MRID: 51808901

202200004

TITLE

Petition for 3 Years Extension of Exclusive Data Use for Ethaboxam as Provided for Under FIFRA Section 3(c) (1) (F) (ii)

TEST GUIDELINE

None

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STUDY COMPLETION DATE

2022-02-21

PERFORMING LABORATORY

Valent U.S.A. LLC

4600 Norris Canyon Road

San Ramon, CA. 94583 U.S.A/

LABORATORY PROJECT ID

V-202200004

TOTAL PAGES

19

NO CLAIM OF CONFIDENTIALITY

No claim of confidentiality, on any basis whatsoever, is made for any information contained in this document. I acknowledge that information not designated as within the scope of FIFRA sec. 10(d)(1)(A), (B) or (C) and which pertains to a registered or previously registered pesticide is not entitled to confidential treatment and may be released to the public, subject to the provisions regarding disclosure to multinational entities under FIFRA sec. 10(g).

Company: Valent U.S.A. LLC

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Signature: ______________________________

Date: _____Feb 14, 2022_____________

GLP COMPLIANCE STATEMENT

This study does not fall under the Good Laboratory Practice Standards set forth in 40 CFR Part 160 of the Code of Federal Regulations.

- No new data were generated.

Sponsor/Submitter:

Date: February 14, 2022

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1.0 Introduction

Valent U.S.A. LLC, hereby petitions EPA to extend by 3 years the period of exclusive data use for Ethaboxam fungicide by applying the provision of FIFRA Section 3(c) (1) (F) (ii).

FIFRA Section 3(c) (1) (F) (ii) states that:

The period of exclusive data use provided under clause (i) shall be extended 1 additional year for each 3 minor uses registered after the date of the enactment of this clause and within 7 years of the commencement of the exclusive use period, up to a total of 3 additional years for all minor uses registered by the Administrator if the Administrator, in consultation with the Secretary of Agriculture, determines that, based on the information provided by an applicant for registration or a registrant, that –

> *(I) there are insufficient efficacious alternative registered pesticides available for the use;*
> *(II) the alternatives to the minor use pesticide pose greater risks to the environment or human health;*
> *(III) the minor use pesticide plays or will play a significant part in managing pest resistance; or*
> *(IV) the minor use pesticide plays or will play a significant part in an integrated pest management program.*

<u>Ethaboxam Registrations</u>

Ethaboxam Technical (EPA Reg. No. 59639-185) and the end-use products AP2™ Fungicide (59639-186) were first granted US registrations on March 04, 2014. The end-use product V-10208 4 SC Fungicide (59639-211) was granted US registration on August 3, 2017.

Currently registered (as of February 14, 2022) foliar uses and seed treatment uses are:

- Tuberous and Corm Vegetables (Subgroup 1C)
- Ginseng
- Legume Vegetables (Succulent or Dried) (Crop Group 6)
- Cucurbit Vegetables (Crop Group 9)
- Pepper/Eggplant (Subgroup 8-10B)
- Cereal Grains (Crop Group 15, except rice and wild rice)
- Rapeseed (Subgroup 20A)
- Sunflower (Subgroup 20B)
- Sugar Beet

2.0 Ethaboxam Minor Use Crop Candidates and Raw Agricultural Commodity (RAC) Residue / Radiotracer Data

It is our understanding that non-food seed treatment uses on crops supported by radiotracer residue studies have not been used in the past in exclusive use extension petitions. However, previous communication between Valent and Marion Johnson, who was the Chief of Minor Use and Emergency Response Branch in 2016, confirmed that there is no reason to preclude non-food seed treatment radiotracer residue data for minor uses from being used to support exclusive use extension petitions. A copy of this communication is attached for your reference in Appendix 1.

RAC residue / radiotracer studies were conducted in crops and the crop group representative crops, including major and minor groups, to support numerous minor crops on which ethaboxam is currently registered. Table 1 shows the minor use crop candidates included in this petition for extension of exclusive use of data and the corresponding RAC residue / radiotracer data used to support the registration of these minor crops.

Therefore, RAC residue / radiotracer studies supporting registration are available for 12 minor use crop candidates. In addition, several minor use registrations supported by residue data generated on representative crops for crop group tolerances are given in Table 1.

All the minor use crop candidates were registered within the requisite seven year period (prior to March 04, 2021) and added to the ethaboxam technical fungicide label.

Table 1: Ethaboxam Minor Use Crop Candidates

Candidate No.	Crop Candidate	2017 Acres[1]	RAC Residue Data to Support	Radio-tracer Data to Support	MRID #	IR-4 Data	Date Registered	Crop Group No.	Document Section Number
1	Ginger	266	Potato		49489934	PR# 11113	August 03, 2017	1C	3.0
2	Ginseng	1,050	Ginseng		49489933	PR# 10682	August 03, 2017	1A	4.0
3	Lima beans	21,557		Soybean	48535676		March 04, 2014	6	5.0
4	Bell pepper	48,801	Bell pepper		49489930	PR# 10650	August 03, 2017	8B	6.0
5	Non-bell pepper	24,165	Non-bell pepper		49489930	PR# 10650	August 03, 2017	8C	7.0
6	Summer squash	37,449	Summer squash		49489929	PR# 10649	August 03, 2017	9	8.0
7	Cucumber	119,655	Cucumber		49489931	PR# 10651	August 03, 2017	9	9.0
8	Cantaloupe	71,436	Cantaloupe		49489932	PR# 10652	August 03, 2017	9A	10.0
9	Buckwheat	27,792		Wheat	48535676		March 04, 2014	15	11.0
10	Popcorn	221,264		Corn	48535676		March 04, 2014	15	12.0
11	Rapeseed	10,655		Canola	48535676		March 04, 2014	20A	13.0
12	Safflower	144,027		Sunflower	49490202		June 23, 2016	20B	14.0

[1]2017 Census of Agriculture.

