Glassy-Winged Sharpshooter

Nursery Stock

Approved Treatment Manual

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Pierce’s Disease Control Program’s Mission

The mission of the Pierce's Disease Control Program (PDCP) is to minimize the statewide impact of Pierce's disease and its vectors in California.

Statement from the Secretary

Invasive pests and disease are a recurring story in California, both for our agricultural community and for the rest of the state's environment, natural resources, and public and private property. California's diverse agricultural production, its varied landscape and its range of weather conditions make this state an ideal place to produce more than half of the nation's supply of fruits and vegetables. Unfortunately, these same conditions make California a hospitable place for an ever-expanding list of invasive pests like the glassy-winged sharpshooter.

While Pierce's disease has been in California for a century or more, the establishment of the glassy-winged sharpshooter infestation in southern California in the 1990's suddenly thrust the disease to the top of the list of threats to crops ranging from grapes to alfalfa to stone fruits. Thanks to substantial investment by both growers and state and federal governments, we have been able to develop a multi-faceted program that has succeeded in keeping this pest and disease from gaining ground.

In the complex case of Pierce's disease and the glassy-winged sharpshooter, Californians deserve no less from their leaders than an innovative solution. The Department's staff, as well as growers and researchers, have known since the beginning of this program that it would take time, effort and investment to succeed.

A.G. Kawamura, Secretary
California Department of Food and Agriculture

GLASSY-WINGED SHARPSHOOTER NURSERY REGULATIONS

Regulatory Overview

Nursery stock is a high-risk commodity for spreading the glassy-winged sharpshooter. California has approximately 12,000 licensed nurseries, 70% of which are located in sharpshooter-infested counties. Many of these nurseries ship to the uninfested areas of the state. Activities to mitigate the risk of moving GWSS on nursery stock include:

1. Inspection of nursery stock in infested areas prior to shipping to non-infested areas;
2. Treatment of nursery stock when necessary;
3. Certification of shipments (blue tag); and
4. Inspection of nursery stock at receiving nurseries prior to sale.

Inspection Results

In 2009, there were 53,700 shipments of nursery stock from infested areas to uninfested areas. Viable life stages of GWSS were discovered on only 23 of these shipments.

The 2005-2007 nursery treatment pilot program tested the effectiveness of treating plants, known to have GWSS egg masses, with approved pesticides. Plants were treated, sleeved with a mesh protective covering and shipped to destination localities where they were observed. To date, the data confirms 100% mortality of all emerging GWSS nymphs.

With the adoption of the “Nursery Stock Approved Treatment Protocol” (NSATP), an option is available for growers to ship without the 100% visual inspection requirement, if they:

- Enter into a compliance agreement with the origin CAC.
  - Qualify for a compliance agreement by establishing a written GWSS Pest Management Plan.
  - Have their GWSS pest management plan approved by the CAC.
- Comply with all compliance agreement and protocol requirements.
- Treat and safeguard all plants and plant material destined for non-infested counties within California with the CDFA-approved pesticides Sevin® (carbaryl) or Tame® (fenpropathrin).
- Ensure applications are made by and/or supervised by an individual trained to meet label requirements and proper application techniques for Sevin® and Tame®.
- Make treatments in the presence of a licensed origin CAC inspector.

Nursery operators who do not participate in the NSATP can ship nursery stock from an area infested with glassy-winged sharpshooter (GWSS) to a non-infested area under a Compliance Agreement with the origin County Agriculture Commissioner (CAC).

Plants shipped under a "Blue Tag" must follow procedures set forth in Plant Quarantine Manual section: 510.1 and 510.2. Non free from nurseries require the shipment to be foliar treated under the supervision of the origin CAC with a insecticide labeled to control leafhoppers in a nursery setting (with Sevin® (carbaryl) or Tame® (fenpropathrin) in Napa and Sonoma only) to eliminate all life stages of GWSS; and be fully inspected by the CAC of the origin county and found to be free of GWSS. Free from nurseries in a generally infested area are required to ship under a blue tag but are not required to treat or have an inspection by the CAC.

Each incoming shipment may be inspected by the County Agricultural Commissioner at destination or at a site designated by the Commissioner, as agreed upon by CDFA and the Commissioner. The Commissioner shall have the authority to destroy and/or return any infested plants with apparently viable life stages found on them and take whatever action the Commissioner feels is an appropriate disposition for the remainder of the shipment.

Complete information on plant quarantine Section 454: Regulations and Section 510: Counties with regulations more stringent than 3650, and the Nursery Stock Approved-Treatment Protocol, can be found in the Plant Quarantine Manual available from the local CAC office, CDFA or the CDFA website:
http://www.cdfa.ca.gov/pdcp/Regulations.html and http://www.cdfa.ca.gov/pdcp.

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GLASSY-WINGED SHARPSHOOTER DAMAGE AND IDENTIFICATION

The glassy-winged sharpshooter (GWSS), *Homalodisca vitripennis* (formerly *H. coagulata*) is an insect that was inadvertently introduced into southern California in the early 1990s. This insect is native to the southeastern United States and was most likely brought into California accidentally as egg masses in ornamental or agricultural plant foliage.

