Evaluation Report ERC2010-10

Hydrogen Peroxide

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Overview

Registration Decision for Hydrogen Peroxide

Health Canada's Pest Management Regulatory Agency (PMRA), under the authority of the *Pest Control Products Act* and Regulations, has granted conditional registration for the sale and use of Biosafe M-70 Hydrogen Peroxide Technical Bactericide and ZeroTolR Broad-Spectrum Algaecide/Fungicide, containing the technical grade active ingredient hydrogen peroxide, as an algaecide/fungicide for non-porous and wood surfaces in greenhouses, greenhouse irrigation waters, ornamentals in greenhouses and outdoors, as well as on turf.

An evaluation of available scientific information found that, under the approved conditions of use, the product has value and does not present an unacceptable risk to human health or the environment.

Although the risks and value have been found acceptable when all risk reduction measures are followed, the applicant must submit additional scientific information as a condition of registration.

This Overview describes the key points of the evaluation, while the Science Evaluation provides detailed technical information on the human health, environmental and value assessments of Biosafe M-70 Hydrogen Peroxide Technical Bactericide and ZeroTolR Broad-Spectrum Algaecide/Fungicide

Biosafe M-70 Hydrogen Peroxide Technical Bactericide (Registration Number 27431) is currently registered in Canada for the treatment of potato and sweet potato storage and also used in combination with peroxyacetic acid for pulp and paper systems.

What Does Health Canada Consider When Making a Registration Decision?

The key objective of the *Pest Control Products Act* is to prevent unacceptable risks to people and the environment from the use of pest control products. Health or environmental risk is considered acceptable[1] if there is reasonable certainty that no harm to human health, future generations or the environment will result from use or exposure to the product under its proposed conditions of registration. The Act also requires that products have value[2] when used according to the label directions. Conditions of registration may include special precautionary measures on the product label to further reduce risk.

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1 "Acceptable risks" as defined by subsection 2(2) of the *Pest Control Products Act.*

2 "Value" as defined by subsection 2(1) of the *Pest Control Products Act*: "the product's actual or potential contribution to pest management, taking into account its conditions or proposed conditions of registration, and includes the product's *(a)* efficacy; *(b)* effect on host organisms in connection with which it is intended to be used; and *(c)* health, safety and environmental benefits and social and economic impact."

To reach its decisions, the PMRA applies modern, rigorous risk-assessment methods and policies. These methods consider the unique characteristics of sensitive subpopulations in humans (e.g. children) as well as organisms in the environment (e.g. those most sensitive to environmental contaminants). These methods and policies also consider the nature of the effects observed and the uncertainties when predicting the impact of pesticides. For more information on how the PMRA regulates pesticides, the assessment process and risk-reduction programs, please visit the Pesticide and Pest Management portion of Health Canada's website at healthcanada.gc.ca/pmra.

What Is Hydrogen Peroxide?

Hydrogen peroxide is an oxidant, producing hydroxyl free radicals, which attacks thiol groups and double bonds of essential cell components such as lipids, proteins and DNA, inhibiting the growth of microorganisms. Hydrogen peroxide demonstrates broad-spectrum activities against fungi, bacteria and algae.

Health Considerations

Can Approved Uses of Hydrogen Peroxide Affect Human Health?

Hydrogen peroxide is unlikely to affect your health when used according to label directions.

Potential exposure to hydrogen peroxide may occur when handling and applying the product. When assessing health risks, two key factors are considered: the levels where no health effects occur and the levels to which people may be exposed. Toxicology studies in laboratory animals describe potential health effects from varying levels of exposure to a chemical and identify the dose where no effects are observed. The dose levels used to assess risks are established to protect the most sensitive human population (e.g., children and nursing mothers). Only uses for which the exposure is well below levels that cause no effects in animal testing are considered acceptable for registration.

Hydrogen peroxide is an oxidizing agent that is highly reactive and upon contact with moisture, degrades quickly to form water and oxygen. The body naturally produces hydrogen peroxide and detoxifying enzymes (eg. catalase and peroxidase) which control the amount of hydrogen peroxide in the body.