RAC residue / radiotracer studies supporting registration are available for 12 minor crops, thus qualifying ethaboxam for a 3-year extension of data exclusivity (1 year for each of 3 minor crops up to a maximum of 3 years) provided that the other criteria listed below are met.

Table 2. Summary of the Criteria Met by Each of the Minor Use Crop Candidates

Candidate No.	Candidate Crop	Key Fungal Diseases	Criteria				Document Section No.
			I	II	III	IV	
1	Ginger	*Pythium* spp.			✓		3.0
2	Ginseng	*Phytophthora cactorum*			✓		4.0
3	Lima beans	*Pythium* spp.			✓		5.0
4	Bell pepper	*Phytophthora capsici*			✓		6.0
5	Non-bell pepper	*Phytophthora capsici*			✓		7.0
6	Summer squash	*Pseudoperonospora cubensis* and *Phytophthora capsici*			✓		8.0
7	Cucumber	*Pseudoperonospora cubensis* and *Phytophthora capsici*			✓		9.0
8	Cantaloupe	*Pseudoperonospora cubensis* and *Phytophthora capsici*			✓		10.0
9	Buckwheat	*Pythium* spp.			✓		11.0
10	Popcorn	*Pythium* spp.			✓		12.0
11	Rapeseed	*Pythium* spp.			✓		13.0
12	Safflower	*Pythium* spp.	✓		✓		14.0

Criteria:

(I) There are insufficient efficacious alternative registered pesticides available for the use;
(II) The alternatives to the minor use pesticide pose greater risks to the environment or human health;
(III) The minor use pesticide plays or will play a significant part in managing pest resistance; or
(IV) The minor use pesticide plays or will play a significant part in an integrated pest management program.

<u>Meeting the Criteria for Extension of the Period of Exclusive Data Use</u>

Details of how ethaboxam meets the exclusivity criteria for various minor uses are described below. Each section gives 1) the acreage for the particular crop(s) and the pest/crop problems; 2) the justification of how ethaboxam meets the criteria for the particular use; and 3) appropriate references for that section.

3.0 Justification for Ethaboxam Minor Use on Ginger

According to the 2017 USDA NASS Census of Agriculture for Hawaii, production acres of ginger totaled 157 acres in Hawaii (15). Minimum information is available regarding the value of cultivated ginger in the US. Oomycete plant diseases can become problematic in ginger production. Rhizome rot or Pythium soft rot caused by *Pythium aphanidermatum*, *P. vexans*, and *P. myriotylum* can stunt plant growth, yellow leaves and stem, brown discoloration of water-conducting stem tissues, and rotting of the rhizome and the root system (16, 17). All of these result in yield loss (16, 17). As many as fifteen Pythium spp. have been implicated as causal agents (17). These *Pythium* spp. favor warm, moist soils and spread through infected seed pieces, which often are asymptomatic in appearance (16). All stages of development are susceptible, including postharvest (17).

3.1 Justification to Meet Criteria

> *(III) The minor use pesticide plays or will play a significant part in managing pest resistance;*

Conventional fungicides labeled for use against Pythium soft rot on ginger include mefenoxam + oxathiapiprolin (FRAC xx + 49), fluopicolide (FRAC 43), azoxystrobin (FRAC 11), and metalaxyl (FRAC 4). A number of biopesticides based on microorganisms such as *Streptomyces* spp., *Bacillus* spp. and *Trichoderma* spp. (examples: Actinovate, Serenade, and RootShield) also have labels for these diseases; however, these products are purely preventative in their recommended uses and require a tank-mix or alternation with another registered product when disease pressure is high (18). Potassium phosphite-based products are labeled for Pythium control but suffer from the same limitations as biopesticides.

No known fungicide resistance exists for ethaboxam (FRAC group 22) outside of lab created mutations (6). Furthermore, zoxamide + chlorothalonil (FRAC 22 + M5) is not labeled for control of soilborne diseases, such as Pythium. Therefore, ethaboxam is an ideal candidate for inclusion in resistance management programs, especially in regard to soilborne diseases.

3.2 References

1. 2017 Census of Agriculture, Hawaii State and County Data. 2019. United States Department of Agriculture National Agricultural Statistics Service.
2. Ginger. Plant Village, Pennsylvania State University publication. https://plantvillage.psu.edu/topics/ginger/infos
3. Le, D., Smith, M., Hudler, G., and Aitken, E. 2014. Pythium soft rot of ginger: detection and identification of the causal pathogens, and their control. Crop Protection. 65:153-167.
4. CDMS Label Search. 2022. Ginger, United States, Fungicides. http://www.cdms.net.

4.0 Justification for Ethaboxam Minor Use on Ginseng

According to the most recent USDA NASS Census of Agriculture, production acres of ginseng totaled 1,050 acres, with 91% of production concentrated in Wisconsin (10). Production in New York, Tennessee, and North Carolina were also reported (10). Ginseng is considered to be a valuable crop in the US, and cultivated plantations require strict environmental conditions, including shaded areas and moist soil (13). These conditions are also ideal for certain Oomycete plant diseases such as Phytophthora leaf blight and root rot caused by *Phytophthora cactorum*. Plants of any age can be affected. By the time the first symptoms of wilting and/or discoloration of foliage are expressed, much damage is already done. Once infected, little can be done to save an individual plant, and the focus must pivot to protecting adjacent, uninfected plants. Left untreated, *P. cactorum* will spread throughout the entire ginseng bed, and the entire crop will be destroyed (11). With a 3-4 year growth cycle, this kind of loss is particularly devastating to growers (11). Phytophthora on ginseng is most active during wet periods.