The glassy winged sharpshooter is in a subgroup of leafhoppers called sharpshooters. Sharpshooters and leafhoppers are in the family Cicadellidae, which all have mouthparts that allow them to pierce the plant tissue and feed on plant juices. Most leafhoppers are about 0.25 inch long and slender and may be brightly colored or similar in color to the host plant. They often jump away or move sideways when disturbed. Leafhoppers and sharpshooters have incomplete metamorphosis, immature (nymphs) are similar in structure to adults but are smaller, wingless, and may differ in color. Their growth is limited by the cuticle, which must be shed and replaced as they grow in size, resulting in the pale cast skins that may be found on leaf surfaces.

The glassy-winged sharpshooter is a large leafhopper (about 0.5 inches long) that obtains its nutrients by feeding on plant fluids in the water-conducting tissues of a plant (the xylem). Feeding on plants rarely causes significant plant damage, although the insects do excrete copious amounts of liquid that can make leaves and fruit appear whitewashed when dry. The excrement is a special nuisance when shade trees are heavily infested because cars parked under the trees tend to become spotted. During hot weather, heavy populations of glassy-winged sharpshooters feeding on small plants may cause them to wilt.

The real problem associated with GWSS is that it can spread the disease-causing bacterium *Xylella fastidiosa* from one plant to another and quickly develops high populations that substantially increase the number of insects vectoring the destructive *Xylella fastidiosa* bacteria to crops. In addition, it

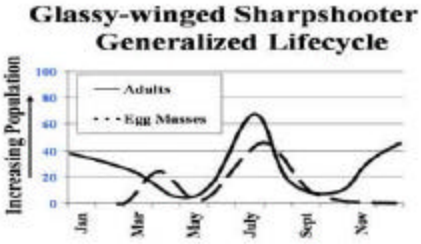
- Travels longer distances in a shorter time than other sharpshooters;
- Makes use of more breeding habitats and plant hosts than native vectors; and
- Transmits the bacteria from vine to vine, resulting in an exponential increase in disease incidence in vineyards.

This bacterium is the causal agent of devastating plant diseases such as Pierce's disease of grape, oleander leaf scorch, almond leaf scorch and mulberry leaf scorch. Other diseases to landscape plants in California include sweet gum dieback and cherry plum leaf scorch. Outside of California, other strains of *X. fastidiosa* cause phony peach disease, plum leaf scald, leaf scorches in sycamore, elm, maple, and oak, and citrus variegated chlorosis (not in California). It should be noted that the strain of *X. fastidiosa* that causes oleander leaf scorch will not cause Pierce's disease in grapes and the strain of *X. fastidiosa* that causes mulberry leaf scorch does not cause disease in oleanders or grapes. At this time there is no cure for any of these diseases.

Because of this, GWSS is under quarantine in California and shipment of host plant material from infested or partially infested areas of California to non-infested or suppression areas of enforcing counties must be shipped under “blue tag”.

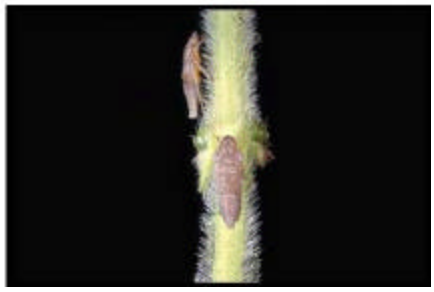
IDENTIFICATION

Glassy-winged sharpshooter, *Homalodisca vitripennis* (formerly *H. coagulata*). Adult glassy-winged sharpshooters are about 0.5 inches long and dark brown in color. Wings are membranous and translucent, with reddish veins. The head is brown to black and covered with numerous ivory to yellow spots. The insect overwinters as adults and begin to lay egg masses about late February. There appear to be two generations of glassy-winged sharpshooters per year in California.



Females lay their eggs in masses of about 10 to 12 under the lower leaf surface of young, fully developed leaves. The eggs lay side-by-side in a single layer. When it is first laid, each individual egg appears as a greenish blister beneath the epidermis of the leaf. The female covers the egg mass with the white chalky material making it more visible. Shortly after the eggs hatch, the leaf tissue begins to turn brown. The dead leaf tissue remains as a permanent brown scar.

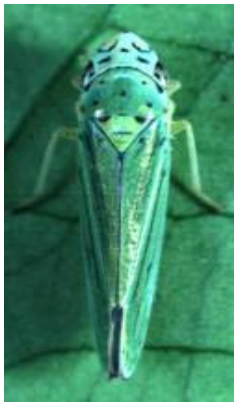
Nymphs hatch in 10 to 14 days and feed on the leaf petioles or small young succulent stems while they progress through five immature stages. The graycolored nymphs are smaller than the adults and wingless. There are five immature stages. As they feed on xylem tissue, they excrete a large amount of liquid substance that drops to the leaves or the ground below. The glassy-winged sharpshooter has a broad host range that includes many ornamental plant species.



In summer first generation adults begin to appear in May through July. Egg laying for the second generation occurs between mid-June through October. The nymphs emerging from these egg masses develop into over-wintering adults.