Technical grade hydrogen peroxide (90% concentration) is moderately toxic by the acute inhalation route in mice. At a concentration of 35%, it is considered to be severely irritating or corrosive to the eye and moderately irritating to the skin of rabbits. Consequently, the statements "Poison" and "Danger - Corrosive to eyes and skin" are required on the label. The end use product ZeroTolR Broad-Spectrum Algaecide/Fungicide is also of moderate toxicity when given as a single dose by the

inhalation route to mice, and is corrosive to the eyes and moderately irritating to the skin of rabbits. Consequently, the statements "Poison" and "Danger – Corrosive to eyes and skin" are required on the label of the end use product.

Hydrogen peroxide is a known mutagen when tested *in vitro* but is not genotoxic *in vivo* and did not cause cancer in animals. It is not expected that hydrogen peroxide would cause damage to the nervous system, have effects on reproduction, or have effects on the developing fetus. The first signs of toxicity in animals given daily doses of hydrogen peroxide over longer periods of time were decreased body weight gain and changes in blood parameters. However, after a single exposure the majority of effects observed will likely be due to the corrosive nature of hydrogen peroxide. The risk assessment protects against these effects by ensuring that the level of human exposure is well below the lowest dose at which these effects occurred in animal tests.

Risks in Residential and Other Non-Occupational Environments

Residential risks are not of concern when ZeroTolR Broad-Spectrum Algaecide/Fungide is used according to the proposed label directions

Given the rapid degradation and low residues of hydrogen peroxide expected after application, residues are not expected to remain on turf after application of this product and post-application exposure to hydrogen peroxide is expected to be minimal following the application of ZeroTolR Broad-Spectrum Algaecide/Fungicide.

Occupational Risks From Handling ZeroTolR Broad-Spectrum Algaecide/Fungicide

Occupational risks are not of concern when ZeroTolR Broad-Spectrum Alagecide/Fungide is used according to the proposed label directions, which include protective measures.

Workers who mix, load or apply ZeroTolR Broad-Spectrum Algaecide/Fungicide as well as workers re-entering freshly treated turf, nurseries and greenhouses can come in direct contact with ZeroTolR Broad-Spectrum Algaecide/Fungicide residues on the skin or in the air. Therefore, the label specifies that anyone mixing/loading and applying ZeroTolR Broad-Spectrum Algaecide/Fungicide must wear goggles or a face shield, coveralls over long-sleeved shirt and long pants, boots, chemical-resistant gloves, and a NIOSH-approved respirator. The label also requires that workers do not enter treated areas until residues have dried. Taking into consideration these label statements, the number of applications and the expectation of the exposure period for handlers and workers, the risk to these individuals are not a concern.

For bystanders, exposure is expected to be much less than that for workers and is considered negligible. Therefore, health risks to bystanders are not of concern.

Environmental Considerations

What Happens When Hydrogen Peroxide Is Introduced Into the Environment?

Once introduced to the environment hydrogen peroxide transforms rapidly to water and oxygen.

Hydrogen peroxide is expected to be highly mobile in terrestrial environments after application. Adsorption to soil particles is not expected. Due to its very short half-life of less than 1 hour in natural soils, movement in the terrestrial environment will be limited to very short distances and leaching to ground water is not expected. Hydrogen peroxide is expected to stay in solution in aquatic environments. Partitioning and accumulation in sediment is not expected. Aquatic half-lives have been observed to be one hour to ten days.

Bioaccumulation and biomagnification are not expected. Hydrogen peroxide is toxic to non-target aquatic organisms and potentially phytotoxic to non-target plants. Based on the use pattern and short half-lives in both terrestrial and aquatic habitats, exposure to birds, mammals and beneficial arthropods is not expected.

Value Considerations

What Is the Value of ZeroTolR Broad-Spectrum Algaecide/Fungicide?

ZeroTolR Broad-Spectrum Algaecide/Fungicide is a broad spectrum antimicrobial for use on greenhouse surfaces and irrigation water treatment. ZeroTolR Broad-Spectrum Algaecide/Fungicide contains hydrogen peroxide that will control or prevent the build up of fungi and algae on surfaces of greenhouse equipment and within the greenhouse irrigation waters, e.g. flooded floors, flooded benches, recycled water systems, capillary mats, humidification and misting systems.

