Almond Leaf Scorch: Role of Insects and Weeds

Project No.: **07-PATH7-Daane**

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Objectives:

1. Compare *X. fastidiosa* presence and strains in ALS-infected orchards with *X. fastidiosa* in alternate hosts nearby, especially weeds;
2. Collect insects in ALS-infected orchards and nearby vegetation and determine if they carry *X. fastidiosa*;
3. Test sharpshooters for *X. fastidiosa* transmission efficiency between almonds and weeds commonly found in almond orchards;
4. Collect ALS epidemiology data with respect to orchard management and the environmental conditions;
5. Describe sharpshooter biology and development; and
6. Conduct experiments to reduce sharpshooter density in winter and spring**.**

Interpretive Summary:

Xylella fastidiosa is the xylem-limited bacterium that causes almond leaf scorch (ALS), Pierce's disease (PD) of grapevines, and other plant diseases. To better understand the epidemiology of *X. fastidiosa* and biology of its insect vectors, six ALS-infected almond orchards in the northern, central, and southern San Joaquin Valley surveyed for *X. fastidiosa* in vegetation and Cicadomorph insects over two years.

Vegetation samples were tested for *X. fastidiosa* by immunocapture PCR. Sixty-three of 1369 samples contained *X. fastidiosa*, with positive samples found between November and March, and 11 of 38 species of common weeds tested were positive, including

shepherd's purse, filaree, cheeseweed, burclover, annual bluegrass, London rocket, and chickweed.

4.9% of <42,000 cicadomorph insects (leafhoppers, spittlebugs, planthoppers and treehoppers) collected were xylem feeders, mostly green sharpshooters, *Draeculacephala minerva*. Insect populations were highly seasonal, with few vectors collected from December to mid-April, populations increasing in late April, and peaking from mid-June through mid-July. Green sharpshooters (GSS) were eliminated inside the orchard when vegetation was removed for almond harvest in mid to late July, although they were still found in adjacent intact vegetation into September. Sites in Butte and Glenn counties had much higher green sharpshooter populations (2.49 and 8.77 GSS/100 sweeps) than sites in Stanislaus (0.66 GSS/100 sweeps) or Kern counties (0.08 GSS/100 sweeps). Green sharpshooters were collected more frequently at the margins (8.4/100 sweeps), compared to >10m inside (1.5/100 sweeps) and >10m outside the almond orchards (3.3/100 sweeps). Roughly the same green sharpshooter populations were found on riparian habitat, orchard floor vegetation, and weeds near roadsides. 1.1% of green sharpshooters tested carried *X. fastidiosa*. Positive insects were collected between May and July on orchard weeds. Bacterial strains in sharp-shooters matched strains isolated from ALS-infected trees and weeds at the same sites.

Both ground vegetation and almond trees were most commonly infected with the almond strain of *X. fastidiosa*. ALS-infected almond samples had bacterial titers within previously reported ranges (1.84 x 106 - 2.15 x 107 CFU/g). Between 1.9 and 0.17% of almond trees at the study sites had ALS in 2004.

An insecticide spray applied to almond orchard floor vegetation in January at one of the study sites did not suppress green sharpshooter populations or populations of cicadomorphs in general for the following growing season.

The biology of the green sharpshooter, the main ALS vector, is much different from the biology of the main PD vectors, the blue-green sharpshooter or the glassy-winged sharpshooter. Green sharpshooters feed and breed on common ground vegetation species that can harbor *X. fastidiosa* on the almond floor. They have multiple generations per year, with generation times between 28 and 49 days in lab tests. While the proportion of almond trees, insects, and alternate weedy hosts with *X. fastidiosa* is low, green sharpshooter populations can be high, and ground cover extensive in orchards with sprinkler or flood irrigation, or in areas with abundant winter rainfall. In orchards with ALS-susceptible varieties, sampling to determine ALS prevalence and green sharpshooter occurrence, and a spring-summer weed control program may assist in ALS management.

