NAPPO
North American Plant Protection Organization
Organización Norteamericana de Protección a las Plantas
MEXICO - USA - CANADA

NAPPO SURVEILLANCE PROTOCOLS

SP 02
Trapping Protocols for Pests of Fruit entering into NAPPO Member Countries

The Secretariat of the North American Plant Protection Organization
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Contents

Review

NAPPO Surveillance Protocols are subject to periodic review and amendment. The next review date for this NAPPO Diagnostic Protocol is 2020. A review of any NAPPO Protocol may be initiated at any time upon the request of a NAPPO member country.

Approval

This Surveillance Protocol was approved by the North American Plant Protection Organization (NAPPO) Executive Committee on March 04, 2015 and is effective immediately.

Signed by:

Greg Wolff Executive Committee Member Canada	Osama El-Lissy Executive Committee Member United States

Javier Trujillo Arriaga
Executive Committee Member
Mexico

Implementation

Not Applicable.

Amendment Record

Amendments to this protocol will be dated and filed with the NAPPO Secretariat.

Distribution

This Protocol is distributed to NAPPO member countries including Sustaining Associate Members and Industry Advisory Groups, the Secretariat of the International Plant Protection Convention, and other Regional Plant Protection Organizations (RPPOs).

I. **General Guidance on Trap Servicing**

It is recommended that the servicing guidelines for traps from commercial suppliers be followed. In addition, these recommendations should be followed:

- Retrieve specimens every two weeks or they will decompose or important identification characteristics will be lost.
- Check traps every two weeks or after bad weather events (rain, strong winds, or snow) which can disturb the sample.
- Examine traps for damage.
- Remove any debris blocking trap entry ports or funnels, including leaves, twigs, spider webs, etc.
- Ensure that all lures are still in place.
- Remove any suspect specimens from the trap and submit the samples according to the sample submission instructions.
- Change lures according to the length of effectiveness for each species.

II. Species

1. *Adoxophyes orana* (Fischer von Röslerstamm), Summer Fruit Tortrix (Lepidoptera: Tortricidae)

Pest Information

Order: Lepidoptera
Family: Tortricidae
Genus: *Adoxophyes*
Species: *orana*
Common name: summer fruit tortrix
Commodities surveyed: pome and stone fruits

The summer fruit tortrix is not known to be present in Canada, Mexico or the United States. It is native to Europe and Asia. It is polyphagous, with the primary hosts in the Rosaceae family. It is principally a pest of apple, pear and stone fruits, such as cherry. Larvae feed on leaves and fruit, with the latter resulting in the majority of economic damage.

General Trap and Lure Information

Pheromone-baited trapping is the most effective monitoring technique for summer fruit tortrix.

Trap design (type). Small and large Delta traps (Fig. 2), traps should be used for trapping summer fruit tortrix moths.

Lure – This is composed commonly of red or gray septa containing the sex pheromone of summer fruit tortrix which is a 9:1 blend of (Z)-9-Tetradecenyl acetate and (Z)-11-Tetradecenyl acetate. The addition of the alcohols of the two acetates increased catch. The Cooperative Agricultural Pest Survey (CAPS) program recommends a lure loaded with a 90:10:10:20 mixture of (Z)-9-Tetradecenyl acetate of high isomeric purity, (Z)-11-Tetradecenyl acetate, (Z)-9-Tetradecen-1-ol, and (Z)-11-Tetradecen-1-ol (http://pest.ceris.purdue.edu/services/approvedmethods/sheet.php?v=466).

Lure Type, Replacement Interval and Trap Servicing

Lure replacement should be done according to the lure manufacturer. Traps should be serviced every two weeks. Gray rubber septa are reported to be effective for 12 weeks. Lures should not be handled with bare hands. Gloves, sticks, or an instrument (with acetone dip) can be used, but whatever tool is chosen, pheromone cross-contamination when working with lures for different moth species must be avoided. Spent lures as well as new lure packaging must be removed from the orchard.

Trap Placement, Location in Production Areas and Densities

The key considerations for effective trap placement within a block are 1) historical "hot spots", and 2) location relative to block perimeter. An area where moth catches from previous seasons were high, or a "hot spot", is a good place to locate a trap. Avoid placing traps on the perimeter row. Instead place traps within the interior of the orchard block, at least 10 rows in. Summer fruit tortrix traps should be placed in the middle third of the canopy, where moth activity is greatest, and in a way that allows moths easy access to the trap. When trapping for more than one species, traps should be separated by at least 20 meters.

Traps for detection. The purpose of the detection survey is to determine whether a pest is present in a specified area. Place pheromone-baited traps in high-risk areas where summer fruit tortrix is more likely to be found. A single trap will survey 6-8 ha. Establish regular sites for trapping along a survey route.

Traps for delimiting survey. Once a new detection is made, delimiting surveys will be conducted to determine the distribution of the pest. Adult summer fruit tortrix are quite mobile, with individuals commonly dispersing several kilometers. Surveys should be most intensive around the known positive detections. Set 10-15 traps per square kilometer in the core area. Set 10-15 traps per square kilometer in 20 square kilometers around the core area.

Traps for monitoring. Deploy at least one trap per 6 ha to monitor for summer fruit tortrix.

References

Den Otter, C. J. and J. W. Klijnistra. 1980. Behaviour of male summer fruit tortrix moths, *Adoxophyes orana* (Lepidoptera:Tortricidae), to synthetic and natural female sex pheromone. Entomologia Experimentalis et Applicata 28(1):15-21.

El-Adl, M.A. and P.J. Charmillot. 1982. Laboratory studies with the sex-pheromone of the summer fruit tortrix, *Adoxophyes orana* F.V.R. (Lepidoptera: Tortricidae) and its components. Acta Phytopathologica 17(1/2):133-137.

Guerin, P.M., H. Arn, H.R. Buser and P.J. Charmillot. 1986. Sex pheromone of *Adoxophyes orana*: Additional components and variability in ratio of (Z)-9- and (Z)-11-tetradecenyl acetate. Journal of Chemical Ecology 12(3): 763-772.

Gyeong-Saeng, B. and H. Gyeong-Sik. "Method for predicting generation of and controlling *Adoxophyes orana* using sex pheromone compounds". Seoul National University, September 12, 2002: KR1020010011066.

Milonas, P.G and M. Savopoulou-Soultani. 2006. Seasonal abundance and population dynamics of *Adoxophyes orana* (Lepidoptera: Tortricidae) in northern Greece. International Journal of Pest Management; 52(1): 45-51.

Navrozidis, E., T. Thomidis, C. Tsipouridis, I. Xatzicharisis, I. Foriadis and D. Servis. 2005. Pheromone-based communication disruption of *Adoxophyes orana* on peach using the new RAK 3+4 dispensers and their effect on development of fruit rot diseases. Phytoparasitica 33(2): 149-153.

Potting, R.P.J., P.M. Lösel and J. Scherkenbeck. 1999. Spatial discrimination of pheromones and behavioural antagonists by the tortricid moths *Cydia pomonella* and *Adoxophyes orana*. Journal of Comparative Physiology A 185(5): 419-425

Sekita, N. 1985. Statistical analyses of pheromone trap catches of the summer fruit tortrix *Adoxophyes orana* fasciata Walsingham (Lepidoptera: Tortricidae) in apple orchards. Applied Entomology and Zoology 20(4): 501-504.

Van Der Kraan, C. and P. Van Deventer. 1982. Range of action and interaction of pheromone traps for the summerfruit tortrix moth, *Adoxophyes orana* (F.v.R.). Journal of Chemical Ecology 8(10):1251-1262.

2. *Anarsia lineatella* (Zeller) Peach Twig Borer (Lepidoptera: Gelechiidae)

Pest Information

Order: Lepidoptera
Family: Gelechiidae
Genus: *Anarsia*
Species: *lineatella*
Common name: peach twig borer
Commodities surveyed: apricots, nectarines, peaches, plums and prunes

Peach twig borer (PTB) moths can migrate into previously un-infested trees from unsprayed or abandoned host trees somewhere in the vicinity. Non-commercial host trees can include: feral or residential almond, apricot, nectarine, peach plum, prune and possibly other fruit trees depending on geographic location. In areas where PTB is established, the pest is often managed with sprays of insecticides targeted to the first emerging larva. Not all orchards will require treatment. A degree day model can be very useful in timing treatments.

General Trap and Lure Information

Trap design (type). The following types of pheromone traps can be used: large plastic delta pheromone traps (Fig. 2) or wing style pheromone traps (Fig. 14).

Lure. Field tests with laboratory-reared females and native males showed that the female peach twig borer, *Anarsia lineatella* Zeller, produces a pheromone that attracts the male (Anthon et al. 1971). Roelofs et al. (1975) found that crude extracts from abdominal tips of female peach twig borers contained trans-5-decenyl acetate (t-5-10:Ac). They also found evidence of *trans-5-decen-l-ol* (t-5- IO:OH). The ratio for these components (acetate:alcohol) was ca. 7: 1. Roelofs et al. (1975) stated that in Washington State the alcohol component of the peach twig borer alone was the most attractive and that mixtures of the alcohol and acetate components were only slightly attractive. In California, treatments with alcohol, either alone or alcohol plus acetate, proved to be attractive.

Lure Replacement, Trap Servicing and Monitoring

Lure replacement interval depends on the lure type and load. Most lures last from 3-4 weeks. Monitoring of traps should be at least every one to three weeks, depending on conditions. Change pheromone caps every 3-4 weeks and change trap bottoms after catching 20–30 moths or after dust and debris have collected on the sticky surface. Traps should be checked more often if in windy or dusty areas to assure that suspect moths can be observed on the traps before too much debris accumulates. Most traps will require replacement after 3-4 weeks.

Trap Placement, Location in Production Areas and Densities

Adults should be monitored with pheromone traps as described below.

Wing style pheromone traps can be used to monitor adult male activity. Lures placed in the traps dispense the female sex pheromone. Place traps in orchards by early May or based on degree-day (temperature) accumulations. A minimum of two traps should be placed in each orchard. Place one trap on the edge and one near the center of the orchard. Place traps within the fruiting canopy of the tree, positioned so that the traps are secured tightly to branches so they do not swing in the wind. Place traps within the upper third of the tree canopy (preferably 2 m high) making sure the trap entrance is not blocked and that it is parallel to prevailing wind direction. If needed, remove foliage from around the trap entrance to make it easier for the moths to approach the trap. The lure can be changed every 14 to 21 days, depending on how long the lure lasts and how contaminated the trap's surface becomes.

If monitoring the production site (orchard), the distance between trap sets should be 60-100 meters along the orchard borders. Where the orchard borders a dusty road or field, place the traps one or two rows into the orchard. Use a higher trap density on sides of the orchard nearest suspected sources of moths. Place the traps within the tree canopy as in non-orchard situations.

Place traps in each orchard for which projections are to be made with at least 2 traps per orchard and 1 trap for every 4 ha (10 acres) for larger orchards. Do not place them closer than 90 m or they may interfere with each other. Hang them on the northeast side of the tree at a height of 2 m and at least 30 m in from the edge of the orchard. If the orchard history indicates “hot spots”, make sure you have a trap there. Traps should be placed in the same general location from year to year so that you can compare the information between years more accurately.

Other information

Poor performance of some peach twig borer, *Anarsia lineatella* Zeller, pheromone lures resulted in identification of 5-decynyl acetate as an antagonist of the pheromone. Addition of 5-decynyl acetate to an otherwise attractive pheromone blend resulted in virtually complete shutdown of trap catches. Identification of 5-decynyl acetate as a pheromone antagonist highlights the importance of stringent quality control in pheromone manufacture and the need for field testing of batches of pheromone, particularly those used for manufacturing monitoring lures, before their release for sale (Millar 1992).

Detection of adult PTB moths on the trap does not necessarily mean the host tree fruit is infested. Further inspection of shoots and fruit by cutting, along with fruit collection and larval rearing should be conducted to determine if PTB is established at that site.

References

Bentley, W.J., J.K. Hasey and K.R. Day. 2012. Insects and Mites. Pp.:14-56. In: UC Statewide IPM Program University of California, Davis (eds).UC IPM Pest Management Guidelines: Peach. UC ANR Publication 3454.

Millar, J.G. and R.E. Rice 1992. Reexamination of the female sex pheromone of the peach twig borer: field screening of minor constituents of pheromone gland extracts and of pheromone analogs. Journal of Economic Entomology 85(5):1709-1716.

Rice, R.E. and R.A. Jones. 1975. Peach twig borer: field use of a synthetic sex pheromone. Journal of Economic Entomology 68:358-360.

Roelofs, W.L., J. Kochansky, E. Anthon, R. Rice, and R. Cardé. 1975. Sex pheromone of the peach twig borer moth (*Anarsia lineatella*). Environmental Entomology 4:580-582.

3. *Anoplophora chinensis* (Forster) Citrus Longhorned Beetle (Coleoptera, Cerambycidae)

Pest Information

Order: Coleoptera
Family: Cerambycidae
Genus: *Anoplophora*
Species: *chinensis*
Common name: citrus longhorned beetle
Commodities surveyed: citrus, pome and stonefruit trees

The citrus longhorned beetle (CLHB) is a wood boring insect that attacks healthy hardwoods, fruit trees and woody ornamentals. Native to East Asia, CLHB is highly polyphagous attacking over 100 species of trees. Damage is caused by larval stages feeding and channeling through the woody portion of the tree trunk. CLHB is considered a severe pest of citrus in China; however, pome and stone fruit trees are also considered primary hosts. No North American populations are known to exist. The first North American introduction occurred in Tukwila, Washington, in 2001 and declared eradicated in 2006.

General Trap and Lure Information

There are no known attractants or traps for CLHB. Visual survey is the only method for detection.

Visual Survey

Based on CAPS (2013), surveyors should visually inspect bark around the base of host trees and exposed roots (CABI 2007). Visual symptoms include T- shaped, ovipositional scars (3 to 4 mm wide [approx. 1/8 to 3/16 in], 1 to 2 mm long [approx. 1/16 in]) on the bark surface at the base of trees; frass and wood pulp extruding from circular adult exit holes 6-11 mm in diameter; and larval tunnels at the base of trees and in exposed roots (CABI 2007). Also, dead young host trees should be inspected for the presence of exit holes, sawdust and oviposition scars, and beetle life stages (CABI 2007).

Adult CLHB are almost morphologically identical to *Anoplophora glabripennis*, Asian Longhorned Beetle (ALB). CLHB differs from ALB in having two pairs of polished white tubercles at the base of the elytra, visible with a 10x hand lens.

References

CABI. 2007. *Anoplophora chinensis*. Crop Protection Compendium.

USDA. CAPS. 2013. Exotic Wood Borer/Bark Beetle Survey Reference.

4. ***Archips argyrospila*** (Walker) Fruittree Leafroller (Lepidoptera:Tortricidae)

Pest Information

Order: Lepidoptera
Family: Tortricidae
Genus: *Archips*
Species: *argyrospila*
Common name: Fruittree leafroller
Commodities surveyed: tree fruits, small fruits, ornamentals and many others

The fruittree leafroller is native to North America. It attacks a wide variety of ornamentals and is a pest of numerous fruit and nut crops, including almond, apple, apricot, cherry, citrus, pear, plum, prune, quince, walnut and cranberries. In fruit crops, larvae feed in the spring on developing blossoms and fruit clusters, reducing yield and scarring fruit. The fruittree leafroller is univoltine and overwinters as eggs. Eggs are laid in masses on twigs of the host and covered by the female with a substance that hardens to create a smooth, hard surface. Eggs are laid in June and July and do not hatch until the following year.

General Trap and Lure Information

Pheromone-baited trapping is the most effective monitoring technique for fruittree leafroller.

Trap design (type). Wing-type (Fig. 14) or delta (Fig. 2) traps should be used for trapping fruittree leafroller moths.

Lure. The pheromone for the fruittree leafroller has been identified as a four-component blend, (Z)-11-tetradecenyl acetate, (E)-11-tetradecenyl acetate, (Z)-9-tetradecenyl acetate and dodecyl acetate. Eastern populations are highly attracted to a 15:10:1:50 blend of the four components, while western populations are most attracted to a 100:64:2:1 blend.

Lure Type, Replacement Interval and Trap Servicing

There are several lures to choose from, however, the most commonly used lure is the red septum. A red septum loaded with the four-component pheromone blend described above has been the standard for monitoring fruittree leafroller and will last for the entire flight. Lures should not be handled with bare hands. Gloves, sticks, or an instrument (with acetone dip) can be used, but whatever tool is chosen, pheromone cross-contamination when working with lures for different moth species must be avoided. Lure packaging must be removed from the orchard. When trapping for more than one species, do not place more than one lure in a single trap and separate traps by at least 20 meters.

