AVF ANNUAL REPORT FOR FIRST YEAR

I. Project Title: Development of Trapping Systems to Trap the Glassy-winged Sharpshooter *Homalodisca Coagulata* Adults and Nymphs in Grape (AVF V107)

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III. Summary

Four trap types in addition to Pherocon AM traps and clones were field tested in 2001 for the ability to catch the glassy-winged sharpshooter *Homalodisca coagulata* (GWSS). Traps were deployed in citrus groves and grape vineyards with known high populations in addition to groves and vineyards with low populations. Trap types tested included flight intercept traps (5 colors), plates (11 colors), colored discs (12 colors), and nymph traps (3 colors). Traps were checked weekly and visual count of egg masses, nymphs, and adults were made. Trapped GWSS were sexed, and females with forewing spots of brochosomes or residue were noted. The data from the intercept traps and colored plates clearly indicated that GWSS are attracted to yellow as well as orange. Attraction to these colors was statistically significant and demonstrated that even though the AM type trap may have reliability issues, it is clearly not a "blunder trap." Traps reliability stems from three key issues. First, the glue is not sticky enough on the AM trap (and clones) especially above 90E F. Second, the reflected wavelengths (8) below 500 nanometers are somewhat repellent to GWSS. Finally, dusty conditions can shorten the AM traps effectiveness from two weeks to 1 week or less, and temperatures above increased the probability of escape.

The yellow and orange colored plates with Stickem Special Holdfast formulation were very successful in catching adult GWSS. Yellow plates caught statistically more GWSS than AM traps while orange traps usually caught more than the AM traps. The interesting thing is that the yellow plates were more reliable at catching GWSS at low population levels than the AM traps. The nymph traps reliably caught 1st through 5th instar nymphs in moderate to low populations. These traps are easy to deploy in grape canes in situations where it could take hours of searching to locate nymphs. Low populations of GWSS nymphs in a vineyard may pose threats of moving *X. fastidiosa* from vine to vine within trellises. Flourescent yellow and canary yellow intercept traps attracted large numbers but the collection mechanism only caught about 15% of the bugs that encountered the panels, which made the traps unreliable. However, intercept traps were capable of catching live insects and may have utility when a better capture devise is incorporated.

Additional progress was made in determining that adult and nymphs are attracted to upper UV, and certain wavelengths in the yellow and orange ranges. The preliminary data indicated relationships between the number of ovipositional females trapped and oviposition in associated vegetation.

Female GWSS secrete and deposit brochosomes on the forewings just prior to oviposition. These spots are then scraped off during oviposition. Furthermore, white spots are secreted before each egg mass is laid, and female GWSS can only produce rod shaped brochosomes after mating. It is therefore feasible to relate preovipositional females with white spots and residues to egg masses in associated vegetation analysis. The white spots are very visible on females caught in traps suggesting they are looking for a place to lay eggs.

IV. Objectives and Experiments Conducted to Meet Stated Objectives:

Objective I. Determine the spectral sensitivity of the glassy-winged sharp shooter (GWSS)

to both reflected and emitted light in order to choose the color providing the best reflectance for trap improvement and development

Electrophysiological measurements will determine the visual sensitivity of GWSS to different wavelengths of light. Electroretinogram techniques will be employed to accomplish this. Tungsten microelectrodes inserted 30 micrometers into the dorsal midline of the compound eyes will allow the measurements of electrical responses to specific wavelengths of light. Once the wavelengths eliciting responses are determined, behavioral bioassays can be employed to determine to which wavelengths the insects actually respond. Mann-Whitney U tests will be applied to determine differences in sensitivity at corresponding wavelengths.

A second set of experiments will be conducted to measure the reflectance of different commercially available sticky traps. Measurements taken from new traps and from deployed traps at weekly intervals for up to 8 weeks will determine if there is a change from the optimum wavelengths that elicit electrophysiological and behavioral responses from GWSS. Preliminary data indicate that the sticky traps are photo-stable, but the glue is adversely influenced by environmental factors such as dust and temperature. Instrumentation used to make these measurements will be a spectrophotometer equipped with a reflectance probe and integrating sphere. Comparisons of trap reflectance and leaf reflectance in areas of sharpshooter feeding will also be made. Should the best color of yellow not be commercially available, the information from these studies will allow the development of a yellow color for GWSS monitoring.