The data submitted to register ZeroTolR Broad-Spectrum Algaecide/Fungicide demonstrates that it will control fusarium leaf spot of dracaena and rhizoctonia aerial blight on Boston fern. ZeroTolR Broad-Spectrum Algaecide/Fungicide will also suppress xanthomonas leaf spot on English ivy and alternaria leaf spot on Schefflera. The claim on these diseases can be extended to other species of ornamental plants susceptible to these pathogens. The data also demonstrates ZeroTolR Broad-Spectrum Algaecide/Fungicide will control anthracnose, brown patch and algae growth on turf.

Measures to Minimize Risk

Labels of registered pesticide products include specific instructions for use. Directions include risk-reduction measures to protect human and environmental health. These directions must be followed by law.

The key risk-reduction measures being proposed on the label of ZeroTolR Broad-Spectrum Algaecide/Fungicide to address the potential risks identified in this assessment are as follows:

Key Risk-Reduction Measures

Human Health

Because there is a concern with users coming into direct contact with ZeroTolR Broad-Spectrum Algaecide/Fungicide on the skin or through inhalation of spray mists, anyone mixing, loading and applying ZeroTolR Broad-Spectrum Algaecide/Fungicide must wear goggles or a face shield, coveralls over long-sleeved shirt and long pants, boots, chemical-resistant gloves, and a NIOSH-approved respirator.

Environment

A default buffer zone of one meter is required for the protection of freshwater and marine habitats.

Environmental risk mitigation statements for the disposal of waste waters and effluent from industrial and greenhouse uses are also required.

What Additional Scientific Information Is Being Requested?

Although the risks and value have been found acceptable when all risk-reduction measures are followed, the applicant must submit additional scientific information as a condition of registration. More details are presented in the Science Evaluation of this Evaluation Report or in the Section 12 Notice associated with these conditional registrations. The applicant must submit the following information within the time frames indicated.

Value

Claims for ornamental bedding plants and turf are conditionally accepted, therefore, additional data is needed as follows:

- Data from one small-scale trial demonstrating that ZeroTolR Broad-Spectrum Algaecide/Fungicide is effective in controlling xanthomonas leaf spot caused by *Xanthomomas* spp. on ornamental bedding plants.

- Data from one small-scale trial demonstrating that ZeroTolR Broad-Spectrum Algaecide/Fungicide is effective in controlling alternaria leaf spot caused by *Alternaria* spp. on ornamental bedding plants.

- Data from one small-scale trial demonstrating that ZeroTolR Broad-Spectrum Algaecide/Fungicide is effective in controlling rhizoctonia aerial blight caused by *Rhizoctonia* spp. on ornamental bedding plants. An additional trial is required to extend the claim to ornamental shrubs.

- Data from one small-scale trial for each of the listed diseases (anthracnose, brown patch and algal) demonstrating that ZeroTolR Broad-Spectrum Algaecide/Fungicide is effective in controlling anthracnose, brown patch and algal growth on turf.

Other Information

As these conditional registrations relate to a decision on which the public must be consulted,[3] the PMRA will publish a consultation document when there is a proposed decision on applications to convert the conditional registrations to full registrations or on applications to renew the conditional registrations, whichever occurs first.

The test data cited in this Evaluation Report (i.e. the test data relevant in supporting the registration decision) will be made available for public inspection when the decision is made to convert the conditional registrations to full registrations or to renew the conditional registrations (following public consultation). If more information is required, please contact the PMRA's Pest Management Information Service by phone (1-800-267-6315) or by e-mail (pmra.infoserv@hc-sc.gc.ca).

[3] As per subsection 28(1) of the *Pest Control Products Act.*

Science Evaluation

Hydrogen Peroxide

1.0 The Active Ingredient, Its Properties and Uses

1.1 Identity of the Active Ingredient

Active substance	Hydrogen peroxide
Function	Crop bactericide and fungicide
Chemical name	
1. International Union of Pure and Applied Chemistry (IUPAC)	Hydrogen Peroxide
2. Chemical Abstracts Service (CAS)	Hydrogen Peroxide (H_2O_2)
CAS number	7722-84-1
Molecular formula	H_2O_2
Molecular weight	34.02
Structural formula	H-O-O-H
Purity of the active ingredient	70%

1.2 Physical and Chemical Properties of the Active Ingredient and End-Use Product

Technical Product—BioSafe M-70 Hydrogen Peroxide Technical Bactericide /Fungicide

Property	Result
Colour and physical state	Colourless liquid
Odour	Mildly pungent
Boiling point	125ºC
Specific Gravity at 20°C	1.29

