United States Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine

Technical Working Group (TWG) Report

Area-wide Control of Asian Citrus Psyllid (ACP)

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United States Department of Agriculture (USDA)
Animal Plant Health Inspection Service (APHIS)
Plant Protection and Quarantine (PPQ)
Center for Plant Health Science and Technology (CPHST)

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Introduction

A technical working group (TWG) was convened in December 2008 to address components of an area-wide control (AWC) program for the Asian citrus psyllid (ACP) (*Diaphorina citri* Kuwayama) in the United States, the insect vector for the destructive huanglongbing (HLB, citrus greening) pathogen (*Candidatus* Liberibacter spp). Outcomes, recommendations and research gaps were identified and published in February of 2009 and are available online in a report entitled "**Area Wide Control of Asian Citrus Psyllid *(Diaphorina citri)* Technical Working Group Report"**.

On 30 September 2010, a second TWG was organized via teleconference (See Appendix 1 for a list of TWG participants) to assess the status of existing area-wide control efforts of ACP that resulted from the December 2008 meeting. The TWG met for approximately two hours and addressed a set of questions broadly covering insecticide applications, production practices, survey practices, and management areas. A list of questions and participant responses are listed in Appendix 2.

Recommendations

- Treat as much citrus acreage as possible during each spray cycle to maximize coverage and prevent the establishment of pest refuge areas.
- Coordinated area-wide treatment applications should be completed within a two to three week time frame.
- Mode of Action (MOA) use should be coordinated and rotated within management areas to prevent development of insect resistance.
- Dormant season applications are most critical overall in maintaining ACP population reductions.
    - Two dormant season applications, utilizing broad spectrum insecticides, should be completed immediately following the last flush of the production season and just prior to the first flush of the next production season.
        - Timing is not as critical for the treatment applied after the last flush of the production season, but nonetheless should be coordinated to prevent pest refuge areas from developing.
        - Timing is more critical (than above treatment) before the first flush of the next season. Pesticide should be applied prior to the development of the flush (versus the fruit) to prevent ACP eggs on new flush. As mentioned above, it is critically important that this treatment timing be coordinated within management areas to prevent pest refuge areas.
    - Within the production season, product selection should be based on control efficacy of APC and other economically damaging arthropod pests, pre-harvest intervals, and other label use requirements.

- Application methods (aerial, ground) should be tailored to fit each management area by considering geographical or environmental influences as well as unique location characteristics such as residential, organic production, or critical habitat interfaces.
- Management areas should be as large as possible, taking advantage of any natural geographic separations and existing cooperative efforts among producers.
- Management practices which promote flushing should ideally be coordinated within a management unit.
- Scouting emphasis for ACP detection should be placed on grove block perimeters. Scouting method(s) (sticky trap, visual, stem tap) should be tailored to the specific area and circumstance. (see "Area Wide Control of Asian Citrus Psyllid *(Diaphorina citri)* Technical Working Group Report"; http://www.aphis.usda.gov/plant_health/plant_pest_info/citrus_greening/downloads/pdf_files/twg/Psyllid%20Area%20Wide%20Control2.09.09.pdf).
- Organic growers within a management area should utilize the most efficacious product available during the coordinated treatment window. Consult a local agricultural professional for product use recommendations in the area of interest.
- Extension, outreach and communication groups should be engaged to assist with education, communication, and public awareness in citrus growing states. These groups should cooperate with industry leaders and others in support of ACP control.

Area-wide ACP control is achieved by providing effective mechanisms for communication to support coordination of ACP treatments among local citrus growers and grove managers. This ACP control strategy is based on a cooperative approach to a controlling a citrus production issue. If ACP is controlled by many in a locale, the insect population will have fewer individuals from which to reestablish. When this is accomplished, both communication and control efforts have succeeded.