4.1 Justification to Meet Criteria

> *(III) The minor use pesticide plays or will play a significant part in managing pest resistance;*

Conventional fungicides labeled for use against Oomycete diseases of ginseng that provide good efficacy include fluopicolide (FRAC group 43), oxathiapiprolin (FRAC group 49), mandipropamid (FRAC group 10), oxathiapiprolin + chlorothalonil (FRAC groups 49 + M5), metalaxyl (FRAC group 4), and zoxamide + chlorothalonil (FRAC groups 22 + M5) (2). Fungicide resistance is documented in *P. cactorum* against mefenoxam (12).

A number of biopesticides based on microorganisms such as *Streptomyces* spp., *Bacillus* spp. and *Trichoderma* spp. (examples: Actinovate, Double Nickel, Bio-Tam, and Tenet) also have labels for these diseases; however, these products are purely preventative in their recommended uses and require a tank-mix or alternation with another registered product when disease pressure is high (14). Potassium phosphite-based products are labeled for the combination of downy mildew, Pythium root rot, and Phytophthora root rot but suffer from the same limitations as biopesticides.

No known fungicide resistance exists for ethaboxam (FRAC group 22) outside of lab created mutations (6). Furthermore, zoxamide + chlorothalonil (FRAC 22 + M5) is not labeled for control of soilborne diseases, such as Phytophthora. Therefore, ethaboxam is an ideal candidate for inclusion in resistance management programs, especially in regard to soilborne diseases.

4.2 References

1. 2017 Census of Agriculture. 2019. United State Department of Agriculture National Agricultural Statistics Service publication. AC-17-A-51.
2. Hausbeck, M. 2019. Control of Diseases, Pests, and Weeds in Cultivated Ginseng. Michigan State University, Ginseng Bulletin. https://veggies.msu.edu/wp-content/uploads/2019/09/GinsengBulletin.pdf
3. Hill, S. and Hausbeck M. 2008. Virulence and Fungicide Sensitivity of *Phytophthora cactorum* Isolated from American Ginseng Gardens in Wisconsin and Michigan. Plant Disease 92:1183-1189.
4. History and Cultivation of Ginseng. 2017. Penn State University Extension publication. https://extension.psu.edu/history-and-cultivation-of-ginseng
5. CDMS Label Search. 2022. Ginseng, United States, Fungicides. http://www.cdms.net.

5.0 Justification for Ethaboxam Minor Use on Lima beans

Reported acres of lima beans (dry) in the U.S. were reported to be slightly over 21,500 in 2017 (1), with the majority of processing beans being grown in California, Idaho, and Washington. Seedling diseases caused by *Pythium* spp., belonging to the Oomycetes class of pathogens, are common in lima bean production areas, particularly where soil moisture is high due to excess rainfall or irrigation, or poor drainage. Losses in these areas to Pythium root rot can approach 100% under favorable conditions. Key management steps include crop rotation, planting when soil temperatures favor rapid germination, use of high-quality seed, and seed treatment fungicides. The latter are a key part of an integrated management system for bean seedling diseases (2).

5.1 Justification to meet criteria

The majority of seed treatment fungicides used in dry beans rely on FRAC Group 4 (metalaxyl and mefenoxam) fungicides for control of *Pythium* diseases, and there are several biopesticides based on *Bacillus subtilis* or *Bacillus amyloliquifaciens* registered for use as seed treatments on lima beans (3). Biologicals alone in seed treatments generally do not perform as well as synthetic counterparts; however, they are useful for organic growers and provide some growth-promotion benefits for both conventional and organic growers (4). Continuous use of FRAC 4 fungicides as seed treatments has led to the emergence of metalaxyl/mefenoxam-resistant strains of *Pythium* (5) in a number of crops, including soybean, resulting in reduced efficacy.

Scott et. al (5) demonstrated that the addition of ethaboxam to FRAC 4 seed treatments provided good efficacy against *Pythium* and other Oomycete pathogens, and that ethaboxam aids in disease control where these resistant strains are present and also to help manage the appearance of metalaxyl/mefenoxam resistance in areas where FRAC 4 fungicides are still effective. Thus, ethaboxam is a useful tool for growers to manage fungicide resistance in seedling disease programs.

5.2 References

1. 2017 Census of Agriculture. 2019. United State Department of Agriculture National Agricultural Statistics Service publication. AC-17-A-51.
2. Schwartz, H.F. 2011. Root Rots of Dry Beans. Fact Sheet 2.938. Colorado State University. URL: https://extension.colostate.edu/docs/pubs/crops/02938.pdf.
3. CDMS Label Search. 2022. Lima Bean, United States, Fungicides. http://www.cdms.net.
4. Bradley, C.A. 2008. Effect of fungicide seed treatments on stand establishment, seedling disease, and yield of soybean in North Dakota. Plant Dis. 92:120-125.
5. Scott, K.E., Eyre, M.E., McDuffee, D. and Dorrance, A.E. 2020. The efficacy of ethaboxam as a soybean seed treatment for *Phytophthora*, *Phytopythium*, and *Pythium* in Ohio. Plant Dis. 104:1421-1432.

