National Organic Standards Board
Crops Subcommittee Petitioned Material Proposal
Pear Ester
Fall 2025

Summary of Petition and Background Information on Pear Ester

In September 2023, the National Organic Program received a petition from Trece Incorporated requesting the addition of Pear Ester (i.e., Ethyl-2E,4Z-Decadienoate), a semiochemical material, to the National List as a synthetic allowed for use in crop production [7CFR§205.601(j)]. Semiochemicals are bioactive molecules released by an organism to signal or provoke a behavioral or physiological response Signaling may be between members of the same species or between two or more distinct species [TR lines 282-284]. Pheromones, Kairomones and Allomones are sub-categories of semiochemicals. Pear ester was previously allowed for use in organic crop production under the synthetic pheromone classification until its correct reclassification as a kairomone. Even though pheromones and kairomones are both semiochemicals, they differ in a couple of significant characteristics. Pheromones are volatile chemicals produced by a given species to communicate with other individuals of the same species to affect their behavior (EPA, 2011).

Pear ester is synthesized by a condensation reaction between two chemicals that are by-products of petroleum processing. The prevalent process for manufacturing pear ester is the condensation reaction between the eight-carbon allyl alcohol, oct-1-yn-3-ol (CAS No. 818-72-4), and triethylorthoacetate (CAS No 78-39-7). The condensation product is heated with propanoic acid as a catalyst, and the subsequent Johnson-Claisen rearrangement gives ethyl 2E, 4Z-decadienoate. It is a convenient one-step synthesis with good yields [TR lines 552 -556].

Pear ester appears on the FDA list of Substances Added to Food (*formerly EAFUS*) for use as a flavoring agent or adjuvant food additive [TR lines 268-2689] . The EPA has registered pear ester formulations for pest management. This behavior-altering chemical (i.e., semiochemical) is particularly useful in the management of the codling moth *Cydia pomonella* – an economically significant pest that principally affects apple, pear, and walnut crops. The proper classification of pear ester as a kairomone instead of a pheromone rendered its continued use under the pheromone category, untenable in organic crop production [TR line 42] The petition is aimed at providing organic crop producers with pest management tools that were available to them prior to the reclassification of pear ester as a kairomone instead of a pheromone.

The 2024 technical report on pear ester has detailed information on significant improvements in pest management outcomes from the incorporation of pear ester relative to results obtained with the use of pheromones alone. The report covers various uses of pear ester in codling moth management. This includes their use,

(a) As lures in traps to monitor populations of codling moth in orchards. These traps help to determine the “biofix point” which is date on which codling moths first appear in monitoring

paths. Pear ester monitoring traps provides information for determining action thresholds and the timing of treatments.

(b) In mating disruption efforts. Research findings show mating disruption dispensers loaded with both codling moth sex pheromone and pear ester can be more than dispensers with pheromone alone.

Available data show that pear ester exerts significant economic impacts on pear and apple growers. The positive economic impact of pear ester is exerted through its documented direct impact on mass trapping, mating disruption and proper timing of treatments (including pesticide applications). These interventions result in significant reductions in fruit damage. The improved effectiveness of traps and monitoring tools when pear ester is combined with pheromones is well documented.

Subcommittee Review Fall 2024

Subcommittee discussions were based on a discussion document that was informed by the 2024 technical report on pear ester. Discussions covered pertinent elements of the petition (to add pear ester to the national list). Discussions also included the previous misclassification of kairomones as pheromones and the distinction between these behavior-altering chemicals. The essentiality of pear ester in apple and pear production was emphasized. There was a suggestion to explore the possibility of broadening the proposal to cover kairomones as a group instead of pear ester alone. All eight attendees voted to accept the discussion document on pear ester.

Fall 2024 Meeting Public Comments

Comments received at the Fall 2024 meeting were in favor of adding pear ester to the national list. A commenting organization stated that synthetic pear ester-based mating disruption products are Generally Recognized as Safe (GRAS) and are more effective in insect pest management in organic orchards relative to their alternatives. It was also pointed out that the chemical structure of synthetic pear ester is identical to the natural kairomone.

