Recommendations of the Technical Working Group

for the

Light Brown Apple Moth Infestation in California

8 June 2007

These recommendations were developed during a meeting of the
Technical Working Group in San Jose, California, 16-18 May 2007

Overriding recommendation: The U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) and the California Department of Food and Agriculture (CDFA) should adopt a long-term goal of eradicating light brown apple moth (LBAM), *Epiphyas postvittana* (Walker), from the continental United States.

Discussion: This recommendation is based on available knowledge of the current distribution of LBAM in the United States and its potential impacts on agricultural and natural systems. The Technical Working Group (TWG) is assuming that it has a basic understanding of the current extent and distribution of LBAM populations. The lack of LBAM captures during a 2005 LBAM survey encompassing areas of California where the insect is now prevalent suggests that this introduction was relatively recent, although there are insufficient data to definitively date this most recent introduction at this time.

The TWG recognizes that all options for dealing with this infestation involve some level of risk. For example, a choice of not attempting to intervene or contain the infestation places our agricultural and natural systems at risk for substantial economic and ecological damage, which would likely result in a significant increase in pesticide usage in agricultural areas. Economic damages would arise not only from the cost of crop damage and insect control, but also from pronounced impacts on interstate and international trade. Following a strategy of managing and containing this pest on a long-term basis could partially reduce some of these risks, but such a strategy would be costly and would not guarantee against the eventual spread of the insect throughout its potential ecological range in North America. To that end, economic and biological assessments of the LBAM population and the various management options should be undertaken as soon as possible. Whether the LBAM program ultimately ends up striving for eradication, or pursues another goal, program activities and expenditures need to be financially and environmentally justified if the program is to receive necessary funding a public support.

In pursuing eradication, the short-term strategy would include delimiting and containing LBAM populations. This will require ongoing monitoring of the infestation, suppression at the edges of the populations, and population reduction in areas with a higher-density of LBAM populations. A strong regulatory component must be maintained to ensure that unintentional, human-mediated spread of the insect is minimized. Also, public outreach and education is an important factor contributing to the success of regulatory and control efforts.

Eradication will require the integration of several control tactics, which may include mating disruption (pheromone) formulations, insecticide treatments (e.g., *Bt*, spinosyns), sterile insects, and other techniques (e.g., biological control). Ground and aerial application of these materials should be used as needed. Some of these tactics are either in the developmental stage or have not been used on the scale that will be required to eradicate this pest from California. As a result, successful eradication will rely on refinement and adaptation of multiple control and regulatory tactics. A strong research and methods development component will be critical for program success.

Fiscal, political, and technical considerations will affect the course and ultimate success of the LBAM program. The TWG recognizes that technical factors could potentially reduce the feasibility and probability of successful eradication. Possible factors could include a significant change (expansion) in the known infested area, the loss of a control tactic that is critical to the successful elimination of populations, a determination that available control tactics are not sufficiently effective to achieve eradication, or the finding through in-depth economic and environmental assessments that the benefits of eradication do not outweigh the associated costs. For such reasons, the TWG believes that it is important to re-evaluate critical aspects of the program, including the overall strategies and goals, on a regular basis. If significant shortcomings are identified, alternatives to eradication should be considered.

Specific Recommendations

Overall Strategy/Management:

- Complete an economic (cost-benefit) analysis to assess comparative risks of various management options for LBAM in California, including no intervention, long-term area-wide management, and eradication.
- Adopt a short-term strategy that will 1) suppress or eradicate "outlier" populations, 2) suppress and contain populations in the Bay Area, and 3) initiate suppression of the Santa Cruz population with the goal of local eradication.
- Establish an on-site methods development capability to work in conjunction with the program.
- Develop an electronic, geo-referenced database and mapping system to aid in LBAM management. The database should include positive and negative trapping observations, along with historic trapping information. Control and other management activities should also be geo-referenced and tracked with this system.

Host range:

- Adapt available ranked LBAM-host lists from New Zealand and, if available, elsewhere to the situation in California. Among plants on the list, identify which species/varieties are grown in California nurseries, agriculture, and natural systems. Quantify the relative abundance of the various host plants. Validate the host range locally via laboratory studies. This should be done in conjunction with efforts to assess risk from various commodities and nursery plants.

Detection:

- Continue piggy-backing LBAM trapping on tephritid fruit fly, glass-winged sharpshooter, and gypsy moth trapping systems, and establish detection trapping systems in agricultural production areas at 1 trap per square mile, per current program practice.
- In addition, extend trapping into previously untrapped areas (e.g., natural areas). Employ transects or other relatively efficient methods to cover large areas with minimal drain on resources. Employ transects at a minimum of 5 miles beyond locations that are known to be infested (i.e., where moths have been captured). Focus initial trapping on untrapped areas adjacent to and between infested areas, such a the Soquel area of California, and then radiate trapping out from these areas in spoke-like fashion, using available roads wherever possible.

- Also extend trapping along major highways through untrapped areas, focusing on rest areas or other sites where traffic stops. Trap in high-risk areas identified through trace-backs, trace-forwards, and other pathway evaluations.
- Conduct adult LBAM trapping to monitor phenology: Place a grid of 10 traps in each of several (5 or 6) areas that are known to be relatively heavily infested. Holding these at a density of 5 traps per square mile would be appropriate. If possible, select sites representing a variety of ecozones (e.g., Contra Costa, Alameda, San Francisco, Soquel, and Monterey/Salinas). These traps will be used to monitor phenology and population trends, thus they should be left at fixed locations rather than being "rotated" among several sites. Ensure that accurate weather data are available for the areas being trapped. If possible, traps should be monitored weekly. Standard LBAM detection trapping within these areas should be suspended to conserve resources and eliminate possible competition between detection and phenology traps.
- Implement a national survey capable of detecting newly introduced populations of LBAM. Re-examine national survey priorities to ensure that survey for other insects of comparable or greater regulatory concern are adequate for early detection and response purposes.
- Switch to a 6-week lure change interval for routine trapping.
- Establish a standardized system for monitoring lure quality.

