SUMMARY OF TAP REVIEWERS' ANALYSES[†]

Ferric phosphate is being petitioned for use as a pesticide (molluscicide) to prevent extensive damage to and/or destruction of vegetables, citrus and non-citrus fruit, berries, field crops, ornamentals, greenhouse and nursery plants, lawns, and gardens for seed production. Slugs and snails, which are slugs with shells, can be very destructive to plants and crops. "Slugs are one of the most destructive and difficult pests to control. Seedlings of many vegetables and flowers are favored foods, and high populations of slugs can cause difficulties in establishing a crop. Slugs also feed on many fruits and vegetables prior to harvest. This preharvest feeding results in wounds that allow various fungi and bacteria to enter and spoil the crop. In addition, the slime trails produced by slugs can contaminate garden produce."[1] Ferric phosphate is a very effective molluscicide and does not harm humans, animals, non-target insects, plants, or soil microbes. It is a very stable and non-reactive substance in the agroecosystem. Ferric phosphate is already abundant in soil. However, it is not naturally available at concentrations required for a molluscicide and must be synthetically produced to be used for this purpose. The petitioner is requesting that ferric phosphate be permitted on the National List of synthetic substances allowed for use in organic crop production.

All three reviewers determined that ferric phosphate, as petitioned, is a synthetic substance. One reviewer recommended that ferric phosphate be allowed as a molluscicide for organic crop production since ferric phosphate does not adversely affect other organisms and is already ubiquitous in the environment. Two reviewers recommended against allowing ferric phosphate as a molluscicide for organic crop production since other organic alternatives exist.

Synthetic or Non-synthetic?	***Allow without restrictions?***	***Allow only with restrictions? (See reviewers' comments for restrictions)***
Synthetic (3) **Non-synthetic (0)**	**Yes (1)** **No (2)**	**Yes (0)** **No (0)**

[†] *This Technical Advisory Panel (TAP) report was based upon the information available at the time this report was generated. This report addressed the requirements of the Organic Foods Production Act of 1990 (OFPA), as amended, to the best of the investigator's ability and was reviewed by experts on the petitioned substance. The substance was evaluated according to the criteria found in Section 2118 (7 U.S.C. 6517) and in Section 2119 (7 U.S.C. 6518) of the OFPA. Any recommendation(s) presented to the National Organic Standards Board (NOSB) was based on the information contained within the TAP report and the evaluation of that information relative to these criteria. The TAP report does not incorporate commercial availability, socioeconomic impact, or other factors related to the petitioned substance, which NOSB and USDA may want to consider in their decision process.*

IDENTIFICATION[2,3,4,5]

Chemical Name: Ferric Phosphate
CAS Registry Number: 10045-86-0
Other Names: Iron (III) Phosphate; Ferric Orthophosphate; Iron (III) Orthophosphate; Iron (III) Phosphate x-hydrate; Phosphoric Acid, Iron(3+) Salt (1:1)

CHARACTERIZATION[6,7,8,9]

Composition: Odorless, yellowish-white to buff-colored powder; may contain from one to four molecules of water of hydration (*Molecular Formula:* $FePO_4 \cdot xH_2O$)
Properties:

Molecular Formula: $FePO_4$ (anhydrous)
Molecular Weight: 150.82 (anhydrous)
Melting Point: Does not melt; degrades into ferric oxide (Fe_2O_3) at temperatures near 500°C
Boiling Point: Not Applicable
Density: 2.87 g/cm^3
Water Solubility: Mostly Insoluble

PRODUCTION[10]

To synthetically produce ferric phosphate, an aqueous iron sulfate solution is mixed with an aqueous disodium phosphate solution in a stainless steel boiler. The mixture is heated up to 50-70°C in order to precipitate ferric phosphate. The precipitate is filtered from the solution, washed with distilled water, and dried with hot air. The ferric phosphate powder is then ready to be packed into containers for shipping. The only by-products of this process are sodium sulfate and water. Sodium sulfate is precipitated with lime and used as a secondary raw material. The water is released into a wastewater clarification plant.

HISTORY OF USE[11,12]

Non-Organic Growers: Originally used in Europe, various ferric phosphate slug and snail baits have been registered with the U.S. Environmental Protection Agency since 1997.

Organic Growers: Currently, no synthetic substance has been approved for use as slug and snail bait in organic crop production.

