California Avocado Society 2004-05 Yearbook 87: 97-110

Glassy Winged Sharpshooters in Avocado Orchards in Southern California

Pascal "Eve" Oevering, Phil Phillips, and Ben Faber
University of California Cooperative Extension, Ventura County

Abstract

After increased populations of *Homalodisca coagulata* (GWSS) in avocado orchards were reported by growers in both San Diego and Ventura Counties in 2001, this study was initiated. In 2002, two sites in each county were selected to document the occurrence of GWSS in an avocado grove adjacent to an orange grove and to evaluate the possible threat of GWSS to the avocado industry. Although the GWSS population in Ventura Co. was significantly lower than in San Diego Co., similar numbers of adults and egg masses were recorded from mature and young avocado and orange trees within the sites in both counties. At all sites, GWSS nymphs were rare on avocado, which may relate to the quality of avocado as a host plant for nymphal development. Avocado was less suitable for reproduction by the first generation adult GWSS in caged tree studies, where, reproduction was found on caged 'Lisbon' lemon; but not on caged 'Lamb Hass' avocado. In Pauma valley, adults were feeding on the fruit pedicels, which resulted in whitish excrement contamination of the avocado fruit surfaces. Fruit observations indicated that second genera- tion adults migrated from orange into avocado after mid September. By October, fruit was equally covered with excrement on trees adjacent to, and 5 and 10 rows from, the orange trees. This study indicated that GWSS population development on avocado is unlikely and that it is improbable that GWSS will achieve a pest status in avocado. However, in areas with a citrus interface, the late season feeding of second generation GWSS adults may contaminate avocado fruit with excrement to such a degree that it affects the marketability of the fruit.

Introduction

Glassy-winged sharpshooters (GWSS) (*Homalodisca coagulata* Say) have spread widely throughout Southern California since their introduction (Sorensen and Gill, 1996). More than 225 plant genera are listed as host plants for GWSS and include agricultural, ornamental and native species (Anon, 2003). The suitability of these host plants can vary for one or more of the GWSS developmental stages. The host plant quality for GWSS development also varies with the phenological stages of the plant (Brodbeck *et al.,* 1999). For most host plants, suitability and quality criteria remain to be studied. On suitable hosts, GWSS adults and nymphs feed on large amounts of xylem fluids, which are generally of low nutritional quality and the amount of excrement produced may be substantial (Andersen *et al.*,1989)

In 2001, large numbers of the generally more numerous second generation adults (Phillips, 2000) were reported feeding on pedicels in avocado groves. In Pauma Valley (San Diego

County) and Fillmore (Ventura County) California, fruit was covered by considerable amounts of white excrement (Faber and Bender, personal communication). Growers expressed concerns that GWSS may develop into a pest on avocado, but quantified records of GWSS in California avocado were not available.

The objective of this study was to assess the potential pest status of GWSS in avocado by monitoring natural populations of GWSS and the egg parasitoids *Gonatocerus morilli* and *G. ashmeadi* in avocado and adjacent orange groves in both regions in 2002. The presence of excrement on the fruit was quantified and the suitability of avocado as a host plant was assessed.

Materials and methods

In both San Diego County and Ventura County, two paired adjacent 'Hass' avocado (*Persea americana* Mill, cv Hass) and "Valencia' orange (*Citrus sinensis* L. Osbeck cv. Valencia) groves were monitored every two weeks from March 2002 to November 2002. All groves remained untreated for GWSS during the observation period.

The two sites located in Pauma Valley, San Diego County were labeled P-I and P-II. In P-I the avocado and orange trees selected for observations were all young (2-5 years old) and up to 5 ft tall, while in P-II the selected avocado and orange trees were mature (8 years old) and 15-20 ft tall. The two sites located in Fillmore, Ventura County were labeled F-I and F-II. In F-I the selected avocado trees were young (3-5 years old) and up to 6ft tall, while the orange trees were young (5 years old) and 7 ft tall. In F-II the selected avocado and orange trees were mature (10 year-old) and 24-30 ft tall.

At the mature sites P-II and F-II, the first row along either side of an unpaved road (about ten feet wide) between the avocado and orange grove was used. After omitting the first 5 trees and the last 5-7 trees of the row, the 20 avocado trees in the row center were selected for observation. On the other side of the road, orange trees opposite the first, fifth, tenth, fifteenth and twentieth avocado tree were also selected for observation.