Objective II. Development of semi-selective intercept traps to monitor the Glassy-winged sharpshooters in grape and crops or ornamentals in close proximity to grape

Both reflected light (e.g. a response to a yellow card) and emitted light of certain wavelengths can illicit behavior response from flying GWSS. The data from the electroretinogram and behavioral assays in Objective I will aid choosing a light source that emits a wavelength that elicits a behavioral response from GWSS for intercept trap development. The intercept trap (i.e. sentinel trap) will employ reflected light to illicit responses from flying GWSS during the day with optional lights of certain wavelengths to enhance reflectance to illicit responses for two hours past dusk. Power efficient dc circuitry will operate the traps at specified times and duration. A randomized complete block design deployed in grape and associated alternate hosts will determine the effectiveness of the intercept trap with and without light augmentation compared to yellow sticky traps. A research version of the sentinel trap will be developed that can be deployed for nocturnal activity studies.

Objective III. Relate trap catches to the number of sharpshooters in a grape vine or citrus tree and develop and test the effectiveness of sticky barriers to monitor GWSS nymphs

Three 60-vine blocks of non-insecticide treated grape will be chosen at five different vineyards. Ten yellow sticky traps and four intercept trap prototypes based on optimum reflectance and behavioral assays determined from the data from objective I will be deployed in each of the blocks. A similar design will be used in citrus, since citrus serves as an alternate host for GWSS allowing populations to buildup and move into grape when in close proximity. Ten trees or vines in each block will be tented and fumigated to kill all GWSS in the canopy, and the dead insects shaken onto a tarp below the plant canopy and counted on a weekly basis. Analysis of covariance (ANCOVA) will be used to determine if there is a relationship between trap catch and numbers of GWSS in citrus trees or grape vines. Visual counts will be made prior to fumigation.

Thirty-two of each of two types of sticky barrier traps will be deployed in grape and 32 in citrus and checked biweekly during egg-laying periods and bimonthly during other periods throughout the year. Nymph catches will be compared to visual nymph counts, egg mass counts, and adult trap catches and correlations determined.

V. Summary of Major Research Accomplishments and Results (by Objectives):

Objective I Accomplishments: Yellow plates treated with Stickem Special Holdfast formulation consistently caught more GWSS than AM traps and clones and caught GWSS at low populations when the AM trap failed to catch GWSS. Yellow is very attractive to GWSS but reflectance below 500 nm needs to minimized and the stickiest glue available used on sticky traps.

Objective II Accomplishments: A intercept panel trap was developed that was capable of attracting large numbers of GWSS but the capture mechnism was not adequate and will be replaced. This trap is capable of capturing either live insects or killing them.

Objective III Accomplishments: A GWSS nymph trap was successfully developed in 2001. The details for proper deployment will be worked out in 2002 and 2003. The data in 2001 suggested that female trap catch especially those with brochosome wing spots related to oviposition in nearby grapes and will be verified in 2002 and 2003.

VI. Outside Presentations of Research:

Publications:

Hix, R. L. 2001. Egg-laying Behavior and Brochosome Production observed in Glassy-winged Sharpshooter. California Agriculture 55(4):19-22.

Hix, R. L. 2001. Development of trapping systems to trap GWSS, Homalodisca coagulata adults and nymphs in grape. Pierce's Disease Research Symposium, Dec 5-7, San Diego, 2001.

Selected Presentations:

Hix, R. L. Insect Monitoring with Traps Based on Insect Behaviors Other than Pheromones. Association of Applied Insect Ecologists 3-5 Feb 2002, Berkeley, CA.

Hix, R. L. Experimental Trapping Methods for the Glassy-winged Sharpshooter, Homalodisca Coagulata**:** Response to Color. National Meeting of the Entomological Society of America, San Diego, CA, 12 Dec 2001. (Poster)

Hix, R. L. Development of Trapping Systems to Trap GWSS, Homalodisca Coagulata Adults and Nymphs in Grape. Pierce's Disease Research Symposium, Dec 5-7 2001, San Diego, CA.