CURRENT STATUS

U.S. Regulatory Agencies:

EPA: According to 40 CFR Part 180 (§180.1191), "[a]n exemption from the requirement of a tolerance is established for residues of the biochemical pesticide, ferric phosphate…in or on all food commodities."[13]

FDA: According to 21 CFR Part 184 (§184.1301), "[f]erric phosphate…meets the specifications of the Food Chemicals Codex, 3rd Ed. (1981), pp. 118-120, which is incorporated by reference…In accordance with §184.1(b)(1), [ferric phosphate] is used in food as nutrient supplement as defined in §170.3(o)(20) of this chapter, with no limitation other than current good manufacturing practice. The ingredient may also be used in infant formula in accordance with section 412(g) of the Federal Food, Drug, and Cosmetic Act (the act) (21 U.S.C. 350a(g)) or with regulations promulgated under section 412(a)(2) of the act (21 U.S.C. 350a(a)(2))…Prior sanctions for [ferric phosphate] different from the uses established in this section do not exist or have been waived."[14]

OSHA: According to the Occupational Safety and Health Administration, ferric phosphate is classified as an "Irritant."[15]

International Certifiers:

EU: Ferric phosphate has been allowed for use as a molluscicide in non-organic crop production in the European Union since 2001.[16] However, the European Union has not approved ferric phosphate for use as a molluscicide in organic crop production.[17]

Japan: Ferric phosphate is not listed as an approved substance for organic agricultural production in Japan.[18]

Canada: Synthetic iron phosphate is prohibited as an organic crop production material in Canada.[19] However, ferric phosphate is a regulated material in organic livestock production. Ferric phosphate is allowed in feed, feed additives, feed supplements, and health care products for organically produced livestock.[20]

Codex Alimentarius: Ferric phosphate is not currently listed as approved for use in the production of organic foods. However, an amendment to include ferric phosphate as a molluscicide in organic food production was recently submitted to the Codex Alimentarius Commission.[21]

APPLICATION[22,23,24,25,26,27]

Ferric phosphate is registered with the U.S. Environmental Protection Agency as a biochemical molluscicide and targets a wide range of slugs and snails, including *Deroceras reticulatum, Derceras laeve, Arion subfuscus, Arion circumscriptus, Arion hortensis, Arion rufus, Arion ater, Limax flavus, Limax tenullus, Ariolimax columbianus, Helix spp., Helicella spp., and Cepaea spp.* Ferric phosphate is applied to soil as part of a pellet that includes a wheat-based bait to attract snails and slugs. After the pellets are consumed, ferric phosphate interferes with calcium metabolism in the digestive tract of the snails and slugs, causing them to stop eating almost immediately. Three to six days later, the snails and slugs die. Ferric phosphate should be applied at a rate of 5 g/m^2 by hand or manure spreader with a maximum of 5 applications per growing season.

INCOMPATIBILITIES[28]

Ferric phosphate is stable under normal conditions of use and storage. Ferric phosphate has no known incompatibilities with other substances. When heated to high temperatures, ferric phosphate may decompose and release carbon dioxide and toxic fumes, including carbon monoxide, nitrogen oxides, and phosphorous oxides.

ORGANIC FOODS PRODUCTION ACT OF 1990 (OFPA), AS AMENDED

7 USC 6517. NATIONAL LIST.

"(a) *In General.* The Secretary shall establish a National List of approved and prohibited substances that shall be included in the standards for organic production and handling established under this chapter in order for such products to be sold or labeled as organically produced under this chapter.

(b) *Content of List.* The list established under subsection (a) of this section shall contain an itemization, by specific use or application, of each synthetic substance permitted under subsection (c) (1) of this section or each natural substance prohibited under subsection (c) (2) of this section.

(c) *Guidelines for Prohibitions or Exemptions.*

(1) *Exemption for Prohibited Substances.* The National List may provide for the use of substances in an organic farming or handling operation that are otherwise prohibited under this chapter only if

(A) the Secretary determines, in consultation with the Secretary of Health and Human Services and the Administrator of the Environmental Protection Agency, that the use of such substances

(i) would not be harmful to human health or the environment;

(ii) is necessary to the production or handling of the agricultural product because of unavailability of wholly natural substitute products; and

(iii) is consistent with organic farming and handling;

(B) the substance

(i) is used in production and contains an active synthetic ingredient in the following categories: copper and sulfur compounds; toxins derived from bacteria; pheromones, soaps, horticultural oils, fish emulsions, treated seed, vitamins and minerals; livestock paraciticides and medicines and production aids including

netting, tree wraps and seals, insect traps, sticky barriers, row covers, and equipment cleansers;

(ii) is used in production and contains synthetic inert ingredients that are not classified by the Administrator of the Environmental Protection Agency as inerts of toxicological concern; or

(iii) is used in handling and is non-synthetic but is not organically produced; and

(C) the specific exemption is developed using the procedures described in subsection (d) of this section."

Therefore, under 7 USC 6517 of the OFPA, as amended, it must be determined if the use of ferric phosphate as a pesticide (molluscicide) in organic crop production (vegetables, citrus and non-citrus fruit, berries, field crops, ornamentals, greenhouse and nursery plants, lawns, and gardens for seed production) is consistent with subsection (c)(1) of 7 USC 6517. If so, then ferric phosphate should be allowed an exemption as a synthetic substance and be included on the National List.