6.0 Justification for Ethaboxam Minor Use on Bell Pepper

According to the USDA NASS Vegetable Summary of 2019, production acres of all bell pepper totaled 39,200 acres, with nearly 80% of production conducted in California, Florida, and Georgia (1). Total value of US bell pepper production is estimated at over $557 million per year (1). Diseases of bell pepper caused by the Oomycete class of plant pathogens are destructive in certain years or environments and include Phytophthora blight caused by *Phytophthora capsici*. Infection cause plant collapse and rapid death; all plant stages can be infected (19). Fruit infections are common, causing unacceptable soft and mushy textures. *P. capsici* overwinters in soil and can persist for over 10 years, making control more difficult and can survive on seed (19, 20). Once established, *P. capsici* is nearly impossible to remove (20).

6.1 Justification to Meet Criteria

> *(III) The minor use pesticide plays or will play a significant part in managing pest resistance;*

Conventional fungicides labeled for use against Oomycete diseases of bell pepper that provide good efficacy include oxathiapiprolin (FRAC 49), oxathiapiprolin + mandipropamid (FRAC 49 + 40), fluopicolide (FRAC 43), mandipropamid (FRAC 40), mefenoxam (FRAC 4), and mefenoxam + copper (FRAC 4 + M1). Fungicide resistance concerns have been reported in *P. capsici* against mefenoxam and mefenoxam + copper (19).

A number of biopesticides based on microorganisms such as *Streptomyces* spp., *Bacillus* spp. and *Trichoderma* spp. (examples: Actinovate, Double Nickel, Bio-Tam, and Tenet) also have labels for these diseases; however, these products are purely preventative in their recommended uses and require a tank-mix or alternation with another registered product when disease pressure is high (21). Potassium phosphite-based products are labeled for the combination of downy mildew, Pythium root rot, and Phytophthora root rot but suffer from the same limitations as biopesticides.

No known fungicide resistance exists for ethaboxam (FRAC group 22) outside of lab created mutations (6). Furthermore, zoxamide + chlorothalonil (FRAC 22 + M5) is not labeled for control of soilborne diseases, such as Phytophthora. Therefore, ethaboxam is an ideal candidate for inclusion in resistance management programs, especially in regard to soilborne diseases.

6.2 References

1. Hausbeck, M., Krasnow, C., and Linderman, S. 2021. Managing Phytophthora on Pepper. Michigan State University publication. https://veggies.msu.edu/wp-content/uploads/2018/07/FS_Managing-Phytophthora-on-Pepper.pdf
2. Hansen, Z., Siegenthaler, T. and Swafford, A. 2019. Managing Phytophthora Blight of Peppers and Cucurbits. March 2019. University of Tennessee Extension publication. https://extension.tennessee.edu/publications/documents/w810.pdf
3. CDMS Label Search. 2022. Bell Pepper, United States, Fungicides. http://www.cdms.net.

7.0 Justification for Ethaboxam Minor Use on Non-Bell Pepper

According to the USDA NASS Vegetable Summary of 2019, production acres of all non-bell pepper totaled 10,600 acres, with nearly all of production conducted in New Mexico and California (1). Total value of US non-bell pepper production is estimated at over $63 million per year (1). Diseases of pepper caused by the Oomycete class of plant pathogens are destructive in certain years or environments and include Phytophthora blight caused by *Phytophthora capsici*. Infection cause plant collapse and rapid death; all plant stages can be infected (2). Fruit infections are common, causing unacceptable soft and mushy textures. *P. capsici* overwinters in soil and can persist for over 10 years, making control more difficult and can survive on seed (19, 20). Once established, *P. capsici* is nearly impossible to remove (20).

7.1 Justification to Meet Criteria

> *(III) The minor use pesticide plays or will play a significant part in managing pest resistance;*

Conventional fungicides labeled for use against Oomycete diseases of non-bell pepper that provide good efficacy include oxathiapiprolin (FRAC 49), oxathiapiprolin + mandipropamid (FRAC 49 + 40), fluopicolide (FRAC 43), mandipropamid (FRAC 40), mefenoxam (FRAC 4), and mefenoxam + copper (FRAC 4 + M1). Fungicide resistance concerns have been reported in *P. capsici* against mefenoxam and mefenoxam + copper (19).

A number of biopesticides based on microorganisms such as *Streptomyces* spp., *Bacillus* spp. and *Trichoderma* spp. (examples: Actinovate, Double Nickel, Bio-Tam, and Tenet) also have labels for these diseases; however, these products are purely preventative in their recommended uses and require a tank-mix or alternation with another registered product when disease pressure is high (22). Potassium phosphite-based products are labeled for the combination of downy mildew, Pythium root rot, and Phytophthora root rot but suffer from the same limitations as biopesticides.

No known fungicide resistance exists for ethaboxam (FRAC group 22) outside of lab created mutations (6). Furthermore, zoxamide + chlorothalonil (FRAC 22 + M5) is not labeled for control of soilborne diseases, such as Phytophthora. Therefore, ethaboxam is an ideal candidate for inclusion in resistance management programs, especially in regard to soilborne diseases.

