United States Department of Agriculture
Agricultural Marketing Service | National Organic Program
Document Cover Sheet
https://www.ams.usda.gov/rules-regulations/organic/national-list/petitioned

Document Type:

☒ **National List Petition or Petition Update**

A petition is a request to amend the USDA National Organic Program's National List of Allowed and Prohibited Substances (National List).

Any person may submit a petition to have a substance evaluated by the National Organic Standards Board (7 CFR 205.607(a)).

Guidelines for submitting a petition are available in the NOP Handbook as NOP 3011, National List Petition Guidelines.

Petitions are posted for the public on the NOP website for Petitioned Substances.

☐ **Technical Report**

A technical report is developed in response to a petition to amend the National List. Reports are also developed to assist in the review of substances that are already on the National List.

Technical reports are completed by third-party contractors and are available to the public on the NOP website for Petitioned Substances.

Contractor names and dates completed are available in the report.

Insect Monitoring Systems and Pheromones
P.O. Box 129 Adair, OK 74330
(918) 785-3061

National List Manager
USDA/AMS/NOP,
Standards Division
1400 Independence Ave.
SW Room 2648-So., Ag Stop 0268
Washington, DC 20250-0268

Please find attached a petition to have 2,4-decadienoic acid, ethyl ester, (E,Z) added to §205.601 of the National List, a synthetic substance for use in monitoring, mating disruption products and control products. Pear ester is currently not on the National List because it is considered a kairomone and does not meet the qualifications of a pheromone. Kairomones are semiochemicals from organisms and plants that give insects key indications that assist in the decision of determining whether or not there is a suitable host plant.

This synthetic substance is identical to the natural substance that you would find in pears and other fruit that contain pear ester (DA). It is the natural and key defining odorant - flavourant of pears. Pear ester is a completely natural plant odor compound, being nontoxic, GRAS recognized, and an FDA approved food, confection, liquor – seltzer and cosmetic additive for over 40+ years.

DA has been proven to disrupt male codling moth and female codling moth as well as codling moth larvae. By having DA available in mating disruption products versus pheromone alone, growers and pest control advisors (PCAs) have the ability to further reduce crop damage. When orchards are under codling moth pheromone alone mating disruption it is impossible to track the flight phenology of codling moth as the monitoring traps containing pheromone alone will have zero catches. With the addition of DA to insect monitoring lures the growers and PCAs will be able to track flight phenology and apply pesticides at the correct timing which is essential for crop protection.

In this petition we present the necessary information for considering 2,4-decadienoic acid, ethyl ester, (E,Z) to be placed on the national list. We request that DA be placed on the national list so that organic growers can continue to have a vital and essential tool for their codling moth management.

Respectfully,

Valerie McKinney
Field Development Coordinator & Regulatory Affairs Specialist
Trécé, Inc.
7569 Highway 28 West
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Petition Prepared By:
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Item A.1 – Indicate which section or sections the petitioned substance will be included on and/or removed from the National List.

This petition seeks to add Ethyl-2E,4Z-Decadienoate or Pear Ester (names used interchangeably) to 7 CFR§205.601(j)(4) as a synthetic substance allowed for use in organic crop production as a pesticide.

Item A.2 – OFPA Category - Crop and Livestock Materials:

This petition applies to the OFPA category of pheromones.

Item B –
Provide concise and comprehensive responses in providing all of the following information on the substance being petitioned. For petitions to add or change an annotation for a substance that is already on the National List, items 5-11 are optional. Petitioners are encouraged to address these items if the information has changed since the NOSB's original review of the substance.

1. Substance Name:
Provide the substance's chemical and/or material common name. The name of the petitioned substance should be consistent with any name(s) used by other Federal agencies (e.g., FDA, EPA, etc.)

The substance name is Ethyl-2E,4Z-Decadienoate also commonly known as Pear Ester.

Petitioner and Manufacturer Information:
2. Provide the name, address, and telephone number for the petitioner and manufacturer (if different).

Petitioner:
Trece, Inc.
P.O. BOX 128
Adair, OK 74330
(918) 785-3061

Petition prepared by:
Victoria Smith – Regulatory Associate I
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3. Intended or Current Use:
Describe the intended or current use of the substance, e.g., use as a pesticide, animal feed additive, processing aid, non-agricultural ingredient, sanitizer, or disinfectant. If the substance is an agricultural ingredient, the petition must provide a list of the types of product(s) (e.g., cereals, salad dressings) for which the substance will be used and a description of the substance's function in the product(s) (e.g., ingredient, flavoring agent, emulsifier, processing aid).

The intention and current use is to use pear ester as a pesticide to disrupt the mating behavior of Lepidoptera species. It is approved for use on all food and non-food crops by the United States Environmental Protection Agency.

4. Intended Activities and Application Rate:
Provide a list of the crop, livestock, or handling activities for which the substance will be used. If used for crops or livestock, the substance's rate and method of application must be described.

Pear Ester is currently approved for use on all food and non-food crops by the United States Environmental Protection Agency and used in formulated and technical products. Application methods include full coverage

spray and aerosolized release from an impregnated dispenser. Application rates are summarized in Table 1.

Table 1 below identifies the crops currently listed on EPA Approved product labels and the respective application method and rate associated with each product.

Product	Uses	Application Method	Application Rate
Bedoukian Pear Ester Technical (EPA Reg. No. 52991-27)	Pre-harvest application for all food and non-food crops	For Manufacturing or Formulating Use Only	See End-Use Product Label
CIDETRAK® DA MEC (EPA Reg. No. 51934-12)	Apple, Pear, Walnut, Pecan, Quince, and other pome fruits	Full Coverage Spray	0.41-2.37 Fl. Oz./Acre 1.01-5.92 Fl. Oz./Hectare
CIDETRAK® CMDA 90/60 (EPA Reg. No. 51934-13)	Apple, Pear, Walnut, Pecan, Quince, and other pome fruits	Impregnated Dispenser	Maximum Rate of 150 g combined a.i./acre per year
CIDETRAK® CMDA 75/45 (EPA Reg. No. 51934-16)	Apple, Pear, Walnut, Pecan, Quince, and other pome fruits	Impregnated Dispenser	Maximum Rate of 150 g combined a.i./acre per year
CIDETRAK® CMDA + NOW MESO (EPA Reg. No. 51934-17)	Almond, Fig, Pistachio, Walnut	Impregnated Dispenser	Maximum Rate of 150 g combined a.i./acre per year
CIDETRAK® CMDA + LR (EPA Reg. No. 51934-18)	Apple, Pear, Quince, Pomegranate, Peaches, Nectarines, Plums, and other pome and stone fruits	Impregnated Dispenser	Maximum Rate of 150 g combined a.i./acre per year
CIDETRAK® CMDA + OFM MESO (EPA Reg. No. 51934-21)	Almond, Fig, Pistachio, Walnut, Peaches, Nectarines, Apricots, Plums, Cherries, and other stone fruits; Apples, Pears, Quince, and other pome fruits, Macadamia, and other tree fruit crops.	Impregnated Dispenser	Maximum Rate of 150 g combined a.i./acre per year

5. Manufacturing Process:

Provide the source of the substance and a detailed description of its manufacturing or processing procedures from the basic component(s) to the final product.

Ethyl Deca-3,4-dienoate [23,R1=Et;R2=(CH2)4Me]; Typical Procedure:[36] Reprinted from (Tsuboi; Masuda; Mimura; Takeda, Organic Syntheses, Collective Volume VIII), Copyright (1993), p 251, with permission from John Wiley & Sons, Inc.

A 300-mL, round-bottomed flask equipped with a reflux condenser was charged with oct-1-yn-3-ol (12.1 g, 0.096 mol), triethyl orthoacetate (100 g, 0.616 mol), and propanoic acid (0.24 g, 3.2 mmol). The solution was heated at 140–150 8C in an oil bath. Every 2 h, the EtOH produced was removed under reduced pressure, and then triethyl orthoacetate (10 g, 0.062 mol) and propanoic acid (0.024 g, 0.32 mmol) were added. The mixture was heated until the starting material was consumed (6–8 h). Excess triethyl orthoacetate was removed under reduced pressure.

The residue was distilled under reduced pressure to give the title compound as a clean oil; yield: 15.4–17.2 g (82–91%); bp 80–85 8C/0.3 Torr. Ethyl (2E,4Z)-Deca-2,4-dienoate [24, R1 = Et; R 2 = (CH2)4 Me]; Typical Procedure: [36]

A dry 500-mL, round-bottomed flask was charged with alumina (50 g) and heated at 200 8C for 2 hours under reduced pressure (0.05 Torr). The flask was fitted with a reflux condenser and connected to a N2 line and a heavy magnetic stirring bar was added; the flask was flushed with N 2. The flask was charged with 200 mL of hexane (can be substituted with cyclohexane or heptane) and ethyl deca-3,4-dienoate [23, R1 = Et; R2 = (CH2) 4Me; 15.4–17.2 g, 78–88 mmol] under positive N 2 pressure. The mixture was refluxed with vigorous stirring for 5 h. The alumina was removed by filtration with suction through a sintered glass funnel of medium porosity, and thoroughly washed with EtOAc (100 mL). The combined filtrates were concentrated under reduced pressure to afford the title compound as a clean oil; yield: 11.6–13.6 g (75–88%); bp 83–88 8C/0.1Torr.

6. Ancillary Substances:
For substances petitioned for use in organic handling or processing, provide information about the ancillary substances (including, but not limited to, carriers, emulsifiers, or stabilizers) that may be included with the petitioned substance, including function, type of substance, and source, if known.

There are no ancillary substances included with the petitioned substance.

7. Previous Reviews:
Provide a summary of any available previous reviews of the petitioned substance by State or private certification programs or other organizations. If this information is not available, this should be stated in the petition. If the substance has been previously reviewed and rejected by the NOSB, the petition must provide new information that was not submitted in an earlier petition or provided for in the previous technical reports for the substance.

There were no previous reviews by the NOSB or other private certification programs found for Ethyl-2E,4Z-Decadienoate.

8. Regulatory Authority
Provide information regarding EPA, FDA, and State regulatory authority registrations, including registration numbers. The information provided must confirm that the intended use of the substance is permitted under EPA or FDA regulations, as applicable. For food ingredients and processing aids, the substance must be approved by FDA for the petitioned use. For pesticide active ingredients, the substance must have an EPA tolerance or tolerance exemption, as applicable. If this information does not exist or is not applicable, the petitioner should state this in the petition.

The substance Ethyl-2E,4Z-Decadienoate (pear ester) is currently registered as an active ingredient with the EPA. It is approved for all food and nonfood uses under EPA regulation and a component in several products registered with the EPA. It is listed under CAS No. 3025-30-7 and PC Code 144022. Table 1 in Section 3 of this petition lists all approved products with their uses and application rates that contain pear ester, both as an inert ingredient and active ingredient.

"Ethyl-2E,4Z-decadienoate (pear ester) is a naturally occurring, volatile substance emitted from mature, ripening fruit, that is particularly attractive to the codling moth (CM), Cydia pomonella. This species of moth is a major agricultural pest of pome fruit worldwide. Both male and female moths have receptors for pear ester in their antenna, which attracts them to ripening fruit where they can mate and their eggs will be laid in the fruit. Synthetic pear ester is structurally and functionally identical to its natural counterpart, and its intended pesticidal use is to disrupt the CM mating behavior by confusing the moths and attracting them away from the fruit, and reducing their chances of finding mates and laying eggs in fruit orchards" (Excerpt from EPA BRAD).

Based on information submitted in support of the tolerance petition in 2011 and a comprehensive risk assessment conducted by the agency, this active ingredient is exempt from requirement of a tolerance as there is a

"reasonable certainty of no harm from aggregate exposures to pear ester, including consumption of food treated with this active ingredient" (EPA BRAD).

Pear ester is also an approved flavor agent or adjuvant listed by the U.S. Food & Drug Administration (FDA) on the Substances Added to Food (formerly EAFUS). The following identifications can be found on FDAs website the FEMA number is 3148, the FEMA GRAS Publication number are 4 & 25, and the JECFA flavor number is 1192 (Appendix E).

9. Chemical Abstracts Service (CAS) Number and Product Labels:
Provide the CAS number or other product numbers of the substance. If the substance does not have an assigned product number, the petitioner should state so in the petition. For food additives, the International Numbering System (INS) number should also be provided. This item should also include labels of products that contain the petitioned substance. If a product label does not apply to this substance, please provide a brief explanation. Product specification sheets, product data sheets, non- retail labels, or other product information may be substituted for the product label, if appropriate.

The substance Ethyl-2E,4Z-Decadienoate (pear ester) is assigned to CAS No. 3025-30-7 and PC Code 144022.

The following list contains all registered product that include the active ingredient Ethyl-2E,4Z-Decadienoate (pear ester):

Bedoukian Pear Ester Technical (EPA Reg. No. 52991-27)
CIDETRAK® DA MEC (EPA Reg. No. 51934-12)
CIDETRAK® CMDA 90/60 (EPA Reg. No. 51934-13)
CIDETRAK® CMDA 75/45 (EPA Reg. No. 51934-16)
CIDETRAK® CMDA + NOW MESO (EPA Reg. No. 51934-17)
CIDETRAK® CMDA + LR (EPA Reg. No. 51934-18)
CIDETRAK® CMDA + OFM MESO (EPA Reg. No. 51934-21)

The currently registered product labels approved by the EPA can be found in Appendix A of this petition.

10. Physical and Chemical Properties:
Provide the substance's physical properties and chemical mode of action including the following:
(a) Chemical interactions with other substances, especially substances used in organic production;
(b) Toxicity and environmental persistence;
(c) Environmental impacts from its use and/or manufacture;
(d) Effects on human health; and
(e) Effects on soil organisms, crops, or livestock

Physical Properties Table for Pear Ester:

Chemical or Physical Property	Description
Color	Colorless
Physical State	Liquid at Room Temperature
Odor	Characteristic Odor of Bartlett Pear
Water Solubility	8.588 mg/l @ 25°C
Vapor Pressure	0.0173 mm Hg @ 25°C
Stability	Deteriorates slightly over storage periods of elevated temperatures; recommended to store product in a cool storage area.
Viscosity	4.56 Centistokes
Boiling Point	258.41 °C

Oxidizing or Reduction Action	Reacts as mild base to neutralized bases. Usually does not react as reducing or oxidizing agent.
Flammability	>230°F
Density (Specific Gravity)	0.903 at 25°C

Toxicity data was submitted to EPA to satisfy Tier I toxiciology requirements when Pear Ester was registered as an active ingredient – the results of these studies found that Pear Ester is of no significant toxicological concern. Furthermore, the biochemical pesticide Human Health Assessment data requirements for Tier II and Tier III were not required due to the low toxicity of the active ingredient and the low levels of exposure expected from its intended uses in end-use products. No toxicological endpoints were identified for Pear Ester. No significant exposure from drinking water is expected when used according to label directions. This ingredient is a naturally occurring component of the human diet, and biodegrades rapidly in the environment. Anticipated exposure is not likely to result in unreasonable risk to humans through any medium. Similarly, ecological exposures are not anticipated to be of any concern due to the overall low toxicity of this active ingredient (EPA BRAD).

11. Safety Information:
Provide safety information about the substance including a Material Safety Data Sheet (MSDS) and a substance report from the National Institute of Environmental Health Studies. If this information does not exist or is not applicable, the petitioner should state so in the petition.

An MSDS for Ethyl-2E,4Z-Decadienoate is provided in Appendix B

12. Research Information:

Introduction
There has been extensive research conducted on 2,4-Decadienoic Acid, Ethyl Ester, (E,Z) (DA) since its discovery in 1998 by Dr. Douglas Light for its effects on codling moth (*Cydia pomonella*) to present.

Description - Benign Odorant
Pear ester, ethyl (*E,Z*)-2,4-decadienoate, is the natural and key defining odorant - flavourant of pears. Pear ester is a completely benign natural plant odor compound, being nontoxic, GRAS recognized, and an FDA approved food, confection, liquor – seltzer, and cosmetic additive for over 40+ years.

Environmental Context – Impact
Pear ester is a naturally occurring odor compound that is released into the environment at pre-harvest when pears reach maturity and also released precociously earlier in the growing season if and when pears become wounded and/or infested. Chemical analysis has shown that the natural pear ester is released at an estimated rate of ~3.7 grams/acre/month from maturing Bartlett pears and ~3.0 grams/acre/month from midseason precociously-maturing Bartlett pears wounded by codling moth infestations. The estimated total synthetic pear ester released in one DA MEC application is ~16% of the expected natural release. Thereby, even as many as six spray applications of pear ester MEC would release less than the natural release per acre by mature Bartlett pears. Thus, the application of DA MEC for codling moth control would be within the range of natural release in pear orchards and thus should not adversely affect other animal – insect species or the overall environment.

Attractant – Monitoring
Adult female and male codling moths are highly attracted to pear ester, along with only a few closely related pest species, but critically it is non-attractive to bees and all beneficial insects (Light et al. 2001, Knight & Light 2004, Il'chev 2004, Thwaite et al. 2004, Schmidt et al. 2005). Unique for host-plant kairomones the pear ester is an effective monitoring attractant and control product at very subtle delivery rates from formulations, similar to the sensitivity and rates eliciting moth responses to sex pheromones (Light et al. 2001). Moreover and

critically, pear ester enhances the attraction of males to their codlemone pheromone (Knight et al. 2005). This allowed for the creation of a high-performance male attractant called PHEROCON® CMDA COMBO Lure, with pear ester enhancing, often doubling, the attraction of males to the codlemone pheromone. This CMDA Combo lure is highly attractive and uniquely effective in monitoring males in orchards treated with pheromone mating disruption (MD) (Knight & Light 2005a, Fernandez et al. 2010, Joshi et al. 2011). This is uniquely different from the inactivity of traditional pheromone-only lures that are overwhelmed by the MD pheromone and thus ineffective in monitoring codling moth populations in or near pheromone treated orchards. CMDA COMBO Lures have been used to develop action thresholds and predict egg hatch of codling moths (Knight & Light 2005a & b). PHEROCON® CMDA Combo Lures have been commercially used for over 18 years worldwide and they are still the "standard lure" to monitor codling moth infestations and population levels, both in conventional and mating disruption treated pomefruit and walnut orchards.

Application Information – Control Mechanisms

The sensitivity, strength and consistency of these elicited behaviors have allowed the pear ester to be formulated for control applications either in solid PVC substrates or microcapsules that provide both enhancement of pheromone mating disruption and enhancement of toxicity/control of a broad range of pesticides including organic materials, respectively. In concert these formulated products provide advantageous new tactics for the advancement of mandated food safety and environmental initiatives for the replacement of detrimental OP and pyrethroid insecticides with reduced-risk organic alternatives. Pear ester has been experimentally used in orchard studies since 2004 to successfully enhance both pheromone formulations in MD control and various insecticides for larval control (Light & Knight, *J. Economic Entomology* 104: 1309-1315, 2011).

Application Information - Microencapsulated Spray Adjuvant

Codling moth eggs are laid on leaves located near target fruit clusters and once hatched larvae must crawl the distance to locate their target fruit/nut to infest. Larvae of codling moth are highly attracted to pear ester and it also arrests/slows/tops their crawling, causing prolonged stationary periods and periods of slow "wandering" on pear ester- treated leaf and fruit surfaces (Light & Beck 2012). Due to its volatility pear ester must be microencapsulated to allow it to be released in a controlled manner for greater than 14 days. This microencapsulated formulation of pear ester, "CIDETRAK® DA MEC," has been shown in the USA and around the world to improve the efficacy of various insecticides and organic materials, e.g. virus. Results consistently showed reduced harvest damage by an overall average of 40% when tank-mixed as a spray adjuvant with a wide-range of registered insecticides. Use of DA MEC has improved the efficacy of both contact and ingestion-based organic insecticides, insect growth regulators, botanical-based products, and both microbial viral and bacterial (*CpGV* and BT) (*e.g.*, Light & Knight 2011, Knight & Light 2013). Material lethality is based both on inherent toxicity and the time – duration of exposure. Furthermore, DA MEC attracts and arrests larvae, prolonging their wandering on leaves, and critically delaying the time to crawl to fruit (Light & Beck 2012). This allows for the critical increase in temporal and spatial exposure of larvae to insecticides and viral and bacterial particles. With a prolonged 14 day residual activity of DA MEC combined with such exposure-enhancing behavior evoking properties of DA MEC together allows for possible use of "weaker" insecticides that are known to be less effective than older OP formulations.

As mentioned, female codling moths lay their single eggs on leaves around or near their perceived fruit/nut clusters. However, in the presence of applied DA MEC spay applications females appear confused – disrupted and "disassociate" their chosen egg laying leaf sites by laying their eggs significantly further away from the true fruit locations. Thereby hatched larvae must exert more energy and crawl further to find host fruit while being disrupted - disoriented by the presence of pear ester from olfactory-based finding their fruit hosts.

Applications of DA MEC adjuvant could lead to reduction in frequency of required spray applications and the capacity for effective and longer residual use of relatively short-lived insecticides (*e.g.*, virus and BT). Such use may make an important impact in decreasing overall insecticide residue on commodities and in the environment. Dr. Doug Light has shown in walnut orchards that enhanced insecticidal control of codling moth

by DA MEC adjuvant can also significantly reduce the damage by a secondary pest, the navel orangeworm, thereby reducing overall insecticide use in a pest complex (Light & Knight 2011).

Application Information - Enhanced Mating Disruption
Further decreases in pesticide use and residue will be achieved with the greater usage and effectiveness of pheromone mating disruption being enhanced by the pear ester – DA additive. The addition of pear ester with pheromone in MD has been shown to cause a reduction in mating below that to pheromone-alone, with an increase in frequency of nonmated - virgins and a decrease in secondary – multiple matings in CM females (Knight et al. 2012a & b, Light 2016, Light et al. 2017).

Additional Information
Furthermore, Chapter 8, Pear Ester – From Discovery to Delivery for Improved Codling Moth Management, in the book of Roles of Natural Products for Biorational Pesticides in Agriculture has been solely dedicated to DA. This chapter delves into the discovery, the neurophysiological aspects of codling moth, the direction, and the uses (monitoring, mating disruption, control) for DA on codling moth. This chapter has been added to appendix D for easy reference (Knight, A. L., Light, D. M., Judd, G. J. R., Witzgall, P. et al. 2018).

The monitoring lures that contain DA can be found on the UC IPM Statewide Integrated Pest Management Program as a staple recommendation for pome fruit and walnuts. Copies of the website pages have been added to appendix F for ease of reference.

See *References* in this petition for citations for the *Research Information* section.

13. Petition Justification Statement:
Provide a "Petition Justification Statement," which provides justification for any of the following actions requested in the petition: A. Inclusion of a Synthetic on the National List (7 C.F.R. §§ 205.601, 205.603, 205.605(b))

2,4-decadienoic acid, ethyl ester, (E,Z) is currently not on the National List because it is considered a kairomone and does not meet the qualifications of a pheromone. Kairomones are semiochemicals from organisms and plants that give insects key indications that assist in the decision of determining whether or not there is a suitable plant host. Kairomones have often been referred to as pheromones or allomones (Klowden & Palli 2023, Galizia 2008, Mori 2010).

Pear ester needs to be added to the National List (7 C.F.R. §§ 205.601, 205.603, 205.605(b)) for multiple reasons. Without DA present in insect monitoring tools, conventional and organic growers using codling moth pheromone alone mating disruption, will be unable to time pesticides at the proper timing. This will cause an increase in use of pesticides, and it will cause an increase in crop damage. Mating disruption products containing codling moth pheromone alone will only allow for the disruption of the male codling moth. With the addition of 2,4-decadienoic acid, ethyl ester, (E,Z) in mating disruption products, there will be disruption for male and female codling moth. Currently, 90% of the organic apple acreage has DA based products present in their IPM programs and it is widely used in organic walnuts.

A current product known as CIDETRAK® DA MEC, a microencapsulated formula, is able to disrupt codling moth larvae. This disruption of larvae allows for the codling moth larvae to be exposed longer to virus or other pesticides. This ensures an increase in larvae mortality. 2,4-decadienoic acid, ethyl ester, (E,Z) is the only product able to disrupt larvae, male, and female codling moth.

In reviewing 7 CFR § 205.601, Synthetic substances allowed for use in organic crop production, there is no non-synthetic or synthetic substance on the list that can be used in place of the petitioned synthetic substance.

The beneficial effects to the environment, human health, and ecosystem are described in depth below. 2,4-decadienoic acid, ethyl ester, (E,Z) is emitted naturally from mature and ripening fruit. The synthetic version of pear ester is structurally identical to the natural form. As with synthetic pheromones, the synthetic pear ester kairomone is indistinguishable in chemistry and toxicology in regard to its natural form. Pear ester is an approved food additive by the U.S. Food and Drug Administration (FDA). It has been shown that in the U.S., the average daily human intake of pear ester is 3.0 μg/day. Another important factor of pear ester is that it is not attractive to bees and other beneficial insects. Bees and other beneficials are important for pollination and removing additional unwanted pests respectively.

Additionally, there is large number of growers, pest control advisors (PCAs), distributors and organizations who currently use this product in organic orchards. The need for these products to be on the National List can be seen from the support letters provided by the U.S. Apple Association, the NW Horticultural Council, the California Apple Commission and etc. These letters of support can be viewed in Appendix G.

References

Regulatory Authority
1. https://www.federalregister.gov/documents/2013/08/28/2013-21019/ethyl-2e4z-decadienoate-pear-ester-exemption-from-the-requirement-of-a-tolerance
2. EPA Biopesticides Registration Action Document for Ethyl-2E,4Z-decadienoate (Pear Ester); PC Code 14402; Last Updated August 7, 2013 (Appendix C)

Physical and Chemical Properties
1. EPA Biopesticides Registration Action Document for Ethyl-2E,4Z-decadienoate (Pear Ester); PC Code 14402; Last Updated August 7, 2013 (Appendix C)

Manufacturing Process
1. Tsuboi; Masuda; Mimura; Takeda, Organic Syntheses, Collective VolumeVIII), Copyright (1993), p 251

Research Information
Discovery:
Light, D. M., Knight A. L., Henrick, C., Rajapaska, D., Lingren, B., Dickens, J. C., Reynolds, K. M., Buttery, R. G., Merrill, G. B., Roitman, J. N., and Campbell, B. C. 2001. A pear-derived kairomone with pheromonal potency that attracts male and female codling moth, *Cydia pomonella* (L.). *Naturwissenschaften* 88: 33-338.

Species Specific attraction:
Knight, A. L., Light, D. M. 2004. Use of ethyl (*E*,*Z*)-2,4-decadienoate in codling moth management: kairomone species specificity. *J. Entomol. Soc. British Col.* 101:61-67.
Schmidt, S., Anfora, G., De Cristofaro, A., Ioriatti, C. 2005. Tortricid species caught by codling moth kairomone ethyl (*E*,*Z*)-2,4-decadienoate: monitoring trials and electrophysiological responses. *IOBC wprs Bull.* 28 (7): 357-362.

Improved Monitoring:
Il'chev, A. L. 2004. First Australian trials of ethyl (2*E*, 4*Z*)-2,4-decandienoate for monitoring of female and male codling moth, *Cydia pomonella* (Lepidoptera: Tortricidae) in pome fruit orchards. *Gen. Appl. Entomol.* 33: 15-20.
Thwaite, W. G.; Hately, A. M.; Eslick, M. A.; Nicol, H. I. 2004. Evaluating pear ester lures for monitoring *Cydia pomonella* (L) (Lepidoptera: Tortricidae) in Granny Smith apples under mating disruption. *Gen. Appl. Entomol.* 33: 55-60.
Knight, A. L., Hilton, R. Light, D. M. 2005. Monitoring codling moth (Lepidoptera: Tortricidae) in apple with blends of ethyl (*E*,*Z*)-2,4-decadienoate and codlemone. *Environ. Entomol*. 34(3):598-603.
Knight, A. L., Light, D. M. 2005. Developing action thresholds for codling moth (Lepidoptera: Tortricidae) with pear ester and codlemone-baited traps in apple orchards treated with sex pheromone mating disruption. *Can. Entomol*. 137: 739-747.
Knight, A. L., Light, D. M. 2005. Timing of egg hatch by early-season codling moth (Lepidoptera: Tortricidae) predicted by moth catch in pear ester- and codlemone-baited traps. *Can. Entomol*. 137: 728-738.
Knight, A., Hilton, R., VanBuskirk, P. and Light, D. 2006. Using pear ester to monitor codling moth in sex pheromone treated orchards. *Oregon State Univ Ext Service Ext Man* 8904:1-8.
Fernandez, D. E., Cichon, L., Garrido, S., Ribes-Dasi, M., Avilla, J. 2010. Comparison of lures loaded with codlemone and pear ester for capturing codling moths, *Cydia pomonella*, in apple and pear orchards using mating disruption. *J. Insect Science* 10:139 available online: insectscience.org/10.139, 12 pp.
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Petition Justification Statement

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Appendices

Appendix A: EPA Approved Product Labels
Appendix B: MSDS
Appendix C: EPA BRAD Document
Appendix D: Book Chapter - Pear ester – from discovery to delivery for improved codling moth management
Appendix E: FDA Approval of DA as a Flavor Agent or Adjuvant
Appendix F: UC IPM Statewide Integrated Pest management Program Recommendations for Monitoring Lures Containing DA
Appendix G: Support Letters from Growers, PCA's and Organizations for Adding Pear Ester to The National List

APPENDIX A: EPA Approved Product Labels

52991-27 8/22/2013 1/2

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Pesticide Programs
Biopesticides and Pollution Prevention Division (7511P)
1200 Pennsylvania Avenue NW
Washington, DC 20460

EPA Reg. Number	Date of Issuance
52991-27	AUG 22 2013

Term of Issuance: **Unconditional**

Name of Pesticide Product:

Bedoukian Pear Ester Technical

NOTICE OF PESTICIDE:
X Registration
___ Reregistration
(under FIFRA, as amended)

Name and Address of Registrant (include ZIP Code):

Jim Wagner
Bedoukian Research, Inc.
P.O. Box 640
7217 Lancaster Pike, Suite A
Hockessin, DE 19707

Note: Changes in labeling differing in substance from that accepted in connection with this registration must be submitted to and accepted by the Biopesticides and Pollution Prevention Division prior to use of the label in commerce. In any correspondence on this product always refer to the above EPA registration number.

On the basis of information furnished by the registrant, the above named pesticide is hereby registered under the Federal Insecticide, Fungicide and Rodenticide Act.

Registration is in no way to be construed as an endorsement or recommendation of this product by the Agency. In order to protect health and the environment, the Administrator, on his motion, may at any time suspend or cancel the registration of a pesticide in accordance with the Act. The acceptance of any name in connection with the registration of a product under this Act is not to be construed as giving the registrant a right to exclusive use of the name or to its use if it has been covered by others.

This registration does not eliminate the need for continual reassessment of the pesticide. If EPA determines at any time that additional data are required to maintain in effect an existing registration, the Agency will require submission of such data under section 3(c)(2)(B) of FIFRA. This product is unconditionally registered in accordance with FIFRA Sec. 3(c)(5) provided you:

1. Submit and/or cite all data required for registration of your product under FIFRA section 3(c)(5) when the Agency requires all registrants of similar products to submit such data.

2. Revise the EPA Registration Number to read, "EPA Reg. No. 52991-27."

3. Submit two (2) copies of the final printed labeling before you release the product for shipment. Refer to the A-79 enclosure for a further description of final printed labeling.

A stamped copy of the label is enclosed for your records.

Signature of Approving Official:

Robert McNally, Director,
Biopesticides and Pollution Prevention Division

Date: 8/22/13

EPA Form 8570-6

CONCURRENCES

SYMBOL ▶	7511P	7511P	7511P					
SURNAME ▶	Burnett	Hollis	McNally					
DATE ▶	8/16/2013	8/19/13	8/21/13					

EPA Form 1320-1A (1/90) OFFICIAL FILE COPY

2/2

52991-27_rev_15 Aug 2013
For all food and non-food crops

FOR MANUFACTURING OR FORMULATING USE ONLY
NOT TO BE USED FOR THE DIRECT TREATMENT OF PESTS

BEDOUKIAN PEAR ESTER TECHNICAL

Active Ingredient:
2,4-decadienoic acid, ethyl ester, (E,Z)- 93.4%
Other Ingredients:.....6.6%
Total:.....100.0%

ACCEPTED
AUG 22 2013
Under the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, for the pesticide registered under EPA Reg. No. 52991-27

KEEP OUT OF REACH OF CHILDREN

CAUTION

FIRST AID	
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15 – 20 minutes. • Call a poison control center or doctor for treatment advice.
If in eyes	• Hold eye open and rinse slowly and gently with water for 15 – 20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
If inhaled	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. • Call a poison control center or doctor for further treatment advice.
If swallowed	• Call poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to do so by the poison control center or doctor. • Do not give anything by mouth to an unconscious person.
HOT LINE NUMBER Have the product container or label with you when calling a poison control center or doctor, or going for treatment. For information on this pesticide product (including health concerns, medical emergencies, or pesticide incidents), call the National Pesticide Information Center at 1-800-858-7378.	

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS: Caution: Harmful if swallowed, absorbed through skin, or inhaled. Causes moderate eye irritation. Avoid contact with skin, eyes, and clothing. Avoid breathing vapor. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, or using tobacco. Remove contaminated clothing and wash before reuse. Wear the appropriate Personal Protective Equipment (PPE).

ENVIRONMENTAL HAZARDS: Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance, contact your State Water Board or Regional Office of the EPA.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

For Use in Manufacturing and Formulation Only. BEDOUKIAN PEAR ESTER TECHNICAL is a manufacturing-use product for formulation of end-use products intended to disrupt mating behavior of Lepidoptera species. This product may only be used to formulate end-use products for the following uses: (1) Pre-harvest application for all food and non-food crops (2) Uses for which EPA has accepted the required data and/or citations of data that the formulator has submitted in support of registration (3) Uses for experimental purposes that are in compliance with EPA registration for the formulated products. This product may be used to formulate products for specific uses not listed on this label if the formulator, user group, or grower has complied with US EPA data submission requirements regarding the support of such uses. Each formulator is responsible for obtaining EPA registration for their end-use product(s). This manufacturing-use product is not for the direct treatment of pests. Do not use from damaged, punctured or unsealed containers.

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

Pesticide Storage: Store container in cool place, preferably at 0°C until used.

Pesticide Disposal: Wastes resulting from use of this product must be disposed of at an approved waste disposal facility.

Container Disposal: Metal containers (non-aerosol)- Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities. Plastic containers- Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke. Glass containers- Triple rinse (or equivalent). Then dispose of in a sanitary landfill or by other approved State and local procedures.

Warranty and Disclaimer Statement

To the fullest extent of the law, **Bedoukian Research, Inc.** warrants that this material conforms to the chemical description on the label. **Bedoukian Research, Inc.** neither makes, nor authorizes any agent or representative to make, any other warranty of fitness or of merchant ability, guarantee or representation, expressed or implied, concerning this material. **Bedoukian Research, Inc.'s** maximum liability for breach of this warranty shall not exceed the purchase price of this product.