One commenter advised the board to direct significant attention to determining whether the word “pheromones” was used in OFPA §6517.c.1.B.i to refer to only pheromones or it could be interpreted to include other semiochemicals such as kairomones. The commenting organization was of the view that this determination will provide a basis (or otherwise) for continuation of the evaluation of pear ester in addition to helping to clearly articulate the Board’s intent for handling future petitions involving semiochemicals. A historical context of negotiations that resulted in the inclusion of pheromones in OFPA was provided. The crops subcommittee was advised to determine the correct interpretation of pheromones in OFPA §6517.c.1.B.i. to ascertain whether it covered only materials that satisfy the technical definition of pheromones or include other semiochemicals. It was argued that the absence of internet-based resources and poor access to technical expertise during the negotiations pertaining to the inclusion of pheromones in OFPA may have led to the wrong interpretation of the intent OFPA drafters. The commenting organization was of the view that if the drafters of OFPA had access to the information available in the 2024 technical report on pear ester, OFPA §6517.c.1.B.i. would have highly likely contained the term “semiochemicals” instead of “pheromones”.

One of the comments was for the board to make a distinction between pear ester that is released from traps and those that are microencapsulated in polyamide materials that are then sprayed. The commenting organization considers the use of pear ester in traps to be consistent with OFPA unlike its use in microencapsulated formulations. The commenter stated that polyamide particulates are microplastics and must be evaluated as such.

According to the commenting organization, the board needs to consider the following pieces of information in its deliberations on pear ester: (a) the essentiality of microplastics in microencapsulated pesticide formulations, (b) the publication by Alijagic et al. (2024) about the need to investigate potential health risks to individuals exposed to polyamide microplastics.

The board was asked to consider the delivery mechanism in its deliberations on pear ester. An annotation to restrict the use of pear ester to traps was recommended.

Another commenting organization acknowledged the efficacy of semiochemicals in insect pest management but stressed the importance of guardrails that permit the use of synthetic materials that are identical to natural kairomones.

In the perpetual quest for more effective pesticides, this guardrail would prevent the development of products that exert unintended/unexpected adverse impacts on non-target organisms in the farm ecosystem because they differ significantly from natural kairomones. The comment endorsed the use of pear ester in trapping and monitoring insect pests but opposed the broadcast application of microencapsulated formulations which release microplastics in the organic environment.

Fall 2024 NOSB Board Meeting Review:
There was widespread support for adding pear ester to the National List. Board members sought information from public commenters on whether there were other kairomones (i.e., apart from pear ester) that were in use in insect pest management. This was to inform the NOSB's decision on whether to pursue the addition of pear ester alone or kairomones as a group to the National List. The Board did not receive any information that justified the addition of kairomones as a group.

Subcommittee Review Spring 2025
Category 1: Classification/categorization
There is a need for clarification and/or pursuit of supporting documentation on the intent or correct interpretation of the word "pheromone" in OFPA §6517.c.1.B.i. A section of the organic community is requesting information on the interpretation that informed the removal of pear ester from the national list. The current position/trajectory of the crop subcommittee is to proceed with a proposal to add pear ester to the national list until a determination that the drafters of OFPA intended to refer to semiochemicals instead of "pheromones" in particular. This approach is informed by the fact that even though kairomones and pheromones are both semiochemicals, they are technically different. The removal of pear ester from the national list represents a previous (correct or incorrect) determination that OFPA drafters did not intend to refer to semiochemicals in general. CS will proceed with the

proposal while it pursues documentation and/or clarification of the intent of OFPA drafters on the use of pheromones and other semiochemicals.

Another item that will feature prominently in discussions on pear ester is its categorization based on the various delivery systems used in deploying them. This will inform the possible introduction of an annotation to distinguish between systems that may be consistent and inconsistent with OFPA.

