Effects of Almond Leaf Scorch Disease on Yield and Tree Vitality

Project No.: **07-PATH9-Sisterson**

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Interpretive Summary:

Almond leaf scorch disease (ALS) has been present in California for more than 60 years. This disease is caused by the bacterium *Xylella fastidiosa* (Xf) and is vectored by xylem feeding insects, including sharpshooters and spittlebugs. The disease is present in orchards throughout the state, but usually affects only a small proportion of trees and large increases in the number of infected trees within orchards between years is typically not observed. A major question for growers is whether or not to replace infected trees. As tree-to-tree spread of ALS appears to be rare, the decision to replace infected trees should focus on productivity. We compared yield and vitality between infected and uninfected almond for the cultivars Sonora and Nonpareil. The cultivar Sonora was examined at three sites over four years and the cultivar Nonpareil was examined at one site over three years. Yields of ALS-affected trees were significantly lower for both cultivars. Due to the reduced productivity of ALS-affected trees, it has been hypothesized that healthy trees which are next to infected trees may produce greater yields than healthy trees which are next to other healthy trees. If true, such yield compensation could negate losses due to ALS. This hypothesis was tested for the cultivars Sonora and Nonpareil in the fall of 2007. While healthy trees that were next to ALS-infected trees produced numerically higher yields, the effect was not stasticially significant. The information collected in this study was used to develop a simple economic model to determine conditions under which replacing infected trees would increase returns. Based on the model, orchard age, yield loss due to infection, and the value of a maximally producing almond tree should be considered when deciding to remove ALS-affected trees.

Objectives:

1. Compare yields of almond leaf scorch affected trees to those of unaffected trees.
2. Determine if yields of unaffected trees adjacent to almond leaf scorch affected trees compensate for yield losses due to almond leaf scorch disease.
3. Develop an economic model to use as a decision tool.

Materials and Methods:

Compare Yields of Almond Leaf Scorch Affected Trees to Those of Unaffected Trees

The yields of ALS-affected and unaffected trees for the cultivars Sonora and Nonpareil were compared at two sites in Fresno County and one site in Kern County over the past four years. In each orchard ten ALS-affected and ten unaffected trees were evaluated.

Determine if Yields of Unaffected Trees Adjacent to Almond Leaf Scorch Affected Trees Compensate for Yield Losses due to Almond Leaf Scorch Disease

Due to the reduced productivity of ALS-affected trees, it has been hypothesized that healthy trees which are next to infected trees may produce greater yields than healthy trees which are next to other healthy trees. If true, such yield compensation could negate losses due to ALS. This hypothesis was tested for the cultivars Sonora and Nonpareil in the fall of 2007 at the same orchard used in the previous study. To accomplish this, yields of unaffected trees that were randomly distributed in each orchard were compared to those of unaffected trees that were next to an infected tree in each orchard. Ten trees of each type were evaluated per orchard.

Develop an Economic Model to use as a Decision Tool

A simple analytical model was developed to determine the condition under which the cost of tree replacement would be warranted. This was accomplished by comparing the value of an infected tree to a replanted tree over the lifetime of an orchard. Several key assumptions are highlighted. First, the orchard was assumed to be sufficiently mature so that trees produced their maximum yield (i.e., > 7 years old). Second, newly replanted trees were assumed to produce lower yields than mature trees until replanted trees reached maturity. Third, infected trees did not die and yield loss due to infection was consistent over years. Fourth, the value of almonds was consistent over years. Fifth, tree-to-tree pathogen spread was assumed to be neglible. Finally, the lifetime of an orchard was finite. The model suggests that ALS-affected trees should be replaced only if the following condition is met (see Sisterson et al. 2008 for derivation):

$$C < S * Y * [R * (1 - P_i) - G]$$

Where *C* is the cost of replacing an infected tree, *S* is the sale price of almonds, *Y* is the average yield of a healthy tree, *R* is the number of years until the orchard is replaced, P_i

is the proportional yield loss of an ALS-affected tree, and *G* is the number of lost production years due to replanting.

Results and Discussion:

Compare Yields of Almond Leaf Scorch Affected Trees to Those of Unaffected Trees

Averaged across sites and years, ALS-affected Sonora trees produced 40% fewer kg of kernel relative to unaffected Sonora trees. Comparisons for the cultivar Nonpareil were made at one site in Kern County over the past four years, although data were not collected in 2006. Averaged over years, ALS-affected Nonpareil trees produced 20% fewer kg of kernel relative to unaffected trees.

Determine if Yields of Unaffected Trees Adjacent to Almond Leaf Scorch Affected Trees Compensate for Yield Losses due to Almond Leaf Scorch Disease

Averaged over three sites, healthy Sonora trees which were next to ALS-affected Sonora trees produced 10% more kg's of kernel than healthy trees which were next to other healthy trees, although this effect was not significant. For the cultivar Nonpareil, we found that healthy trees next to ALS-affected trees produced 8% more kg's of kernel than healthy trees next to other healthy trees, although this effect was also not significant. Thus, after one year of testing it appears that the compensatory effects are minimal.

Develop an Economic Model to use as a Decision Tool

A key assumption of the model is that replanted trees produce lower yields than fully mature trees until replanted trees reach maturity. Thus, an ALS-affected tree should never be replaced if the yield loss due to replanting (i.e., yield loss due to waiting for a replanted tree to mature), exceeds the yield loss due to keeping an ALS-affected tree over the lifetime of the orchard (i.e., $G > R^*[1 - P_l]$). In general, replacing an infected tree would never be cost effective if the entire orchard were replaced before the replanted tree produced yields that were at least equivalent to the infected tree it replaced. Consequently, higher replanting costs are acceptable for young orchards compared to old orchards.

Recent Publications:

Sisterson, M. S., J. Chen, M. A.Viveros, E. L. Civerolo, C. Ledbetter, & R. L. Groves. 2008. Effects of almond leaf scorch disease on almond yield: implications for management. Plant Disease 92: 409-414.

Groves, R. L., J. Chen, E. L. Civerolo, M. W. Freeman, and M. A. Viveros. 2005. Spatial analysis of almond leaf scorch disease in the San Joaquin Valley of California: factors affecting pathogen distribution and spread. Plant Disease 89: 581-589.