SECTION 2118 (7 U.S.C. 6517) AND SECTION 2119 (7 U.S.C. 6518) OFPA CRITERIA

Category 1: Impact of the Substance on Humans and the Environment

1. *What is the probability of environmental contamination during manufacture, use, misuse, or disposal of the substance [§6518(m)(3)]?*

   The probability of environmental contamination during manufacture, use, misuse, or disposal of ferric phosphate is minimal and highly unlikely since ferric phosphate is naturally abundant in soil. When used as a molluscicide, ferric phosphate is not recommended for use near waterways. In addition, "[l]osses incidental to correct application of [ferric phosphate] in its intended uses are not expected to be harmful to people, animals, or the environment."[29]

   Accidental release measures for ferric phosphate include:

   - "Dike spill area to prevent spread and movement into drains, storm sewers, and ditches that lead to waterways.
   - Keep children, animals, and unauthorized personnel away from spills.
   - Collect spilled material in suitable containers for removal.
   - As conditions warrant, notify proper authorities, downstream sewer and water treatment operations, and other downstream users about potentially contaminated water."[30]

2. *Is the substance harmful to the environment [§6517(c)(1)(A)(i); §6517(c)(2)(A)(i)]?*

   A molluscicide containing ferric phosphate is not expected to have any negative environmental impacts since this subtance:

   - Occurs naturally in soil
   - Is a virtually insoluble, stable substance
   - Is applied at very low dosage rates
   - Is not intended to be applied in or near water systems
   - Is non-toxic to most animal species
   - Is a GRAS food additive
   - Is an essential metabolic nutrient for animals and plants[31]

3. *Does the substance contain List 1, 2, or 3 inert pesticide ingredients identified by U.S. EPA's Office of Pesticide Programs [§6517(c)(1)(B)(ii); §205.601(m)(2)]?*

   Ferric phosphate does not contain any List 1, 2, or 3 inert pesticide ingredients identified by U.S. EPA's Office of Pesticide Programs.[32]

4. *What is the potential of the substance for detrimental chemical interactions with other materials used in organic farming systems [§6518(m)(1)]?*

   The potential of ferric phosphate for detrimental chemical interactions with other materials used in organic farming systems is exceedingly low since ferric phosphate has no known incompatibilities with other substances and is extremely stable.

5. *Does the substance cause adverse biological and chemical interactions in the agroecosystem [§6518(m)(5)]?*

   "[Ferric phosphate] is not harmful to humans, to other non-target organisms, or to the environment. It is an alternative to a more toxic chemical that has been used for controlling snails and slugs."[33]

   "A number of ecological effects toxicology data requirements were waived based on the known lack of toxicity of iron phosphate to birds, fish and non-target insects, its low solubility in water, conversion to less soluble form in the environment (soil), and its use pattern (soil application)...Submitted studies involving ground beetles, rove beetles and earthworms demonstrated that [ferric phosphate] will not affect these organisms at up to two times the maximum application rate."[34]

6. *Does the substance cause detrimental physiological effects to soil organisms (including the salt index and soil solubility), crops, or livestock [§6518(m)(5)]?*

   Ferric phosphate is a stable compound that is already abundant in soil. Therefore, ferric phosphate is not expected to cause detrimental physiological effects to soil organisms, even when applied as a molluscicide. Since ferric phosphate contains minerals (iron and phosphorus) that are essential for plant and animal development, it is not expected to cause detrimental physiological effects to crops or livestock, especially at the suggested application rate.

7. *Do either the substance or its breakdown products/contaminants cause a toxic or other adverse action in the environment [§6518(m)(2)]?*

   Under normal conditions, ferric phosphate and its breakdown products—Fe^{+3} and $(PO_4)^{-3}$—will not cause toxic or other adverse actions in the environment. Ferric phosphate is a stable, non-volatile solid that does not readily dissolve in water. This property minimizes ferric phosphate's dispersal beyond where it is applied. Only under conditions of extremely high temperatures will ferric phosphate decompose and release toxic fumes.

8. *What is the probability of an undesirable persistence or concentration of the substance or its breakdown products/contaminants in the environment [§6518(m)(2)]?*

   It is highly unlikely that ferric phosphate or its breakdown products—Fe^{+3} and $(PO_4)^{-3}$—will persist or become highly concentrated in the environment.[35] When ferric phosphate is applied as a molluscicide, the amount of additional iron and phosphorus added to the soil is negligible compared to the amount of iron (0.5-5%) and phosphorus (0.01-0.20%) already present in soil.[36] In addition, ferric phosphate and its breakdown products are a source of nutrients utilized by all plants for energy production and growth.[37]

9. *Is the substance harmful to human health [§6517(c)(1)(A)(i); §6517(c)(2)(A)(i); §6518(m)(4)]?*