Manufactured By:
Bedoukian Research, Inc.
21 Finance Drive
Danbury, CT 06810-4192
Phone: 203-830-4000

EPA Reg. No. 52991-~~xx~~ 27
EPA Establishment No. 52991-CT-1

Net Contents:_____
Lot Number:_____

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

July 23, 2020

Keeva Shultz
Agent
Trece, Inc.
c/o Wagner Regulatory Associates, Inc.
P.O. Box 640
Hockessin, DE 19707

Subject: Labeling Notification per Pesticide Registration Notices (PRN) 98-10 and 2007-4 – Notification to add storage and disposal language and additional container sizes to the label. Some typos in the name of the product have been updated.
Product Name: CIDETRAK® DA MEC
EPA Registration Number: 51934-12
Application Date: 7/15/2020
OPP Decision Number: 564682

Dear Ms. Shultz:

The U.S. Environmental Protection Agency (EPA) is in receipt of your application for notification under Pesticide Registration Notices (PRN) 98-10 and 2007-4 for the above referenced product. The Biopesticides and Pollution Prevention Division (BPPD) has conducted a review of this request for its applicability under PRN 98-10 and 2007-4 and finds that the action requested falls within the scope of PRN 98-10 and 2007-4.

The labeling submitted with this application has been stamped "Notification" and will be placed in our records. You must submit one (1) copy of the final printed labeling with the modifications.

Should you wish to add/retain a reference to your company's website on your label, then please be aware that the website becomes labeling under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and is subject to review by the EPA. If the website is false or misleading, the product will be considered to be misbranded and sale or distribution of the product is unlawful under FIFRA section 12(a)(1)(E). 40 CFR § 156.10(a)(5) lists examples of statements the EPA may consider false or misleading. In addition, regardless of whether a website is referenced on your product's label, claims made on the website may not substantially differ from those claims approved through the registration process. Therefore, should the EPA find or if it is brought to our attention that a website contains false or misleading statements or claims substantially differing from the EPA-approved registration, the website will be referred to the EPA's Office of Enforcement and Compliance Assurance.

If you have any questions, please contact Sydnie Hetzel of my team by phone at (703) 347-0220 or via email at Hetzel.Sydnie@epa.gov.

Sincerely,

Andrew Bryceland, Team Leader
Biochemical Pesticides Branch
Biopesticides and Pollution
Prevention Division (7511P)
Office of Pesticide Programs

Enclosure

Notification to update storage and disposal language

CIDETRAK® DA MEC™

AN ENHANCEMENT FOR CONTROL OF LARVAE AND ADULT CODLING MOTH, *Cydia pomonella*

ACTIVE INGREDIENTS:	
2,4-Decadienoic Acid, Ethyl Ester, (E, Z)	**5.00%**
OTHER INGREDIENTS:	**95.00%**
TOTAL:	**100.00%**

NOTIFICATION
51934-12
The applicant has certified that no changes, other than those reported to the Agency have been made to the labeling. The Agency acknowledges this notification by letter dated:
07/23/2020

EPA Reg. No. 51934-12
EPA Est. No.
NET CONTENTS: [Fl. Oz./mL/Gals.] ~~4.06 fl. oz. (120 mL)~~ ~~8.12 fl. oz. (240 mL)~~ ~~16.23 fl. oz. (480 mL)~~ ~~55 gallons~~ ~~275 gallons~~ ~~330 gallons~~]

KEEP OUT OF REACH OF CHILDREN
CAUTION

FIRST AID STATEMENT	
IF ON SKIN OR CLOTHING:	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
IF INHALED:	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. • Call a poison control center or doctor for further treatment advice.
IF IN EYES:	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing. • Call a poison control center or doctor for treatment advice.
IF SWALLOWED:	• Call a poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to by a poison control center or doctor. • Do not give anything to an unconscious person.
HOT LINE NUMBER:	Have the product container or label with you when calling a poison control center or doctor or going for treatment. – For emergency information on (product, use, etc.), call the National Pesticides Information Center at **1-800-858-7378**, 8:00 AM to 12:00 PM Pacific time (PT), Monday-Friday. During other times, call the poison control center **1-800-222-1222**. For additional information, you may also contact Trécé Inc. at **1-866-785-1313.**

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION. Avoid contact with skin or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco or using the toilet. Wear the appropriate PPE. Remove and wash contaminated clothing before reuse.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Applicators and other handlers must wear:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves made of any waterproof material such as nitrile rubber, butyl rubber, neoprene rubber, barrier laminate, polyethylene, polyvinyl chloride (PVC), or Viton.
- Shoes plus socks
- Protective eyewear

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

USER SAFETY RECOMMENDATIONS

Users should:

- Remove clothing/PPE immediately if pesticide gets underneath clothing. Then, shower cleaning skin thoroughly with soap and water and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves with soap and water before removing.
- Remove and wash contaminated clothing before reuse. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS

Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwater or rinsate.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handers may be in the area during application. For any requirement specific to your State and Tribe, consult the State/Tribal agency responsible for pesticide regulation.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

READ ENTIRE LABEL BEFORE USING

~~**DIRECTIONS FOR USE**~~

~~It is a violation of Federal law to use this product in a manner inconsistent with its labeling.~~

~~READ ENTIRE LABEL BEFORE USING~~

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protection equipment (PPE), notification to workers, and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 4 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:
- Long-sleeved shirt and long pants
- Chemical-resistant gloves made of any waterproof material such as nitrile rubber, butyl rubber, neoprene rubber, barrier laminate, polyethylene, polyvinyl chloride (PVC), or Viton.
- Shoes plus socks
- Protective eyewear

CIDETRAK® DA MEC is enhancement for mixing with insecticides or Codling Moth pheromone formulations intended to be applied to apple, pear and walnut orchards for control of codling moth, *Cydia pomonella*.

Crop	Apple, Pear, Walnut, Pecan, Quince, and other pome fruits
Targeted Pest	Codling Moth (*Cydia pomonella*), Hickory Shuckworm *(Cydia caryana).*
Rate	Mix CIDETRAK® ~~CIDETRAK~~ DA MEC with prescribed and/or lower label rates of a suitable insecticide or CM pheromone for control of codling moth, *Cydia pomonella*, only if such reduced rates of the insecticide or CM pheromone have been shown effective by industry, government and/or university scientists. Use CIDETRAK® DA MEC at a rate of 0.41-2.37 fl. oz./acre (12 to 70 mls/acre (0.6-3.5 gms acre)) or 1.01-5.92 fl. oz./hectare 30 to 175 mls/hectare (1.5-8.75 gms/hectare). Apply CIDETRAK® DA MEC usually at a rate of 0.41 fl. oz. (12 mls (0.6 gms)) per acre or 1.01 fl. oz. 30 mls (1.5 gms) per hectare in a mixture only, with a suitable, registered insecticide or CM pheromone and water. Do not exceed 8 applications of CIDETRAK® DA MEC at 0.41 fl. oz. (12 mls (0.6 gms)) product per acre or 1.01 fl. oz. (30 mls) per hectare per application or a total seasonal amount of 3.25 fl. oz. (96 mls or 4.8 gms a.i.) per acre or 8.12 fl. oz. (240 mls (12 gms a.i.)) per hectare.
Application	Apply the foregoing mixture in a full coverage spray, according to directions for use of the insecticide or pheromone. Coverage should be complete but do not allow “run-off.”
Monitoring/Timing	Always monitor for codling moth presence and phenology with PHEROCON® CM-DA COMBO + AA lures in CIDETRAK® DA MEC + insecticide or pheromone treated orchards. Time applications of CIDETRAK® DA MEC + insecticide or CM pheromone mixtures according to the directions of the manufacturer of the insecticide or CM pheromone with which CIDETRAK® DA MEC is mixed, local extension agents and other authorities. Repeat applications of CIDETRAK® DA MEC + insecticide or CM pheromone mixtures according to directions for insecticide.
Chemical Compatibility	Check physical compatibility of CIDETRAK® DA MEC + insecticide or CM pheromone formulations before mixing in spray tanks. No plant phytotoxicity has been observed with mixtures of CIDETRAK® DA MEC. But one may check plant phytotoxic response to mixtures of CIDETRAK® DA MEC + insecticide or CM pheromone formulations by treating 4-5 plants or small area of foliar surface of plantings with chosen mixtures. Observe the effect over 2 days.
Spray/Sprayer Preparation	Shake CIDETRAK® DA MEC vigorously before measuring for spray solution. Fill sprayer half full of water. Start physical or by-pass agitation on spray application equipment. Carefully measure and pour or place insecticide or CM pheromone formulation into the spray tank. Carefully measure and pour the required amount of CIDETRAK® DA MEC into the spray tank. Fill

	spray tank to the required level and initiate application.

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

Pesticide Storage: Store in a cool, dry place, out of direct sunlight, and in such a manner as to prevent cross contamination with other pesticides, fertilizers, food, and feed. Store in original container and out of the reach of children, preferably in a locked storage area.

Pesticide Disposal: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

CONTAINER DISPOSAL:

Nonrefillable container (equal to or less than 5 gallons): Do not reuse or refill this container. Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container ¼ full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Offer for recycling, if available or reconditioning, or puncture and dispose of in a sanitary landfill or by incineration, or if allowed by State and local authorities, by burning. If burned, stay out of smoke.

Nonrefillable container [Greater Than 5 Gallons]: Do not reuse or refill this container. Offer for recycling, if available. Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank. Fill the container ¼ full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times. Then offer for recycling, if available or reconditioning if appropriate, or puncture and dispose of in a sanitary landfill or by incineration.

Refillable container [For Bulk and Mini-Bulk Containers, Greater than 5 Gallons]: Refill this container with pesticide only. Do not use this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the person refilling. To clean container before final disposal, empty the remaining contents from this container into application equipment or mix tank. Fill the container about 10% full with water. Agitate vigorously or recirculate water with the pump for 2 minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure two more times. Then offer for recycling, if available or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures allowed by State and local authorities.

WARRANTY AND LIMITATION OF DAMAGES

All statements concerning the use of this product apply only when used as directed as stated on this product label. Trécé Inc. warrants that the product conforms to this label and under normal conditions of use according to this label, is reasonably fit for the stated label purpose. To the extent consistent with applicable law, the manufacturer makes no express or implied warranties of merchantability or fitness for a purpose concerning this product, or its use, extending beyond the label. To the extent consistent with applicable law, under no circumstance will Trécé Inc. be liable for damage (special, consequential or incidental) that result from the handling, storage, or use of this product which is not in compliance with the label. Read all label directions carefully.

To the extent consistent with applicable law, buyer's exclusive remedy, should this product be defective, is replacement of the product, or if this is impracticable, a purchase price refund.

TRÉCÉ INCORPORATED
Mailing Address: P.O. Box 129 · Adair, Oklahoma 74330
Shipping Address: 7569 Hwy 28 W · Adair, Oklahoma 74330
Phone: (918) 785-3061 · Fax: (918) 785-3063

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG 0 5 2014

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

Cheryl Wagner, Agent
Trece, Inc.
c/o Wagner Regulatory Associates, Inc.
P.O. Box 640
Hockessin, DE 19707

Subject: Cidetrak CMDA 90/60
EPA Registration No. 51934-13
Label Amendment revise directions and net contents to include meso dispenser, a new commercial package size.
Decision # 487458
Application Dated: January 31, 2014

Dear Mrs. Wagner:

The amendment referred to above, submitted in connection with registration under FIFRA section 3(c)(5), is **acceptable** provided that you:

1. Submit and/or cite all data required for registration/reregistration of your product under FIFRA section 3(c) (5) when the Agency requires all registrants of similar products to submit such data.

2. Submit three (3) copies of your final printed labeling before you release the product for shipment. Final printed labeling means the label or labeling of the product when distributed or sold. Clearly legible reproductions or photo reductions will be accepted for unusual labels, such as those silk-screened directly onto glass or metal containers or large bags or drum labels.

If these conditions are not complied with, the registration will be subject to cancellation in accordance with FIFRA section 6(b). Your release for shipment of the product bearing the amended labeling constitutes acceptance of these conditions.

If you have any questions contact Ms. Menyon Adams at 703-347-8496 or by email at: adams.menyon@epa.gov. A stamped copy of the label is enclosed for your records.

Sincerely,

Linda A. Hollis, Chief
Biochemical Pesticides Branch
Biopesticides and Pollution
Prevention Division (7511P)

CIDETRAK® CMDA 90/60
CODLING MOTH PHEROMONE
MATING DISRUPTANT

A Mating Disruption Formulation for Codling Moth, *Cydia pomonella,* and Hickory Shuckworm *(Cydia caryana)*

CIDETRAK CMDA 90/60:

ACTIVE INGREDIENTS:	
8,10-Dodecadien-1-ol, (8E, 10E)	**1.80%**
2,4-decadienoic acid, ethyl ester, (E, Z)	**1.20%**
OTHER INGREDIENTS:	**97.00%**
TOTAL:	**100.00%**

NET CONTENTS:

CIDETRAK CMDA 90/60 MESO FOR WALNUTS:
Dispensers per package : 15 dispensers
One dispenser contains : 1440 mg *8,10-Dodecadien-1-ol, (8E,10E)*
960 mg *2,4-decadienoic acid, ethyl ester, (E,Z)*

CIDETRAK CMDA 90/60 MESO FOR APPLES, PEARS, QUINCE & OTHER POME FRUITS
Dispensers per package : 40 dispensers
One dispenser contains : 900 mg *8,10-Dodecadien-1-ol, (8E,10E)*
600 mg *2,4-decadienoic acid, ethyl ester, (E,Z)*

CIDETRAK CMDA 90/60 PUZZLE PIECE FOR APPLES, PEARS, QUINCE & OTHER POME FRUITS
Dispensers per package : 400 dispensers
One dispenser contains : 90 mg *8,10-Dodecadien-1-ol, (8E,10E)*
60 mg *2,4-decadienoic acid, ethyl ester, (E,Z)*

EPA Registration No. 51934-13
EPA Establishment No. 51934-OK-1

KEEP OUT OF REACH OF CHILDREN
CAUTION

FIRST AID STATEMENT	
IF ON SKIN OR CLOTHING:	◦ Take off contaminated clothing. ◦ Rinse skin immediately with plenty of water for 15-20 minutes. ◦ Call a poison control center or doctor for treatment advice.
IF INHALED:	◦ Move person to fresh air. ◦ If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. ◦ Call a poison control center or doctor for further treatment advice.

IF IN EYES:	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing. • Call a poison control center or doctor for treatment advice.
IF SWALLOWED:	• Call a poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to by a poison control center or doctor. • Do not give anything to an unconscious person.
HOT LINE NUMBER:	Have the product container or label with you when calling a poison control center or doctor or going for treatment. – For emergency information on (product, use, etc.), call the National Pesticides Information Center at 1-800-858-7378, 6:30 AM to 4:30 PM Pacific time (PT), seven days a week. During other times, call the poison control center 1-800-222-1222. For additional information, you may also contact Trece Inc. at 1-866-785-1313.

Precautionary Statements
Hazards to Humans and Domestic Animals

Caution. Avoid contact with skin or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco or using the toilet.

ENVIRONMENTAL HAZARDS

Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwater or rinsate.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

READ ENTIRE LABEL BEFORE USING

CIDETRAK® CMDA 90/60 disrupts the mating communication between adult male and female moths, reduces fertile egg laying, suppresses subsequent larval infestation, and reduces the need for applying insecticides.

For maximum effectiveness, growers should remove and destroy infested fruit from trees and the ground. Growers should maintain accurate records of CM adult population monitoring and larval damage within their orchards. Consult your local extension specialist, certified crop advisor, or Trece representative for assistance in designing the best CIDETRAK® CMDA 90/60 program for your orchard.

Crop	Apple, Pear, Walnut, Pecan, Quince, and other pome fruits
Targeted Pest	Codling Moth (Cydia pomonella), Hickory Shuckworm *(Cydia caryana).*
Rate – MESO for Walnuts	CIDETRAK CMDA 90/60: Minimum of 15 dispensers per acre (38 dispensers per hectare) or 13.5 gm CM a.i. and 9 gm DA a.i. per acre per application. Maximum of 32 dispensers per acre (80 dispensers per hectare) or 28.8 gm a.i. and 19.2 gm DA a.i. per acre per application. Apply 20 dispensers per acre (50 dispensers per hectare) for moderate populations. Apply the maximum dispenser rate to all orchard borders, to orchards that are heavily infested with CM, or adjacent to an untreated orchard. Do not exceed 150 gm combined a.i. per acre per year.
Rate – MESO for Apples, Pears, Quince & Other Pome Fruit	CIDETRAK CMDA 90/60: Minimum of 20 dispensers per acre (50 dispensers per hectare) or 18 gm CM a.i. and 12 gm DA a.i. per acre per application. Maximum of 40 dispensers per acre (100 dispensers per hectare) or 36 gm a.i. and 24 gm DA a.i. per acre per application. Apply 32 dispensers per acre (80 dispensers per hectare) for moderate populations. Apply the maximum dispenser rate to all orchard borders, to orchards that are heavily infested with CM, or adjacent to an untreated orchard. Do not exceed 150 gm combined a.i. per acre per year.
Rate – Puzzle Piece for Apples, Pears, Quince & Other Pome Fruit	CIDETRAK CMDA 90/60: Minimum of 200 dispensers per acre (500 dispensers per hectare) or 18 gm CM a.i. and 12 gm DA a.i. per acre per application. Maximum of 400 dispensers per acre (1,000 dispensers per hectare) or 36 gm a.i. and 24 gm DA a.i. per acre per application. Apply 320 dispensers per acre (800 dispensers per hectare) for moderate populations. Apply the maximum dispenser rate to all orchard borders, to orchards that are heavily infested with CM, or adjacent to an untreated orchard. Do not exceed 150 gm combined a.i. per acre per year.
MESO Application	Walnuts - Attach dispensers securely to lateral branches at 20% of the distance between the trunk and branch terminal at ½ the tree height in mature trees. Pome Fruit – Attach dispensers securely to lateral branches at 10-20% of the distance between the trunk and branch terminal in the upper 1/5th of the canopy. Attach the dispensers from the ground using a pole applicator or from a hydraulic man-lift.
Puzzle Piece Application	Pome Fruit - Attach dispensers securely to lateral branches at 5-10% of the distance between the trunk and branch terminal in the upper 1/5th of the canopy. Attach the dispensers from the ground using a pole applicator or from a moving trailer.
Timing	Apply prior to moth emergence in early spring. Monitor moth activity using PHEROCON® IIB or PHEROCON VI traps and PHEROCON CMDA COMBO + AA lures. Begin monitoring in early spring and continue throughout the season to assess treatment effectiveness. Note - CIDETRAK® CMDA 90/60 will not prevent crop damage from immigration of mated female moths into treated orchards. Nearby (500

	yards) untreated Codling Moth hosts, such as apple, walnut, pear, quince, crabapple, plum and others, can be a source of these mated females. Treatment with pheromone is recommended only when all host crops within or near treated blocks have been treated with CIDETRAK® CMDA 90/60.
Treatment Tips	CIDETRAK® CMDA 90/60 suppresses mating of Codling Moth. Immigration of mated female moths from adjacent, infested orchards can reduce the level of control. Area-wide treatment of the entire host plant block is the most effective strategy. To supplement CIDETRAK® CMDA 90/60, use insecticides to control high populations. Monitor all pest populations to determine timely use of insecticides. To manage immigration and high population pressures, consider: 1. Treatment of external sources of infestation with CIDETRAK® CMDA 90/60 2. Treatment of external sources of infestation with an insecticide 3. Treatment of pheromone treated orchard with insecticide Consult your local extension specialist, certified crop advisor, or Trece representative for local field condition management strategies. Monitoring Tip – PHEROCON CMDA COMBO + AA lures capture significantly more adults than PHEROCON CMDA COMBO lures in DA treated orchards.

STORAGE AND DISPOSAL

Do not contaminate food or feed by storage or disposal of unused or used dispensers.

PESTICIDE STORAGE: Store unopened original package in a dry location at temperature below 40° C. To avoid contamination of food or feed items, only unopened product packages may be stored in cold storage facilities that are used for food storage.

PESTICIDE DISPOSAL: Product wastes resulting from use of this product may be disposed of on use site or at an approved waste disposal facility.

CONTAINER DISPOSAL: Offer for recycling, if available. Dispose of empty dispensers and foil envelopes in the trash.

WARRANTY AND LIMITATION OF DAMAGES

All statements concerning the use of this product apply only when used as directed as stated on this product label. To the extent consistent with applicable law, Trece Inc. warrants that the product conforms to this label and under normal conditions of use according to this label, is reasonably fit for the stated label purpose. To the extent consistent with applicable law, the manufacturer makes no express or implied warranties of merchantability or fitness for a purpose concerning this product, or its use, extending beyond the label. Under no circumstance will Trece Inc. be liable for damage (special, consequential or incidental) that result from the handling, storage, or use of this product which is

not in compliance with the label. Read all label directions carefully.

Buyer's exclusive remedy, should this product be defective, is replacement of the product, or if this is impracticable, a purchase price refund.

TRÉCÉ INCORPORATED
Mailing Address: P.O. Box 129 · Adair, Oklahoma 74330
Shipping Address: 7569 Hwy 28 W · Adair, Oklahoma 74330
Phone: (918) 785-3061 · Fax: (918) 785-3063

November 18, 2021

Ms. Annette Marine
Agent
Trece, Inc.
c/o Wagner Regulatory Associates, Inc.
P.O. Box 640
Hockessin, Del. 19707

Subject: Non-PRIA (Pesticide Registration Improvement Act) Labeling Amendment – Correcting typo under "Timing"
Product Name: Cidetrak CMDA 75/45
EPA Registration Number: 51934-16
Application Date: 10/18/2021
OPP Submission Number: 1076973
OPP Case Number: 00332961

Dear Ms. Marine:

The amended labeling referred to above, submitted in connection with registration under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended, is acceptable.

This approval does not affect any terms or conditions that were previously imposed on this registration. You continue to be subject to existing terms or conditions on your registration and any deadlines connected with them.

A stamped copy of your labeling is enclosed for your records. This labeling supersedes all previously accepted labeling. You must submit one (1) copy of the final printed labeling before you release this product for shipment with the new labeling. In accordance with 40 CFR § 152.130(c), you may distribute or sell this product under the previously approved labeling for 18 months from the date of this letter. After 18 months, you may only distribute or sell this product if it bears this new revised labeling or subsequently approved labeling. "To distribute or sell" is defined under FIFRA section 2(gg) and its implementing regulation at 40 CFR § 152.3.

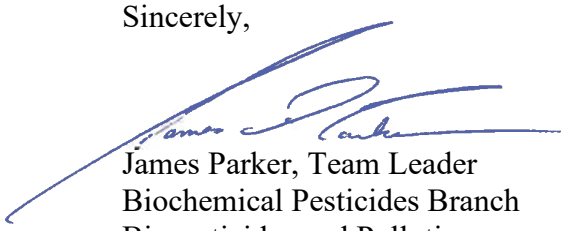
Should you wish to add/retain a reference to your company's website on your label, then please be aware that the website becomes labeling under FIFRA and is subject to review by the U.S. Environmental Protection Agency (EPA). If the website is false or misleading, the product will be considered to be misbranded and sale or distribution of the product is unlawful under FIFRA section 12(a)(1)(E). 40 CFR § 156.10(a)(5) lists examples of statements the EPA may consider false or misleading. In addition, regardless of whether a website is referenced on your product's label, claims

made on the website may not substantially differ from those claims approved through the registration process. Therefore, should the EPA find or if it is brought to our attention that a website contains false or misleading statements or claims substantially differing from the EPA-approved registration, the website will be referred to the EPA's Office of Enforcement and Compliance Assurance.

Your release for shipment of this product constitutes acceptance of these terms. If these terms are not complied with, this registration will be subject to cancellation in accordance with FIFRA section 6.

If you have any questions, please contact Nina Naimy via email at naimy.nina@epa.gov.

Sincerely,



James Parker, Team Leader
Biochemical Pesticides Branch
Biopesticides and Pollution
Prevention Division (7511P)
Office of Pesticide Programs

Enclosure

CIDETRAK® CMDA 75/45
ABNs: CIDETRAK® CMDA COMBO, CIDETRAK® CMDA COMBO MESO-A, CIDETRAK® CMDA COMBO MESO-W

CODLING MOTH PHEROMONE MATING DISRUPTANT
A Mating Disruption Formulation for Codling Moth, *Cydia pomonella,* and Hickory Shuckworm *(Cydia caryana)*

ACTIVE INGREDIENTS:	**Percent by Wt.**
8,10-Dodecadien-1-ol, (8E, 10E)	1.70%
2,4-decadienoic acid, ethyl ester, (E, Z)	1.00%
OTHER INGREDIENTS:	97.30%
TOTAL:	**100.00%**

KEEP OUT OF REACH OF CHILDREN

CAUTION

FIRST AID STATEMENT	
IF ON SKIN OR CLOTHING:	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
IF INHALED:	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. • Call a poison control center or doctor for further treatment advice.
IF IN EYES:	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing. • Call a poison control center or doctor for treatment advice.
IF SWALLOWED:	• Call a poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to by a poison control center or doctor. • Do not give anything to an unconscious person.
HOT LINE NUMBER:	Have the product container or label with you when calling a poison control center or doctor or going for treatment. For emergency information concerning this product, call the National Pesticides Information Center (NPIC) at **1-800-858-7378** seven days a week, 6:30 a.m. to 4:30 p.m. pacific time or your poison control center at **1-800-222-1222**. For additional information, you may also contact Trece Inc. at **1-866-785-1313**.

EPA Registration Number: 51934-16 **EPA Establishment Number: 51934-OK-1**

Net Contents: See last page

Manufactured By:
TRÉCÉ INCORPORATED
7569 Hwy 28 W · Adair, Oklahoma 74330

Precautionary Statements
Hazards to Humans and Domestic Animals

Caution. Avoid contact with skin or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco or using the toilet.

ENVIRONMENTAL HAZARDS

Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment wash water or rinsate.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

READ ENTIRE LABEL BEFORE USING

CIDETRAK® CMDA 75/45 disrupts the mating communication between adult male and female moths, reduces fertile egg laying, suppresses subsequent larval infestation, and reduces the need for applying insecticides.

For maximum effectiveness, remove and destroy infested fruit from trees and the ground. Maintain accurate records of CM adult population monitoring and larval damage within their orchards. Consult your local extension specialist, certified crop advisor, or Trece representative for assistance in designing the best CIDETRAK® CMDA 75/45 program for your orchard.

Crop	Apple, Pear, Walnut, Pecan, Quince, and other pome fruits
Targeted Pest	Codling Moth (Cydia pomonella), Hickory Shuckworm *(Cydia caryana).*
MESO Rate – **for Walnuts**	CIDETRAK® CMDA 75/45: Depending on the population abundance, use a minimum of 11 dispensers per acre (28 dispensers per hectare) to a maximum of 22 dispensers per acre (55 dispensers per hectare). For example, apply 20 dispensers per acre 50 dispensers per hectare) for moderate populations. Apply the maximum dispenser rate to all orchard borders including orchards that are heavily infested with CM, adjacent to an untreated orchard, or otherwise at risk. Do not exceed 150 gm combined a.i. per acre per year.
MESO Rate – **for Apples, Pears, Quince & Other Pome Fruit**	CIDETRAK® CMDA 75/45: Depending on the population abundance, use a minimum of 18 dispensers per acre (45 dispensers per hectare) to a maximum of 36 dispensers per acre (90 dispensers per hectare). For example, apply 32 dispensers per acre (80 dispensers per hectare) for moderate populations. Apply the maximum dispenser rate to all orchard borders including orchards that are heavily infested with CM, adjacent to an untreated orchard, or otherwise at risk. Do not exceed 150 gm combined a.i. per acre per year.
Puzzle Piece Rate – **for Apples, Pears,**	CIDETRAK® CMDA 75/45: Depending on the population abundance, use a minimum of 180 dispensers per acre (450 dispensers per hectare) to a maximum of 360 dispensers per acre (900 dispensers per hectare). For example, apply 288 dispensers per acre (720 dispensers per hectare) for moderate populations. Apply the maximum dispenser rate to all orchard borders, including orchards that

Quince & Other Pome Fruit	are heavily infested with CM, adjacent to an untreated orchard, or otherwise at risk. Do not exceed 150 gm combined a.i. per acre per year.
Application	Meso for walnuts: Attach dispensers securely to lateral branches at 20% of the distance between the trunk and branch terminal at ½ tree height in mature trees. Meso for apples, pears, quince, & other pome fruit: Attach dispensers securely to lateral branches at 10-20% of the distance between the trunk and branch terminal in the upper 1/5th of the canopy. Puzzle piece for apples, pears, quince, & other pome fruit: Attach dispensers securely to lateral branches at 5-10% of the distance between the trunk and branch terminal in the upper 1/5th of the canopy. Attach the dispensers from the ground using a pole applicator, a moving trailer, a hydraulic man-lift or other safe means.
Timing	Apply prior to moth emergence in early spring. Monitor moth activity using PHEROCON® IIB or PHEROCON VI traps and lures. Begin monitoring in early spring and continue throughout the season to assess treatment effectiveness. Depending on temperature, CIDETRAK® CMDA 75/45 dispensers will release pheromone for 120-180 days. In areas with a long field season (i.e., more than 120 days), a second application may be necessary prior to subsequent CM flights. Note - CIDETRAK® CMDA 75/45 will not prevent crop damage from immigration of mated female moths into treated orchards. Nearby (500 yards) untreated Codling Moth hosts, such as apple, walnut, pear, quince, crabapple, plum and others, can be a source of these mated females. Treat with pheromone only when all host crops within or near treated blocks have been treated with CIDETRAK® CMDA 75/45.
Treatment Tips	CIDETRAK® CMDA 75/45 suppresses mating of Codling Moth. Immigration of mated female moths from adjacent, infested orchards can reduce the level of control. Area-wide treatment of the entire host plant block is the most effective strategy. To supplement CIDETRAK® CMDA 75/45, use insecticides to control high populations. Monitor all pest populations to determine timely use of insecticides. To manage immigration and high population pressures, consider: 1. Treatment of external sources of infestation with CIDETRAK® CMDA 75/45 2. Treatment of external sources of infestation with an insecticide 3. Treatment of pheromone treated orchard with insecticide Consult your local extension specialist, certified crop advisor, or Trece representative for local field condition management strategies.

STORAGE AND DISPOSAL

Do not contaminate food or feed by storage or disposal of unused or used dispensers.

PESTICIDE STORAGE: Store unopened original package in a dry location at temperature below 40°F. To avoid contamination of food or feed items, only unopened product packages may be stored in cold storage facilities that are used for food storage.

PESTICIDE DISPOSAL: Product wastes resulting from use of this product may be disposed of on use site or at an approved waste disposal facility. .

CONTAINER HANDLING: Offer for recycling, if available. Dispose of empty dispensers and foil envelopes in the trash.

WARRANTY AND LIMITATION OF DAMAGES

All statements concerning the use of this product apply only when used as directed as stated on this product label. To the extent consistent with applicable law, Trece Inc. warrants that the product conforms to this label and under normal conditions of use according to this label, is reasonably fit for the stated label purpose. To the extent consistent with applicable law, the manufacturer makes no express or implied warranties of merchantability or fitness for a purpose concerning this product, or its use, extending beyond the label. Under no circumstance will Trece Inc. be liable for damage (special, consequential or incidental) that result from the handling, storage, or use of this product which is not in compliance with the label. Read all label directions carefully.

Buyer's exclusive remedy, should this product be defective, is replacement of the product, or if this is impracticable, a purchase price refund.

TRÉCÉ INCORPORATED
Mailing Address: P.O. Box 129 · Adair, Oklahoma 74330
Shipping Address: 7569 Hwy 28 W · Adair, Oklahoma 74330
Phone: (918) 785-3061 · Fax: (918) 785-3063

Lot Number/Batch Code: _____ Net Contents:

CIDETRAK® CMDA 75/45 MESO FOR WALNUTS:
Dispensers per package : 20 dispensers
One dispenser contains : 1,360 mg *8,10-Dodecadien-1-ol, (8E,10E)*
800 mg *2,4-decadienoic acid, ethyl ester, (E,Z)*

CIDETRAK® CMDA 75/45 MESO FOR APPLES, PEARS, QUINCE & OTHER POME FRUITS
Dispensers per package : 40 dispensers
One dispenser contains : 850 mg *8,10-Dodecadien-1-ol, (8E,10E)*
500 mg *2,4-decadienoic acid, ethyl ester, (E,Z)*

CIDETRAK®® CMDA 75/45 PUZZLE PIECE FOR APPLES, PEARS, QUINCE & OTHER POME FRUITS
Dispensers per package : 400 dispensers
One dispenser contains : 85 mg *8,10-Dodecadien-1-ol, (8E,10E)*
50 mg *2,4-decadienoic acid, ethyl ester, (E,Z)*

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

December 26, 2017

Keeva Shultz
Agent for Trece, Inc.
c/o Wagner Regulatory Associates, Inc.
PO Box 640
Hockessin, DE 19707

Subject: Non-PRIA (Pesticide Registration Improvement Act) Labeling and Formulation Amendment – Acceptable Revision to the Active Ingredient Name to Use a Synonymous Nomenclature on the Label and CSFs
Product Name: Cidetrak CMDA+LR
EPA Registration Number: 51934-18
Application Date: 11/21/2017
OPP Decision Number: 536174

Dear Ms. Shultz:

The amended labeling and Confidential Statements of Formula (CSFs) referred to above, submitted in connection with registration under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended, are acceptable.

This approval does not affect any terms or conditions that were previously imposed on this registration. You continue to be subject to existing terms or conditions on your registration and any deadlines connected with them.

Please note that the record for this product currently contains the following acceptable CSFs:

- Basic CSF dated 11/21/2017
- Alternate CSF #1 dated 11/21/2017

Any CSFs other than those listed above are superseded/no longer valid.

A stamped copy of your labeling is enclosed for your records. This labeling supersedes all previously accepted labeling. You must submit one (1) copy of the final printed labeling before you release this product for shipment with the new labeling. In accordance with 40 CFR § 152.130(c), you may distribute or sell this product under the previously approved labeling for 18 months from the date of this letter. After 18 months, you may only distribute or sell this product if it bears this new revised labeling or subsequently approved labeling. "To distribute or sell" is defined under FIFRA section 2(gg) and its implementing regulation at 40 CFR § 152.3.

