

**National Organic Standards Board
Crops Subcommittee
Petitioned Material Checklist - Allyl Isothiocyanate
December 16, 2014**

Summary of Proposed Action:

Allyl Isothiocyanate has been petitioned to be added to the National List under §205.601 Synthetic substance allowed for use in organic crop production, as a pre-plant fumigant.

The petitioned form of Allyl Isothiocyanate is a synthetic produced from allyl iodide and potassium thiocyanate. A natural source for AITC comes from Oil of Mustard (black mustard seed) and is also found in cooked cabbage, kale, mustard plants, and horseradish.

AITC is being petitioned for use in organic crop production as a pre-plant biofumigant to control soil-borne fungi, nematodes, weeds, and insects.

Background:

The petition for Allyl Isothiocyanate (dated December 20, 2013) was received by the NOSB on January 21, 2014. The petitioner is Isagro, USA, Inc. The Crops sub-committee received a Technical Report (per their request) on October 6, 2014. The petition along with a completed checklist were discussed and voted upon by the Crops sub-committee on December 2, 2014 with the outcome of that discussion of the vote resulting in the proposals listed elsewhere in this document.

The Technical Evaluation Report dated October 3, 2014 states that the current petition represents the first consideration of synthetic AITC bio-fumigant in any form of organic production in the United States.

Discussion:

Allyl Isothiocyanate is a pre-plant bio-fumigant used to control soil borne pathogens, nematodes, weeds, and insects. AITC is a naturally occurring compound found in the Oil of Mustard (from black mustard seed, Brassica Ingra L) and is produced naturally (when black mustard seeds are crushed) when enzymes of cruciferous plants, myrosinase, and glucosinolate, are combined in the presence of water. Mustard seed meal or tilling in mustard plants (green manuring) can also be a viable source of AITC.

The petitioned form of AITC as previously stated is a synthetic. The same CAS # 57-06-7 is used for both natural and synthetic AITC. It is a colorless or pale yellow liquid substance, with a very pungent odor.

In the petition, the petitioner provides a significant amount of information to justify how similar their synthetic substance and the natural substance are in final material composition and breakdown. In comparison the petitioned synthetic form can move in multiple directions within the soil and is readily active upon application. While, the natural source of AITC, such as mustard seed meal, green manuring (from tilling in a mustard plant cover crop), rice bran, etc. must rely upon its organic matter to first breakdown before the AITC can become active.

In the petition it is stated that there is only enough organic AITC formulated annually to treat about 1,000 acres. The petitioner claims that their target would be to treat 200,000 acres of crop land eventually. Synthetic AITC is not allowed in any other organic crop production systems in the world according to the information provided in the TR.

One concern is the impact on soil microbial health and ecosystem biodiversity. The concern is that this material is non-selective by nature and thus could potentially have a negative impact on beneficial soil organisms, fungi, and beneficial insects. The petitioner claims that this should not be an issue if the

material label instructions for use are followed and references the comparison of crops treated and production yield of those crops not treated, with AITC pre-plant as to why this is a material that can assist organic crop production. They say that it actually provides a healthy soil condition, which is better for plant health, crop growth and production yield.

There are a number of alternative materials and farming practices currently available for use in organic crop production. Another key question is whether or not a synthetic bio-fumigant is consistent with organic farming principles. In conventional farming soil fumigation for both pre-planting and replanting situations occur for a variety of cropping systems.

Evaluation Criteria (see attached checklist for criteria in each category)

	Criteria Satisfied?		
1. Impact on Humans and Environment	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
2. Essential & Availability Criteria	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	<input type="checkbox"/> N/A
3. Compatibility & Consistency	<input type="checkbox"/> Yes	<input checked="" type="checkbox"/> No	<input type="checkbox"/> N/A

Substance Fails Criteria Category: [] **Comments:**

Subcommittee Action & Vote, including classification proposal (state actual motion):

Classification Motion: Move to classify Allyl Isothiocyanate as synthetic.