Property	Result
Vapour pressure at 25°C	% Vapour Pressure, Pa 20 142.65 35 150.65 50 158.65 60 165.32 70 906.59 (at 20°C)
Henry's law constant at 20°C	7 x 10^{-3} Pa m^3/mol
Ultraviolet (UV)-visible spectrum	Mixture of H_2O_2 and peracetic acid absorbs below 300 nm
Solubility in water	Miscible
Solubility in organic solvents	Miscible with many polar organic solvents (low molecular weight alcohols, glycols, ketones)
n-Octanol-water partition coefficient (K_{OW})	log K_{ow} = 0.3
Dissociation constant (pK_a)	8.2
Stability (temperature, metal)	Stable in high purity aluminum and 304/316 series stainless steel. Decomposition is highly exothermic and catalysed by: transition metal ions, solid metals or metal oxides, pH 7 or greater, heat or sunlight.

End-Use Product—ZeroTolR Broad-Spectrum Algaecide/Fungicide

Property	Result
Colour	Colourless
Odour	Characteristic smell of acetic acid
Physical state	Liquid
Formulation type	Solution
Guarantee	27%
Container material and description	Plastic (high density polyethylene) jug or tote: 1-200 Litres
Density	1.091 g/mL
pH	1.05

Property	Result
Oxidizing or reducing action	It is a strong oxidizing agent.
Storage stability	Hydrogen peroxide declines less than 2% per year at room temperature when stabilizers are used.
Corrosion characteristics	The end-use product is moderately corrosive.
Explodability	The end-use product does not contain explosive material.

1.3 Directions for Use

ZeroTolR Broad-Spectrum Algaecide/Fungicide is used for the prevention and control of fungi and algae on wood and non-porous hard surfaces and in irrigation waters (for use on non-food crops in greenhouses only) at concentrations between 3.3 ml and 20 ml per litre of clean water.

ZeroTolR Broad-Spectrum Algaecide/Fungicide controls fusarium leaf spot (*Fusarium* spp*)* on dracaena and rhizoctonia aerial blight (*Rhizoctonia* spp) on Boston fern, at the application rate of 10 mL per litre of clean water (Use 11-19 litres of mixed solution per 100 m^2. It also suppresses alternaria leaf spot *(Alternaria* spp) on schefflera and Xanthomonas leaf spot (*Xanthomonas* spp*)* on English ivy at the application rate of 10 mL per litre of clean water (Use 11-19 litres of mixed solution per 100 m^2). The claim on these diseases can be extended to other species of ornamental plants susceptible to these pathogens.

ZeroTolR Broad-Spectrum Algaecide/Fungicide also controls anthracnose (*Colletotrichum graminicola*) and brown patch *(Rhizoctonia solani)* on turf at 12 mL per 100 m^2, and controls algae (green and bluegreen) on turf at 100 mL per 100 m^2.

1.4 Mode of Action

Hydrogen peroxide is an oxidant, producing hydroxyl free radicals (OH), which attacks thiol groups and double bonds of essential cell components such as lipids, proteins and DNA, inhibiting the growth of microorganisms.

2.0 Methods of Analysis

2.1 Methods for Analysis of the Active Ingredient

The methods provided for the analysis of the active ingredient and impurities in BioSafe M-70 Hydrogen Peroxide Technical Bactericide /Fungicide have been assessed to be acceptable for the determinations.

2.2 Method for Formulation Analysis

The method provided for the analysis of the active ingredient in the formulation has been validated and assessed to be acceptable for use as an enforcement analytical method.

2.3 Methods for Residue Analysis

Methods for residue analysis were not required.

3.0 Impact on Human and Animal Health

3.1 Toxicology Summary

The registrant submitted waiver requests for all required toxicity data citing a previously submitted database. Toxicology studies using hydrogen peroxide were previously submitted and reviewed for food and pulp and paper uses. A detailed review of hydrogen peroxide can be found in the Proposed Regulatory Decision Documents: PRDD2000-02 *VigorOx* and PRDD2006-02 *BioSafe OxiDate Bactericide/Fungicide Potato Storage Treatment Containing Hydrogen Peroxide.* These Proposed Regulatory Decision Documents also refer to reviews of hydrogen peroxide by the European Centre for Ecotoxicology of Chemicals (ECETOC 1993) and USEPA's Reregistration Eligibility Decision document for peroxy compounds (1993).

