SAMPLING, SEASONAL ABUNDANCE, AND COMPARATIVE DISPERSAL OF GLASSY-WINGED SHARPSHOOTERS IN CITRUS AND GRAPES: DISPERSAL PROGRESS REPORT

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ABSTRACT
Environmental variables and host-plant quality influence insect population dynamics and the timing and extent of their dispersal. An understanding of how these factors influence glassy-winged sharpshooter (GWSS) development and movement is needed to better predict the spread of Pierce's disease and to aid area-wide management strategies. We investigated how plant factors (i.e., amino acids, osmolality, xylem pressure) and environmental parameters (i.e., wind speed, temperature, relative humidity, barometric pressure) influenced sharpshooter population dynamics and movement in a citrus grove setting. Number of egg masses and adults were counted on branches that were sampled for xylem sap. Collection date, tree, and cardinal direction were noted, and xylem pressure, and amino acids (total, essential and amides) were measured. In conjunction with xylem sap collections, movement of sharpshooters was monitored with yellow and clear sticky traps at 4-h intervals during the day and throughout the night. During replicated sampling periods, 40 times more sharpshooters were trapped on yellow sticky traps in comparison to clear sticky traps and the majority, regardless of sex, were trapped between 1000 and 1400 h. Higher trap catches were associated with increasing temperatures above 18ºC, but were not significantly associated with changes in wind speed, relative humidity or barometric pressure. Trap catches varied significantly over the trapping season, but did not differ due to trap location, indicating that there was no strong edge effect for GWSS. Relative to xylem sap collections, xylem pressure and amides varied due to collection date and time of day, and xylem pressure was positively correlated with trap catches. Osmolality, total amino acids, essential amino acids, and percent amides had no apparent relationship with trap catch. GWSS egg counts varied significantly due to collection date and cardinal direction, with the majority of eggs observed on the east and south sides of the trees.

INTRODUCTION
Insect dispersal can be influenced by numerous factors, such as increasing population densities, reproductive status, biased sex ratios, host breadth, declining host quality and changing environmental conditions (Denno 1979, 1985; Taylor 1985; Denno et al. 1991; Blackmer and Phelan 1991; Blackmer and Byrne 1993a,b, 1999; Blackmer and Cross 2001). A better understanding of how these factors influence the movement of GWSS will be crucial in the management of this pest and the spread of Pierce's disease (PD).

OBJECTIVE
Determine the effects of host-plant quality and environmental variables on GWSS movement as an aid to predicting insect and disease spread.

RESULTS
In Fillmore, CA movement of GWSS in a citrus orchard was measured relative to time of day, environmental parameters, and xylem flux. Temperature, relative humidity, barometric pressure, wind speed, and wind direction were monitored at the center of the site with a portable weather station. Sticky traps were changed and xylem sap was collected at 4-h intervals from 0600 to 2200 h (8 samples per time interval on five collection dates). Xylem sap was extracted from 25-cm-long orange stems with a pressure chamber (Scholander et al. 1965). An equal number of samples were taken from the four cardinal directions from each of four trees for each sampling interval for a total of 200 samples. We used a Fiske Model 110 micro-sample osmometer to determine osmolality of the xylem sap, and a Beckman 7300 Analyzer to detect amino acids.

Trap Catch
Significantly more sharpshooters were trapped between 1000-1400 h than at any other time interval during the 24-h-sampling periods; very few sharpshooters were trapped at night ($F=14.36$; $df=4, 128$; $P<0.0001$). Yellow traps captured significantly more sharpshooters than the clear control traps (85.6 ± 24.3 versus 2.1 ± 0.88, respectively). However, the patterns of recapture relative to time of day and week were similar regardless of trap color ($R^2=0.44$, $P<0.0005$). Equivalent numbers of males and females were captured relative to collection date, time of day, and trap color. Trap catch varied over the five weeks of the sampling period, and was higher from mid-July to early August when compared to collections made in late August to early September ($F=16.82$; $df=4, 44$; $P<0.0001$). Trap catch relative to position in the field was not significantly different ($P=0.34$), indicating that there was no strong edge effect. Of the environmental parameters monitored, only temperature explained a significant amount of the variability in trap catch in the citrus setting ($R^2=0.58$, $P< 0.0001$). Sharpshooters were rarely trapped when temperatures fell below 18°C.

Xylem Collections

Twenty amino acids were detected, with aspartic acid, serine, asparagine, glutamic acid, arginine, and proline being predominant (comprising 80-90% of the samples). Total amino acids, essential amino acids, percent amides, xylem pressure, and osmolality varied significantly due to collection date ($P < 0.005$ for each). Total amino acids, percent amides and xylem pressure also varied significantly due to time of day ($P < 0.005$), but only xylem pressure and percent amides varied in a consistent manner from week-to-week (Figure 1). Xylem pressure and percent amides peaked at approximately 1400 h. Cardinal direction from which the samples were taken had no effect on amino acid concentrations, or xylem pressure, and only a slight effect on osmolality ($P < 0.05$); highest readings were on the eastern side of the trees.