Additional Information

Citrus Health Management Areas (CHMA's): Developing a psyllid management plan.
http://www.crec.ifas.ufl.edu/extension/chmas/pdf/chma_spray%20plan_10_11_10.pdf

List of Pesticides Tested and Recommended for Asian Citrus Psyllid Control in Texas.
http://www.texascitrusgreening.org/treatment.php
http://www.texascitrusgreening.org/files/Suggested%20Insecticides%20for%20Dormant%20Sprays.pdf

A New Pest in California, *Diaphorina citri* (Asian Citrus Psyllid): Provisional Treatment Guidelines for Citrus in Quarantine Areas. http://www.ipm.ucdavis.edu/EXOTIC/diaphorinacitri.html

University of California, Kearney Agricultural Center Citrus Entomology: Asian Citrus Psyllid Management: Psyllid Treatment Strategies.
http://ucanr.org/sites/KACCitrusEntomology/Home/Asian_Citrus_Psyllid/Management_420/

University of California, Kearney Agricultural Center Citrus Entomology: Coachella Valley: ACP Treatment Strategy.
http://ucanr.org/sites/KACCitrusEntomology/Home/Asian_Citrus_Psyllid/Management_420/Coachella_Valley_Region/

Appendix 1. TWG participants.

Name	Organization
David Bartels	USDA APHIS PPQ CPHST
Russ Bulluck	USDA APHIS PPQ CPHST
Henry Fadamiro	Auburn University
Beth Grafton-Cardwell	University of California, Davis
Megan Henderson	USDA APHIS PPQ CPHST
Charla Hollingsworth	USDA APHIS PPQ CPHST
Natalie Hummel	Louisiana State University
Michael Rogers	University of Florida
Don Seaver	USDA APHIS PPQ CPHST
Mamoudou Setamou	Texas A&M University, Kingsville Citrus Center
Glen Wright	University of Arizona

Appendix 2. TWG Questions and Responses

Insecticide application technology

1. ***What is the general timeline for everyone in a management area to complete treatment? What happens if treatments for a subset of groves are delayed (weather, equipment failures, miscommunications, etc)?***

   Florida. Growers should complete applications within two weeks (approximate length of the psyllid lifecycle). There are sometimes issues that complicate timely completion of field work within a given Citrus Health Management Area (CHMA) such as equipment failures or weather, but growers should make every attempt to treat as quickly as possible, not to exceed three weeks.

   Texas. Treatment urgency is described according to production cycle, e.g. dormant and active. During the dormant production cycle, a pyrethroid treatment is applied during two to three week time periods in January (15 to 31) as well as November (1 to 21). These application timings precede the first flush which is produced during mid-February to March, and follow the fourth flush which is produced from September to October. Treatment applications made during the growing season are preferably completed within a two week window in Citrus Pest Management Areas (CPMAs). Information regarding CPMAs is available at: http://www.texascitrusgreening.org/manage.php

   Louisiana. Due to the limited commercial citrus acreage (approximately 500 acres), insecticide application is generally completed within one to three days by helicopter. Treatment occurs in April and again in October using insecticide products such as Danitol® and Provado®.

   Alabama, Arizona, California. These states are not currently engaged in area-wide Asian citrus psyllid (ACP) control treatment programs due to limited insect populations. Arizona and California have aggressive urban treatment programs, but the timeframe for completing such treatments varies from a few days to a few weeks. Alabama has a program which focuses on annual survey of commercial groves and backyard citrus for ACP and treatment of localized infestations. In Arizona, treatments are completed within 2 weeks of the initial find. Once commercial citrus becomes infested in California growers will be required to treat within a 2-3 week time frame.

2. ***Please estimate the average length of time ACP is controlled by insecticides (both systemic and non-systemic) after a foliar application (assume mature citrus) using rates and products most commonly used.***

   The terminology used in this question can be interpreted in a number of ways. Insecticide-derived "control" of ACP is achieved (*i*) directly via insecticide active

ingredient residue protection, (*ii*) indirectly by reducing the insect population across a large citrus production area (area-wide) which functions to slow population recovery and recolonization of treated groves, or (*iii*) directly and indirectly simultaneously.

Non-systemics. Most studies from field trials (from Florida and Texas) have demonstrated (direct) residual control of adult ACPs up to two weeks post-application; however, in a more arid environment, residual control may be extended up to four weeks post application (citing limited observational data from foliar applications in California). In short, the length of time that the insecticide remains effective is dependent, in part, on the rate at which it is applied, growth stage of the trees, and environmental conditions.