ZeroTolR Broad-Spectrum Algaecide/Fungicide is of slight acute toxicity (LD_{50} of 1231 mg/kg in rats), low acute dermal toxicity (LD_{50} greater than 2000 mg/kg in rabbits) and moderate acute inhalation toxicity (LC_{LO} of 227 ppm – equivalent to 0.315 mg/L in mice). It is corrosive to the eyes and moderately irritating to the skin of rabbits.

The previous reviews evaluated the toxicity of technical grade hydrogen peroxide at 35%. Although the current application is for a 70% solution in water, the previous assessment is still applicable and the submitted data/information can be used in support of this active ingredient. The only expected difference in toxicity between the 35% and 70% forms of hydrogen peroxide is a likely increase in the acute corrosive properties due to the increase in oxidative activity of the active ingredient. Hydrogen peroxide is an oxidizing agent that is highly reactive and rapidly decomposes into water and oxygen upon contact with moisture. Due to the highly corrosive nature of hydrogen peroxide following acute exposure, the anticipated intermittent exposure associated with the proposed new uses and the rapid decomposition of hydrogen peroxide to oxygen and water, there is not expected to be any significant risk associated with chronic exposure.

3.1.1 PCPA Hazard Characterization

For assessing risks from potential residues in food or from products used in or around homes or schools, the *Pest Control Products Act* requires the application of an additional 10-fold factor to take into account potential prenatal and postnatal toxicity and completeness of the data with respect to the exposure of and toxicity to infants and children. A different factor may be determined to be appropriate on the basis of reliable scientific data.

With respect to the completeness of the toxicity database as it pertains to the exposure of and toxicity to infants and children, the available literature was considered insufficient to allow for an adequate evaluation of potential reproductive or developmental toxicity. However, it was concluded that studies to evaluate the reproductive and developmental toxicity of hydrogen peroxide were not necessary in view of the rapid decomposition of hydrogen peroxide into water and oxygen. Hydrogen peroxide and its metabolites are unlikely to accumulate in mammalian organs or tissue long enough to exert significant effects on reproduction and development or induce neurotoxicity (PRDD2006-02). On the basis of this information, the 10-fold factor required under the *Pest Control Products Act* was reduced to 1-fold.

3.2 Determination of Acute Reference Dose

An acute reference dose was not established as no food uses were proposed.

3.3 Determination of Acceptable Daily Intake

An acceptable daily intake was not established as no food uses were proposed.

3.4 Occupational and Residential Risk Assessment

3.4.1 Toxicological Endpoints

The primary toxicology hazard is considered to be acute in nature, related to the corrosive properties of hydrogen peroxide to eyes, skin and mucous membranes.

Acute toxicology endpoints are considered most appropriate for the occupational risk assessment for the following reasons:

- hydrogen peroxide is highly reactive and subject to rapid decomposition to water and oxygen upon contact with moisture;
- occupational exposure is expected to be intermittent; and
- this compound is highly corrosive

Occupational exposure to ZeroTolR Broad-Spectrum Algaecide/Fungicide is characterized as long-term/intermittent and is predominantly by the dermal and inhalation routes.

3.4.2 Occupational Exposure and Risk

3.4.2.1 Mixer/loader/applicator Exposure and Risk Assessment

Individuals have potential for exposure to ZeroTolR Broad-Spectrum Algaecide/Fungicide during mixing, loading and application. Exposure to workers mixing, loading and applying ZeroTolR Broad-Spectrum Algaecide/Fungicide is expected to be long term, but intermittent in duration and to occur primarily by the dermal and inhalation routes.

At high doses, hydrogen peroxide is corrosive to eyes and irritating to skin and mucous membranes; however, residues are not expected to remain on crops after application of this product. Hydrogen peroxide is highly reactive and short-lived due to instability of the peroxide bond, which leads to rapid degradation and low residues of hydrogen peroxide expected after application. It is the conclusion of the PMRA that mitigation against acute exposures through labelling is the most appropriate regulatory approach for this active ingredient. As such, a quantitative risk assessment was not conducted and acute risk was mitigated through the use of personal protective equipment.