Smoke tree sharpshooter (*Homalodisca liturata).* The smoke tree sharpshooter is native to the desert region of southern California. The head of the smoke tree sharpshooter is covered with wavy, light-colored lines, rather than spots. In profile, the immature stages (nymphs) of the glassy-winged sharpshooter look similar to that of the adult, except they are smaller, wingless, uniform olive-gray in color, and have prominent bulging eyes.

Aster leafhopper [*Macrosteles fascifrons* (Stal)]. The aster leafhopper is also called the six-spotted leafhopper because it has three pairs of black spots on its head. The adults are small (about 0.12 inches long) and usually light green to yellow, with black marking on the thorax and abdomen. Their wings are transparent. Nymphs are usually dark green.



Blue-green sharpshooter (*Graphocephala atropunctata*). The blue-green sharpshooter has green to bright blue wings, head, and thorax, and yellow legs and abdomen, which are visible on the underside. It is about 0.25 inches long. There is one generation a year in most of California and a second generation in some southern areas of the state. Adults become active in late winter/early spring. They can become abundant in ornamental landscaping around homes. They also feed on numerous weeds mostly along stream banks or in ravines or canyons where there is dense vegetative growth. As natural vegetation dries up, adults disperse into crops and irrigated plantings. Eggs hatch from May through July with some of the nymphs becoming adults by mid-June.

Green Sharpshooter (*Draeculacephala minerva*)**.** The green sharpshooter is considered to be one of two important species of insect vectors for Pierce's disease and alfalfa dwarf diseases in the Central Valley of California. It also occurs in coastal areas in grasses and sedges along streams. Although it has been found on many species of herbaceous plants, it strongly prefers to feed and reproduce on grasses. It is most common on water grass (*Echinochloa cruz-galli*), fescues, perennial rye grass and Bermuda grass. Its most common habitats are ditch banks, weedy hay fields and permanent irrigated pastures, anywhere that its preferred grasses continue to grow throughout the year. For this reason it is common in orchard or vineyard cover crops only when there are attractive plants in the cover crop at all times of the year. It is only rarely seen feeding on grape. Its role as a Pierce's disease vector is based on the consistent occurrence of its breeding habitats near vineyards.

Two-Spotted Leafhopper (*Sophonia orientalis*).

Two-spotted leafhopper adults are about 0.25 inches (5mm) long and pale yellow with a dark stripe down the center of the back. A red or pink flush of varying degrees borders the black dorsal stripe. On the end of the wings are two prominent eye spots that make it appear that the leafhopper is walking backwards. This leafhopper feeds on a wide range of ornamental plants. Feeding may cause chlorosis of leaves in some species.

Red-Headed Sharpshooter [*Xyphon (=Carneocephala) fulgida*.] The red-headed sharpshooter is a sharpshooter of historical importance as a vector of alfalfa dwarf. It is about 0.25 inch (6 mm) long and similar in appearance to the green sharpshooter except that it has reddish coloration on the front tip of its head. The red-headed sharpshooter usually has four generations per year in the Central Valley and strongly prefers to breed on Bermuda grass. It tolerates slightly drier conditions than the green sharpshooter.

DETECTION AND MONITORING

Detection and monitoring data enable growers to measure results and spot trends. Did we get the results we expected from BMP's, are peak populations lower or higher than previous years? If monitoring shows GWSS populations migrating into the nursery from adjacent properties than it may be time to link efforts with neighbors to reduce population pressure or to join or lobby for a local "Area Wide Management Program".

Even though this insect is large enough to be seen with the naked eye, it is very inconspicuous in nature. The brown coloration of the insect blends very well with the color of the twigs where it is usually found, and it hides by moving to the other side of the twig or branch when it detects movement or is otherwise approached or disturbed. A very fine mist or a whitish, powdery coating on leaves or fruit may indicate heavy glassy-winged sharpshooter feeding. Detection and monitoring data should tell you the life stage(s) in an area, population intensity, and help to determine where the populations are located.

Yellow Sticky Traps

Commonly used in orchards and nurseries to monitor for the adults, this method will only detect adult GWSS at relatively high population densities. Consult CDFA recommendations for number of traps per acre. The current recommendation is placement of traps spaced evenly throughout the nursery growing areas at a minimum density of 2 traps per ½ acre and at nursery shipping docks. Traps will be inspected a minimum of once every two weeks by a shipping California Agriculture Commissioner (CAC) inspector.

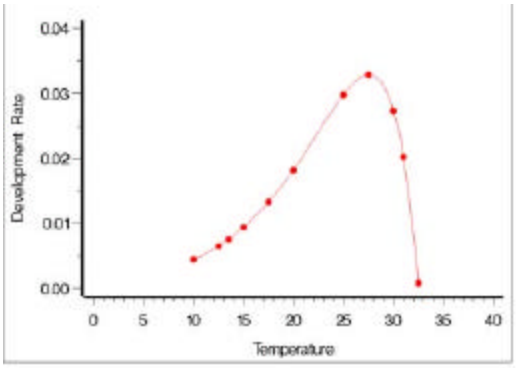
Beat sheets, Beat Trays or Sweep Nets
When the ambient air temperature is cool, GWSS can be detected by having a white sheet, or hand held, light colored tray or umbrella underneath the canopy and then striking or shaking the canopy vegetation and examining the debris. Sweeping an insect net through the foliage is another detection method.