Motion by: Harold Austin

Seconded by: Francis Thicke

Yes: 5 No: 0 Absent: 2 Abstain: 0 Recuse: 0

Listing Motion: Move to add Allyl Isothiocyanate to the National List under §205.601 Synthetic substance allowed for use in organic crop production.

Motion by: Harold Austin

Seconded by: Colehour Bondera

Yes: 0 No: 5 Absent: 2 Abstain: 0 Recuse: 0

Proposed Annotation (if any): none

Approved by Zea Sonnabend, Subcommittee Chair, to transmit to NOSB February 25, 2015

NOSB Evaluation Criteria for Substances Added To the National List: Crops

Category 1. Adverse impacts on humans or the environment?

Allyl Isothiocyanate

Question	Yes	No	N/A	Comments/Documentation (TAP; petition; regulatory agency; other)
1. Is there a probability of environmental contamination during use or misuse? [§6518(m)(3)]	X			The TR (Oct. 3, 2014) lines 433-435 states: considering its moderately high volatility (3.7mm Hg at 25°C), high application rates (85-340lbs/acre), and agricultural use as a soil fumigant, releases of allyl isothiocyanate into the environment are inevitable. AITC is both flammable and potentially toxic to non-target organisms such as mammals and fish. "Because AITC is a volatile organic compound and has the potential to cause irritation and systemic toxicity, exposure of and potential adverse effects on non-target receptors (humans and wildlife) is likely considering its proposed use pattern as a pre-plant soil biofumigant at the application rates proposed (85–340 lbs/acre)." (TR lines 304-309)
2. Is there a probability of environmental contamination during, manufacture or disposal? [§6518(m)(3)]	X			The TR (Oct 3, 2014) lines 443-447 states: The release of chemical reagents (e.g. allyl iodide and potassium thiocyanate) and highly toxic, flammable and hazardous solvents (e.g. 1,2-dichloroethane) used in the production of AITC due to improper handling/disposal could lead to serious environmental impairments and ecotoxicity in both terrestrial and aquatic environments (Sigma Aldrich, 2014b). No reports of such releases have been reported to date.
3. Are there any adverse impacts on biodiversity? (§205.200)	X			AITC may have an impact on certain fungi that produce mutualistic relationships with plants and prey on insect pests (Cantor, 2011; Vaicekonyte, 2012) TR lines 561-563. Exposure to livestock, birds, freshwater fish, freshwater invertebrates, non-target plants, and non-target insects is not expected based on the application methods proposed and the rapid environmental degradation of AITC. AITC does not specifically target soil pests; rather, AITC is a broad-spectrum antimicrobial compound that effectively kills both plant pathogens and beneficial

				soil microorganisms. Additionally, it is known that certain species of soil fungi enhance the bioavailability of organic soil nutrients and mediate the uptake of these nutrients by their mycorrhiza host plants (Näsholm, 2009). AITC drift would therefore be problematic for both the beneficial soil fungi and associated plants.” (TR lines 503-510)
4. Does the substance contain inerts classified by EPA as ‘inerts of toxicological concern’? [§6517 (c)(1)(B)(ii)]		X		
5. Is there potential for detrimental chemical interaction with other materials used in organic farming systems? [§6518(m)(1)]	X			TR (Oct 3, 2014) lines 467-475 says- One possible interaction between the petitioned substance and other materials used in organic crop production involves the reaction of AITC with free amino acids, peptides, and proteins contained in organic composts and fertilizers. Diminished enzymatic digestibility was documented for some of the resulting protein-AITC adducts: however, it is uncertain how these chemical transformation products might affect the absorption and metabolism of amino acid building blocks in plants.
6. Is there a toxic or other adverse action of the material or its breakdown products? [§6518(m)(2)]	X			TR (Oct 3, 2014) lines 404-407 & 409-412 says: One of the degradation products of AITC is carbon disulfide, CS ₂ (CDS). There are concerns regarding exposure to CDS because it is listed by the State of California on the Proposition 65 List as a developmental toxicant (OEHHA, 2014) and is known to induce neuropathological changes and other toxic effects in rodents (OEHHA, 2001). The petitioner does state that CDS is naturally occurring in the environment, and is released from tree roots, tidal marshes, and soil. It is considered ubiquitous in the environment. “Data are lacking on inhalation toxicity; however, the structural similarity of AITC to methyl isothiocyanate (MITC; CH ₃ N=C=S) and known irritant properties of AITC (see Evaluation Question #10 below) would indicate that inhalation toxicity may be a concern.” TR lines 546-549 “The release of chemical reagents (e.g., allyl iodide and potassium