Trap Placement, Location in Production Areas and Densities

Trap placement is a critical factor for optimizing trap performance. The key decisions are 1) how many traps to deploy, 2) where to place them in the orchard, and 3) location of the trap within the tree. Deploy at least 1 trap per 6 ha to monitor for fruittree leafroller. The key considerations for effective trap placement within a block are 1) historical “hot spots”, and 2) location relative to block perimeter. An area where moth catches from previous seasons were high, or a “hot spot”, is a good place to locate a trap. Avoid placing traps on the perimeter row. Instead place traps within the interior of the orchard block. The location of the trap within the tree is the third critical factor. Traps need to be located where moth activity is greatest and placed in a way that allows moths’ easy access to the trap. Fruittree leafroller traps should be placed in the middle third of the canopy.

Traps for detection. The purpose of the detection survey is to determine whether a pest is present in a specified area. Place pheromone-baited traps in high-risk areas where fruittree leafroller is more likely to be found. A single trap will survey 6-8 ha. Establish regular sites for trapping along a survey route.

Traps for delimiting survey. Once a new detection is made, delimiting surveys will be conducted to determine the distribution of the pest. Adult fruittree leafroller females are fairly dispersive, especially during the second-generation flight. Individuals commonly dispersed several kilometers. Surveys should be most intensive around the known positive detections. Set 10-15 traps per square kilometer in the core area. Set 10-15 traps per square kilometer in 20 square kilometers around the core area.

References

Deland, J.P., G.J.R. Judd and B.D. Roitberg. 1994. Disruption of pheromone in three sympatric leafroller (Lepidoptera:Tortricidae) pests of apple in British Columbia. Environmental Entomology 23(5):1084-1090.

Goyer, R.A., T.D. Paine, D.P. Pashley, G.J. Lenhard, J.R. Meeker and C.C. Hanlon. 1995. Geographic and host-associated differentiation in the fruittree leafroller (Lepidoptera:Tortricidae). Annals of the Entomological Society of America 88(4):391-396.

5. *Archips rosanus* (L) European Leafroller (Lepidoptera:Tortricidae)

Pest Information

Order: Lepidoptera
Family: Tortricidae
Genus: *Archips*
Species: *rosanus*
Common name: European leafroller
Commodities surveyed: fruit and nut crops

The European leafroller is native to the Palearctic region but is distributed worldwide except in the Far East. It has a wide host range, including fruit and nut crops and forest trees. The European leafroller is univoltine.

General Trap and Lure Information

Pheromone-baited trapping is the most effective monitoring technique for European leafroller.

Trap design (type). Wing-type (Fig. 14) or delta traps (Fig. 2) should be used for trapping European leafroller moths.

Lure. The sex pheromone of European leafroller is a 90:10 blend of (Z)-11-Tetradecenyl acetate and (Z)-11-Tetradecen-1-ol.

Lure Type, Replacement Interval and Trap Servicing

There are several lures to choose from; however, the most commonly used lure is the red septum. A red septum loaded with the two-component pheromone blend described above has been the standard for monitoring European leafroller and will last for the entire flight. Lures should not be handled with bare hands. Gloves, sticks, or an instrument (with acetone dip) can be used, but whatever tool is chosen, pheromone cross-contamination when working with lures for different moth species must be avoided. Lure packaging must be removed from the orchard. When trapping for more than one species, do not place more than one lure in a single trap and separate traps by at least 20 meters.

Trap Placement, Location in Production Areas and Densities

Traps for monitoring. Trap placement is a critical factor for optimizing trap performance. The key decisions are 1) how many traps to deploy, 2) where to place them in the orchard, and 3) location of the trap within the tree. Deploy at least 1 trap per 6 ha to monitor for European leafroller. The key considerations for effective trap placement within a block are 1) historical “hot spots”, and 2) location relative to block perimeter. An area where moth catches from previous seasons were high, or a “hot spot", is a good place to locate a trap. Avoid placing traps on the perimeter row. Instead place traps within the interior of the orchard block. The location of the trap within the tree is the third critical factor. Traps need to be located where moth activity is greatest and placed in a way that allows moths' easy access to the trap. European leafroller traps should be placed in the middle third of the canopy.

Traps for detection. The purpose of the detection survey is to determine whether a pest is present in a specified area. Place pheromone-baited traps in high-risk areas where European leafroller is more likely to be found. A single trap will survey 6-8 ha. Establish regular sites for trapping along a survey route.

Traps for delimiting survey. Once a new detection is made, delimiting surveys will be conducted to determine the distribution of the pest. Adult European leafroller females are fairly dispersive, especially during the second-generation flight. Individuals commonly dispersed several kilometers. Surveys should be most intensive around the known positive detections. Set 10-15 traps per square kilometer in the core area. Set 10-15 traps per square kilometer in 20 square kilometers around the core area.

References

Minyailo, V.A. and A.K. Minyailo. 1988. Number of pheromone traps required for estimation of population density in rose leaf rollers *Archips rosanus* (Lepidoptera:Tortricidae). Zoologicheskii Zhurnal 67(5):760-765.

Siscaro, G., S. Longo, and S. Ragusa. 1988. Notes on population dynamics of *Archips rosanus* (L) and *Cacoecimorpha pronubana* (Hb) in Sicilian citrus groves, pp.1299-1305. In: Goren, R, K. Mendel, and N. Goren (eds). Citriculture: Proceedings of the Sixth International Citrus Congress. Middle-East, Tel Aviv, Israel, March 6-11.

6. *Argyrotaenia velutinana* (Walker) Redbanded Leafroller (Lepidoptera: Tortricidae)

Pest Information

Order: Lepidoptera
Family: Tortricidae
Genus: *Argyrotaenia*
Species: *velutinana*
Common name: redbanded leafroller
Commodities surveyed: tree fruits and small fruits

The redbanded leafroller is native to temperate eastern North America. It has a wide host range, including apple, peach, pear, plum cherry and a variety of other plants including a variety of vegetables, weeds, trees and shrubs. It overwinters as pupae in folded leaves in the ground cover. There are two to three generations of redbanded leafroller each year. Larvae feed on leaves and fruit, with the latter resulting in the majority of economic damage.

General Trap and Lure Information

Pheromone-baited trapping is the most effective monitoring technique for redbanded leafroller.

Trap design (type). Wing-type (Fig. 14), pyramid (Fig. 7) or delta shaped traps (Fig. 2) should be used for trapping redbanded leafroller moths.

Lure. The sex pheromone of the redbanded leafroller is a 93:7 blend of (Z)-11-Tetradecenyl acetate and (E)-11-Tetradecenyl acetate.

Lure Type, Replacement Interval and Trap Servicing

There are also many lures to choose from. The most commonly used lure is the red septum. A red septum loaded with the two-component pheromone blend described above has been the standard for monitoring redbanded leafroller. Lure replacement interval depends on the lure type, but replacing the lure at the start of each new flight period (generation) is a good practice. Lures should not be handled with bare hands. Gloves, sticks, or an instrument (with acetone dip) can be used, but whatever tool is chosen, pheromone cross-contamination when working with lures for different moth species must be avoided. Spent lures as well as new lure packaging must be removed from the orchard. When trapping for more than one species, do not place more than one lure in a single trap and separate traps by at least 20 meters.

Trap Placement, Location in Production Areas and Densities

Traps for monitoring. Trap placement is a critical factor for optimizing trap performance. The key decisions are 1) how many traps to deploy, 2) where to place them in the orchard, and 3) location of the trap within the tree. Deploy at least 1 trap per 4 ha to monitor for redbanded leafroller. The key considerations for effective trap placement within a block are 1) historical "hot spots", and 2) location relative to block perimeter. An area where moth catches from previous seasons were high, or a "hot spot", is a good place to locate a trap. Avoid placing traps on the perimeter row. Instead place traps within the interior of the orchard block. The location of the trap within the tree is the third critical factor. A trap needs to be located where moth activity is greatest and placed in a way that allows moths easy access to the trap.

Traps for detection. The purpose of the detection survey is to determine whether a pest is present in a specified area. Place pheromone-baited traps in high-risk areas where redbanded leafroller is more likely to be found. A single trap will survey 4-6 ha. Establish regular sites for trapping along a survey route.

Traps for delimiting survey. Once a new detection is made, delimiting surveys will be conducted to determine the distribution of the pest. Adult redbanded leafroller are fairly dispersive, however surveys should be most intensive around the known positive detections. Set 20-30 traps per square kilometer in the core area. Set 20-30 traps per square kilometer in 20 square kilometers around the core area.

References

Bjostad, L.B., W.A. Wolf, and W.L. Roelofs. 1981. Total lipid analysis of the sex pheromone gland of the redbanded leafroller moth, *Argyrotaenia velutinana*, with reference to pheromone biosynthesis. Insect Biochemistry 11(1):73-79.

Fadamiro, H.Y. 2004. Monitoring the seasonal flight activity of *Cydia pomonella* and *Argyrotaenia velutinana* (Lepidoptera:Tortricidae)in apple orchards by using pheromone baited traps. Environmental Entomology 33(6): 1711-1717. http://dx.doi.org/10.1603/0046-225X-33.6.1711

Foster, S.P. and W.L. Roelofs. 1987. Comparative sex pheromone biosynthesis in the obliquebanded leafroller, *Choristoneura rosaceana* and the redbanded leafroller *Argyrotaenia velutinana*, moths. Zeitschrift fuer Naturforschung, a Journal of Biosciences 42C:961-964.

Jurenka, R.A., F. Fabriás, L. DeVoe, and W.L. Roelofs. 1994. Action of PBAN and related peptides on pheromone biosynthesis in isolated pheromone glands of the redbanded leafroller moth, *Argyrotaenia velutinana*. Comparative Biochemistry and Physiology Pharmacology, Toxicology and Endocrinology 108(2):153-160.

Miller, J.R. and W.L. Roelofs. 1980. Individual variation in sex pheromone component ratios in two populations of the redbanded leafroller moth, *Argyrotaenia velutinana*. Environmental entomology 9(3):359-363.

7. *Autographa gamma* (L.) Silver Y Moth (Lepidoptera, Noctuidae)

Pest Information

Order: Lepidoptera
Genus: *Autographa*
Species: *gamma*
Common name: Silver Y Moth
Commodities surveyed: tree fruits and small fruits

The silver Y moth is distributed throughout Europe, Asia, and North Africa. Grapes are a major host of *A. gamma* along with many other food crops.

General Trap and Lure Information

Trap design (type). Plastic bucket traps (Fig. 11) should be used for trapping silver y moth. This trap is also known as the unitrap. The trap has a green canopy, yellow funnel, and white bucket and is used with a dry kill strip. For instructions on using the trap, see Brambila et al. (2010).

Lure. Pheromone-baited trapping is the most effective monitoring technique for silver Y moth. The sex pheromone of the silver Y moth is (*Z*)-7-Dodecenyl acetate and (Z)-7-Dodecen-1-ol in ratios from 100:1 to 95:5, and has been used to attract and monitor male flight of *A. gamma* (Tóth et al. 1983, Mazor and Dunkelblum 1992, Dunkelblum and Mazor 1993,
http://pest.ceris.purdue.edu/services/approvedmethods/sheet.php?v=1638

Lure Type, Replacement Interval and Trap Servicing

In field applications, the pheromone may be dispensed from rubber septa at a loading rate of 1 mg (Tóth et al. 1983, CAPS 2014). Lures should be replaced every 28 days (Sullivan and Molet 2007). Service traps every 2 weeks. Newly-emerged adult males of *A. gamma* are not attracted to the pheromone; 3-d old males are most responsive to the lure (Szöcs and Tóth 1979).

The pheromone of *A. gamma* may also attract other Lepidoptera in the US such as *Anagrapha ampla*, *Anagrapha falcifera*, *Autographa ampla*, *Autographa biloba*, *Autographa californica*, *Caenurgia* spp., *Epismus argutanus*, *Geina periscelidactyla*, *Helvibotys helvialis*, *Lacinipolia lutura*, *Lacinipolia renigera*, *Ostrinia nubilalis*, *Pieris rapae*, *Polia* spp., *Pseudoplusia includens*, *Rachiplusia ou*, *Spodoptera ornithogalli*, *Syngrapha falcifera* (CAPS 2014, Cooper 1998), and *Trichoplusia ni* (Mazor and Dunkelblum 1992, Dunkelblum and Mazor 1993).

Trap Placement, Location in Production Areas and Densities

Traps for detection. Traps should be placed on or near the host plant during the growing season. The traps are monitored for suspects and serviced at least once a month.

Due to the migratory nature of this species, adult *A. gamma* can be observed every month from April to November, usually peaking in late summer (Sullivan and Molet 2007).

Trap spacing. When trapping for more than one species of moth, separate traps for different moth species by at least 20 meters (65 feet).

Other information

USDA (1986) provides some considerations for visual inspections of host plants for the presence of eggs, larvae, or pupae. In general, eggs may be found on the lower and upper surfaces of leaves. Larvae are likely to be found, if left undisturbed, on leaves that have been skeletonized or that have holes in the interior. Pupae may be found on the lower leaf surface (USDA 1986).

Sticky traps are relatively ineffective at capturing *A. gamma*; modified versions of an inverted cone trap (similar to Hartstack traps) baited with 0.1 mg of (97:3) *E*:*Z*-11-tetradecenyl acetate, a general attractant of several pest species of moths, captured 30-135 times more *A. gamma* than did sticky traps (Burgio and Maini 1995). Adult males and females have also been collected using Robinson black-light traps (Craik 1979), but these traps attract moths non-discriminately. Such traps, placed 3 m above the ground, have been used to successfully monitor the dynamics of *A. gamma* and other Noctuid moths (Zanaty et al. 1984-1985).

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at https://caps.ceris.purdue.edu/approved_methods.

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8. ***Choristoneura rosaceana*** **(Harris) Obliquebanded Leafroller (Lepidoptera: Tortricidae)**

Pest Information

Order: Lepidoptera
Family: Tortricidae
Genus: *Choristoneura*
Species: *rosaceana*
Common name: obliquebanded leafroller
Commodities surveyed: tree fruits, small fruits, hardwoods and many others

The obliquebanded leafroller is native to North America. It has an extremely wide host range, feeding on most tree fruits berry crops, and hardwoods. The obliquebanded leafroller overwinters as young larvae in a protective shelter called a hibernaculum and completes two generations per year.

General Trap and Lure Information

Pheromone-baited trapping is the most effective monitoring technique for obliquebanded leafroller.

Trap Design (type). Wing-type (Fig. 14), pyramid (Fig. 7) or delta traps (Fig. 2) should be used for trapping obliquebanded leafroller moths.

Lure. The pheromone for the obliquebanded leafroller has been identified as a three- or four-component blend of (Z)-11-tetradecenyl acetate, (E)-11-tetradecenyl acetate, (Z)-11-tetradecen-1-ol, (E)-11-tetradeceno-1-ol acetate and (Z)-11-tetradecenal. Eastern populations are highly attracted to a 97:2:1 blend of the acetates and the alcohol, while western populations are most attracted to a 96:2:1:1: blend of all four components.

Lure Type, Replacement Interval and Trap Servicing

There are many lures to choose from. The most commonly used lure is the red septum. A red septum loaded with 3.0 mg of the three or four component pheromone blend described above has been the standard for monitoring obliquebanded leafroller. Lure replacement interval depends on the lure type, but replacing the lure at the start of each new flight period (generation) is a good practice. Lures should not be handled with bare hands. Gloves, sticks, or an instrument (with acetone dip) can be used, but whatever tool is chosen, pheromone cross-contamination when working with lures for different moth species must be avoided. Spent lures as well as new lure packaging must be removed from the orchard. When trapping for more than one species, do not place more than one lure in a single trap and separate traps by at least 20 meters.

Trap Placement, Location in Production Areas and Densities

Traps for monitoring. Trap placement is a critical factor for optimizing trap performance. The key decisions are 1) How many traps to deploy, 2) where to place them in the orchard, and 3) location of the trap within the tree. Deploy at least 1 trap per 6 ha to monitor for obliquebanded leafroller. The key considerations for effective trap placement within a block are 1) historical "hot spots", and 2) location relative to block perimeter. An area where moth catches from previous seasons were high, or a "hot spot", is a good place to locate a trap. Avoid placing traps on the perimeter row. Instead place traps within the interior of the orchard block. The location of the trap within the tree is the third critical factor. Traps need to be located where moth activity is greatest and placed in a way that allows moths' easy access to the trap. Obliquebanded leafroller traps should be placed in the middle third of the canopy.