   Generally, ferric phosphate is not harmful to human health, but some undesirable consequences can occur with excessive ferric phosphate exposure. Skin and eye contact is the most probable route of ferric phosphate exposure followed by ingestion and dust inhalation. The lethal dose for 50% of those persons exposed to ferric phosphate is greater than 5000 mg/kg body weight (LD50>5000 mg/kg) for both oral and dermal routes of exposure. Potential health effects include:

   - Eyes—possible moderate irritation
   - Skin—normally no irritation
   - Inhalation—normally no irritation

- Ingestion—possible nausea, vomiting, stomach pain, cramps, and/or diarrhea from consumption of large amounts

Although chronic exposure to ferric phosphate may result in conjunctivitis or dermatitis, ferric phosphate is mostly benign.[38]

"No unreasonable adverse effects to human health are expected from the use of iron phosphate."[39]

Category 2: Importance of the Substance for Organic Production

1. *Is the substance necessary to the production or handling of an agricultural product due to the unavailability of wholly natural substitute materials [§6517(c)(1)(A)(ii)]?*

   Although ferric phosphate is abundant in soil, it does not exist in a form that can be readily incorporated into a molluscicide. Ferric phosphate can occur in the environment as amorphous ferric phosphate or as a mineral (i.e. Strengite, Phosphosiderite, Koninckite, Dufrenite, Beraunite).[40] Ferric phosphate minerals are relatively rare and often form crystals, which are prized as gemstones. Natural sources of amorphous ferric phosphate typically contain considerable amounts of impurities. The ferric phosphate petitioned for use as a molluscicide is a highly-refined, food-grade material that was specifically chosen due to its low toxicity and GRAS status.

2. *Is the substance non-synthetic, but not produced organically, and used in handling [§6517(c)(1)(B)(iii)]?*

   Since ferric phosphate is being petitioned as a synthetic substance allowed for use in organic crop production, this question is not applicable.

3. *Would other available materials be suitable alternatives to using the substance [§6518(m)(6)]?*

   Other molluscicides are available and could be used instead of ferric phosphate. However, these alternative molluscicides are not suitable to organic crop production.

   Metaldehyde (2, 4, 6, 8-tetramethyl-1, 3, 5, 7-tetraoxycyclo-octane) is a very effective molluscicide and is the most common active ingredient in synthetic chemical baits. Metaldehyde is classified as a Restricted Use Pesticide (RUP) by the U.S. Environmental Protection Agency and as a Class II (moderately hazardous) Pesticide by the World Health Organization. Metaldehyde is highly toxic by inhalation, moderately toxic by ingestion, and slightly toxic by dermal absorption. The metaldehyde bait commonly used by home gardeners is toxic to wildlife and may be fatal to pets if eaten. Metaldehyde is also toxic to

earthworms and may affect other non-target insects. If weather conditions are too wet, slugs and snails can recover from metaldehyde poisoning.[41,42,43]

An ammonia spray, composed of a 1:1 ratio of household ammonia to water, has been used as a molluscicide, but it must be sprayed directly onto the snails and slugs for it to be effective.[44,45]

4. *Would other practices either reduce or eliminate the requirement for the substance [§6518(m)(6)]?*

Other practices that reduce the requirement for molluscicides do exist, but they each have their limitations:

- Biological controls (i.e. predatory insects, reptiles, and birds) can only be used on small organic farms against certain slug species in years of low infestation. Biological controls are not a viable option on large organic farms or in years of heavy infestation.[46]

- Barrier controls (i.e. copper strips and diatomaceous earth) can be fairly effective against slug infestation. However, copper strips are expensive, making them impractical for large organic farms or in years of heavy infestation. Diatomaceous earth is only effective when used in dry conditions, making it impractical for use outdoors unless it is continuously reapplied.[47]

- Repellent controls (i.e. copper silicate and copper sulfate) are effective repellents, but do not actually kill slugs. These compounds must be mixed with water and sprayed directly on plants. In years of heavy infestation, repellants may not prevent extensive damage to plants and crops.[48]

- Physical controls (i.e. beer traps and hand-picking) have limited effectiveness in controlling slugs. Beer attracts slugs and draws them into the traps where they then drown. Beer traps must constantly be replenished since the beer either evaporates or becomes diluted with rain water. Hand-picking is difficult since slugs only emerge to feed at night. Hand-picking can be aided by erecting slug shelters on the ground. Shelters must be checked every morning for slugs, and the captured slugs must then be killed. Both of these options are impractical for large organic farms or in years of heavy infestation.[49,50]

- Cultural controls (i.e. eliminating potential shelters and reducing moisture levels) are only slightly effective at reducing slug populations and may be impractical for organic growers. Some organic cultivation methods—mulches, hedges, field-edge strips—provide places for slugs to hide.[51,52]

Category 3: Compatibility of the Substance with Organic Production Practices

1. *Is the substance consistent with organic farming and handling [§6517(c)(1)(A)(iii); §6517(c)(2)(A)(ii)]?*

   When used as a molluscicide, ferric phosphate is consistent with organic farming and handling. Ferric phosphate is not harmful to humans, animals, plants, non-target insects, or soil microbes. Ferric phosphate is a stable compound that does not persist or form undesirable products in the environment under normal conditions of use and storage.