Should you wish to add/retain a reference to your company's website on your label, then please be aware that the website becomes labeling under FIFRA and is subject to review by the U.S. Environmental Protection Agency (EPA). If the website is false or misleading, the product will be considered to be misbranded and sale or distribution of the product is unlawful under FIFRA section 12(a)(1)(E). 40 CFR § 156.10(a)(5) lists examples of statements the EPA may consider false or misleading. In addition, regardless of whether a website is referenced on your product's label, claims made on the website may not substantially differ from those claims approved through the registration process. Therefore, should the EPA find or if it is brought to our attention that a website contains false or misleading statements or claims substantially differing from the EPA-approved registration, the website will be referred to the EPA's Office of Enforcement and Compliance Assurance.

Your release for shipment of this product constitutes acceptance of these terms. If these terms are not complied with, this registration will be subject to cancellation in accordance with FIFRA section 6.

If you have any questions, please contact Alex Horansky by phone at (703) 347-0128 or via email at horansky.alex@epa.gov.

Sincerely,

For

Andrew Bryceland, Team Leader
Biochemical Pesticides Branch
Biopesticides and Pollution
Prevention Division (7511P)
Office of Pesticide Programs

Enclosure

CIDETRAK® CMDA+LR

ABNs: **CIDETRAK® CMDA+LR Dual MESO**
CIDETRAK® CMDA COMBO +LR MESO
CIDETRAK® CMDA +LR Dual
CIDETRAK® CMDA +LR MESO

ACCEPTED
12/26/2017
Under the Federal Insecticide, Fungicide and Rodenticide Act as amended, for the pesticide registered under EPA Reg. No. 51934-18

CODLING MOTH & LEAFROLLER PHEROMONE MATING DISRUPTANT
A Mating Disruption Formulation for Codling Moth (*Cydia pomonella)*, Hickory Shuckworm *(Cydia caryana)*, Pandemis Leafroller *(Pandemis pyrusana)*, and Obliquebanded Leafroller *(Choristoneura rosaceana)*,

Dispenser A

Active Ingredients:	**Percent by Wt.**
(8*E*,10*E*)-8,10-Dodecadien-1-ol	1.70%
Ethyl (2*E*,4*Z*)-2,4-Decadienoate	1.00%
Other Ingredients:	97.30%
Total:	100.00%

Dispenser B

Active Ingredient:	**Percent by Wt.**
11-Tetradecenyl Acetate	4.93%
Other Ingredients:	95.07%
Total:	100.00%

KEEP OUT OF REACH OF CHILDREN

CAUTION

FIRST AID STATEMENT	
IF ON SKIN OR CLOTHING:	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
IF INHALED:	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. • Call a poison control center or doctor for further treatment advice.
IF IN EYES:	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing. • Call a poison control center or doctor for treatment advice.
IF SWALLOWED:	• Call a poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to by a poison control center or doctor. • Do not give anything to an unconscious person.

HOTLINE NUMBER

Have the product container or label with you when calling a poison control center or doctor or going for treatment.

For emergency information concerning this product, call the National Pesticides Information Center (NPIC) at **1-800-858-7378** Monday-Friday, 8:00 a.m. to 12:00 p.m. pacific time or your poison control center at **1-800222-1222**. For additional information, you may also contact Trece Inc. at **1-866-785-1313**.

EPA Registration Number: 51934-18 **EPA Establishment Number: 51934-OK-002**

Net Contents: See Back Panel

Manufactured by:
TRÉCÉ INCORPORATED

7569 Hwy 28 W. Adair, Oklahoma 74330

PRECAUTIONARY STATEMENTS

Hazards to Humans and Domestic Animals

Caution. Harmful if swallowed, inhaled or absorbed through the skin. Causes moderate eye and skin irritation. Avoid breathing vapor. Avoid contact with eyes, skin or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco or using the toilet.

Environmental Hazards

Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment wash water or rinsate.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

READ ENTIRE LABEL BEFORE USING

CIDETRAK® CMDA+LR is a dual dispenser system using dispensers A and B which contain behavior modifying pheromones in a polymeric matrix. It disrupts the mating communication between adult male and female codling moths and leafrollers, reduces fertile egg laying, suppresses subsequent larval infestation, and reduces the need for applying insecticides.

For maximum effectiveness, remove and destroy infested fruit from trees and the ground. Maintain accurate records of CM and LR adult population monitoring and larval damage within treated orchards. Consult your local extension specialist, certified crop advisor, or Trece representative for assistance in designing the best CIDETRAK®CMDA+LR program for your orchard.

Crop	Apple, Pear, Quince, Pomegranate, Peaches, Nectarines, Plums, and Other Pome and Stone Fruit
Targeted Pest	Codling Moth *(Cydia pomonella)*, Hickory Shuckworm *(Cydia caryana)*, Pandemis Leafroller *(Pandemis pyrusana)*, and Obliquebanded Leafroller *(Choristoneura rosaceana*)
Use Rate	CIDETRAK® CMDA+LR: Attach both dispenser A and dispenser B to a special rotating hook then attach to trees. Depending on the population abundance, use a minimum of 18 A and B dispensers per acre (45 A and B dispensers per hectare) to a maximum of 36 A and B dispensers per acre (90 A and B dispensers per hectare). For example, apply 32 A and B dispensers per acre (80 A and B dispensers per hectare) for moderate populations. Apply the maximum dispenser rate to all orchard borders including orchards that are heavily infested with CM and/or LR adjacent to an untreated or otherwise at risk orchard. Do not exceed 150 gm combined a.i. per acre per year.
Application	Place both dispensers on the rotating hook, place the hook into the applicator tip, and hook both dispensers on the tree from the ground using a pole applicator, a moving trailer, a hydraulic man-lift or other safe means. Distribute dispensers in a grid pattern within the orchard except on borders. Attach both dispensers securely to lateral branches at 10-20% of the distance between the trunk and branch terminal in the upper 1/5th of the canopy.
Timing	Apply prior to moth emergence. Monitor moth activity using PHEROCON® IIB or PHEROCON® VI traps and lures. Begin monitoring in early spring and continue throughout the season to assess treatment effectiveness. Depending on temperature, CIDETRAK® CMDA+LR dispensers will release pheromone for 150-180 days. In areas with a long field season, (i.e. more than 180 days), a second application may be necessary prior to subsequent CM and/or LR flights. Note - CIDETRAK® CMDA+LR will not prevent crop damage from immigration of mated female moths and leafrollers into treated orchards. Nearby (within 500 yards) untreated codling moth and leafroller hosts, such as apple, pear, quince, pomegranate, peaches, nectarines, plums and other pome and stone fruit can be a source of these mated females. Treat with CIDETRAK® CMDA+LR only when all host crops within or near treated blocks have been adequately treated for these pests.

Treatment Tips	CIDETRAK® CMDA+LR suppresses mating of codling moth and leafroller in targeted orchards. Immigration of mated female moths and leafrollers from adjacent, infested orchards can reduce the level of control. Area-wide treatment of the entire host plant block is the most effective strategy. Use insecticides to supplement CIDETRAK® CMDA+LR to control high populations. Monitor all pest populations to determine timely use of insecticides. Consider the following to manage immigration and high population pressures: 1. Treatment of external sources of infestation with CIDETRAK® CMDA+LR 2. Treatment of external sources of infestation with an insecticide 3. Treatment of pheromone treated external orchards with an insecticide Consult your local extension specialist, certified crop advisor, or Trece representative for local field condition management strategies.

STORAGE AND DISPOSAL

Do not contaminate food or feed by storage or disposal of unused or used dispensers.

PESTICIDE STORAGE: Store unopened original package in a dry location at temperature below 40° F. To avoid contamination of food or feed items, only unopened product packages may be stored in cold storage facilities that are used for food storage.

PESTICIDE DISPOSAL: Product wastes resulting from use of this product may be disposed of on use site or at an approved waste disposal facility.

CONTAINER HANDLING: Offer for recycling, if available. Dispose of empty dispensers and foil envelopes in the trash.

WARRANTY AND LIMITATION OF DAMAGES

All statements concerning the use of this product apply only when used as directed as stated on this product label. To the extent consistent with applicable law, Trece Inc. warrants that the product conforms to this label and under normal conditions of use according to this label, is reasonably fit for the stated label purpose. To the extent consistent with applicable law, the manufacturer makes no express or implied warranties of merchantability or fitness for a purpose concerning this product, or its use, extending beyond the label. Under no circumstance will Trece Inc. be liable for damage (special, consequential or incidental) that result from the handling, storage, or use of this product which is not in compliance with the label. Read all label directions carefully.

Buyer's exclusive remedy, should this product be defective, is replacement of the product, or if this is impracticable, a purchase price refund.

TRÉCÉ INCORPORATED
Mailing Address: P.O. Box 129 · Adair, Oklahoma 74330
Shipping Address: 7569 Hwy 28 W · Adair, Oklahoma 74330
Phone: (918) 785-3061 · Fax: (918) 785-3063

Batch Code: _____

Net Contents:
CIDETRAK® CMDA+LR: Dispensers per package: 40 dual dispenser systems
One dispenser "A" contains: 850 mg (8*E*,10*E*)-8,10-Dodecadien-1-ol
500 mg Ethyl (2*E*,4*Z*)-2,4,Decadienoate

One dispenser "B" contains: 966 mg 11-Tetradecenyl acetate

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Pesticide Programs
Biopesticides and Pollution Prevention Division (7511P)
1200 Pennsylvania Ave., N.W.
Washington, D.C. 20460

NOTICE OF PESTICIDE:
_X_ Registration
___ Reregistration
(under FIFRA, as amended)

EPA Reg. Number:	**Date of Issuance:**
51934-21	8/9/2018

Term of Issuance:
Unconditional

Name of Pesticide Product:
Cidetrak CMDA+OFM Meso

Name and Address of Registrant (include ZIP Code):

Trece, Inc.
7569 HWY 28 West
P.O. Box 129
Adair, Oklahoma 74330

Note: Changes in labeling differing in substance from that accepted in connection with this registration must be submitted to and accepted by the Biopesticides and Pollution Prevention Division prior to use of the label in commerce. In any correspondence on this product, always refer to the above EPA Registration Number.

On the basis of information furnished by the registrant, the above named pesticide is hereby registered under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA or the Act).

Registration is in no way to be construed as an endorsement or recommendation of this product by the U.S. Environmental Protection Agency (EPA). In order to protect health and the environment, the Administrator, on his or her motion, may at any time suspend or cancel the registration of a pesticide in accordance with the Act. The acceptance of any name in connection with the registration of a product under the Act is not to be construed as giving the registrant a right to exclusive use of the name or to its use if it has been covered by others.

This product is unconditionally registered in accordance with FIFRA section 3(c)(5) provided that you:

1. Submit and/or cite all data required for registration or registration review of your product when the EPA requires all registrants of similar products to submit such data.

2. Submit storage stability and corrosion characteristics (Guidelines 830.6317 and 830.6320) data as these data requirements are not satisfied. A one-year study is required to satisfy these data requirements. You have 18 months from the date of this registration to provide these data to the EPA.

Signature of Approving Official:

For

Andrew C. Bryceland, Team Leader
Biochemical Pesticides Branch
Biopesticides and Pollution Prevention Division (7511P)
Office of Pesticide Programs

Date:
8/9/2018

EPA Form 8570-6

3. Make the following labeling change before you release this product for shipment:

    - Revise the EPA Registration Number to read, "EPA Reg. No. 51934-21."

4. Submit one (1) copy of the final printed labeling for the record before you release this product for shipment.

Should you wish to add/retain a reference to your company's website on your label, then please be aware that the website becomes labeling under FIFRA and is subject to review by the EPA. If the website is false or misleading, the product will be considered to be misbranded and sale or distribution of the product is unlawful under FIFRA section 12(a)(1)(E). 40 CFR § 156.10(a)(5) lists examples of statements the EPA may consider false or misleading. In addition, regardless of whether a website is referenced on your product's label, claims made on the website may not substantially differ from those claims approved through the registration process. Therefore, should the EPA find or if it is brought to our attention that a website contains false or misleading statements or claims substantially differing from the EPA-approved registration, the website will be referred to the EPA's Office of Enforcement and Compliance Assurance.

Your release for shipment of this product constitutes acceptance of these terms. If these terms are not complied with, this registration will be subject to cancellation in accordance with FIFRA section 6. A stamped copy of the labeling is enclosed for your records. Please also note that the record for this product currently contains the following acceptable Confidential Statement of Formula (CSF):

- Basic CSF dated 12/29/2017

If you have any questions, please contact Alex Horansky of my branch by phone at (703) 347-0128 or via email at Horansky.alex@eap.gov.

Sincerely,

Andrew C. Bryceland, Team Leader
Biochemical Pesticides Branch
Biopesticides and Pollution Prevention Division (7511P)
Office of Pesticide Programs

Enclosure

CIDETRAK® CMDA+OFM MESO

Alternate Brand Names: **CIDETRAK® CMDA COMBO+OFM MESO**

CODLING MOTH & ORIENTAL FRUIT MOTH PHEROMONE MATING DISRUPTANT
A Mating Disruption Formulation for Codling Moth (*Cydia pomonella)*, Hickory Shuckworm *(Cydia caryana)*, Oriental Fruit Moth (*Grapholita molesta*), Macadamia Nut Borer (*Cryptophelbia ambrodelta*), and KOA Seedworm (*Cryptophlebia illepida*)

Active Ingredients:	**Percent by Wt.**
(8*E*,10*E*)-8,10-Dodecadien-1-ol	1.60%
Ethyl (2*E*,4*Z*)-2,4-Decadienoate	0.90%
Z-8-Dodecen-1-yl Acetate	0.99%
E-8-Dodecen-1-yl Acetate	0.09%
Z-8-Dodecen-1-ol	0.01%
Other Ingredients:	96.41%
Total:	100.00%

ACCEPTED
08/09/2018
Under the Federal Insecticide, Fungicide and Rodenticide Act as amended, for the pesticide registered under EPA Reg. No. 51934-21

KEEP OUT OF REACH OF CHILDREN
CAUTION

FIRST AID STATEMENT	
IF ON SKIN OR CLOTHING:	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
IF INHALED:	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. • Call a poison control center or doctor for further treatment advice.
IF IN EYES:	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing. • Call a poison control center or doctor for treatment advice.
IF SWALLOWED:	• Call a poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to by a poison control center or doctor. • Do not give anything to an unconscious person.
HOT LINE NUMBER:	Have the product container or label with you when calling a poison control center or doctor or going for treatment. For emergency information concerning this product, call the National Pesticides Information Center (NPIC) at **1-800-858-7378** seven days a week, 6:30 a.m. to 4:30 p.m. pacific time or your poison control center at **1-800-222-1222**. For additional information, you may also contact Trece Inc. at **1-866-785-1313**.

EPA Registration Number: 51934-XX **EPA Establishment Number: 51934-OK-002**

Manufactured by:
TRÉCÉ INCORPORATED
7569 Hwy 28 W . Adair, Oklahoma
74330

Precautionary Statements
Hazards to Humans and Domestic Animals

Caution. Harmful if swallowed. Avoid contact with skin or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco or using the toilet.

ENVIRONMENTAL HAZARDS

Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment wash water or rinsate.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

READ ENTIRE LABEL BEFORE USING

CIDETRAK® CMDA+OFM MESO is a combination of behavior modifying pheromones in a polymeric matrix. It disrupts the mating communication between adult male and female codling moths, hickory shuckworms, oriental fruit moths, macadamia nut borers, and koa seedworms, reduces fertile egg laying, suppresses subsequent larval infestation, and reduces the need for applying insecticides.

For maximum effectiveness, remove and destroy infested nuts from trees and the ground. Maintain accurate records of Codling Moth (CM), Oriental Fruit Moth (OFM) and other labeled insects adult population monitoring and larval damage within treated orchards. Consult your local extension specialist, certified crop advisor, or Trece representative for assistance in designing the best CIDETRAK® CMDA+OFM MESO program for your orchard.

Crop	**Almond, Fig, Pistachio, Walnut, Peaches, Nectarines, Apricots, Plums, Cherries, and other stone fruits; Apples, Pears, Quince, and other pome fruits, Macadamia, and other tree fruit crops.**
Targeted Pest	Codling Moth *(Cydia pomonella)*, Hickory Shuckworm *(Cydia caryana)*, Oriental Fruit Moth (*Grapholita molesta*), Macadamia Nut Borer (*Cryptophelbia ambrodelta*), and KOA Seedworm (*Cryptophlebia illepida*)
Use Rate	CIDETRAK® CMDA+OFM MESO: Attach the special rotating hook then attach to trees. Depending on the population abundance, use a minimum of 30 dispensers per acre (75 dispensers per hectare) to a maximum of 38 dispensers per acre (95 dispensers per hectare). For example, apply 32 dispensers per acre (80 per hectare) for moderate populations. Apply the maximum dispenser rate to all orchard borders including orchards that are heavily infested with Codling Moth, Oriental Fruit Moth or other labeled insects adjacent to an untreated or otherwise at risk orchard. Do not exceed 150 gm combined a.i. per acre per year.
Application	Place the dispenser on the rotating hook, place the hook into the applicator tip, and hook the dispenser on the tree from the ground using a pole applicator, a moving trailer, a hydraulic man-lift or other safe means. Distribute dispensers in a grid pattern within the orchard except on borders. Attach dispensers securely to lateral branches at 10 - 20% of the distance between the trunk and branch terminal in the upper 1/5th of the canopy.
Timing	Apply prior to moth emergence in early spring. Monitor moth activity using PHEROCON® IIB or PHEROCON® VI traps and lures. Begin monitoring in early spring and continue throughout the season to assess treatment effectiveness.

	Depending on temperature, CIDETRAK® CMDA+OFM MESO dispensers will release pheromone for 150-180 days. In areas with a long field season, (i.e. more than 180 days), a second application may be necessary prior to subsequent Codling Moth and/or Oriental Fruit Moth flights. Note - CIDETRAK® CMDA+OFM MESO will not prevent crop damage from immigration of mated female moths into treated orchards. Nearby (up to 500 yards or greater) untreated hosts, such as almonds, apple, pear, quince, and walnuts and others, can be a source of mated females. Treat with pheromone only when all host crops within or near treated blocks have been adequately treated for these pests.
Treatment Tips	CIDETRAK® CMDA+OFM MESO suppresses mating of codling moth, hickory shuckworm, oriental fruit moth, macadamia nut borer, and koa seedworm in targeted orchards. Immigration of mated female moths from adjacent, infested orchards can reduce the level of control. Area-wide treatment of the entire host plant block is the most effective strategy. Use insecticides to supplement CIDETRAK® CMDA+OFM MESO to control high populations. Monitor all pest populations to determine timely use of insecticides. Consider the following to manage immigration and high population pressures: 1. Treatment of external sources of infestation with CIDETRAK® CMDA+OFM MESO 2. Treatment of external sources of infestation with an insecticide 3. Treatment of pheromone treated external orchards with an insecticide Consult your local extension specialist, certified crop advisor, or Trece representative for local field condition management strategies.

STORAGE AND DISPOSAL

Do not contaminate food or feed by storage or disposal of unused or used dispensers.

PESTICIDE STORAGE: Store unopened original package in a dry location at temperature below 40° F. To avoid contamination of food or feed items, only unopened product packages may be stored in cold storage facilities that are used for food storage.

PESTICIDE DISPOSAL: Product wastes resulting from use of this product may be disposed of on use site or at an approved waste disposal facility.

CONTAINER HANDLING: Offer for recycling, if available. Dispose of empty dispensers and foil envelopes in the trash.

WARRANTY AND LIMITATION OF DAMAGES

All statements concerning the use of this product apply only when used as directed as stated on this product label. To the extent consistent with applicable law, Trece Inc. warrants that the product conforms to this label and under normal conditions of use according to this label, is reasonably fit for the stated label purpose. To the extent consistent with applicable law, the manufacturer makes no express or implied warranties of merchantability or fitness for a purpose concerning this product, or its use, extending beyond the label. Under no circumstance will Trece Inc. be liable for damage (special, consequential or incidental) that result from the handling, storage, or use of this product which is not in compliance with the label. Read all label directions carefully.

Buyer's exclusive remedy, should this product be defective, is replacement of the product, or if this is impracticable, a purchase price refund.

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74330

Shipping Address: 7569 Hwy 28 W . Adair, Oklahoma 74330
Phone: (918) 785-3061 . Fax: (918) 785-3063

Net Contents:
CIDETRAK® CMDA+OFM MESO:
Dispensers per package: 40 dispensers
One dispenser contains: 800 mg (8*E*,10*E*)-8,10-Dodecadien-1-ol
450 mg Ethyl (2*E*,4*Z*)-2,4,Decadienoate
497.4 mg Z-8-Dodecen-1-yl Acetate
45.2 mg E-8-Dodecen-1-yl Acetate
7.4 mg Z-8-Dodecen-1-ol

APPENDIX B: MSDS

SAFETY DATA SHEET

BEDOUKIAN®

1. Identification

Product identifier **ETHYL 2,4-DECADIENOATE**

Other means of identification

BRI Product Code 433

FEMA number 3148

Synonyms 2,4-Decadienoic acid, ethyl ester, (2E,4Z)- * ethyl (2E,4Z)-decadienoate * Ethyl e-2,z-4-decadienoate * Ethyl trans-2,cis-4-decadienoate * Pear ester * Ethyl (2E,4Z)-2,4-decadienoate

Recommended use flavors and fragrances

For Manufacturing Use Only

Recommended restrictions Not for use in Tobacco or Nicotine delivery device applications and/or products.

Manufacturer/Importer/Supplier/Distributor information

Manufacturer

Company name Bedoukian Research US

Address 6 Commerce Drive
Danbury, CT 06810
United States

Telephone 1-203-830-4000

Website www.bedoukian.com

E-mail customerservice@bedoukian.com

Contact person Joseph Bania

Emergency phone number Chemtrec (North America) 1-800-424-9300
Chemtrec (International) 1-703-527-3887

2. Hazard(s) identification

Physical hazards	Not classified.	
Health hazards	Skin corrosion/irritation	Category 2
Environmental hazards	Hazardous to the aquatic environment, acute hazard	Category 1
	Hazardous to the aquatic environment, long-term hazard	Category 1
OSHA defined hazards	Not classified.	

Label elements

Signal word Warning

Hazard statement Causes skin irritation. Very toxic to aquatic life. Very toxic to aquatic life with long lasting effects. Contains D,L-alpha tocopherol. May produce an allergic reaction.

Precautionary statement

Prevention Wash thoroughly after handling. Avoid release to the environment. Wear protective gloves.

Response If on skin: Wash with plenty of water. If skin irritation occurs: Get medical advice/attention. Take off contaminated clothing and wash before reuse. Collect spillage.

Storage Not applicable.

Disposal Dispose of contents/container in accordance with relevant area regulations.

Hazard(s) not otherwise classified (HNOC) None known.

Supplemental information Contains Dl-.alpha.-tocopherol. May produce an allergic reaction.

3. Composition/information on ingredients

Substances

Chemical name	Common name and synonyms	CAS number	%
Ethyl (2E,4Z)-2,4-decadienoate	2,4-Decadienoic acid, ethyl ester, (2E,4Z) - ethyl (2E,4Z)-decadienoate Ethyl e-2,z-4-decadienoate Ethyl trans-2,cis-4-decadienoate Pear ester Ethyl (2E,4Z)-2,4-decadienoate	3025-30-7	100
Dl-.alpha.-tocopherol		10191-41-0	0.1

*Designates that a specific chemical identity and/or percentage of composition has been withheld as a trade secret.

Composition comments See Section 11 below for testing of the substance as a whole for skin sensitization.

4. First-aid measures

Inhalation Move to fresh air. Call a physician if symptoms develop or persist.

Skin contact Remove contaminated clothing. Wash with plenty of soap and water. If skin irritation occurs: Get medical advice/attention. Wash contaminated clothing before reuse.

Eye contact Rinse with water. Get medical attention if irritation develops and persists.

Ingestion Rinse mouth. Get medical attention if symptoms occur.

Most important symptoms/effects, acute and delayed Skin irritation. May cause redness and pain.

Indication of immediate medical attention and special treatment needed Provide general supportive measures and treat symptomatically. Keep victim under observation. Symptoms may be delayed.

General information Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. Fire-fighting measures

Suitable extinguishing media Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2).

Unsuitable extinguishing media Do not use water jet as an extinguisher, as this will spread the fire.

Specific hazards arising from the chemical During fire, gases hazardous to health may be formed.

Special protective equipment and precautions for firefighters Self-contained breathing apparatus and full protective clothing must be worn in case of fire.

Fire fighting equipment/instructions Move containers from fire area if you can do so without risk.

Specific methods Use standard firefighting procedures and consider the hazards of other involved materials.

General fire hazards No unusual fire or explosion hazards noted.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Wear appropriate protective equipment and clothing during clean-up. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.

Methods and materials for containment and cleaning up This product is miscible in water. Prevent entry into waterways, sewer, basements or confined areas.

Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Absorb in vermiculite, dry sand or earth and place into containers. Following product recovery, flush area with water.

Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination.

Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS.

Environmental precautions	Avoid release to the environment. Inform appropriate managerial or supervisory personnel of all environmental releases. Prevent further leakage or spillage if safe to do so. Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling	Avoid contact with eyes, skin, and clothing. Provide adequate ventilation. Wear appropriate personal protective equipment. Avoid release to the environment. Observe good industrial hygiene practices.
Conditions for safe storage, including any incompatibilities	Store in original tightly closed container. Store away from incompatible materials (see Section 10 of the SDS). Recommended Packaging: Glass, Plastic, Aluminum or Phenolic Lined Steel. Store tightly sealed under inert gas below 0 deg. C

8. Exposure controls/personal protection

Occupational exposure limits	This substance has no PEL, TLV, or other recommended exposure limit.
Biological limit values	No biological exposure limits noted for the ingredient(s).
Appropriate engineering controls	Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Eye wash fountain and emergency showers are recommended.

Individual protection measures, such as personal protective equipment

Eye/face protection	Face shield is recommended. Wear safety glasses with side shields (or goggles).
Skin protection	
Hand protection	Wear appropriate chemical resistant gloves. Select suitable chemical resistant protective gloves (EN 374) with a protective index 6 (>480min permeation time).
Other	Wear appropriate chemical resistant clothing. Use of an impervious apron is recommended.
Respiratory protection	In case of insufficient ventilation, wear suitable respiratory equipment.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
General hygiene considerations	Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance	
Physical state	Liquid.
Color	colorless to slightly yellow
Odor	responsible for bartlett pear odor.
Odor threshold	Not available.
pH	Not available.
Melting point/freezing point	-60.3 OECD 102
Initial boiling point and boiling range	479.84 °F (248.8 °C) OECD 103
Flash point	> 212 °F (> 100 °C) EPA OPPTS 830.6315 The flash point was tested using the Pensky-Martens Closed Cup technique. The temperature of the substance exceeded 100 degrees C, so testing was stopped. The flash point was greater than 100 degrees C. The substance is therefore not flammable. 243 °F (117 °C) Closed Cup
Evaporation rate	Not available.
Flammability (solid, gas)	Not applicable.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not available.
Flammability limit - upper (%)	Not available.
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	160.0 Pa OECD 104 at 21.1°C

Vapor density	6.8 Relative to air; air = 1
Relative density	Not available.
Solubility(ies)	
Solubility (water)	7.12 mg/l OECD 105 at 19°C
Partition coefficient (n-octanol/water)	4.4 OECD 117 4.1 - 4.7 was the range.
Auto-ignition temperature	512.6 °F (267 °C) ASTM E659
Decomposition temperature	Not available.
Viscosity	Not available.
Other information	
Density	0.905 g/ml OECD 109
Explosive properties	Not explosive.
Flammability class	Combustible IIIB estimated
Molecular formula	C12H20O2
Molecular weight	196.28
Oxidizing properties	Not oxidizing.
Specific gravity	0.9 - 0.905 at 25°C

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Contact with incompatible materials.
Incompatible materials	Strong oxidizing agents.
Hazardous decomposition products	No hazardous decomposition products are known.

11. Toxicological information

Information on likely routes of exposure

Inhalation	May cause allergy or asthma symptoms or breathing difficulties if inhaled.
Skin contact	Causes skin irritation. May cause an allergic skin reaction.
Eye contact	Direct contact with eyes may cause temporary irritation.
Ingestion	Expected to be a low ingestion hazard.
Symptoms related to the physical, chemical and toxicological characteristics	Skin irritation. May cause redness and pain.

Information on toxicological effects

Acute toxicity

Components	Species	Test Results
Ethyl (2E,4Z)-2,4-decadienoate (CAS 3025-30-7)		
Acute		
Dermal		
Liquidc		
LD50	Rabbit	> 5000 mg/kg Guideline: FHSA, 16 CFR 1500.3(c)(2)(i). The acute dermal toxicity of ethyl decedienoate was determined. Two animals were dosed at 5.0 g/ kg dermally. If either of these animals die, then three additional groups are given various doses to determine the LD50. If neither animal in the initial dose group die, then an additional eight animals are dosed at 5.0 g/kg. As the two initial animals did not die, an additional 8 animals were dosed at 5.0 g/kg. Dermal exposure was for 24 hrs with occlusive covering. Animals were observed for mortality, toxicity, pharmacological effect, body weight, dermal irriation and gross pathology. No animals died during the study.
Oral		
Liquidc		
LD50	Rat	> 5000 mg/kg Guideline: FHSA, 16 CFR 1500.3(c)(2)(i). The oral toxicity of ethyl decadienoate was tested in 10 rats. The 10 male rats were given doses of 5 g/kg of the test substance. They were then monitored for 14 days. No animals died during the study. Some minor clinical signs were noted, and only one abnormality was noted during the necropsies.

* Estimates for product may be based on additional component data not shown.

Skin corrosion/irritation Causes skin irritation.

Irritation Corrosion - Skin

Ethyl (2E,4Z)-2,4-decadienoate	3 % Patch test, Vehicle Petrolatum. Result: No irritation observed. Species: Human Organ: Skin Notes: RIFM 5000 mg/kg LD50, Evaluated on days 1, 7, and 14 of an LD50 study, 10 animals evaluated. moderate redness in 8, slight redness in 2; moderate edema in 2, slight edema in 8. Day 14, severe redness in 4 with flaking & eschar formation. Result: Irritation noted. Species: Rabbit Organ: Skin Notes: RIFM OECD 404, 3 male rabbits were exposed to 0.5 cc of test substance for 4 hrs. The test substance was then removed, and observations made at 1, 24, 48, and 72 hrs after removal, and also at 6, 9, 12, and 14 days after removal. All animals showed evidence of irritation that was not fully resolved by Day 14. The test substance is moderately irritating to skin. Result: Irritation noted. Species: Rabbit Organ: Skin

Serious eye damage/eye irritation Direct contact with eyes may cause temporary irritation.

Irritation Corrosion - Eye

Ethyl (2E,4Z)-2,4-decadienoate	OECD 405, Three rabbits were exposed to 0.1 cc of test substance. The other eye remained untreated as a control. Some redness and discharge was seen at the 1 hr and 24 hr observations, but there were no signs of irritation at the 48 hr observation. The irritation index was 1.83/110. The test substance is therefore not irritating to the eye. Result: Not irritating. Species: Rabbit Organ: Eye

Respiratory or skin sensitization

Respiratory sensitization Not a respiratory sensitizer.

Skin sensitization This product is not expected to cause skin sensitization.

Skin sensitization

Ethyl (2E,4Z)-2,4-decadienoate	3 % Patch test, Vehicle Petrolatum. 30 volunteers, 27 completed the study. Result: Not sensitizing. Species: Human Organ: Skin Notes: RIFM OECD 422E, In theory, the test item is considered to be no skin sensitiser. However, since the log KOW is higher than 3.5, the results must be considered as inconclusive. The controls confirmed the validity of the study for all experiments. In this study under the given conditions the test item did not upregulate the expression of the cell surface markers in at least two independent experiment runs. However, since the log KOW is higher than 3.5, the results must be considered as inconclusive. Result: inconclusive. Organ: In vitro human cell line activation test (h-CLAT) OECD 442C, The skin sensitization potential of the test substance was determine in a peptide reactivity assay. The test evaluates the reactivity of the test sustance to peptides containing lysine and cysteine. Although the control show the test to be valid, phase seperation of the test substance means a prediction of sensitivity cannot be made. Result: not determinable. Species: In chemico OECD 442D, In this study under the given conditions the test item did not induce the luciferase activity in the transgenic KeratinoSens™ cell line in at least two independent experiment runs. Therefore, the test item can be considered as nonsensitiser. The data generated with this method may not be sufficient to conclude on the absence of skin sensitisation potential of chemicals and should be considered in the context of integrated approach such as IATA. Result: Not sensitizing. Organ: In vitro KeratinoSens™ assay

Germ cell mutagenicity No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Germ cell mutagenicity: Ames test

Ethyl (2E,4Z)-2,4-decadienoate	OECD 471, E. coli WP2 uvrA. The mutagenicity was tested both in the presence and absence of S9 using DMSO as a solvent. Doses of 5.00, 15.0, 50.0, 150, 500, 1500, and 5000 ug/plate were tested. Toxicity was seen at doses of 500 ug/plate or higher. The test substance was not mutagenic either in the presence or absence of S9. Result: Not mutagenic. Species: Escherichia coli

Germ cell mutagenicity: Ames test

Ethyl (2E,4Z)-2,4-decadienoate	OECD 471, S. typhimurium TA 1535, TA 1537, TA 98, TA 100. The mutagenicity was tested both in the presence and absence of S9 using DMSO as a solvent. Doses of 5.00, 15.0, 50.0, 150, 500, 1500, and 5000 ug/plate were tested. Toxicity was seen at doses of 500 ug/ plate or higher. The test substance was not mutagenic either in the presence or absence of S9. Result: Not mutagenic. Species: Salmonella typhimurium

Carcinogenicity Not classifiable as to carcinogenicity to humans.

IARC Monographs. Overall Evaluation of Carcinogenicity

Not listed.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not regulated.

US. National Toxicology Program (NTP) Report on Carcinogens

Not listed.

Reproductive toxicity This product is not expected to cause reproductive or developmental effects.

Specific target organ toxicity - single exposure Not classified.

Specific target organ toxicity - repeated exposure Not classified.

Aspiration hazard Not an aspiration hazard.

Further information May cause allergic respiratory and skin reactions.

12. Ecological information

Ecotoxicity Very toxic to aquatic life with long lasting effects.

Components		Species	Test Results
Ethyl (2E,4Z)-2,4-decadienoate (CAS 3025-30-7)			
Aquatic			
Acute			
Algae	EC50	Algae	0.13 mg/l, 72 hr OECD 201
	NOEC	Algae	0.074 mg/l, 96 hr OECD 201
Crustacea	EC50	Daphnia	1.4 mg/l, 48 hr OECD 202. Groups of Daphnia magna were exposed to concentrations of 0.18 mg a.i./L, 0.34 mg a.i./L, 0.66 mg a.i./L, 1.5 mg a.i./L, or 2.6 mg a.i./L (measured), for 48 hrs. 60% immobility was seen in the 1.5 mg a.i./L group, and 100% immobility in the 2.6 mg a.i./L group. No immobility was seen in other groups.

* Estimates for product may be based on additional component data not shown.