Texas and Florida. Where a dormant season occurs, a broad spectrum application after the last flush of the production cycle and before the first flush of the next production cycle may have indirect control effects up to three to five months and provides the rationale for area-wide coordinated sprays.

Systemic; soil drench application. Estimates vary regarding the period of effective control. In general, control extends between 45 and 90 days depending upon the size (age) of trees and the soil and water conditions. This mode of action (MOA) primarily targets nymphs on new flush, but is also effective on adult psyllids.

Florida. Control of both adults and nymphs usually extends from six to eight weeks on young trees. Beyond a certain size (age) of tree, soil-applied insecticides cannot be applied to acreages at labeled rates (e.g., active ingredient/acre) sufficient to control ACP.

Texas. During the active production cycle if larger areas are treated simultaneously and in a coordinated manner, control efficacy may occur during the entire flush period (four to six weeks) even in environments that promote ACP population growth. Protection of young trees from ACP using soil-applied systemic products is usually effective for a period up to three months.

California. In urban settings, control lasts 6-9 months when systemic imidacloprid is applied in combination with foliar cyfluthrin. When foliar and systemic insecticides are applied together, the effective length of control is much longer than either applied alone, because they affect different parts of the population (egg laying, adults, nymphs).

Arizona. There has been no need for foliar or soil drench retreatment, so it is uncertain as to the duration of control.

3. ***Describe the products, timing, number, and type (dormant oil, foliar-applied, drench, ultra low) of treatments to control ACP that are recommended in your state. If you***

have published an extension document describing this information please provide a link or file.

Florida. http://www.crec.ifas.ufl.edu/extension/chmas/pdf/chma_spray%20plan_10_11_10.pdf

Organophosphates are recommended after the last flush of the season (Nov/Dec) followed by pyrethroids just prior to the first flush of the following season (Jan/Feb). Due to restricted entry interval (REI) and pre-harvest interval (PHI) issues, growers harvesting fruit during the Nov/Dec application window may choose to apply a pyrethroid and rotate to an organophosphate during the Jan/Feb application window. Other options are available for in-season management of pest complexes.

Texas. http://www.texascitrusgreening.org/manage.php

Pyrethroids are utilized before and after the growing season (Jan. 15-31 and Nov. 1-21). During the growing season, tank mixed pesticides targeting additional citrus pests are utilized. http://www.texascitrusgreening.org/treatment.php

California, Arizona. In urban areas an imidacloprid drench and pyrethroids (Cyfluthrin) have been utilized. Few products are available to homeowners since most companies stopped registering products for fruit trees in residential situations.

http://www.ipm.ucdavis.edu/EXOTIC/diaphorinacitri.html.

California commercial citrus: There are 5 regions of citrus with management plans developed to address psyllid infestations once they become established. Similar to Florida and Texas, recommendations will include an early season pyrethroid, followed by in-season ACP effective insecticides (depends on region what is used), followed by late summer imidacloprid and late season organophosphate or pyrethroids.

http://ucanr.org/sites/KACCitrusEntomology/Home/Asian_Citrus_Psyllid/Management_420/

Arizona. Commercial citrus management plan would be similar to the plan already developed for the Coachella valley region of California.

http://ucanr.org/sites/KACCitrusEntomology/Home/Asian_Citrus_Psyllid/Management_420/Coachella_Valley_Region/

Louisiana. Coretect® (ai: imidacloprid) tablets are applied prophylactically each year in residential citrus near production areas using a local needs exemption label (24c). Size of the tree determines the dosage (# of tablets). Control efficacy comparing tablets to drench application should be studied by Frank Byrne at UC-Riverside.

Alabama. Insecticides recommended for control of ACP in Alabama include the soil applied systemics AdmirePro® or Temik® [1] (January), and foliar insecticides such as Lorsban® (January), Movento® or Portal® (April-May and also in July).