7.2 References

1. CDMS Label Search. 2022. Pepper, United States, Fungicides. http://www.cdms.net.

8.0 Justification for Ethaboxam Minor Use on Summer Squash

According to the USDA NASS Vegetable Summary of 2019, production acres of all squash totaled 45,000 acres, with over 50% of production conducted in Michigan, Florida, and California (1). Total value of US squash production is estimated at nearly $220 million per year (1). Diseases caused by the Oomycete class of plant pathogens are destructive in certain years or environments and include downy mildew and Phytophthora blight. While Cucurbit downy mildew caused by *Psuedoperonospora cubensis* rarely infects squash fruit, severe foliar infections can lead to fruit that fails to color properly, becomes sunburned, and usually is tasteless (3). Cool temperatures, around 60 °F, high humidity and/or moisture conditions foster Cucurbit downy mildew development (4). This pathogen overwinters on plants in the southern US and in greenhouses. Fungicides are required for control (4). Yellow squash is especially susceptible to Phytophthora blight caused by *Phytophthora capsici* (5). Phytophthora blight causes plant collapse and rapid death; all plant stages can be infected. *P. capsici* overwinters in soil and can persist for over 10 years, making control more difficult (5). Yellow squash is especially susceptible to Phytophthora blight caused by *Phytophthora capsici* (5).

8.1 Justification to Meet Criteria

(III) The minor use pesticide plays or will play a significant part in managing pest resistance;

Conventional fungicides labeled for use against Oomycete diseases that provide good efficacy (offering 85-100% control) include propamocarb (FRAC 28), zoxamide + chlorothalonil (FRAC 22 + M5), cyazofamid (FRAC 21), fluazinam (FRAC 29), oxathiapiprolin (FRAC 49), oxathiapiprolin + mandipropamid (FRAC 49 + 40), fluopicolide (FRAC 43), and mandipropamid (FRAC 40), and cymoxanil (FRAC 27). (2, 3, 5). Recommendations cite a need for fungicide applications to be made on a 7-10 day interval for adequate control of Cucurbit downy mildew, requiring as many as eight fungicide applications per season (4, 5).

Fungicide resistance in Cucurbit downy mildew has been confirmed in FRAC groups 4, 11, 28, 40, and 43 (3). Many other labeled fungicides have a single-site mode of action and are, therefore, at risk for development of resistance (7). These products require users to adhere to resistance management tactics that include tank-mixing or alternation with a different mode of action (designated by FRAC grouping). Two clades of *P. cubensis* exist with pathotypes within each one. The pathotypes have different levels of pathogenicity on different crops and differing levels of fungicide resistance (3, 4).

Several biopesticides based on microorganisms such as *Streptomyces* spp., *Bacillus* spp. and *Trichoderma* spp. (examples: Actinovate, Serenade, and Tenet) also have labels for these diseases; however, these products are purely preventive in their recommended uses and require a tank-mix or alternation with another registered product when disease pressure is high (7). Potassium phosphite-based products are labeled for the combination of downy mildew, Pythium root rot, and Phytophthora root rot but suffer from the same limitations as biopesticides.

No known fungicide resistance exists for ethaboxam (FRAC group 22) outside of lab created mutations (6). Furthermore, zoxamide + chlorothalonil (FRAC 22 + M5) is not labeled for control of soilborne diseases, such as Phytophthora. Therefore, ethaboxam is an ideal candidate for inclusion in resistance management programs, especially in regard to soilborne diseases.

8.2 References

1. Vegetables 2019 Summary. 2020. United States Department of Agriculture National Agricultural Statistics Service publication. ISSN: 0884-6413.
2. Cucurbit Downy Mildew Fungicide Efficacy in Ohio 2018-2020 and Recommendations for 2021. 2021. Vegnet Newsletter, The Ohio State University. https://u.osu.edu/vegnetnews/2021/06/19/cucurbit-downy-mildew-fungicide-efficacy-in-ohio-2018-2020-and-recommendations-for-2021/
3. Managing Cucurbit Downy Mildew. 2021. Cornell University publication. https://www.vegetables.cornell.edu/pest-management/disease-factsheets/downy-mildew-of-cucurbits/current-management-guidelines-based-on-research-results/
4. Cucurbit Downy Mildew. 2021. Vegetable Fact Sheets, North Carolina State University publication. https://content.ces.ncsu.edu/cucurbit-downy-mildew#section_heading_1008
5. Managing Phytophthora on Cucumber. 2018. Michigan State University publication. https://veggies.msu.edu/wp-content/uploads/2018/06/FS_Managing-Phytophthora-on-Cucumber.pdf

6. Young, D. 2019. Fungicides acting on mitosis and cell division: Zoxamide, and antitubulin fungicide for control of Oomycete pathogens. Ch. 18 in Modern Crop Protection Compounds, Vol. 3. https://onlinelibrary.wiley.com/doi/10.1002/9783527699261.ch18
7. CDMS Label Search. 2022. Squash, United States, Fungicides. http://www.cdms.net.

9.0 Justification for Ethaboxam Minor Use on Cucumber

According to the USDA NASS Vegetable Summary of 2019, production acres of all cucumber totaled 101,700 acres, with 73% of production conducted in Michigan, Florida, and North Carolina (1). Total value of cucumber production is estimated at over $278 million per year (1). Diseases caused by the Oomycete class of plant pathogens are destructive in certain years or environments and include downy mildew and Phytophthora blight. While Cucurbit downy mildew caused by *Psuedoperonospora cubensis* rarely infects cucumber fruit, severe foliar infections can lead to fruit that fails to color properly, becomes sunburned, and usually is tasteless (3). Cool temperatures, around 60 °F, high humidity and/or moisture conditions foster Cucurbit downy mildew development (2, 4). This pathogen overwinters on plants in the southern US and in greenhouses. Fungicides are required for control (4). Phytophthora blight causes plant collapse and rapid death; all plant stages can be infected. *P. capsici* overwinters in soil and can persist for over 10 years, making control more difficult (8).