Traps for detection. The purpose of the detection survey is to determine whether a pest is present in a specified area. Place pheromone-baited traps in high-risk areas where obliquebanded leafroller is more likely to be found. A single trap will survey 6-8 ha. Establish regular sites for trapping along a survey route.

Traps for delimiting survey. Once a new detection is made, delimiting surveys will be conducted to determine the distribution of the pest. Adult obliquebanded leafroller females are fairly dispersive, especially during the second-generation flight. Individuals commonly dispersed several kilometers. Surveys should be most intensive around the known positive detections. Set 10-15 traps per square kilometer in the core area. Set 10-15 traps per square kilometer in 20 square kilometers around the core area.

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9. ***Conotrachelus nenuphar* (Herbst) Plum Curculio (Coleoptera, Curculionidae)**

Pest Information

Order: Coleoptera
Family: Curculionidae
Genus: *Conotrachelus*
Species: *nenuphar* (Herbst)
Common name: plum curculio
Commodities surveyed: apples, peaches, apricots, pears, cherries, quince.

The plum curculio, *Conotrachelus nenuphar*, is native to North America. It is widely distributed east of the Rocky Mountains where it attacks apples, peaches, apricots, pears, cherries, quince, and other wild and cultivated fruits (i.e., pome and stone fruits). The plum curculio completes two generations per year and overwinters as an adult in the soil, litter, ground cover and surrounding areas. Overwintering adults begin to move into fruit orchards in the spring as soon as daytime and evening temperatures exceed 15.5°C. Movement is enhanced by light rain or humid nights accompanying the warming temperatures. The major injury to fruit occurs from adult feeding and puncture associated with oviposition and that cause malformation and scarring of fruit. Early season insecticide treatments targeting the adult are the primary means of controlling this pest (Lienk 1980).

General Information on Traps and Lures

Trap design. Pyramid traps (Fig. 7) are the most efficient design for monitoring plum curculio activity early in the season. In-tree screen traps that are placed on tree limbs also can be used, but are less effective than pyramid traps. (See CABI 2013 for list of references). This trap type is a structural type trap that captures insects based on adult behavior, not attractant based although they can be used with attractants to increase catch (Johnson et al. 2002).

Lure. Baiting traps with lures containing plum essence or benzaldehyde substantially increases catch. A male-produced aggregation pheromone, grandisoic acid, has been identified for plum curculio, but the addition of this bait to traps only slightly improves catch (Leskey and Wright 2004).

Lure Type, Replacement Interval and Trap Servicing

Adults should be monitored with baited pyramid traps as described above. Attractant replacement interval depends on the lure type and load, but generally should be replaced at two-week intervals. Traps should be inspected weekly, if possible, but at least every two weeks.

Trap Placement, Location in Production Areas and Densities

Place traps on the borders of orchards where plum curculio damage has been observed in past years. Plum curculio traps are effective over fairly short distances. Deploy two traps in orchards under 2 ha. In larger plantings, the distance between trap sets should be 60-100 m along the field perimeters, which works out to one trap/1.5-2.0 ha. Traps placed along the perimeter are most effective since most beetles captured in commercial orchards will be immigrants from adjacent areas. Place the traps 6-8 m, or a few rows, into the orchard.

Suggested trapping guidelines for delimiting surveys, for monitoring and for detection are summarized in Table 1 below. The suggested guidelines will cover trap locations/purpose, trap densities, lure/attractant types and other information.

Table 1. Suggested trapping guidelines for *Conotrachelus nenuphar*

Trapping purpose/Location	**Trap type**[1]	**Lure/Attractant**	**Trap density/km² (2)**			
			Production area	**Marginal**	**Urban**	**Points of entry**[3]
Monitoring survey, no control	PYR	PE/BZ	0.5-1.0	0.2-0.5	0.25-0.5	0.25-0.5
Monitoring for suppression	PYR	PE/BZ	2-4	1-2	0.25-0.5	0.25-0.5
Delimiting survey in FF-ALPP after unexpected detection(s)	PYR	PE/BZ	3-5	3-5	3-5	3-5
Monitoring for eradication	PYR	PE/BZ	3-5	3-5	3-5	3-5
Detection survey in FF-PFA to verify pest absence and for exclusion	PYR	PE/BZ	1	0.4-3	3-5	3-5
Delimitation survey in a PFA after a detection in addition to detection survey	PYR	PE/BZ	20-304	20-50	20-50	20-50

1. Different traps can be combined to reach the total number
2. Refers to the total number of traps
3. Also other high-risk sites
4. This range includes high-density trapping in the immediate area of detection (core area). However, it may decrease towards the surrounding trapping zones.

Abbreviations: PYR - Pyramid; PE - Plum Essence; BZ - Benzaldehyde

Other types of information

Detection of plum curculio in the trap does not necessarily mean the host tree fruit is infested. Inspection of the fruit for signs of egg-laying or feeding should be conducted to determine if a population has established at that site.

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10 *Copitarsia decolora* (Hampson) complex (Lepidoptera: Noctuidae)

Pest Information
Order: Lepidoptera
Family: Noctuidae
Genus: *Copitarsia*
Species: *decolora, incommoda,* and *corruda*
Common name: N.A.
Commodities surveyed: cabbage, cauliflower, asparagus, artichoke, carnation, rose, grape, Asian pear, and raspberry

The *Copitarsia decolora* complex is native to South America, and includes *C*. *decolora*, *C*. *corruda*, and *C*. *incommoda*. Females lay their eggs alone or in masses, depending on the species, on host plants. They have 5-6 larval stages, pupate in the soil and have many generations a year. The only way to differentiate members of this complex is by the differences in the characteristics of their genitals or by mitochondrial DNA analysis (Simmons and Scheffer 2004, Pogue and Simmons 2008). *Copitarsia decolora* is present from Mexico to Ecuador. *Copitarsia corruda* is present in Colombia, Ecuador, and Peru, while *C. incommoda* is present from Colombia to southern Chile and east of Argentina (Simmons and Pogue 2004).

Members of the *C*. *decolora* complex are highly generalists, feeding on plants of the following families: Alliaceae, Apiaceae, Asteraceae, Brassicaceae, Campanulaceae, Caryophyllaceae, Chenopodiaceae, Clusiaceae, Fabaceae, Iridaceae, Lamiaceae, Liliaceae, Papaveraceae, Plumbaginaceae, Primulaceae, and Rosaceae (Pogue and Simmons 2008).

General Information on Traps and Lures

Trap design. An evaluation of the effect of trap design on male captures of *C*. *decolora* by Diaz-Gomez et al. (2012) concluded that the water trap (Fig. 13) captured more males compared to those trapped with the plastic juice bottle trap (Fig. 5) and Scentry "Heliothis" trap (Fig. 9). In the U.S., a black light trap is commonly used for monitoring of this pest (CAPS 2014).

i. Scentry "Heliothis" trap (Fig. 9). This trap has two mesh cones, one big cone (50 cm long, 15 cm upper diameter, 52 cm lower diameter) and a small cone (22 cm long x 15 cm diameter) (Fig. 1). The small cone must be fitted over the large cone and secured with velcro material. Traps are mounted on a wooden stake and the pheromone bait inside the center bottom of the large cone. This trap is commercially available in the US.

ii. Water trap (Fig. 13). The water trap consists of plastic containers, one of them (14 cm high x 40 cm diameter) filled with soapy water. The second container (25 cm high x 20 cm diameter) has two openings on each side (7 x 10 cm) that allows delivery of the pheromone. The second container is placed upside down above the first container (Fig. 2). Trap colour may affect the number of insects captured. It is recommended to use a green container (Diaz-Gomez et al. 2012).

iii. Plastic juice bottle trap (Fig. 5). This trap consists of an empty juice or plastic milk bottle (3.8 L) with three openings on each side to allow the delivery of the pheromone and for males to enter the trap (Fig. 3). A 6 cm space between the openings and the bottom of the container is used as a reservoir filled with soapy water. The pheromone septum is held with a clip.

iv. UV light traps (Fig. 12) . USDA-APHIS-CAPS approved methods recommends the use of 15, 22 and 40 watt blacklight traps (CAPS 2014). Most commercially available traps contain 2 lamps with a choice of AC or DC power, a 3.5 to 5.0 gallon bucket, a funnel, rain drain, and cover.

Lure. The *Copitarsia decolora* pheromone has two components: Z9-tetradecenyl acetate and Z9-tetradecenol (Rojas et al. 2006). The pheromone for the two other members of the complex are unknown. Testing done in Peru showed that the pheromone lure for *C. decolora* does not attract *C. corruda*. Rubber septa are used as releasers, with 500 µg of each component (Figure 4). The pheromone has a half-life of 6-8 weeks in the field, depending on environmental conditions. It can be stored for a two year period in cold storage A septum must be placed in each trap.

Lure Replacement, Traps Servicing and Monitoring

Trap height position does not seem to affect male captures of *C. decolora.* However, traps should be placed above the plant canopy (Diaz-Gomez et al. 2012). Depending on the trap and population density, traps may be serviced every 3 to 8 days. The water traps and juice bottle traps should be serviced every third day to replace the water that may have evaporated. Five drops of liquid detergent or 1 g of solid detergent may be added to break surface tension in water traps and juice container traps. Septa with pheromones must be changed between the 6th and 8th weeks.

Trap Placement, Location in Production Areas and Densities

Delimiting surveys. Pheromone traps are ideal tools to delimit areas where the pest is present or to monitor pest movement. Commodities to be monitored are detailed in (Pogue and Simmons 2008).

Trap density: There is no published information available on trap density when using pheromones for this species complex. In Peru, light traps have been used at a density of 1 trap per 4 ha. However, when using these traps, it is difficult to differentiate specimens of *Copitarsia* spp. from other Noctuidae. NAPIS recommends the use of 15, 22 and 40 W blacklight traps for surveys (CAPS 2014).

Additional information: Due to its polyphagous nature and because members of this complex have many generations per year, it is recommended to use pheromones within the monitoring strategy and not as a control tool (i.e., mass trapping or mating disruption).

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10. ***Cydia pomonella* (L.) Codling Moth (Lepidoptera, Tortricidae)**

Pest Information

Order: Lepidoptera
Family: Tortricidae
Genus: *Cydia*
Species: *pomonella* (L.)
Common name: codling moth
Commodities surveyed: apple, pear, quince, hawthorn, English walnuts

The codling moth is native to Asia Minor, but was introduced into North America in the mid-eighteenth century. The codling moth thrived as the US apple industry grew and by the beginning of the 20^{th} century had established itself as the most injurious pest of apple wherever the crop was commercially grown. Although apple is the preferred host, it also feeds upon pear, quince, crab apple, hawthorn, English walnut and infrequently attacks various stone fruits. The codling moth overwinters as a mature larva in a cocoon under the bark, in a sheltered place near the base of the tree, or in picking bins. In the absence of control measures, crop losses caused by larval feeding typically are in excess of 20% and may be as high as 95%. Larvae damage the fruit by feeding minimally on the outside of fruit creating small "stings" on the fruit surface and tunneling into fruit, and feeding on the pulp and seeds causing extensive interior breakdown of tissue (Ontario CropIPM 2009, UC IPM 2011).

General Information on Traps and Lures

Pheromone-baited trapping is the most effective monitoring technique for codling moth.

Trap design (type). Wing-type (Fig. 14), delta (Fig. 2) or diamond shaped traps (Fig. 3) can be used for trapping codling moths.

Lure. The pheromone for the codling moth is comprised of a major component, (E, E)-8,10-dodecadien-1-ol (codlemone), and several minor components, most notably dodecanol and tetradecanol (Ebbinghaus et al. 1997). Codlemone alone or blended with minor components are equally attractive to males, thus lures containing the major component are used to monitor this pest.

Lure Type, Replacement Interval and Trap Servicing

Every trap is composed of three essential components. The design of the trap, the pheromone baited lure and the sticky surface needed to retain the moths. The three most commonly used traps for codling moth are the wing, large delta and diamond traps. Each can be an effective tool, however, the delta trap is probably the overall best option as the trapping area is a sticky insert that can be removed to count moths and is easily replaced if needed. Trap comparisons have consistently revealed that the delta trap catches at least 30% more moths than other traps, primarily because it has a larger trapping surface.

There are also many lures to choose from. The most commonly used lure is the red septum. A red septum loaded with 1 mg of codlemone has been the standard for monitoring codling moth. However, the performance of this lure declines after about three weeks in the spring and two weeks in the summer. Changing lures this often is difficult and expensive, thus some longer-lasting lures have been developed. These include the L2 gray septa and Biolure CM1x lures that last six or more weeks. Lures should be placed centrally in the trap. Lure replacement interval depends on the lure type, but replacing the lure at the start of new flight period is a good practice.

Trap Placement, Location in Production Areas and Densities

Trap placement is a critical factor for optimizing trap performance. The key decisions are 1) how many traps to deploy, 2) where to place them in the orchard, and 3) location of the trap within the tree. There is no way to avoid the fact that deploying more traps will increase the reliability of the information gathered. Deploy at least 1 trap/2 ha to monitor for codling moth. This density is actually a compromise between accurate monitoring and what is practical. The key considerations for effective trap placement within a block given this constraint are 1) historical “hot spots”, and 2) location relative to block perimeter. An area where moth catches from previous seasons were high, or a “hot spot”, is a good place to locate a trap. Avoid placing traps on the perimeter row. Instead place traps at least 3-4 rows in.

The location of the trap within the tree is the third critical factor. A trap needs to be located where moth activity is greatest and placed in a way that allows moths easy access to the trap. The height that a trap is placed is especially important for codling moth as catches of male moths vary substantially depending on trap location in the tree canopy. Higher catches will be recorded in upper compared to lower canopy positions. Very few moths will be captured above or below the canopy. To optimize monitoring codling moth, the trap should be placed in the upper third of the canopy (UC IPM 2011).

Traps for detection. The purpose of the detection survey is to determine whether a pest is present in a specified area. Place pheromone-baited traps in high-risk areas where CM is more likely to be found. Establish regular sites for trapping along a survey route (Madsen and Procter 1986). Appropriate trap densities will vary depending on the codling moth management tactics used, the type of codling moth lure and the cropping system in which the monitoring is being conducted. Refer to local recommendations for suggested trap densities.

Traps for delimiting survey. Once a new detection is made, delimiting surveys will be conducted to determine the distribution of the pest. Adult codling moths primarily remain close to where they emerge with over 90% dispersing less than 150 m. However, individuals have been reported to disperse up to 800 m. Surveys should be most intensive around the known positive detections. Set 60-90 traps per square kilometer in the core area. Set 60-90 traps per square kilometer in 20 square kilometers around the core area.

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12. *Epiphyas postvittana* (Walker) Light Brown Apple Moth (Lepidoptera, Tortricidae)

Pest Information

Order: Lepidoptera
Family: Tortricidae
Genus: *Epiphyas*
Species: *postvittana*
Common name: light brown apple moth
Commodities surveyed: tree fruits, small fruits, ornamentals and many others

The light brown apple moth (LBAM) is native to Australia and its known distribution includes New Zealand, New Caledonia, Hawaii, and the United Kingdom. LBAM was detected in California in 2007, affecting their apple, grape and ornamental industries. It is a highly polyphagous insect, with a host range in excess of 120 plant genera in over 50 families. There are three complete generations of this tortricid in Australia, with a partial to complete fourth generation in years with favorable weather conditions. In the cooler climates of New Zealand and the UK, there are generally two complete generations per year. Populations in California have been reported to complete four generations a year with adults present from March through November. Larvae feed on foliage, buds, shoots, and the surface of host plant fruits. Mature larvae generally cause fruit injury. Early instars typically feed on sub-surface tissue on the underside of leaves and buds.

General Trap and Lure Information

Pheromone-baited trapping is the most effective monitoring technique for light brown apple moth.

Trap design (type). The three most commonly used traps for light brown apple moth are the wing (Fig. 14), delta (Fig. 2) and diamond (Fig. 3) traps.

Lure. The pheromone for light brown apple moth has been identified as (E)-11-tetradecenyl acetate (96%) and (E, E)-9,11-tetradecadienyl acetate (4%) (CDFA 2013).