Persistence and degradability The product is readily biodegradable.

Biodegradability

Percent degradation (Aerobic biodegradation-ready)

Ethyl (2E,4Z)-2,4-decadienoate	OECD 301F, 30 mg/L of test substance was monitored for biodegradation by activated sludge for 34 days. Sodium benzoate was used as a reference substance. The oxygen consumption was monitored during this time. The reference substance results met the validity criteria. The test substance biodegraded 72% in 28 days, and met the 10-day window requirement. It is therefore readily biodegradable. Result: Readily biodegradable. Species: activated sludge, domestic (adaptation not specified)

Bioaccumulative potential

Partition coefficient n-octanol / water (log Kow)

ETHYL 2,4-DECADIENOATE	4.4 OECD 117, 4.1 - 4.7 was the range.

Partition coefficient n-octanol / water (log Kow)

Ethyl (2E,4Z)-2,4-decadienoate	4.1 - 4.7 OECD 117

Mobility in soil No data available.

Other adverse effects No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal instructions Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container. Dispose of contents/container in accordance with local/regional/national/international regulations.

Local disposal regulations Dispose in accordance with all applicable regulations.

Hazardous waste code The waste code should be assigned in discussion between the user, the producer and the waste disposal company.

Waste from residues / unused products Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

Contaminated packaging Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. Transport information

DOT

Not regulated as dangerous goods.

IATA

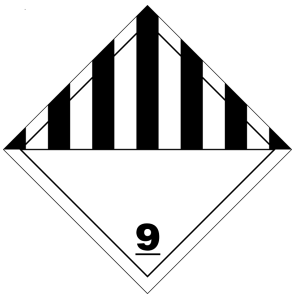
UN number	UN3082
UN proper shipping name	Environmentally hazardous substance, liquid, n.o.s. (ETHYL 2,4-DECADIENOATE)
Transport hazard class(es)	
Class	9
Subsidiary risk	-
Packing group	III
Environmental hazards	Yes
ERG Code	9L
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Other information	
Passenger and cargo aircraft	Allowed with restrictions.
Cargo aircraft only	Allowed with restrictions.

IMDG

UN number	UN3082
UN proper shipping name	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (ETHYL 2,4-DECADIENOATE), MARINE POLLUTANT
Transport hazard class(es)	
Class	9
Subsidiary risk	-
Packing group	III
Environmental hazards	
Marine pollutant	Yes
EmS	F-A, S-F
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not established.

IATA; IMDG



Marine pollutant

General information IMDG Regulated Marine Pollutant.

15. Regulatory information

US federal regulations This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

CERCLA Hazardous Substance List (40 CFR 302.4)

Not listed.

SARA 304 Emergency release notification

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not regulated.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories Immediate Hazard - Yes
Delayed Hazard - No
Fire Hazard - No
Pressure Hazard - No
Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical No

SARA 313 (TRI reporting)

Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA) Not regulated.

US state regulations California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65): This material is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
Taiwan	Taiwan Toxic Chemical Substances (TCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date 16-May-2015

Revision date 21-March-2023

Version # 16

Disclaimer Bedoukian Research US cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.

Revision information This document has undergone significant changes and should be reviewed in its entirety.

APPENDIX C: EPA BRAD Document

BIOPESTICIDES REGISTRATION ACTION DOCUMENT

Ethyl-2E,4Z-decadienoate
(Pear Ester)

PC Code: 144022

U.S. Environmental Protection Agency
Office of Pesticide Programs
Biopesticides and Pollution Prevention Division

(last updated August 7, 2013)

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BIOPESTICIDES REGISTRATION ACTION DOCUMENT (BRAD) TEAM

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Product Chemistry/Human Health Effects/Nontarget Organisms
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I. EXECUTIVE SUMMARY

Ethyl-2E,4Z-decadienoate (pear ester) is a naturally occurring, volatile substance emitted from mature, ripening fruit, that is particularly attractive to the codling moth (CM), *Cydia pomonella*. This species of moth is a major agricultural pest of pome fruit worldwide (Ref. 1). Both male and female moths have receptors for pear ester in their antenna, which attracts them to ripening fruit where they can mate and their eggs will be laid in the fruit. Synthetic pear ester is structurally and functionally identical to its natural counterpart, and its intended pesticidal use is to disrupt the CM mating behavior by confusing the moths and attracting them away from the fruit, and reducing their chances of finding mates and laying eggs in fruit orchards.

The manufacturing-use pesticide product, Pear Ester Technical Grade (EPA File Symbol No. 52991-ET), is proposed to be registered. This product contains pear ester at 93.4% and is intended for formulating end-use products that will be applied pre-harvest, as a foliar spray or contained within polymeric dispensers, to pome fruit orchards in agricultural settings where codling moths appear in order to disrupt their normal mating patterns.

Data derived from appropriate tests give no indication that pear ester is toxic or pathogenic to humans. No unreasonable adverse effects to humans are expected from its use as a codling moth mating disruptor. Furthermore, pesticide products containing pear ester are not likely to pose a risk to the environment, including nontarget organisms.

On October 1, 2009, the U.S. Environmental Protection Agency (EPA or the Agency) announced a policy to provide a more meaningful opportunity for the public to participate in major registration decisions before they occur. According to this policy, EPA provides a public comment period prior to making a registration decision for the following types of applications: new active ingredients; first food uses; first outdoor uses; first residential uses; or any other registration actions for which EPA believes there may be significant public interest.

Consistent with the policy of making registration decisions more transparent, the public is provided 15 days in which to submit comments to the Agency regarding its pending decision to register pear ester as a new pesticide active ingredient, including its first food use and first outdoor use. The following documents are available for comment in the docket, identification number EPA-HQ-OPP-2011-1031: this draft Biopesticides Registration Action Document (BRAD) and the draft product label for Pear Ester Technical Grade (EPA File Symbol 52991-ET), accessed through either *http://www.regulations.gov* or *http://www.epa.gov/pesticides/regulating/registration-status.html*.

For definitions of scientific terms, please refer to *http://www.epa.gov/pesticides/glossary/*.

II. ACTIVE INGREDIENT OVERVIEW

Common Name: Pear Ester

Chemical Names: Ethyl-2E,4Z-decadienoate

Trade & Other Names: Pear Ester Technical Grade

CAS Registry Number: 3025-30-7

OPP Chemical Code: 144022

Type of Pesticide: Biochemical Pesticide – Mating Disruptor

Biochemical Classification

To be classified as a biochemical pesticide, an active ingredient must be naturally occurring and have a non-toxic mode of action on their targeted pests. As a structural and functional mimic of naturally occurring ethyl-2E,4Z-decadienoate, with a non-toxic mode of action (mating disruption by confusion) towards the target pest, pear ester meets the qualifications to be classified as a biochemical pesticide.

For more information regarding product chemistry data requirements, please refer to Tables 1 and 2 in Appendix A.

III. REGULATORY BACKGROUND

A. Application for Pesticide Registration

On July 12, 2011, Wagner Regulatory Associates, Inc., on behalf of Bedoukian Research, Inc. (hereafter referred to as "Bedoukian" or "applicant"), 21 Finance Drive, Danbury, CT, 06810, submitted applications to register a new biochemical pesticide product, Pear Ester Technical Grade (EPA File Symbol No. 52991-ET), containing ethyl-2E,4Z-decadienoate (pear ester) as the active ingredient. The product is intended to be used to manufacture end-use pesticide products that cause mating disruption in codling moths in pome fruit orchards. A notice of receipt (NOR) of the applications was published in the Federal Register on February 29, 2012, (77 FR 12295). No comments were received during the 30-day comment period following publication of the NOR.

B. Food Clearances/Tolerances

On July 12, 2011, Wagner Regulatory Associates, on behalf of Bedoukian, filed a petition (PP 1F9701) proposing to establish an exemption from the requirement of a tolerance for residues of Pear Ester in or on all food commodities. A notice of filing (NOF) was published in the Federal Register on March 14, 2012 (77 FR 15012). No comments were received regarding pear ester

during the 30-day comment period following the publication of the NOF.

Pear ester is an approved additive listed by the U.S. Food and Drug Administration (FDA) on the Everything Added to Food in the United States (EAFUS) list (Ref. 2). It has an intensely fruity flavor and is used in candies and other processed foods. The average daily intake of pear ester reported by the Joint Food and Agriculture Organization of the United States/World Health Organization Expert Committee on Food Additives is 34µg in Europe and 3µg in the United States. JECFA has determined that current intake of pear ester poses no safety concerns (Ref. 1).

Foliar sprays of pear ester that reach the fruit are expected to degrade over the course of the season prior to harvest because this biochemical is a volatile kairomone (Henry's Law Constant estimated 7 x 10^{-4} atm m^3/mol) that dissipates rapidly in the environment and undergoes degradation in the presence of air and light (Ref. 1). However, assuming a foliar spray worst case scenario (no volatilization or degradation), the potential dietary exposure of pear ester has been calculated as 6.4µg in unwashed fruit. When the product is to be released over time (volatilization) from a polymeric dispenser attached to the tree branch, a worst case scenario indicates 0.16 µg pear ester in unwashed fruit (Ref. 3). Therefore, consumption of pear ester as a result of pesticidal exposure is not expected to exceed the current exposure to pear ester as a flavoring agent.

Based on information submitted in support of the tolerance petition, and the comprehensive risk assessment conducted by the Agency, EPA concludes that there is a reasonable certainty of no harm from aggregate exposures to pear ester, including the consumption of food treated with this active ingredient in accordance with label directions and good agricultural practices. EPA has made this determination for the following reasons: (1) available toxicology data and information indicate that the active ingredient is of low acute toxicity and is not a likely developmental toxicant, mutagen, or toxic via repeat oral exposure (2) available information from the scientific literature indicates that humans are already exposed to pear ester in their diet from foods that naturally contain the chemical and from foods to which the chemical has been added as higher levels.

IV. RISK ASSESSMENT

A. Product Analysis Assessment (40 CFR § 158.2030)

Biochemical pesticide product analysis data requirements include product chemistry and composition, analysis and certified limits, and physical and chemical characteristics. Product chemistry and composition data include information about the identity of the active ingredient, the manufacturing process, and discussion of the potential for formation of unintentional ingredients. Analysis and certified limits data include information on analysis of samples and certification of limits. Physical and chemical characteristics data describe basic characteristics of the registered pesticide products, including color, physical state, odor, stability, miscibility, pH, corrosion characteristics, viscosity and density.

EPA assigned a unique PC code (144022) to pear ester, and all product analysis data required for an unconditional registration have been fulfilled.

Refer to Table 1 in Appendix A for a summary of product chemistry and composition, analysis and certified limits data. Refer to Table 2 in Appendix A for a summary of physical and chemical characteristics data.

B. Human Health Assessment

1. Tier I Toxicology

Adequate mammalian toxicology data and information are available to support registration of pear ester as a biochemical pesticide. All toxicology data requirements for pear ester have been satisfied, and are summarized below (see also Table 3 in Appendix A of this document).

Acute Toxicity *(OCSPP Guideline Nos. 870.1100, 870.1200, 870.1300, 870.2400, 870.2500, and 870.2600; Master Record Identification (MRID) Nos. 48538708, 48538906, 48975101):*

Acute toxicity testing is required to 1) determine systemic toxicity from acute exposure via the dermal, inhalation and oral routes, 2) determine irritant effects from exposure to the eyes, and 3) determine the potential for skin sensitization (allergic contact dermatitis). Acute toxicity categories I, II, III, or IV are assigned to an active ingredient and end-use product(s) containing that active ingredient, and are based on the hazard(s) identified from studies and/or other information submitted to support the application to register an active ingredient and on file with the Agency. Toxicity Category I indicates the highest toxicity, and Toxicity Category IV indicates the lowest toxicity.

The applicant submitted data on two pear ester analogs, ethyl-2,4,7-decatrienoate and methyl-2-nonenoate, in order to fulfill the biochemical pesticide date requirements for Acute Toxicity. These two compounds are structural and functional analogs of pear ester, according to the Research Institute for Fragrance Materials (RIFM), and are expected to have biochemical pathways comparable to pear ester (Ref. 4). RIFM categorizes pear ester and the two analogs as "Ester/Simple C1-C4 Alcohol Straight Chain Ester/Unsatured/α, β-Unsaturated (Ref. 4)." Based upon data on ethyl-2, 4, 7-decatrienoate and methyl-2-nonenoate, pear ester is estimated to have an Acute Oral Toxicity (rat) of LD50 > 4,027 mg/kg (Ref. 4). Researchers have found a nearly 100% concordance between results of oral and dermal routes for over 1,600 substances where the oral LD50 > 2,000 mg/kg (Ref. 4). Therefore, the Agency predicts the Acute Dermal Toxicity (rat) of pear ester to be LD50 > 2,000 mg/kg.

The applicant provided scientific rationale to fulfill the data requirement of Acute Inhalation Toxicity: Pear ester has a low vapor pressure (0.173 mm Hg) and is 137 times less volatile than water at 25°C (Pear ester volatility = 23.8 mm Hg at 25oC. Maximum manufacturing operating temperatures are 110 °C and 50 °C, which is much lower than its boiling point (258.4 °C). This information suggests that airborne concentrations of Pear ester will be minimal and unlikely to pose potential risk from inhalation exposure in the work place. In addition, Bedoukian, Inc., has produced pear ester for more than 30 years for non-pesticide uses with no reported worker related adverse effects (Ref. 4).

Acute toxicity data on pear ester submitted by the applicant indicate Primary Eye Irritation

(rabbit): moderately irritating; Primary Dermal Irritation (rabbit): non-irritant; and Dermal Sensitization (guinea pig): not a dermal sensitizer (Ref. 4).

Subchronic Toxicity, Developmental Toxicity, and Mutagenicity Testing (Tier I) ***(OCSPP Guideline Nos. 870.3100, 870.3250, 870.3465; 870.3700, 870.5100, 870.5300, 870.5375; MRID Nos. 48975101, 48975102):***

The applicant submitted scientific rationale to fulfill Subchronic Toxicity, Developmental and Mutagenicity Tier I testing data requirements. The rationale states that 1) pear ester is ubiquitous in nature and the maximum amount of pear ester recommended for foliar application (1.2 grams pear ester per acre per month) is about three times less than the natural background levels reported for pear ester release in a typical orchard (3.712 grams of pear ester per acre per month) (Ref. 1, Ref. 3); 2) the maximum amount of pear ester recommended for a dispenser treatment program is about three times more than the amount that can be expected from natural background emissions (about 12g pear ester per acre per month) but results of a theoretical air concentration calculation show pear ester levels of only 0.0008 ppm within the orchard (Ref. 3); 3) pear ester dietary pesticidal exposure is not expected to exceed the current exposure to pear ester as a flavoring agent (Ref. 3, Ref 4.) ; 4) pear ester is a volatile kairomone (Henry's Law Constant estimated 7 x 10^{-4} atm m^3/mol) that dissipates rapidly in the environment and undergoes degradation in the presence of air and light (Ref. 1); 5) pear ester is structurally similar to straight chain lepidopteran pheromones (unbranched aliphatic chains between 9 and 18 carbons ending in an alcohol, aldehyde, or acetate functional group and containing up to three double bonds in the aliphatic backbone), which have well documented low toxicity (Ref. 5); and 6) has a non-toxic mode of action (Ref. 1); and 7) data submitted to fulfill the requirements for Acute Toxicity data indicate that pear ester is of low toxicity (Unit B. 1. a., above).

2. Tier II and Tier III Toxicity Studies

The biochemical pesticide Human Health Assessment data requirements for Tier II and Tier III were not required due to the low toxicity of the active ingredient and the low levels of exposure expected from its intended uses in EP products.

3. Effects on the Endocrine System

As required under FFDCA section 408(p), EPA has developed the Endocrine Disruptor Screening Program (EDSP) to determine whether certain substances (including pesticide active and other ingredients) may have an effect in humans or wildlife similar to an effect produced by a “naturally occurring estrogen, or other such endocrine effects as the Administrator may designate.” The EDSP employs a two-tiered approach to making the statutorily required determinations. Tier 1 consists of a battery of 11 screening assays to identify the potential of a chemical substance to interact with the estrogen, androgen, or thyroid (E, A, or T) hormonal systems. Chemicals that go through Tier 1 screening and are found to have the potential to interact with E, A, or T hormonal systems will proceed to the next stage of the EDSP where EPA will determine which, if any, of the Tier 2 tests are necessary based on the available data. Tier 2 testing is designed to identify any adverse endocrine related effects caused by the substance, and establish a dose-response relationship between the dose and the E, A, or T effect.

Between October 2009 and February 2010, EPA issued test orders and data call-ins for the first group of 67 chemicals, which contains 58 pesticide active ingredients and nine inert ingredients. This list of chemicals was selected based on the potential for human exposure through pathways such as food and water, residential activity, and certain post-application agricultural scenarios. This list should not be construed as a list of known or likely endocrine disruptors.

Pear ester is not among the group of 58 pesticide active ingredients on the initial list to be screened under the EDSP. Under FFDCA section 408(p), the Agency must screen all pesticide chemicals. Accordingly, EPA anticipates issuing future EDSP test orders and data call-ins for all pesticide active ingredients.

For further information on the status of the EDSP, the policies and procedures, the list of 67 chemicals, the test guidelines and the Tier 1 screening battery, please visit our website: http://www.epa.gov/endo/.

4. Dose Response Assessment

No toxicological endpoints were identified for this active ingredient; therefore, a dose-response assessment was not required.

5. Drinking Water Exposure and Risk Characterization

No significant exposure from drinking water is expected when pear ester is used according to the product label directions. The active ingredient is a naturally occurring component of the human diet and biodegrades rapidly in the environment. Its proposed use requires low application rates, and will not be directly applied to water, so residues of pear ester are unlikely to accumulate in drinking water. In the event that exposure to pear ester via drinking water occurs, human health risks are expected to be minimal due to its low toxicity.

6. Occupational, Residential, School and Day Care Exposure and Risk Characterization

a. Occupational Exposure and Risk Characterization

Agricultural treatments of pome fruit orchards with pear ester are limited to pre-harvest applications, and appropriate PPE requirements on end-use product labels will mitigate any potential exposure to applicators and/or handlers. Additionally, no relevant toxicological endpoints have been identified. Based on the data and information available to the Agency, anticipated exposure is not likely to result in unreasonable risk to humans.

b. Residential, School and Day Care Exposure and Risk Characterization

Exposure to pear ester from its pesticidal uses in residential, school, and day care areas will be minimal, as the active ingredient is intended only for use in agriculture.

7. Aggregate Exposure from Multiple Routes Including Dermal, Oral, and Inhalation

There is reasonable certainty of no harm to U.S. populations, including infants and children, from aggregate exposures to residues of pear ester when used as proposed. This includes all anticipated dietary exposures and all other exposures for which there is reliable information. Moreover, potential non-occupational inhalation and dermal exposure is not likely to pose any adverse effects to exposed populations via aggregate and cumulative exposure.

a. Food Exposure

Dietary exposure of pear ester is already occurring, given that this substance is used as a flavoring agent in many foods commonly consumed by humans (for its intensely fruity flavor) and is emitted naturally from mature, ripening fruit, including Bartlett pears and concord grapes (Ref. 1). In addition, the proposed rates of application for use of pear ester as a codling moth mating disruptor, under worst case scenarios, are not expected to produce dietary exposure to pear ester exceeding that of current exposure due to use of pear ester as a flavoring agent (Ref. 3, Ref. 4).

b. Drinking Water Exposure

Polymer dispenser products containing pear ester would not result in water residues because the product would be volatizing from the dispenser, dissipating, and degrading rapidly. Foliar spray products containing pear ester are intended for use at rates of less than one gram of active ingredient per acre with no direct applications to bodies of water. Therefore, drinking water exposure from the proposed used pattern is not expected to pose incremental risk to adults, infants and children via drinking water consumption (Ref. 4).

c. Other Non-occupational Exposure

Non-occupational dermal exposure to pear ester when used as a codling moth mating disrupter is considered negligible because agricultural treatments of pome orchards are limited by label directions to pre-harvest applications (Ref. 4). Non-occupational dermal exposure via treated food commodities is not greater than naturally occurring background levels of pear ester and not greater than exposure due to use of pear ester as a food additive (Ref. 4).

8. Cumulative Effects from Substances with a Common Mechanism of Toxicity

Pear ester has no demonstrated toxicity, and there are no other pear ester-based products registered as pesticides; thus, there is no reason to expect cumulative effects of exposure to Pear Ester and to other substances with common mechanism of toxicity.

9. Determination of Safety for United States Population, Infants and Children

Pear ester is a synthetic compound that is structurally identical to, and mimics the naturally occurring form which is ubiquitous in nature and is responsible the characteristic aroma of pears and other fruits. Synthesized pear ester is structurally identical to naturally occurring pear ester.

Therefore, as with straight chain lepidopteran pheromones, the Agency does not distinguish between the synthesized kairomone and its naturally occurring form with regards to physical-chemical characteristics or toxicology. The available data and information on pear ester indicate that the chemical (1) is of low toxicity and not a likely developmental toxicant, (2) naturally occurs in the human diet, and (3) has been approved by FDA for use in foods as a food additive without limitation. When compared to the amount of pear ester that is likely already consumed in the human diet, dietary exposure from pesticidal use is not anticipated to significantly increase overall dietary exposure of infants and children.

Therefore, it is expected that no harm will result from aggregate exposure to the United States population, including infants and children, to the residues of pear ester on food commodities. This includes all anticipated dietary exposures and all other exposures for which there is reliable information. Thus, there are not threshold effects of concern and consequently, provisions requiring additional margin of safety do not apply. Furthermore, considerations of consumption patterns, special susceptibility, and cumulative effects do not apply to pesticides without a demonstrated significant adverse effect.

10. Risk Characterization

The Agency considered human exposure to pear ester in light of the relevant safety factors in FQPA and FIFRA. A determination has been made that no unreasonable adverse effects to the U.S. population in general, and to infants and children in particular, will result from the use of pear ester when label instructions are followed.

C. Environmental Assessment

1. Ecological Hazards

The non-target toxicology information submitted by the applicant satisfies the non-target toxicology data requirements for pear ester and supports its registration.

Avian Oral Acute Toxicity, Avian Dietary Toxicity, Fish Acute Toxicity, Freshwater and Marine, and Aquatic Invertebrate Acute Toxicity *(OCSPP Guideline Nos. 850.2100, 850.2200,850.1075, and 850.1010)*

The following biochemical ecological data requirements are not required if the pesticide is highly volatile (estimated volatility > 5×10^{-5} atm-m^3/mol) (40 CFR 158.2060): Avian Oral Acute Toxicity, Avian Dietary Toxicity, Fish Acute Toxicity, Freshwater and Marine, and Aquatic Invertebrate Acute Toxicity (OCSPP Guideline Nos. 850.2100, 850.2200, 850.1075, and 850.1010). The volatility of pear ester (7.54×10^{-4} atm-m^3/mol (Henry's Law Constant at 25°C)) is above that value. Due to its volatility it dissipates rapidly in the environment.

Seedling Emergence and Vegetative Vigor *(OCSPP Guidelines Nos. 850.4100 and 850.4150)*

Pear ester is intended for formulation into EPs in which the active ingredient is contained in a polymeric dispenser to passively dissipate, or as a folier spray with maximum application of 24

grams of pear ester/acre/application. Assuming an equal, steady release of pear ester active ingredient over a 120-day = 4 months growing season, the respective exposures would be 24 g pear ester/acre/application ÷ 4 months growing season, and 15 g pear ester/acre/application ÷ 4 months growing season = 6, which equates to 6 and 3.75 g a.i./Acre/month, respectively. Due to the volatility and ready photodegradability of pear ester, it is unlikely that the use of these EPs at the recommended rate would result in adverse effects of pear ester to non-target plants.

Non-target Insect Testing *(OCSPP Guideline 880.4350)*

Pear ester is a non-toxic kairomone very similar to straight chain lepidopteran pheromones. It is specific to lepidopteran pests, especially the codling moth, *Cydia pomonella* (Ref. 6). Pear ester also exhibits a degree of species specificity similar to that of pheromone, by being non-attractive to other insect species, both beneficial and pests, including eight key lepidopteran pests of pome fruits and other horticultural fruit and nut crops (Ref. 7). Furthermore, once it volatilizes, it readily undergoes oxidative photodegradation (Ref. 8). As a result, it presents no or very low toxicity risk to non-target insect species such as the honeybee.

2. Environmental Fate and Ground Water Data

Environmental fate and groundwater data are not required at this time because the results of the nontarget organism toxicity assessment (Tier I data requirements) did not trigger these Tier II data requirements.

3. Ecological Exposure and Risk Characterization

As stated above, pear ester exhibits a degree of species specificity similar to that of a pheromone, by being non-attractive to other insect species, both beneficial and pests, including eight key lepidopteran pests of pome fruits and other horticultural fruit and nut crops (Ref. 7). In addition, it is highly volatile and dissipates rapidly in the environment. Little to no exposure is expected for non-target organisms; however, any incidental exposures are not anticipated to be of any concern due to the low toxicity of this active ingredient.

4. Endangered Species Assessment

The Agency has not conducted a risk assessment that supports a complete endangered species determination. The ecological risk assessment planned during registration review will allow the Agency to determine whether the uses of pear ester have “no effect” or “may effect” federally listed threatened or endangered species (listed species) or their designated critical habitats. Pear ester is structurally identical to the naturally occurring compound produced in pome fruit. It is not known to be toxic to any insect species or other non-target organisms. In addition, pear ester exhibits a degree of species specificity similar to that of a pheromone, by not attracting other insect species, including beneficials and several key lepidopteran pests of pome and other fruit and nut crops, while being highly attractive to the codling moth, *Cydia pomonella*. Based on this information, it is unlikely that pear ester will affect listed species. Furthermore, the listed lepidopteran species do not share the same habitats as the targeted pest. For example, the Karner blue butterfly (*Lycaeldes melissa samuelis)* is a listed lepidopteran species that feeds exclusively

on wild lupine (*Lupinus perennis)* in oak savannas and sandy lands and thus is not likely to inhabit areas where the products containing pear ester as an active ingredient will be used. Should this species inhabit areas where pome fruits are grown, they would be exposed to naturally occurring pear ester; however, due to the use patterns and high volatility of pear ester, it would not be expected to affect this or any other listed species.

Should an assessment conclude that a pesticide's use "may affect" a listed species or its designated critical habitat, the Agency will consult with the U.S. Fish and Wildlife Service and/or National Marine Fisheries Services (the Services), as appropriate.

D. Product Performance Data

Product performance (efficacy) data must be developed for all pesticides to ensure that the products will perform as intended and that unnecessary pesticide exposure to the environment will not occur as a result of the use of ineffective products. The Agency reserves the right to require, on a case-by- case basis, the submission of efficacy data for any pesticide product registered or proposed for registration, but applications to register pesticide products intended to control a pest of significance public health importance, as defined in FIFRA section 28(d) and section 2(nn), must include such data. For further guidance on the product performance data requirement, refer to Pesticide Registration Notice (PR) Notices 96-7, 2002-1 and Explanation of Statutory Framework for Risk-Benefit Balancing for Public Health Pesticides (http://www.epa.gov/PR _Notices/pr1996-7.pdf) (http://www.ea.gov/PR_Notices/pr2002-1.pdf) and (http://www.epa.gov/pesticides/health/risk-benefit.htm).

This pear ester is not intended to be formulated into products to control public health pests as defined in FIFRA section 28(d) and section 2(nn), and product performance (efficacy) was not evaluated by the Agency.

V. RISK MANAGEMENT DECISION

A. Determination of Eligibility for Registration

Section 3(c)(5) of FIFRA provides for the registration of a new active ingredient if it is determined that: (A) its composition warrants proposed claims; (B) its labeling and other materials comply with the requirements of FIFRA; (C) it will perform its intended function without unreasonable adverse effects on the environment; and (D) when used in accordance with widespread and commonly recognized practice, it will not generally cause unreasonable adverse effects on the environment.

The four eligibility criteria have been satisfied for the proposed pesticide products containing the active ingredient, pear ester; therefore, pear ester is eligible to be registered for the intended uses.

B. Regulatory Decision

The data submitted fulfill the requirements for the unconditional registration of pear ester as a mating disrupter for the codling moth. For product-specific information, please refer to

http://www.epa.gov/pesticides/pestlabels.

C. Environmental Justice

EPA seeks to achieve environmental justice—the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income—with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. At this time, EPA does not believe that use of pear ester pesticide products will cause harm or a disproportionate impact on at-risk communities. For additional information regarding environmental justice issues, please visit EPA's website at *http://www.epa.gov/compliance/environmentaljustice/index.html*.

VI. ACTIONS REQUIRED BY REGISTRANTS

EPA evaluated all data submitted in connection with the registration of the new active ingredient, pear ester, and determined that these data are sufficient to satisfy current registration data requirements. At this time, no additional data must be submitted to EPA for these particular products. For new uses and/or changes to existing uses, EPA may require additional data. Notwithstanding the information stated in the previous paragraph, it should be clearly understood that certain specific data are required to be reported to EPA as a requirement for maintaining the federal registration for a pesticide product. A brief summary of these types of data are listed below.

A. Reporting of Adverse Effects

Pursuant to FIFRA section 6(a)(2), reports of all incidents of adverse effects to the environment must be submitted to EPA.

B. Reporting of Hypersensitivity Incidents

Under the provisions of 40 CFR Part 158.2050(d), all incidents of hypersensitivity (including both suspected and confirmed incidents) must be reported to the Agency.

VII. Appendix A. Data Requirements (40 CFR Part 158-Subpart U)

NOTE: Master Record Identification (MRID) numbers listed in the following tables are representative of supporting data/information for the original registration of the product containing this active ingredient. Subsequent to this registration, there may be additional MRIDs that support registration of other products containing this active ingredient.

TABLE 1. Product Identify, Composition, Analysis and Certified Limits for Bedoukian Pear Ester Technical (40 CFR § 158.2030) MRIDs 48538901 thru 48538903

OPPTS Guideline Reference No.	Study	Results
830.1550 to 830.1670	Product identity; Manufacturing process; Discussion of formation of unintentional ingredients	Acceptable; Confidential Business Information (CBI)
830.1700	Analysis of samples	Acceptable; CBI
830.1750	Certification of limits	Limits listed in the CSF are adequate / acceptable.
830.1800	Analytical method	Acceptable; CBI

TABLE 2. Physical and Chemical Properties for Bedoukian Pear Ester Technical (40 CFR § 158.2030)
MRIDs 48538904 and 48538905

OCSPP Guideline Reference No./Property		Description of Result	Methods
830.6302	Color	Colorless	Visual inspection
830.6303	Physical State	Liquid at room temperature	Visual inspection
830.6304	Odor	Characteristic odor of Bartlett pear	Olfactory inspection
830.6313	Stability	Deteriorates slightly after 14 days at 54°C. Stable in the presence of iron, iron acetate, aluminum, or aluminum acetate for 14 days at room temperature or 54°C.	OCSPP 860.6313
830.6314	Oxidation/Reduction: Chemical Incompatibility	Not applicable, the product does not contain oxidizing ingredients.	
830.6315	Flammability	Flash point >230°F	Pensky Martens Closed Cup
830.6316	Explodability	Not applicable, the product does not contain explosive ingredients.	
830.6317	Storage Stability[b]	Stable for 12 months when stored at 0°C.	OCSPP 860.6317
830.6319	Miscibility	Not applicable, the product is not an emulsifiable liquid to be diluted with petroleum solvents.	-
830.6320	Corrosion Characteristics[b]	No changes in integrity or appearance of aluminum containers after 12 months storage at 0°C.	OCSPP 830.6320
830.6321	Dielectric Breakdown Voltage	Not applicable, the product is not for use around electrical equipment.	-
830.7000	pH	Not applicable, the product is not soluble or dispersible in water.	-
830.7100	Viscosity	4.56 cSt	ASTM D445
830.7200	Melting Range	Not applicable, the product is a liquid.	-
830.7220	Boiling Range	258.41°C	EPISuite
830.7300	Density/Relative Density/Bulk Density	Specific gravity = 0.903 at 25°C	Anton Parr Density Meter
830.7370	Dissociation Constant in Water	Not applicable, the product is not soluble or dispersible in water.	-
830.7550	Partition Coefficient	4.36	SRC Interactive PhysProp database
830.7840	Water Solubility	8.588 mg/L at 25°C	EPISuite
830.7950	Vapor Pressure	0.0173 mm Hg at 25°C	EPISuite

TABLE 3. Acute Toxicity Data for Bedoukian Pear Ester Technical (40 CFR 158.2050)			
Study Type/OPPTS Guideline	**LD_{50}/LC_{50}/Results**	**Toxicity Category**	**MRID**
Acute Oral Toxicity/OPPTS 870.1100	4027 mg/kg [a]	III	Firmenic,1966 Givaudan,1982
Acute Dermal Toxicity/OPPTS 870.1200	2,000 mg/kg [b]	III	Seidle at al. 2011
Acute Inhalation Toxicity/OPPTS 870.1300	Registrant's rationale	IV	48975101
Acute Eye Irritation/OPPTS 870.2400	Moderate irritating	III	Firmenich,1996
Acute Dermal Irritation/OPPTS 870.2500	Non-irritant	IV	48538906 48538708
Skin Sensitization/OPPTS 870.2600	Not skin sensitizer	IV	Givaudan, 1981

a Predicted value (estimated using the US EPA program "Toxicity estimation Software Tool" (T.E.S.T.) version 4.1, available at http://www.epa.gov/ordntrnt/ORD/NRMRL/std/qsar.html).

b Predicted value

TABLE 4. Ecological Toxicity Data Requirements for Bedoukian Pear Ester Technical (40 CFR § 158.2060)			
Guideline # Test	**Results/Toxicity Category**	**MRID**	**Study Conclusion**
Acute Avian Oral OCSPP 850.2100	Waiver Request	48538907	Acceptable
Acute Avian Dietary OCSPP 850.2200	Waiver Request	48538907	Acceptable
Fish Acute Toxicity OCSPP 850.1075	Waiver Request	48538907	Acceptable
Acute Aquatic Invertebrate OCSPP 850.1010	Waiver Request	48538907	Acceptable
Terrestrial Plant (Seedling Emergence) OCSPP 850.4100	Due to the volatility and ready photodegradability of pear ester, it is unlikely that its use would result in adverse effects to non-target plants.	48538907	Acceptable
Terrestrial Plant (Vegetative Vigor) OCSPP 850.4150		48538907	Acceptable
Nontarget Insect OCSPP 880.4350	Pear ester exhibits a degree of species specificity similar to that of pheromone, by being non-attractive to other insect species.	48538907	Acceptable

VIII. Appendix B. References

1. U.S. EPA, 2012. Memorandum from Clara Fuentes, Ph.D., to Gina Burnett. Tolerance Exemption Petition Review in support of registration of the following products: a) Bedoukian Pear Ester Technical – a manufacturing use product, containing 93.4 % w/w of 2,4-Decadienoic acid, ethyl ester, (2E,4Z); b) end use microencapsulated formulation Cidetrak DA-MEC, containing 5.0% w/w of Pear Ester, for foliar application to control larvae and adult Codling moth, *Cydia pomonella*, in apple, pear and walnut trees, and c) Cidetrack CM-DA Combo MD polymeric dispensers: Cidetrak CM-DA 115/30, containing 115 mgs of Codling Moth Pheromone and 30 mgs of Pear Ester; Cidetrak CM-DA 185/60, containing 185 mgs of Codling Moth Pheromone and 60 mgs of Pear Ester, and Cidetrak CM-DA 90/60, containing 90 mgs of Codling Moth Pheromone and 60 mgs of Pear Ester to control Codling moth, *Cydia pomonella*, and hickory Shuckworm, *Cydia caryana*, in apple, pear, walnut, pecan, quince, and other pome fruit trees. U.S. Environmental Protection Agency, Office of Pesticide Programs. June 28, 2012.