At the younger sites P-I and F-I the blocks were smaller and all avocado trees in the first row adjacent to the orange trees were selected for observation (17 trees in P-I and 13 trees in F-I). In these blocks, avocado trees in the second row at equal distance from one another were used to obtain a total of 20 trees per site. In the first row of orange trees adjacent to the first avocado row, a total of 5 trees per site were selected for observation (every 5th tree in P-II and F-II, every third tree in P-I and every other orange tree in F-I).

GWSS population observations

Field samples: The 25 trees selected per site (5 orange, 20 avocado) were observed every other week for the duration of one season (March - November 2002). With each observation the number of egg masses, nymphs and adults on the branch tips (0.6m in length) of 5 randomly selected branches at head height were counted using both visual inspection and beat sampling. Relative changes in observed population densities were analyzed using ANOVA unless mentioned otherwise.

Sticky Cards: In August and September, yellow sticky cards (5x5 inch) were used to monitor movement of adult GWSS and GWSS egg parasitoids *(Gonatocems ashmeadi* and *G. morilli)* in both the orange and avocado groves. In each grove, 6 sticky cards were placed within the trees' canopies (1 card per each of 6 sample trees). Cards were changed every other week and the numbers of adult GWSS and parasitoids per card were recorded. Data from P-I and P-II was analyzed using ANOVA. In F-I and F-II the numbers trapped were too few to analyze: No *Gonatocems* was recorded in avocado and a total of five *G. ashmeadi* and one *G. morrilli* were recorded in the orange groves.

Reproduction of GWSS on avocado and lemon

In Fillmore, three groups often two-year-old 'Lamb Hass' trees (5 ft tall) were used for GWSS feeding, development and reproduction studies. After removing any leaves containing GWSS egg masses, 20 trees were entirely caged with 70% shade cloth. A total of 200 adult GWSS (collected from local lemon trees) were released in each often cages. The remaining 10 caged trees and 10 uncaged trees were used as controls. After 101 days (May 3 to August 12, 2002) the 10 cages with GWSS adults were sprayed with Tame 2.4 EC (application rate 0.84ml/l water, 300ml per tree, active ingredient: fenpropathrin, Valent USA Corporation, Walnut Creek, CA) to kill active GWSS stages. The number of egg masses per tree and the number of GWSS found after spraying on a tarp placed underneath the caged tree were counted. Since the recovery of any GWSS life stage from the caged avocado trees was very low, this procedure was repeated on 5 one-year-old 'Lisbon' lemon trees to determine if the low recovery was related to the caging rather than the tree species. Each lemon tree was caged with 50 GWSS for 38 days (August 30 - October 7). Temperatures inside cages and in adjacent tree canopies were recorded using 4 HOBO® data loggers.

GWSS excrement on avocado fruit

In September and October in sites P-I and P-II, the percentage of the avocado fruit surface covered by excrement was estimated on a total of 160 fruit hanging at a height of 3-6ft on the observation trees. The size of each avocado fruit was also recorded. An additional 160 fruit was observed hanging on mature avocado trees in P-II at a distance of 5 rows and 10 rows from the border of the orange grove. Fruit observations in Ventura County were omitted because the numbers of GWSS were not high enough to produce excrement contamination of the fruit.

Results and Discussion

Significantly fewer GWSS of each life stage were recorded in Fillmore (Kruskal Wallis (unequal variance), $P < 0.01$) (Fig. 1, 2 and 3), indicating that the population in Fillmore was consistently smaller than in Pauma Valley in 2002. Despite this population difference the observations in both locations were very similar. Within each location, similar numbers of adult GWSS were recorded in avocado and orange trees, in both the young groves and the mature groves (Pauma Valley: 3df, F= 1.39,7, P=0.2599; Fillmore: 3df, F=2.43, P=0.079) (Fig.1). In Fillmore, significantly more egg masses were recorded on orange trees than on avocado trees (3df, F= 11.76, $P<0.0001$), while in Pauma Valley the number of egg masses on orange trees only exceeded those from mature avocado trees, not the small trees (3df, F=6.35, P=0.0013) (Fig. 2). In Fillmore and Pauma Valley, significantly fewer GWSS nymphs were recorded on young and mature avocado trees (Fillmore: 3df, F=6.51, P=0.011; Pauma Valley: 3df, F=5.26, P=0.003 8) (Fig. 3). Because similar numbers of GWSS adults and egg masses were recorded in orange and avocado groves per site (Fig. 1 and 2), the lack of nymphs in avocado (Fig. 3) suggests a source of mortality of the egg masses or early instar nymphs in avocado, that does not occur to the same degree in orange groves. This would suggest host quality differences.