Visual Inspection
Glassy-winged sharpshooter infestations can also be determined by examining the underside of plant leaves for egg masses.

Degree-Days
Insects require a certain amount of heat to develop from one point in their life cycle to another. Because of yearly variations in weather, calendar dates are not a reliable basis for predicting when these events will occur. Measuring the amount of heat accumulated over time provides a physiological time scale that is biologically more accurate than calendar days.

All organisms have temperature thresholds above and below which growth does not occur. These thresholds vary from species to species. The amount of heat above the lower developmental threshold required to complete a given organism's development does not vary-the combination of temperature (between thresholds) and time will always be the same. Physiological time is often expressed in units called degree-days (DD or °D). A degree-day is the amount of heat that accumulates over a 24 hour period when the average temperature is 1° above the lower developmental threshold of an organism.

Preliminary data developed by Dr. Rick Redak at the University of California at Riverside indicate that the lower developmental threshold temperature for GWSS is approximately 11°C and the upper thermal maximum is approximately 32°C. At the optimum developmental temperature (approximately 27°C), approximately 850 degree-days are required for post embryonic development.



The lower and upper threshold temperatures can be entered into the UC IPM degree day calculator at: http://www.ipm.ucdavis.edu/WEATHER/ddretrieve.html. Select weather station or manually enter weather data and the calculator will print a table of degree days accumulated.

BEST MANAGEMENT PRACTICES

Inspections - Transfers and Incoming Shipments

Do not jeopardize your GWSS management program by failing to manage incoming plant material. You should buy only from knowledgeable and reputable suppliers that are willing to make sure you receive clean product even though there are no GWSS regulations within the infested area. Hold all incoming stock in a quarantine area until it can be inspected and treated. Do not send it directly to the growing area or to the dock for shipment. Incoming stock that has been treated with an approved insecticide at time of shipment by the supplier should still be inspected before being moved within your facility. Consult with your local CAC to find out what the specific requirements may be for transfers and incoming shipments. Document all buy in or transferred stock transactions. This is particularly important if your facility has limited outside pest pressure (e.g. free from status).

Inspections - Outgoing Shipments

Outgoing shipments from GWSS infested areas (see CDFA Plant Quarantine Manual section 510.1 or Appendix B of the State Miscellaneous Ruling: Pierce's Disease Control Program, pages 454.7 through 454.10) to noninfested or suppression areas of enforcing counties require 100% visual inspection by CAC personnel(except for free-from nurseries) if shipped under "Blue Tag". Plants shipped under the "Approved Treatment Protocol" should be visually inspected by nursery personnel. CDFA 2000-2007 shipment rejection data by host with greater than 10 rejections lists the following hosts in descending order:

1. Lagerstroemia	7. Nandina
2. Photinia	8. Tristania
3. Ligustrum/Privet	9. Camellia
4. Raphiolepsis indica	10. Melaleuca
5. Pittosporum	11. Roses
6. Vinca	

NUMBER OF REJECTIONS BY PLANT AND MONTH												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Lagerstoemia		0	0	X	X	XXX	XXX	XXX	XX	X	0	
Photinia			XXX	X	0		XX	XX	X		XX	0
Ligustrum	0	X	XXX	XX			XX	XX	X			
Raphiolepis			X	XX	X	0	X	X	XX	0		
Pittosporum		X	XX	0			XX	XX	X	0		
Vinca			0	0			X	XXX	XX			
Nandina		X	XX	0	0			XX	X	XX		
Tristania		X	0		0		XX	X	X		0	
Camellia		0		0	0		XX	XX	0		0	
Melaleuca			XX	0	X		0		X	0		
Roses					0		XX	XX	X			
Key XXX = 5+ XX = 3-5 X = 2												

Data such as the distribution of GWSS finds by month which document the time of year when each of the top 10 host plants were rejected can be used to determine when extra monitoring and management are needed. For example, Lagerstroemia rejections were highest from June through September, while Photinia and Ligustrum rejections were highest in March and April and in July and August.

Site Design Field layout

When planning on where to place plants in the field, use all available data to aid you in this process. Use trapping data to identify fly ways and points of entry into the facility. Acquire monitoring data from neighbors if possible. Knowing the wind patterns is also important. Place the most preferred host plants in the most sheltered, least GWSS impacted areas. Placing preferred host plants the farthest from known entry points can also be helpful. This may not stop infestation but will help limit the amount and degree of the problem. Place preferred host plants in areas where mitigative measures have been taken (behind barriers in shade or greenhouses if applicable). Given favorable wind patterns placing preferred host in open areas between structures can be very effective in providing protection.

Physical, Mechanical, and Biological Measures

Barriers

Barriers can be any type of physical intervention that prevents GWSS from entering an area. Greenhouses could be referenced as barriers if the air intake and venting systems were screened to prevent GWSS from being pulled into the house.