Category 2: Adverse Impacts of Pear Ester

Human Health Impacts

Pear ester is a Generally Recognized as Safe (GRAS) food additive. In 2013, the EPA exempted it from the need to establish food tolerance for residues in or on food crops at 40 CFR 180.1323. The EPA concluded that "there is a reasonable certainty that no harm will result to the U.S. population from aggregate exposures to ethyl-2E-4Z-decadienoate (pear ester)" (78 FR 53051, August 28, 2013) [TR lines 889-892]. Pear ester has low acute toxicity to mammals, and the oral LD_{50} for rats is 4,027 mg/kg.[1] This number means pear ester is nearly non-toxic. Additionally, pear ester is an FDA approved food additive, and average human consumption in the U.S. is about 3 µg per day (US EPA, 2013) [TR lines 876-880]. According to the EPA, pear ester also has low chronic toxicity, and is not likely a developmental toxicant, or a mutagen. It is not on the EPA list of carcinogens, or on the IARC carcinogen list. The EPA reported in 2013 that pear ester had not been evaluated for endocrine disruption [TR lines 882-884].

Even though the 2024 technical report on pear esters found no publications indicating harm to humans from pear ester or polyamide particulates, the products safety data sheet states that it may cause allergy or asthma symptoms or breathing difficulties if inhaled. Contact with skin or eyes may cause irritation. It must be noted that the food tolerance exemption provided by the EPA does not include an evaluation for occupational exposure. The maximum label amount is about 400 µg pear ester/day which is well below the acute toxicity of 4027 mg/kg. Pear ester vapors are not likely a health problem for orchard workers [Tr lines 909-911].

Exposure to Polyamide Particulates

Sprays of about 30 g/ha decadienoic acid (DA) ethyl ester (i.e. pear ester) commercially known as DA MEC™ are applied to tree canopies with an air- blast sprayer [TR lines 913-914]. Even though exceedingly tiny amounts of DA MEC™ are used, the sprays contain a large number of small polyamide particles. Each tree canopy receives about five hundred million microencapsulated pear ester particles. There might be a respiratory hazard from inhaling plastic microparticles when the spray is applied by air blast sprayer to individual trees. However, effects of exposure to the polyamide spherical capsules in the spray have not been evaluated by the EPA. Given the 4-hr re-entry restriction, the greatest acute risk is probably during spray applications with an air blast sprayer. But the DA MEC™ label does not require respiratory protection for workers [TR lines 916-921]. It is important to note that maximum 8-hr worst

case chronic exposure would be about 0.0357 mg/m^3 or 36 µg/m^3. This exposure is below the U.S. 24-hr particulate standard of 150 µg/m^3 for PM 10 (89 FR 16202, May 6, 2024) [TR lines 941-942].

Given the fact that sprayable microencapsulated pheromone particles can be washed out of tree canopies by wind, rain, and overhead irrigation sprays, pear esters are assumed/expected to meet the same fate [TR lines 935-936].