2. U.S. FDA, 2013. Everything Added to Food in the United States (EAFUS) list. U.S. Food and Drug Administration (FDA), accessed on April 1, 2013. Available at: http://www.accessdata.fda.gov/scripts/fcn/fcnDetailNavigation.cfm?rpt=eafusListing&id=1183

3. Trece, 2011. Petition proposing the exemption from the requirement of a tolerance under 40 CFR § 180 for the biochemical active ingredient Ethyl 2,4 Decadienoate (CAS 3025-30-7) for pre-harvest uses on all agricultural commodities. Trece, Inc. July 8, 2011.

4. U.S. EPA, 2013. Memorandum from Clara Fuentes, Ph.D., to Gina Burnett. Science review of registrant's response to deficiencies concerning Tolerance Exemption Petition in support of registration of Bedoukian Pear Ester Technical – a manufacturing use product, containing 93.4 % w/w of 2,4-Decadienoic acid, ethyl ester, (2E,4Z). U.S. Environmental Protection Agency, Office of Pesticide Programs. January 10, 2013.

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6. Pasqualini, E., Villa, M., Civolani S., Espinha I., Ioriatti, C. Schmidt, S., Molinari, F., DeCristofaro A., Sauphanor B., and Ladurner, E., 2005. The Pear Ester Ethyl (E,Z)-2,4-decadienoate as a Potential Tool for the control of *Cydia pomonella* larvae: Preliminary Investigation. Bull. of Insectology, Vol. 58. No. 1: 65-69.

7. Knight, A. L. and Light D. M. 2004. Use of (*E,Z*)-2,4-decadienoic Acid in Codling Moth management improved Monitoring in Bartlett Pear with high dose Lures. J. Entomol. Soc. Br. Columbia. 101:59–66.

8. Heinz, D. E. and Jennings, W.G., 1966. Volatile Components of Bartlett Pear. Journal of Food Science. Vol 31, Issue 1: 69-80.

IX. GLOSSARY OF ACRONYMS AND ABBREVIATIONS

a.i.	active ingredient
BPPD	Biopesticides and Pollution Prevention Division
BRAD	Biopesticide Registration Action Document
bw	body weight
CBI	Confidential Business Information
CFR	Code of Federal Regulations
cm^3	cubic centimeter
CSF	Confidential Statement of Formula
°C	degrees Celsius
EC_{50}	median effective concentration. A statistically derived single concentration in environmental medium that can be expected to cause an effect in 50% of the test animals when administrated by the route indicated (inhalation). It is expressed as a concentration in air or water (e.g. mg/L).
EDSP	Endocrine Disruptor Screening Program
EDSTAC	Endocrine Disruptor Screening and Testing Advisory Committee
EP	end-use product
EPA	Environmental Protection Agency (the "Agency")
FDA	Food and Drug Administration
FFDCA	Federal Food, Drug, and Cosmetic Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FQPA	Food Quality Protection Act
FR	Federal Register
g	gram
ha	hectare
kg	kilogram
Kow	octanol-water partition coefficient
L	liter
LC_{50}	median lethal concentration. A statistically derived single concentration in air or water that can be expected to cause death in 50% of the test animals when administrated by the route indicated (inhalation and environment). It is expressed as a concentration in air or water (e.g. mg/L).
LD_{50}	median lethal dose. A statistically derived single dose that can be expected to cause death in 50% of the test animals when administered by the route indicated (oral and dermal). It is expressed as a weight of substance per unit weight of animal (e.g., mg/kg).
MRID No.	Master Record Identification Number
mg	milligram
mPa	millipascal
mL	milliliter
MP	manufacturing-use product
N/A	not applicable
NE	"No Effect"
NIOSH	National Institute for Occupational Safety and Health

nm	nanometer
NOEL	no-observed-effect-level
NOF	notice of filing
NOR	notice of receipt
OPP	Office of Pesticide Programs
OCSPP	Office of Chemical Safety and Pollution Prevention
pa	pascal
PPE	personal protective equipment
PR Notice	Pesticide Registration Notice
TGAI	technical grade of the active ingredient
ug	microgram
USDA	United States Department of Agriculture
UV	ultra-violet

APPENDIX D: Book Chapter - Pear ester – from discovery to delivery for improved codling moth management

Chapter 8

Pear Ester – From Discovery to Delivery for Improved Codling Moth Management

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The chemical ecology of codling moth, *Cydia pomonella* (L.), has been the subject of a worldwide research effort spanning five decades. The initial focus of this work was the characterization of codling moth sexual behavior and the identification of its sex pheromone, followed by the development of effective monitoring and management programs. Subsequently, a large body of work was dedicated to deciphering the chemical messaging systems that exist between both moth sexes and their apple host. However, it was from pear that a potent kairomone, pear ester, ethyl (*E,Z*)-2,4-decadienoate, was discovered, and surprisingly from field studies in walnut. Pear ester over the last decade has been the basis for the development of a range of commercial products that impact larval and adult behaviors and reduce levels of fruit injury. A review of codling moth and behavioral-active apple volatiles, the discovery of pear ester, and the development of useful technologies is provided here. A recounting of this story provides some considerations

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ACS Symposium Series; American Chemical Society: Washington, DC, 2018.

for the reader. First, that single odorants from a host e.g. (*E,E*)-α-farnesene and pear ester and maybe not complex volatile blends that more thoroughly characterize a host odor, are fruitful targets to develop female attractants. However, practical concerns such as chemical stability and synthesis cost will limit the implementation of any discovery. Second, it is not clear what semiochemical evoked behaviors should be targeted to develop an effective lure, i.e. suitable host for sexual rendezvous, oviposition, or as a food source. Background odors from immature fruits and undamaged foliage are generally more dilute and less complex than from ripening fruits or damaged foliage. Thus, effective chemical signals need to be more intense and apparent to lure moths. Third, it appears that adding acetic acid to host plant volatile lures is effective in drawing moths into traps, perhaps as a short-range food cue. Fourth, it was a field bioassay with a pear volatile in a walnut grove that unveiled the power of pear ester. Only later did a series of physiological and molecular studies detail the evolved interplay of pear ester and sex pheromone in the brain of codling moth. It is possible that this more basic approach will in the future allow the purposeful discovery of new attractants which can aid pest management of tortricids and other pest species. But more likely, chemists and applied insect ecologists need to continue to identify, synthesize, and test the various semiochemicals that define the lives of insects.

Background

Growers of commercial apple, *Malus domestica* Borkhausen, are engaged in a dynamic enterprise based on the production, storage, and shipping of high-quality fruits throughout the world. To achieve this market-mandated level of perfection, apple has become one of the most chemically-treated fruit crops; annually receiving multiple sprays of fungicides, growth regulators, and insecticides (*1*). A key driver in the international market is the enforcement of ever increasing regulatory restrictions on permitted post-harvest residues of crop protection chemicals (*2*). Typically, these standards restrict the types, timing, and rates of materials that can be applied during the season. Within this regulatory framework, producers are attempting to grow perfect fruit in a complex agricultural environment where an array of arthropod pests feed on the roots, wood, flowers, foliage, and fruits of the crop throughout the year (*3*, *4*). Single tactic approaches, such as repeated applications of broad-spectrum insecticides have a documented history that demonstrates the complexity of the ecological associations among pests in apple orchards (evolution of resistance, outbreaks of secondary pests), their natural enemies, and the associated externalities within and surrounding orchards (*5*). Today, several consistent trends, including: lower

chemical residues, greater protection for workers and their families, containment of spray drift and surface water run-off, and suburban expansion are together all placing greater restrictions on pesticide usage that directly impact production of apple.

To achieve successful production of fruit with judicious use of the available pesticides requires ongoing research and education (*6*). Conceptual development of an integrated pest management (IPM) strategy for apple was pioneered in the 1970's, and widely showcased as an IPM success story (*7*). The development of predictive models and monitoring tools has allowed growers to reduce their reliance on pesticides, enhance biological control, and likely slow the evolution of pesticide resistance and loss of efficacy of existing materials (*8*, *9*). Another key component of apple IPM has been the identification and development of natural products, such as semiochemicals, including sex pheromones and plant volatiles (kairomones) (*10*, *11*). Various behaviorally active compounds have been identified and countless studies have evaluated the potential effectiveness of these compounds and suggested how they might be used. In some cases, innovative tools have been developed and adopted by industry to improve management of key pests with minimal supplemental use of pesticides (*12*).

The major pest group attacking apples throughout its world-wide distribution are the larvae of moths (Family, Tortricidae) that feed on both the skin and internal tissues of fruit including the seed cavity (*13*). Codling moth, *Cydia pomonella* (L.), (Lepidoptera: Tortricidae), the most important species in this group, also attacks pear, *Pyrus communis* L., and walnut, *Juglans regia* (L.) (*14*). In addition to codling moth, it is common for one or more regionally endemic tortricid species to reach pest status in most apple growing districts, and these tortricid pests often require additional management practices, including insecticides (*15*, *16*).

The life history and several adaptive traits make management of codling moth problematic for IPM. Eggs are often laid near or on the fruit and neonate larvae enter fruits quickly, completing development in the seed cavity (*17*). Mature larvae leave the fruit and construct protective silken cocoon chambers under the bark of trees (*18*). Adults can emerge, mate, and begin to lay eggs, within 24 hours (*19*). Naturally-occurring biological control agents are unable to protect fruit in commercial orchards at levels demanded by the fresh market (*20*). Typically, codling moth is managed with a series of insecticide sprays that cover or blanket the crop with toxic residues (i.e., cover sprays) during the season (*21*). The switch from broad spectrum to more selective classes of "reduced-risk" insecticides has not always reduced the number of sprays applied, but has created new issues with several secondary pests and new invasive pests (*22*, *23*). Development of natural products which might impact adult mating and oviposition or disrupt larval behaviors has been advocated as an important priority to reduce the repeated dependence on insecticides, and improve the efficacy of less-effective, but more selective materials, especially within organic production systems (*24*, *25*).

One of the major non-insecticide developments affecting management of codling moth and other tortricid pests of apple has been the identification, synthesis, and use of sex pheromones as management tools and direct control agents. Low-cost, effective sex pheromone lures in traps are widely used by

growers to monitor adult populations (*26*). Moth counts are used to track the seasonal occurrence of pests and to estimate the relative pest population activity and abundance within orchards (*27*). Unfortunately, the use of sex pheromones to monitor pests has several associated problems. There is an inherent uncertainty in establishing thresholds for what are primarily female-based behaviors based on male catches due to the likely occurrence of either false-negative or false-positive male catches, the errors associated with timing egg hatch based on male flight, and the inability to monitor the potential immigration of female moths into orchards (*28*).

One approach to eliminate these inherent problems with sex pheromone-based male monitoring systems could be to develop similar tools based on kairomones that allow managers to directly track female moths. Key chemically-mediated behaviors of female moths include both detecting and following host signals that reveal suitable sites for mating, oviposition, and feeding (*29*). Numerous studies have characterized the volatiles emanating from tortricid host plants and an array of laboratory and field trials have attempted to develop effective management tools for codling moth and other tortricids. However, the development of effective kairomone-based monitoring lures for female moths, including codling moth, has been difficult.

Sex pheromones have also been used to directly manage pests by disrupting moth mating, and a variety of products have been tested against codling moth (*30–33*). The development of mating disruption (MD) technologies for codling moth was initially concerned with formulation issues, i.e. chemical stability of the conjugated diene, (*E,E*)-8,10-dodecadien-1-ol and dispenser's blend, emission rate, and longevity (*34–37*). Secondly, the possible mechanisms by which the different formulations of sex pheromones, i.e. sprayables, hand-applied, and aerosol dispensers, affect mating behaviors have been tested and detailed (*38*). MD was shown to work well when applied in an areawide program that included growers' collective cooperation, careful pest monitoring, and elimination of unmanaged hosts surrounding treated areas (*12*). The effectiveness of MD for managing codling moth is impacted by aspects of its biology, especially the mating frequency of both sexes (*19*, *39*) and the aggregation of overwintering larvae before pupation (*40*). Temporal delays in mating and subsequent reductions in fecundity and egg fertility were shown to be important in net population reductions (*41–43*). Unfortunately, levels of mating of female codling moth in populations under management with MD, has been shown to be high (*44*, *45*). Female codling moths can detect sex pheromone (*46*), and exposure to its sex pheromone can impact female behaviors, such as calling and egg laying (*47*). Positive interactions between sex pheromones and plant volatiles were found with male codling moth (*48–50*). It is possible that further improvements in MD for codling moth could involve behavioral disruption of both sexes with kairomones (*24*, *51*).

The history of identifying host-plant volatiles and developing their applied uses for managing codling moth has been fraught with difficulty and punctuated by serendipitous discovery. This chapter briefly discusses critical aspects of this history and attempts to draw conclusions about the most productive approaches future scientists could use to identify additional compounds to

improve management of codling moth and other related pest species. As the key example, we will summarize the research that has led to the identification of pear ester and the development of its use for monitoring and managing codling moth. We are fortunate that following the extensive applied development of pear ester as a novel attractant the sensory perception, genetic basis, and molecular underpinning of the significance of pear ester in the biology of codling moth and related species has been revealed and will also be summarized.

The Path to Pear Ester

Codling moth larvae and adults have long been known to exhibit a strong olfactory and behavioral response to apple fruits (*52*, *53*). But, it was not until the 1970's that the (*E,E*) and (*Z,E*)- stereo-isomers of α-farnesene, were identified as the principal volatiles released from the skin of apple, pear, and quince fruits eliciting various behavioral responses (*54–56*). Unfortunately, Russ (*57*) showed that pear was less attractive than apple in his assays and assumed this response was directly related to the lower levels of α-farnesene. No other pear volatiles were considered as possible attractants. Also, due to the known chemical instability of α-farnesene (*58*). the potential to develop management tools based on α-farnesene was not discussed in these early papers, and over the next two decades no further work was reported on host-plant attractants for codling moth.

During this period of inactivity on kairomones analytical chemistry based on headspace collections and gas chromatographic and mass spectrometric (GC-MS) analyses, became more widely available for applied laboratories to characterize the volatiles emitted by codling moth host plants (*59–63*), and to develop new attractants for other apple pests, including the apple maggot, *Rhagoletis pomonella* (Walsh) (Diptera: Tephritidae (*64*, *65*). By comparison, tortricid sex pheromones were identified with relative ease and this led to new monitoring tools and commercial formulations for mating disruption (*66*). The proliferation and availability of sex pheromones temporarily placed advances in kairomone chemistry in the background. During this same period, insecticide resistance in codling moth continued to develop to an ever-increasing number of classes of insecticides (*67*). Social and political trends led to further reductions in available effective insecticides in pest management, e.g. Food Quality and Protection Act 1996. Thus, new efforts were undertaken to characterize host volatiles in attempts to develop more effective management tools targeting the disruption of neonate searching behaviors and adult mating. This included looking at whether host plant volatiles could be used to improve the attractiveness of sex pheromones (*48*, *49*); or whether plant volatiles could be used as oviposition deterrents (*68*). Yet, the largest part of this chemical ecology renaissance targeted a reconsideration of the activity of α-farnesene for larvae and adult codling moth (*50*, *69–71*). These studies largely confirmed the previous body of work, but also continued to suggest that the release of α-farnesene alone did not fully explain the levels of larval or adult attraction elicited by fruit and this renewed the scientific curiosity to identify additional apple volatiles as attractants (*24*, *72–74*).

In response to this challenge, two different research approaches were used to identify additional compounds that could account for the behavioral response of adult codling moth to apple. The first approach used a combination of GC-MS analyses of volatiles released by developing fruits and whole plants throughout their phenological season combined with electroantennographic detection (EAD) techniques to identify the most electrophysiologically sensitive compounds. Analysis of headspace volatiles from fruits and branches showed that terpenoids were most prevalent early and esters later in the apple phenology season (*75*). Among the early-season apple volatiles that codling moth antennae strongly responded to were six terpenoids, including β-linalool, β-caryophyllene, (*E*)-β-farnesene, germacrene D, (*Z,E*)-α-farnesene, and (*E,E*)-α-farnesene, the homoterpene 4,8-dimethyl-1,3,(*E*)7-nonatriene (DMNT), and the benzenoid methyl salicylate (*76*). Neither antennal response nor the strength of this depolarization response is an indication that chemicals are attractive, for example methyl salicylate is purported to be a codling moth repellent (*77*). Subsequent laboratory and field trials established some effectiveness for (*E,E*)-farnesol and (*E*)-β-farnesene as male attractants, but only in the wind tunnel or field, respectively (*78*, *79*). The addition or combination of other volatiles eliciting antennal responses did not increase moth catches. Two additional studies were performed using volatile collections throughout the season and electroantennographic responses of codling moth to both apple and walnut volatiles (*80*, *81*). Several compounds were found to elicit antennal depolarization responses, but the work was not extended to behavioral assays and no new attractants were identified. Instead, this work with its overwhelming numbers of identified compounds (e.g., > 80) is an excellent example of how limiting these types of large data sets are in unraveling the complexities of insect-host plant communication, where volatiles can be attractive or repellent, the magnitude of responses can often be primarily concentration-sensitive, and that volatiles always occur as components of natural blends that vary seasonally and among hosts.

A second target for finding attractants for adult codling moth management focused primarily on the esters released by ripening fruits. These studies characterized the seasonal occurrence of various compounds from healthy and injured fruits (*82–84*), but behavioral bioassays to identify blends and individual attractants were only conducted in the laboratory (*82*, *85*). This approach yielded two esters, hexyl hexanoate (*82*) and butyl hexanoate that attracted female moths (*85*). Interestingly, the former had elicited the strongest antennal response from females but the latter exhibited the second lowest antennal response among the seven esters evaluated previously (*75*). Field trials have not yet found these esters to be attractive to codling moth in orchard settings (*78*, *79*, *86*).

The potential for host odour masking of putative attractants developed from electroantennogram (EAG) screening or laboratory olfactometer bioassays is a fundamental problem in identifying useful tools for pest management (*78*, *87*). One assumption implicit in this approach is that the emission of a higher concentration above background of a ubiquitous volatile can create a chemical signal plume that would allow moths to orient to baited traps. Further, the effectiveness of any lure would need to be retained over the course of the season as the host odour profile evolves. Oligophagous and polyphagous pests have

evolved to respond to a variety of effective kairomones comprised of different volatiles derived from their uniquely different host plants e.g., apple, pear and walnut (*80*, *81*). Thereby a different approach to discover new kairomones could be to identify volatiles from one host and test them for attraction in a different host context. Of course, this would be contrary to the assumption that any volatile attractant should be present in all hosts all the time (*80*, *81*, *88*). Yet, testing in a different host context is exactly how pear ester, ethyl (*E,Z*)-2,4-decadienoate, a well-known odorant of ripe pear (*89*), was discovered to be a potent bisexual attractant for codling moth.

Discovery of Pear Ester

Chemists at the USDA laboratory in Albany, CA assembled an extensive library of volatile plant compounds which were available for testing with codling moth. Initially the focus of the work was to screen for possible synergists of the sex pheromone as had been done previously with green leaf volatiles (*48*). Ninety-two pome volatiles were organized into 23 blends based on their chemical structure, i.e. common carbon-chain length and/or alcohol, aldehyde, or ester moieties and tested as pheromone synergists in a walnut grove (*90*). It was assumed that the terpenoid odor profile of walnut (*81*) might only minimally mask these compounds. Six blends were found to significantly increase and synergize male attraction to the sex pheromone codlemone, (*E,E*)-8,10-dodecadien-1-ol. However, only one blend (Ester-10) a 4-compound blend of methyl and ethyl 10-carbon esters caught both moth sexes and both mated and virgin females. Field tests of these 23 host volatile blends without the presence of sex pheromone were repeated in walnut and expanded to pome fruits and this substantiated that the Ester-10 blend was the only blend attractive to females and males (*86*, *90*). The most effective constituent of the Ester-10 blend was determined to be ethyl (*E,Z*)-2,4-decadienoate, "the pear ester" (*86*). GC-EAD studies confirmed that pear ester was the only pear volatile identified from among the 15 FID peaks that elicited an obvious and significant depolarization response (*90*). Laboratory behavioral assays with codling moth larvae also demonstrated the potent activity of pear ester, i.e. attractive at 1,000-fold lower concentration than α-farnesene (*91*). Surprisingly, pear ester exhibited a similar dose response threshold (10 μg dose per septum) as sex pheromone for adults, and within walnut caught similar numbers of moths as a sex pheromone lure (*86*, *90*). Thus, pear ester for both adults and larvae was an effective attractant at very low concentrations and emission rates. Fortuitously, the combination of its low synthesis cost, good chemical stability, and a high level of potency quickly demonstrated pear ester's potential commercial value, and its discovery was protected with two patents (*92*, *93*).

The attractiveness of pear ester to both larvae and adult codling moth was recognized as an opportunity to develop behaviorally-active management tools. The dose-response (0.01 μg – 50 mg) of loading pear ester in grey halobutyl septa was explored and the loading rate was found to be an important factor affecting

catch numbers, sex ratio, and mating status of females (*94*). Results from the initial studies in pome fruit and walnut comparing sex pheromone and pear ester lures found equivalence between lures in conventional apple and walnut orchards but lower attraction for pear ester in pear; while in both apple and walnut orchards treated with sex pheromone dispensers the pear ester lure attracted significantly more moths than the sex pheromone lure (*90*, *95*). However, further studies showed that pear ester lures could be used in commercial pear orchards (*96*, *97*). The effectiveness of pear ester was only compromised in 'Bartlett' pear orchards with high levels of codling moth injury, likely due to the release of pear ester and other volatiles from herbivore-injured fruits (*98*). An effort to improve monitoring of codling moth in pear by switching to propyl (*E,Z*)-2,4-decadienoate lures was not successful (*99*).

The seasonal flight patterns of codling moth monitored with pear ester were compared with male monitoring with sex pheromone in apple orchards treated with sex pheromone and several interesting findings were found (*100*). For example, sex pheromone-baited traps caught moths before traps with pear ester, peak catch coincided between the two lures, while for pear ester-baited traps the sex ratio was only slightly skewed in favor of males over females, >80% of females were mated, and pear ester outperformed the sex pheromone lure when the density of sex pheromone MD dispensers was increased. The influence of various physical factors on the performance of pear ester-baited traps for male and female codling moths was examined in a range of early studies (*101*). For example, females were trapped with pear ester several hours before the start of male activity to sex pheromone (*102*). Moth catches in pear ester-baited traps were 6- to 14-fold higher in the late-season cultivar 'Granny Smith' than four other cultivars and this was supported with similar results from Australia (*103*). Trap size impacted the catch of moths, especially with greater numbers of females being caught on large sticky surfaces and always >15 cm from the lure, while males were often caught nearer or beside the lure. Similar results were found in Italy with larger traps catching more females (*104*). Trap height in the canopy was not a significant factor affecting the catch of females with pear ester, unlike males, caught mostly in the higher canopy, as similarly shown previously with males to sex pheromone (*36*). Also, the proximity of the pear ester-baited trap to sex pheromone dispensers placed in the canopy did not impact female catch unlike the interference previously shown with male codling moth and sex pheromone-baited traps (*105*). Interestingly, significantly more females were caught in pear ester-baited traps surrounded by foliage versus traps without adjoining foliage, and higher female counts occurred in traps placed adjacent to uninjured fruits compared with the absence of near-by fruits (*101*). It is important to emphasize that most of the factors that were shown in these studies to significantly impact female moth catches with pear ester are typically not considered and left uncontrolled by orchard managers utilizing traps to monitor codling moth.

In response to increasing concerns among U.S. apple growers that the use of sex pheromone dispensers for mating disruption made monitoring with sex pheromone lures problematic and that moth catch was too low with pear ester alone, a "Combo" lure combining pear ester with sex pheromone was

developed (*106*). An optimal loading per septum was established, but studies also showed that suboptimal loadings could have significant effects on moth catch. For example, increasing the loading of pear ester above the optimum (1 mg) could decrease female catch and adding pear ester to traps with a high-load sex pheromone lure could significantly decrease male catch. This was confirmed in later studies with various experimental lure loadings in untreated orchards where combining sex pheromone and pear ester decreased male catches compare with a sex pheromone lure alone (*107*, *108*). This competitive interference observed in traps combining pear ester with sex pheromone was also found in Italy; and a possible mechanism was suggested through saturation studies of antennal response to pear ester when the receptors were continuously stimulated by sex pheromone (*109*). However, later studies conducted with the commercial lure, Pherocon CM-DA Combo ("Combo" lure) loaded with equal amounts of both pear ester and sex pheromone, in MD apple orchards have been more consistent and clearly showed it out-performs sex pheromone lures (*97*, *110*). Yet, the literature detailing the use of pear ester to monitor codling moth is somewhat variable. For example, some results are consistent with U.S. studies, e.g. higher catches in orchards treated with sex pheromone in Australia (*103*) and lower catches in orchards left untreated in Italy (*104*, *111*); other results diverged. For example, traps with pear ester failed to catch any female moths in Bulgaria (*112*), while over a two-year period they caught 35 – 50% females in Italy (*111*) but in other cases females contributed only 1 and 4% of the total catch during the second moth flight in Italy (*113*) and Canada (*108*), respectively. Interestingly, the relatively low proportion of females caught with pear ester lures in one country was shown to be due to a male bias from inadvertent contamination of trapping materials with sex pheromone (unpublished results).

The greatest excitement around the discovery of pear ester has primarily been its attractiveness to female moths (*90*). With this greater ability to monitor female moths, studies were conducted to develop new protocols to enhance detection of females and their potential immigration into sex pheromone-treated orchards. Dark colored sex pheromone-baited traps were found to catch more codling moth males and fewer honeybees than white traps (*114*). Orange traps had a lower spectral reflectance than white traps and were hypothesized to be less visually disruptive for the dusk-flying moths and this was supported by flight tunnel studies observing moth behaviors to traps (*115*). In other field trials there was no influence of trap color on female catches with pear ester, perhaps because they orient to pear ester-baited traps prior to sunset (*101*). However, related studies with pear ester lures found that female catch was 30-fold higher on clear horizontal interception traps than in white delta traps (*116*). Clear delta traps were developed and these caught 6-fold more females than similar orange delta traps when baited with pear ester (*117*). Similarly, clear delta traps baited with either the "Combo" lure or pear ester plus acetic acid lures caught 4-fold more female codling moths than orange traps (*118*), but these catches were still only about half as many as caught on the clear horizontal interception traps, suggesting that further improvements could be made to increase trap performance (*116*). Unfortunately, while clear traps are widely used in Hungary they have not been adopted in the U.S. or in other countries.

Various studies have been undertaken to improve the attraction of females to pear ester in both conventional and sex pheromone-treated orchards. Moth catches in traps baited with only pear ester is typically 40 – 60% female (*90*, *119*). However, when pear ester has been used as a "Combo" lure with codlemone added females comprise only 5 to 10% of the catch in (*97*, *106*) and 21% in walnut (*119*). Several research efforts were conducted to further improve the use of pear ester to monitor female codling moth and increase their catch. The addition of an acetic acid co-lure with pear ester was found to significantly increase male and female moth catches (*120*). Acetic acid is often a microbial-produced fermentation product and these authors suggested codling moth's attraction to the acetic acid pear ester combination was a response to overripe or damaged fruit as a food source (*74*). Within orchards treated with sex pheromone dispensers this new combination of pear ester and acetic acid was much more effective than sex pheromone lures and caught 40% females in apple (*121*) and 62% in walnut (*119*). Clear or orange traps baited with pear ester and acetic acid performed similarly to orange traps baited with the "Combo" lure but with the advantage of a much higher proportion (>60%) of females (*122*, *123*). Interestingly, the positional placement of the acetic lure within a delta trap (either hung from the inside roof of the trap or on the liner) was shown to be important factor affecting male but not female catches (*124*).

The discovery that acetic acid synergized the activity of pear ester suggested that other volatile combinations should be reassessed. A review of the literature suggested that the damage-associated volatile DMNT could be another attractant for codling moth (i.e. evokes male and female antennal response and is present in both immature and ripening apples). Subsequent, laboratory and field studies demonstrated that it was attractive when used with acetic acid, but not as attractive as the combination of pear ester and acetic acid (*125*). DMNT was also found to be effective when used with sex pheromone (*119*, *126*). Binary lures formulated with DMNT and pear ester marginally increased total and female moth catches compared to pear ester alone when both were used with acetic acid (*127*). Perhaps more importantly the use of combinational lures with DMNT either with or replacing pear ester plus sex pheromone and acetic acid demonstrated some utility in orchards treated with dispensers loaded with sex pheromone and pear ester (*119*, *123*, *127*, *128*). Other plant volatiles purported to be attractive for codling moth were tested alone and in combination with acetic acid, including (*E*)-β-ocimene, butyl hexanoate, (*E*)-β-farnesene, *Z*-(3)-hexenyl acetate and farnesol and were found to be ineffective (*123*, *129*). Similarly, neither the addition of (*E*)-β-farnesene or farnesol with sex pheromone and acetic acid were effective female attractants within orchards treated with sex pheromone and pear ester dispensers (*123*). Binary blends of pear ester with either DMNT or decanal significantly increased female catch compared with pear ester alone but comparable to pear ester with acetic acid (*130*). Unfortunately, this study did not test these binary blends in combination with acetic acid. One additional codling moth attractant blend has been reported that includes the use of N-butyl sulfide in combination with either pear ester or pear ester and acetic acid (*131*). These authors reported that adding N-butyl sulfide doubled the female catch; however, more extensive trials conducted in four countries over several years using the same lures have not shown it to be more effective than the "Combo" lure (*132*).

Monitoring with Pear Ester

Practical use of pear ester to improve codling moth population monitoring has included both the establishment of action thresholds based on moth catches in traps and a consideration of predicting the phenology of egg hatch based on female moth flight instead of males. Action thresholds based on moth catches in traps baited with pear ester or sex pheromone were developed during a three-year study in 102 apple blocks treated with sex pheromone dispensers and left largely unsprayed (*28*). Use of pear ester lures was found to be more effective than sex pheromone lures in predicting mid- and late-season codling moth fruit injury at levels >0.3%. However, neither lure was effective in predicting low levels of fruit injury, <0.3%. Pear ester has been used to implement precision management of codling moth, where site-specific practices are applied to subplots defined by orchard size, topography, and spray tank coverage and monitored with a grid of baited traps (*133*, *134*). Sprays are applied based on cumulative moth catches exceeding thresholds (5 males or 1 female), grower risk preference, pest history, and the status of other pests and protection of biological control. This approach has been demonstrated in both pear and apple and reduced the number of sprays and overall management costs (monitoring, labor, insecticides) by >50%. Similarly, effective action thresholds (10 total and 0.5 females) using the "Combo" lure were developed during a three year study in Utah (*135*).

Similarly, pear ester has been used to improve the timing of insecticides targeting neonate larvae. A three-year study compared the prediction of egg hatch based on the timing of cumulative degree days following the start of sustained moth catch using either sex pheromone (males) or pear ester (males, females, total) lures (*136*). The cumulative degree-day totals differed between lures and sexes, yet both lures were shown to be effective. However, the associated variability with these predictions was found to be lowest using female moth catch in pear ester-baited traps. This work was expanded in Chile and the prediction of egg hatch using female instead of male moth catches provided a four-day improvement (*137*). Also, the addition of the acetic acid lure increased female catches and improved the use of the female-based model in this study.

Utility of Pear Ester

The use of sex pheromone technologies to manage codling moth is purported to be due to mating disruption, and this implies that the success of any of the various commercial sex pheromone products could be measured by measuring female mating status. Prior to the development of pear ester lures, the mating success of female codling moth was evaluated using catches of moths in light traps (*44*), bait-pans, or passive oil-coated interception traps (*45*). Studies demonstrated that the proportion of unmated females was somewhat lower in traps with pear ester than with the passive interception traps suggesting some active bias of mated females for pear ester (*138*). The proportion of unmated females (ca. 40%) was higher in apple orchards with lower population densities (1-2 female moths per trap per season) than in orchards with 3 to >20 females per trap per season (ca. 20%). Surprisingly, the levels of mating were found to be similar

for populations in untreated or sex pheromone-treated orchards (*138–140*). These unexpected findings, however, were consistent with a previous study suggesting that a primary effect of sex pheromone disruption technology was to delay mating which reduced the fecundity of moths and fertility of eggs (*41*). The use of pear ester-baited traps also facilitated a more laborious research approach to evaluate the effectiveness of sex pheromone dispensers using dissections of mated females and counts of their remaining oocytes (*45*). An additional technique has been used to classify the size of deposited male spermatophores (*39*). However, perhaps a more useful approach to ascertain the effectiveness of sex pheromone dispensers has been to measure the reduction in the proportion of multiple-mated females caught in pear ester-baited traps (*39*, *141*). Nevertheless, while apple growers have widely adopted the "Combo" lure to monitor codling moth, they largely ignore the additional information provided by the female moths caught in traps to assess the effectiveness of mating disruption technology.

Several other useful pest management applications have followed the discovery of pear ester as an attractant for codling moth. Initially, pear ester was thought to be a specific attractant for codling moth because eight moth pests common in fruit and nut orchards in the western U.S., including the oriental fruit moth, *Grapholita molesta* (Busck), in peach were not caught in baited traps (*142*). However, authors of a later Italian study, using EAG responses and laboratory olfactometers hypothesized that male *G. molesta* might be attracted to pear ester within pome fruit but not peach, *Prunus* spp (*143*). Unfortunately, field trials were never conducted to support this claim. However, pear ester in combination with (*E*)-β-ocimene did not improve the performance of a sex pheromone lure for *G. molesta* in stone and pome fruit orchards (*144*). Another Italian study found that pear ester was attractive to three tortricid pests of chestnut, *Castanea sativa* Miller, but at a 10-fold higher lure loading than with codling moth (*112*). In comparison the polyphagous species, *Hedya nubiferana* Haworth was not attracted to pear ester, but the combination of pear ester and acetic acid was an effective lure for this species (*145*). Pear ester when used with acetic acid has also been shown to be attractive for apple clearwing moth, *Synanthedon myopaeformis* (Borkhausen) (*146*). The fact that neither of these pests infest fruits, even though they are associated with these pome host plants, and they only respond to pear ester in combination with acetic acid lends support to the hypothesis that this combination lure is attractive to these moths, including codling moth as a food cue.