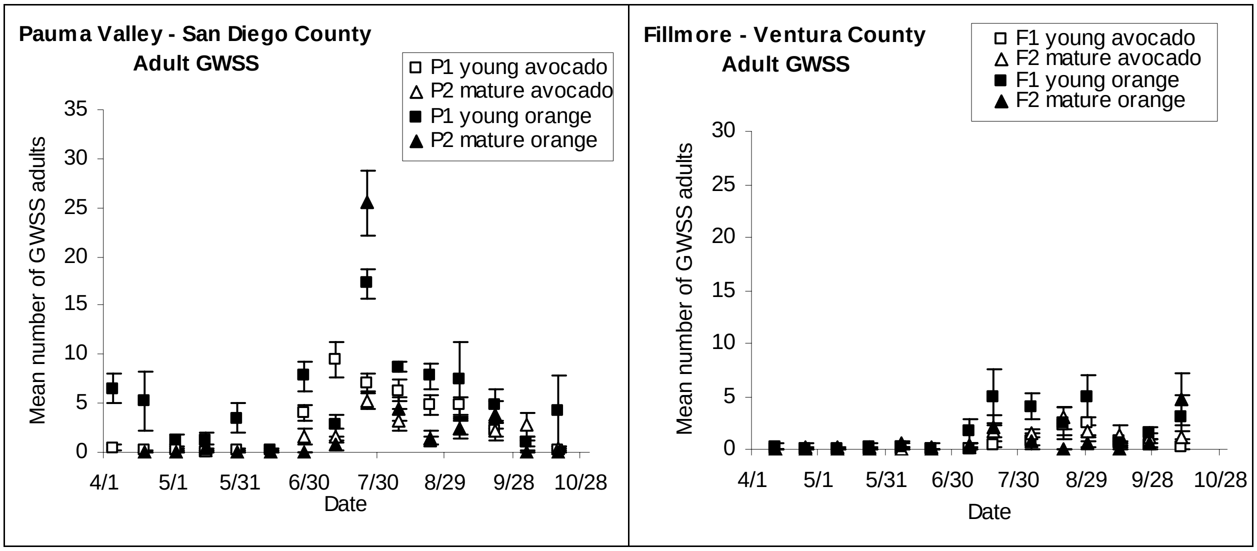

Figure 1 Mean number of GWSS adults + SE recorded using both beat samples and visual inspection of 5 branch tips per tree in two plots in Pauma Valley and two plots in Fillmore from April to November, 2002.(More adults recorded in Pauma valley compared to Fillmore [KKW, t=7.297; *P*=0.0069]; no difference in numbers recorded on mature and young orange and avocado within Pauma valley (ANOVA, 3df, F=1.39, *P*=0.2599) or Fillmore (ANOVA, 3df, F=2.43, *P*=0.079)