Lure Type, Replacement Interval and Trap Servicing

There are many lures to choose from. A red septum loaded with the two-component pheromone blend described above has been the standard for monitoring light brown apple moth. Lure replacement interval depends on the lure type, but replacing the lure at the start of each new flight period (generation) is a good practice. Lures should not be handled with bare hands. Gloves, sticks, or an instrument (with acetone dip) can be used, but whatever tool is chosen, pheromone cross-contamination when working with lures for different moth species must be avoided. Spent lures as well as new lure packaging must be removed from the orchard. When trapping for more than one species, do not place more than one lure in a single trap and separate traps by at least 20 meters. Septa should be changed every 6 weeks or sooner if temperatures are above 35°C (95°F).

Trap Placement, Location in Production Areas and Densities

Traps for monitoring. Trap placement is a critical factor for optimizing trap performance. The key decisions are 1) How many traps to deploy, 2) where to place them in the orchard, and 3) location of the trap within the tree. There is no way to avoid the fact that deploying more traps will increase the reliability of the information gathered. Deploy at least 1 trap per 4 ha to monitor for light brown apple moth. The key considerations for effective trap placement within a block are 1) historical "hot spots", and 2) location relative to block perimeter. An area where moth catches from previous seasons were high, or a "hot spot", is a good place to locate a trap. Avoid placing traps on the perimeter row. Instead place traps within the interior of the orchard block, at least 10 rows in. The location of the trap within the tree is the third critical factor. A trap needs to be located where moth activity is greatest and placed in a way that allows moths easy access to the trap. Light brown apple moth traps should be placed in the middle third of the canopy.

Traps for detection. The purpose of the detection survey is to determine whether a pest is present in a specified area. Place pheromone-baited traps in high-risk areas where light brown apple moth is more likely to be found. A single trap will survey 4-6 ha. Establish regular sites for trapping along a survey route. In 'at risk' areas, use 3 traps per square km (5 traps per square mile) (CDFA 2013).

Traps for delimiting survey. When a confirmed LBAM is trapped, pheromone baited Jackson traps will be placed uniformly over a 10 square kilometer area (4 square miles) with 25 traps placed every 2.5 square kilometer (in each of the square miles). A total of 100 traps will be deployed. All traps should be placed within 72 hr and inspected once within the first 7 days. Traps should be serviced every 14 days thereafter for a period of time equal to two generations beyond the date of the last LBAM detection (CDFA 2013).

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13. *Eudocima phalonia* Fruit-Piercing Moth (L.) (Lepidoptera: Noctuidae)

Pest Information

Order: Lepidoptera
Family: Noctuidae
Genus: *Eudocima*
Species: *phalonia* (Linneaus)
Synonyms*:* Genera – *Phalaena, Noctua, Othreis.* Species – *fullonia* Clerck*, fullonica* L.
Common name: fruit-piercing moth
Commodities surveyed: Diverse hosts (Grapes and small grains recommended by USDA).

Eudocima phalonia (= *fullonia*), also known as the fruit-piercing moth, is a significant pest of citrus and numerous other commercial fruit crops (Baptist 1944, CABI 2012). This insect occurs in subtropical and tropical Africa, Asia, Australia, and the Pacific region, where it is native (Indo-Malaysian region) (Baptist 1944, APPPC 1987, CABI 2012, CABI/EPPO 2001). Unlike most other moths, *Eudocima phallonia* adults use a strongly sclerotized proboscis to puncture fleshy fruit to feed, which causes attacked fruit to become dry, spongy, and unmarketable. More than 100 fruit-bearing plant species are attacked, including economically important one such as citrus, apple, pear, grape, melon, tomato, banana, mango, papaya, pineapple, and strawberry (Muniappan et al. 2002). Larvae are primarily foliage feeders of different hosts than the adult stage, and include shrubs and vines within the families Menispermaceae and Fabaceae (Sands and Chan 1996).

Control strategies for *Eudocima phalonia* have been limited to physical barriers such as bagging or netting fruit or trees, and pheromone-based attractants and strategies have yet to be developed. Research on fruit-based attractants found banana, guava, and orange based materials to be the significantly better than other fruit (Reddy et al. 2006). Pesticides are ineffective against adults which may fly into fruit production areas at night in large numbers and cause extensive damage in a short period of time.

General Trap and Lure Information

Trap design (type). Pheromone attractants for *E. phalonia* are not known, thus traps are not currently an option.
Light-trap (Fig. 12) detection surveys may be possible, as the species is attracted to ultraviolet light, but must be used with caution since certain wavelengths are known to repel *E. phalonia* (Martin Kessing and Mau 1993). Light traps may be able to determine presence/absence, but the effect of weather on trap catches makes their survey use problematic for pest management decisions (Yela and Holyoak 1997).

Visual inspection of host plants and night survey with spotlights (for adult moth eye-shine) for detection survey purposes is considered, but for most situations is not practical (Davis et al. 2005)

Lure. Not applicable.

Lure Type, Replacement Interval and Trap Servicing
N.A.

Trap Placement, Location in Production Areas and Densities
N.A.

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14. *Grapholita molesta* (Busck) Oriental Fruit Moth (Lepidoptera: Tortricidae)

Pest Information

Order: Lepidoptera
Family: Tortricidae
Genus: *Grapholita*
Species: *molesta*
Common name: Oriental fruit moth
Commodities surveyed: stone and pome fruits

The Oriental fruit moth is native to China, but is now found in most stone and pome fruit productions regions in the world, including Australia, Europe, Japan, New Zealand, North America, South Africa and South America. Although peach and other stone fruits are the preferred host, it also feeds upon apple, pear and quince. The Oriental fruit moth overwinters as a mature larva in a cocoon under the bark or in a sheltered place near the base of the tree

General Trap and Lure Information

Pheromone-baited trapping is the most effective monitoring technique for the Oriental fruit moth.

Trap design (type). Wing-type (Fig. 14), delta (Fig. 2) or diamond (Fig. 3) shaped traps can be used for trapping Oriental fruit moths. The bottom, and sometimes sides, of these traps are covered with a sticky material to ensnare moths that enter the trap.

Lure. Oriental fruit moth males are monitored using lures loaded with a 100:6:10 blend of (*Z*)-8-dodecenyl acetate, (*E*)-8-dodecenyl acetate and Z-8-dodecenol.

Lure Type, Replacement Interval and Trap Servicing

There are many lures to choose from. The most commonly used lure is the red septum. A red septum loaded with 0.1 mg of a 100:6:10 blend of (*Z*)-8-dodecenyl acetate, (*E*)-8-dodecenyl acetate and Z-8-dodecenol is usually the standard for monitoring Oriental fruit moth. However, there are also many other lures available. Lure replacement should be done according to the lure manufacturer. Lures should not be handled with bare hands. Pheromone cross-contamination when working with lures for different moth species must be avoided. Spent lures as well as new lure packaging must be removed from the orchard. When trapping for more than one species, traps should be separated by at least 20 meters.

Trap Placement and Location in Production Areas and Densities

Trap placement is a critical factor for optimizing trap performance. The key decisions are 1) how many traps to deploy, 2) where to place them in the orchard, and 3) location of the trap within the tree. There is no way to avoid the fact that deploying more traps will increase the reliability of the information gathered. Deploy at least 1 trap per 4 ha to monitor for Oriental fruit moth. The key considerations for effective trap placement within a block are 1) historical “hot spots”, and 2) location relative to block perimeter. An area where moth catches from previous seasons were high, or a “hot spot”, is a good place to locate a trap. Avoid placing traps on the perimeter row. Instead place traps within the interior of the orchard block, at least 10 rows in. Oriental fruit moth traps should be placed in the middle third of the canopy. Trap needs to be located where moth activity is greatest and placed in a way that allows moths easy access to the trap.

Traps for monitoring. Traps should be located in areas where there has been high level of detections historically. One trap per 4 ha should be deployed to monitor for Oriental fruit moth.

Traps for detection. The purpose of the detection survey is to determine whether a pest is present in a specified area. Place pheromone-baited traps in high-risk areas where Oriental fruit moth is more likely to be found. A single trap will survey 4-6 ha.

Traps for delimiting survey. Once a new detection is made, delimiting surveys will be conducted to determine the distribution of the pest. Adult Oriental fruit moths primarily remain close to where they emerge, but individuals have been reported to disperse up to 2 km. Surveys should be most intensive around the known positive detections. Set 20-30 traps per square kilometer in the core area. Set 20-30 traps per square kilometer in 20 square kilometers around the core area.

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15. *Keiferia lycopersicella* (Walsingham) Tomato Pinworm (Lepidoptera: Gelechidae)

Pest Information
Order: Lepidoptera
Family: Gelechidae
Genus: *Keiferia*
Species: *lycopersicella*
Common name: tomato pinworm
Commodities surveyed: tomato (*Solanum lycopersicum*) all varieties, eggplant (*Solanum melongena*) and exceptionally potato (*Solanum tuberosum*).

The tomato moth, *Keiferia lycopersicella*, is a tropical and subtropical species that can be found in the field or in greenhouses. Depending on the climatic conditions, it can reach up to eight generations per cycle of tomato crop (*Solanum lycopersicum*), its main host (Ferguson 2007). It has been noted that on average, the complete cycle lasts 28 days in warm weather and in cooler or colder weathers it can last up to 67 days (Elmore and Howland 1943). Damage in this crop is caused by the first and second instar larvae, which feed on the mesophyll tissue leaving only the epidermis; while feeding they leave frass and characteristic galleries. Third and fourth instar larvae usually fold or roll the leaf making a refuge where they keep on feeding, or they look for other structures such as stems or fruit. However, depending on the crop's stage of development they may damage stems, flowers and fruit. The action threshold is 0.7 larvae in 1.82 linear meters (Schuster and Stansly 2005) or when 5 adult moths per trap are captured per night in one week (SummitAgro 2012).

General Trap and Lure Information

Trap design. Delta (Fig. 2), water (Fig. 13), ultraviolet light (Fig. 12) and wing (Fig. 14) traps can be used on *Keiferia lycopersicella.*

Delta trap (Fig. 2). It has a delta shape, with three sides closed and two open. In general, each side of the trap measures approximately 7 x 21 cm, although they may vary. There are several models, some have a sheet covered with glue, which can be switched when the glue loses its effect or when it is full of moths (Figure 1, left). With the other model, the three internal sides are covered with glue which increases the contact surface. The downside of this model is that the whole trap has to be replaced when it is full of moths or the glue loses its adherence (Figure 1, right).

Water traps (Fig. 13). They are the best option for detection, monitoring and mass trapping; the bigger the tray, the better its efficiency. These traps work well at 20 or 80 cm height from the soil; height is adjusted according to the crop height, going no higher than 80 cm. The dome used by these traps, along with the moisture produced by the water, helps with the even distribution, release and stabilization of the pheromone. It has been noted that the trap colours do not influence moth preference (Figure 2). This figure includes a modified trap which uses the same principle of attraction and capture.

This trap can use oil or soap to loosen the surface tension and avoid adults escaping. This facilitates trap handling as there is less risk of water spillage when changing its position in the crop.

Ultraviolet light traps (UV) (Fig. 12). They are used for monitoring and mass trapping in enclosed locations such as warehouses, wholesale markets and greenhouses (Figure 3). Some UV light traps use a tray impregnated with glue to trap moths attracted by the light. The trays or bases should be replaced once they are filled with moths.

Wing trap (Fig. 14). Same principle as the delta trap, they are made out of cardboard and are impregnated with glue to trap moths. The same pheromone is used at the dose indicated in the following section.

Lure. The only bait used is the sexual pheromone (Z/E4-tridecadienyl acetate) at a dose of 500 µg per septum or releaser (Figure 4), which must be placed on the glue base. The pheromone has a half-life of 6-8 weeks, depending on environmental conditions; in cold storage it has a two year period. A septum must be placed for each trap.

Lure Type, Replacement Interval and Trap Servicing

Traps must be checked every three days; septa with pheromones must be changed between the 6th and 8th weeks. Five drops of liquid detergent or 1g of solid detergent must be added to water traps to break the surface tension. Monitoring of this pest must start when transplant takes place. To apply pesticides, an action threshold of 0.7 larvae in 1.8 linear meters or 5 adults/trap/night, on average, must be used during a 5 day period.

Monitoring of *K. lycopersicella* can be done using the “wing” traps (Figure 5) with the sexual pheromone and the dose indicated per trap, with a density of one wing trap/5 ha. Traps are revised twice/weekly. The trap floor or stikem must be changed monthly. Septa with pheromone must be changed every 6-8 weeks. Traps may be changed as needed.

Trap Placement, Location in ProductionAreas and Densities

Traps are place above the plant’s terminal shoots, the highest tip of the plant, and are distributed around the lot.

Delimiting studies. They provide information on real pest distribution within an area with previous outbreaks or incursions. In addition to using traps in this area, sampling must be intensified around the detection point or area.

Location in production areas. Using a GPS, the location is identified on the map with international cartographic divisions on a scale of 1:50 000; radials at 100 (safety area), 300 (buffer 1), and 500 m (buffer 2) are drawn from the detection point, to cover an approximate surface area of 100 ha or 1 km^2, regardless of territorial divisions (Graph

1). Once the radials have been drawn, water traps baited with the sexual pheromone are placed.

Trap density. Traps are placed at a density of 6 /ha in the first quadrant which corresponds to a surface of 4 ha with a total of 24 traps in the safety area. In the buffer zone 1 with an average area of 32 ha, a trap density of 4 traps/ha with a total de 128 traps should be used. In the second buffer zone, 2 traps per ha should be deployed to cover an area of 64 ha, for a total of 128 traps. Once the traps have been deployed, necessary data must be registered to place them properly in the map. Traps must be equally distributed giving preference to areas with primary hosts. Traps must be placed at 20 cm height.

500 300 100 0 100 300 500 m

2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2
2	2	4	4	4	4	4	4	2	2
2	2	4	4	4	4	4	4	2	2
2	2	4	4	6	6	4	4	2	2
2	2	4	4	6	6	4	4	2	2
2	2	4	4	4	4	4	4	2	2
2	2	4	4	4	4	4	4	2	2
2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2

Safety area (4 ha) Buffer 1 (32 ha) Buffer 2 (64 ha)

Graph 1. Delimiting and outbreak containment diagram for *K. lycopersicella* with the number of traps per ha and a minimum total density of 640 traps/km^2.

Adults captured in traps should be higher in safety areas than in buffer areas, otherwise that would indicate that the moth is spreading quickly or that there is more than one outbreak. In such a case, the delimiting area should be increased, drawing an additional radial at 1 km which will be buffer 3 with the same trap density as in buffer 2.

When population densities start to exceed the action threshold, higher doses of pheromone are recommended. These should be applied in watery form and the objective is to saturate the environment with the sexual pheromone to keep the male from finding the female and mating.

Another alternative is to use clips of the sexual pheromone (for eg. Isomate-TPW). To confuse the moths, a dose of 102 g active ingredient equivalent to 500 clips per ha in alternating rows must be placed. Separation between clips will depend on the distance between rows. For rows 1.5 m apart, the distance between clips is 6.7 m. For rows 1.6 m apart, the distance between clips must be 6.25 m and for rows at 1.9 m apart, the distance between clips will be of 5 m.

Additional information: Traps should be properly labelled with a permanent numbering regardless of the place where they are found, which should correlate to the number of active traps. When a moth is trapped, a picture should be taken of it before it loses certain morphological characteristics important for its identification.

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16. *Leucoptera malifoliella* (Costa) Pear Leaf Blister Moth (Lepidoptera: Lyonetiidae)

Pest Information

Order: Lepidoptera
Family: Lyonetiidae
Genus: *Leucoptera*
Species: *malifoliella*
Common name: Pear leaf blister moth
Commodities surveyed: Pear, apples, cherry and hawthorn

The pear leaf blister moth is one of the major pests in apple orchards, and problems are arising because the resistance it shows towards some of the agents currently being used for their control (Rama and Capuzzi 1989). This pest can migrate into previously un-infested trees from unsprayed or abandoned host trees somewhere in the vicinity. Feral and residential pear, apple, hawthorn and possibly other fruit trees may serve as a source of infestation for commercially grown host tree.

General Trap and Lure Information

Trap design (type). Large plastic delta trap (Fig. 2) (7 x 21 cm) and wing style pheromone traps (Fig. 14) can be used to monitor adult male activity (Fig. 1). CAPS recommends using a large plastic delta trap (http://pest.ceris.purdue.edu/services/approvedmethods/sheet.php?v=1605).

Lure. Synthetic sex pheromones in baited traps have been used successfully to monitor for adults. Minor components had been previously found by Riba et al. (1990). See also http://www.pherobase.com/database/speci liella.php

Lure Type, Replacement Interval and Trap Servicing

Baited traps require periodic replacement. Pheromone capsules should be changed every 30 – 40 days. CAPS recommends every 70 days. Traps also should be replaced when the sticky surface is too soiled with debris to catch insects effectively (Radoslav et al. 2001, reviewed in CABI 2007).

