HOST PLANT INFLUENCE ON GLASSY-WINGED SHARPSHOOTER AND ITS NATURAL ENEMIES

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ABSTRACT

We followed the abundance of glassy-winged sharpshooter and its natural enemies on different host plants in residential areas near Bakersfield, California. We also used potted plants to provide a replicated array of similarly-conditioned GWSS host species in order to follow GWSS host plant preference. Results show GWSS seasonal-long densities were influenced by host plant species, with oleander, *Xylosma*, and crape myrtle as some of the preferred host plant species for the spring and summer GWSS populations. GWSS preferred different host plant species for adult and nymph feeding as compared with egg-laying. The most effective natural enemies were mymarid parasitoids, with *Gonatocerus ashmeadi* and *G. triguttatus* reared from egg masses collected on most host plants. Predators were present, especially spiders, and often observed feeding on GWSS. However, results did not show any one predator species to be consistently associated with GWSS or with a reduction in GWSS densities.

INTRODUCTION

The commercial existence of table, raisin, and wine grapes grown in the San Joaquin Valley (SJV) is now threatened by the presence of both the glassy-winged sharpshooter (GWSS), *Homalodisca coagulata*, and the bacterial pathogen, *Xylella fastidiosa* (*Xf*). *Xf* is a xylem-limited bacterium that, in highly susceptible host plants, will clog the xylem and result in severe water stress. In grapes, *Xf* is the causal agent of Pierce's disease (PD). Prior to the arrival of GWSS, the most common vectors of PD in California were native sharpshooters (the green sharpshooter, the red-headed sharpshooter, and the blue-green sharpshooter). While PD has long been present in the SJV, its spread and damaging effects were limited because breeding habitats of these native sharpshooters usually were not adjacent to vineyards and these sharpshooters rarely feed on grapevines. GWSS has now dramatically changed PD epidemiology. GWSS has a wide host range, and feeds on many of the same plant species that host *Xf* (Purcell and Sanders, 1989; Blua et al., 1999; Redak et al., 2003). It is a strong flyer that, when hosts are available, can move the bacterium great distances (Blua and Morgan, 2003).

While GWSS has been successfully controlled in citrus and vineyards through areawide insecticide-based control programs, long-term suppression of this pest in urban areas will be better achieved by cultural and biological controls. Here, we present results from GWSS host plant studies designed to test GWSS age structure and population dynamics on common ornamental plants species found in the San Joaquin Valley. We also followed densities of GWSS natural enemies to determine which natural enemies followed GWSS densities and whether host plant species might also influence natural enemy abundance.

MATERIALS AND METHODS

Field survey

GWSS numbers, age structure and natural enemies were surveyed in residential areas in Bakersfield, California. In 2003-2004, we sampled six residential sites that had common ornamental plants that are hosts of GWSS adults or nymphs. At each site there were 3-8 individual plants of each plant species sampled, and >5 GWSS host plant species in close proximity. This combination allowed for multiple samples of each host plant species at each site. Here, we present data from only one site, which had the highest GWSS densities.

To sample GWSS adults and nymphs, as well as their mobile predators, we used a modification of the bucket trap by placing a large sweep net under sections of plant foliage and beating the foliage for 30 s to dislodge insects and spiders into the net. After which, GWSS numbers and developmental stages were recorded. Potential predators were recorded by stage (immature or adult) and family or genus. To sample for GWSS eggs, 100 leaves were non-destructively searched and the number and condition (new, hatched, parasitized, damage/predation) of all GWSS egg masses were recorded. To determine GWSS egg parasitoids present, we collected newly deposited or parasitized egg masses and reared parasitoids to adults in the laboratory.

Host plant preference

In a controlled experiment, we used potted host plants to test the preference of resident GWSS and natural enemy populations to different host plant species. Potted (6.6 L) plants were used to establish a replicated array of similarly-conditioned (e.g., age, size, irrigation) GWSS host plant species in order to study the sharpshooter's egg deposition and nymph and adult feeding preferences. The study was conducted in an unsprayed, GWSS-infested citrus orchard, to replicate conditions in an agricultural site, and an unsprayed, GWSS-infested residence, to replicate conditions in a residential site. At each site, separate trials were conducted with common perennial ornamentals. In 2003-04, perennial species used were ivy, photinia, citrus, gardenia, privet, euonymus, hibiscus, agapanthus (lily of the Nile), grapevine, crape myrtle, eucalyptus, and oleander. The plants were set in a randomized block design (5 blocks each in the citrus orchard and residential area). GWSS eggs, nymphs and adults and GWSS predators and parasitoids were non-destructively counted weekly, from late-March through October 2003 (perennials), by visually searching each leaf and stem for GWSS.