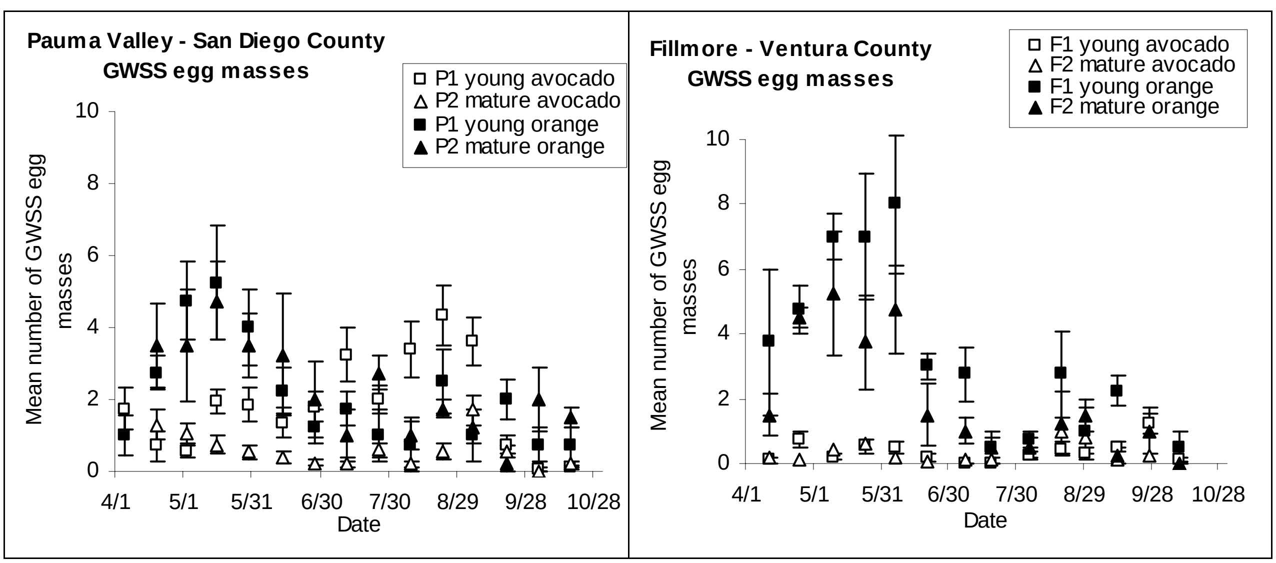

Figure 2 Mean number of GWSS egg masses + SE recorded by visual inspection of 5 branch tips per tree in two plots in Pauma Valley and two plots in Fillmore from April to November, 2002.(More egg masses recorded in Pauma valley compared to Fillmore [KKW, t=6.113; *P*=0.0013]; significantly more egg masses found on mature and young orange trees than mature and young avocado trees in Fillmore (ANOVA, 3df, F=11.76, *P*<0.0001), Significantly fewer egg masses recorded on mature avocado trees compared to young avocado and mature and young orange trees in Pauma valley (ANOVA, 3df, F=6.35, *P*=0.0013).

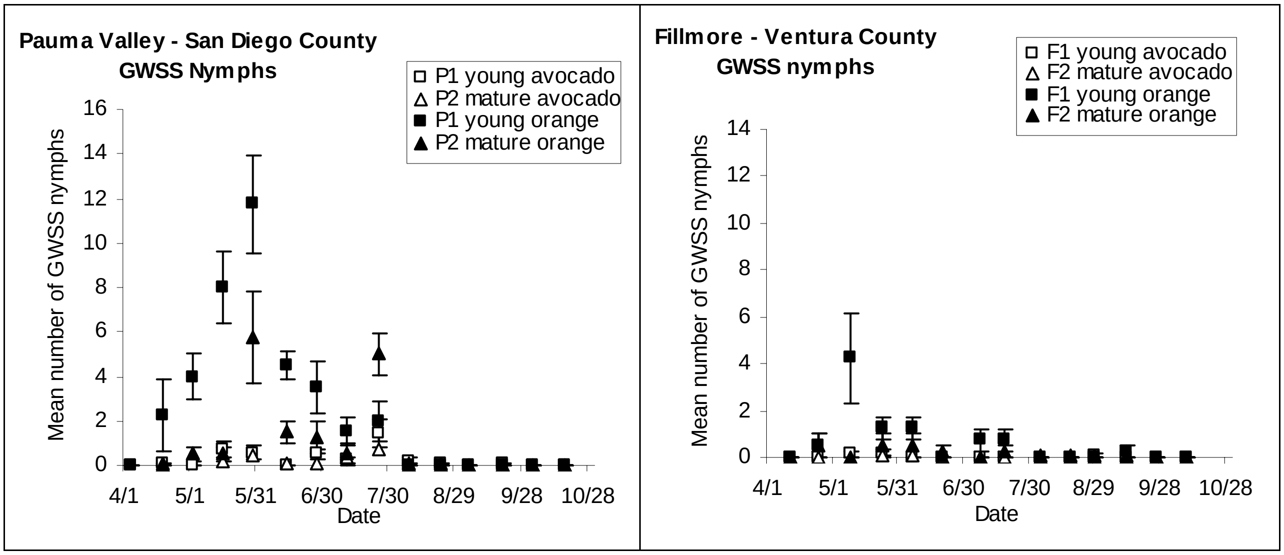

Figure 3 Mean number of GWSS nymphs + SE recorded using both beat samples and visual inspection of 5 branch tips per tree in two plots in Pauma Valley and two plots in Fillmore from April to November, 2002. (More nymphs recorded in Pauma Valley compared to Fillmore [KKW, t=13.47; *P*=0.00024]; significantly more nymphs found on young orange trees than mature and young avocado trees in Fillmore (ANOVA, 3df, F=6.51, *P*=0.011), and Pauma Valley (ANOVA, 3df, F=5.26, *P*=0.0038).

