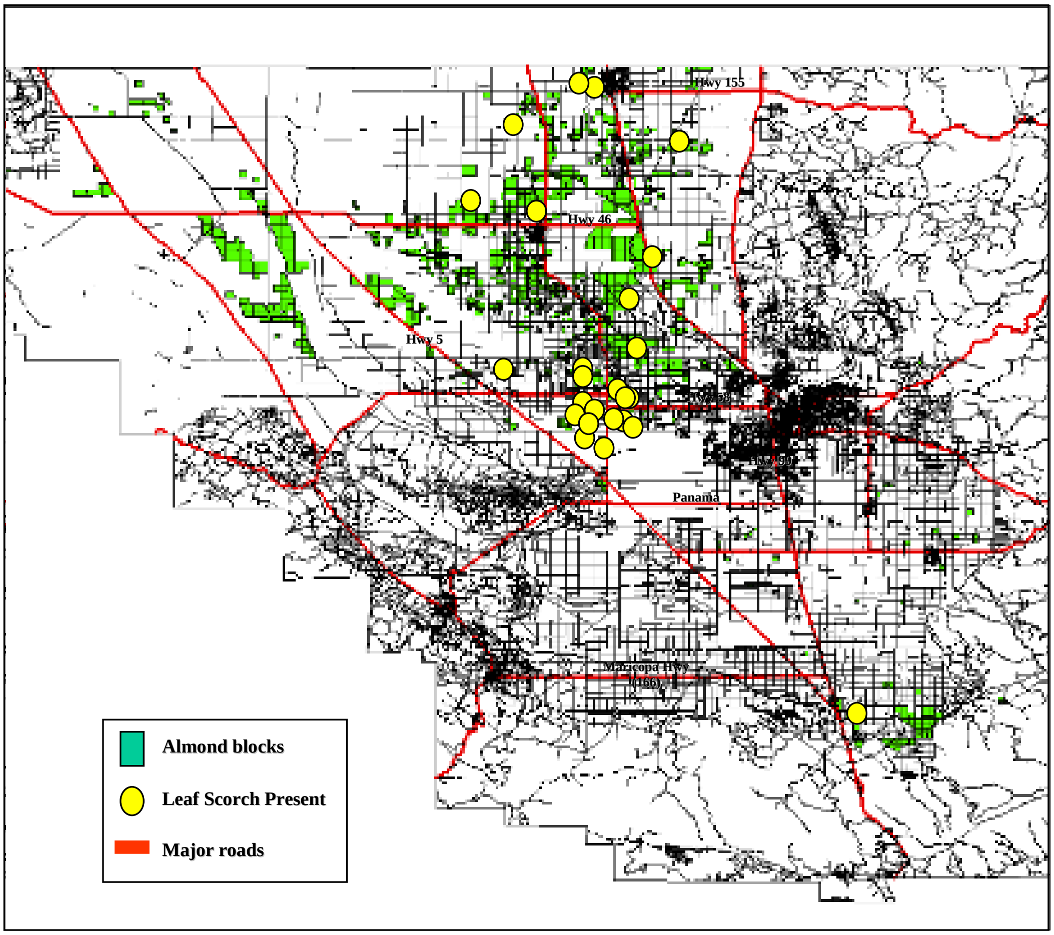

Table 1. Location of orchards affected by almond leaf scorch in Kern County, CA., including almond varieties expressing and not expressing foliar symptoms in each orchard in fall 2004.

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Site #	General location	Varieties with at least one symptomatic tree	Varieties expressing no symptoms	Approx. age of orchard in 2004 (years)
1	Wheeler Ridge	Nonpareil	Monterey Carmel Fritz	10
2	Enos Lane South of Stockdale Highway	Sonora Butte	Nonpareil	10
3	Stockdale Hwy. East of Enos Lane	Sonora Price Nonpareil	Carmel	15
4	Enos Lane North of Stockdale Hwy.	Nonpareil Sonora	Carmel	20
5	North of Stockdale Hwy. West of Enos Lane (A)	Sonora Nonpareil	Fritz	15
6	North of Stockdale Hwy. West of Enos Lane (B)	Sonora	Nonpareil Butte	15
7	North of Rosedale Highway East of Enos Ln.	Sonora Fritz	Nonpareil	10
8	North of Hwy. 58 West of Mayer Ave	Sonora Nonpareil Fritz		10
9	South of Sullivan West of Wasco Way	Sonora	Nonpareil Fritz	10
10	North of 7th Standard East of Santa Fe Way	Sonora Nonpareil	Mission Padre Butte	12
11	West of Enos Lane South of Snow Road	Sonora	Nonpareil Fritz	10
12	North of Lerdo Hwy. East of Hwy. 99	Nonpareil	Sonora Butte	12
13	North of Lerdo Hwy West of Friant-Kern Canal	Sonora	Carmel Nonpareil	10
14	Riverside Dr West of Hwy. 43	Sonora	Nonpareil Butte	10
15	Kimberlina West of Hwy 99	Sonora Fritz	Nonpareil	10
16	Hwy 46 West of Palm	Sonora	Nonpareil Carmel	15
17	Wildwood North of McCombs	Padre	Butte	
18	Peterson Zerker	Sonora	Nonpareil Carmel	20
19	Cecil Ave. East of Timmonds	Sonora	Fritz Nonpareil	15
20	Cecil Ave. West of Timmonds	Sonora	Fritz Nonpareil	15
21	Whisler Rd. West of Garzoli	Sonora	Nonpareil Aldrich	12
22	Zerker North of 7th Standard	Sonora	Nonpareil Fritz	12
23	Magnolia North of Pond Rd.	Sonora	Nonpareil Fritz	12