Trap Placement, Location in Production Areas and Densities

Place traps within the fruiting canopy of the tree, positioned so that the traps are secured tightly to branches so they do not swing in the wind. Place traps within the upper third of the tree canopy making sure the trap entrance is not blocked and that it is parallel to prevailing wind direction. If needed, remove foliage from around the trap entrance to make it easier for the moths to approach the trap.

If monitoring the production site (orchard), the distance between trap sets should be 60-100 meters along the orchard borders. Where the orchard borders a dusty road or field, place the traps one or two rows into the orchard. Use a higher trap density on sides of the orchard nearest suspected sources of moths.

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17. *Lobesia botrana* (Denis & Schiffermuller) European Grapevine Moth (Lepidoptera: Tortricidae)

Pest Information

Order: Lepidoptera
Family: Tortricidae
Genus: *Lobesia*
Species: *botrana*
Common name: European grapevine moth
Commodities surveyed: Grapes and stone fruits

The European grapevine moth is not known to be present in Canada or Mexico, and is only known to occur in California, where it is under quarantine and eradication action. Native to Europe, it is highly polyphagous, with the primary hosts in the Rosaceae family, although known hosts occur in other plant families. It is principally a pest of grapes and stone fruits, such as cherry. Larvae feed on flowers and fruit, with the latter resulting in the majority of economic damage.

General Trap and Lure Information

Trap design (type). Wing (Fig. 14) or large delta traps (Fig. 2), should be used for trapping European grapevine moth. CAPS recommends paper delta traps (brown, green, or orange), 3-sided paper delta traps (orange), or large plastic delta traps (red) (http://pest.ceris.purdue.edu/services/approvedmethods/sheet.php?v=719).
Pheromone-baited trapping is the most effective monitoring technique for European grapevine moth.

Lure. The most attractive sex pheromone of European grapevine moth is (E, Z) 7,9 Dodecadienyl acetate; http://www.pherobase.com/database/compound/compounds-detail-E7Z9-12Ac.php The preferred dispenser is the grey rubber septum, loaded with 1.0 mg of the above pheromone (CAPS 2014).

Lure Type, Replacement Interval and Trap Servicing

The preferred traps for European grapevine moth are delta shaped traps or large delta traps with sticky inserts. Lure replacement interval depends on the lure type, but gray rubber septa lures should be replaced after 4 weeks.
http://pest.ceris.purdue.edu/services/approvedmethods/sheet.php?v=719

Lures should not be handled with bare hands. Gloves, sticks, or an instrument (with acetone dip) can be used, but whatever tool is chosen, pheromone cross-contamination when working with lures for different moth species must be avoided. Spent lures as well as new lure packaging must be removed from the orchard. When trapping for more than one species, do not place more than one lure in a single trap and separate traps by at least 20 meters.

Trap Placement, Location in Production Areas and Densities

Traps for monitoring. Trap placement is a critical factor for optimizing trap performance. The key decisions are 1) how many traps to deploy, 2) where to place them in the orchard, and 3) location of the trap within the tree. There is no way to avoid the fact that deploying more traps will increase the reliability of the information gathered. Deploy at least 1 trap per 6 ha to monitor for European grapevine moth. The key considerations for effective trap placement within a block are 1) historical “hot spots”, and 2) location relative to block perimeter. An area where moth catches from previous seasons were high, or a “hot spot”, is a good place to locate a trap. Avoid placing traps on the perimeter row. Instead place traps within the interior of the orchard/vineyard block, at least 10 rows in. The location of the trap within the tree is the third critical factor. A trap needs to be located where moth activity is greatest and placed in a way that allows moths easy access to the trap. European grapevine moth traps should be placed in the middle third of the canopy.

Traps for detection. The purpose of the detection survey is to determine whether a pest is present in a specified area. Place pheromone-baited traps in high-risk areas where European grapevine moth is more likely to be found. A single trap will survey 6-8 ha. Establish regular sites for trapping along a survey route.

Traps for delimiting survey. Once a new detection is made, delimiting surveys will be conducted to determine the distribution of the pest. Female moths are reported to fly distances of 80-100 meters in search of oviposition sites; males can fly further in search of females. Because of its relatively short flight distance, EGVM spreads slowly through natural means (USDA-APHIS 2010). Surveys should be most intensive around the known positive detections. Set 10-15 traps per square kilometer in the core area. Set 10-15 traps per square kilometer in 20 square kilometers around the core area.

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18. *Opogona sacchari* (Bojer) Banana Moth (Lepidoptera: Tineidae)

Pest Information

Order: Lepidoptera
Family: Tineidae
Genus: *Opogona*
Species: *sacchari* (Bojer)
Common name: banana moth
Surveyed hosts: banana, sugar cane

The banana moth is native to tropical and sub-tropical regions of Africa. Outside its area of origin it has become a polyphagous pest, affecting a large number of vegetables, fruits and ornamentals (OEPP/EPPO 1988, EPPO 2013). Damage is caused by larvae which are borers of stems, flowers, fruit and leaves. Plants lacking water and nutrients are more susceptible to moth attacks. In banana, the larva feeds on the pseudostem, leaf petiole, branch peduncle, inflorescence and the fruit (SENASA 2007). Despite its inability to disperse over long distances, it has spread quickly to several regions in Europe, Asia, North and South America through importation of plant material, and as a result has become a quarantine pest (CABI 2013). *Opogona saccharis* is a serious pest of banana in the Canary Islands and Brazil (Sampaio et al. 1983). Early detection is achieved by inspecting material from areas where the moth is present, in addition to using sex pheromone baited traps.

General Trap and Lure Information

Trap design (type). The most common traps for monitoring *O. sacchari* are the Jackson (Fig. 4), and the Unitrap (Fig. 11). They have strips impregnated with dichlorvos or amitraz. For the Jackson trap, the interior lower side is covered with glue for insects; however, sometimes the three sides are covered to improve moth captures. The external part of the trap is covered with a wax or sometimes it is plasticized to increase its half-life in the field.

Due to their high capacity or volume, Unitraps have been targeted for mass trapping high populations of moths as they can store up to 5,000 moths. The airtight design allows captured moths to be free from moisture which helps to avoid decomposition. PVC strips impregnated with contact pesticide, such as dichlorvos or amitaz, must be placed inside the trap.

Lure. The banana moth pheromone consisting of 250 ug of (E, Z)-2,13-octadecadienal is placed inside a septum (Fig. 15). The pheromone has a half-life of 4-6 weeks in the field, depending on environmental conditions. It has a two year storage period under refrigeration.

Trap Placement, Location in Production Areas and Densities

Monitoring traps

a. Location in production areas

Trap distribution at the regional level is done according to risk. For this, a risk map should be used which includes variables such as distance from areas with pest presence or source areas, areas with primary host and climatic conditions for pest development considering the presence of host crops, quarantine areas or nurseries receiving material from quarantine areas, urban/tourist centers, collection of varieties and testing at state and private experimental stations, among others. Each trapping location must be geo-referenced. Traps must be deployed on trees, posts, or structures, etc. at a height of 1.5 - 2 m above soil level, in the pest host or around it.

b. Trap density

The trap number or trap density will depend on the risk areas. For high risk areas, it is suggested to deploy one trap per 5 ha; for medium risk areas, 1 trap per 10 ha and for low risk areas 1 trap per 20 ha, using delta or Jackson traps, together with the sex pheromone [(E,Z)-2,13-octadecadienal].

c. Other information

If after applying the phytosanitary measures there are no detections or captures in baited traps during three life cycles (at 15°C it has a life cycle of approx. three months) of the pest in the field, the pest would be considered eradicated. However, under greenhouse conditions, if the host is present, more than three cycles are suggested to eliminate any residual pupae. Pests under this condition may have up to 10 generations a year. Eradication is declared after three generations with no captures.

Traps for detection

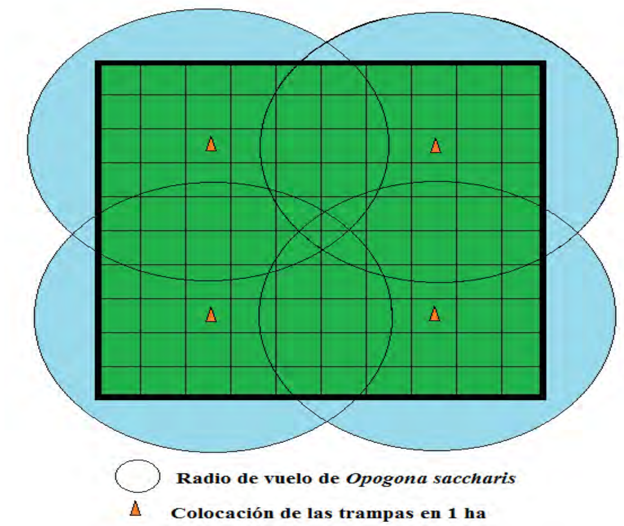
The number of traps for detection will depend on the risk area. In addition to traps with pheromone, there must be a sampling program, survey and establishment of sentry places for timely detection. UV light traps are recommended for enclosed areas.

Traps for delimiting studies

Delimiting studies provide information on real pest distribution within an area with previous outbreaks or incursions. In addition to using traps in this area, sampling must be intensified around the detection point or area.

a. Location in production areas

Due to the flight range of this moth, sex pheromone-baited traps should be deployed at a density of 4 traps/ha. Each trap should be placed 25 meters from the edge and at a distance of 50 meters between traps. The pest flies short distances (25- 40 meters). With this distribution, the whole area is covered by pheromones, and the traps are placed at a reachable distance by the moth on a single flight (Graph 2).



Graph 2 Trap distribution with sex pheromone for *O. sacchari* in a one hectare orchard.

b. Trap density

Since flight ranges for this moth are short, and the moth may be moved by wind, a 1 km^2 area is considered as a delimiting area. This area should be divided into three sub-zones. The first quadrant is the safety zone, which is surrounded by two buffer zones.

In a commercial area of 1 km^2, delta trap distributions for monitoring should be as follows: in the first safety zone, 4 traps/ha covering 4 ha from the source of infestation; in the second zone, buffer zone 1, 2 traps per ha should be deployed to cover an area of 32 ha; and in the third zone, buffer zone 2, 1 trap per ha should be deployed to cover an area of 64 ha (Graph 3).

To obtain the average moths captured/trap/week in the delimiting area, the total of moths trapped per week is divided by 16; for instance, if 40 moths were captured in one week, then divide 40/16 = 2.5 moths/trap/week. For the second and third zones, the total number of moths captured is divided by 64 to obtain the moths/trap/week; for instance, if 100 moths were captured, then divide 100/64 = 1.56 moths/trap/week.

c. Bait loading

The pheromone dispenser must be placed inside the delta trap, using trap glue to adhere it. Be careful that glue does not obstruct the area where the pheromone is released. The trap design protects the septum against rain, dust or sun.

d. **Lure replacement interval**

Checking and changing the cardboard of the trap should be done every 15 days. As the pheromone dispenser lasts 4 weeks, it must be carefully handled (tweezers only) and placed on the new trap for the next 15 days.

If there are no Lepidoptera or other pests adhered to the trap, it may remain for another 15 days. After this time, the dispenser must be destroyed since the pheromone loses its effect. For traceability purposes, it is important to identify the traps with a number and the area they come from.

1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1
1	1	2	2	2	2	2	2	1	1
1	1	2	2	2	2	2	2	1	1
1	1	2	2	4	4	2	2	1	1
1	1	2	2	4	4	2	2	1	1
1	1	2	2	2	2	2	2	1	1
1	1	2	2	2	2	2	2	1	1
1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1

Graph 3. Delimiting with pheromone traps for *O. sacchari*.

d. Trap servicing

The tray with the glue must be changed weekly or every 15 days, depending on environmental conditions such as rain, dust or other insects that may fill the trap. The glue adherence will be an indicator to change the tray with glue.

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19. *Paralobesia viteana* (Clemens) Grape Berry Moth (Lepidoptera, Tortricidae)

Pest Information

Order: Lepidoptera
Family: Tortricidae
Genus: *Paralobesia*
Species: *viteana* Clemens
Synonyms*:* Genera – *Endopiza*
Common name: Grape berry moth
Commodities surveyed: grapes

The grape berry moth is native to eastern North America where it originally inhabited wild grapes. It presently occurs east of the Rocky Mountains wherever wild or cultivated grapes are grown. The grape berry moth overwinters as a pupa in fallen leaves. There are generally three generations per year and the pest feeds only on grapes (Riedl and Taschenberg 1984). First generation larvae feed superficially on berry florets and developing berries. Second generation larvae feed on the expanding berries, and feeding sites are visible as holes with a purple or reddish discolouration. Third generation larvae feed on the flesh inside the berries (Ontario CropIPM 2009).

General Trap and Lure Information

The three most commonly used traps for grape berry moth are the wing, delta and diamond traps. Pheromone-baited trapping is the most effective monitoring technique for grape berry moth.

Trap design (type). Wing-type (Fig. 14), delta (Fig. 2) or diamond (Fig. 3) shaped traps can be used for trapping grape berry moths. The bottom, and sometimes sides, of these traps are covered with a sticky material to ensnare moths that enter the trap.

Lure. Grape berry moth males are monitored using lures loaded with a 90:10 blend of the sex pheromone (Z)-9-dodecenyl acetate and (Z)-11-tetradecenyl acetate (Jordon et al. 2013). Also females are monitored using a kairomone blend (Cha et al. 2013).

Lure Type, Replacement Interval and Trap Servicing

There are many lures to choose from. The most commonly used lure is the red septum. A red septum loaded with the two-component pheromone blend described above has been the standard for monitoring grape berry moth. Lure replacement interval depends on the lure type, but replacing the lure at the start of each new flight period (generation) is a good practice. A minimum of one set of five traps per four hectares is recommended. Place traps on the top wire of the trellis. Install one trap at the edge of the vineyard and the rest of the traps at 40 m intervals following a row into the vineyard (Ontario CropIPM 2009).

Trap Placement, Location in Production Areas and Densities

Traps for detection. The purpose of the detection survey is to determine whether a pest is present in a specified area. Place pheromone-baited traps in high-risk areas where grape berry moth is more likely to be found. A single trap will survey 2-3 ha. Establish regular sites for trapping along a survey route.

Traps for delimiting survey. Once a new detection is made, delimiting surveys will be conducted to determine the distribution of the pest. Surveys should be most intensive around the known positive detections. Set 25-35 traps per square kilometer in the core area.

References

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20. *Platynota flavedana* (Clemens) Variegated Leafroller (Lepidoptera: Tortricidae)

Pest Information

Order: Lepidoptera
Family: Tortricidae
Genus: *Platynota*
Species: *flavedana*
Common name: variegated leafroller
Commodities surveyed: tree fruit and berry crops

The variegated leafroller is native to North America. It has a wide host range, including apple, peach, strawberry, blackberry, azalea, clover, sunflower, maple and rose. Larvae overwinter in the ground cover, feeding on weeds (Hamilton 1940). There are two generations of variegated leafroller each year.

General Trap and Lure Information

Pheromone-baited trapping is the most effective monitoring technique for variegated leafroller. According to David et al. (1989), the Pherocon IC trap baited with a rubber septum impregnated with 2.5 mg pheromone, hung at 2.1 and 3.0 m high and in the outside-canopy trap position, captured the greatest number of *Platynota flavedana* moths.

Trap design (type). Wing-type (Fig. 14) or delta (Fig. 2) shaped traps can also be used for trapping variegated leafroller moths (Fig. 1).

Lure. A 9:1 blend of (E)-11-Tetradecen-1-ol and (Z)-11-Tetradecen-1-ol is highly attractive to variegated male moths (Hills et al 1977). A mix of 67.2% *E*11-14:Ac ((*E*)-11-tetradecenyl acetate), 28.8% *Z*11-14:Ac ((*Z*)-11-tetradecenyl acetate), 1.4% *E*11-14:OH ((*E*)-11-tetradecenol), 0.6% *Z*11-14:OH ((*Z*)-11-tetradecenol) and 2% *Z*9-12:Ac ((*Z*)-9-dodecenyl acetate), is considered as a putative generic disruption blend (Pfeiffer et al. 1993).