Sticky Cards

In Pauma Valley, similar numbers of adult GWSS were trapped in avocado and orange in late August (2df, F=3.45, *P=0*.059) and late September (3df, F=0.83, *P=0*.494). However, in early September the number of adult GWSS numbers in mature orange trees exceeded those in old and young avocado (3df, F=4.5, ^=0.014) (Table 1), indicating that migration into avocado from citrus occurred after this time.

More *G. ashmeadi* were trapped in young orange and avocado trees in late August (2df, F=6.9, *P=0.0075)* and early September (3df, F=3.64; *P=0*.0303), but in late September *G. ashmeadi* was found in similar numbers in old and young trees (3df, F=2.82, *P=0.065)* (Table 1). The opposite pattern was recorded for *G. morrilli;* with similar numbers trapped in late August (2df, F=0.46, P=0.82) and early September (3df, F=2.63, *P=0.01),* and more *G. morrilli* recorded in young avocado trees in late September (3df, F=4.04, *P*=0.021) (Table 1).

The presence of the two *Gonatocerus* egg parasitoids in young avocado suggests that the lack of nymphs may be partially explained by parasitization of GWSS egg masses. However, lack of nymphs in avocado is likely due to an additional mechanism, because similar numbers of parasitoids were trapped in young orange trees that hosted nymphs. For other host plants, a sub optimal chemical composition of xylem fluid has been reported to increase the mortality of certain GWSS life stages or force them to search for better hosts (Brodbeck *et al.* 1999). Perhaps as a GWSS host plant, avocado is of inferior quality for nymphal survival and development.

Reproduction of GWSS on avocado and lemon

Only 3 adult GWSS, no nymphs and no egg masses were found on the 10 caged 'Lamb Hass' avocado trees after 101 days, indicating that reproduction by the first generation did not occur on avocado. On the caged lemon trees, 1.6 ± 0.5 adults, no nymphs and 6.2 ±

1.9 egg masses were found per tree after 38 days, with 78% of the egg masses parasitized. Temperatures recorded inside the cages were similar to those in the canopies of surrounding, uncaged trees (3df, F=0.43; P=0.85, data not shown).

Table 1 Mean number of adult GWSS, *Gonatocerus ashmeadi* and *G. morrilli* ± SE trapped on 6 yellow sticky cards (5×5inch) in two Pauma Valley avocado and orange plots (P1 = young trees, P2 = mature trees).

	GWSS adults	*G. ashmeadi*	*G. morrilli*
		8/23/02	
P1 avocado	69.83±16.61a[1]	28.33±4.1b	3.67±1.38a
P1 orange	99.5±20.37a	30.5±3.35b	2.67±1.15a
P2 avocado	39.83±9.13a	10.0±5.2a	5.0±1.34a
P2 orange	X[2]	X	X
ANOVA	2df, F=3.45, *P*=0.059	2df, F=6.9, *P*=0.0075	2df, F=0.46, *P*=0.82
		9/5/2002	
P1 avocado	24.17±8.44a	30.83±10.02b	5.83±1.38a
P1 orange	47.5±10.15ab	34.0±6.38b	8.0±1.95a
P2 avocado	25.83±9.84a	11.83±3.55a	4.83±1.66a
P2 orange	61.67±4.32b	11.5±2.41a	1.67±0.84a
ANOVA	3df, F=4.5, *P*=0.014	3df, F=3.64, *P*=0.0303	3df, F=2.63, *P*=0.07
		9/20/2002	
P1 avocado	12.83±5.21a	10.83±2.26a	28.33±7.65c
P1 orange	14.83±3.59a	8.83±1.54a	22.17±2.73bc
P2 avocado	16.83±4.72a	6.67±1.09a	6.83±2.12a
P2 orange	22.0±3.54a	5.0±0.73a	14.5±3.97ab
ANOVA	3df, F=0.83, *P*=0.494	3df, F=2.82, *P*=0.065	3df, F=4.04, *P*=0.021

[1]Different letters indicate significantly different means, ANOVA, LSD < 0.05.
[2]X = no data collected.