Regulatory

- *Regulatory treatment for nursery stock.* Currently two treatments are available in response to LBAM detections: chlorpyrifos and phosmet treatments. Other treatments may be available in the near future, but they require validation (see research recommendations). A screening process should be initiated immediately to identify alternatives treatments rapidly, but longer-term studies may be necessary to address all regulatory issues.
- *Vegetable and fruit crops* grown in California should be reviewed on a crop-by-crop basis to assess risk and determine if specific crops can be de-regulated or if regulations can be streamlined (this should be done in conjunction with the effort to rank host quality). For those crops at risk, methods should be developed to mitigate risk.
- Quickly conduct a pathway analysis on hays and straws to determine if they can be de-regulated.
- Chipped green waste may be moved if held on site for 2 weeks. Additional studies should be undertaken to see if the holding period can be eliminated.
- *Bulk herbs and spices*. Dried herbs and spices do not represent a risk. Green herbs that are known hosts require regulation. Possible options for treating green herbs must be explored, including cold, modified atmosphere, fumigation, and irradiation treatments.
- *Fruits (harvested produce)*. U.S. inspection standards for the international import of fruits should be followed.
- Fruit and vegetables in stalls and open market pose negligible risk for LBAM oviposition and do not need to be safeguarded or regulated.
- On an international scale, ensure that no existing pathway exists that facilitates repeated introductions of LBAM into the United States, especially into northern California.

Area-wide suppression strategies.

Mating disruption. The TWG envisions mating disruption as the primary strategy for LBAM suppression. Currently, there is one registered formulation that requires hand application and thus would be useful for relatively small and sensitive areas. Several sprayable formulations are near operational status, but need registration and, in some cases, evaluation and optimization (see research recommendations). "Puffer" dispensers may have some applications in urban areas. One caveat is that the efficiency of mating disruption is inversely related to population density (i.e., it works best in sparse infestations). Also, the often windy conditions in the San Francisco Bay area may reduce the effectiveness of mating disruption.

Pesticides. Pesticides will likely be a part of any eradication program, and large-scale (e.g., aerial) application will likely be needed to reduce high LBAM populations to the point where other tactics (e.g., mating disruption, SIT) will be effective. "Soft" insecticides (e.g., *Bt*, spinosins) are available but require frequent application and may not be as highly effective as needed. Other chemical pesticides may be required in special situations.

Sterile Insect Technique (*SIT*). LBAM appears to be amenable to SIT, and the technique could potentially prove very valuable to the program, especially in eliminating populations that are very sparse either naturally or following suppression by other means. Work to develop SIT for LBAM has been initiated in New Zealand and Australia, but it is probably several years away from being ready for deployment on a large scale (see research recommendations). There are logistical considerations regarding the development of mass rearing and distribution capacity. A site for mass-production of LBAM must be selected, and mass-rearing technology and capacity must be developed quickly if SIT is to be a substantial component of a large eradication effort.

Biological control. Biological control is not often a major component of eradication efforts, but could be a major suppression strategy if program goals change. At present, the TWG is recommending assessing the effectiveness of available *Trichogramma* egg parasites as a possible means of aiding suppression (via augmentative releases) in specific areas.

Research recommendations (un-prioritized)

- Develop improved methods for identification of immature LBAM (morphological, molecular, and serological).
- Evaluate candidate insecticides (focusing on registered products for the short term) as regulatory treatments. This work would be best conducted overseas or in Hawaii. Possible candidates include (among others) Acephate, *Bt*, spinosyns, insect growth regulators, neonicotinoids, and newer materials.
- Evaluate effectiveness of insecticides for control of LBAM populations, with focus on more biorational insecticides such as *Bt* and spinosyns. Where possible, screen insecticides used against LBAM to minimize contact with California populations.
- Develop information on population dynamics and ecology of LBAM in North America.
- Develop effective mating disruption technology for use in a variety of situations. Identify and register effective sprayable formulations. Assess functionality of aerial application. Determine the role of the diene and the *cis* isomer of the monoene in disruption. Determine how height of application affects efficacy where tall host plants are involved. Assess food-bait traps (female dissection) as a tool for monitoring the effectiveness of disruptant applications.
- Evaluate effectiveness of mobile mating disruption of LBAM.

- Evaluate and, if appropriate, work for registration of attract-and-kill formulations (air and ground) for LBAM.
- Work toward developing a large-scale SIT program against LBAM. In particular, a mass sterile rearing technology needs to be developed and optimized. Other elements of SIT development needed to address LBAM include competitiveness and strain development, distribution methods, genetic markers, and radiation biology (involving complete and inherited sterility).
- Evaluate and develop biological control methods for LBAM: augmentative releases (e.g., *Trichogramma*), classical biological control, and insect pathogens (e.g., nucleopolyhedrosis virus). Develop information on parasitism and predation of LBAM by natural enemies that are native to California.
- Evaluate effects of LBAM program activities on threatened and endangered species.
- Develop population and phenology models for LBAM in North America. Test (validate) available phenology and population model(s) using New Zealand, Australian, and United States trapping data. Climex and Dymex models are available to support this effort, but need validation.
- Optimize traps, lures, release rates, and methods of deployment (e.g., trap placement parameters such as height).
- Determine sensitivity of survey traps (distance/capture curves) for LBAM (including food-bait as well as pheromone traps).
- Determine LBAM dispersal distances under California conditions (females, males, and larvae).

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