				thiocyanate) and highly toxic, flammable and hazardous solvents (e.g., 1,2-dichloroethane) used in the production of AITC due to improper handling/disposal could lead to serious environmental impairments and ecotoxicity in both terrestrial and aquatic environments.” TR lines 554-559
7. Is there persistence or concentration of the material or breakdown products in the environment? [§6518(m)(2)]		X		TR (Oct 3, 2014) lines 537-538 says that, soil decomposition half-lives for AITC range from 20 to 60 hours, with higher rates of AITC degradation in soils with high organic carbon and total nitrogen contents. Line 540 – it rapidly dissipates in water due to facile hydrolysis and volatilization from the water surface.
8. Would the use of the substance be harmful to human health or the environment? [§6517 (c)(1)(A)(i); §6517 (c)(2)(A)(i); §6518(m)(4)]	X			TR (Oct 3, 2014) line 545 – AITC is classified as an eye and skin irritant and is moderately acutely toxic to mammals via the oral route of exposure. Line 551-552 – In comparison to moderate acute oral toxicity in mammals, AITC is highly toxic to aquatic organisms, such as fish and aquatic invertebrates. Lines 560-563 in addition to targeting soil pathogens, insects, and weeds, AITC is also toxic to fungi that produce mutualistic relationships with plants and prey on pest insects (Cantor, 2011; Vaicekonyte, 2012). The petitioner states that U.S.EPA has considered human exposure to AITC to be light and determined that no unreasonable adverse effects to the U.S. population in general when label instructions are followed.
9. Are there adverse biological and chemical interactions in the agro-ecosystem? [§6518(m)(5)]		X		The TR (Oct 3, 2014) line 484-485 says – the available literature suggests the risk of impairment is minimal when label instructions and precautions are followed. See responses to questions 3, 5, 6, and 8 above, which document adverse chemical and biological interactions.
10. Are there detrimental physiological effects on soil organisms, crops, or livestock? [§6518(m)(5)]	X			TR (Oct 3, 2014) Line 511 – In addition to soil microorganisms, plants insect pests, and animal have demonstrated varying responses to AITC soil treatments. Lines 488-489 – Toxicity of AITC to soil-dwelling organisms is well documented in the scientific literature due to use of the substance as a pre-plant soil biofumigant. Lines 483-485 The petitioner claims that

				<p>AITC does not kill everything in the soil, but instead serves to provide a healthier environment in the soil that is in fact beneficial to plant growth with minimal to no negative impact on crop growth or those organisms that survive and thrive once the favorable soil environment is established post application. TR lines 505-510 indicates that there are detrimental effects: “These reports provide direct evidence that AITC does not specifically target soil pests; rather, AITC is a broad-spectrum antimicrobial compound that effectively kills both plant pathogens and beneficial soil microorganisms. Additionally, it is known that certain species of soil fungi enhance the bioavailability of organic soil nutrients and mediate the uptake of these nutrients by their mycorrhiza host plants (Näsholm, 2009). AITC drift would therefore be problematic for both the beneficial soil fungi and associated plants.”</p>
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Category 2. Is the Substance Essential for Organic Production? Allyl Isothiocyanate