Since some reproduction occurred on caged lemon trees and caged and uncaged canopy temperatures were similar, a cage effect cannot be exclusively responsible for the lack of GWSS reproduction on 'Lamb Hass'. This further indicates that avocado may not be a suitable reproductive host plant for the first generation adults. A GWSS developmental study on avocado analyzing its chemical quality for survival of first generation adults and the development of second generation nymphs is needed to test the hypothesized avocado host plant unsuitability to GWSS. However, no differences in second generation GWSS adult numbers on mature and young avocado and orange trees were recorded (Fig. 1), and although GWSS may not complete either of its generations on avocado, second generation adults can be abundant on avocado.

GWSS excrement on avocado fruit

Most of the 1440 fruit observed had 0 to 20% percent of its surface covered with GWSS excrement. Although the mean percentage excrement coverage on fruit of intermediate size (# 84, 70, 60 and 48) exceeded that of larger sized fruit (#40 and #36 or larger), neither differed from coverage observed on the smallest fruit observed (up to #96) (ANOVA, 6df, F=6.0, *P*<0.001, LSD<0.05) (Fig. 4). This indicates that adult GWSS feeding on the fruit pedicels can coat considerable fruit surface areas with their excrement. The effect of feeding on fruit development is not studied here in detail, but when considering excrement coverage on fruit as an indicator for adult GWSS feeding, no evidence that feeding (excrement coverage) impedes fruit size development was found (Fig. 4). Further study on fruit quality of excrement-covered fruit may be warranted to aid in local management decisions, or to support the marketability of this excrement-covered fruit (although GWSS excrement can be washed off, not all pack houses wash fruit).

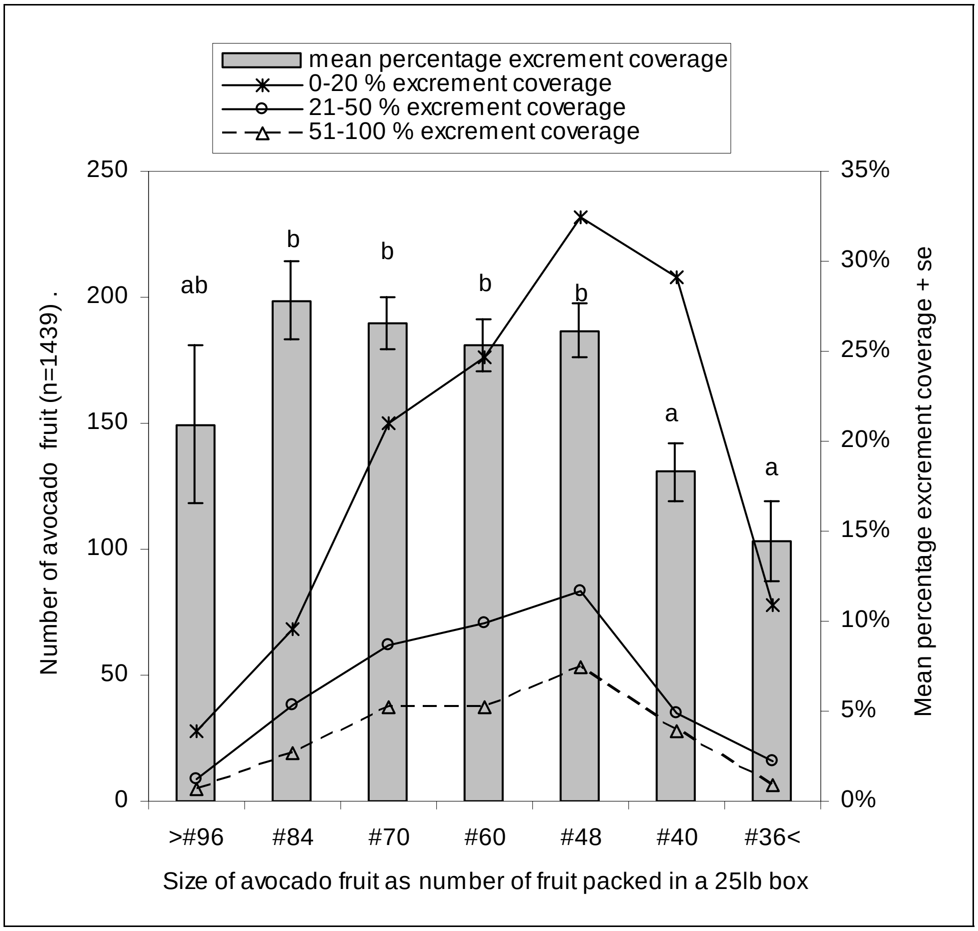

Figure 4 Number of fruit observed per size category with 0-20%, 21-50% and 51-100% excrement-covered surface (indicated with lines), and the mean percentage excrement coverage per size category + SE (indicated with bars). (Different letters indicate significant differences in mean excrement coverage [ANOVA, 6df, F=6.0, P<0.001, LSD<0.05]).