The attractiveness of pear ester has been useful in a range of other studies assessing the biology of codling moth. For example, pear ester has been used to study the distribution and dispersal of female codling moth using immunological techniques and marking dyes at various scales through typical agroecosystems (*147*, *148*). Traps baited with acetic acid and pear ester were very effective at assessing the overflooding ratio of sterile codling moths released as part of the British Columbia sterile insect program (*149*). The sterile to wild ratio of male, female and total moth catches with acetic acid and pear ester lures were near identical, and all were better predictors of control and damage, than moth catches with either pheromone or CM-DA lures. Codling moth response to pear ester was shown to differ or not among populations with varying levels of resistance to

organophosphate insecticides (*109*, *150*). The use of pear ester was influential in demonstrating the unrecognized sublethal effects of insecticides on both male and female behaviors (*151*, *152*).

Disruption of Larvae with Pear Ester

Codling moth neonate larvae were shown to orient to pear ester in several laboratory assays and this suggested that pear ester could be used in additional approaches to manage codling moth (*91*). Behavioral impacts observed with exposure to pear ester, including, increased larval wandering and longer arrestment times before entering fruits, would likely increase topical exposure of larvae to contact with surface toxicants (*153*, *154*). Greater exposure to insecticides when combined with pear ester could allow managers to reduce rates of insecticides, boost the effectiveness of some classes of insecticides, and ameliorate the effects of poor spray coverage (*91*). Codling moth, in general, deposit eggs on foliage close to developing fruit early in the season and more often on fruits later in the season (*17*). Choice and non-choice bioassays demonstrated that pear ester stimulated oviposition (*155*), however, a practical method to develop an egg trap to monitor populations which could be standardized compared with mechanically injured fruits was not successful (*156*). The practical disruption of oviposition by applying pear ester to foliage was demonstrated in pear orchards where the distance between eggs and fruits increased by 50% leading to reduced fruit injury (*157*, *158*). A microencapsulated (MEC) formulation of pear ester (CideTrak DA-MEC, 5% A.I.) was developed (received U.S. registrations for conventional and organic production systems), and has been carefully characterized, including capsule density, size range, emission rates, and a residual attractiveness of 14 days (*153*). Various field trials were conducted that added pear ester to different classes of insecticides which have a range of residual and *per os* route of exposures in both walnut (*159*, *160*) and apple (*161*, *162*). In general, pear ester significantly improved the performance of insecticides with residual effectiveness and also reduced nut injury by the navel orangeworm, *Amyelois transitella* Walker in walnut (*160*). However, more variable results were found between laboratory assays and field trials with the granulosis virus of codling (*160*, *163*, *164*), including when used in combination with sugar and various yeasts (*Metschnikowia*, *Cryptococoxcus* and *Aureobasidium*) isolated from codling moth larval feeding (*165*), and with the commercially-available *Saccharomyces cerevisiae* Meyen ex E. C. Hansen (*166*).

Mating Disruption with Pear Ester

The first field trials evaluating whether pear ester applied either as a MEC spray or as an experimental hand-applied dispenser could disrupt mating of codling moth were judged to be successful based on the shut-down of male capture in sex pheromone-baited traps and reduced nut and fruit injury (*141*). Field trials continued over a 7-year period to refine proprietary “Combo” MD dispensers with variable loadings and ratios of pear ester and sex pheromone (*119*, *167–170*)

and to assess the addition of DA-MEC sprays to sex pheromone dispenser-based programs (*171*). All studies were conducted in replicated small plots (0.1 – 3.0 ha) and assessments of dispensers were conducted via male catches in sex pheromone-baited traps or in traps with "Combo" lures and/ or sampling of fruit injury. However, studies varied widely in their direct and indirect assessments of dispensers on actual disruption of sexual communication and included the frequency of mating of tethered females (*170*, *172*) and moth catches in traps baited with virgin females, female-equivalent sex pheromone lures, and pear ester lures in screened cages (*169*). Female moths caught with pear ester lures were also dissected to determine their mating status. These studies demonstrated that neither male moth catch in sex pheromone-baited traps nor levels of fruit injury in small plots supplemented with seasonal spray programs were useful measures to assess the efficacy of adding pear ester to sex pheromone dispensers (*168*, *169*). Instead, male catches in female-baited traps and the proportion of unmated wild females caught in pear ester-baited traps were more effective and a more direct measure to compare dispenser treatments (*162*, *168*, *169*). The use of tethered virgin females is an excellent direct measure of sexual disruption but is more laborious to deploy and provided little consistent discrimination between sex pheromone and "Combo" dispenser treatments, across generations and years (*170*, *172*). Moreover, significant increases in the proportions of both unmated females and decreases in multiply-mated females were found when pear ester was used to augment MD (*140*, *162*). Utilizing pear ester in an integrated program through repeated applications of the DA-MEC added to insecticides and the use of "Combo" dispensers was shown to be the most effective program to disrupt mating of codling moth in apple across studies conducted from 2006 to 2012 (*162*). Practical implementation of MD in walnuts due to their large canopy size required the formulation of 'Meso' PVC dispensers which were 10-fold larger and could be applied at $1/10^{th}$ the rate (50 ha^{-1}) of standard PVC dispensers (*119*). "Combo" 'Meso' dispensers have been shown to be effective in both walnut (*119*, *140*) and apple (80 dispensers ha^{-1}) (*128*). Similar to the results with the MEC formulation added to insecticides in walnut (*160*) 'Meso' dispensers were also effective in reducing nut injury by *A. transitella* (*119*).

Lure and Kill with Pear Ester

Several earlier applications were developed to test the concept that sex pheromone formulations could be used to trap out or kill adult male codling moths (*173*, *174*). Previous simulation models had suggested that in mating systems where males can mate more than once, control efforts that rely exclusively on male removal, would be ineffective unless pest populations were extremely low (*175*). The concept of using pear ester lures to remove male and female codling moth, either through mass trapping or attract and kill stations, was shown via similar simulation models to have some potential, especially if virgin females could be removed (*176*). A variety of trapping and killing approaches were considered and tested over a 5-year period, including sticky traps, and use of insecticide-coated traps, clear sticky panels, and screen netting (*177*, *178*).

Following the identification of acetic acid as a synergist for pear ester new studies looked at low volume spot sprays of insecticide either alone or with MEC pear ester in the canopy surrounding acetic acid lures or stations baited with pear ester and acetic acid (unpublished data). Studies were conducted in replicated small plots (0.1 – 1.0 ha) with typically 60 traps or stations ha^{-1}, and levels of fruit injury were never reduced > 50% compared with untreated plots. The key limitations of this method appeared to be the high labor and material costs associated with station and lure maintenance, and the short residual effectiveness of the toxicants. However, Washington growers remain interested in using lure and kill for troublesome hot-spots, including orchard borders. A recent registration of an insecticide-impregnated netting used for mosquito suppression and malaria control, has renewed interest in this approach in tree fruits (*179*).

Sensory Physiology and Perception of Pear Ester

Neurophysiological studies have helped us understand the chemoreception of pear ester by codling moth. Motivating these studies were the observed behavioral responses to pear ester in both the field and laboratory demonstrating that both adult males and females, and larvae of codling moth respond with high specificity and sensitivity to this kairomone. In addition, male moths are more attracted to the combination of sex pheromone and pear ester than sex pheromone alone, suggesting that the sensory pathways dedicated to these two semiochemicals interact.

At the antennal level, EAG screenings of host plant volatiles on female antennae found that pear ester elicited the largest depolarization responses of the 16 headspace volatiles captured from ripe Bartlett pear fruit (*90*). and the 37 and 25 synthetic apple volatiles (*79*, *80*). In dose-response experiments, both male and female antennae exhibited the same response thresholds to low amounts of pear ester (*109*, *112*, *180*). No differences in antennal sensitivity were found among moths collected from apple, pear, or walnut orchards in Italy, and EAG amplitudes were not significantly different between unmated and mated males and females, respectively (*109*). Further, neither the occurrence of organophosphate insecticide resistance nor topical treatments of methoxyfenozide had any effect on EAG responses of moths when compared to untreated moths collected from an organic apple orchard or from a laboratory colony (*109*, *181*).

Electrophysiological recordings of action potentials from single sensilla recordings (SSR) have been conducted on several types of olfactory hairs – *sensilla trichodea*, pegs – *s. basiconica*, and shoehorn – rabbit-eared *s. auricillica* (*109*, *182*). SSR studies have also demonstrated a variety of olfactory sensory neurons (OSN) specificities, some responding to a range of host-plant volatiles, others specifically tuned to codlemone, or pear ester, alone or combined. Male antennae have a large proportion and number of OSNs specifically responsive to codlemone and other pheromone components, while females have OSNs tuned to pheromone, but far fewer relative to OSNs responsive to host-plant volatiles (*109*, *182*). Codlemone-OSNs, pear ester-OSNs, and those responsive to both compounds were present at ratios of 45:15:40% in males and 20:40:40% in

females (*109*). While the two morphological types of *s. auricillica* housed OSNs that are responsive to various host-plant volatiles, the dominate number of sensilla for both sexes had an affinity specific for pear ester alone, ranging from 50 to 78% of the regular shoehorn and rabbit-eared shoehorn sensilla, respectively (*182*).

Availability of new molecular tools has enabled the discovery, identification, and characterization of the genes that code for olfactory receptor (OR) proteins (*183*, *184*). Transcriptome analyses of male and female antennae have revealed 58 ORs in codling moths, with twelve of these belonging to the clade of lepidopteran pheromone receptors (*183*, *184*). Among the ORs which are highly expressed in the adult moths, some were subsequently expressed in heterologous cell systems and functionally characterized by screening their affinity and sensitivity with a panel of semiochemicals (*185*, *186*). One putative pheromone receptor, CpomOR3 was shown to selectively respond to pear ester only and not to any pheromone compounds found in codling moth and related species. The CpomOR3 gene is equally expressed in both males and females (*184*). Interestingly CpomOR3 chemoreceptors are 100-fold less sensitive to the natural pear-produced methyl (*E,Z*)-2,4-decadienoate analog of pear ester, which parallels its lower attractiveness relative to pear ester in field trapping trials (*86*).

Olfactory neurons housing the ORs send their axons into the antennal lobe (AL) of the brain, where they converge and synapse with AL interneurons. The codling moth AL is comprised of 50 glomeruli, i.e., dense spherical entanglements of synaptic neurons (*187*). Most of these are ordinary glomeruli, the primary sites for integration of plant odors for both sexes. In addition, males also possess an enlarged macroglomerular complex (MGC) a dedicated neuropile where the neurons of pheromone ORs (from CpomOR1 to CpomOR6) project (*183*). Intracellular electrophysiological recordings from AL projection interneurons innervating either ordinary glomeruli or the MGC, showed that when antennae were exposed to single volatiles or two-component blends, a variety of integrated excitatory, inhibitory, and synergistic interaction responses was observed (*187*, *188*). Moreover, synergistic excitatory interactions were found in certain projection interneurons when stimulated with blends of codlemone and pear ester, or pear ester and acetic acid (*187*). In males, a specific ordinary glomerulus (satellite 20), as seen through calcium imaging of neural activity, responds to pear ester and codlemone puffed onto the antennae, but not when both are puffed together (*188*). Moreover, and truly surprising, calcium imaging of the MGC-cumulus showed that when male antennae were exposed to pear ester alone no increased activity was apparent. Stimulation by codlemone activated approximately 30% of the cumulus volume, and stimulation by the pheromone-kairomone blend activated 70% of the cumulus (*188*).

This synergistic activity of pear ester with codlemone observed in males has been attributed to the affinity of CpomOR3, that uniquely, among all host-plant volatiles, allows specifically pear ester to join in the initial integration of pheromone OSN afferent signals in the pheromone-dedicated neuropile of the MGC. The molecular phylogeny of codling moth OR groups like CpomOR3, together with receptors tuned to sex pheromone compounds (*183–186*), matches the behavioural, physiological and morphological evidence. It is also interesting that related *Cydia* species, such as the beech moth, *Cydia fagiglandana* (Zeller)

and *G. molesta*, are attracted to pear ester (*112*, *143*), and that AL interneurons of both male and female *G. molesta* respond to pear ester (*189*), while adult *C. fagiglandana* possess a gene CfagOR3 that is a highly conserved ortholog of CpomOR3 (*190*). Thus the affinity for pear ester is evolutionarily conserved in these related species, even though their host preferences and host associations diverged.

In aggregate, these studies suggest that pear ester is unique in influencing and adding to or completing the integration of the pheromone signal in adult codling moth. CpomOR3 and associated sensory circuitry allows pear ester to join the primary pheromonal afferent inputs and access the exclusive pheromone integration center (MGC), where otherwise OSNs for other plant volatiles do not directly arborize and synapse. The existence of a pheromone clade OR dedicated to pear ester underlines the biological significance of pear ester integration and interactions with sex pheromone reception. The molecular and neurophysiological synergistic integration of pear ester with pheromone confirms the demonstrated enhancement of male attraction to CM-DA Combo lures and the enhanced degree of mating disruption of both males and females by the CM-DA Combo dispensers (*106*, *119*, *162*, *168*, *169*). Thus, pear ester for male codling moth is likely perceived as a kairomone and perhaps as a unique parapheromone, enhancing both pheromone reception and behavioral activity (*191*).

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APPENDIX E: FDA Approval of DA as a Flavor Agent or Adjuvant

FDA

Substances Added to Food *(formerly EAFUS)*

ETHYL TRANS-2,CIS-4-DECADIENOATE

CAS Reg. No. (or other ID)*:	3025-30-7
Substance*:	ETHYL TRANS-2,CIS-4-DECADIENOATE
Other Names:	♦ ETHYL TRANS-2,CIS-4-DECADIENOATE ♦ ETHYL 2,4-DECADIENOATE, (E,Z)- ♦ 2,4-DECADIENOIC ACID, ETHYL ESTER, (E,Z)-
Used for*† (Technical Effect):	FLAVORING AGENT OR ADJUVANT
FEMA No.*:	3148
FEMA GRAS Publication No(s).*:	(4, 25)
JECFA Flavor Number*:	1192

*Definitions

- **CAS Reg. No. (or other ID)**: Chemical Abstract Service (CAS) Registry Number® for the substance or a numerical code assigned by CFSAN to those substances that do not have a CAS Registry Number (977nnn-nn-n series).
- **Substance**: The name of the ingredient as recognized by CFSAN.
- **Used for† (Technical Effect)**: The physical or technical effect(s) the substance has in or on food; see 21 CFR 170.3(o)[6] for definitions.
- **21 CFR**: Title 21 of the Code of Federal Regulations.
- **FEMA No.**: The trade association, Flavor and Extract Manufacturers Association (FEMA), has established expert panels to evaluate and make independent determinations on the GRAS status of flavoring substances. The FEMA number is provided here as a reference to FEMA's GRAS assessments.
  - The **GRAS Pub. No.** is the FEMA GRAS™ publication number.
  - **NLFG** is no longer FEMA GRAS™.
  - For more information about FEMA GRAS, see About the FEMA GRAS™ Program[7] <External Link Disclaimer> [8].
- **JECFA**: The Joint Expert Committee on Food Additives (JECFA) is an international expert scientific committee that is administered jointly by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO). See JECFA Specifications for Flavourings[9] <Externa Link Disclaimer>[10]

†Color Additives

- For a substance to be used as a color additive in the US, it must be authorized by a regulation in 21 CFR Part 73, 74, or 82.

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FDA

U.S. Food and Drug Administration
10903 New Hampshire Avenue
Silver Spring, MD 20993
Ph. 1-888-INFO-FDA (1-888-463-6332)
Contact FDA

Appendix F: UC IPM Statewide Integrated Pest management Program Recommendations for Monitoring Lures Containing DA

Codling Moth

Cydia pomonella

Description of the Pest

Codling moths overwinter as full-grown larvae in thick, silken cocoons(/PMG/C/I-LP-CPOM-PP.006.html) under loose scales of bark or in trash on the ground near the trunk. Moth emergence usually coincides with the leafing out of early walnut cultivars. During the day, moths rest on branches and trunks. Codling moths(/PMG/C/I-LP-CPOM-AD.002.html) can be distinguished from other small moths likely to occur in the orchard by the coppery markings on their wing tips.

The first flight of codling moth typically starts sometime from early March to early April and is from the overwintered generation. The flight of the overwintered generation may have two peaks (often referred to as 1A and 1B) and can last several months. These moths lay eggs that signal the beginning of the first generation. The second moth flight results when the larvae of the first generation complete their development. When the moths in the second flight lay their eggs, this starts the second generation. The following table outlines the life history of codling moth:

Generation	Resulting moth flight	Lay eggs for
overwintered	first	first generation
first	second	second generation
second	third	third generation
third	fourth*	

* Only occurs in warm growing locations

Each overwintered female deposits about 30 eggs(/PMG/C/I-LP-CPOM-EG.011.html) singly on leaves near nuts. Later generations of females will lay an average of 60 eggs on leaves or nuts. Eggs are disk-shaped and opaque white. Eggs of the overwintered generation hatch after 5 to 20 days, depending on the temperature, and young larvae(/PMG/C/I-LP-CPOM-LV.003.html) bore into nutlets through the blossom end. Most nuts with codling moth damage from the overwintered generation drop to the ground along with blighted nuts. However, if damage occurs from second flight peak (1B) of overwintered codling moths and the weather is cool, all damaged nuts do not drop. So only use nut drop thresholds when there is no second peak in the flight of the overwintered generation.

Codling moth egg hatch period is dependent on temperatures but typically the egg hatch period for the overwintered generation lasts 4 to 6 weeks and 4 weeks for later generations. The egg hatch period is important for timing sprays. In cool springs or cool locations, the flight of the overwintering generation lasts longer than subsequent flights and has two peaks.

The larvae leave the nut after completing their development and pupate(/PMG/C/I-LP-CPOM-PU.002.html) under loose bark on the tree. Adults of the first generation begin to emerge from the end of May to as late as the last week of June in the Central Valley, depending on the season. In coastal areas, emergence begins in late June to early July. Because of the higher temperatures, eggs and larvae of the first generation develop faster than those laid by the overwintered generation.

Newly-hatched second-generation larvae bore into walnuts anywhere on their surfaces but prefer the spot where two nuts touch. If the nut has hardened, it may take them up to a week to enter the nut. The larvae develop into adults that begin to emerge by late July or the beginning of August. In most valley locations they produce a third generation; in warmer locations a partial fourth generation may be produced in September. These later generations can cause significant damage. Older larvae leave the nuts and move to tree trunks or debris to spin cocoons and overwinter. Occasionally some may be present in nuts if they are harvested before the larvae have matured. However, most larvae found in nuts at harvest are navel orangeworm.

It is important to distinguish between codling moth and navel orangeworm damage. In harvest samples(/PMG/C881/m881hppests.html), it is easy to tell codling moth damage from navel orangeworm damage when the worms are present. Navel orangeworm(/PMG/A/I-LP-ATRA-LV.006.html) has a brown

crescent-shaped marking behind the head capsule on both sides of the first thoracic segment; this mark is absent in codling moth larvae(/PMG/C/I-LP-CPOM-LV.001.html). There can be multiple navel orangeworm larvae but only one codling moth larva per nut. If the worm is not present, look at the damage: navel orangeworm leaves behind more webbing and frass. However, navel orangeworm frequently infest nuts that were previously infested by codling moth, so if navel orangeworm is present, it doesn't mean codling moth wasn't previously there.

Damage

The damage caused by the codling moth is different with each generation. First-generation larvae reduce yield directly by causing nutlets to drop from the tree. Codling moth-damaged nutlets have frass at the blossom end(/PMG/C/I-LP-CPOM-CD.017.html). Be careful not to confuse nuts damaged by codling moths with unpollinated nutlets or blight-infected nutlets, which have dark lesions but no frass and drop at the same time. Damage is generally most severe on early-season cultivars, although it has been increasing steadily over the years on late-season cultivars such as Chandler.

Nuts attacked by larvae from the last part of the first generation and from the second and third generations remain on the trees but are unmarketable because of the feeding damage to the kernel. These damaged nuts can also serve as a breeding site for the navel orangeworm. Feeding that is confined to the husk results in minor shell staining but no damage to the kernel.

You can often detect codling moth infestations by looking for frass produced by the larvae at the point of entry into the husk. Second-generation larvae often enter through the side of the husk where the two nuts touch. After the shell hardens, the larvae enter the nuts through the soft tissue at the stem end.

Management

Management options for codling moth in walnut orchards include both pheromone mating disruption and insecticide sprays. The options that work best for a given orchard depends on the size of the orchard and the trees and the degree of codling moth infestation. In all cases, monitor with pheromone (codlemone), pheromone plus kairomone (CM-DA combo), or both and check for damage. Monitoring and checking for damage is necessary to follow codling moth generations, assess the degree of infestation, and assess the effectiveness of control actions. Programs that use mating disruption alone or in combination with sprays of least-toxic insecticides or parasite releases pose fewer water quality and environmental risks than programs that rely on organophosphate or pyrethroid insecticides.

Biological Control

Natural enemies alone do not keep codling moth numbers below economic levels. In orchards where mating disruptants are used, augmentative releases of the tiny, naturally-occurring parasitic wasp *Trichogramma platneri*(/PMG/C/I-LP-CPOM-TP.001.html), which attacks codling moth eggs, can be helpful to control eggs laid by mated female moths immigrating into the area from surrounding areas, but this may not be economically feasible. They are most effective when the orchard's codling moth population is low.

Organically Acceptable Methods

Organically approved insecticides and some pheromone mating disruption products are acceptable for use in organically certified crops. While certain oil products are organically certified and will supply 30–40% egg kill, there is a concern of phytotoxicity with oils, especially when weather is hot. Oils have also been shown to kill the walnut aphid parasite, *Trioxys pallidus.* **Always check with your organic certifier to determine what products are approved for organic certification.**

Establishing Biofix and Accumulation of Degree-Days

Degree-days (DD) are an important tool for managing many pests. Calculate degree-days(/calludt.cgi/DDMODEL?MODEL=CM&CROP=walnuts) for codling moth in walnut for you location using the codling moth pest model. To learn more about using degree-days to time insecticide applications, watch the degree-days video(https://www.youtube.com/watch?v=RNYevBVIhYQ).

In early March, place traps in your orchards to determine first moth emergence.

- If using traps with standard 1 mg pheromone (1X) lures, put traps in the southeast quadrant of the tree about 6 to 7 feet high. Traps placed higher in the tree canopy catch more moths, which may be useful in orchards with low codling moth numbers.
- Traps with CM-DA lures should be hung mid-canopy and are most useful in orchards that are either using mating disruption or near other orchards using mating disruption.

Biofix is the first date that moths are consistently found in traps and sunset temperatures have reached 62°F. All moths caught in traps with standard 1 mg pheromone lures will be males. Traps with CM-DA combo lures, which contain codlemone pheromone (the male attractant used in 1 mg lures) and a kairomone made of pear volatiles, attract only males before females emerge and both males and females thereafter. The first sustained catch of female moths in these traps is referred to as "female biofix", but degree-day calculations and the treatment timings are all based on the biofix established using male trap captures, regardless of the lure used for monitoring. To predict egg hatch, begin accumulating degree-days from the biofix, using a lower threshold of 50°F and an upper threshold of 88°F.

Because biofix points vary from orchard to orchard, monitor each orchard separately to determine the biofix point for that orchard. See Table 1(#TABLE1) for information on setting biofix points for subsequent generations.

Monitoring and Treatment Decisions in a Mating Disruption Orchard

Unless the orchard is isolated, mating disruption is most successful in large, uniform orchards on flat ground, with a square shape (as opposed to a narrow rectangular shape), and with relatively low to moderate numbers of codling moths. It is less effective in orchards with susceptible varieties (e.g., Ashley, Payne, Serr, Vina) or in orchards that have a history of high numbers of codling moths or economically significant codling moth damage. In these situations, make the transition to a mating disruption program using both mating disruption and chemical control the first year or two to reduce codling moth damage.

Air currents entering the windward (upwind) sides of orchards adjacent to open areas may reduce the effectiveness of mating disruption along orchard edges. In addition, the edges of orchards adjacent to other walnuts not under mating disruption may have immigration of mated females from those blocks. Monitor these situations closely, especially in puffer-treated orchards where the distance between dispensers is large. An insecticide spray applied 4 to 5 trees deep along the affected edge of the orchard may help reduce the risk of damage in these areas.

Setting Out Traps

Traps using standard 1 mg pheromone lures catch few or no moths when mating disruption is present. Therefore, in mating disruption orchards, use codling moth traps with CM-DA combo lures to monitor development and moth numbers.

- Place CM-DA combo traps (1 trap per 25 acres) in the mid-canopy of trees. High counts of codling moths in these traps will help determine the need for supplementing mating disruption with insecticides.
- Also, hang a smaller number of standard 1 mg traps (1 trap per 50 acres or per block) to assess the effectiveness and longevity of the mating disruptant. Hang these traps at 6 to 8 feet in the trees. If moths are caught in these traps consistently for 2 consecutive weeks, the mating disruptant may have broken down or expired, and insecticides may be necessary.

Change trap lures and bottoms at the frequency recommended by the manufacturer.

Setting Out Mating Disruptants

There are three types of pheromone mating disruption products available for use in walnuts:

- **Sprayable liquid formulations** designed to be applied with standard orchard sprayers, which contain pheromones in tiny microcapsules that release pheromones into the air once they are deposited on leaves.
- **Hand-applied dispensers** of various sorts that are hung in the orchard at rates ranging from 20 to 200 units per acre. Pheromones are released into the orchard continuously over a prolonged period of time.
- **Aerosol dispensers** hung in the orchard at low densities, typically one unit per 1.5 to 2 acres. These mechanically dispense small amounts of pheromones into the orchard air at programmed intervals.

Aerosol or plastic dispensers: Hang in the upper quarter of the tree canopy before the historic date of first-flight biofix: typically mid-March in the central and southern San Joaquin Valley to early April further north.

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Sprayable pheromone: Apply at or after biofix when leaves have started growing and are partially expanded. Sprayable formulations have short residual activity. They must be applied at 3- to 4-week intervals for sustained mating disruption, as applications at longer intervals have not been proven effective. Make additional applications shortly after the biofix of the second and third flights. When large moth numbers are present in an orchard, sprayable pheromones have been shown to reduce codling moth damage when added to a conventional spray program. As with hand-applied dispensers, standard 1 mg trap catches are helpful for deciding when sprayable pheromones need to be re-applied.

Nut Sampling

Check nuts for damage during each codling moth generation, particularly near the end of the generation when it is easier to see the frass (excrement). Examine 1,000 mid-canopy nuts in each block (20 nuts per tree on 50 trees per block) for signs of codling moth larval entry. Damaged nuts exceeding 1% after the first generation or 2% after the second indicate an infestation that may exceed 5% at harvest. In these cases supplement the mating disruption treatment with insecticide spray during the egg hatch of the next flight, which is 300 degree-days after the biofix.

At harvest, collect and crack out 1,000 nuts to assess damage(/PMG/C881/m881hppests.html) and plan for next year.

Supplemental Treatments

When making the transition from managing codling moth with insecticides to mating disruption:

- **High codling moth numbers** (i.e., where damage from previous season's harvest sample was over 4%): supplement mating disruption with insecticide applications to reduce the codling moth numbers.

- **Moderate numbers of moths** (i.e., where the previous season's damage was 2 to 4% at harvest) or in the second year of transition: supplement mating disruption with sprays of insecticides that will not disrupt natural enemies.
- **Low moth numbers** (where the harvest damage was less than 1% the previous season): mating disruption alone can be used.

Where insecticide sprays are needed, use degree-day calculations (see below) to apply insecticides at the most effective time.

Monitoring and Treatment Decisions in a Conventional Orchard

In orchards sprayed with contact or ingested insecticides (e.g., spinosad and oil, organophosphates, pyrethroids, and carbamates), time all insecticide applications to kill larvae as they emerge from eggs. If insect growth regulators are used, apply insecticides before egg laying (Dimilin) or egg hatch (Confirm, Intrepid), depending on label instructions. If using a diamide insecticide (e.g., Altacor or Exirel), apply at or before peak egg laying of the targeted generation. Use pheromone (1 mg) or CM-DA combo traps, degree-days (DD)(/WEATHER/ddretrieve.html), and sunset temperatures(/calludt.cgi/SSTSTATIONLIST?YESTERDAY) to monitor codling moth activity and determine when egg hatch occurs. If nearby orchards are using mating disruptants, use the CM-DA combo lure traps for monitoring.

Treatment Decisions

The need for treatment and the timing of sprays is different for the different generations of codling moth. The degree-day model(/calludt.cgi/DDMODEL?MODEL=CM&CROP=walnuts) used in this guideline for codling moth reflects the concept that each subsequent codling moth generation time is longer than the preceding one.

First Generation

The first flight of codling moth can last a long time and have two peaks (1A and 1B). To minimize interference with the walnut aphid parasite and, in most cases, avoid the necessity for aphid insecticide applications, it is best to delay sprays until the second generation or the end of the first generation (1B), especially in later-season varieties.

Low populations

If damage did not exceed 3% the previous season and less than an average of two moths per trap per night are being caught with 1 mg traps, delay insecticide applications until the second flight peak (1B). If you see an increase in trap catches, spray when 600 to 700 degree-days have accumulated from biofix.

Moderate to high populations

If damage exceeded 3% the previous season or more than an average of two moths per trap per night are being caught with 1 mg traps, plan to spray both the 1A and 1B larvae:

Treating 1A larvae

Apply a pesticide when 300 degree-days accumulate after biofix, using a short-residual material to minimize disruption of the aphid parasite, *Trioxys pallidus.*

Treating 1B larvae

When you see an increase in moths caught in traps around 600 to 700 degree-days from the first biofix, apply a second spray when the residual period (i.e., the length of time the insecticide controls the pest) of the first pesticide ends. Residual periods for many of the pesticides are listed in the treatment table below. In most cases, a range of days is given. The actual length of a residual period is influenced by several factors, including the pH of the solution and the susceptibility of the population to that material. If the population has developed any resistance to the material, then the residual period will be shorter than it would be for a highly susceptible population.

Second and Later Generations

Codling moth has two to four generations a year. Continue monitoring with traps and accumulating degree-days (as outlined in TABLE 1(#TABLE1)) until the crop is harvested or numbers decline to below damaging levels in September. At the beginning of each generation, determine the biofix point for that generation in order to predict the best treatment timing during egg hatch for that generation.

To time an insecticide application for second-generation larvae, determine the biofix for the second generation. This generally occurs around 1060 degree-days from the first biofix point. However, any increase in trap catches after 800 degree-days can be considered the biofix. To better determine this biofix, clean and service the traps around 700 degree-days and start checking traps more frequently.

If there was no second peak in the first flight of codling moth, the number of dropped nuts can be used to determine if the second generation requires an insecticide application. All nuts damaged by codling moth early in the season drop, except when there is a second peak of the first flight or if the weather is not hot enough.

1. Look for frass at the blossom end of nuts to confirm that codling moth caused the drop.
2. Examine all the nuts under the same 10 trees in an orchard block each week during the nut drop period (4 to 6 weeks from the end of bloom).
3. Record the total number of damaged nuts per tree (not the percent damaged).

- If an average of 4 or less infested nuts are found per tree, you can expect less than 5% codling moth damage by harvest without a spray.
- If there are between 4 and 24 infested nuts per tree, spray at 250 degree-days from the second biofix and use a short residual pesticide.
- If you collect more than 24 codling moth-damaged nuts per tree, apply an insecticide as soon as eggs of the second generation start hatching (250 degree-days from the second biofix), and use a long residual pesticide to cover the entire hatch period (about 1 month).

Third-generation Egg Hatch

A third (or fourth) generation of codling moth eggs does not occur every year in every location. Codling moth larvae normally go into diapause (winter dormant state) around August 22, but in warm years and warm locations they will have already started pupation before August 22, and these pupae will soon emerge as adults to produce a third generation. If 650 degree-days have accumulated between the peak of the second-generation flight and August 22, most of the codling moth will not go into diapause but will pupate and emerge in August to early September, depending on climate.

If degree-day accumulation data indicates a third generation will occur, use pheromone traps to establish a third biofix point around 1100 to 1200 degree-days from the second biofix. Apply a spray when 200 to 250 degree-days have accumulated from the third biofix unless trap catches are high, in which case spray at 160 degree-days. If needed, apply the second spray when the residual of the previous spray ends.

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Table 1. Codling Moth Management in Walnuts.

EVENT	ACTION
FLIGHT OF OVERWINTERED GENERATION	• Hang traps out at bud break (first week in March) and determine first-flight biofix.
Low populations	• If damage did not exceed 3% the previous season and less than an average of 2 moths per trap per night are being caught with 1 mg traps, delay treatment until the second flight peak (1B); When you see an increase in trap catches, treat when 600 to 700 degree-days (DD) have accumulated from biofix.
Moderate to high populations	• If damage exceeded 3% the previous season or more than an average of 2 moths per trap per night are being caught with 1 mg traps, treat both the 1A and 1B larvae.
First treatment (1A)[1]	• Spray at 300 DD[2] (or 250 DD if using an insect growth regulator) from first-flight biofix or when small nutlets first appear, whichever is later.
Second treatment (1B)[1]	• Look for second peak about 600 to 700 DD from first biofix by checking traps frequently. • If a second peak occurs, spray when residual effectiveness of first treatment ends.
SECOND FLIGHT	• Determine second biofix to time sprays for second-generation egg hatch. • Use trap catch data to detect resumption of moth flight activity and establish biofix. The second biofix will be when an increase occurs in trap catches between 800 to 1300 DD from first biofix (average is 1060 DD). • Begin accumulating degree-days from second biofix. • Check traps frequently; trap maintenance important.
Visual monitoring	• If there is a second peak in the first flight, use visual inspection. Look at a minimum of 10 nuts on each of 10 trees at least 10 feet up in the canopy. • If less than 2% infestation in visual inspection, don't treat. • If more than 3% infestation in visual inspection, spray at 250 DD[2] from second biofix and use a short residual insecticide. • If there is more than 5% infestation in visual inspection, spray at 250 DD[2] from second biofix and use a long residual pesticide to cover entire hatch period (about 1 month).