Question	Yes	No	N/A	Comments/Documentation (TAP; petition; regulatory agency; other)
1. Is the substance agricultural? [§6502(1)]		X		Some forms could be considered to be agricultural, but not the petitioned material.
2. Is the substance formulated or manufactured by a chemical process? [§6502(21)]	X			The petitioned substance is produced using chemical synthetic methods. AITC is produced on an industrial scale by reaction of allyl iodide with potassium thiocyanate, in a two-phase solvent system comprised of water and 1,2-dichloroethane(Scheme2)(Romanowski, 2000).
3. Is the substance formulated or manufactured by a process that chemically changes a substance extracted from naturally occurring plant, animal, or mineral sources? [§6502(21)]	X			TR (lines 292-295) – industrial sources of AITC are produced through chemical synthesis, and would therefore be considered synthetic due to the application of synthetic chemicals (reagents and solvents) in both the production as well as the purification/processing of crude AITC. [So the answer is No.]

4. Is the substance created by naturally occurring biological processes? [§6502(21)]		X		<i>In situ</i> production of AITC from mustard and related cover crops or mustard seed meals constitute a natural (nonsynthetic) process. The petitioned material is not.
5. Is there a natural source of the substance? [§ 205.600(b)(1)]	X			Mustard seed meal, composting of mustard greens (kale, cabbage, horseradish) can be used to create a natural source of AITC.
6. Is there an organic substitute? [§205.600(b)(1)]	X			<i>Actinovate (S.lydicus)</i> is a bacteria. . Also there is a beneficial nematode available – <i>Heterorhabditis bacteriophora</i> . <i>Mustard seed meals, mustard green manures (worked into the soil) can be used as a biofumigant.</i>
7. Is there a wholly natural substitute product? [§6517(c)(1)(A)(ii)]	X			Mustard green manures or seed meals (worked into the soil) can be used as a biofumigant. Mustard meal.
8. Are there any alternative substances? [§6518(m)(6)]	X			Mustard seed meals, mustard green manures (plowed cover crop), Regalia (OMRI approved material) is a biopesticide that is available. SoilGard (<i>Trichoderma virens</i>) is a fungal biocontrol material. Serenade (<i>Bacillus subtilis</i> strain 713), Bionematicide Melocon (<i>Paecilomyces lilacinus</i> and <i>Gliocladium</i>) are also possible alternative materials available for use in organic crop production systems.
9. Are there other practices that would make the substance unnecessary? [§6518(m)(6)]	X			Crop rotation and soil nutrient management can help. Cultural practices the enhance crop health. For pest problems: introduction of predators or parasites of a pest species, lures, traps and/or repellants. For weed control: mulching, flaming, mowing, hand or mechanical weeding are some examples of practices currently in use. Also, the tilling in of mustard plant cover crops to create a green manure is currently being used and could be considered as a viable option.

Category 3. Is the substance compatible with organic production practices? Allyl Isothiocyanate

Question	Yes	No	N/A	Comments/Documentation (TAP; petition; regulatory agency; other)
1. Is the substance consistent with organic farming and handling? [§6517(c)(1)(A)(iii); 6517(c)(2)(A)(ii)]		X		
2. Is the substance compatible with a system of sustainable agriculture? [§6518(m)(7)]		X		
3. If used in livestock feed or pet food, Is the nutritional quality of the food maintained with the substance? [§205.600(b)(3)]				
4. If used in livestock feed or pet food, Is the primary use as a preservative? [§205.600(b)(4)]				
5. If used in livestock feed or pet food, Is the primary use to recreate or improve flavors, colors, textures, or nutritive value lost in processing (except when required by law)? [§205.600(b)(4)]				
6. Is the substance used in production, and does it contain an active synthetic ingredient in the following categories: [§6517(c)(1)(B)(i); copper and sulfur compounds	X			AITC contains a single sulfur atom in its molecular formula, so it could be considered a sulfur compound by definition.
toxins derived from bacteria				
pheromones, soaps, horticultural oils, fish emulsions, treated seed, vitamins and minerals				
livestock parasiticides and medicines				
production aids including netting, tree wraps and seals, insect traps, sticky barriers, row covers, and equipment cleansers				