When correlating the distance between avocado trees and orange trees with the percentage of fruit that had any amount of GWSS excrement on its surface, a strong linear relationship was found in September (R^2=0.923, F=23.8, P=0.0395), with fewer fruit having excrement coverage with increasing distance from orange trees. In October, the same plots no longer showed this correlation (R^2=0.378, F= 1.21, P=0.386) (Fig. 5). The actual mean percentage of excrement coverage on fruit (excluding fruit without excrement) also showed a strong linear relationship in September (R^2=0.94, F=31.58, *P*=0.0302), where a similar decline in mean percentage coverage occurred with increasing distance from orange. This correlation was also no longer significant in October (R^2=0 253 F=0.68, P=0.49) (Fig.6).

These observations, together with the sticky card data, confirm that the second generation GWSS adults are migrating into the avocado grove around mid September from the direction of the orange trees. Although feeding is initially more intense closer to the orange trees, the adult GWSS move further into the avocado grove with time (Fig 5 and 6). In October about 80% of the avocado fruit on trees ten rows from the orange trees had some GWSS excrement coverage and this clearly identifies a problem for growers in such a situation.

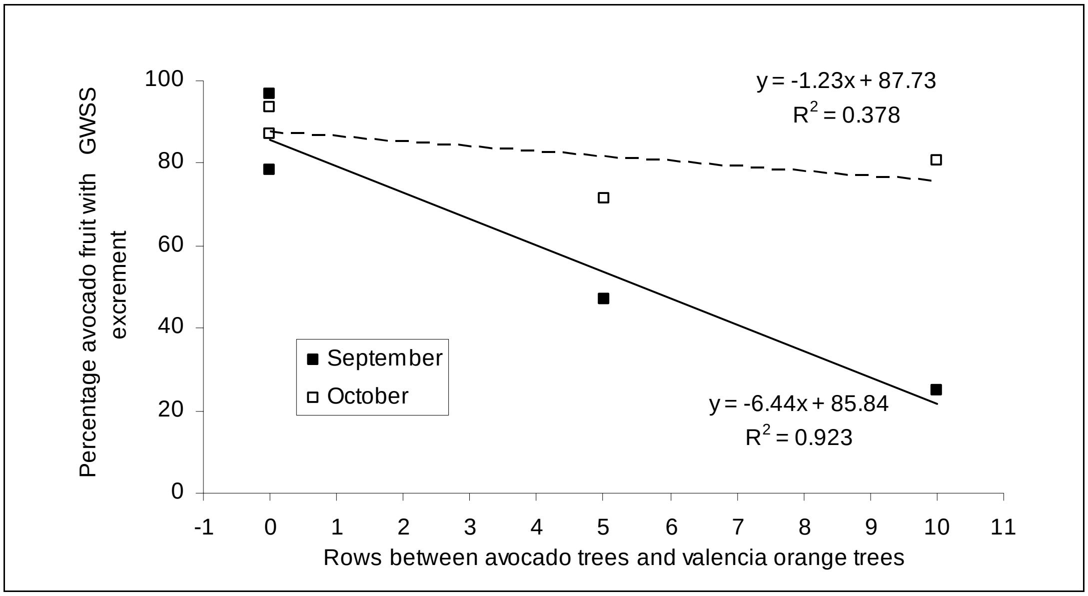

Figure 5. The relationship between the percentage of avocado fruit (on trees) with GWSS excrement coverage and the distance from orange trees (linear regression, significant in September R^2=0.923, F=23.8, *P*=0.0395, not in October R^2=0.378, F=1.21, *P*=0.3855).