Hix, R. L. Glassy-winged Sharpshooter Response to Color. 29-30 Oct 2001. DANR Glassy-Winged Sharpshooter Workgroup, Kern County Ag Pavilion, Bakersfield, CA.

Hix, R. L. The Importance of Brochosome Secretions in Glassy-winged Sharpshooter Monitoring. 16 April 2001. Temecula Valley Glassy-Winged Sharpshooter/Pierce's Disease Task Force. Temecula, CA.

Hix, R. L. Biology and monitoring of the glassy-winged sharpshooter. Northern San Joaquin Valley Viticulture Seminar, 31 Jan 2001. Turlock, CA

Hix, R. L. Alternative Yellow Sticky Traps for Glassy-Winged Sharpshooter Monitoring. GWSS/PD WORKSHOP: MEETING THE CHALLENGE. 16 Nov 2000-Riverside Convention Center, Riverside, CA.

VII. Research Success Statements:

Improved vector monitoring and development of alternative trapping methods are one of the areas of concern for the Glassy-winged Sharpshooter (GWSS), *Homalodisca coagulata,* and the Diseases They Vector DANR Workgroup. The current trap being deployed by PCA's, California Department of Food and Agriculture, and United States Department of Agriculture for monitoring GWSS populations throughout California is the Pherocon AM trap and its clones designed about thirty years ago for the apple maggot, hence 'AM' designation. The reliability of that trap is questionable, especially at low populations. Furthermore, the relationships between trap catch and grape or citrus canopy populations are unknown.

Research for trap improvement and development for GWSS monitoring is addressing the following: 1) which hue of yellow is the most attractive to GWSS; 2) the field longevities of a trap before weather and photo degradation impact trap reliability; 3) relationships of trap catch to populations of GSS in citrus and grape; 4) the wave length of both emitted and reflected light to which GSS responds (i.e., spectral sensitivity).

We have a yellow trap that consistently catches more GWSS at high populations than does the 'AM' trap (Figs. 1, 2, 3, 4, and 5); it is also more reliable than the 'AM' trap at low populations (Fig. 6). We also have an orange trap that is as reliable as the 'AM' trap at high and low populations. While the yellow prototypes catch significantly more GWSS overall, the interesting thing is that the orange prototypes catch about as many ovipositional GWSS females as yellow prototypes. While yellow is clearly the best choice for trap color, a more reliable trap design than the 'AM' trap is feasible. One approach would be to modify existing sticky cards from the various manufacturers to eliminate reflectance below 500 nm and apply a stickier glue to the cards. Other improvements may come from shape and dimension modification. Alternatively, a new trap could be created from scratch incorporating all of the positive features from experimental and existing traps in regards to catching GWSS.

We now know that GWSS females with white forewing spots are mated and ovipositional Fig. 7). These wing spots consist of rod-shaped brochosomes, which are only produced by mated females. These brochosomes are scraped onto the egg masses during oviposition. This information provides us with a link to trap catches and oviposition in associated vegetation. The interesting thing is that while the yellow prototypes caught two to three times as many GWSS as the orange prototypes, the orange prototypes caught as many females with white forewing spots consisting of rod-shaped brochosomes.

Current work is being done to determine ways to enhance the trapping day length. The current optimum trapping period is about three hours per day. This will increase our chances of detecting GSS at low populations.

VII. Funds Status. As of 7 Jan 2002, there was and estimated balance of $5700 in this account. The majority of this will be spent by 31 March 2002 for salaries, benefits, and travel.