2. *Is the substance compatible with a system of sustainable agriculture [§6518(m)(7)]?*

   Sustainable agriculture is defined as the integration of environmental health, economic profitability, and social/ economic equity.[‡] Using ferric phosphate as a molluscicide is very compatible with sustainable agriculture. Not only does ferric phosphate maintain environmental health, it also allows organic growers to effectively control a devastating garden pest. Controlling plant and crop destruction caused by snails and slugs increases profits to organic crop producers as well as the availability of organic crops to consumers.

3. *Is the substance used in production, and does it contain an active synthetic ingredient in the following categories [§6517(c)(1)(B)(i)]:*

   a) Copper and sulfur compounds?

   Neither ferric phosphate nor the wheat-based bait in which it will be incorporated contains copper or sulfur compounds.

   b) Toxins derived from bacteria?

   Neither ferric phosphate nor the wheat-based bait in which it will be incorporated contains toxins derived from bacteria.

   c) Pheromones, soaps, horticultural oils, fish emulsions, treated seed, and vitamins and minerals?

   Neither ferric phosphate nor the wheat-based bait in which it will be incorporated contains pheromones, soaps, horticultural oils, fish emulsions, treated seed, or vitamins and minerals. Ferric phosphate has previously been used as a nutritional (mineral) supplement for humans, animals, and plants. However, it is currently being petitioned only for use as a molluscicide in organic crop production.

[‡] University of California Sustainable Agriculture Research and Education Program. "What is Sustainable Agriculture?" 1997; http://www.sarep.ucdavis.edu/concept.htm.

d) Livestock parasiticides and medicines?

Neither ferric phosphate nor the wheat-based bait in which it will be incorporated contains livestock parasiticides or medicines.

e) Production aids including netting, tree wraps and seals, insect traps, sticky barriers, row covers, and equipment cleansers?

Neither ferric phosphate nor the wheat-based bait in which it will be incorporated includes production aids (i.e. netting, tree wraps/seals, insect traps, sticky barriers, row covers, and equipment cleansers).

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REVIEWER 1

M.S. in Biochemistry and Chemistry with Forensic Drug Testing Experience, Adjunct Instructor for Mid-Atlantic Academy, East Coast, USA

A. Comments on Database

The IDENTIFICATION and CHARACTERIZATION sections are reasonably well-summarized and complete. Ferric phosphate is very slightly soluble in water (K_{sp}=4.0 x 10^{-27}). The remaining sections of the database (pg. 1-5) provide succinct and accurate summaries of each of the topics addressed.

B. Evaluation of OFPA Criteria

Category 1: Impact of the Substance on Humans and the Environment

1. *What is the probability of environmental contamination during manufacture, use, misuse, or disposal of the substance [§6518(m)(3)]?*

   I agree with the criterion evaluation.

2. *Is the substance harmful to the environment [§6517(c)(1)(A)(i); §6517(c)(2)(A)(i)]?*

   I agree with the criterion evaluation.

3. *Does the substance contain List 1, 2, or 3 inert pesticide ingredients identified by U.S. EPA's Office of Pesticide Programs [§6517(c)(1)(B)(ii); §205.601(m)(2)]?*

   I agree with the criterion evaluation.

4. *What is the potential of the substance for detrimental chemical interactions with other materials used in organic farming systems [§6518(m)(1)]?*

   I agree with the criterion evaluation. Its very low water solubility would make detrimental chemical interactions with other materials used in organic farming unlikely.

5. *Does the substance cause adverse biological and chemical interactions in the agroecosystem [§6518(m)(5)]?*

   I agree with the criterion evaluation.

6. *Does the substance cause detrimental physiological effects to soil organisms (including the salt index and soil solubility), crops, or livestock [§6518(m)(5)]?*

   I agree with the criterion evaluation.

7. *Do either the substance or its breakdown products/contaminants cause a toxic or other adverse action in the environment [§6518(m)(2)]?*

   I agree with the criterion evaluation. With its very low water solubility, the rapid release of Fe^{3+}(aq) and PO_4^{3-}(aq) would not occur; the high temperature needed for decomposition would not exist in the environment.

8. *What is the probability of an undesirable persistence or concentration of the substance or its breakdown products/contaminants in the environment [§6518(m)(2)]?*

   I agree with the criterion evaluation.