4. ***How important is it to use the same product (same mode of action, MOA), the same rate of application, and the same type of application (drench vs foliar, air vs ground) across a management area?***

Florida. Using the same MOA over the entire area is important, and rotating product MOA's during the coordinated spray periods, will help to prevent resistance development. The type of application method is left to the discretion of the growers since this program is voluntary and acreage, access, and management practices are variable. Additionally, product choices differ for fresh market fruit vs. juice fruit, when maximum residue limits and pre-harvest intervals are considered.

Texas. A consistent mode of action is encouraged for the two dormant season applications, primarily to have a very short PHI to fit in with the harvest schedule. During the growing season, selection of MOA is left up to growers, while rotation of MOAs is encouraged.

California, Arizona and Alabama. Will follow the Texas and Florida models and emphasize rotation of chemicals to prevent selection of resistance in the insect population. PHI, control of other pests and maximum residue limits will guide the choice of insecticides. California will likely have more restrictions on insecticide use because some of the acreage in the southern region where psyllid will infest first is organic.

5. ***If ACP population increases are localized within a management area, is an application conducted across the entire area, or is an application made just where the insect is increasing?***

The larger the area receiving an insecticide treatment, the more effective will be the control of ACP populations. Timing of an application is dependent on flush occurring which is determined, in large part, by grove management, environment, and variety grown.

Florida. Ideally, the whole area should receive treatment when ACP is detected, but in reality it is a mixed bag. Treatment decisions are generally made block by block and many opt to treat blocks, rather than groves. In one example, a CHMA coordinated seven area-wide applications (three aerial and four ground) with the result being that it was difficult to find an ACP across the treatment area.

[1] Bayer cancelled the use of Temik for citrus on August 16, 2010. Farmers may continue to use stocks on hand through December 31, 2011.

Texas. Treatment decisions are generally made by block since the flush cycles vary between blocks. Coordinated area-wide treatments are currently employed only during the pre- and post-growing season (dormant applications). For recommendations, we will always advise treating the largest area possible.

California. Scientists have recommended treatment of the largest area possible, but ultimately it will depend on the willingness of the growers to comply and carry through. Spraying will not be recommended until ACP is found to be established. Initially, treatment will be the infested orchard and neighboring orchards. Once the psyllid becomes established in citrus, the width of the area treated will be determined by an analysis of the contiguous acreage and recommendations of the Pest and Disease Prevention Committee. Current recommendation is to spray a 400 meter radius around an urban find site. The sprayed area for commercial citrus will include entire citrus orchards that intersect with the 400 meter radius around a find site

Alabama. Orchards with no detection of ACP in their own orchard or within a 2.5 mile radius are considered low risk and should scout regularly and follow a sound IPM program for other pests. Orchards with detection in or near the orchard should make insecticide treatments for ACP in addition to other pests.

Arizona. Current recommendations include spraying a 400 meter radius around ACP detections.

Existing production practices

6. ***In production areas that have additional pests (e. g., sharpshooters, leafminers, citrus rust mites, scale, mealybugs), are pests considered cooperatively by the management area, or are these treatments implemented independently?***

There is general agreement that multi-target pesticide applications are most advantageous and cost-effective for growers. To be truly practical, it is imperative that an area-wide program control most, if not all, economically important pests of citrus. When the program is identified to deliver increased benefits while controlling production costs, more growers will want to participate.

Florida. Growers utilize broad-spectrum and tank-mixed fungicide and insecticide applications to control a number of pests, but the primary focus is on psyllid control.

Texas. During the active growing season, mites are the pest of concern. Knowing when various pest issues are likely to arise allows control strategies to be modified to address additional production issues.

Alabama. Mites and whiteflies are the main economic production issues during the growing season. ACP management is integrated with these endemic pests.

California. A control program is being designed to match the suite of citrus pests with effective products and timing of applications to achieve the greatest likelihood for successful control and to maintain an IPM program.

7. ***Are management practices that promote flush (hedging, fertilization, irrigation, topping) also coordinated within management areas?***
   The approach is sound and is being discussed. It is feasible that this can be accomplished in the future when area-wide management strategies have matured.

   Florida. Studies are underway to determine the feasibility of this approach.