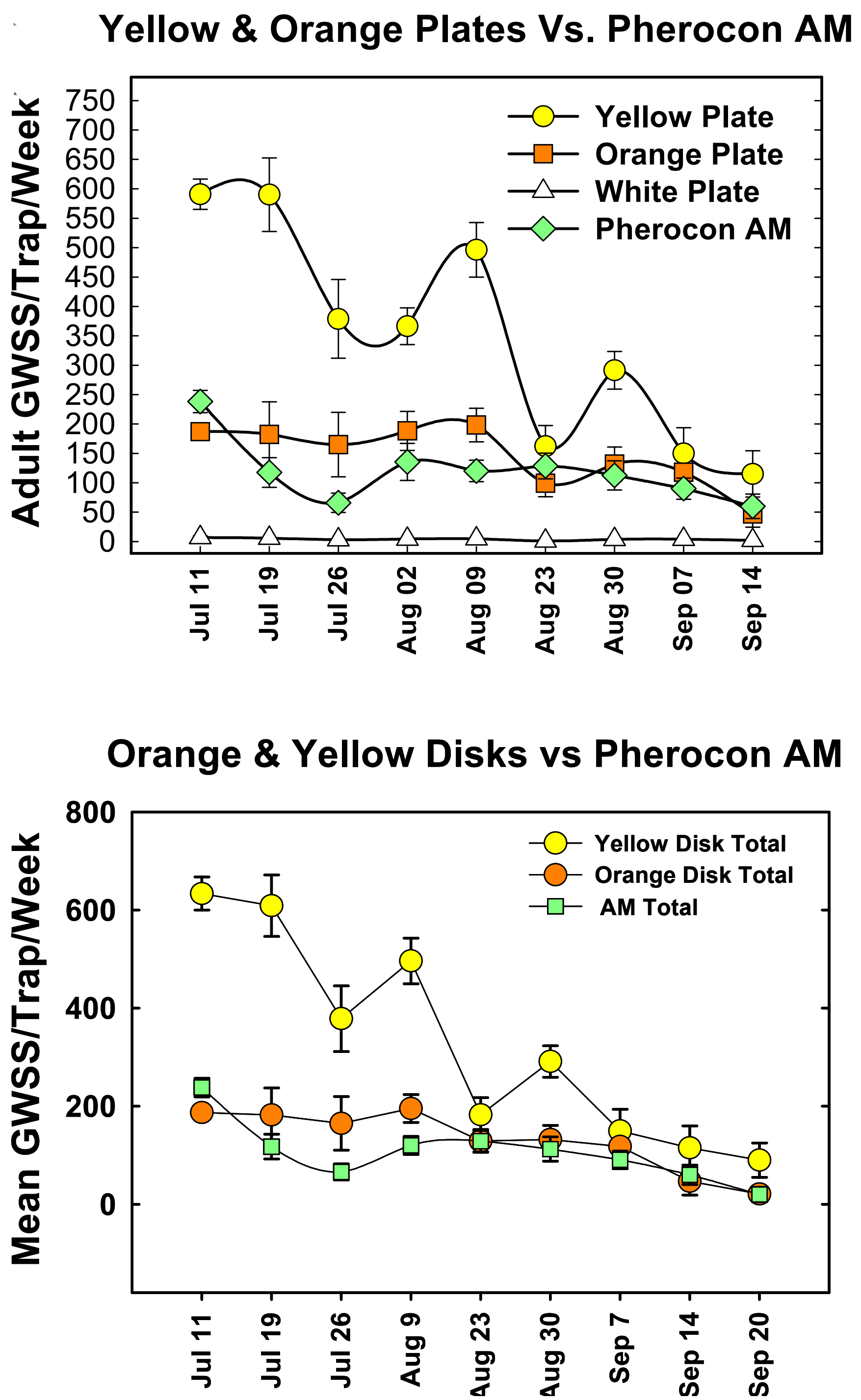
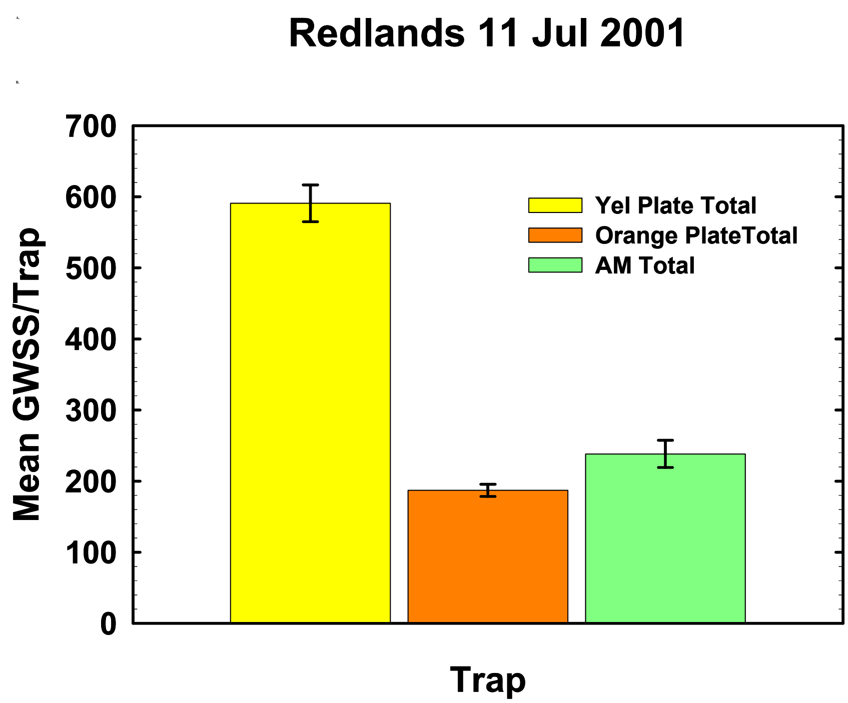