Probably the best known and widely used barrier BMP is the use of shade cloth. University testing of shade cloth barriers determined that over 90% of adult GWSS fly at heights between 1 and 6 meters above ground. Therefore the posts and cable system must support netting/ saran cloth to at least this height to be effective.

Determination of where to place these barriers is also very important (see diagrams). Barriers facing into prevailing wind patterns are most often used. This may or may not be the best use of this BMP at particular facilities. If the facility is downwind of a GWSS reservoir source such as citrus but only in a Santa Ana wind condition then it would be best to place it where it mitigates the problem best. The location near an infested hillside is also critical. In this case the barrier needs to be set back far enough to mitigate movement from the incline.

Another physical barrier method is the use of yellow sticky tape. This is available under several brand names. The use of this material as a BMP is limited. Trapping as a method to reduce populations is generally not effective. It may however be useful in certain situations as a barrier to GWSS.

Plant Screening

This barrier is very similar to the shade cloth barrier but consists of hedging non- preferred host plant or plants such as junipers or cypress that have leaf structures that do not provide enough area to lay eggs on. This is very similar to trap cropping but is not intended to draw GWSS to it. In this case it is used as a physical barrier. This BMP will require occasional treatment to get rid of buildup of trapped adults. The fact that there should be no oviposition means that an endemic infestation should not occur. A good example would be an Italian Cypress or pine hedge. The chosen plant would need to grow to the needed height and again should not be a host plant species.

Trap Crops

There is no documented process for the use of trap crops in the traditional sense of this methodology at the present time. If not situated away from production areas and maintained properly, drawing GWSS to a trap crop (preferred host) may actually cause compliance problems under the pest management protocol and trapping thresholds. However, continuously treating a preferred host trap crop such as crape myrtle with a systemic such as imidacloprid could be very efficacious. Anecdotally, growers have reported that injecting insecticide into Eucalyptus windrows significantly reduced GWSS populations inhabiting the trees.

Biological Control

The California Department of Food and Agriculture initiated the biological control component of the Pierces Disease Control Program in 2000. The Program recognized that this control strategy could play two important roles:

1. To reduce GWSS populations area-wide through the introduction of biological control agents new to the location.
2. To reduce GWSS populations locally through the augmentation of biological control agents already present at the location.

A total of six species of biological control agents have been produced by the CDFA production facilities in Kern and Riverside counties. Since the inception of the program, 1.9 million parasitoids have been released to control GWSS in 13 counties. A structured monitoring protocol has been in place at all release sites since 2002. The best practice at present is to observe the biological control activity in the field and manage pesticide use to promote continued activity.

TREATMENTS

Plant Destruction

In some instances, destruction of plant material may be necessary due to the presence of GWSS (i.e. the presence of adult or nymphal stages). If mobile life stages are found during inspection and the immediate return of the nursery stock is not an option, the nursery and/or county employees may opt to destroy the infested stock. This may be done by bagging the material and hauling to a landfill. If the material is chipped onsite, care must be taken to ensure the infested material is either treated or handled in a manner to eliminate the potential spread of the insect.

Insecticides

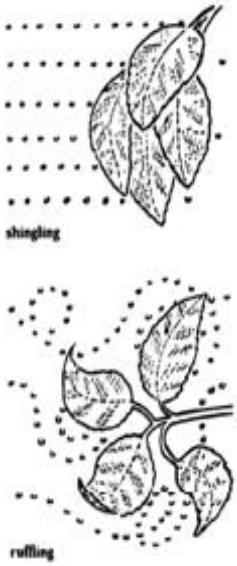
Insecticides are one of the major tools used to successfully control GWSS populations in an infested nursery.

However, the insecticides, Tame® and Sevin® SL should only be used to treat plants being shipped to prevent the possibility of GWSS insecticide resistance. Use of Tame® and Sevin® SL in nursery production is strongly discouraged.

Grower should pay special attention to chemical rotation when other classes of insecticides are available. Change insecticide chemistry whenever the situation allows. For example, do not substitute one pyrethroid for another pyrethroid, instead, select an insecticide from another class of pesticide (see appendix "Leafhopper and Sharpshooter Insecticides").

Application Techniques and Procedures

To comply with NSATP protocol and procedures:



- Treatments shall be conducted in the presence of a licensed CAC inspector.
- Plant foliage must be dry before applying insecticides.
- Treated plants must be protected from overhead irrigation or rain until pesticide has dried.
- Applications must be made/and or supervised by an individual trained to meet label requirements and proper application techniques for carbaryl and fenpropathrin for GWSS control.
- Proper preparation: Make sure that the pesticide is mixed in the most effective range of solution pH and kept in agitation.
- Make sure the application equipment is working properly and calibrated. This will be especially important in treating plant material with approved materials for certification.
- Spray guns, wands, nozzles and pressure should be selected

for the type of plant material being sprayed, such as large trees, shrubs, potted flowering plants, and ground cover.