Lure Type, Replacement Interval and Trap Servicing

There are several lures to choose from; however, the most commonly used lure is the red septum. A red septum loaded with the two-component pheromone blend described above has been the standard for monitoring variegated leafroller. Lure replacement interval depends on the lure type, but replacing the lure at the start of each new flight period (generation) is a good practice. Lures should not be handled with bare hands. Gloves, sticks, or an instrument (with acetone dip) can be used, but whatever tool is chosen, pheromone cross-contamination when working with lures for different moth species must be avoided. Lure packaging must be removed from the orchard. When trapping for more than one species, do not place more than one lure in a single trap and separate traps by at least 20 meters.

Trap Placement, Location in Production Areas and Densities

Trap placement is a critical factor for optimizing trap performance. The key decisions are 1) how many traps to deploy, 2) where to place them in the orchard, and 3) location of the trap within the tree. Deploy at least 1 trap per 2 ha to monitor for variegated leafroller. The key considerations for effective trap placement within a block are 1) historical “hot spots”, and 2) location relative to block perimeter. An area where moth catches from previous seasons were high, or a “hot spot”, is a good place to locate a trap. Avoid placing traps on the perimeter row. Instead place traps within the interior of the orchard block. The location of the trap within the tree is the third critical factor. A trap needs to be located where moth activity is greatest and placed in a way that allows moths’ easy access to the trap. Tufted apple bud moth traps should be placed in the middle third of the canopy.

Traps for detection. The purpose of the detection survey is to determine whether a pest is present in a specified area. Place pheromone-baited traps in high-risk areas where variegated leafroller is more likely to be found. A single trap will survey 1-2 ha. Establish regular sites for trapping along a survey route.

Traps for delimiting survey. Once a new detection is made, delimiting surveys will be conducted to determine the distribution of the pest. Surveys should be most intensive around the known positive detections. Set 60-90 traps per square kilometer in the core area. Set 60-90 traps per square kilometer in 20 square kilometers around the core area.

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21. *Platynota idaeusalis* (Walker) Tufted apple bud moth (Lepidoptera: Tortricidae)

Pest Information

Order: Lepidoptera
Family: Tortricidae
Genus: *Platynota*
Species: *idaeusalis*
Common name: tufted apple bud moth
Commodities surveyed: tree fruit crops

The tufted apple bud moth is native to North America. It has a wide host range, including apple, peach, pear, nectarine and a number of herbaceous plants that comprise the orchard groundcover. Larvae overwinter on the ground in shelters constructed of rolled leaves or decaying fruit. There are two generations of tufted apple bud moth each year. Economic damage occurs when larvae web a leaf onto an apple fruit and feed directly on the fruit (Hogmire and Howitt 1979).

General Trap and Lure Information

Pheromone-baited trapping is the most effective monitoring technique for tufted apple bud moth.

Trap design (type). Wing-type (Fig. 14) or delta (Fig. 2) shaped traps should be used for trapping variegated leafroller moths (Fig. 1).

Lure. The sex pheromone of tufted apple bud moth is a 1:1 blend of (E)-11-Tetradecenyl acetate and (E)-11-Tetradecen-1-ol. Males *Platynota idaeusalis* were previously known to be attracted to this compounds that were found in extracts of female abdominal tips in an alcohol:acetate ratio of about 2:1 (Hill et al. 1974).

Lure Type, Replacement Interval and Trap Servicing

There are several lures to choose from; however, the most commonly used lure is the red septum. A red septum loaded with the two-component pheromone blend described above has been the standard for monitoring tufted apple bud moth. Lure replacement interval depends on the lure type, but replacing the lure at the start of each new flight period (generation) is a good practice. Lures should not be handled with bare hands. Gloves, sticks, or an instrument (with acetone dip) can be used, but whatever tool is chosen, pheromone cross-contamination when working with lures for different moth species must be avoided. Lure packaging must be removed from the orchard. When trapping for more than one species, do not place more than one lure in a single trap and separate traps by at least 20 meters.

Trap Placement, Location in Production Areas and Densities

Trap placement is a critical factor for optimizing trap performance. The key decisions are 1) how many traps to deploy, 2) where to place them in the orchard, and 3) location of the trap within the tree. Deploy at least 1 trap per 2 ha to monitor for tufted apple bud moth. The key considerations for effective trap placement within a block are 1) historical "hot spots", and 2) location relative to block perimeter. An area where moth catches from previous seasons were high, or a "hot spot", is a good place to locate a trap. Avoid placing traps on the perimeter row. Instead place traps within the interior of the orchard block. The location of the trap within the tree is the third critical factor. A trap needs to be located where moth activity is greatest and placed in a way that allows moths' easy access to the trap. Tufted apple bud moth traps should be placed in the middle third of the canopy. The use of a sex pheromone trap grid consisting of 105 traps spaced 200 by 140 m apart have been useful to study the population biology of this pest (Knight and Hull 1988).

Traps for detection. The purpose of the detection survey is to determine whether a pest is present in a specified area. Place pheromone-baited traps in high-risk areas where tufted apple bud moth is more likely to be found. A single trap will survey 1-2 ha. Establish regular sites for trapping along a survey route.

Traps for delimiting survey. Once a new detection is made, delimiting surveys will be conducted to determine the distribution of the pest. Surveys should be most intensive around the known positive detections. Set 60-90 traps per square kilometer in the core area. Set 60-90 traps per square kilometer in 20 square kilometers around the core area.

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22. *Rhagoletis cingulata* (Loew), Eastern Cherry Fruit Fly (Diptera: Tephritidae)

Pest Information

Order: Diptera
Family: Tephritidae
Genus: *Rhagoletis*
Species: *cingulata*
Common name: eastern cherry fruit fly
Commodities surveyed: sweet, tart cherries

The eastern cherry fruit fly is native to North America. It is found in all cherry production regions in middle and eastern North America, from Michigan to New Hampshire and southward to Florida. In addition to sweet and tart cherries, the insect will infest wild cherry species. The eastern cherry fruit fly is univoltine and overwinters as a pupa in the soil. A portion of the population overwinters for 2 or 3 years. Adults can emerge from the soil over a period of 3 or more months around 950 degree-days above 4.4°C after March 1. Insecticide treatments targeting the adult are the primary means of controlling this pest. A very high level of control is required due to the zero tolerance level of fruit flies in processed cherries.

General Trap and Lure Information

Trap design (type). Use a yellow panel trap (YP) (Fig. 6) consisting of a 23cm x 14cm rectangle cardboard panel covered on both sides with a thin layer of sticky material. The trap must be baited with protein hydrolysate or an ammonia compound. More detailed descriptions and images of these traps can be found in Annex 1 of ISPM 26: 2006.

Lure. Traps can be baited with lures containing ammonium carbonate, ammonium acetate, or pre-baited with protein hydrolysate. See Boller and Prokopy (1976), and Economopoulos (1989) for a discussion of these traps.

Lure Type, Replacement Interval and Trap Servicing

Attractant replacement interval depends on the lure type and load. Traps pre-baited with protein hydrolysate may need to be changed weekly. Other attractants generally last 3 or more weeks depending on the loading rate. Because yellow panel traps capture many kinds of non-target insects they need to be inspected and cleaned regularly. Traps should be inspected weekly, if possible, but at least every two weeks. Traps should be checked more often if in windy or dusty areas to facilitate detection of flies before too much debris accumulates. Most traps will require replacement after 3-4 weeks. Suggested trap servicing intervals are summarized in Table 1.

Trap Placement, Location in Production Areas and Densities

Place traps on the southern side of trees (flies are more active on the warmer side of trees) and in the mid- to upper- portion of the canopy. Traps placed in the upper canopy (within 50 cm of the top) will capture significantly more flies that those hung at mid-canopy. Remove foliage from around the trap for 15 to 25 cm (6 to 10 inches) to make it more visible to the western cherry fruit flies. Secure the traps tightly to branches so they do not swing in the wind.

Unlike pheromone traps, which attract moths from a considerable distance, cherry fruit fly traps are effective over fairly short distances. Deploy two traps in fields under 2 ha. In larger fields, the distance between trap sets should be 60-100 meters along the field perimeters, which works out to one trap/1.5-2.0 ha. Traps placed along the perimeter, facing out of the field are most effective since most flies captured in commercial orchards will be immigrants from adjacent areas. Place the traps 6-8 meters, or a few rows, into the field.

Suggested trapping guidelines for delimiting surveys, for monitoring and for detection are summarized in Table 2 below. The suggested guidelines cover trap locations/purpose, trap densities, lure/attractant types and other information. It should be noted that detection of adult eastern cherry fruit flies on the trap does not necessarily mean the host tree fruit is infested. Fruit collection and larval rearing may be required to determine if a population has established at that site.

Table 2. Suggested trapping guidelines for *Rhagoletis cingulata*

Trapping purpose/Location	**Trap Type[1]**	**Lure**	**Trap density/km^2 (2)**			
			Production area	**Marginal**	**Urban**	**Points of entry[3]**
Monitoring survey, no control	YP	PH/AC/AA	0.5-1.0	0.2-0.5	0.25-0.5	0.25-0.5
Monitoring for suppression	YP	PH /AC/AA	2-4	1-2	0.25-0.5	0.25-0.5
Delimiting survey in FF-ALPP after unexpected detection(s)	YP	PH /AC/AA	3-5	3-5	3-5	3-5
Monitoring for eradication	YP	PH /AC/AA	3-5	3-5	3-5	3-5
Detection survey in FF-PFA to verify pest absence and for exclusion	YP	PH /AC/AA	1	0.4-3	3-5	3-5
Delimitation survey in a PFA after a detection in addition to detection survey	YP	PH /AC/AA	20-304	20-50	20-50	20-50

Trap type: YP **=** Yellow Panel; **Lure:** AA = Ammonium Acetate, AC = Ammonium Carbonate, PH = Protein hydrolysate (Pre-baited YP). 1 Different traps can be combined to reach the total number; 2 Refers to the total number of traps; 3 Also other high-risk sites; 4 This range includes high-density trapping in the immediate area of detection (core area). However, it may decrease towards the surrounding trapping zones.

References

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EPPO. 2014. http://www.eppo.int/QUARANTINE/insects/Rhagoletis_cingulata/RHAGCI_ds.pdf

ISPM 26. 2006. *Establishment of pest free areas for fruit flies (Tephritidae*). Rome, IPPC, FAO.

23. *Rhagoletis indifferens* (Walsh) Western Cherry Fruit Fly (Diptera: Tephritidae)

Pest Information

Order: Diptera
Family: Tephritidae
Genus: *Rhagoletis*
Species: *indifferens*
Common name: western cherry fruit fly
Commodities surveyed: cherry, all varieties

The western cherry fruit fly is native to western North America, found infesting 15 cherry host plant species. In addition to sweet and tart cherries, the insect will infest wild cherry species. This species requires chilling to break diapause, so it needs areas that have cold winters to establish. This species is rarely found in commercial cherry orchards (Yee et al. 2013).

General Trap and Lure Information

Trap design (type). A yellow panel (YP) (Fig. 6) trap should be used and should consist of a 23cm x 14cm rectangle cardboard panel covered on both sides with a thin layer of sticky material and baited with ammonium carbonate. Attached to the top of the trap is a wire hanger used to hang the trap from cherry tree branches. A three-dimensional YP-type trap with two crossed yellow panels (Rebell trap, RB) (Fig. 8) may also be used. More detailed descriptions and images of these traps can be found in Annex 1 of ISPM 26: 2006.

Lure. Traps can be baited with lures containing ammonium carbonate or ammonium acetate.

Lure Type, Replacement Interval and Trap Servicing

Lure replacement interval depends on the lure type and load. Most attractants last from 4 to 12 weeks. Suggested trap servicing intervals are as follows:

Traps should be monitored at least every one to three weeks depending on conditions. Traps should be checked more often in windy or dusty areas to assure that suspect flies can be observed on the traps before too much debris accumulates. Most traps will require replacement after four weeks.

Western cherry fruit flies migrate into previously un-infested trees from unsprayed or abandoned host trees somewhere in the vicinity. In areas where western cherry fruit fly is established, the pest is often managed with sprays of insecticides targeted to the first emerging adult flies. Not all orchards require treatment.

Adults should be monitored with sticky traps. Use a bright yellow panel and an attractant listed in Table 1. Unlike pheromone traps, which attract moths from several yards, a western cherry fruit fly trap is effective only over short distances, generally the tree in which it is located. Because traps, particularly the yellow panel type, capture many kinds of insects, they need to be inspected and cleaned regularly.

Place traps within the fruiting canopy of the tree in the outer third, with panel traps positioned so that the broad surface is exposed to the foliage. Remove foliage from around the trap for 30 to 45 cm (12 to 18 inches) to make it more visible to the western cherry fruit fly. Place traps at intervals of 45 meters (150 feet) along the orchard border. Where the orchard borders a dusty road, place the traps one or two rows into the orchard. The commercially available pre-baited trap should be changed every 7 days. Yellow panel traps using ammonium carbonate as a lure can be changed every 14 to 21 days, depending on how long the lure lasts and how contaminated the trap's surface becomes. If monitoring the production site (orchard), the distance between trap sets should be 60-100 meters along the orchard borders.

Trap Placement, Location in Production Areas and Densities

The most effective trap is an adhesive covered yellow panel with an ammonium-carbonate lure. These traps should be placed in the fruiting canopy of the tree, with fruit and foliage removed from around it for 30 to 45 cm (12 to 18 inches). A degree-day model is available to predict first emergence and seasonal activity.

Traps for delimiting surveys, for monitoring and for detection are summarized in Table 3 below. The suggested guidelines cover trap locations/purpose, trap densities, and other information.

Table 3: Suggested trapping guidelines for *Rhagoletis indifferens*

Trapping purpose/Location	**Trap type**[1]	**Lure**	**Trap density/km² (2)**			
			Production area	**Marginal**	**Urban**	**Points of entry**[3]
Monitoring survey, no control	RS,YP,RB	AC/AA	0.5-1.0	0.2-0.5	0.25-0.5	0.25-0.5
Monitoring for suppression	RS,YP,RB	AC/AA	2-4	1-2	0.25-0.5	0.25-0.5
Delimiting survey in FF-ALPP after unexpected detection(s)	RS,YP,RB	AC/AA	3-5	3-5	3-5	3-5
Monitoring for eradication	RS,YP,RB	AC/AA	3-5	3-5	3-5	3-5
Detection survey in FF-PFA to verify pest absence and for exclusion	RS,YP,RB	AC/AA	1	0.4-3	3-5	3-5
Delimitation survey in a PFA after a detection in addition to detection	RS,YP,RB	AC/AA	20-304	20-50	20-50	20-50

survey							

1. Different traps can be combined to reach the total number
2. Refers to the total number of traps
3. Also other high-risk sites
4. This range includes high-density trapping in the immediate area of detection (core area). However, it may decrease towards the surrounding trapping zones.

Trap type		**Lure**	
YP	Yellow panel	AA	Ammonium acetate
RB	Rebell trap	AC	Ammonium carbonate
RS	Red sphere trap (Fig. 10A)		

The western cherry fruit fly is difficult to monitor, as it is not strongly attracted to traps. The above can be used as general guidelines, even though there are no adequate data at this time to support them, and cherry fruit fly may be found where there are unmanaged cherry and other host trees.

Detection of adult WCFF on the trap does not necessarily mean the host tree fruit is infested. Further inspection of the fruit by cutting, along with fruit collection and larval rearing should be conducted to determine if WCFF has established at that site.

References

ISPM 26. 2006. *Establishment of pest free areas for fruit flies (Tephritidae*). Rome, IPPC, FAO.

Tree Fruit Research and Extension Center (TFREC) 2014. Orchard Pest Management Online. http://jenny.tfrec.wsu.edu/opm/displaySpecies.php?pn=150

Yee, W.L., V. Hernández-Ortiz, J. Rull, B.J. Sinclair and Neven, L.G. 2014. Status of *Rhagoletis* (Diptera: Tephritidae) pests in the NAPPO countries. Journal of Economic Entomology 107(1): 11-28.

24. *Rhagoletis mendax* (Curran) Blueberry Maggot (Diptera: Tephritidae)

Pest Information

Order: Diptera
Family: Tephritidae
Genus: *Rhagoletis*
Species: *mendax*
Common name: blueberry maggot
Commodities surveyed: wild and cultivated blueberries

The blueberry maggot is native to North America. It is found in all eastern US blueberry production regions. In addition to highbush and low bush blueberries, the insect will infest huckleberry (*Gaylussacia)* and deerberry (*Vaccinium stamineum*). The blueberry maggot is a member of the *pomonella* species group within the genus *Rhagoletis* that also includes *pomonella, zephyria* and *cornivora*. It is univoltine and overwinters as a pupa in the soil. A portion of the population overwinters for 2 or 3 years. Adults can emerge from the soil over a period of 3 or more months. In areas where blueberry maggot is established, the pest is managed with sprays of insecticides targeted to the first emerging adult flies.