9.1 Justification to Meet Criteria

> *(III) The minor use pesticide plays or will play a significant part in managing pest resistance;*

Conventional fungicides labeled for use against Oomycete diseases that provide good efficacy (offering 85-100% control) include propamocarb (FRAC 28), zoxamide + chlorothalonil (FRAC 22 + M5), cyazofamid (FRAC 21), fluazinam (FRAC 29), oxathiapiprolin (FRAC 49), oxathiapiprolin + mandipropamid (FRAC 49 + 40), fluopicolide (FRAC 43), and mandipropamid (FRAC 40), and cymoxanil (FRAC 27). (2, 3, 5). Recommendations cite a need for fungicide applications to be made on a 7-10 day interval for adequate control of Cucurbit downy mildew, requiring as many as eight fungicide applications per season (4, 5).

Fungicide resistance in Cucurbit downy mildew has been confirmed in FRAC groups 4, 11, 28, 40, and 43 (3). Other labeled fungicides have a single-site mode of action and are, therefore, at risk for development of resistance (8). These products require users to adhere to resistance management tactics that include tank-mixing or alternation with a different mode of action (designated by FRAC grouping). Resistance is thought to be worse with cucumber than other Cucurbits. Two clades of *P. cubensis* exist with pathotypes within each one. The pathotypes have different levels of pathogenicity on different crops and differing levels of fungicide resistance (3, 4). For example, clade 1 isolates infect watermelon, pumpkin, and squash while clade 2 isolates infect cucumber and cantaloupe (3). Clade 2 develops fungicide resistance more quickly, which means the fewer fungicides are available for control of Cucurbit downy mildew on cucumber and cantaloupe (4).

Several biopesticides based on microorganisms such as *Streptomyces* spp., *Bacillus* spp. and *Trichoderma* spp. (examples: Actinovate, Serenade, and Tenet) also have labels for these diseases; however, these products are purely preventive in their recommended uses and require a tank-mix or alternation with another registered product when disease pressure is high (8). Potassium phosphite-based products are labeled for the combination of downy mildew, Pythium root rot, and Phytophthora root rot but suffer from the same limitations as biopesticides.

No known fungicide resistance exists for ethaboxam (FRAC group 22) outside of lab created mutations (6). Furthermore, zoxamide + chlorothalonil (FRAC 22 + M5) is not labeled for control of soilborne diseases, such as Phytophthora. Therefore, ethaboxam is an ideal candidate for inclusion in resistance management programs, especially in regard to soilborne diseases.

9.2 References

1. CDMS Label Search. 2022. Cucumber, United States, Fungicides. http://www.cdms.net.

10.0 Justification for Ethaboxam Minor Use on Cantaloupe

According to the USDA NASS Vegetable Summary of 2019, production acres of all cantaloupe totaled 53,500 acres, with 95% of production conducted in California, Arizona, and Georgia (1). Total value of cantaloupe production is estimated at over $303 million per year (1). Diseases caused by the Oomycete class of plant pathogens are destructive in certain years or environments and include downy mildew and Phytophthora blight. While Cucurbit downy mildew caused by *Psuedoperonospora cubensis* rarely infects fruit, severe foliar infections can lead to fruit that fails to color properly, becomes sunburned, and usually is tasteless (3). Cool temperatures, around 60 °F, high humidity and/or moisture conditions foster Cucurbit downy mildew development (4). This pathogen overwinters on plants in the southern US and in greenhouses. Fungicides are required for control (4). Phytophthora blight causes plant collapse and rapid death; all plant stages can be infected. *P. capsici* overwinters in soil and can persist for over 10 years, making control more difficult (5).

10.1 Justification to Meet Criteria

(III) The minor use pesticide plays or will play a significant part in managing pest resistance;

Conventional fungicides labeled for use against Oomycete diseases that provide good efficacy (offering 85-100% control) include propamocarb (FRAC 28), zoxamide + chlorothalonil (FRAC 22 + M5), cyazofamid (FRAC 21), fluazinam (FRAC 29), oxathiapiprolin (FRAC 49), oxathiapiprolin + mandipropamid (FRAC 49 + 40), fluopicolide (FRAC 43), and mandipropamid (FRAC 40), and cymoxanil (FRAC 27). (2, 3, 5). Recommendations cite a need for fungicide applications to be made on a 7-10 day interval for adequate control of Cucurbit downy mildew, requiring as many as eight fungicide applications per season (4, 5).

Fungicide resistance in Cucurbit downy mildew has been confirmed in FRAC groups 4, 11, 28, 40, and 43 (3). Many other labeled fungicides have a single-site mode of action and are, therefore, at risk for development of resistance (9). These products require users to adhere to resistance management tactics that include tank-mixing or alternation with a different mode of action (designated by FRAC grouping). Two clades of *P. cubensis* exist with pathotypes within each one. The pathotypes have different levels of pathogenicity on different crops and differing levels of fungicide resistance (3, 4). For example, clade 1 isolates infect watermelon, pumpkin, and squash while clade 2 isolates infect cucumber and cantaloupe (3). Clade 2 develops fungicide resistance more quickly, which means the fewer fungicides are available for control of Cucurbit downy mildew on cucumber and cantaloupe (4).