- It is crucial that applicators use the proper nozzles, pressure (per factory recommendations), and application guns/wands that will ensure pesticide coverage on all upper and lower leaf surfaces.

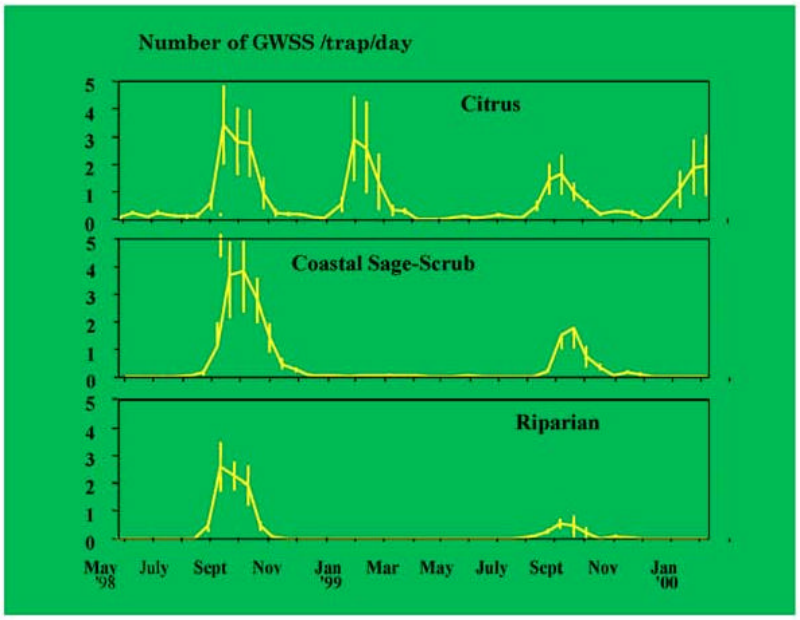
When factory recommendations do not specify the spray gun pressure (psi), it is the grower and CAC responsibility to determine the appropriate pressure by assessing spray coverage using water sensitive spray cards, spray dyes or visual inspection.

Difficult to reach foliage (e.g. foliage beyond the applicator's reach) may require the trees to be laid on their side. Plants must be spaced in a manner that allows full access to each plant by the applicator.

Sprays improperly aimed at the foliage may cause shingling, a condition in which leaves clump together and prevent droplets from reaching some leaf surfaces, especially at high pressures. The application should produce ruffling so spray droplets are evenly dispersed on both sides of foliage.

Developing a Pest Management Program

A successful pest management program requires a commitment to detection and monitoring program that is maintained and documented regularly. Collected data should be analyzed regularly and used to develop, update and implement a plan of attack. For GWSS this plan must be completed before receiving a compliance NSATP agreement and ideally should be created at the end of the previous year before overwintering adults become active.



Use the data that shows the seasonal occurrence of GWSS, to identify the most opportune time to attack this pest. In the case of GWSS the goal is to suppress the density of the first generation of adults. If the population is on site as over wintering adults, reduce their numbers in November and certainly no later than December. Since the vast majority of the population is in the adult stage at this time, choose an appropriate insecticide that is effective and economical that targets the adult stage. In pest management there is a principle referred to as topping populations. Basically this means you do not wait for the population to get to the peak point before you act. Use trapping data and, if available, degree day data to develop a population cycle model.

This can be used to estimate the next point where the adult population will begin to increase, which should be around April.

For example, if trapping records indicate movement from surrounding citrus occurs first in these areas, treat the site starting with the perimeter area first, using a material that is effective on emerging nymphs. This will impact the development of the next generation. Therefore we treat with a product that is effective on emerging nymphs at the end of March or early April.

Reference and compare weather data from the previous year. If the weather conditions are similar then you may time treatments appropriately. If treatment timing is accurate, then fewer adults should be detected in traps in May then at the May peak in the previous year. If the next valley occurred in June, it is at or near this point that another treatment should be scheduled. Again, the goal is to block the development of the current generation which consists primarily of immature stages.

In keeping with pest management principles of pesticide chemistry rotation, use a different pesticide with a totally different chemistry or mode of action, for this treatment. This should result in trap numbers that show a lower July peak. Adult detections in traps should gradually decline by September. We should plan our rotational treatment back to an insecticide to eliminate any adults that will be seeking overwintering sites.

It is now time to evaluate the current year's treatment. Were peak populations decreased compared to the previous year's records? The scenario used is an example of an actual implemented plan in Irvine, California. At this nursery, peak populations (May, July, and Aug) were cut in half after the first year. Even with the dramatic impact in suppression of GWSS pest pressure as attained in this example, GWSS populations may still be at a higher level of pest pressure than we want. With further scrutiny of data from trap records and other monitoring in space and time, we may indicate that preventing GWSS from flying into the nursery may require linking efforts with neighbors to further impact resident populations, or coordinating with local Area Wide Management Programs.

EMPLOYEE TRAINING

In addition to the California Department of Pesticide Regulation's annual training requirements and Regional Water Quality Control Board runoff regulations, applications must be made/and or supervised by an individual trained to meet label requirements and proper application techniques for carbaryl and fenpropathrin for GWSS control.