Environmental and Ecological Health Impacts

The EPA did not require testing for bird, fish, and aquatic invertebrate toxicity because pear ester is expected to quickly disperse and degrade in the environment. However, the pear ester safety data sheet from Boudakian Research (Boudakian Research, 2023) states that pear ester is "very toxic to aquatic life with long lasting effects." [TR lines 650-653]. The substance is, however, exempt from testing for toxicity to bird, fish, and aquatic invertebrates. According to the safety data sheet, pear ester is a marine toxicant and hazard (Boudakian Research, 2023). Environmental damage may be mitigated by the low application rate of 12 g DA MEC™/acre or 30 g/ha. That is about 0.27 mg DA MEC™/ft^2. That is a small amount, but each ml of the usual diluted field spray contains about 260,000 particles (Light & Beck, 2010) [TR lines 862-865]. Once applied, microcapsules probably stay on the leaves until dislodged by wind and rain which is the case for microencapsulated sprayable pheromones (A. L. Knight et al., 2004). When particles are dislodged by rain, they likely become part of runoff from an orchard (Trécé, Inc., 2023) [TR lines 857-860]. Once the microencapsulated particles reach water, fish or other aquatic creatures might ingest them. No density information is given (Light & Beck, 2010), but likely the polyamide particles are less dense than water. The pear ester contained in the microparticles is an aquatic hazard (Boudakian Research, 2023) [TR lines 869-871]. The 2024 technical report found no information on the environmental effects of pear ester polyamide microcapsules. There is no published information on the effects of these particles on earthworms. Birds can be exposed by feeding on earthworms that ingest polyamide microcapsules. However, again, the amounts of pear ester involved are exceedingly small. Because of its volatility, pear ester dissipates quickly in the environment. Manufacturers encapsulate volatile components of spray formulations to limit volatilization and produce products that have a lasting effect (US EPA, 2013) [TR lines 87-88].

The EPA did not require the product manufacturer to submit environmental toxicity tests of microencapsulated pear ester (US EPA, 2013) [TR lines 872-874].

Category 3: Alternatives/Compatibility

Performance of Alternatives

It is important to note that codling moth management performance of natural alternatives to synthetic pear ester tend to be enhanced when combined with the synthetic product. Products such as granulosis virus, Spinosad, BT products and the use of degree day methods are employed against the codling moth. The performance of these alternatives is, however, enhanced by pear ester in monitoring traps to determine the biofix point and thus the correct and most effective timing of pesticide applications.

SPRING 2025 PUBLIC COMMENTS

Public comments were generally in favor of adding pear ester to the National List. An environmental and public health advocacy organization stated its support for the listing only if an annotation was introduced to limit the use of the semiochemical to traps and disallow its use in microencapsulated forms. It cited findings by Alijagic et al. (2024) that "the increasing use of polyamide microplastics may pose a potential health risk for the exposed individuals, and it merits more attention." The commenting organization warned the NOSB against over-reliance on Environmental Protection Agency (EPA) registration documents that state EPA conclusions rather than data on environmental risk. It went further to state that the world would have been less contaminated if the EPA were doing its job to protect humans and the biosphere from the negative impacts of pesticides. This advocacy group further differentiated between the use of pear ester in traps and its spray application in polyamide microcapsules. It stressed the fact that the polyamide capsules are microplastics which it had previously tasked the NOSB to work towards eliminating from organic production and handling. It listed adverse human, environmental, and ecological effects of microplastics. According to the commenting organization, unlike traps, microplastics are essential to the microencapsulated formulations. It stated its belief that "the use of pear ester in traps may be consistent with OFPA, but the use in sprays does not fit into any of the OFPA categories and poses unnecessary risks." The organization encouraged the crops subcommittee to investigate information on the relative effectiveness of the use of pear ester in traps and in sprays. A coalition of various stakeholders in the organic industry expressed their support for listing pear ester with an annotation prohibiting its use in microencapsulated polyamides. The organization mentioned further evidence that the charges on microparticles function as "collectors" for other pollutants in addition to their own detrimental effects. In summary, the commenting organization requested annotation(s) that have the following elements:

- Requirement to use forms of synthetic pear ester that are identical to the natural versions.
- Preclude the use of microencapsulated polyamides, and
- Ensure no direct contact with crops or soil.