Several biopesticides based on microorganisms such as *Streptomyces* spp., *Bacillus* spp. and *Trichoderma* spp. (examples: Actinovate, Serenade, and Tenet) also have labels for these diseases; however, these products are purely preventive in their recommended uses and require a tank-mix or alternation with another registered product when disease pressure is high (9). Potassium phosphite-based products are labeled for the combination of downy mildew, Pythium root rot, and Phytophthora root rot but suffer from the same limitations as biopesticides.

No known fungicide resistance exists for ethaboxam (FRAC group 22) outside of lab created mutations (6). Furthermore, zoxamide + chlorothalonil (FRAC 22 + M5) is not labeled for control of soilborne diseases, such as Phytophthora. Therefore, ethaboxam is an ideal candidate for inclusion in resistance management programs, especially in regard to soilborne diseases.

10.2 References

1. CDMS Label Search. 2022. Cantaloupe, United States, Fungicides. http://www.cdms.net.

11.0 Justification for Ethaboxam Minor Use on Buckwheat

According to the 2017 Census of Agriculture (1), buckwheat was grown on 27,762 acres, mainly in North Dakota, Minnesota, Washington, and New York. Seedling diseases caused by *Pythium* spp., part of the Oomycete class of plant pathogens, are less frequent than in other seeded crops but can be problematic where soil moisture is high due to excess rainfall or irrigation, or poor drainage. Key management steps include crop rotation, planting when soil temperatures favor rapid germination, use of high-quality seed, and seed treatment fungicides. The latter are useful when used in conjunction with good cultural practices (2).

11.1 Justification to meet criteria

The majority of seed treatment fungicides used on buckwheat contain fungicides from FRAC Group 4 (metalaxyl and mefenoxam) for control of *Pythium* diseases. A number of biological seed treatments, most based on *Bacillus* spp., are registered for use as seed treatments on buckwheat (3). Little information is available on efficacy against buckwheat seedling diseases; however, biologicals alone in seed treatments generally do not perform as well as synthetic counterparts; however, they are useful for organic growers and provide some growth-promotion benefits for both conventional and organic growers (4). Continuous use of FRAC 4 fungicides as seed treatments has led to the emergence of metalaxyl/mefenoxam-resistant strains of *Pythium* (5) in a number of crops, including soybean, resulting in reduced efficacy. However, resistance to FRAC 4 fungicides has not been reported in buckwheat. Based on experience in other crops, resistance development to FRAC 4 fungicides is possible and mixtures or alternations with fungicides having a different mode of action, such as ethaboxam, can help delay the appearance of resistance. As with lima bean, ethaboxam is therefore a useful tool for growers to manage fungicide resistance in seedling disease programs.

11.2 References

1. 2017 Census of Agriculture. 2019. United State Department of Agriculture National Agricultural Statistics Service publication. AC-17-A-51.
2. Bjorkman, T. 1999. Northeast Buckwheat Growers Newsletter. Cornell NYSAES. URL: http://www.hort.cornell.edu/bjorkman/lab/buck/NL/june99.php.
3. CDMS Label Search. 2022. Buckwheat, United States, Fungicides. http://www.cdms.net.
4. Bradley, C.A. 2008. Effect of fungicide seed treatments on stand establishment, seedling disease, and yield of soybean in North Dakota. Plant Dis. 92:120-125.
5. Radmer, L, Anderson, G., Malvick, D., Kurle, J.E., Rendahl, A., and Mallik, A. 2017. *Pythium*, *Phytophthora*, and *Phytopythium* spp. associated with Soybean in Minnesota, their relative aggressiveness on soybean and corn, and their sensitivity to seed treatment fungicides. Plant Dis. 101:62-72.

12.0 Justification for Ethaboxam Minor Use on Popcorn

In 2017, popcorn was grown on over 221,000 acres according to the 2017 Census of Agriculture. Indiana, Nebraska, and Illinois were the states where the majority of popcorn acres were planted. Seedling diseases caused by *Pythium* spp., part of the Oomycete class of plant pathogens, occur with a similar frequency as in field corn (2). *Pythium* spp. are part of a complex of fungi that can lead to significant stand loss in fields where soil moisture is high as a result of excess rainfall or irrigation, or poor drainage. Key management steps include crop rotation, planting when soil temperatures favor rapid germination, use of high-quality seed, and seed treatment fungicides. Seed treatments function best for corn seedling disease control when used alongside good cultural practices (3).

12.1 Justification to meet criteria

Most popcorn seed treatment fungicides contain active ingredients from FRAC Group 4 (metalaxyl and mefenoxam) for control of *Pythium* diseases. Several biological seed treatments are registered for use as seed treatments on popcorn as well (4). Little information is available on efficacy against corn seedling diseases; however, biologicals do not generally appear in university recommendations for seed treatments (5). Continuous use of FRAC 4 fungicides as seed treatments has led to the emergence of metalaxyl/mefenoxam-resistant strains of *Pythium* in a number of crops, including corn, resulting in reduced efficacy (6). Resistance to FRAC 4 fungicides has not been reported in popcorn, but on experience in other crops, specifically field corn, indicates that resistance development to FRAC 4 fungicides is possible. Mixtures or alternations with fungicides having a different mode of action, such as ethaboxam, can help delay the appearance of resistance to these seed treatment fungicides. As with other crops listed in this document, ethaboxam is therefore a useful tool for growers to manage fungicide resistance in seedling disease programs.