EVENT	ACTION
FLIGHT OF OVERWINTERED GENERATION	• Hang traps out at bud break (first week in March) and determine first-flight biofix.
Monitoring nut drop	• If there is no second peak in the first flight (overwintered generation), monitor nut drop to determine the need to spray. • If there are 4 or less infested nuts that have dropped from the tree, don't treat. • If there are 4 to 24 infested nuts per tree, spray at 250 DD from second biofix and use short residual insecticide. • If there are more than 24 infested nuts per tree, spray at 250 DD from second biofix and use long residual pesticide to cover entire hatch period (about 1 month).
THIRD FLIGHT	• Time sprays for third generation egg hatch. Use trap catch data to detect resumption of moth flight activity. Third biofix is when trap increase occurs between 800 to 1300 DD from second biofix (average is 1100 DD). • Check traps frequently; trap maintenance important.
Low populations	• Do not treat if there is no or little (less than 2%) evidence of canopy infestation.
Moderate to high populations	• Spray at 300 DD[2] (or 250 DD if using an insect growth regulator) from 3rd biofix when there is obvious canopy infestation (more than 2%).
FOURTH FLIGHT	• Time sprays for fourth generation egg hatch. Use trap catch data to detect resumption of moth flight activity. Fourth biofix is when trap increase occurs between 800–1300 DD from third biofix (average is 1200 DD). • Check traps frequently, trap maintenance important.
Low populations	• Do not treat if there is no or little (less than 2%) evidence of canopy infestation.
Moderate to high populations	• Spray at 300 DD[2] from fourth biofix when there is obvious canopy infestation (more than 2%).
HARVEST SAMPLE	• Collect and crack out 1,000 nuts to **assess damage(/PMG/C881/m881hppests.html)** and to plan for next year.

1	1A and 1B refer to the two flight peaks of the first codling moth flight
2	Timing is 50 to 100 DD earlier for growth regulators

Additional Treatment Considerations

If there was a second peak in the first flight, not all of the infested nuts will have dropped, so visually inspect the tree canopy for infested nuts.

1. Look at a minimum of 10 nuts on each of 10 trees at least 10 feet up in the canopy.
   - If less than 2% are infested, don't spray.
   - If greater than 2% infested nuts are found, a pesticide application is necessary.
2. Apply an insecticide as soon as eggs of the second generation start hatching (250 degree-days from the second biofix).
   - Use a short residual material if the percent infestation is between 3 and 5, or
   - if greater than 5% infestation is found a long residual material to cover the entire hatch period (about 1 month).

For the third and fourth generation, the decision to spray must be based on a combination of factors including previous pesticide applications, number of nuts infested in the previous generation, trap catches, and the ability to harvest early. To determine the number of nuts infested in the previous generation, visually inspect 20 nuts at least 10 feet up in the canopy on 50 trees.

- If less than 2% are infested, don't spray.
- If greater than 2% are infested, spray.

If you spray, it is important to determine a biofix for third and fourth generations. The generation times get longer with each generation. Look for the third biofix around 1100 degree-days from the second biofix and for the fourth biofix around 1200 degree-days from the third biofix (the range for both biofix points is 800 to 1300 degree-days). Pesticide applications are often not needed at this time; but if stings are found on nuts, apply sprays 300 degree-days after the biofix.

Common name	Amount to use**		REI‡	PHI‡
(Example trade name)	(conc.)	(dilute)	(hours)	(days)

Pesticide precautions

Protect water

Calculate VOCs

Protect bees

Not all registered pesticides are listed. The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees(/agriculture/walnut/Relative-Toxicities-of-Some-of-the-Pesticides-Used-in-Walnuts-to-Natural-Enemies-and-Honey-Bees/), and the environment(/mitigation/index.html) are at the top of the table. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.

Note: Residual periods mentioned in the comments will be influenced by many variables, including spray coverage, weather, resistance, population pressure, etc. and may vary from the actual effective control period, depending upon these variables.

MATING DISRUPTION

A. MATING DISRUPTANTS

COMMENTS: Most effective in isolated blocks or larger blocks that have a squarish shape and low to moderate codling moth numbers, with trees of uniform size and moderate height. Consult with a crop advisor for help deciding whether specific orchards are suitable for mating disruption and information on how to deploy dispensers for maximum effectiveness. Apply just prior to first-flight biofix in mid-March to mid-April. Reapply if needed at the interval recommended on the label. Hang 1 mg pheromone traps at 6 to 8 feet high in the canopy and assess them weekly to ensure mating disruption product has not expired. Use traps baited with CM-DA combo lures high in the canopy to monitor population development. Check nuts for damage after each generation and treat with insecticides if needed to ensure a low level of damage at harvest. Be sure to monitor for other pests such as walnut husk fly, aphids, and redhumped caterpillar normally controlled by codling moth sprays.

AEROSOL DISPENSERS#			*Period of effectiveness (days)*
(Isomate-CM Mist, Isomate CM-Mist Walnut)1 dispenser/1.5–2 acres		0	Up to 200
(CheckMate Puffer CM-O, CheckMate CM-O-Pro)	1 dispenser/1.5–2 acres	0	Up to 200

COMMENTS: Hang aerosol dispensers in the upper third of tree canopies. Hang aerosol dispensers at a spacing of one per 180 to 200 linear feet in trees around the perimeter; within the orchard's interior, place units in a roughly square grid pattern to achieve an interior density of one per 2 acres. This will result in an overall density of one dispenser per 1.5 to 2 acres. Although densities of less than 1 unit per acre are not recommended by either manufacturer, research has demonstrated that densities of 1 unit per 1.5 to 2 acres provides good suppression where a substantial monitoring program (as described above) is carried out and supplemental sprays are applied in the first few years, if needed, to lower codling moth numbers. The pheromone plume released by aerosol dispensers is large and has been shown to reduce 1 mg trap catches up to 2000 feet downwind. Use CM-DA combo traps (as well as standard 1 mg traps) to monitor conventionally managed orchards near orchards with aerosol dispensers to provide an accurate assessment of codling moth numbers and activity.

HAND-APPLIED DISPENSERS#			*Period of effectiveness (days)*
(Isomate-CTT)	100–200 dispensers/acre	0	160+
(Isomate-CM Ring)	20–40 dispensers/acre	0	160+
(CheckMate CM-XL1000)	120–200 dispensers/acre	0	Up to 150 days

COMMENTS: Attach dispensers to branches in the upper third of tree canopies. Apply dispensers individually in trees at a rate sufficient to give the recommended number of dispensers per acre. Hang lower density products such as the CM-Ring in a uniform pattern (e.g. every other tree in every row) to ensure even distribution of pheromone throughout the orchard. Make application shortly before first biofix.

SPRAYABLE FORMULATIONS			
(CheckMate CM-F)	2.4–4.8 oz	4	NA

COMMENTS: Sprayable formulations have short residual activity and should be applied at 3- to 4-week intervals for continuous suppression. Delay the first application until leaves have emerged and are partially expanded.

Common name	Amount to use**		REI‡	PHI‡
(Example trade name)	(conc.)	(dilute)	(hours)	(days)
INSECTICIDE CONTROLS				
Moderate to High Codling Moth Numbers				
A. SPINETORAM				
(Delegate WG)	4.5–7 oz	—	4	1
MODE-OF-ACTION GROUP NUMBER[1]: 5				
COMMENTS: Larvicide. The best time to apply is at egg hatch (about 200 DD). Do not make more than four applications per year. To reduce the development of resistance, do not make more than three consecutive applications of any group 5 insecticides (spinosad or spinetoram) per season and do not apply to more than one generation per season.				
B. CHLORANTRANILIPROLE				
(Altacor)	3–4.5 oz	—	4	10
MODE-OF-ACTION GROUP NUMBER[1]: 28				
COMMENTS: Larvicide. The best timing is to apply before egg hatch (about 200 DD). Do not make more than four applications per year. To reduce the development of resistance do not make more than three consecutive applications of any group 28 insecticides (anthranilic diamide) per generation per season.				
C. CYANTRANILIPROLE				
(Exirel)	10–20.5 fl oz	—	12	5
MODE-OF-ACTION GROUP NUMBER[1]: 28				
COMMENTS: To reduce the development of resistance do not make more than three consecutive applications of any group 28 insecticides (anthranilic diamide) per generation per season.				
D. LAMBDA-CYHALOTHRIN*				
(Warrior II with Zeon)	2.56 fl oz	—	24	14
MODE-OF-ACTION GROUP NUMBER[1]: 3A				
COMMENTS: Larvicide. Residual at the acre rate is about 21 days. Addition of oil improves coverage and aids in suppressing mites. During the first codling moth generation, add oil at 1% if the 1A eggs are being treated and at 0.5% for the 1B eggs. During the second generation add oil at 0.25%.				
E. CYFLUTHRIN*				
(Baythroid XL)	2–2.4 fl oz	0.5–0.6 fl oz	12	14
MODE-OF-ACTION GROUP NUMBER[1]: 3A				
F. BIFENTHRIN*				
(Brigade WSB)	8–32 oz	2–8 oz	12	7
MODE-OF-ACTION GROUP NUMBER[1]: 3A				
COMMENTS: Provides about a 21- to 28-day residual at the high label rate.				
Moderate Codling Moth Numbers				
A. ACETAMIPRID				
(Assail 70WP)	2.3–4.1 oz	0.271–1 oz	12	14
MODE-OF-ACTION GROUP NUMBER[1]: 4A				
COMMENTS: Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.				
B. EMAMECTIN BENZOATE*				
(Proclaim)	3.2–4.8 oz	0.8–1.2 oz	See comments	14
MODE-OF-ACTION GROUP NUMBER[1]: 6				
COMMENTS: REI is 48 hours for poling, pruning, and thinning; 12 hours for all other activities.				

Common name	Amount to use**		REI‡	PHI‡
(Example trade name)	(conc.)	(dilute)	(hours)	(days)
C. PHOSMET				
(Imidan 70W)	5 lb	1–2 lb	7 days	28
MODE-OF-ACTION GROUP NUMBER[1]: 1B				
COMMENTS: Do not apply after husk split. Provides a residual of about 21 days. Buffer to a pH of 5.5–6.0.				
D. METHOXYFENOZIDE/ SPINETORAM				
(Intrepid Edge)	10–18 fl oz	—	4	7
MODE-OF-ACTION GROUP NUMBER[1]: 18/5				
COMMENTS: Apply at the beginning of egg hatch, which is earlier than organophosphorous or carbamate insecticide timings. **It is recommended that methoxyfenozide be applied at 200 degree-days after the first biofix.**				
E. METHOXYFENOZIDE				
(Intrepid 2F)	16–24 fl oz	—	4	7
MODE-OF-ACTION GROUP NUMBER[1]: 18				
COMMENTS: An insect growth regulator that provides 10 to 18 days of residual protection depending on the rate of application and nut expansion. Kills young larvae but does not kill adult moths. It is a reduced risk insecticide that has little or no effect on beneficial insects and mites. Only use in orchards with low to moderate codling moth populations. Spray coverage is extremely important. Do not apply to large trees unless adequate spray coverage can be verified. Use no less than 100 gal water/acre for ground applications. Sprayer speed should not exceed 1.5 mph. The use of Latron B-1956, CS-7, or similar sticker-spreader is highly recommended. Apply at the beginning of egg hatch, which is earlier than organophosphorous or carbamate insecticide timings. **It is recommended that methoxyfenozide be applied at 200 degree-days after the first biofix.**				
F. ESFENVALERATE*				
(Asana XL)	9.6–19.2 fl oz	4 fl oz	12	21
MODE-OF-ACTION GROUP NUMBER[1]: 3A				
COMMENTS: Residual of about 14 to 21 days (lower rates have less residual activity). This is a broad-spectrum pesticide that is harmful to beneficials at higher rates and can cause outbreaks of aphids and mites. Lower rates may also be harmful to beneficials, but the effects of secondary pest outbreaks are less obvious. It is best to use broad-spectrum pesticides late in the season. Provides control of the hyperparasite that attacks the aphid parasite *Trioxys pallidus,* and it does not kill *Trioxys*. This pesticide is not effective on scales, so if you have a scale problem choose another chemical.				
G. PERMETHRIN				
(Ambush)*	12.8–25.6 oz.	0.05–0.1 lb a.i.	12	1
(Pounce 25WP)*	12.8–16 oz.	0.05–0.0625 lb a.i.	12	1
MODE-OF-ACTION GROUP NUMBER[1]: 3A				
COMMENTS: Residual of about 14 to 21 days (lower rates have less residual activity). There is no university data on the effectiveness of this material on codling moth in walnuts; follow information for esfenvalerate. This is a broad-spectrum insecticide and the high rate will be harmful to beneficials. This material is not effective on scales, so if you have a scale problem choose another chemical. It also may cause mite outbreaks. Do not graze livestock in sprayed area.				
H. CARBARYL*				
(Sevin)	Label rates		12	14
MODE-OF-ACTION GROUP NUMBER[1]: 1A				
COMMENTS: There has been little research on this pesticide in walnuts, but in apples carbaryl is a good codling moth material and has a residual period of about 28 days. Carbaryl causes mites to reproduce more rapidly, possibly resulting in mite outbreaks, so monitor for mites if carbaryl is used. This pesticide is best used later in the season. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.				
Low Codling Moth Numbers				
A. DIFLUBENZURON*				

Common name		Amount to use**		REI‡	PHI‡
(Example trade name)		(conc.)	(dilute)	(hours)	(days)
	(Dimilin 2L)	16 fl oz	—	12	28
	MODE-OF-ACTION GROUP NUMBER[1]: 15				
	COMMENTS: An insect growth regulator that has a residual of about 21 days. **It kills eggs, does not kill adult moths**, and is safer to some beneficials than organophosphates and carbamates. Only use in orchards with low to moderate codling moth numbers. Coverage is extremely important: it is not recommended for the first generation because the rapid growth of leaves in spring does not allow for leaves to remain completely covered during the residual period (21 days.) Apply in a minimum of 125 gal water/acre and the ideal amount is 250 gal water/acre for mature trees. Ground speed should not exceed 1.5 mph. Diflubenzuron must be applied earlier than the other pesticides because it needs to be on the leaf before eggs are laid. Treatment timing is before the start of the second generation fight, which is about 800–900 degree-days from the first biofix and before the start of the third generation flight, which is 1800 to 1900 degree-days from the first biofix. Diflubenzuron is not a stand-alone material and should be used in combination with another control.				
Supplemental Control in Organic Orchards					
A.	CYDIA POMONELLA GRANULOVIRUS#				
	(Cyd-X, etc.)	1–6 fl oz	—	4	0
	COMMENTS: A larvicide; time to egg hatch at 200 to 250 degree-days; larvae must ingest to become infected by this virus. Make a second application 7 to 10 days later, a third application at 600 degree-days, and a fourth 7 days later for a total of 4 applications per flight.				
B.	SPINOSAD				
	(Entrust)#	1.25–3 oz	0.3–0.75 oz	4	1
	MODE-OF-ACTION GROUP NUMBER[1]: 5				
	COMMENTS: A short-residual insecticide. When combined with 1% spray oil to improve spray coverage, this insecticide is best used as a supplement to mating disruption. May be used without oil but may not be as effective. Only higher rates of spinosad have been tested for codling moth control. Spray coverage is extremely important. At best, controls 50 to 60% of population. Do not use more than 9 oz. of Entrust/acre per crop. Do not apply spinosad sprays less than 7 days apart. Limited experience with use in California walnuts.				
	. . . PLUS . . .				
	NARROW RANGE OILS#				
		See label	See label	4	0
	MODE OF ACTION: Contact including smothering and barrier effects.				
	COMMENTS: Do not apply if trees have suffered from a lack of adequate soil moisture or other stressing factors (insect, disease damage, etc.) at any time during the year or if temperatures are expected to exceed 90°F at time of application. Do not apply after husk split. Not all oils are organically acceptable: check label and your organic certifying agency.				

1	Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers are assigned by IRAC (Insecticide Resistance Action Committee) (http://irac-online.org/).
**	For concentrate application, use the amount given in 80 to 100 gal water/acre, or lower if the label allows; for dilute application, amount is per 100 gal water to be applied in 300 to 500 gal water/acre, according to label.
‡	Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of these two intervals is the minimum time that must elapse before harvest may occur.
*	Permit required from county agricultural commissioner for purchase or use.
#	Acceptable for use on organically grown crops.
NA	Not applicable.

Important Links

- Degree-day table(/WEATHER/DDTABLE/codling_moth.html)
- Degree-day calculator(/WEATHER/ddretrieve.html)
- Identifying seasonal pests in harvest samples (/PMG/C881/m881hppests.html)

- Using degree-days to time insecticide applications(https://www.youtube.com/watch?v=RNYevBVIhYQ)

UC PEER REVIEWED

UC IPM Pest Management Guidelines: Walnut
UC ANR Publication 3471

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Treatment Table Updated: 07/17

Codling Moth

Cydia pomonella

Description of the Pest

Codling moth(/PMG/C/I-LP-CPOM-AD.003.html) has a 0.5 to 0.75 inch wingspan. The tip of each forewing has a coppery-tinged, dark brown band that distinguishes codling moth from other moths found in apple orchards. Females lay eggs(/PMG/C/I-LP-CPOM-EG.001.html) singly on leaves and sometimes on fruit later in the season. The eggs are smaller than a pinhead, disk-shaped, and opaque white when first laid. Just before hatching the black head of the larvae becomes visible. Newly hatched(/PMG/C/I-LP-CPOM-LV.012.html) larvae are white with black heads. Mature larvae(/PMG/C/I-LP-CPOM-PP.006.html) are 0.5 to 0.75 inch long, pinkish white, with mottled brown heads. Depending on climatic conditions and location in the state, there are two to four generations of codling moth each year.

Damage

Codling moth has the greatest potential for damage of any apple pest, yet it can be effectively controlled with properly timed treatments. It causes two types of fruit damage: stings and deep entries. Stings(/PMG/C/I-LP-CPOM-CD.023.html) are entries where larvae bore into the flesh a short distance before dying. Deep entries(/PMG/C/I-LP-CPOM-CD.029.html) occur when larvae penetrate the fruit skin, bore to the core, and feed in the seed cavity. Larvae may enter through the sides, stem end, or calyx end of the fruit. One or more holes plugged with frass on the fruit's surface are a characteristic sign of codling moth infestation. Calyx entries are difficult to detect without cutting the fruit.

Management

An IPM program uses a combination of tools for codling moth management, including insecticides, mating disruption, and cultural controls. Mating disruption is the preferred tool because of its low toxicity to people, natural enemies, and the environment, but it may need to be supplemented with insecticide sprays, especially during the first few years. In orchards where codling moth is managed primarily with insecticides, alternate insecticides that have a different mode-of-action Group number to avoid the development of resistance. If you see trap catches increasing and suspect insecticide tolerance or resistance, combine the use of mating disruption with the insecticides. All codling moth management programs should be supplemented with cultural controls.

Biological Control

Alone, natural enemies are not able to keep codling moth populations below economic levels. Augmentative releases of the egg parasite *Trichogramma platneri* have been applied to reduce codling moth populations, but research has shown that this technique has limited effectiveness and is too expensive for practical use.

Cultural Control

Remove host trees in nearby abandoned orchards (apple, pear, and walnut) to destroy reservoirs of codling moth. Also remove props, picking bins, and fruit piles from the orchard. Proper pruning and orchard sprayer calibration will improve spray coverage. An option for small, organic orchards is hand thinning to remove all infested fruit during each generation, before worms leave fruit, and removal of dropped fruit.

Organically Acceptable Methods

Organically acceptable tools for the control of codling moth include cultural control in conjunction with mating disruption and sprays of approved oils, codling moth granulovirus (Cyd-X), the Entrust formulations of spinosad, and kaolin clay (Surround). Check with your certifier about the exact status of all materials.

Monitoring and Treatment Decisions in a Mating Disruption Orchard

Mating disruption works best in large, uniform orchards that are relatively square in shape. It is not recommended for orchards less than 3-5 acres in size. The larger the contiguous block of mating disruption, the more effective it will be. In orchards with moderate-to-high populations of codling moth and/or in the first year of mating disruption, insecticides or other supplemental controls will likely be

needed in addition to the mating disruption program. Using mating disruption successively over a number of years can effectively lower the codling moth population so that alternative, reduced-risk chemical treatments can be effectively used to supplement control when needed.

Setting Out Pheromone Dispensers

Pheromones are deployed as either hand-applied dispensers or in an aerosol canister (puffer). Sprayable pheromones are available but not currently recommended for pome fruit orchards because of their very short residual.

Using historical biofix dates to time the application, hang all pheromone products shortly before the first moth emergence in early March to early April. It is important to put out pheromone products early in order to disrupt the mating of overwintering moths as soon as they emerge. A late pheromone application will require supplemental spray treatment.

Place hand-applied pheromone dispensers in the upper third of the tree canopy. When placing puffers, put them on the inside of the canopy of edge trees or on the outside of trees in the second row. Upwind placement is one puffer every 50 to 65 feet, and downwind placement is one every 100 to 130 feet, or an average of 20 units per quarter mile. For large blocks, also place a few puffers towards the middle of the orchard on the upwind side. Reapply the dispensers according to the manufacturer's guidelines if the product residual will not last through harvest or through the end of the last generation.

Monitoring with Traps

Monitor pheromone-treated orchards with traps(/PMG/C/I-LP-CPOM-TR.017.html) carefully to help ensure that mated moths have not moved in from adjacent orchards and that the pheromone is successfully disrupting mating.

Supercharged (10 mg) pheromone traps.

Place pheromone traps with supercharged (10 mg) pheromone lures in the orchard when pheromone dispensers are set out. Put these traps in trees at the same level as the pheromone dispensers. These traps serve to help set the biofix point for degree-day accumulation, which is used to time both fruit sampling and supplemental treatments. Check traps one to two times a week until biofix is set and once a week thereafter. Biofix is the first date that moths are found in traps for three consecutive checks and sunset temperatures have reached 62°F. (Replace lures at the frequency recommended by the manufacturer.)

Supercharged traps do not attract moths from far, so place as many traps as you can monitor in areas of the orchard that are known hot spots and areas vulnerable to wind where pheromone concentration is likely to be reduced. Examples include high spots and orchard edges; five to six rows inside the orchard is a good location. If the supercharged traps consistently catch high numbers of moths, monitor fruit in the surrounding area for eggs and damage to determine if a supplemental treatment is necessary. No thresholds have been established for these supercharged traps but 5 moths/week can be considered a relatively high trap count.

Regular (1 mg) pheromone traps

Another tool in a mating disruption program is the use of pheromone traps with the regular (1 mg) lures to verify the effectiveness of the mating disruption dispensers. A good idea is to pair a 1 mg trap with a supercharged one. Check traps weekly and replace lures at the frequency recommended by the manufacturer. *The supercharged traps should catch a few moths, but the 1 mg traps should not catch any.* If moths are caught in the 1 mg traps, check the fruit in the surrounding area. If eggs or damage are found, apply a supplemental treatment to prevent further damage. Traps with regular lures can also be used in upwind border trees (placed in trees in the second row) to monitor the influx and development of codling moth. When moths are caught in these edge traps, it signals the need to monitor fruit.

DA lures

A plant-derived chemical (kairomone) lure has been developed to assist in monitoring codling moth populations. This lure is sold commercially as the "DA" lure and is available alone and in combination with pheromone ("combo lure"). The DA lure has been shown to catch both female and male moths, whereas pheromone lures catch only male moths. The sex of moths caught in traps using the DA lure can be determined by observing the tip of the abdomen(/PMG/C/I-LP-CPOM-KC.100.html). If the moth is female, the abdomen can be squeezed to eject the bursa pouch and give some idea of whether the moth is unmated(/PMG/C/I-LP-CPOM-KC.003.html), mated once(/PMG/C/I-LP-CPOM-KC.004.html), or more than once(/PMG/C/I-LP-CPOM-KC.005.html). Generally, if the female's abdomen feels hard to the touch, the moth is most likely mated.

The DA lure appears to work best in mating-disrupted apple orchards early in the season. The DA and DA/pheromone combo lure may also be used to assess the success of mating disruption in an orchard, similar to using a supercharged (10X) pheromone lure. Because these lures are relatively new to the market and there appears to be some variability in these lures from one season to the next, use them in conjunction with standard 10X and 1X pheromone lures in order to become familiar with them.

Fruit Sampling

Fruit damage can occur even when no moths are caught in traps, so always check fruit for damage towards the latter half of each generation (900 to 1000 degree-days from biofix) and whenever moths are being caught in traps. Examine at least 200 fruit from throughout the orchard as well as in known hot spots and areas vulnerable to wind (edges, high spots), which can reduce pheromone concentration.

If fruit damage exceeds 0.5%, supplemental sprays should be used for the next generation. If the damage is quite light and very localized along a border, treating five to ten rows along the problem border may be adequate. However, if damage is not clearly localized, or is localized but more than a few percentages, then a larger area or the entire orchard may need to be sprayed.

Supplemental Treatments

First generation

In orchards with moderate-to-high codling moth populations or if the orchard is in the first year of mating disruption, supplement the mating disruption with an insecticide spray of Altacor, Delegate, Assail, Imidan, or Warrior at 250 degree-days after the biofix to target hatching eggs from the first peak of the overwintered moth flight. If monitoring indicates continued flight, apply a second application about 600 to 700 degree-days from the biofix to suppress egg hatch from the second flight peak of the overwintered moths.

For low populations, applying a supplemental spray to the first generation may not be necessary. Use trap catch information and monitor fruit to determine if a spray is needed. Using a reduced risk material such as the IGRs (methoxyfenozide-Intrepid) or an organically acceptable alternative (oil, spinosad-Entrust, or codling moth granulovirus – Cyd-X) may be sufficient for control of low populations.

Second and third generation

To determine if treatment is needed for subsequent generations, careful trap and fruit monitoring is essential. If treatment is needed, use the guidelines in the section below to determine the best time to spray.

Monitoring and Treatment Decisions in a Conventional Orchard

In orchards where codling moth is managed primarily with insecticides, pheromone traps, in conjunction with degree-days and sunset temperatures, are used to determine egg hatch and proper spray timing. When using pheromone traps, keep in mind the many factors, such as tree size, trap density, type of trap, trap placement, brand of pheromone, as well as climatic conditions, that can affect trap counts.

Establishing Biofix and Accumulation of Degree-Days

Hang 1 mg pheromone traps in the orchard in mid-March (or at bloom in foothill orchards) about 6 to 7 feet high, with one trap every 10 acres and at least two traps per orchard. The first date that moths are found in traps for three consecutive trap checks and sunset temperatures have reached 62°F is first biofix. (Service traps one to two times a week until biofix is set and once a week thereafter. Replace lures at intervals specified by the manufacturer.)

Spray Timing

Once biofix is reached, calculate degree-days using a lower threshold of 50°F and an upper threshold of 88°F.

The most effective spray timing for each generation is outlined below. For all generations, if high levels of moths are being caught in traps, do not wait until 200–250 degree-days to treat, but apply the first spray at *the beginning* of egg hatch (160 degree-days).

Codling moth has two to four generations each season. Continue to monitor the generations with traps and accumulate degree-days until the crop is harvested or populations decline below damaging levels in September.

First generation egg hatch

Two to three sprays may be necessary to adequately control the first generation particularly if the population is high or a short-residual insecticide is used. In addition, if rainfall exceeds 0.5 inch or an irrigation with overhead sprinklers is scheduled within 2 weeks after treatment, a second spray will be needed. Apply the first spray when 250 degree-days have accumulated from the first biofix, unless high levels of moths are being caught, in which case spray at 160 degree days.

Make the second and third, if needed, application when the residual effectiveness of the previous spray has ended; this will vary, depending on the chemical used. If trap catches are low or the weather turns too cool for moth activity, you can delay treatment, but continue to monitor.

Second generation egg hatch

Use pheromone trap catches to detect an increase in moth flight activity around 1060 degree-days from the first biofix, which signals the start of the next flight and is the second biofix. For low moth populations, a single application may be sufficient; make this application when 200 to 250 degree-days have accumulated from the second biofix. If you are catching high levels of moths per trap per week, spray at 160 degree-days. If needed, apply a second spray when the residual of the previous spray ends. These two sprays should provide control during the entire egg hatch period.

Third generation egg hatch

A third generation of codling moth eggs does not occur every year in every location. Codling moth larvae normally go into diapause (winter dormant state) around August 22, but in warm years and warm locations they will have already started pupation before August 22, and these pupae will soon emerge as adults to produce a third generation. If 650 degree-days have accumulated between the peak of the second generation flight and August 22, most of the codling moth will not go into diapause but will pupate and emerge in August to early September, depending on climate.

If degree-day accumulation data indicates a third generation will occur, use pheromone traps to establish a third biofix point around 1100 to 1200 degree-days from the second biofix. Apply a spray when 200 to 250 degree-days have accumulated from the third biofix unless trap catches are high, in which case treat at 160 degree-days. If needed, apply the second spray when the residual of the previous spray ends.

Fourth generation egg hatch

In the hottest growing regions of the state, such as the southern San Joaquin Valley, a fourth or partial fourth generation may occur in some years. When flight activity increases around 1100 to 1200 degree-days from the third biofix, establish the fourth biofix. Apply a spray when 200 to 250 degree-days have accumulated from the fourth biofix and, if needed, a second spray when the residual of the previous spray ends.

()

Degree Days

Calculate degree days(/calludt.cgi/DDMODEL?MODEL=CM&CROP=apples) for codling moth for your location using the codling moth pest model or degree-day table(/WEATHER/DDTABLE/codling_moth.html). To learn more about using degree days to time insecticide applications, watch the degree-days video(https://www.youtube.com/watch?v=RNYevBVIhYQ). Use the online tool to find your sunset temperature(/calludt.cgi/SSTSTATIONLIST?YESTERDAY).

Common name	Amount per acre**		REI‡	PHI‡
(Example trade name)	(conc.)	(dilute)	(hours)	(days)

Pesticide precautions

Protect water

Calculate VOCs

Protect bees

Not all registered pesticides are listed. The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees(/agriculture/apple/Relative-Toxicities-of-Insecticides-and-Miticides-Used-in-Apples-to-Natural-Enemies-and-Honey-Bees/), and the environment(/mitigation/index.html) are at the top of the table. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.

MATING DISRUPTION

A. MATING DISRUPTANTS

COMMENTS: Most effective in isolated blocks and larger blocks (more than 10 acres for hand-applied, more than 40 acres for aerosol dispensers) with low to moderate codling moth numbers and trees of uniform size and moderate height. Can also be used in smaller blocks to lower codling moth numbers over time. If used in smaller blocks, supplemental insecticides will likely be required. Apply just prior to first flight biofix in mid-March to mid-April. Reapply, if needed, at the interval recommended on the label. Hang 1 mg pheromone traps at 6 to 8 feet high in the canopy and assess them weekly to ensure the mating disruption product has not expired. Use traps baited with CM-DA combo lures high in the canopy to monitor population development. Check fruit for damage after each generation and treat with insecticides if needed to ensure a low level of damage at harvest.

Aerosol dispensers#				*Period of Effectiveness (days)*
CheckMate Puffer CM-O	1–2 dispensers/acre	0	Up to 200	
Isomate CM Mist	1–2 dispensers/acre	0	Up to 200	

COMMENTS: Hang dispensers in the upper third of tree canopies at a spacing of one per 180 to 209 linear feet in trees around the perimeter. Within the orchard's interior, place dispensers in a roughly square grid pattern to achieve an interior density of one per acre. The pheromone plume released by dispensers is large and has been shown to reduce 1 mg trap catches up to 2000 feet downwind. Use CM-DA combo traps (as well as standard 1 mg traps) to monitor conventionally managed orchards near orchards with aerosol dispensers to provide an accurate assessment of codling moth population and activity.

Hand-applied dispensers#				*Period of Effectiveness (days)*
Isomate-C Plus	200–400 dispensers/acre	0	160+	
Isomate-C TT	100–200 dispensers/acre	0	160+	
Isomate-CM Ring	20–40 dispensers/acre	0	160+	
CheckMate CM-XL1000	120–200 dispensers/acre	0	160+	

Common name	Amount per acre**		REI‡	PHI‡
(Example trade name)	(conc.)	(dilute)	(hours)	(days)
	COMMENTS: Attach dispensers to branches in the upper third of tree canopies. Apply dispensers individually in trees at a rate sufficient to give the recommended number of dispensers per acre. Hang lower density products such as the CM-Ring in a uniform pattern (e.g. every other tree in every row) to ensure even distribution of pheromone throughout the orchard. Make application shortly before first biofix.			
INSECTICIDE CONTROLS				
A.	SPINETORAM			
	(Delegate WG)	6–7 oz	4	7
	MODE-OF-ACTION GROUP NUMBER [1]: 5			
	COMMENTS: Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
B.	CHLORANTRANILIPROLE			
	(Altacor)	3–4.5 oz	4	5
	MODE-OF-ACTION GROUP NUMBER [1]: 28			
	COMMENTS: Do not apply dilute applications of more than 200 gal/acre; use 100–150 gal/acre for best results.			
C.	ACETAMIPRID			
	(Assail 70 WP)	1.7–3.4 oz	12	7
	MODE-OF-ACTION GROUP NUMBER[1]: 4A			
	COMMENTS: Larvicide; use in orchards with moderate-to-high populations. Begin applications 250 DD after biofix. Residual at 3.4 oz/acre rate is about 14 days. May cause outbreaks of mites, especially in orchards with chronic mite problems; addition of 1% oil (volume by volume) and limiting applications to a single application may help mitigate mite problems. Otherwise, to help prevent the development of insect resistance, limit applications to one generation per year. Repeat applications of *any* neonicotinoid insecticide (acetamiprid-Assail and imidacloprid- Admire Pro) can lead to resistance to *all* neonicotinoids. Alternate neonicotinoids with an insecticide that has a different mode-of-action Group number to help delay the development of resistance. To help prevent development of resistance, do not use for both codling moth and aphid control. Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
D.	PHOSMET			
	(Imidan 70W)	3.5–5.75 lb	168 (7 days)	7
	MODE-OF-ACTION GROUP NUMBER[1]: 1B			
	COMMENTS: Larvicide; use in orchards with high populations. Make applications 250 DD after biofix. Residual at the 5.33 lb/acre rate with a pH of 5.5 is about 14 days. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
E.	LAMBDA-CYHALOTHRIN*			
	(Warrior II with Zeon)	1.28–2.56 fl oz	24	21
	MODE-OF-ACTION GROUP NUMBER[1]: 3A			
	COMMENTS: Larvicide; use in orchards with moderate-to-high populations. Make applications 250 DD after biofix. Residual at the 5 oz/acre rate is about 21 days. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
F.	METHOXYFENOZIDE			
	(Intrepid 2F)	16 fl oz	4	14
	MODE-OF-ACTION GROUP NUMBER[1]: 18			
	COMMENTS: Use only in orchards with low-to-moderate populations. Functions as a larvicide (must be ingested for it to be effective). Apply at 100 DD from first biofix and again in 10 to 18 days if flights are extended.			
G.	SPINOSAD			

Common name	Amount per acre**		REI‡	PHI‡
(Example trade name)	(conc.)	(dilute)	(hours)	(days)
(Entrust) #	2–3 oz	0.67–1 oz	4	7
MODE-OF-ACTION GROUP NUMBER[1]: 5				
COMMENTS: Use only in orchards with low-to-moderate populations or as a supplement to mating disruption. Tank mixing with 1% oil (volume by volume) increases efficacy: oil suppresses egg hatch and spinosad kills young larvae that ingest it. Apply 200 DD from first biofix, and reapply at 10-day intervals if continued coverage is needed. Do not apply more than 9 oz/acre per season. Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.				
H. CYDIA POMONELLA GRANULOVIRUS#				
(Cyd-X)#	1–6 fl oz	4	0	
COMMENTS: Use only in orchards with low-to-moderate populations or as a supplement to mating disruption. A larvicide; larvae must ingest to become infected by this virus. Make first application at 200 to 250 DD. Make a second application 7 to 10 days later, a third application at 600 DD and a fourth 7 to 10 days later for a total of 4 applications per flight. The use of oil will help to provide increased control by distributing the virus better over leaf surfaces and serving as an ovicide by suffocating eggs. May also be tank-mixed with acetamiprid (Assail) for increased efficacy of both materials. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum a.i. on any label when tank mixing products that contain the same a.i.				
I. NARROW RANGE OIL#	—	1–1.5 gal	4	when dry
MODE OF ACTION: Contact including smothering and barrier effects.				
COMMENTS: Best used as a supplement to mating disruption and where population pressure is quite low. Functions as both an ovicide and larvicide. Oils are mildly effective against codling moth eggs and work by smothering them; they need to be reapplied frequently during egg-laying period, which is anytime moths are flying. Begin oil applications at 100 to 200 DD after the biofix. Reapply every 7 to 10 days as long as significant flight is occurring. Good coverage is essential. Effectiveness may be enhanced with more dilute applications (i.e., 200–400 gal water/acre). Oils may be phytotoxic if used within a few weeks of a sulfur or captan spray or if applied at higher rates during hot weather (above 90°F). May be used to maintain lower populations in mating-disrupted orchards. May cause a greasy appearance to some fruit if applied close to harvest or with high seasonal volumes. Check with certifier to determine which products are organically acceptable.				