9. *Is the substance harmful to human health [§6517(c)(1)(A)(i); §6517(c)(2)(A)(i); §6518(m)(4)]?*

   I agree with the criterion evaluation. The undesirable effects cited would require significantly higher exposure amounts than would normally be encountered with careful handling when ferric phosphate is used at the application rate (about 25 kg/acre).

Category 2: Importance of the Substance for Organic Production

1. *Is the substance necessary to the production or handling of an agricultural product due to the unavailability of wholly natural substitute materials [§6517(c)(1)(A)(ii)]?*

   I agree with the criterion evaluation as far as it goes. Even though ferric phosphate occurs in the soil, a concentrated dose of the salt is required to act as a molluscicide. However the routine necessity for any molluscicide is not documented. The frequency of heavy infestations of slugs and snails was not addressed. Perhaps some crop loss to these particular pests would be an acceptable trade-off to eliminate the expense of multiple routine applications of ferric phosphate.

2. *Is the substance non-synthetic, but not produced organically, and used in handling [§6517(c)(1)(B)(iii)]?*

   I agree with the criterion evaluation.

3. *Would other available materials be suitable alternatives to using the substance [§6518(m)(6)]?*

   I agree with the criterion evaluation in part. Metaldehyde would not be appropriate due to its toxicity. There are reports that the use of a 4:1 ratio of water to household ammonia applied directly on the plant was highly effective in controlling these pests at least with ornamental hostas.

4. *Would other practices either reduce or eliminate the requirement for the substance [§6518(m)(6)]?*

   I agree with the criterion evaluation for the most part. The report provides a good summary of the potential snail and slug controls and their limitations. The conclusion that the use of these other practices is impractical or overly burdensome is not adequately supported. What constitutes a "large organic farm" and "heavy infestation" is not well defined. Many organic farmers may be able to effectively use the natural snail and slug controls.

   Another practice not mentioned that might reduce or eliminate the requirement for the petitioned substance is the use of trap or decoy plants near favorite plants to deter their damage from the pests. I am not sure that this is any less practical than applying a salt-laced bait over many acres several times a growing season.

Category 3: Compatibility of the Substance with Organic Production Practices

1. *Is the substance consistent with organic farming and handling [§6517(c)(1)(A)(iii); §6517(c)(2)(A)(ii)]?*

   I agree with the criterion evaluation.

2. *Is the substance compatible with a system of sustainable agriculture [§6518(m)(7)]?*

   I agree with the criterion evaluation for the most part. Economic profitability is important, but the economic costs of controlling snail and slug pests using natural methods was not well defined in Category 2: Question 4. Some internet sources indicate a ferric phosphate cost of less than $150 per acre per application, but this could vary significantly for large purchasers. How this would compare, for example, with the use of traps or barriers even for large farms is not clear.

3. *Is the substance used in production, and does it contain an active synthetic ingredient in the following categories [§6517(c)(1)(B)(i)]:*

   a) *Copper and sulfur compounds?*

      I agree with the criterion evaluation.

   b) *Toxins derived from bacteria?*

      I agree with the criterion evaluation.

   c) *Pheromones, soaps, horticultural oils, fish emulsions, treated seed, and vitamins and minerals?*

      I agree with the criterion evaluation.

   d) *Livestock parasiticides and medicines?*

      I agree with the criterion evaluation.

   e) *Production aids including netting, tree wraps and seals, insect traps, sticky barriers, row covers, and equipment cleansers?*

      I agree with the criterion evaluation.

C. <u>Conclusion</u>--Summarize Why This Substance Should Be Allowed or Prohibited for Use in Organic Crop or Livestock Production

Iron (III) phosphate should not be allowed in organic crop production. The petitioned material is synthetic (manufactured in a simple metathesis reaction). In my opinion, the report does not justify a conclusion that the requirement of *§6517(c)(1)(A)(ii)* "necessary to the production or handling of the agricultural product because of the unavailability of wholly natural substitute products" has been met. There are many other control options, and better support for the assumption that they would not work on large farms should be provided. *§6517(c)(1)(B)(i)* requires that the petitioned substance "is used in production and contain an active synthetic ingredient in the following categories." This is not the case, and ferric phosphate would appear to not be eligible for inclusion on the National List

D. <u>Recommendation Advised to NOSB</u>

Iron (III) phosphate is synthetic. Iron (III) phosphate should not be added to the National List under the exceptions for synthetic substances for use in organic crop production (§205.601).

REVIEWER 2

Ph.D., Assistant Professor of Chemistry, Gulf Coast, USA

A. Comments on Database

The TAP report is straightforward and well-written. All points are addressed sufficiently, and the necessary background data and references are provided. The points raised in the TAP report in Category 2: Section 1 regarding amorphous ferric phosphate not having the same effects as synthetic ferric phosphate to be used as a molluscicide sound unusual. More references are needed here regarding bioavailability of the different morphologies of solid-state ferric phosphate. Alternatively, an argument could be made regarding the higher local concentration of ferric phosphate from a farmer's application that is critical for molluscicide effects versus ferric phosphate that is available naturally in the soil. Because ferric phosphate in soil is spread out, local concentrations may not exist and thus could not act as a molluscicide.