Fig. 1. A. Comparison of Yellow, orange, and white plates to Pherocon AM traps at high GWSS population density in Redlands, CA. Bars= ∀SE. n=5. There was no significant difference in the green, brown, blue, black, red, and white plates, therefore only white is shown. **B.** Comparison of yellow and orange disk to Pherocon AM Trap. Bars= ∀ SE. N=4.



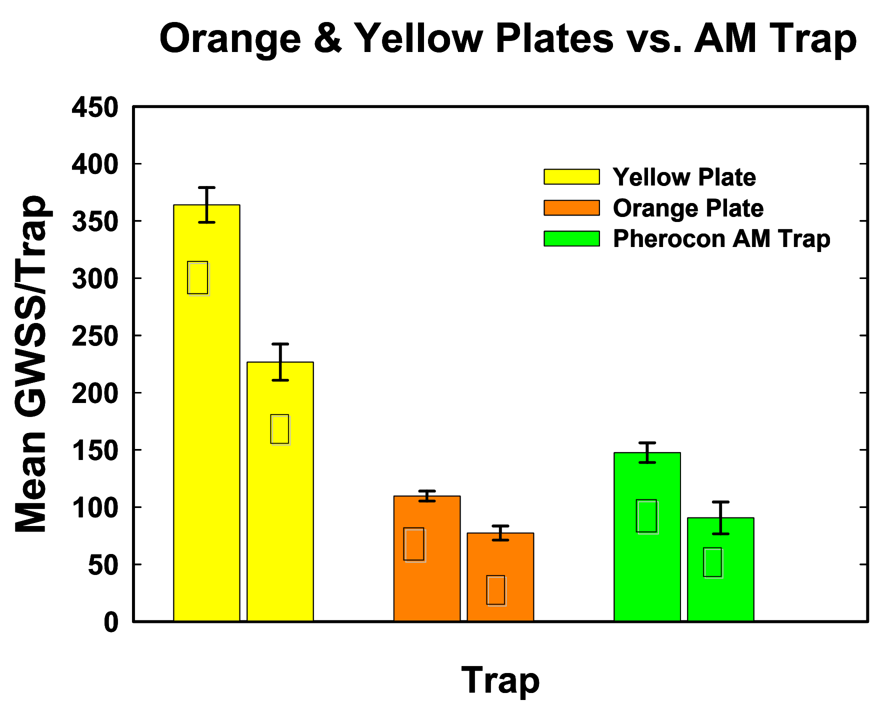


Fig. 2. Comparison of the 2 best plate colors and Pherocon AM trap. For Redlands, CA. Bars = ∀ SE. n =5. A. Total Means. B. Means by sex.