A B

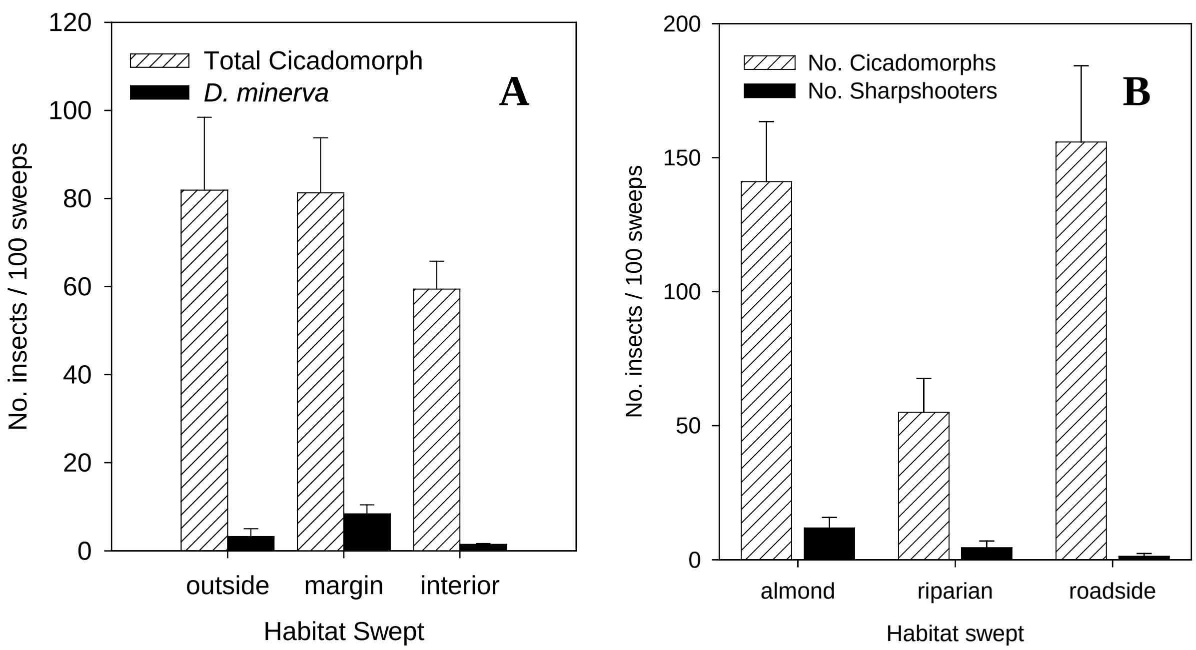
120
100
80
60
40
20
0
No. insects / 100 sweeps
Total Cicadomorph
D. minerva
A
outside
margin
interior
Habitat Swept
200
150
100
50
0
No. insects / 100 sweeps
No. Cicadomorphs
No. Sharpshooters
B
almond
riparian
roadside
Habitat swept

Table 2: *X. fastidiosa* infection in greenhouse (GH) and field-grown alternate hosts following needle inoculation with ALS-6 and Fresno-ALS strains. Infections assessed after 4 to 8 weeks in field-grown plants, and 4 weeks in greenhouse-grown plants.

Species	Growing location	No. tested	No. infected (%)	CFU/g
Burclover - *Medicago polymorpha*	GH	36	21 (58)	1.77×10^{7}
	field	54	13 (24)	3.00×10^{6}
Cheeseweed - *Malva parviflora*	GH	-	-	-
	field	38	6 (16)	1.35×10^{7}
Chickweed - *Stellaria media*	GH	35	30 (86)	5.93×10^{7}
	field	5	3 (60)	-
Filaree - *Erodium* sp.	GH	-	-	-
	field	6	2 (33)	6.44×10^{7}
Common groundsel - *Senecio vulgaris*	GH	-	-	-
	field	28	3 (11)	3.34×10^{3}
London rocket - *Sysimbrium irio*	GH	17	8 (47)	1.61×10^{6}
	field	17	0 (0)	-
Burning nettle - *Urtica urens*	GH	27	9 (33)	1.09×10^{6}
	field	14	1 (7)	-
Shepherd’s purse - *Capsella bursa-pastoris*	GH	-	-	-
	field	2	0 (0)	-
Sowthistle - *Sonchus oleraceus*	GH	50	15 (30)	3.87×10^{7}
	field	38	3 (8)	8.33×10^{4}

Figure 3: Total Cicadomorph **(A: top)** and *D. minerva* **(B: bottom)** populations swept from vegetation in a Butte County almond orchard in 2005. Treatment was with Asana insecticide on 27 January 2005. Means of the two treatments are not significantly different (repeated measures ANOVA: Cicadomorphs: $P = 0.25$, n = 47, *D. minerva*: $P = 0.68$, n = 47).