B. Evaluation of OFPA Criteria

Category 1

B-1.1. Ferric phosphate is already fairly abundant in soil; therefore, risks of environmental contamination are low. Ferric phosphate has very low solubility in water; therefore, it is not likely to be transported by aqueous systems. The low possibility of mass transfer of insoluble ferric phosphate particles via waterways is avoided by recommendation not to use near waterways and easy-to-follow accidental release measures.

B-1.2. Ferric phosphate will not harm humans, other animals, plants, and insects other than the targeted mollusks (e.g. snails and slugs).

B-1.3. Ferric phosphate does not have any List 1, 2, or 3 inert ingredients.

B-1.4. Ferric phosphate has not been reported to have incompatibilities with other substances.

B-1.5. Chemically, ferric phosphate is very stable and will not dissociate unless in the presence of concentrated acid, which is not present in natural surroundings. Because of its low solubility in the aqueous agroecosystem, there is little contamination beyond treated areas. It is known that ferric phosphate lacks toxicity for fish, birds, and

non-target insects, such as rove beetles, ground beetles and earthworms.

B-1.6. Ferric phosphate is not expected to cause detrimental physiological effects to crops, livestock, or humans. The low solubility of ferric phosphate implies it will have a negligible effect on the salt index of the soil.

B-1.7. Ferric phosphate has low solubility in water; therefore, there are only trace amounts of the breakdown products of ferrous/ferric ions and phosphate ions. None of the breakdown products are harmful to the environment.

B-1.8. Although ferric phosphate has low solubility in the environment, the small amount used for the intended application is negligible compared to that already existing in the environment for iron (0.5%-5% of the soil volume) and phosphates (up to 20% of the soil volume). Furthermore, breakdown products are utilized by environmental organisms, This will aid in environmental breakdown and lessening of persistence.

B-1.9. The lethal dose for 50% of humans to ferric phosphate exposure is 5.0 grams per kilogram body weight. This makes it impossible to ingest enough ferric phosphate once it is applied to soil. Direct ingestion from unapplied material causes nausea and dysentery, while exposure to eyes may cause minor irritation. No irritation is expected from topical exposure. The ferric phosphate described in the TAP report is a highly-refined, food-grade material that already has GRAS status.

Category 2

B-2.1. There is no wholly natural substitute reported.

B-2.2. Not applicable; ferric phosphate is presented as a synthetic additive.

B-2.3. Although other molluscicides are available, they are more toxic than ferric phosphate or provide unsuitable application conditions to be effective for medium- or large-sized crops.

B-2.4. Other practices are available, such as predatory wildlife or physical barrier controls. However, these will not be effective for medium- or large-sized crops.

Category 3

B-3.1. The non-toxicity in all documented cases, except for as a molluscicide, make ferric phosphate consistent with organic farming.

B-3.2. The use of ferric phosphate as a molluscicide is compatible with and enhances sustainable organic agriculture. Environmental health is maintained while pest problems are adequately handled, allowing economic profitability of organically grown crops.

B-3.3. Ferric phosphate does not have any of the following components:

a. Copper or sulfur compounds

b. Toxins derived from bacteria

c. Pheromones, soaps, horticulture oils, fish emulsions, treated seed, vitamins, or minerals

d. Livestock parasiticides or medicines

e. Production aids including netting, tree wraps/seals, insect traps, sticky barriers, row covers, or equipment cleaners

C. Conclusion

Ferric phosphate should be allowed for use in organic crop production. Although the ferric phosphate in this application comes from synthetic sources, ferric phosphate is already found in the existing environment, often in quantities greater than those being used for molluscicide purposes. Except for its effects as a molluscicide, there are virtually no other effects to animals, plants, or anything else in the agroecosystem. All other alternatives to ferric phosphate are either more toxic or impractical for farming needs.

D. Recommendation Advised to NOSB

Ferric phosphate is synthetic and should be allowed without restrictions.

REVIEWER 3

USDA Accredited Certifier, Midwest, USA

A. Comments on Database

The TAP report on ferric phosphate was well done. However, it could have contained more information on the other materials that would be in the pellets which contain ferric phosphate.

B. Evaluation of OFPA Criteria

Category 1: Impact of the Substance on Humans and the Environment

1. *What is the probability of environmental contamination during manufacture, use, misuse, or disposal of the substance [§6518(m)(3)]?*

   According to the TAP, "The probability of environmental contamination during manufacture, use, misuse, or disposal of ferric phosphate is minimal and highly unlikely since ferric phosphate is naturally abundant in soil." However, the TAP also states "When used as a molluscicide, ferric phosphate is not recommended for use near waterways." The accidental release measures indicate that the material has the potential to contaminate water. It seems possible that there is probability of environmental contamination should the ferric phosphate be spilled.