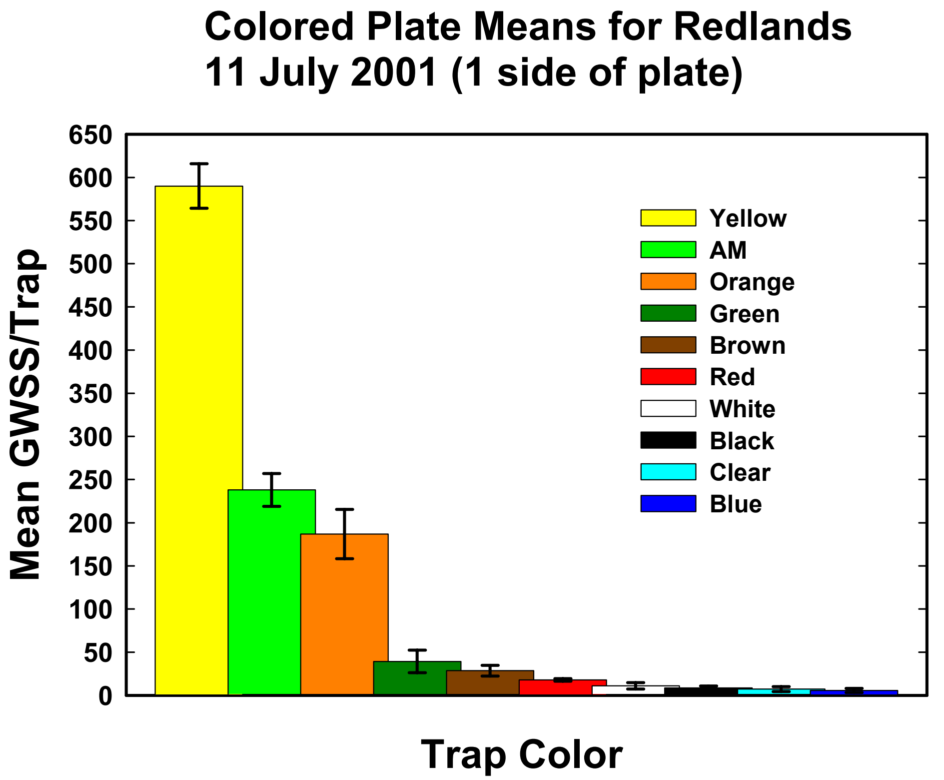
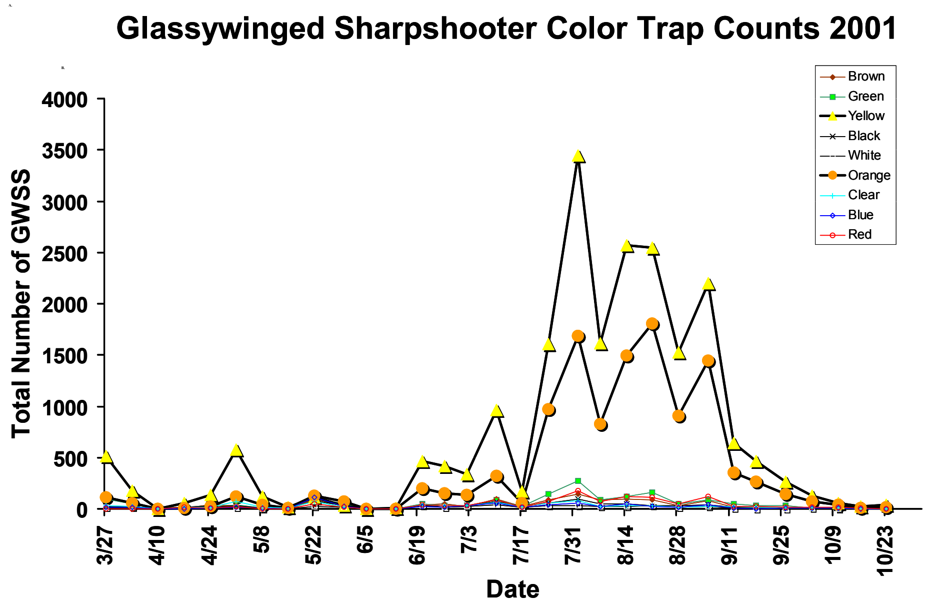


Fig. 3. Comparison varius colored plate GWSS means and Pherocon AM means for the peak capture date. Bars=∀ SE. n=5.