In answering the NOSB's question on whether there were other kairomones other than pear ester that were in use in insect pest management, a Materials Review Organization (MRO) stated that the totality of kairomones and other semiochemical products is not necessarily identifiable through databases such as the National Pesticide Information Center (NPIC)'s database, NPRO (https://npic.orst.edu/NPRO/). The organization attributed this to the fact that kairomones and other semiochemicals are often exempt from EPA registration requirements. It cited the work of Murali-Baskaran et al., who in 2018 published a list of substances that can behave as kairomones. The list included, tricosane, linalool-L, alpha-pinene, caryophyllene, myristic acid, alpha-humulene, octacosane, and methyl salicylate. The MRO stated that even though it had reviewed materials containing some of these substances, the reported role of the substances may not have been as kairomones due to multiple uses/functions of some of these chemicals. The commenting organization cited a publication by Nigg et al. (2022) which reported that at least one research group classified ammonium carbonate as a kairomone for attracting fruit flies. The commenting MRO stated the need for a technical report that reviews literature on chemicals used as kairomones in research and those used in commercial products.

According to an organic crop producer who stated support for the addition of pear ester to the National List, farmers find it challenging to control codling moths even in conventional orchards so organic farmers need as many tools as they can in their toolbox to maintain an acceptable level of control of the pest in orchards. According to the commenting farmer, failure to control the codling moth could cause over 80% of their apple and pear orchards to withdraw from organic certification and go back to conventional farming to avoid the significant risk that the pest poses to them. The farmer also stated that the availability of alternative pest management materials or practices is a decision-making factor that must be evaluated critically because these alternatives may not necessarily be effective against targeted pests. Another farmer concurred on the difficulty of controlling the pest (even on conventional farms), the need to have as many tools as possible against it, and the risk of farms reverting to conventional production in the absence of effective tools against the pest. The farmer stated that in the Pacific Northwest the codling moth situation had become bad enough to necessitate the creation of a codling moth task force made up of research, industry, university, and growers in the quest for better management of the pest.

A farmers' association wrote to state its support for the listing of pear ester as a "pheromone" provided there is an annotation that restricts its use to traps with no contact with soil or crops. It requested the NOSB to clarify that kairomones and pheromones that are identical to natural kairomones are the only types that are allowed. This statement is meant to prevent the production of novel forms of the material produced through irradiation, genetic manipulation, or other means. According to the farmers' association pear esters should not be allowed in the spray form due to adverse impacts of the polyamide material (used in microencapsulation) on human, environmental, and ecological health.

A manufacturer of a relevant behavior-based pest management tool provided additional information on pear ester products. It stressed that lures never touch or come into contact with the crop and mating disruption products use pear ester in passive dispensers that are housed in solid delivery systems. The commenting manufacturer stated some of the pest management advantages of using pear ester-based products. It emphasized the use pattern for solid products which only allow for pear ester to emit as a gas, preventing the presence of the product in water residues. It stated that the microencapsulated products are not water-soluble, and label instructions specify full coverage sprays that must be complete but do not allow "runoff." It stated that the polyamide encapsulating agent is introduced into the environment at a low rate. The commenting organization admitted that microplastic contamination is a real issue because of possible adverse effects on humans, crops, and other organisms. It however stated that polyamide plastics are currently allowed as inerts in organic production. It cited the fact that the 2004 EPA list includes polyamide resins (CAS RN: 63428-83-1) as a List 4 material. The pest management material manufacture stated that while polyamide does not appear on the NOP's list of inert ingredients that are currently believed to be in use on organic operations (known as Appendix A), it is technically allowed under 205.601(m)(1).

A coalition of wholesalers stated its support for the addition of pear ester to the National List but stated that the motion to do so in the Spring 2025 NOSB packet referenced §205.601(j). The coalition asserts that pear ester should be listed at §205.601(f) which is titled, "As insect management, "whereas