General Trap and Lure Information

Trap design (type). Use a yellow panel trap (YP) (Fig. 6) consisting of a 23cm x 14cm rectangle cardboard panel covered on both sides with a thin layer of sticky material. Trap must be baited with hydrolyzed protein or an ammonia compound. A green or red sphere trap (GS, RS) (Fig. 10) can also be used for monitoring. Spheres should be 8-9 cm in diameter and covered with a sticky material . Ammonia baits should be used to increase effectiveness of the sphere traps.

Lure. Traps can be baited with lures containing ammonium carbonate, ammonium acetate, or pre-baited with protein hydrolysate.

Lure Type, Replacement Interval and Trap Servicing

Attractant replacement interval depends on the lure type and load. Traps pre-baited with protein hydrolysate may need to be changed bi-weekly or when the sticky material is no longer useful due to excessive amount of insect debris or dust. Other attractants generally last three or more weeks depending on the loading rate. Because sphere and yellow panel traps capture many kinds of non-target insects they need to be inspected and cleaned regularly and should be inspected weekly, if possible. Traps should be checked more often if in windy or dusty areas to facilitate detection of flies before too much debris accumulates. Most traps will require replacement after 3-4 weeks. Sphere traps will need to have the adhesive renewed every 4 weeks or more often if they lose their tackiness.

Trap Placement, Location in Production Areas and Densities

Traps should be placed in the upper half of the canopy, halfway between the center and edge of the plant. Good results have also been achieved by suspending traps at the very top of the blueberry plants or even 10 to 15 cm (4 to 6 inches) above the tips of fruiting blueberry plants. Remove foliage from around the trap for 20 to 30 cm (8 to 12 inches) to make it more visible to the blueberry maggot flies. Secure the traps tightly to branches so they do not swing in the wind.

Unlike pheromone traps, which attract moths from a considerable distance, blueberry maggot traps are effective over fairly short distances. Deploy two traps in fields under 2 ha. In larger fields, the distance between trap sets should be 60-100 meters along the field perimeters, which works out to one trap/1.5-2.0 ha. The more traps deployed the greater the reliability of the information gathered. Traps placed along the perimeter, facing out of the field are most effective since most flies captured in commercial orchards will be immigrants from adjacent areas. Use a higher trap density on sides of the orchard nearest suspected sources of flies. Place the traps 6-8 meters, or a few rows, into the field.

Suggested Trapping Guidelines for delimiting surveys, for monitoring and for detection are summarized in Table 4 below. The suggested guidelines cover trap locations/purpose, trap densities, lure/attractant types and other information.

Table 4. Suggested trapping guidelines for *Rhagoletis mendax*

Trapping purpose/Location	Trap type[1]	Lure	Trap density/km^2 (2)			
			Production area	**Marginal**	**Urban**	**Points of entry[3]**
Monitoring survey, no control	GS,RS,YP	PH/AC/AA	0.5-1.0	0.2-0.5	0.25-0.5	0.25-0.5
Monitoring for suppression	GS,RS,YP	PH /AC/AA	2-4	1-2	0.25-0.5	0.25-0.5
Delimiting survey in FF-ALPP after unexpected detection(s)	GS,RS,YP	PH /AC/AA	3-5	3-5	3-5	3-5
Monitoring for eradication	GS,RS,YP	PH /AC/AA	3-5	3-5	3-5	3-5
Detection survey in FF-PFA to verify pest absence and for exclusion	GS,RS,YP	PH /AC/AA	1	0.4-3	3-5	3-5
Delimitation survey in a PFA after a detection in addition to detection survey	GS,RS,YP	PH /AC/AA	20-304	20-50	20-50	20-50

1 Different traps can be combined to reach the total number
2 Refers to the total number of traps
3 Also other high-risk sites
4 This range includes high-density trapping in the immediate area of detection (core area). However, it may decrease towards the surrounding trapping zones.

Trap type		Lure	
YP	Yellow panel	AA	Ammonium acetate
GS	Green sphere trap	AC	Ammonium carbonate
RS	Red sphere trap (Fig. 10A)	PH	Protein hydrolysate (Pre-baited YP)

Detection of adult blueberry maggot flies on the trap does not necessarily mean the host crop is infested. Further inspection of the fruit by cutting, along with fruit collection and larval rearing, should be conducted to determine if a population has established at that site.

References

Government of New Brunswick Canada (GNB). 2014. Blueberry Fruit fly: *Rhagoletis mendax* Curren. http://www.gnb.ca/0171/10/c230e.pdf

University of Maine Cooperative Extension. 2014. Insects - 201-Monitoring for the Blueberry Maggot (*Rhagoletis mendax* Curran). http://umaine.edu/blueberries/factsheets/insects/201-monitoring-for-the-blueberry-maggot/

Virginia Tech-Virginia Fruit Page. Blueberry Maggot. 2014. http://www.virginiafruit.ento.vt.edu/BlueberryMaggot.html

25. *Rhagoletis pomonella* (Walsh) Apple Maggot (Diptera: Tephritidae)

Pest Information

Order: Diptera
Family: Tephritidae
Genus: *Rhagoletis*
Species: *pomonella*
Common Name: apple maggot
Commodities Surveyed: apple, all varieties

The apple maggot is native to eastern North America and found in all three NAPPO countries. Populations in Mexico may also be native. Populations in the western United States are almost certainly introduced, likely from the eastern United States (Yee et al. 2014). Apple maggot flies can migrate into previously un-infested trees from unsprayed or abandoned host trees somewhere in the vicinity. Non-commercial host trees can include: feral or residential apple, crabapple, ornamental hawthorn, native hawthorn and possibly other fruit trees such as pear and apricot depending on geographic location. In areas where apple maggot is established, the pest is often managed with sprays of insecticides targeted to the first emerging adult flies.

General Trap and Lure Information

Trap design (type). A red sphere trap (RS) (Fig. 10A) may be used. The 8 cm diameter red sphere trap mimics the size and shape of a ripe apple. The trap is covered with a sticky material and baited with a synthetic fruit odor and/or an ammonium based feeding attractant (see Lure below). Attached to the top of the sphere is a wire hanger used to hang the trap from apple tree branches.

A yellow panel (YP) (Fig. 6) trap may also be used and should consist of a 23cm x 14cm rectangle cardboard panel covered on both sides with a thin layer of sticky material. A three-dimensional YP-type trap with two crossed yellow panels (Rebell trap, RB) (Fig. 8) may also be used. More detailed descriptions and images of these traps can be found in Annex 1 of ISPM 26: 2006.

Lure. Traps can be baited with lures containing 5 component apple volatile or ammonium carbonate or ammonium acetate. Do not use both types on the same trap.

Lure Type, Replacement Interval and Trap Servicing

Lure replacement interval depends on the lure type and load. Most attractants last from 4 to 12 weeks. Monitoring of traps should be once a week or bi-weekly depending on conditions. Traps should be checked more often if in windy or dusty areas to assure that suspect flies can be observed on the traps before too much debris accumulates. Most traps will require replacement after four weeks.

Unlike pheromone traps, which attract moths from several yards, an apple maggot trap is effective only over short distances, generally the tree in which it is located. Because both red sphere and yellow panel traps baited with ammonium carbonate capture many kinds of insects, they need to be inspected and cleaned regularly.

Trap Placement, Location in Production Areas and Densities

Place traps within the fruiting canopy of the tree, positioned so that the broad surface is exposed to the foliage and fruit. Remove foliage from around the trap for 30 to 45 cm (12 to 18 inches) to make it more visible to the apple maggot flies. Secure the traps tightly to branches so they do not swing in the wind. Commercially available pre-baited apple maggot traps with ammonium acetate should be changed every 7 days. Yellow panel traps using ammonium carbonate as a lure can be changed every 14 to 21 days, depending on how long the lure lasts (how much ammonium carbonate is used) and how contaminated the trap's surface becomes. Red sphere traps should be replaced or have the adhesive renewed every 4 weeks or more often if they lose their tackiness. If monitoring the production site (orchard), the distance between trap sets should be 60-100 meters along the orchard borders. Traps placed in the border row, facing out of the orchard are most effective since most flies captured in commercial orchards will be immigrants from adjacent unsprayed residential or wild host trees. Where the orchard borders a dusty road or field, place the traps one or two rows into the orchard. Use a higher trap density on sides of the orchard nearest suspected sources of flies. Place the traps within the tree canopy as in non-orchard situations.

Suggested trapping guidelines for delimiting surveys, monitoring and detection are summarized in Table 5 below. The suggested guidelines cover trap locations/purpose, trap densities, lure/attractant types and other information.

Detection of adult apple maggot flies on the trap does not necessarily mean the host tree fruit is infested. Further inspection of the fruit by cutting, along with fruit collection and larval rearing, should be conducted to determine if apple maggot has established at that site.

Table 5. Suggested trapping guidelines for *Rhagoletis pomonella*

Trapping purpose/Location	Trap type[1]	Lure	Trap density/km² (2)			
			Production area	Marginal	Urban	Points of entry[3]
Monitoring survey, no control	RS,YP,RB	CB/AC/AA	0.5-1.0	0.2-0.5	0.25-0.5	0.25-0.5
Monitoring for suppression	RS,YP,RB	CB/AC/AA	2-4	1-2	0.25-0.5	0.25-0.5
Delimiting survey in FF-ALPP after unexpected detection(s)	RS,YP,RB	CB/AC/AA	3-5	3-5	3-5	3-5
Monitoring for eradication	RS,YP,RB	CB/AC/AA	3-5	3-5	3-5	3-5
Detection survey in FF-PFA to verify pest absence and for exclusion	RS,YP,RB	CB/AC/AA	1	0.4-3	3-5	3-5
Delimitation survey in a PFA after a detection in addition to detection survey	RS,YP,RB	CB/AC/AA	20-304	20-50	20-50	20-50

1. Different traps can be combined to reach the total number
2. Refers to the total number of traps
3. Also other high-risk sites
4. This range includes high-density trapping in the immediate area of detection (core area). However, it may decrease towards the surrounding trapping zones.

Trap type **Lure**

Trap type		Lure	
YP	Yellow panel	AA	Ammonium acetate
RB	Rebel trap	AC	Ammonium carbonate
RS	Red sphere trap	CB	5-component blend of apple volatiles*

* This blend works best in apple trees, less so in hawthorn trees, depending on area.

References

ISPM 26. 2006. *Establishment of pest free areas for fruit flies (Tephritidae*). Rome, IPPC, FAO.

Tree Fruit Research and Extension Center (TFREC) 2014. Orchard Pest Management Online. http://jenny.tfrec.wsu.edu/opm/displaySpecies.php?pn=140

Yee, W.L., V. Hernández-Ortiz, J. Rull, B.J. Sinclair and Neven, L.G. 2014. Status of *Rhagoletis* (Diptera: Tephritidae) pests in the NAPPO countries. Journal of Economic Entomology 107(1): 11-28.

26. *Spilonota ocellana* (Denis and Schiffermuller) Eye-spotted Bud Moth (Lepidoptera, Tortricidae)

Pest Information

Order: Lepidoptera
Family: Tortricidae
Genus: *Spilonota*
Species: *ocellana*
Common name: eye-spotted bud moth
Commodities surveyed: apple, cherry and blueberry

The eye-spotted bud moth was first reported in North America in the 1800's. It was introduced from Europe. The eye-spotted bud moth is primarily a pest of apples, cherries and blueberries. Larvae feed on leaves and fruit, with the latter resulting in the majority of economic damage. It is most often found in feral plantings or where there are minimal insecticide inputs. Larvae spend the winter in a cocoon on the bark in the crotches of small-diameter limbs. They become active around budbreak and feed on leaves and buds, webbing together leaves and feeding within these nests. After feeding they pupate within the nest and adult moths emerge in early to mid-summer. Eggs are laid on the lower surface of leaves. The larvae emerge and feed on the lower leaf surface until early August, at which time they construct their overwintering cocoons (hibernacula).

General Trap and Lure Information

Trap design (type). Wing-type (Fig. 14) or delta (Fig. 2) shaped traps should be used for trapping eye-spotted bud moth.

Lure. Pheromone-baited trapping is the most effective monitoring technique for eye-spotted bud moth. The sex pheromone of eye-spotted bud moth is a 99:1 blend of (Z)-8-Tetradecenyl acetate and (Z)-8- Tetradecen-1-ol.

Lure Type, Replacement Interval and Trap Servicing

The most commonly used traps for eye-spotted bud moth are the wing or delta traps. There are several lures to choose from, however the most commonly used lure is the red septum. A red septum loaded with the two-component pheromone blend described above has been the standard for monitoring eye-spotted bud moth and will last for the entire flight. Lures should not be handled with bare hands. Gloves, sticks, or an instrument (with acetone dip) can be used, but whatever tool is chosen, pheromone cross-contamination when working with lures for different moth species must be avoided. Lure packaging must be removed from the orchard. When trapping for more than one species, do not place more than one lure in a single trap and separate traps by at least 20 meters.

Trap Placement, Location in Production Areas and Densities

Traps for monitoring. Trap placement is a critical factor for optimizing trap performance. The key decisions are 1) how many traps to deploy, 2) where to place them in the orchard, and 3) location of the trap within the tree. Deploy at least 1 trap per 2 ha to monitor for eye-spotted bud moth. The key considerations for effective trap placement within a block are 1) historical “hot spots”, and 2) location relative to block perimeter. An area where moth catches from previous seasons were high, or a “hot spot”, is a good place to locate a trap. Avoid placing traps on the perimeter row. Instead place traps within the interior of the orchard block. The location of the trap within the tree is the third critical factor. A trap needs to be located where moth activity is greatest and placed in a way that allows moths easy access to the trap. Eye-spotted bud moth traps should be placed in the middle third of the canopy.

Traps for detection. The purpose of the detection survey is to determine whether a pest is present in a specified area. Place pheromone-baited traps in high-risk areas where eye-spotted bud moth is more likely to be found. A single trap will survey 1-2 ha. Establish regular sites for trapping along a survey route.

Traps for delimiting survey. Once a new detection is made, delimiting surveys will be conducted to determine the distribution of the pest. Surveys should be most intensive around the known positive detections. Set 60-90 traps per square kilometer in the core area. Set 60-90 traps per square kilometer in 20 square kilometers around the core area.

References

Mayer, M.S. and J.R. McLaughlin. 1991. Handbook of insect pheromones and sex attractants. CRC Press, University of Minnesota, 1083 pp.

Tree Fruit Research and Extension Center (TFREC) 2014. Orchard Pest Management Online. http://jenny.tfrec.wsu.edu/opm/displaySpecies.php?pn=40

27. *Spodoptera littoralis* (Boisduval) Egyptian Cotton Leafworm (Lepidoptera, Noctuidae)

Pest Information

Order: Lepidoptera
Family: Noctuidae
Genus: *Spodoptera*
Species: *littoralis*
Common name: Egyptian cotton leafworm, Egyptian cotton worm
Commodities surveyed: corn (*Zea mays*), alfalfa (*Medicago sativa*), tomato (*Solanum lycopersicum)*, cotton (*Gosssypium barbadense*), bean (*Phaseolus vulgaris*), cauliflower (*Brassica oleracea*), Brussels sprout (*Brassica oleracea gemmifera*), eggplant (*Solanum melongena*), potato (*Solanum tuberosum*), melon (*Cucumis melo*), among others.

The Egyptian cotton leafworm is an insect that can be found attacking the above mentioned crops and other type of horticultural crops in the Mediterranean, countries in northern Africa and Asia. Females can produce over 1000 eggs, which are deposited on the underside of the leaves, making clusters of 200 to 500 eggs. These eggs are covered with scales from the abdomen of the female moth, which help protect the eggs (Cabello et al. 1984, Amate et al. 2000). This insect has nocturnal habits. Damage in crops is caused by larvae that eat the leaves (and sometimes flowers or fruits). When the number is high, they move on to a new plant to feed on. When the larva reaches maturity, it burrows a few centimetres into the soil and builds a cell in which it pupates. This stage lasts approximately 15 days. The adult then emerges to give origin to a new generation. The adult's longevity depends on climatic conditions and may vary from 2-6 weeks, reaching up to 6 generations annually (Cabello et al. 1984, Amate et al. 2000). Tolerance threshold is very low and generally is 3 males of *S. littoralis* /trap/week, which indicates it is time to initiate mass-trapping to control the moth. Adults can fly up to 1.5 km in a 4-hour period at night, making easier the spread and oviposition in several hosts (Salama and Shoukry 1972).