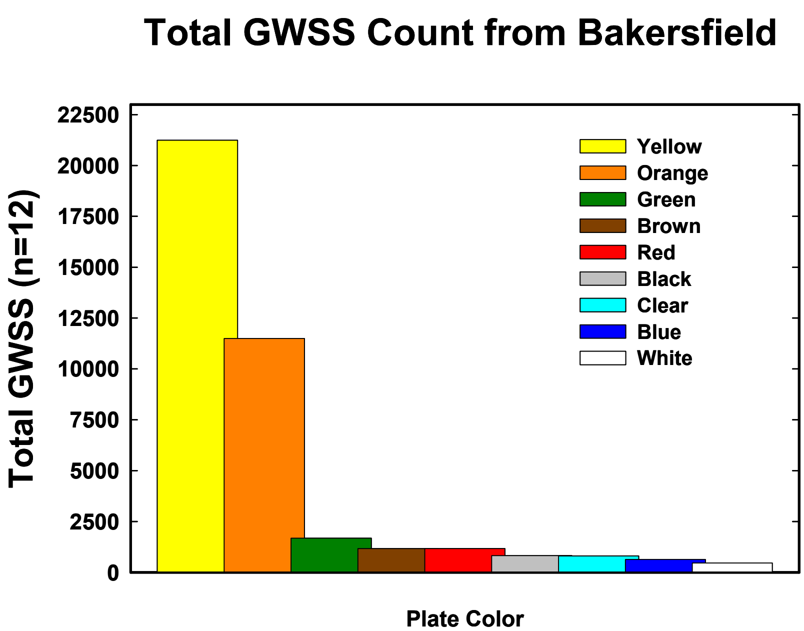


Fig. 4. A. Weekly totals for various colored plates in Bakersfield for the highest pupulation of 3 sites. n=4. **B**. Season totals for the same site.

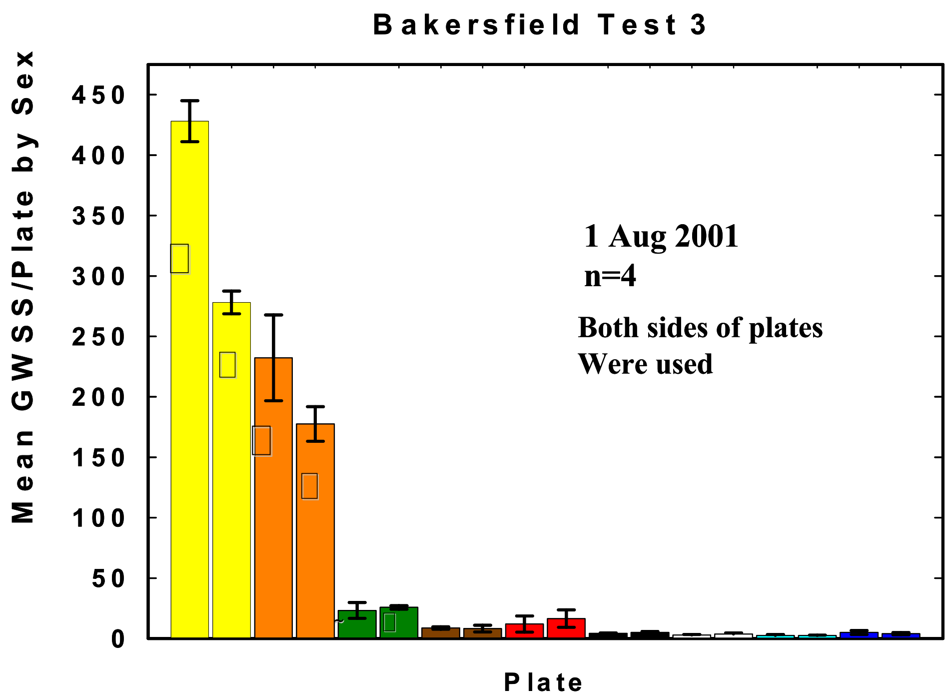


Fig. 5. August 1, 2001 GWSS means for the Bakersfield site with highest populations. Bars= ∀ SE. n=4.