Data are presented as means (± SEM). Treatment influence was determined using regression analysis and Analysis of Variance, with treatment means separated using Turkey's HSD test.

RESULTS AND DISCUSSION

Field survey

When data are combined over all plant species, the seasonal trend shows a strong spring and early summer increase in GWSS,, followed by late fall and overwintering depression (Fig. 1). The summer decline is largely attributed to egg parasitism of the summer brood, which reach >80% by August. Note the presence of both GWSS adults and large nymphs during the winter period. Based on the season-long averages, host plant preference by GWSS adults and nymphs was clearly for oleander and Xylosma at this sampling site (Fig. 2). However, host plant preference GWSS egg deposition shows, as have other studies (Redak et al., 2004), that GWSS adult and nymphs may prefer to feed on host plants that are not the preferred oviposition sites.

We believe that GWSS overwintering may be especially important and provide the following brief analysis of all of the sample sites. No egg masses or recently hatched nymphs were found from November through February. However, GWSS adults, medium and large nymphs were collected on "preferred" overwintering hosts during this period. These are privet (*Ligature* spp.), Japanese Boxwood (*Boxes microphylla*), Wheeler's dwarf (Japanese Mock Orange, *Pittosporum tobira*), red tip photinia (*Photinia* spp.), citrus, and Oleander (*Nerium oleander*). We also found GWSS overwintering exclusively on the "suckers" of the following tree species: Eucalyptus (*Eucalyptus* spp.), Carob tree (*Ceratonia siliqua*), Chinese Elm (*Ulmus parvifolia*), and Olive (*Olea europea*). Oleander and privet may be the most important overwintering hosts in the urban regions. Host plants such as crape myrtle (*Lagerstroemia indica*) and crabapple (*Malus* spp.) are dormant throughout winter and, according to our samples, play no role in the GWSS overwintering. However, they are excellent hosts for oviposition and nymph development during late spring and summer time. In contrast, the flowering pear trees end dormancy early in the year and start blooming by the first week of February and GWSS adults have been found on theses plants in winter.

While nymphs were present throughout the winter, they were typically quite large (late developmental stages) and their density was low, often decreasing to zero on the final winter survey dates. This suggests that either they became adults and moved of the overwintering host or there was increased predator activity or natural mortality in the February-March period. We found are first fresh egg masses in April (2003) and March (2004). The host plants that were preferred as early oviposition hosts are Xylosma, photinia and flowering pear. We note that we have few citrus trees in our urban survey sites, and on those present, we have not found early-season oviposition on citrus was any more preferred than on the listed ornamentals. During this initial oviposition period, the preferred summer oviposition hosts (crab apple, crape myrtle, and grapevines) are not available. Interestingly, few GWSS adults were found in the March-April survey, although new egg masses were detected.

In the urban survey, we found egg parasitism beginning as early as April (<15%) and continuing to build throughout the growing season. By August, there was typically >80% parasitism. *Gonatocerus ashmeadi* and *G. triguttatus* were reared from the egg masses; there was no clear trend in parasitism levels among sampled host plants. In contrast, the density of possible GWSS predators had significant differences among sampled host plant species (Fig. 4); however, predator density did not increase during the spring and summer with GWSS densities, and was not positively related to either the GWSS adult or nymph populations or GWSS egg mass densities.

Host plant preference

Results show GWSS seasonal-long densities were influenced by host plant species, with a significant difference ($P < 0.001$) among host plants, for both perennial and annual categories, in the numbers of GWSS adults and nymphs (Fig. 5) and egg masses (Fig. 6). These data represent seasonal averages, and, therefore, the host plant densities are biased towards those host species that were preferred in June and July, when GWSS densities were the highest in this plot. Interestingly, GWSS egg mass density was not related to adult or nymph density (P=0.25, r^2=0.03; P=0.35, r^2=0.01, respectively). We conclude that GWSS adults have oviposition preferences that may be different from the nymph feeding preference. For example, GWSS nymphs were significantly more common on oleander, which had few GWSS egg masses, than citrus, which had the most GWSS egg masses. We believe this difference is a result of both GWSS adults and nymphs switching among host plants for better food resources throughout the season, and not to a disparate level of predator or parasitoid activity. Within each array of potted host plant species, plants were close enough to each other that GWSS adults could fly and nymphs hop between adjacent host plants.