   Texas. There is a level of cooperation between growers, but no coordinated approach.

   Arizona and California. The timing on production activities such as hedging and topping could be coordinated, but irrigation and fertilization schedules would be nonnegotiable.

Survey practices

8. ***Should groves located in the interior of management areas be scouted as frequently as groves located at the perimeter? Who does the surveying? How often should it be done?***

   Louisiana. USDA conducts visual surveys using a predetermined survey plan.

   Texas. A self-survey program has been designed to support grower surveys for estimating populations of Asian citrus psyllid (ACP). The program encourages inspections of trees located on block perimeters. Two years of data support this approach as more psyllids are found on the perimeters of grove blocks than in the center of a block. This program utilizes three methods; sticky traps, visual inspection of flush shoots and stem tapping. Traps appear more effective than stem taps when population levels are low.

   California. Citrus Research Board (CRB) has placed traps in all the commercial acreage and also performs visual surveys. Traps are replaced every two to three weeks and a visual inspection is made of each deployed trap. All groves receive the same level of survey to detect ACP. Once ACP is found, then surveys will intensify in that area by adding more traps.

   Arizona. Department of Agriculture employees have placed traps in all commercial acreage within the quarantined areas. Traps are replaced every 2 weeks. Trapping density is 25/sq. mile. If an ACP is found, a more intensive trapping and visual survey is conducted.

Alabama. The Alabama Department of Agriculture & Industries in conjunction with USDA-APHIS conduct visual surveys for ACP using a predetermined survey plan.

9. ***If the management area is discontinuous and includes dooryard citrus or non-participating production groves, is ACP control still feasible? How are these kind of situations addressed?***

   Florida. There is currently no emphasis on controlling ACP in dooryard citrus because the number of abandoned and unmanaged acreages is so large. Once these acreages are under uniform ACP control, promoting ACP control in dooryard citrus will be emphasized.

   Texas. Current area-wide strategies do not address insect contributions made by dooryard citrus. Growers are encouraged to track populations in adjacent residential areas and aggressively control incoming ACP populations as necessary.

   California. Current recommendations emphasize preventing the spread of ACP by coordinating communication between organizations assisting with urban and commercial control. The CRB and the CPDPC (Citrus Pest and Disease Prevention Committee) work primarily with commercial producers while the California Department of Food and Agriculture supports ACP control in urban areas. When ACP is determined to be widespread, bio-control will likely be the primary tool for control in urban settings.

   Arizona. Current ACP control efforts are conducted and/or supervised by Arizona Department of Agriculture employees. Trapping is occurring in urban areas at 10 traps per square mile density.

   Louisiana. Dooryard citrus is treated because residents are supportive of the commercial citrus industry and because commercial acreages are discontinuous. Treatment costs are funded by the Parish.

Dooryard and/or organic citrus

10. ***How problematic are residential plantings to the commercial citrus industry in your state? Are they a constant source of pests or is their impact so small that it's negligible?***

    Florida. Residential plantings are problematic, but the impact is small compared to abandoned and unmanaged groves.

    California. Dooryard plantings and abandoned groves are a huge problem due to the proximity to commercial acreage. Organic orchards are also a problem. They are a source of both ACP and potentially a source of HLB.

Louisiana. Abandoned groves are big problem and were included in the aerial sprays around the commercial locations. The cost of treating them was borne by the Parish.

Arizona. Abandoned groves are not irrigated, so they die fairly quickly. Dooryard plantings are a significant problem because of their proximity to commercial orchards. Organic orchards are also a problem.

Alabama. Residental/dooryard citrus planting are a major source of ACP in Alabama. In fact, ACP has been detected in Alabama primarily in backyard citrus.

11. ***How is organic citrus production addressed in management areas? Products available for use (oils, kaolin clay and pyrethrins) have different application timing since they are life stage specific. Also, what are the timing considerations for surrounding groves due to avoidance behavior by adult ACP.***

A suite of products are undergoing evaluation by researchers at Texas A&M University in cooperation with USDA-APHIS. Treatments include white, vegetable, hot pepper, garlic and neem oils as well as kaolin clay. No product currently tested by Florida or Texas provides more than 10 days control.