General Trap and Lure Information

Trap design (type). One of the most common traps for *S. littoralis* is the plastic bucket trap. It could be completely green or other colour, where the upper part is green and the lower part is white or yellow (Fig. 1). CAPS (2014) recommend the use of the tri-color plastic bucket trap (Fig. 1A) (green canopy, yellow funnel, and white bucket) (http://caps.ceris.purdue.edu/webfm_send/398.) For pest monitoring, 1-2 traps per hectare are recommended; and for mass trapping 20 traps per ha are recommended.

A DDVP strip is placed inside the trap to kill trapped insects, although sometimes soapy water can be added. Some companies use their own names for these traps. Water trap and funnel trap (Kehat and Dunkelblum 2005) have been successfully used in Israel for *S. littoralis.* According to testing done in that country, the dry trap was more efficient than water trap (Kehat and Greenberg 1978). Additional information can be found in Sullivan (2007).

The delta trap is the most common for monitoring moths (Fig. 2), although it can also be used for other insects.

Lure. There are several reports on the identification of sex pheromone for *Spodoptera littoralis* (Nesbitt et al. 1973, Dunkelblum et al. 1982, Tamaki and Yushima 1974), and they suggest that more than one race may exist for this species, due to variation in pheromone composition. However, in field testing done in Israel it was found out that the pheromone is composed of (Z,E)-9,11-tetradecadienyl acetate as the main component and (Z,E)-9-12-tetradecadienyl acetate as the minor component (Kehat and Dunkelblum 2005).

Lure Type, Replacement Interval and Trap Servicing

A mix of both pheromones described above is loaded in rubber septa (Fig. 15), or a laminate septa, which must be placed in the trap. A septum must be placed for each trap. Delta traps containing the synthetic sex pheromone remain attractive for approximately 2 weeks, and should be replaced every 2 weeks. Laminate septa can last for 12 weeks (Sullivan 2007).
(http://www.aphis.usda.gov/import_export/plants/manuals/emergency/downloads/nprg_spodoptera.pdf).

Trap Placement, Location in Production Areas and Densities

Traps are placed on wooden stakes, at 1.5 m height and are spread around the crop. Trap servicing can be done every three days or each week; usually, septa are loaded with an amount of pheromone that allows changing the septa each month depending on environmental conditions. Monitoring of this pest must start the first week after planting.

Traps for monitoring. For monitoring, traps should be placed at 3 to 4 traps per hectare. Traps should be placed over the crop to allow for optimal ventilation and moved as the crop grows higher during the season. Traps should be monitored on a regular basis and the lure replaced every 6 weeks (Sullivan 2007).

Additional information. Traps should be properly labelled with a permanent numbering regardless of the place where they are found, which should correlate to the number of active traps. When a moth is trapped, a picture should be taken of it before it loses certain morphological characteristics important for its identification.

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28. *Synanthedon exitiosa* (Say) Peachtree Borer (Lepidoptera: Tortricidae)

Pest Information

Order: Lepidoptera
Family: Tortricidae
Genus: *Synanthedon*
Species: *exitiosa*
Common name: peachtree borer
Commodities surveyed: stone fruits – peach, cherry, plum, nectarine, apricot and a variety of ornamental and nursery plants in the genus *Prunus*

The peachtree borer is native to eastern North America and is present wherever host plants grow. It occurs mainly east of the Rocky Mountains. The adult peachtree borer is a clear wing moth with a 1-1/4 wing span. Larvae tunneling into roots and the lower trunk and feeding on the growing tissue cause damage that reduces yield, and can lead to tree death. The peachtree borer overwinters in the larval stage in woody tissues. One generation is produced each year.

General Trap and Lure Information

Trap design (type). Wing-type (Fig. 14), delta (Fig. 2) or diamond (Fig. 3) shaped traps can be used for trapping peachtree borer moths. The bottom, and sometimes sides, of these traps are covered with a sticky material to ensnare moths that enter the trap.

Lure. Pheromone-baited trapping is the most effective monitoring technique for peachtree borer. Peachtree borer males are monitored using lures loaded with a 98:2 blend of (Z, Z) and of (E, Z)-3,13-octadecadienyl acetates.

Lure Type, Replacement Interval and Trap Servicing

There are many lures to choose from. The most commonly used lure is the red septum. A red septum loaded with the two-component pheromone blend described above has been the standard for monitoring peachtree borer. Since the pheromone is not species specific, examine trapped moths carefully as other clearwing moths are attracted to the pheromone components. Lure replacement interval depends on the lure type. It is recommended to replace lures monthly or at the start of each new flight period is a good practice. Lures should not be handled with bare hands. Gloves, sticks, or an instrument (with acetone dip) can be used, but whatever tool is chosen, pheromone cross-contamination when working with lures for different moth species must be avoided. Spent lures as well as new lure packaging must be removed from the orchard. When trapping for more than one species, do not place more than one lure in a single trap and separate traps by at least 20 meters.

Trap Placement, Location in Production Areas and Densities

Traps for monitoring. Trap placement is a critical factor for optimizing trap performance. The key decisions are 1) how many traps to deploy and 2) where to place them in the vineyard. Deploy at least 1 trap per 3 ha to monitor for peachtree borer. An area where moth catches from previous seasons were high, or a "hot spot", is a good place to locate a trap. Traps should be hung from lower tree limbs, preferably no higher than 1-1.3 meters and placed at least 30 meters apart within the interior of the orchard.

Traps for detection. The purpose of the detection survey is to determine whether a pest is present in a specified area. Place pheromone-baited traps in high-risk areas where peachtree borer is more likely to be found. A single trap will survey 2-3 ha. Establish regular sites for trapping along a survey route.

Traps for delimiting survey. Once a new detection is made, delimiting surveys will be conducted to determine the distribution of the pest. Surveys should be most intensive around the known positive detections. Set 25-35 traps per square kilometer in the core area.

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Tree Fruit Research and Extension Center (TFREC) 2014. Orchard Pest Management Online. http://jenny.tfrec.wsu.edu/opm/displaySpecies.php?pn=560

29. *Thaumatotibia leucotreta (Meyrick*) False Codling Moth (Lepidoptera, Noctuidae)

Pest Information

Order: Lepidoptera
Family: Noctuidae
Genus: *Thaumatotibia*
Species: *leucotreta*
Synonyms: Genera – *Cryptophlebia*
Common name: False Codling Moth
Commodities surveyed: Citrus, stone fruit, corn, avocadoes, cotton, and various other agricultural crops.

The false codling moth (FCM) is native to Ethiopia, and is now found in most sub-Saharan Africa Countries. Although stone fruits, citrus, corn, and cotton are significant economic hosts, it also feeds upon a wide range of other economic and native plants. The FCM life cycle can take from 30 to over 170 days. From 2 to 10 generations per year are possible, depending on temperature, food availability and quality, photoperiod, humidity, latitude, and diseases. With suitable climate and uninterrupted food supply, FCM is active throughout the year. Eggs are deposited singly or in bunches on host fruit and hatch after 2 to 22 days depending on temperature. Larvae feed in the rind or below the skin of most host fruits, but also feed internally on developing seeds and pulp of some hosts. Larval development consists of 5 instars, and can take from 12 to over 60 days to develop before exiting fruit and dropping to the ground on silk threads. Pupal development includes a pre-pupa stage, lasting from 2 to 27 days, and pupa, which can last up to 60 days. Pupation generally occurs on or in the ground, but can also occur in bark crevices, dropped fruit, or debris. Adults are small greyish moths with an average wingspan of 16 mm and are active only at night, with males living up to 57 days and females up to 70 days. The lower developmental threshold is 12°C and the upper developmental threshold is 40°C. Temperatures below 0 to 10°C are considered lethal to most life stages (Daiber 1979a,b,c, 1980)

General Information on Traps and Lures

Pheromone-baited trapping is an effective method for detecting FCM.

Trap design (type). The following types of pheromone traps can be used: Wing-type (Fig. 14), delta (Fig. 2) or diamond (Fig. 3) shaped traps can be used for trapping adult male FCM adult.

Lure. The pheromone lure for male FCM is a mixture of (Z) and (E)-8-dodecenyl acetate, with recommended ratios of either 50:50 or 66:75.
http://www.pherobase.com/database/species/species-Cryptophlebia-leucotreta.php.
Sullivan (2007) indicates that a 90:10 ratio of_(E)-8-Dodecenyl acetate and (Z)-8-Dodecenyl acetate is most effective. Blends will differ depending on the manufacturer and the region.

Lure Type, Replacement Interval and Trap Servicing

Lure replacement interval depends on the lure type and load - check with lure source for active period. Most lures last from 3 - 4 weeks, with some (Sullivan 2007) lasting up to 8 weeks, and lures should not be handled with bare hands. Monitoring of traps should be at least every one to three weeks, depending on conditions.

Suggested trap servicing intervals are:
Change pheromone lures every 3-4 weeks, or up to 8 weeks (Sullivan 2007),and change traps, inserts, or bottoms after catching multiple (non-target) moths or after dust and debris have collected on the sticky surface. Traps should be checked more often if in windy or dusty areas to assure that suspect moths can be observed on the traps before too much debris accumulates.

Trap Placement, Location in Production Areas and Densities

Traps for monitoring. Traps should be put in host trees at ca. 1.5 m in height or higher, and on stakes in row crops.

Traps for detection. The purpose of the detection survey is to determine whether a pest is present in a specified area. Place pheromone-baited traps in high-risk areas where False Codling Moth is more likely to be found. A single trap will survey 4-6 ha. Establish regular sites for trapping along a survey route.

Traps for delimiting survey. Once a new detection is made, delimiting surveys will be conducted to determine the distribution of the pest. False Codling Moth primarily remains close to where they emerge, but individuals have been reported to disperse up to 2km (Stotter 2009). Surveys should be most intensive around the known positive detections. Set 20-30 traps per square kilometer in the core area. Set 20-30 traps per square kilometer in 20 square kilometers around the core area.

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30. Fruit Flies (Diptera: Tephritidae)

Pest Information

Order: Diptera
Family: Tephritidae
Genus: See Table 6.
Species: See Table 6.
Common name: Fruit flies (various)
Commodities surveyed: See Table 6.

Table 6. Tephritid species of quarantine importance in the NAPPO region

Order	Scientific name	Common name	Completed	Referencia
Diptera	*Bactrocera caramboleae*	Carambola fruit fly	ISPM 26	Fruit-Fly-ISPM-26
Diptera	*Bactrocera cucurbitae*	Melon fruit fly	ISPM 26	Fruit-Fly-ISPM-26
Diptera	*Bactrocera dorsalis*	Oriental fruit fly	ISPM 26	Fruit-Fly-ISPM-26
Diptera	*Bactrocera latifrons*	Malaysian fruit fly	ISPM 26	Fruit-Fly-ISPM-26
Diptera	*Bactrocera raminax*	Chinese fruit fly	ISPM 26	Fruit-Fly-ISPM-26
Diptera	*Bactrocera museae*	Banana fruit fly	ISPM 26	Fruit-Fly-ISPM-26
Diptera	*Bactrocera oleae*	Olive fruit fly	ISPM 26	Fruit-Fly-ISPM-26
Diptera	*Bactrocera passifloreae*	Fijian fruit fly	ISPM 26	Fruit-Fly-ISPM-26
Diptera	*Bactrocera pedestris*	No common name	ISPM 26	Fruit-Fly-ISPM-26
Diptera	*Bactrocera psidi*	South Sea guava fruit fly	ISPM 26	Fruit-Fly-ISPM-26
Diptera	*Bactrocera tryoni*	Queensland fruit fly	ISPM 26	Fruit-Fly-ISPM-26
Diptera	*Bactrocera zonata*	Peach fruit fly	ISPM 26	Fruit-Fly-ISPM-26
Diptera	*Bactrocera tsuneonis*	Japanese fruit fly	ISPM 26	Fruit-Fly-ISPM-26
Diptera	*Ceratitis capitata*	Mediterranean fruit fly	ISPM 26	Fruit-Fly-ISPM-26

For details on the fruit fly species listed in Table 6, please see:

ISPM 26. 2006*. Establishment of pest free areas for fruit flies (Tephritidae*). Rome, IPPC, FAO. Appendix 1: Fruit fly trapping.
https://www.ippc.int/search/node/ISPM%2026

III. Figures of Traps

Figure 1. Bucket traps. A) Plastic bucket trap cut in half to show its interior. (Source: https://caps.ceris.purdue.edu/webfm_send/398). 1B) Green plastic bucket trap.

Figure 2. Delta trap (Sources: Chemtica 2013 (A); Velázquez-González 2013 (B & C)).

Figure 3. Diamond trap (Source: http://www.chemtica.com/site/?p=2098)

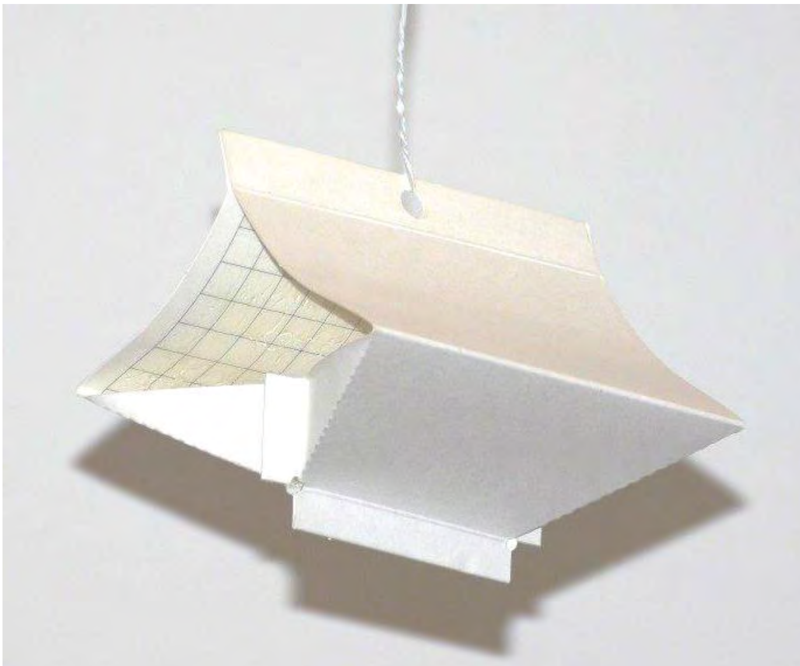

Figure 4. Jackson trap (Source: Scentry Biologicals, Inc. 2006).

Figure 5. Juice bottle trap.

Figure 6. Panel traps. A) Placement of yellow panel trap in tree canopy.B) Apple Maggot trap (Yellow panel trap) (Minnesota State Dept. Ag.) http://www.mda.state.mn.us/news/publications/pestsplants/pestmanagement/ipm/ipmapplemanual.pdf

Figure 7. Pyramid trap (Source: Minnesota State Dept. Ag.). http://www.mda.state.mn.us/news/publications/pestsplants/pestmanagement/ipm/ipmapplemanual.pdf

Figure 8. Rebell trap (Source: http://www.novagrica.com/product/rebell-trap/)

Figure 9. Scentry trap for *Heliothis.*

Figure 10. Sphere traps. A) Red sphere trap (Minnesota State Dept. Ag. http://www.mda.state.mn.us/news/publications/pestsplants/pestmanagement/ipm/ipmapplemanual.pdf). B) Green sticky sphere for monitoring walnut husk fly (Source: R. Van Steenwyk). (http://jenny.tfrec.wsu.edu/opm/displaySpecies.php?pn=160)

Figure 11. Unitraps for mass capture of moths (Source: Pherobank 2012).

Figure 12. UV light traps (Source: Ferguson D. 2007).

Figure 13. Water traps (Source: Chemtica 2013).

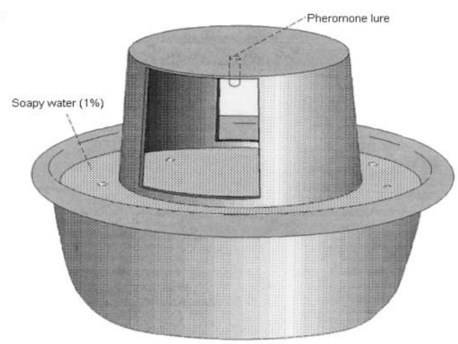

Figure 14. Wing trap

Figure 14. Rubber septum typically used to dispense attractants