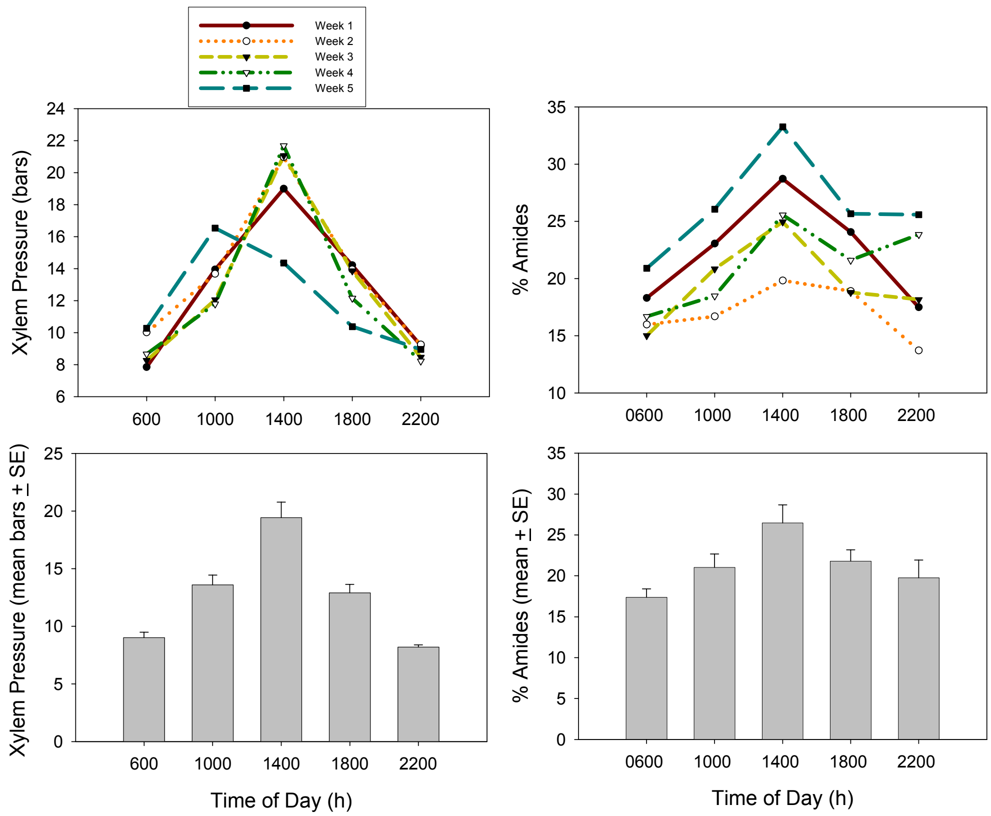

Figure 1. Weekly and mean (± SE) xylem pressure and amides (% ± SE) from orange cuttings relative to time of day, Fillmore, CA.

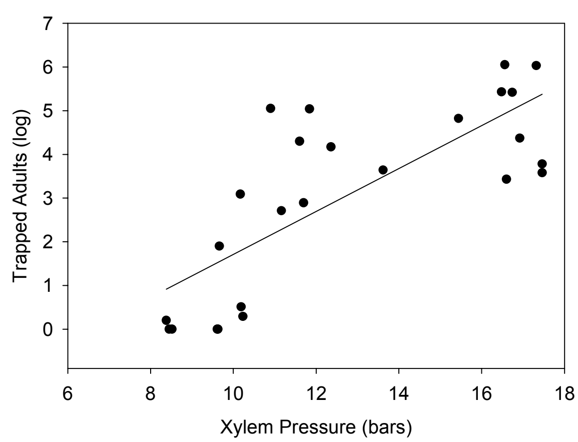

Figure 2. Association between xylem sap pressure (bars) and number of adult GWSS trapped on yellow sticky traps in an orange grove, Fillmore, CA.

Xylem Dynamics and Insect Movement

The number of adults and eggs found on the sampled orange branches varied significantly due to collection dates (P< 0.0001); number of eggs also varied due to cardinal direction (P< 0.0001). Fewer egg masses were found in mid-July than on other collection dates, and most egg massees were found on the east (x = 12.4) or south (x = 10.2) sides rather than the west (x = 6.5) or north (x =5.2) sides of the trees. The number of egg masses was not associated with the number of adults, and was only weakly associated with osmolality (R=0.16; df= 1,198; P=0.025) and essential amino acids (R=0.2; df=1,198; P=0.003). The number of adults trapped on yellow sticky traps was only associated significantly with xylem pressure readings (R = 0.77; df=1,23; P<0.001; Figure 2).

CONCLUSIONS

- Trap catch was influenced by trap color, collection date, and time of day. In the citrus setting, trap catch increased with temperatures above 18ºC. Previously, we found that in a more open setting, flight activity was suppressed by temperatures below 17ºC and by wind speeds above 3 m s^{-1} (Blackmer et al. in press).
- Xylem parameters varied considerably due to collection date, and total amino acids, percent amides and xylem pressure varied due to time of day. However, the number of adults trapped on yellow sticky traps was only associated with xylem pressure. Higher pressures at midday may limit the insects feeding efficiency and lead to opportunistic movements that result in the exploitation of alternate hosts.
- The east and south sides of the citrus trees were preferred sites for oviposition as indicated by higher numbers of egg masses. This preference was weakly associated with higher osmolality and a greater concentration of essential amino acids.

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