Texas. Kaolin clay cannot be used later than June due to citrus scale infestation.
List of products, timing, rates available at:
http://www.texascitrusgreening.org/treatment.php#id3

California. Kaolin clay is not acceptable due to flaring California red scale populations. Organic acreage is concentrated in Southern California where ACP was first found and where HLB is likely to appear first. The lack of organic solutions to ACP control is a huge problem for preventing spread of the psyllid and the disease.

Arizona. Kaolin clay not currently used because of high cost as compared with traditional whitewash. Lack of organic solutions for ACP control will be a problem in AZ as well.

Florida. Organic growers are encouraged to apply the approved organic material of their choosing during the coordinated spray window of the CHMA in which they are located. While the organic options are inferior to the traditional insecticides, some suppression may be achieved.

Management area group structure and communication

12. ***Young trees produce a greater number of flushes and are at greater risk for feeding and reproduction of ACP compared with older trees. Fortunately, they also have more treatment options (drench as well as foliar application). Is grove age considered when designing management areas?***

Florida. Grove age is not a consideration, all blocks in an area should be treated simultaneously to reduce psyllid populations and prevent movement of psyllids from treated to untreated areas.

Alabama. There is no distinction to tree maturity in terms of management except as it relates to insecticide labeling instructions.

13. Does an extension/outreach and communications group also need to be created and support management areas in each state? If yes, does this currently exist in your state?

Florida. The CHMA concept has a foundational communications component. Groups that support and promote this aspect include extension (county agents and state specialists), growers, as well as state and federal agencies.

Texas. The CPMA has a grower board of directors that makes treatment decisions after receiving input from Texas A&M Extension personnel. Board meetings are scheduled on a monthly basis. An example of outreach to growers is available at: http://www.texascitrusgreening.org/files/November%20Spray%20for%20ACP%20AWM%20in%20Texas_latest.pdf

Arizona. When an area-wide approach is developed, it is likely that it may be similar to the model used in Texas.

Alabama. A working group including extension, researchers, state regulators, and growers meets two to three times each year to develop programs and organize workshops for growers.

California. A number of entities contribute to outreach and communications including Citrus Research Board, California Department of Food and Agriculture, the USDA and the University of California. The newly formed statewide CPDPC committee will be taking a leadership role in coordinating activities.

14. Is there a production area size or grower participant limit in each management area?

No size limit by default but rather driven by logic/practicality.

Texas. Size is not a limiting factor. CMPA participation is encouraged for as many growers as possible.

California. Contiguous acreage of commercial citrus will be the main definition of a region. Some regions are already forming such as the Ventura area. Other regions such

as the San Joaquin Valley are very large and will need to be subdivided. This has yet to be done since the psyllid has not yet appeared in commercial citrus in most areas of California.

Florida. Logical CHMA delineations should be made that capitalize on contiguous production acreages as well as grower preferences for CHMA participation.

Economic feasibility

15. ***What is the cost/benefit of the different area-wide control strategies? Would using a biannual spray regime (before the first flush and after the final) give a high enough percent control that it would be difficult to convince growers to do anything additional?***

Louisiana. Two insecticide applications each year appear effective at controlling ACP populations. More frequent applications, and greater production costs, are not likely to be supported by growers unless HLB is found beyond the initial area of infestation.

California. As psyllid populations move into commercial citrus two insecticide applications will be used to control the pest, and initially that may be very effective. But as the psyllid populations expand and/or HLB is detected, the number of applications will increase to 5-6 per year.

Arizona. One to two insecticide applications per year will likely be needed as psyllid populations increase. Additional applications will be recommended if necessary.

Florida. The recommendations in Florida are for each CHMA to attempt to coordinate 2-4 sprays per season with additional sprays used by growers to manage psyllids and other pests when needed. The level of participation by growers in the coordinated spraying will vary from minimal to exceeding the current minimum suggested recommendations.

Texas. An estimated 58% of Texas growers are working to control psyllids. This figure continues to grow as more outreach and communication tools are employed.