12.2 References

1. 2017 Census of Agriculture. 2019. United State Department of Agriculture National Agricultural Statistics Service publication. AC-17-A-51.
2. Carter, P.R., Hicks, D.R., Doll, J.D., Schulte, E.E., Schuler, R., and Holmes, B. 1989. Popcorn in: Alternative Field Crops Manual. University of Wisconsin / University of Minnesota. URL: https://www.hort.purdue.edu/newcrop/afcm/popcorn.html.
3. Wise, K. and Bradley, C.A. 2021. Seedling Diseases of Corn. PPFS-AG-C-02. University of Kentucky.
4. CDMS Label Search. 2022. Popcorn, United States, Fungicides. http://www.cdms.net.
5. Anon. Pythium – an early season pain in corn and soybeans. 2020. Illinois Field Crop Disease Hub. URL: http://cropdisease.cropsciences.illinois.edu/?p=1071.
6. Radmer, L, Anderson, G., Malvick, D., Kurle, J.E., Rendahl, A., and Mallik, A. 2017. *Pythium*, *Phytophthora*, and *Phytopythium* spp. associated with Soybean in Minnesota, their relative aggressiveness on soybean and corn, and their sensitivity to seed treatment fungicides. Plant Dis. 101:62-72.

13.0 Justification for Ethaboxam Minor Use on Rapeseed

The 2017 Census of Agriculture (1) reported that 10,655 acres of rapeseed were grown in that year, with Idaho, North Carolina, and South Carolina being the three most important states for production. *Pythium* spp. can be a significant problem on stand establishment in rapeseed, especially in late-seeded (winter) crops (2). *Pythium* spp. are part of a complex of fungi that can lead to significant stand loss in fields where soil moisture is high as a result of excess rainfall or irrigation, or poor drainage. Recommended management include crop rotation, planting when soil temperatures favor rapid germination, and seed treatment fungicides. Seed treatments are most effective when deployed with good cultural practices.

13.1 Justification to meet criteria

Mefenoxam and metalaxyl (FRAC Group 4) are the key active ingredients for the majority of rapeseed seed treatment fungicides registered for control of *Pythium* diseases. No biofungicide seed treatments are currently available for rapeseed (3). Continuous use of FRAC 4 fungicides as seed treatments has led to the emergence of metalaxyl/mefenoxam-resistant strains of *Pythium* in a number of crops (4). Resistance to FRAC 4 fungicides has not been reported in rapeseed, however, but is possible if experience in other cropping systems is considered. Mixtures or alternations with fungicides having a different mode of action, such as ethaboxam, can be effective in delaying the appearance of resistance. As discussed previously, ethaboxam can be effectively used by growers to manage fungicide resistance in Pythium seedling diseases.

13.2 References

1. 2017 Census of Agriculture. 2019. United State Department of Agriculture National Agricultural Statistics Service publication. AC-17-A-51.
2. Veseth, R. 1990. Winter Rapeseed Recropping Considerations. Conservation Tillage Handbook Series. Oregon State University. URL: http://pnwsteep.wsu.edu/tillagehandbook/chapter8/081490.htm.
3. CDMS Label Search. 2022. Rapeseed, United States, Fungicides. http://www.cdms.net.

4. White, D.J., Chen, W., and Schroeder. 2019. Assessing the contribution of ethaboxam in seed treatment cocktails for the management of metalaxyl-resistant Pythium ultimum var. ultimum in Pacific Northwest spring wheat production. Crop. Prot. 115:7-12.

14.0 Justification for Ethaboxam Minor Use on Safflower

Approximately 144,000 acres of safflower were planted in the U.S. in 2017 (1). Major states for safflower include California, Montana, South Dakota, Utah, and Idaho. Safflower production can be constrained by *Pythium* spp., which causes substantial stand losses under favorable conditions (2). Crop rotation, shallow planting, seeding into properly-prepared seedbeds when soil temperatures favor relatively quick germination, and seed treatment fungicides are the key recommended practices to minimize the impact of Pythium root rot of safflower. Seed treatments are most effective when deployed with good cultural practices.

14.1 Justification to meet criteria

Apron XL (mefenoxam; FRAC Group 4) is the only seed treatment registered on safflower for control of *Pythium* diseases. No biofungicide seed treatments are currently available for rapeseed (3). Continuous use of FRAC 4 fungicides as seed treatments has led to the emergence of metalaxyl/mefenoxam-resistant strains of *Pythium* in a number of crops, including corn, resulting in reduced efficacy (4), although such resistance has not been detected to date in safflower. Because there is only one registered product for control of Pythium root rot in safflower, there is a risk of resistance development in *Pythium* spp. Ethaboxam's mode of action differs from mefenoxam, offering growers an efficacious option to manage Pythium diseases in safflower as well as adding an alternative to mefenoxam for management of fungicide resistance in *Pythium* spp.

14.2 References

1. 2017 Census of Agriculture. 2019. United State Department of Agriculture National Agricultural Statistics Service publication. AC-17-A-51.
2. Schwartz, H.F. and Gent, D. 2005. Safflower – Pythium Root Rot. High Plains IPM Guide. URL: https://wiki.bugwood.org/uploads/PythiumRootRot-Safflower.pdf.
3. CDMS Label Search. 2022. Safflower, United States, Fungicides. http://www.cdms.net.
4. Radmer, L, Anderson, G., Malvick, D., Kurle, J.E., Rendahl, A., and Mallik, A. 2017. *Pythium*, *Phytophthora*, and *Phytopythium* spp. associated with Soybean in Minnesota, their relative aggressiveness on soybean and corn, and their sensitivity to seed treatment fungicides. Plant Dis. 101:62-72.