We looked at egg and nymph mortality among treatments. We found a season-long "egg mass" parasitism rate of 44%; when an egg mass was attacked most of the eggs were parasitized (there were an average 13.8 eggs per egg mass). Emerged parasitoids were *Gonatocerus ashmeadi* and *G. triguttatus* present. Spiders were the most common predator collected (Fig. 7); however, we have yet been able to identify a specific predator as a key mortality agent in either the host plant surveys or the potted plant studies described here. There was a significantly positive relationship between the number of spiders found, the most common predator group, and the number of GWSS egg masses ($P < 0.001$, $r^2=0.28$); in contrast, there was no relationship between the density of egg masses and either GWSS nymphs ($P = 0.20$, $r^2=0.014$) or adults ($P = 0.78$, $r^2=0.001$). Nevertheless, there is a great amount of mortality from the number of deposited eggs to the number of eclosed adults (Fig. 7). Abiotic and biotic mortality factors accounts for a reduction of ca. 3.9 eggs to 0.22 large GWSS nymphs per plant (Fig. 8). These results suggest that natural enemies of eggs (Triapitsyn et al. 1998) and small nymphs significantly reduced the GWSS population.

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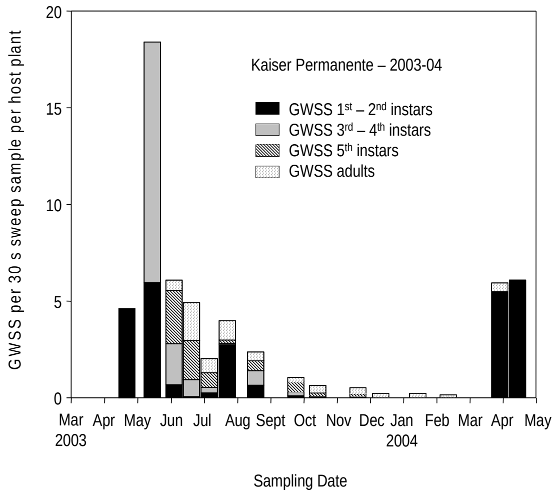

Fig. 1. GWSS densities on ornamental plants show an overwintering decline and a spring to early summer increase in GWSS densities. The summer decline is attributed to egg parasitism. Bakersfield, CA. (Kaiser Permanente, sample site)

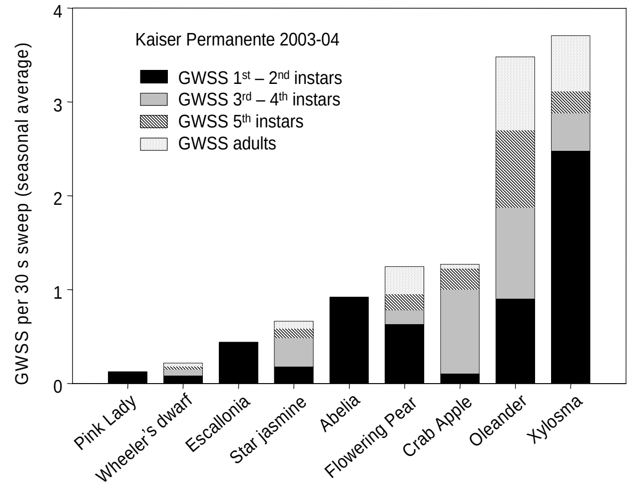

Fig. 2. The seasonal average for host plant preference of GWSS adults and nymphs for oleander and Xylosma at this sampling site. Data are seasonal averages, and are skewed by higher spring GWSS densities. Bakersfield, CA. (Kaiser Permanente, sample site)

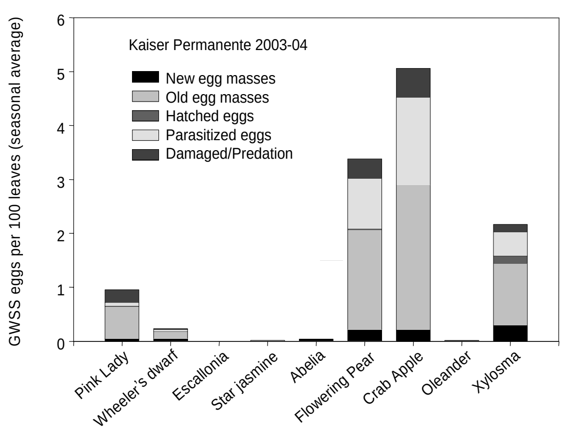

Fig. 3. Seasonal average for GWSS egg masses on common ornamental host plants, note GWSS adult and nymphs have different host preferences (compare with Fig. 2, plant order is similar). Bakersfield, CA.