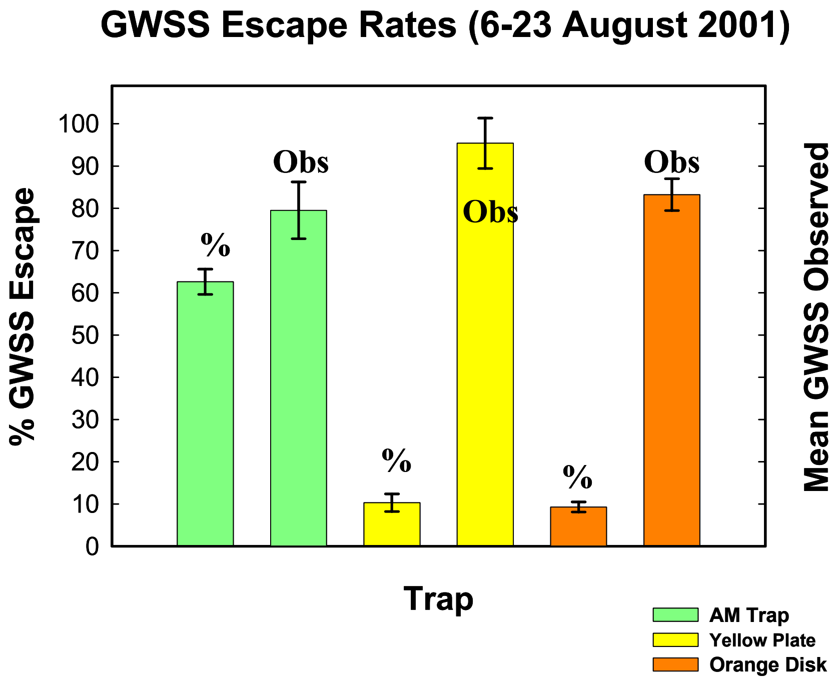


Fig. 6. Percentage GWSS escaped (left bar of same color) of total GWSS observed (right bar of same color). Bars represent means (∀ SE) from 10 sets of observations .

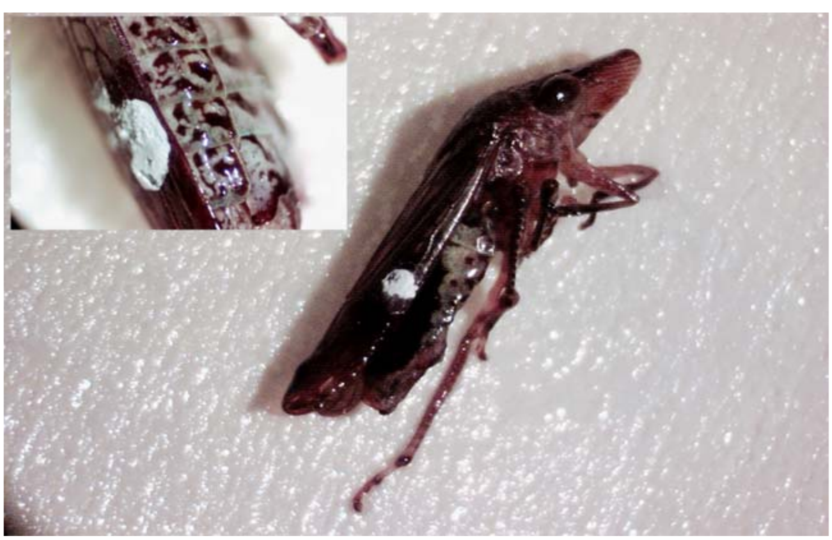


Fig. 7. Female GWSS on white disk with white spots on forewing indicating female is looking for suitable host for egg laying. Only mated females generate wing spots. Spots consist of rod-shaped brochosomes.