**	For dilute application, rate is per 100 gal water to be applied in 300 to 500 gal water/acre, according to label; for concentrate applications, use 80 to 100 gal water/acre or lower if the label allows.
‡	Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.
*	Permit required from county agricultural commissioner for purchase or use.
#	Acceptable for use on organically grown produce.
—	Not recommended or not on label.
1	Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode-of-action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee) (http://www.irac-online.org/).

Important Links

- Degree-day table(/WEATHER/DDTABLE/codling_moth.html)
- Degree-day calculator(/calludt.cgi/DDMODEL?MODEL=CM&CROP=apples)
- Sunset temperatures(/calludt.cgi/SSTSTATIONLIST?YESTERDAY)
- Using degree-days to time insecticide applications(https://www.youtube.com/watch?v=RNYevBVIhYQ)

UC PEER REVIEWED

UC IPM Pest Management Guidelines: Apple
UC ANR Publication 3432

L.R. Wunderlich(https://ucanr.edu/About/DirectorySearch/index.cfm?facultyid=2501), UC Cooperative Extension Central Sierra

J.L. Caprile(https://ucanr.edu/About/DirectorySearch/index.cfm?facultyid=302) (emeritus), UC Cooperative Extension Contra Costa County

P.M. Vossen(https://ucanr.edu/About/DirectorySearch/index.cfm?facultyid=2365) (emeritus), UC Cooperative Extension Sonoma and Marin counties

L.G. Varela(https://ucanr.edu/About/DirectorySearch/index.cfm?facultyid=2333) (emeritus), UC IPM and UC Cooperative Extension Sonoma County

J.A. Grant(https://ucanr.edu/About/DirectorySearch/index.cfm?facultyid=849) (emeritus), UC Cooperative Extension San Joaquin County

Acknowledgement for Contributions to Insects, Mites, and Other Invertebrates

H.L. Andris (emeritus), UC Cooperative Extension Fresno County

W.J. Bentley(https://ucanr.edu/About/DirectorySearch/index.cfm?facultyid=148) (emeritus), UC IPM and Kearney Agricultural Research and Extension Center, Parlier

W.W. Coates (emeritus), UC Cooperative Extension San Benito County

C. Pickel(https://ucanr.edu/About/DirectorySearch/index.cfm?facultyid=1796) (emeritus), UC IPM and UC Cooperative Extension Sutter and Yuba counties

Text Updated: 12/09
Treatment Table Updated: 10/15

Appendix G: Support Letters from Growers, PCA's and Organizations for Adding Pear Ester to The National List

USApple

7600 Leesburg Pike
Suite 400 East
Falls Church, VA 22043

June 5, 2023

National Organic Standards Board
National List Manager
USDA/AMS/NOP, Standards Division
1400 Independence Ave. SW
Room 2648-So., Ag Stop 0268
Washington, DC 20250-0268

Re: Request in Support of Adding Pear Ester Kairomone to the List of Synthetic Materials Allowed for Use in Organic Production-7 CFR 205.601.

Dear Board Members,

USApple is the national trade association representing all segments of the apple industry. Members include 36 state and regional apple associations, representing 26,000 apple growers throughout the country and more than 3,700 apple-related companies. Our members collectively grow more than 10 billion pounds of apples a year on average, supporting about 150,000 jobs and generating more than $8 billion in total wages and almost $23 billion in economic activity.

Codling moth ("CM") remains one of the key insects of pome fruit and creates a significant amount of damage to conventional orchards despite best efforts. Organic growers are hampered by a lack of more effective insecticides, so damage is often much higher.

(E,Z) -2,4-decadienoate pear ester kairomone ("DA") mating disruption-based products disrupt male codling moth, female codling moth and larvae. Importantly, these are also the only products that reduce female codling moth oviposition. The ability to trap and monitor females provides a comprehensive assessment of CM populations including determining their location. This enables growers to limit companion pesticide sprays to identified hot spots and not the entire orchard. Furthermore, the monitoring tools that consist of DA are the only tools for growers to determine proper insecticide sprays when the orchard is under mating disruption.

If DA based monitoring tools are not available, there will be no way to determine when to spray pesticides. This will result in an improper timing of spray and loss of crop. If DA mating disruption products are not available, it will result in an increase of pesticide use.

Without DA based products, growers won't be able to time codling moth flights for proper pesticide applications and will not have a tool to disrupt both male and female CM and

USApple

7600 Leesburg Pike
Suite 400 East
Falls Church, VA 22043

codling moth larvae. Bottom line, we implore the NOSB to please place pear ester (DA) on the NOSB list of synthetic substances allowed for use in organic production so that growers can continue to have tools to combat CM.

Sincerely,

Diane C. Kurrle
Senior Vice President

NORTHWEST HORTICULTURAL COUNCIL
105 South 18th Street, Suite 105
Yakima, Washington 98901
509-453-3193
www.nwhort.org

June 1, 2023

National Organic Standards Board
National List Manager
USDA-AMS-NOP, Standards Division
1400 Independence Ave. SW
Room 2648-So., Ag Stop 0268
Washington, DC 20250-0268

Dear Members of the National Organic Standards Board,

The Northwest Horticultural Council (NHC) appreciates the opportunity to provide support for Trécé Inc.'s petition before the National Organic Standards Board (NOSB) to add decadionic acid (DA), also known as ethyl ester or pear ester, to the National List of Allowed and Prohibited Substances. The NHC represents the growers, packers, and shippers of conventional and organic apples, pears, and cherries in Washington, Oregon, and Idaho on federal and international regulatory and policy issues.

The Pacific Northwest region leads the nation in the production of organic apples, pears, and cherries. Over 15.5 million boxes of organic apples are now harvested from nearly 29,000 acres in Washington state, amounting to over 90 percent of the value of sales of the fresh organic apple crop grown in the United States. Additionally, more than 7,200 acres of organic pears and cherries are planted across the Pacific Northwest. The total value of the organic tree fruit crop for the region topped $693 million in 2020, of which organic apples alone accounted for $606 million. In fact, tree fruit accounted for 50 percent of farm gate sales for all Washington state organics that year.

Organic tree fruit production is very complex. Our growers must routinely manage dozens of pests that have the potential to make fruit unfit for consumption, or that suppress tree growth and overall production. In the Pacific Northwest, growers must protect fruit from injury by 33 direct insect pests (those that feed directly on the fruit) and 47 indirect insect pests (those that feed on the tree). Of the direct insect pests, codling moth (*cydia pomonella*), a non-native species, is the key pest of pome fruit in the Pacific Northwest.

Codling moth (CM) causes significant damage to tree fruits, primarily when larvae feed directly on the fruit. The larvae bore through the flesh of the fruit, eventually arriving at the center of the apple or pear, where they feed primarily on seeds. A red-colored ring often forms around a new entry hole, also called a sting. Brown frass, or excrement, extrudes from the entry hole or a new hole the mature larva will use as an exit. This damage makes fruit unmarketable. It is also a problem in stored fruit because bacteria and fungi associated with the entries can increase fruit rot.

As the principal insect pest of pome fruit in the Pacific Northwest, management of CM is critical. In the absence of control measures, crop losses caused by larval feeding are typically 80 to 90 percent.

Pheromone-based mating disruption is a method of control that has become widely adopted by both organic and conventional tree fruit growers due to its high efficacy and low toxicity to humans, natural enemies, and the environment. It is now the foundation of apple and pear Integrated Pest Management (IPM) programs and enables growers to apply fewer sprays than would otherwise be necessary.

Female codling moths produce a pheromone that enables males to find them when they are ready to mate. Mating disruption entails dispensing synthetic CM sex attractant into an orchard so as to prevent or delay males from mating with females, interfering with their ability to produce viable offspring. In conjunction with the dispensers, traps are placed in orchards at the same height as the dispensers to monitor CM populations, track whether mated moths have moved in from adjacent orchards, and ensure that the pheromone is successfully disrupting mating.

Control of codling moth in organic orchards is exponentially more difficult without the use of pheromone-based mating disruption. For organic tree fruit producers, the number and kinds of organic pesticides allowed for CM control are limited, therefore control is more challenging and damage to the fruit is often much higher than in conventional operations. The insecticide spinosad (Entrust®) is one of the few effective organic insecticides, but the number of applications per season is restricted by the label. Other botanical and biological insecticides have been less effective at controlling CM in organic orchards. The DA-based products within this petition are considered by many tree fruit growers to be the most effective CM monitoring and mating disruption products on the market today.

Lures with DA have been shown to catch both female and male moths, whereas pheromone lures catch only male moths. Prior to DA products being available, CM monitoring was less efficient, offering monitoring of male CM populations only. The DA lures allow monitoring of female codling moths, providing a more comprehensive assessment of the female population within a mating disrupted orchard, as well as a tool to trap and measure the mating status of trapped females. Monitoring male moths with pheromone-only lures has always been a challenge as the trap lures must compete with pheromone dispensers for a male moth's attention.

By using a different semiochemical to monitor CM, these DA-based products give growers a more reliable measure of both male and female CM populations and where they are located. This provides an opportunity to limit companion pesticide sprays to identified hotspots in the orchard, not the entire orchard, significantly decreasing the number of sprays and total quantity of insecticide used. Growers can often treat as little as 10 percent of an orchard and achieve good control of CM using mating disruption. The ability to accurately assess female populations is an important aspect of overall management decision-making and is made possible by the lures and traps containing DA.

Pear ester technology provides additional benefits beyond uses in mating disruption and monitoring. A microencapsulated DA MEC sprayable product is used by growers to mask an ester produced by CM larvae to locate fruit in the orchard. By masking the apple or pear fruit essence, larvae are inhibited from finding the fruit. In spending more time searching, the larva ingests more of the organic insecticide and increases its exposure to biological control agents, as well as hot and dry climactic conditions that are fatal to the larva. The DA MEC spray also reduces female codling moth oviposition. The results of using these DA-based products are increased control of CM, decreased fruit damage, fewer pesticide sprays in the orchard, and a more sustainable organic program by improving the ability to determine the best time and place to apply pesticides.

Without DA-based monitoring tools, organic growers will have fewer and less effective options for determining when and where to spray pesticides, thereby increasing the number of sprays to manage CM. Pheromone dispensers and lures containing DA provide the only ability to assess and manage both male and female CM, resulting in their use by conventional growers as well. DA improves monitoring capabilities, which enables proper timing of sprays, thus decreasing the number of insecticide sprays and limiting the potential loss of fruit to CM-related damage.

The most robust and repeatable management programs, with the fewest number of interventions, are those with a full toolbox of options. The more organic growers are reliant on one technique, the less confidence they have in the system, with the ultimate response being more insecticide sprays that stress resistance management and poor product stewardship. Having a monitoring technique that is different than pheromones allows growers to measure populations more accurately and confidently, and prevent unnecessary applications.

The Northwest Horticultural Council supports this petition and asks the NOSB to add pear ester (DA) to the National List so that organic growers can continue to have this effective tool for combating codling moth. We thank the NOSB and National Organic Program for their thorough review of this petition and its supporting documents.

Sincerely,

NORTHWEST HORTICULTURAL COUNCIL

Dan Langager
Technical Communications Manager

CALIFORNIA APPLE COMMISSION

National Organic Standards Board
National List Manager
USDA/AMS/NOP, Standards Division
1400 Independence Ave. SW
Room 2648-So., Ag Stop 0268
Washington, DC 20250-0268

May 23, 2023

Dear Members,

Codling moth (CM) remains one of the key insects of pome fruit in California and creates a significant amount of damage to conventional orchards despite best efforts. Organic growers are hampered by a lack of more effective insecticides, so damage is often much higher. Furthermore, CM resistance has become a documented problem in Pennsylvania and other states and has been noted by researchers in Washington state as an evolving issue.

The California Apple Commission, a state mandated commodity board representing the entire fresh apple industry in California, is firmly in support of any additional products that can help the organic sector. California produces roughly 1.5 million boxes of fresh apples, with roughly 40% of that total being organic. The percentage of organic apples has been increasing every year as California apple growers try and meet the demand of the local consumer. Any increase in CM populations will severely hinder the grower's ability to get those apples to the organic consumer.

The DA mating disruption-based products are currently the only available products that have the ability to disrupt male codling moth, female codling moth and larvae. These products are also the only products that reduce female codling moth oviposition. Furthermore, the monitoring tools that consist of DA are the only tools for growers to determine proper insecticide sprays when the orchard is under mating disruption. If DA based monitoring tools are taken away there will be no way to determine when to spray pesticides. This will result in an improper timing of spray and loss in crop. If DA mating disruption products are taken away this will result in an increase of pesticide use.

Without DA based products, we will not be able to time codling moth flights for proper pesticide applications, and we will not have a tool to disrupt both male and female codling moth and codling moth larvae. Bottom line, we implore the NOSB to please place pear ester (DA) on to the NOSB list so that growers can continue to have tools to combat codling moth.

Sincerely,

Todd Sanders
Executive Director
California Apple Commission

2565 Alluvial Avenue, Suite #152
Clovis, CA 93611
559-225-3000 T
559-456-9099 F
www.calapple.org
calapple@calapple.org

MICHIGAN APPLES

13750 S. Sedona Parkway, Suite 3 Lansing, MI 48906
PHONE: 800.456.2753 • **FAX:** 517.669.9506

MichiganApples.com

June 1, 2023

National Organic Standards Board
National List Manager
USDA/AMS/NOP, Standards Division
1400 Independence Ave., SW
Room 2648-So., Ag Stop 0268
Washington, DC 20250

Dear National List Manager,

I am writing this letter on behalf of the Michigan Apple Committee (MAC) in support of Trece, Inc's petition submission to add pear ester (DA) as an allowed substance to the National List of Allowed and Prohibited Substances (National List).

MAC is a grower organization dedicated to improving the profitability and sustainability of the Michigan apple industry. Pest management is key to a successful crop year and any tools and resources that aid growers in pest management would be of great value to the apple industry.

Codling moth is a pest that creates a significant amount of damage to conventional orchards but often their damage in organic orchards is much higher due to the lack of effective insecticides allowed in organic farming. Washington researchers have noted that this pest is becoming a greater issue to apple growers and continues to be an issue in other states such as California, Pennsylvania, and Michigan. As the only available products that reduce female codling moth oviposition, DA mating disruption-based products have demonstrated to dramatically improve results of reducing codling moth populations when used with other insecticides and mating disruptions.

DA based monitoring tools are imperative to determining when to spray pesticides. If not available to organic growers it will result in improper timing of spray and a loss in crop, proving codling moth management more difficult. The addition of DA to the National List will be a useful and sustainable tool for apple growers. On behalf of Michigan's 775 apple growers, MAC fully supports this petition. Thank you for your consideration.

Sincerely,

Diane Smith
Executive Director

Jim Bittner
Executive Director
6620 EAST LAKE RD
APPLETON, NY 14008
Office 716-778-7330
Email Jim@singerfarms.com
June 2, 2023

National Organic Standards Board
National List Manager
USDA/AMS/NOP, Standards Division
1400 Independence Ave. SW
Room 2648-So., Ag Stop 0268
Washington, DC 20250-0268

Dear Members,

Codling moth (CM) remains one of the key insects of tree fruit and creates a significant amount of damage to conventional and organic orchards despite best efforts. Organic growers are hampered by a lack of more effective insecticides, so damage is often much higher. The DA mating disruption-based products are currently the only available products that have the ability to disrupt male codling moth, female codling moth and larvae. These products are also the only products that reduce female codling moth oviposition. Furthermore, the monitoring tools that consist of DA are the only tools for growers to determine proper insecticide sprays when the orchard is under mating disruption. If DA based monitoring tools are taken away there will be no way to determine when or if to spray pesticides. This will result in an improper timing of spray and loss in crop. If DA mating disruption products are taken away this will result in an increase of pesticide use.

Without DA based products, we will not be able to time codling moth flights for proper pesticide applications, and we will not have a tool to disrupt both male and female codling moth and codling moth larvae.

Bottom line, we implore the NOSB to please place pear ester (DA) on to the NOSB list so that growers can continue to have tools to combat codling moth.

Sincerely Yours,

Executive Director, NY State Horticultural Society

California Walnut Board
101 Parkshore Drive, Suite 250
Folsom, CA 95630-4726
Phone: (916) 932-7070
Fax: (916) 932-7071
info@walnuts.org
An Equal Opportunity Employer and Provider

May 30, 2023

National Organic Standards Board
National List Manager
USDA/AMS/NOP, Standards Division
1400 Independence Ave. SW
Room 2648-So., Ag Stop 0268
Washington, DC 20250-0268

Dear Members,

I am writing on behalf of the California Walnut Board (CWB) to express our support for Trece Corporation's petition to add products containing the synthetic DA pear ester, 2,4-decadionic acid, ethyl ester, (E,Z), to the list of products approved for use in organic agriculture.

I serve as the CWB's Production Research Director. The CWB is a federally authorized marketing order representing over 4,500 growers and 80 handlers of California walnuts. California accounts for 99% of US walnut production and is the world's largest exporter of walnuts with over 60% shipped to Europe, Asia and the Middle East. In 2022, California produced 752,000 tons of walnuts on 400,000 bearing acres with a farm gate revenue of $474M.

Codling moth (CM) is a key pest of walnuts and pome fruits in California, causing significant damage to both conventional and organic orchards of these crops. Pheromone mating disruption is used very successfully as a management tool in these crops. Monitoring lures containing the DA kairomone are critically important for assessing CM population pressure and determining proper insecticide spray timing in orchards under mating disruption.

Products containing the DA pear ester are also used to augment CM suppression in mating disrupted walnut, apple, and pear blocks – both conventional and organic. DA mating disruption-based products are currently the only available products with the ability to disrupt male codling moth, female codling moth and larvae. They are also the only products that reduce female codling moth oviposition.

In short, products containing the DA kairomone have become a central component of successful integrated pest management of CM in California walnuts. We strongly encourage the NOSB to place the DA pear ester on to the NOSB list so that organic growers can continue to have tools to combat codling moth.
Sincerely Yours,

Sincerely,

Joseph A. Grant

Joseph Grant
Director, Production Research

P.O. Box 190 · Selah, WA 98942 · Office (509) 697-6101 · Fax (509) 697-3801

Zirkle FRUIT COMPANY

National Organic Standards Board
National List Manager
USDA/AMS/NOP, Standards Division
1400 Independence Ave. SW
Room 2648-So., Ag Stop 0268
Washington, DC 20250-0268

May 15, 2023

Dear NOSB Members,

Codling moth (CM) remains the principal insect pest of pome fruit in WA State and creates a significant amount of damage to conventional orchards despite best efforts. Organic growers are hampered by a lack of more effective insecticides, so damage is often much higher. Furthermore, CM resistance has become a documented problem in Pennsylvania and has been noted by researchers in Washington state as an evolving issue.

Zirkle Fruit Company produces a large amount of non-organic and organic pome fruit in Washington. We currently use CIDETRAK® CMDA COMBO™ PP and CIDETRAK® DA MEC for our organic and non-organic pome fruit. The DA mating disruption-based products are currently the only available products that can disrupt male codling moth, female codling moth and larvae. These products are also the only products that reduce female codling moth oviposition. Furthermore, the monitoring tools that consist of DA are the only tools for growers to determine proper insecticide sprays when the orchard is under mating disruption. If DA mating disruption products are taken away this will result in an increase of pesticide use, improper application timing and crop loss.

Without DA based products, we will not be able to monitor codling moth flights for proper pesticide applications, and we will not have a tool to disrupt both male and female codling moth and codling moth larvae. Bottom line, we implore the NOSB to please place pear ester (DA) on to the NOSB list so that organic growers can continue to have tools to combat codling moth.

Sincerely,

Teah Smith

Teah Smith
Entomologist/ Ag. Consultant
Zirkle Fruit Company
(509) 423-3056
TeahS@zirklefruit.com

WASHINGTON
FRUIT & PRODUCE CO.

P.O. Box 1588 Yakima, WA 98907, USA- PHONE 509-457-6177 – FAX 509-457-3675

May 17, 2023

National Organic Standards Board
National List Manager
USDA/AMS/NOP, Standards Division
1400 Independence Ave. SW
Room 2648-So., Ag Stop 0268
Washington, DC 20250-0268

Dear Members,

Codling moth (CM) remains the principal insect pest of pome fruit in WA State and creates a significant amount of damage to conventional orchards despite best efforts. Organic growers are hampered by a lack of more effective insecticides, so damage is often much higher. Furthermore, CM resistance has become a documented problem in Pennsylvania and has been noted by researchers in Washington state as an evolving issue.

Washington Fruit & Produce Co. produces a large amount of non-organic and organic pome fruit in Washington. We currently use CIDETRAK® CMDA COMBO™ PP and CIDETRAK® DA MEC for our organic and non-organic pome fruit. The DA mating disruption-based products are currently the only available products that can disrupt male codling moth, female codling moth and larvae. These products are also the only products that reduce female codling moth oviposition. Furthermore, the monitoring tools that consist of DA are the only tools for growers to determine proper insecticide sprays when the orchard is under mating disruption. If DA based monitoring tools are taken away there will be no way to determine when to spray pesticides. This will result in an improper timing of spray and crop loss. If DA mating disruption products are taken away this will result in an increase of pesticide use.

Without DA based products, we will not be able to time codling moth flights for proper pesticide applications, and we will not have a tool to disrupt both male and female codling moth and codling moth larvae. Bottom line, we implore the NOSB to please place pear ester (DA) on to the NOSB list so that organic growers can continue to have tools to combat codling moth.

Sincerely,

Dan Plath

President of Orchard Operations

Washington Fruit & Produce Co.

Bear Creek Orchards, Inc.

May 25, 2023

National Organic Standards Board
National List Manager
USDA/AMS/NOP, Standards Division
1400 Independence Ave. SW
Room 2648-So., Ag Stop 0268
Washington, DC 20250-0268

Dear Members,

Codling moth (CM) remains the principal insect pest of pome fruit in Oregon and creates a significant amount of damage to conventional orchards despite our best efforts. Organic growers are hampered by a lack of more effective insecticides, so damage is often much higher. Furthermore, CM resistance to virus treatments has become a documented problem in Pennsylvania and has been noted by researchers in Washington and Oregon as an evolving issue.

Bear Creek Orchards, agricultural department of Harry and David, Inc., produces a large amount of non-organic and organic pome fruit in Southern Oregon for the gift and commercial markets. We currently use CIDETRAK® CMDA COMBO™ PP and CIDETRAK® Mesos for our organic and non-organic pear orchards. The pear ester (DA) mating disruption-based products are currently the best available products that have the ability to disrupt male and female codling moth mating. In fact, DA infused lures are excellent for attracting female codling moths. These products are also the only products that reduce female codling moth oviposition. Furthermore, the monitoring tools that consist of DA are the best tool, in conjunction with degree-day models, for growers to determine proper insecticide spray timings when the orchard is under mating disruption.

The proposed elimination of DA is very similar to the arguments made many years ago concerning codlemone. The thought was the use of codlemone for mating disruption in organic orchards was not a "natural" product, but rather synthesized from petroleum. Reason prevailed and synthetic codlemone has been allowed for organic production for decades. Thus, worm-free organic apple, pear, and walnut production is possible.

If DA based monitoring tools are taken away in organic production systems, the most effective tool to determine when to spray pesticides will not be available. This will result in improper timing of sprays because valuable data will not be available, thus resulting in unacceptable damage to the crop. If DA mating disruption products are taken away this will result in an increase of insecticide use.

Without DA based products, and we will not have the best tool to disrupt both male and female codling mating. Bottom line, we implore the NOSB to please place DA on to the NOSB acceptance list so organic growers can continue to have tools to combat codling moth.

Sincerely Yours,

Matthew Borman
Vice- President Orchards
Bear Creek Orchards, Harry and David, Inc.

National Organic Standards Board
National List Manager
USDA/AMS/NOP, Standards Division
1400 Independence Ave. SW
Room 2648-So., Ag Stop 0268
Washington, DC 20250-0268

May 23, 2023

Dear Members,

Codling moth (CM) remains one of the key insects of pome fruit in California and can create a significant amount of damage to conventional orchards despite best efforts. Organic growers are hampered by a lack of more effective insecticides, so damage is often higher. Furthermore, CM resistance has become a documented problem in Pennsylvania and has been noted by researchers in Washington state as an evolving issue. Unfortunately, being an organic grower places a grower in the difficult position of having only one reasonably effective material to, if necessary, augment the mating disruption technique currently in widespread use for CM control. Overuse of one material makes it likely that the origin of resistance to the one material will be an organic orchard.

The Pear Doctor Inc advises growers of pome fruit in California. We currently use mating disruption for our pome fruit and monitor the CM population with DA Combo lures and Megalure 4K+AA lures. The monitoring tools that consist of DA are the only tools for growers to determine proper insecticide sprays when the orchard is under mating disruption. If DA based monitoring tools are taken away there will be no way to determine when to spray pesticides. This will result in an improper timing of spray and loss in crop. If DA mating disruption products are taken away this will result in an increase of pesticide use.

Without DA based products, we will not be able to time codling moth flights for proper pesticide applications, and we will not have a tool to disrupt both male and female codling moth and codling moth larvae. Bottom line, we implore the NOSB to please place pear ester (DA) on to the NOSB list so that growers can continue to have tools to combat codling moth.

Sincerely Yours,

Broc Zoller

Broc Zoller

President and Agricultural Pest Control Advisor

The Pear Doctor Inc

6570 Kelsey Creek Dr

Kelseyville, CA 95451

Randy Hansen
Agricultural and Environmental Consulting

National Organic Standards Board
National List Manager
USDA/AMS/NOP, Standards Division
1400 Independence Ave. SW
Room 2648-So., Ag Stop 0268
Washington, DC 20250-0268

May 31, 2023

Dear Members,

Codling moth (CM) remains one of the key insects of pome fruit in California and creates a significant amount of damage to conventional orchards despite best efforts. Organic growers are hampered by a lack of more effective insecticides, so damage is often much higher.

I have worked as a Pest Control Advisor in California for over 45 years. I work primarily with pear and apple growers - both organic and non-organic operations. Many of these growers use Cidetrak DA based mating disruption products. The DA mating disruption-based products are currently the only available products that with the ability to disrupt male codling moth, female codling moth and larvae. These products are also the only products that reduce female codling moth oviposition. Furthermore, the monitoring tools that consist of DA are the only tools for growers to determine proper insecticide sprays when the orchard is under mating disruption. If DA based monitoring tools are taken away there will be no way to determine when to spray pesticides. This will result in an improper timing of spray and loss in crop. If DA mating disruption products are taken away this will result in an increase of pesticide use.

Without DA based products, we will not be able to time codling moth flights for proper pesticide applications, and we will not have a tool to disrupt both male and female codling moth and codling moth larvae. Bottom line, we implore the NOSB to please place pear ester (DA) on to the NOSB list so that growers can continue to have tools to combat codling moth.

Sincerely Yours,

Randy Hansen

Randy Hansen, Owner

Agricultural and Environmental Consulting

National Organic Standards Board
National List Manager
USDA/AMS/NOP, Standards Division
1400 Independence Ave. SW
Room 2648-So., Ag Stop 0268
Washington, DC 20250-0268

May 17, 2023

Dear Members of the National Organic Standards Board,

I am writing to urge your continued support for the use of DA (pear ester) in organic and non- organic pome fruit production. I consult with twenty fruit growers totaling about 500 acres of apples and pears in Washington state and DA has been a vital tool in the monitoring and management of codling moth, one of the most destructive pests that can impact pome fruit orchards. Organic growers in particular have faced increasing challenges in controlling codling moth due to the limited availability of effective and approved insecticides. Without DA-based monitoring products such as CMDA+AA approved for use in organic systems, we would not be able to time insecticide applications effectively which could result in increased crop loss and pesticide use. Additionally, my clients use mating disruption containing DA (CMDA Combo MESO-A, CMDA PP) as well as DA MEC, all of which drastically reduce codling moth populations which in turn decreases crop loss, pesticide applications, and benefits the environment and farming sustainability.

Given the critical role that DA plays in the control and monitoring of the codling moth, I strongly encourage the National Organic Standards Board to support its continued use in organic apple and pear production. Doing so will help to ensure that growers have access to the most effective tools for pest control, while also upholding the high standards of organic agriculture.

Thank you for your attention to this matter.

Sincerely,

Christopher Strohm

Horticulturist

Northwest Wholesale, Inc.

Ag IPM Consultants, Inc.

P.O. Box 1095 Exeter, CA

June 1, 2023

National Organic Standards Board
Nation List Manager
USDA/AMS/NOP, Standards Division
1400 Independence Ave. SW
Room 2648-So., Ag Stop 0268
Washington, DC 20250-0268

Dear Members,

Codling Moth (CM) is a key pest of walnuts and pome fruit in California. It can cause significant amounts of damage in conventional farming and even more so in Organic farming. Organic growers are hindered even more by the lack of effective insecticides so the damage from codling moth is often much higher than conventional farms.

Ag IPM Consultants Inc. is a company of private Pest Control Advisors in the Southern San Joaquin Valley. We have personally used CIDETRAK CMDA COMBO MESO-W (2583), PHEROCON CMDA COMBO-P (2932), and PHEROCON CMDA COMBO-P + AA (3312). We have used these products in the testing process and in commercial use to help track and disrupt codling moth in organic and conventional walnuts, plums, Asian pears, and other pome crops in the Southern San Joaquin Valley. If these monitoring products are taken away from our organic growers it would greatly hinder our ability to monitor their ranches resulting in an inability to properly time treatments and a potential loss of their crop. If the mating disruption is taken away that would significantly increase pesticide use for our organic growers and result in significant loss of crop.

By removing products with Pear Ester (DA) from our tool kit would remove our ability to time codling moth flights for proper application as well as removing the tool which disrupts both male and female codling moths and their larvae. We urge the NOSB to please place pear ester (DA) on the NOSB list so we and our growers can continue to have the tools needed to combat codling moth.

Sincerely,

James R Stewart

James R. Stewart
Partner
AG IPM Consultants Inc.
Phone: (559) 730-6243

National Organic Standards Board
National List Manager
USDA/AMS/NOP, Standards Division
1400 Independence Ave. SW
Room 2648-So., Ag Stop 0268
Washington, DC 20250-0268

May 29, 2023

Dear Members,

Codling moth (CM) remains the principal insect pest of pome fruit in WA State and creates a significant amount of damage to apple and pear orchards despite best efforts. Organic growers are hampered by a lack of more effective insecticides, so damage is often much higher. Furthermore, CM resistance has become a documented problem in other areas of the country and has been noted by researchers in Washington state as an evolving issue.

I consult with a large amount of organic pome fruit in Washington and my growers use CIDETRAK® DA MEC to control codling moth in their orchards. The DA mating disruption-based products are currently the only available products that have the ability to disrupt male codling moth, female codling moth and larvae. The Trece monitoring tools containing DA are the only tools available to determine proper location and timing for insecticide use when the orchard is under mating disruption. Without these products, there will be no way to determine proper insecticide application timing, which will result in loss of crop, increase potential for pesticide resistance and overall pesticide use.

Bottom line, I implore the NOSB to please place pear ester (DA) on to the NOSB list so that organic growers can continue to have tools to combat codling moth.

Sincerely Yours,

M. Hodge

Michael R. Hodge

Tree Fruit & Vine Consultant

G.S. Long Co.

1012 Walla Walla Ave.

Wenatchee, WA 98801

G. S. LONG CO., INC.
P. O. Box 9783 • Yakima, Washington 98909
Phone (509) 575-8382 • (800) 338-5664 WA Only

May 5th, 2024

James Petersen
National Sales Manager
Trécé, Inc.
jpetersen@trece.com

RE: NOSB PETITION – SYNTHETIC PEAR ESTER

To Whom it May Concern,

Founded in 1980, G.S. Long Company is a family-owned agricultural consulting and supply firm with locations in Yakima, Wenatchee & Pasco Washington, and also in Hood River Oregon. Our staff of over 40 state licensed crop advisors focus on all aspects of Tree Fruit, Hops, Wine Grape & Berry production.

Monitoring Lures – The codling moth is a primary pest in apple and pear production. The use of synthetic pear esters has increased our ability to effectively monitor codling moth populations and be more accurate and efficient with pesticide application timings. Observation and monitoring are key principles of good IPM systems.

Mating Disruption Products – Also commonly referred to as 'Pheromone Confusion', confusion being the key word. The idea being to prevent the male & female Codling Moth from mating. The addition of synthetic pear ester improves this 'confusion' by increasing the attraction from the male species while also effecting the behavior of the females – potentially leading to less mating and oviposition disruption. Codling Moth management is critical to successful apple and pear production – every little thing counts.

DA Mec – By further confusing the female, this product can cause her to lay her eggs up to 50% farther from the fruit than normal. What this means is that the larvae have a more difficult time finding the fruit, which means that they can be much less likely to bore into the fruit - which renders it unsellable. It can also further decrease the male's ability to find females.

We hope that USDA NOP will determine that synthetic pear ester can be classified as a semiochemical insect attractant, and allowed for continued use in organic production. Thank you for the opportunity to comment!

Aaron Avila

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