3.4.2.2 Exposure and Risk Assessment for Workers Entering Treated Areas

There is potential for exposure to workers re-entering areas treated with ZeroTolR Broad-Spectrum Algaecide/Fungicide. Hydrogen peroxide is highly reactive and short-lived due to instability of the peroxide bond, which leads to rapid degradation and low residues of hydrogen peroxide expected after application. As such, residues are not expected to remain on crops after application of this product and post-application exposure to hydrogen peroxide is expected to be minimal following the application of ZeroTolR Broad-Spectrum Algaecide/Fungicide.

3.4.3 Residential Exposure and Risk Assessment

3.4.3.1 Handler Exposure and Risk

There are no domestic class products; therefore, a residential handler assessment was not required.

3.4.3.2 Postapplication Exposure and Risk

There is potential for exposure to individuals re-entering residential turf treated with ZeroTolR Broad-Spectrum Algaecide/Fungicide. Hydrogen peroxide is highly reactive and short-lived due to instability of the peroxide bond, which leads to rapid degradation and low residues of hydrogen peroxide expected after application. As such, residues are not expected to remain on turf after application of this product and post-application exposure to hydrogen peroxide is expected to be minimal following the application of ZeroTolR Broad-Spectrum Algaecide/Fungicide.

3.4.3.3 Bystander Exposure and Risk

Bystander exposure should be negligible since the potential for drift is expected to be minimal. Application is limited to turf only when there is low risk of drift to areas of human habitation or activity such as houses, cottages, schools and recreational areas, taking into consideration wind speed, wind direction, temperature inversions, application equipment and sprayer settings.

3.5 Food Residues Exposure Assessment

Food Residues Exposure Assessment was not established as no food uses were proposed.

4.0 Impact on the Environment

4.1 Fate and Behaviour in the Environment

Hydrogen peroxide is expected to be highly mobile in the environment once applied. The end use product does not contain binders to aid in the adsorption of the active ingredient to foliage or soil. Adsorption to soil particles is not expected. However, hydrogen peroxide is very short lived in the environment with reported half-lives ranging from several minutes to 15 hours in soil under worse case degradation conditions and up to 10 days in aquatic environments. As such movement of hydrogen peroxide in natural soils is only expected for very short distances due to the very fast degradation half-life in natural soils. Hydrogen peroxide is not expected to leach to ground water. Hydrogen peroxide is expected to stay in solution in aquatic environments, thus, partitioning to sediment is not expected. Volatilization and long range transport are also not expected. The transformation products from the degradation of hydrogen peroxide are water and oxygen.

4.2 Effects on Non-Target Species.

The environmental risk assessment integrates the environmental exposure and ecotoxicology information to estimate the potential for adverse effects on non-target species. This integration is achieved by comparing exposure concentrations with concentrations at which adverse effects occur. Estimated environmental exposure concentrations (EECs) are concentrations of pesticide in various environmental media, such as food, water, soil and air. The EECs are estimated using standard models which take into consideration the application rate(s), chemical properties and environmental fate properties, including the dissipation of the pesticide between applications. Ecotoxicology information includes acute and chronic toxicity data for various organisms or groups of organisms from both terrestrial and aquatic habitats including invertebrates, vertebrates, and plants. Toxicity endpoints used in risk assessments may be adjusted to account for potential differences in species sensitivity as well as varying protection goals (i.e. protection at the community, population, or individual level).

Initially, a screening level risk assessment is performed to identify pesticides and/or specific uses that do not pose a risk to non-target organisms, and to identify those groups of organisms for which there may be a potential risk. The screening level risk assessment uses simple methods, conservative exposure scenarios (e.g. direct application at a maximum cumulative application rate) and sensitive toxicity endpoints. A risk quotient (RQ) is calculated by dividing the exposure estimate by an appropriate toxicity value (RQ = exposure/toxicity), and the risk quotient is then compared to the level of concern (LOC = 1). If the screening level risk quotient is below the level of concern, the risk is considered negligible and no further risk characterization is necessary. If the screening level risk quotient is equal to or greater than the level of concern, then a refined risk assessment is performed to further characterize the risk. A refined assessment takes into consideration more realistic exposure scenarios (such as drift to non-target habitats) and might consider different toxicity endpoints. Refinements may include further characterization of risk based on exposure modelling, monitoring data, results from field or mesocosm studies, and probabilistic risk assessment methods. Refinements to the risk assessment may continue until the risk is adequately characterized or no further refinements are possible.