2. *Is the substance harmful to the environment [§6517(c)(1)(A)(i); §6517(c)(2)(A)(i)]?*

   Ferric phosphate may be harmful to the environment if spilled.

3. *Does the substance contain List 1, 2, or 3 inert pesticide ingredients identified by U.S. EPA's Office of Pesticide Programs [§6517(c)(1)(B)(ii); §205.601(m)(2)]?*

   No.

4. *What is the potential of the substance for detrimental chemical interactions with other materials used in organic farming systems [§6518(m)(1)]?*

   Unlikely unless it is spilled.

5. *Does the substance cause adverse biological and chemical interactions in the agroecosystem [§6518(m)(5)]?*

   Unlikely unless it is spilled.

6. *Does the substance cause detrimental physiological effects on soil organisms (including the salt index and soil solubility), crops, or livestock [§6518(m)(5)]?*

   Unlikely unless it is spilled.

7. *Do either the substance or its breakdown products/contaminants cause a toxic or other adverse action in the environment [§6518(m)(2)]?*

   Not likely.

8. *What is the probability of an undesirable persistence or concentration of the substance or its breakdown products/contaminants in the environment [§6518(m)(2)]?*

   Highly unlikely.

9. *Is the substance harmful to human health [§6517(c)(1)(A)(i); §6517(c)(2)(A)(i); §6518(m)(4)]?*

   Excessive exposure may cause irritation to eyes and skin. Ingestion may cause nausea, vomiting, stomach pain, cramps, and/or diarrhea if consumed in large amounts. Chronic exposure to ferric phosphate may result in conjunctivitis or dermatitis.

Category 2: Importance of the Substance for Organic Production

1. *Is the substance necessary to the production or handling of an agricultural product due to the unavailability of wholly natural substitute materials [§6517(c)(1)(A)(ii)]?*

   No. There are natural alternatives as well as mechanical alternatives. Diatomaceous earth and bait stations are examples of alternatives currently being used on organic farms.

2. *Is the substance non-synthetic, but not produced organically, and used in handling [§6517(c)(1)(B)(iii)]?*

   No.

3. *Would other available materials be suitable alternatives to using the substance [§6518(m)(6)]?*

   Yes. See #1 above.

4. *Would other practices either reduce or eliminate the requirement for the substance [§6518(m)(6)]?*

   Yes. Other practices that reduce the requirement for molluscicides exist. Although the TAP considers them to be impractical, organic growers have relied for many years on biological controls, barriers, diatomaceous earth, repellents, and physical controls. Improvements in trap designs, baits, and barriers have been made in some products.

Category 3: Compatibility of the Substance with Organic Production Practices

1. *Is the substance consistent with organic farming and handling [§6517(c)(1)(A)(iii); §6517(c)(2)(A)(ii)]?*

   Ferric phosphate has not historically been allowed in organic production. This reviewer does not consider it consistent as there are alternatives, albeit more inconvenient than a molluscicide, that have been successfully used on organic farms. Considering the size of many of these farms today, it is hard to believe that ferric phosphate is necessary to production. Organic farming is not about making it easy to get bigger. It is about using appropriate materials and methods and finding non-synthetic alternatives.

2. *Is the substance compatible with a system of sustainable agriculture [§6518(m)(7)]?*

   Yes.

3. *Is the substance used in production, and does it contain an active synthetic ingredient in the following categories [§6517(c)(1)(B)(i)]:*

   a) Copper and sulfur compounds?

   No.

   b) Toxins derived from bacteria?

   No.

   c) Pheromones, soaps, horticultural oils, fish emulsions, treated seed, and vitamins and minerals?

   No.

   d) Livestock parasiticides and medicines?

   No.

   e) Production aids including netting, tree wraps and seals, insect traps, sticky barriers, row covers, and equipment cleansers?

   No.

C. <u>Conclusion</u>--Summarize Why This Substance Should Be Allowed or Prohibited for Use in Organic Crop or Livestock Production

This substance should not be allowed for use in organic crop production for the following reasons:

- Natural and allowed alternatives exist
- There is potential for harm to the environment if spilled
- There is potential for harm to human health and animals if spilled
- Use of ferric phosphate may cause problems for organic farmers wishing to sell their crops to countries who do not allow this material in their organic standards
- Not enough information is provided about other ingredients that may be used in the production of the pellets that contain ferric phosphate; there are references to wheat, in which case determination of the presence of GMO wheat in the product needs to be taken into consideration

D. Recommendation Advised to NOSB

Ferric phosphate is synthetic and should not be allowed for use in organic crop production.