To comply with the training requirement of the NSATP, the Glassy-winged Sharpshooter BMP training for nursery workers must include the following information:

- GWSS Regulatory Overview
  - What is required to ship out of regulated counties?
- Pest Description and Damage
- Pest Population Detection and Monitoring
- Inspections
  - On-site and incoming shipments
- Best Management Practices
  - Site Design
  - Physical, Mechanical, and Biological Preventative Measures
    - Greenhouse and Shade House
    - Barriers
      - Shade Cloth
      - Plant Screening/Non-egg laying hosts
    - Biological Control
  - Treatments
    - Plant destruction
    - Insecticides
    - Application Techniques and Procedures

Assessing spray coverage with water sensitive spray cards or spray dyes
A spray card is a strip of water- or oil-sensitive paper. The cards are produced in a range of sizes. Various spray dyes and fluorescent dyes are available that leave a residue on foliage that can be used to qualitatively assess spray coverage. Water sensitive spray cards and spray dyes were developed for use in the field for quick evaluation of spray coverage and droplet size.

Using spray cards

Spray cards are one of several tools you can use to assess spray coverage. They cost approximately $1 per 2" x 3" card, and allow you to see where the spray is going in your crop and what sort of spray coverage you are getting with your spray equipment. The spray cards can be placed in the crop using staples, pegs or paper clips prior to any spray operation. Be sure to use bright colored pegs as the water sensitive spray cards turn blue when wet, and can be difficult to see in green foliage. The cards should be collected as soon as they are dry.

Water-sensitive yellow cards turn blue where water droplets hit them, showing spray density and penetration. Oil-sensitive cards are gray and are for use with oil-based sprays.Since these cards are water sensitive and fingers have moisture on them, the applicators being trained or instructor, need to be provided with gloves to handle the cards. The pesticide applicator trainee or trainer should place cards within a grouping of plants similar to actual conditions at the nursery and attach cards that have been

sized to match the leaf size of the plant species within the canopy horizontally and vertically. The pesticide applicator trainee or instructor should then spray the plants. The spray solution will be water only. After letting the cards dry for a few minutes, collect cards and place in a labeled Zip-loc bag. Droplets on the cards can then be counted to visually assess application technique.

Spray cards can also be used to evaluate different spray guns, nozzles, and pressures.

Materials

- Gloves
- Water sensitive paper
- Card holders
- Zip-loc bags

NURSERY GLASSY-WINGED SHARPSHOOTER BEST MANAGEMENT PRACTICES TRAINING RECORD

Trainers Name;		Date:	
Trainer's Signature:		Location:	

Trainee's Name (print)	Signature	Comments

This training complied with the Glassy-Winged Sharpshooter BMP training for nursery workers and included the following information:

- GWSS Regulatory Overview
  - What is required to ship out of regulated counties?
- Pest Description and Damage
- Pest Population Detection and Monitoring
- Inspections
  - On-site and incoming shipments
- Best Management Practices
  - Site Design
  - External Sources of GWSS
  - Preventative Measures
    - Greenhouse and Shade House
    - Barriers
      - Shade Cloth
      - Plant Screening/Non-egg laying hosts
  - Treatments
    - Plant destruction
    - Insecticides
    - Application Techniques and Procedures

Appendices

GWSS/PIERCE'S DISEASE REFERENCES

BMP Record Keeping Forms

Leafhopper and Sharpshooter Insecticides

GWSS Links/Sources of Information

Date:	BMP CHECKLIST:		BARRIER					MONITORING		
NURSERY LEVE Crop, Area, Section	*Insecticide(s)	Rotate Insecticides	Shade Cloth	Non egg laying host	Greenhouse	Shade house	Trap Crop	Beating Sweeping	*Yellow Sticky Card	Visual
Name and title of Nursery Authorized Agent		Signature		Date	CAC Inspector		Signature		Date	

*Required BMP

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Leaf Hopper and Sharpshooter Insecticides