4.2.1 Effects on Terrestrial Organisms

Exposure of wild birds, mammals and beneficial arthropods as well as terrestrial plants to hydrogen peroxide and the end-use product ZeroTolR Broad-Spectrum Algaecide/Fungicide from use in greenhouses is expected to be limited to the disposal of unused or unwanted product as well as from the cleaning of equipment and disposal of waste waters from greenhouses.

Exposure of wild birds, mammals and beneficial arthropods to ZeroTolR Broad-Spectrum Algaecide/Fungicide from use on turf and outdoor ornamentals is expected to be limited, and it is expected that the proposed use pattern will not result in an unacceptable risk to these organisms. Hydrogen peroxide is a contact algaecide/fungicide. Dried residues on food sources for wild birds, mammals and beneficial arthropods are expected to be negligible due to the short half-life. Dried residues on foliage are also expected to be negligible. Hydrogen peroxide is naturally occurring, does not persist and is not expected to bioaccumulate.

Risk to terrestrial vascular plants could not be quantitatively evaluated due to a lack of terrestrial plant data. However, hydrogen peroxide is a well known consumer product which is broadly used on plants. Furthermore, based on the proposed use pattern, the short half-life and that plant damage on ornamental plants was not identified as a concern in the value review, the PMRA does not expect the use of ZeroTolR Broad-Spectrum Algaecide/Fungicide to result in an unacceptable risk to non-target terrestrial plants.

4.2.2 Effects on Aquatic Organisms

Aquatic organisms can be exposed to hydrogen peroxide during the disposal of unused or unwanted product as well as from the cleaning of equipment and disposal of waste waters from greenhouses. Exposure to aquatic organisms from hydrogen peroxide may also occur from drift following the application of ZeroTolR Broad-Spectrum Algaecide/Fungicide to turf and outdoor ornamentals.

To assess the potential effects from exposure to hydrogen peroxide, the screening level estimated environmental concentrations in the aquatic environment based on direct application to water. The calculated estimated environmental concentrations were those determined in 15 cm body of water for amphibians and 80 cm body of water for all other aquatic organisms. For the screening level risk assessment for aquatic organisms, end points were adjusted using uncertainty factors to account for differences in species sensitivity and protection goals (e.g. community, population and individual). More specifically, the risk quotients were calculated using one of the following formulas: RQ = EEC (appropriate water depth) / (most sensitive species (EC_{50}/2 or LC_{50}/2 for invertebrates and algae and LC_{50}/10 for fish). The longest reported half-life for hydrogen peroxide in natural aquatic systems was 2.5 days. Chronic exposure to aquatic organisms, given the very short half-life, is therefore not expected. As such, a quantitative risk assessment for chronic exposure was not carried out. In those cases where the screening level assessments resulted in a risk to the non-target organism, a refined assessment was conducted to further characterize the risk resulting from drift. The calculated screening level risk quotients are summarised in Table 4, Appendix I. The refined risk quotients are summarised in Table 5, Appendix I. The refined risk characterization indicated that spray drift of hydrogen peroxide will not result in an unacceptable risk to aquatic organisms.

Risk resulting from run-off is not expected given the short half-life of hydrogen peroxide in natural soils (half-life of less than 1 hour).

5.0 Value

5.1 Effectiveness Against Pests

Data from several laboratory trials and field trials carried out with a variety of surfaces were submitted, as well as data for water treatment. These studies demonstrated the antimicrobial properties of ZeroTolR Broad-Spectrum Algaecide/Fungicide against various fungi and algae in the different setups.

Twenty studies were submitted for applications to control or suppress various diseases on ornamental plants and turf. Twelve studies were not reviewed since these studies contained information not relevant to the label, did not provide efficacy data, were of a testimonial nature or did not identify the disease organism. Eight studies from various locations in the United States were evaluated; these demonstrated the effectiveness to control/suppress some fungal and bacterial diseases on ornamental plants and turf, and to control algae on turf.

5.1.1 Acceptable Efficacy Claims

The submitted data established acceptable use rates that are displayed in Table 5.1.1.