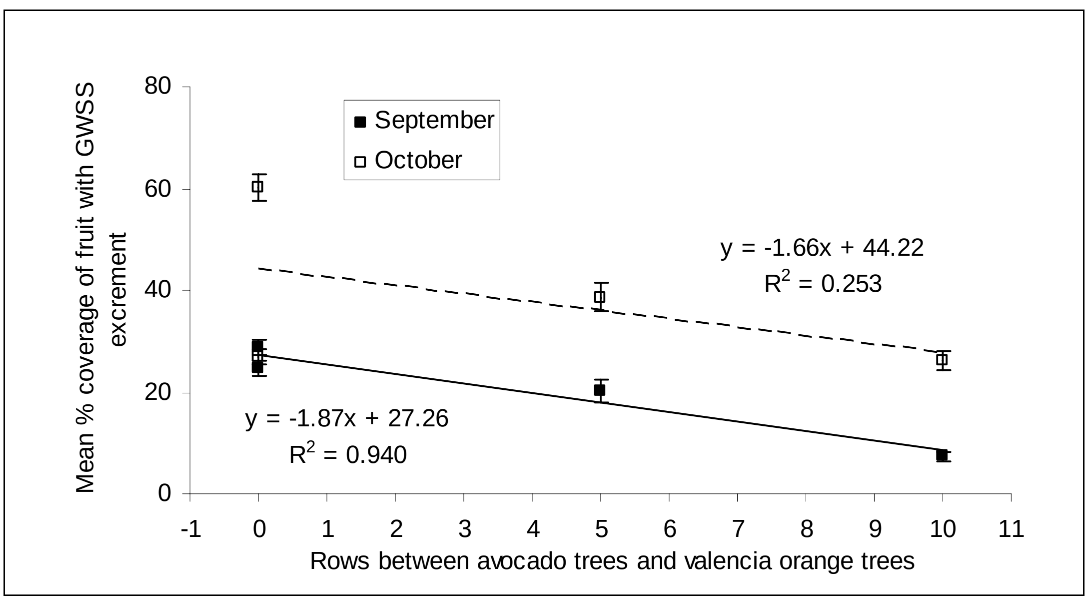

Figure 6 The relationship between the mean percentage of GWSS excrement coverage on avocado fruit (on trees) and the distance from orange trees (linear regression, significant in September R^2=0.9404, F=31.58, *P*=0.0302, not in October R^2=0.253, F=0.68, *P*=0.49).

Conclusions

GWSS adults and egg masses may be found on ‘Hass’ avocado in the vicinity of orange groves and the excrement of feeding GWSS adults may cover a substantial amount of fruit surface area. The effect of this excrement coverage on fruit quality is not known, but the data do not indicate that feeding or excrement coverage impedes fruit development. This study indicates that GWSS nymphs may not be able to use avocado to the extent that second generation adults do, and GWSS may not be able to complete its life cycle solely on avocado. Considering these observations, we think that GWSS is unlikely to become a general problem in avocado groves. Excrement coverage of avocado fruit may be problematic in areas with a citrus-avocado interface, and we recommend a focus on surrounding citrus when GWSS control is desired. Research on the quality of excrement-covered fruit is needed to determine if this presents an economic concern to the grower.

Acknowledgements

We gratefully acknowledge the California Avocado Commission for financial support. We thank Gary Bender, Doug King, Christine Payne, John Rodgers, and Michi Yamamoto for their assistance in the field.

References

Andersen, P.C., Brodbech, B.V. and Mizzell, R.F., 1989. Metabolism of aminoacids, organic acids and sugar extracted from the xylem fluid of four host plants by adult *Homalodisca coagúlala. Entomología Experimentally et Applicata,* 50: 149-159.

Brodbeck, B.V., P. C. Andersen & R. F. Mizell, III. 1,999. The effects of total dietary nitrogen and amino acid balance on the development of xylophagous leafhoppers. Arch, of Ins. Biochem. & Physiol. 42:37-50.

Anon, 2003. Pierces' Disease Program, section 3658, article 1. California Department of Food and Agriculture, http://pi.cdfa.ca.gov/pqm/manual/454.htm#appendixa

Phillips, P.A., 2000. The glassy-winged sharp shooter - a new threat for California citrus as a potential vector of CVC. CAPCA Advisor Magazine, July/August, pp. 16-17,28.

Sorensen, J.T. and Gill, R.J., 1996. A range extension *of Homalodisca coagulata* (Say) (Hemiptera: Clypeorrhyncha:Cicadellidae) to Southern California. *Pan Pacific Entomologist,* 72 (3): 160-161.