Class	Pesticide (commercial name)	Manufacturer	R.E.I.	Comments
Botanical	Pyrethrin/PBO[2] (PT 1100 Pyrethrum TR)	Whitmire MicroGen	12	An aerosol.
	pyrethrin/rotenone (Pyrellin EC)	Webb Wright	12	
carbamate	carbaryl* (Sevin SL)	Bayer	12	May be applied through sprinkler irrigation systems only.
insect growth regulator	azadirachtin (Azatin XL Plus)	Olympic	4	Must contact insect. Repeated applications as necessary. Aphid suppression only. Label permits low-volume application.
	azadirachtin (Ornazin 3%EC)	SePRO	12	Do not exceed 22.5 oz/acre/application.
	s-kinoprene (Enstar II)	Wellmark	4	Apply prebloom. Also labeled for low volume use. Do not use through any type of irrigation system.
neonicotinoid	acetamiprid (TriStar 70WSP)	Cleary	24	Alternate with insecticides that have a different mode of action to prevent development of resistance to neonicotinoids.
	imidacloprid (Marathon 1G) (Marathon II)	Olympic	12	Not to be used more than once every 16 weeks. Alternate with insecticides that have a different mode of action to prevent development of resistance to neonicotinoids. Do not apply to soils that are water logged or saturated. Do not apply to bedding plants intended to be used as food crops.
	imidacloprid (Marathon 60 WP)	Olympic	12	As above, but apply only as a drench.
oil[3]	clarified hydrophobic extract of neem oil (Triact 70)	Certis	4	Do not spray plants under stress. Target pest must be completely covered with spray-this material may not effectively control melon aphid because it is often on the underside of lower leaves. Check label for list of plants that can be treated. May cause injury to flowers. Do not use through any type of irrigation system.
	horticultural oil			
	Ultra-Fine Oil	Whitmire MicroGen	4	Use as above for neem oil. Also, do not use with sulfur fungicides; check label for tank mix restrictions.
	SafTSide	Brandt	4	
	JMS Stylet Oil	JMS Farms	4	
organophosphate	acephate	Dow	24	Do not use through any type of irrigation system.
	acephate (Orthene T, T&O Spray) 75WP	Valent	24	A number of chrysanthemum varieties have exhibited phytotoxic reactions. Only labeled for use on anthurium, cactus, carnation, rose, orchids, some foliage plants, young poinsettias and some varieties of chrysanthemum. Can stunt new growth in roses. Do not use through any type of irrigation system.
	acephate (PT 1300 Orthene TR)	Whitmire MicroGen	24	An aerosol that is only for greenhouse use.
	chlorpyrifos* (PT DuraGuard ME)	Whitmire MicroGen	12	
organophosphate/ pyrethroid	chloropyrifos/ cyfluthrin* (PT Duraplex TR)	Whitmire MicroGen	12	An aerosol.

Leaf Hopper and Sharpshooter Insecticides

Class	Pesticide (commercial name)	Manufacturer	R.E.I.	Comments
pyrethroid[4]	bifenthrin* (Talstar Flowable)	FMC	12	Label permits low -volume application. Do not use through any type of irrigation system.
pyrethroid[4]	bifenthrin* (Talstar Flowable)	FMC	12	Label permits low-volume application. Do not use through an / type of irrigation system.
	cyfluthrin (Decathlon 20 WP)	Olympic	12	Label permits low-volume application. Do not use through an / type of irrigation system.
	deltamethrin (DeltaGard T&O)	Aventis	12	For outdoor use only. Do not use through any type of irrigatic ı system.
	fenpropathrin* (Tame 2.4 EC)	Valent	24	Label permits low-volume application. Do not use through an / type of irrigation system.
	fluvalinate (Mavrik Aquaflow)	Wellmark	12	Label permits low-volume application. Do not use through an / type of irrigation system. Also labeled as a cutting dip at 5 fl oz/100 gal.
	lambda-cyhalothrin* (Scimitar)	Syngenta	24	Supplemental label for greenhouse and nursery use. Apply a 7-day intervals. Do not apply more than 52.4 fl oz of concentrate/acre/year. Do not mix with EC formulations or oils.
	permethrin* (Astro)	FMC	12	Direct application to blooms may cause browning of petals. Marginal leaf burn may occur on salvia, diffenbachia and pteris fern. Label permits low-volume application. Do not app y more than 2 lb a.i./acre/year.
soap[3]	potash soap (Insecticidal soap)	Olympic	12	Must contact insect, so thorough coverage is important. Repeat weekly as needed up to 3 times. Test for phytotoxicit ·. Do not spray new transplants or newly rooted cuttings. Do nc t add adjuvants.
	(M-Pede)	DowAgro	12	

1 Restricted entry interval (hours

2 PBO = piperonyl butoxide

3 Single doses of soaps or oils can be used at anytime in a pesticide rotation scheme without negatively impacting resistance mgmt programs.

4 Pyrethroids are generally not effective against green

* Restricted use material. Permit required for purchase or use.

in a pesticide rotation scheme without negatively impacting resistance mgmt programs

or use.

Glassy-winged Sharpshooter (GWSS)
Links/Sources of Information

California Department of Food and Agriculture
http://www.cdfa.ca.gov/pdcp/

Complete information on plant quarantine Section 454: Regulations and Section 510: Counties with regulations more stringent than 3650, and the Nursery Stock Approved-Treatment Protocol, can be found at your local CAC office or the following links:
http://www.cdfa.ca.gov/pdcp/Regulations.html

http://www.cdfa.ca.gov/pdcp/NSATP.pdf

University of California Agriculture and Natural Resources Media Kit
http://www.news.ucanr.org/mediakits/gwsskit/gwsskit.shtml

University of California, Riverside, Media Resources Page
http://info.ucr.edu/gwss/

University of California, GWSS workgroup
http://gwss.ucanr.org/mainindex.html

Dr. Beth Grafton -Cardwell, Research & Extension Entomologist, UC Riverside and Kearney Ag Center
http://citrusent.uckac.edu/glassywing.htm

Bug Spot.Org
http://www.bugspot.org/

Citrus Research Board Website
www.citrusresearch.org

California Department of Pesticide Regulation
http://www.cdpr.ca.gov/