§205.601(j) is titled, "As crop or soil amendments." It also mentioned that the loss of the most effective organic codling moth treatment occurred in 2014 when streptomycin and tetracycline were delisted. It stressed the increased importance of pear ester in the management of codling moths. On the issue of essentiality and the availability of alternatives, the coalition of wholesalers emphasized the fact that moth control materials allowed for organic production are less effective than their conventional counterparts. It stated that this fact made trapping and monitoring programs critically important to organic producers. It further stated the increased effectiveness of permitted moth management methods such as granulosis virus, Spinosad (insecticide), Bt (insecticide) products, and degree day models when they are used in combination with pear ester**.** It called for a technical clarification of the regulatory status of semiochemicals other than pheromones, describing it as important to the long-term viability of the listing of pear ester and thus its availability to organic orchardists. It cited a publication titled, "*Role of kairomone in biological control of crop pests-A review* by Ramasamy Kanagaraj Murali-Baskaran, Kailash Chander Sharma, Pankaj Kaushal, Jagdish Kumar, Packirisamy Parthiban, Sengottayan Senthil-Nathan, and Richard W. Mankind, which was not included in the bibliography of the technical report on pear ester. The study is said to contain information about the development of other types of kairomones and delivery systems that may increase their effectiveness in field applications.

A retailer echoed widespread support for the addition of pear ester to the national list and concerns about the use of microencapsulated polyamides as a dispersal method for pear ester. It listed adverse environmental and human health impacts of plastic contamination. It stated its belief that spraying of plastic materials is counter to the spirit of organic, which prioritizes soil health and holistic management practices. It called for an annotation to prohibit the use of microencapsulation polyamide materials if pear ester is to be added to the National List.

A certifier stated its support for the addition of kairomones to the National List as an addition to the allowance of pheromones for use as insect management under §205.601(f). It currently approves six different kairomone materials under the previous approval as pheromones and has forty clients using one or more of these products.

A regional horticultural organization in stating its support for the listing of pear ester as a kairomone, emphasized the fact that the synthetic material is identical in chemical structure to the natural version. The commenting organization stated that this was the justification for the EPA not requesting environmental toxicity tests from the pear ester product manufacturer. It listed the codling moth as the principal pest among thirty-three insect pests that feed directly on tree fruits in the Pacific Northwest. Increasing populations of the pest, which is classified as a quarantine pest, has been reported by tree fruit growers in the Pacific Northwest. The commenting organization stated that 80 to 90 percent crop losses are typical if larval feeding is left uncontrolled. The use of semiochemicals in Integrated Pest Management (IPM) programs enable growers to apply fewer sprays than would otherwise be necessary. The regional organization stated that it was only aware of pear ester and acetic acid as the kairomones currently used in managing codling moths in the Pacific Northwest. It suggested that the Crops Subcommittee reach out to certifiers for information on any kairomone-based materials listed in the

Organic System Plan (OSP) of organic growers. It also offered to compile a comprehensive list of kairomones to support a future NOSB decision to tackle kairomones as a class.

A trade association stated its staunch support for the expanded use of pear ester in organic production of fruit trees and management of pests; it described pear ester tools as absolutely critical and safe pest management tools for growers. It highlighted products that combine both groups of semiochemicals as the only ones that help growers to assess and manage both male and female codling moths. It also stated that pear ester products also enable growers to gain a better understanding of codling moth locations and population density. These pieces of information are critical in determining when and where to apply insecticides. The trade association stated that there were no documented risks of harm to the environment or human health pertaining to pear ester. The trade association underscores that pear ester tools are absolutely critical as safe pest management tools for growers.

Questions for Stakeholders:
The CS has the following specific questions for stakeholders and welcomes any additional perspectives, solutions, and information related to pear ester.

1. Is there additional/new research-based information on the environmental and human health impacts of pear ester used in microencapsulated formulations and in traps.

Subcommittee Votes

Motion to classify pear ester as synthetic
Motion by: Franklin Quarcoo
Seconded by: Brian Caldwell
Yes: 5 No: 0 Abstain: 0 Recuse: 0 Absent: 2

Motion to add pear ester to the National List at § 205.601(f) with the following annotation: use of pear ester is limited to passive traps/monitors and not for use in microencapsulated formulations
Motion by: Franklin Quarcoo
Seconded by: Logan Petrey
Yes: 5 No: 0 Abstain: 0 Recuse: 0 Absent: 2