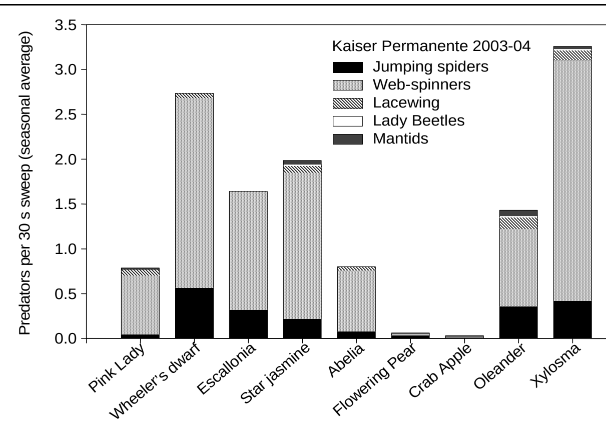

Fig. 4. Seasonal average for GWSS "potential" predators on common ornamental host plants. Predator density was not a significant function of either GWSS adult and nymph (Fig. 2) or egg mass (Fig. 3) densities ($r^2 = 0.23$, $P < 0.05$ and $r^2 = 0.18$, $P < 0.05$). Bakersfield, CA.

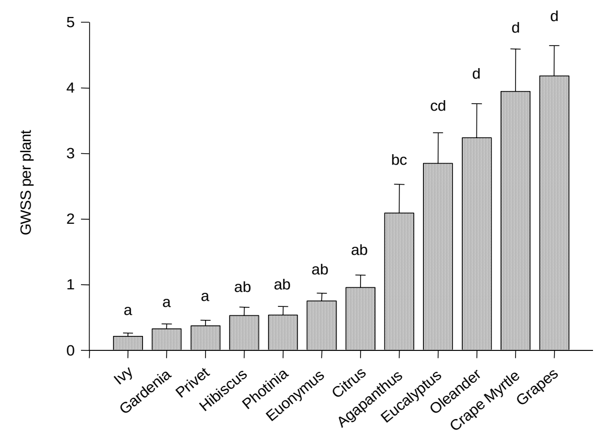

Fig. 5. Average densities (± SEM) of GWSS (nymphs and adults) were significantly different among perennial host plants, Tukey's HSD at $P < 0.05$.

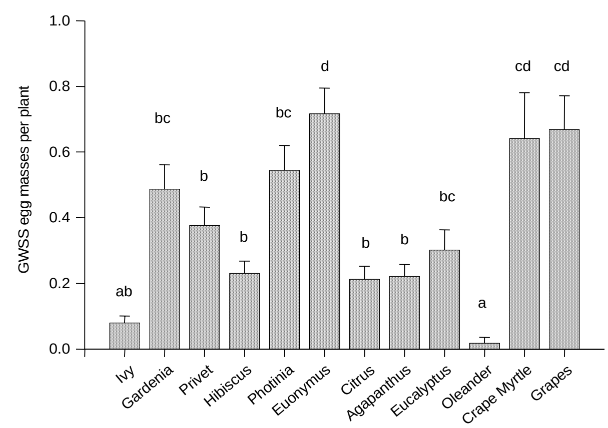

Fig. 6. Average densities (± SEM) of GWSS egg masses were significantly different among perennial host plants, Tukey's HSD at $P < 0.05$.

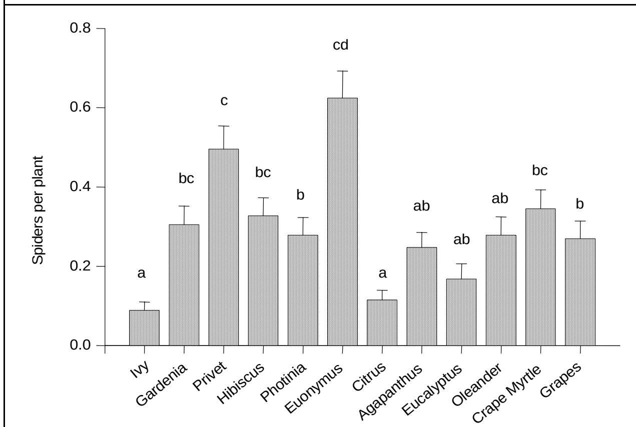

Fig. 7. Average densities (± SEM) of spiders were significantly different among perennial host plants, Tukey's HSD at $P < 0.05$.

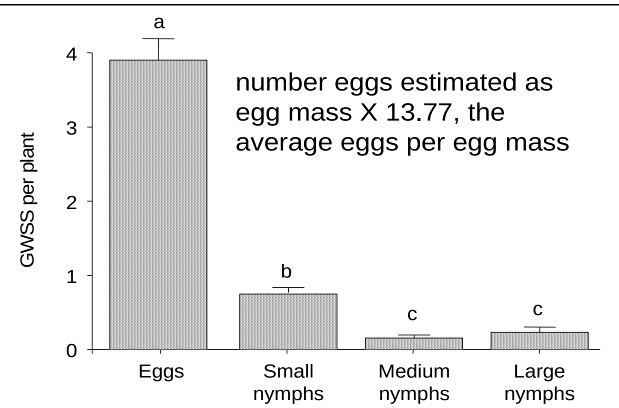

Fig. 8. Average densities (± SEM) of GWSS separated by development stages, Tukey's HSD at $P < 0.05$.