Table 5.1.1 Use rates as supported by data

End Use	Rates
Non-porous surfaces and wood in greenhouse structures	Spray or foam at dilution rates from 3.3 mL and 20 mL of ZeroTolR Broad-Spectrum Algaecide/Fungicide per litre of clean water.
Irrigation waters (for use on non-food crops in greenhouses only)	From 0.1 mL and 3.3 mL of ZeroTolR Broad-Spectrum Algaecide/Fungicide per litre of water (use the higher concentration for water with heavy organic load).
Foliar spray treatment in greenhouse and field to **control** fusarium leaf spot (*Fusarium* spp.) on dracaena and rhizoctonia aerial blight (*Rhizoctonia* spp.) on bedding plants	10 mL ZeroTolR Broad-Spectrum Algaecide/Fungicide per litre of clean water. Use 11-19 litres of mixed solution per 100 m^2.
Foliar spray treatment in greenhouse and field to **suppress** xanthomonas leaf spot (*Xanthomonas* spp.) and alternaria leaf spot (*Alternaria* spp.) on bedding plants	
Turf application to control anthracnose (*Colletotrichum graminicola*) and brown patch (*Rhizoctonia solani*)	12 mL ZeroTolR Broad-Spectrum Algaecide/Fungicide per 100 m^2. Use 11-19 litres of mixed solution per 100 m^2.
Turf application to control algae (green and bluegreen).	100 mL ZeroTolR Broad-Spectrum Algaecide/Fungicide per 100 m^2. Use 11-19 litres of mixed solution per 100 m^2.

5.2 Non-safety Adverse Effects

No phytotoxic reactions were reported in any of the trials.

5.3 Economics

No information was provided.

5.4 Sustainability

5.4.1 Survey of Alternatives

There are only two other products currently registered specifically for greenhouse or agricultural hard-surfaces use (see table 7 in Appendix I): Floralife Formula (Registration Number 20397 containing 5% of n-Alkyl dimethyl benzyl ammonium chloride) and Effersan (Registration Number 25087 containing 30% of sodium dichloro-s-triazinetrione). No product is currently registered to treat the water for irrigation in greenhouses.

Chemical fungicides in use for managing anthracnose and brown patch on turf include various products with different modes of action. There are many products registered for use on turf, such as products containing active ingredients of azoxystrobin, captan, chlorothalonil, fosetyl AL, iprodione, propiconazole, pyraclostrobin, quintozene, trifloxystrobin and triticonazole, etc. However, products registered for fusarium leaf spot (*Fusarium* spp.), rhizoctonia aerial blight (*Rhizoctonia* spp.), alternaria leaf spot *(Alternaria* spp.) and xanthomonas leaf spot (*Xanthomonas* spp.) on ornamental bedding plants are limited. See Table 7 in Appendix I for the list of registered chemical fungicides.

5.4.2 Compatibility with Current Management Practices Including Integrated Pest Management

No information was provided.

5.4.3 Information on the Occurrence or Possible Occurrence of the Development of Resistance

Hydrogen peroxide is proposed for use against fungal, bacterial pathogens and algae in Canada. It is a surface disinfectant, which works by forming a strong hydroxyl radical that chemically reacts with the proteins and enzymes of target pathogens, interfering with cellular respiration, and leading to cell death. Because of the immediate nature of the chemical interaction between hydrogen peroxide and the pathogens, there is little chance of mutations occurring, which will greatly reduce chances for resistant development. Currently, hydrogen peroxide is not listed by the Fungicide Resistance Action Committee, and there are no recommendations for resistance management.

5.4.4 Contribution to Risk Reduction and Sustainability

Anthracnose and brown patch on turf can be managed by various chemical fungicides along with other control practices, while fungicide selections are limited for fusarium leaf spot (*Fusarium* spp.), rhizoctonia aerial blight (*Rhizoctonia* spp.), alternaria leaf spot *(Alternaria* spp.) and xanthomonas leaf spot (*Xanthomonas* spp.) on ornamental bedding plants. Registration and use of ZeroTolR Broad-Spectrum Algaecide/Fungicide could lead to a reduction in the use of other chemical fungicides in an overall Integrated Pest Management program.

6.0 Pest Control Product Policy Considerations

6.1 Toxic Substances Management Policy Considerations

The Toxic Substances Management Policy (TSMP) is a federal government policy developed to provide direction on the management of substances of concern that are released into the environment. The TSMP calls for the virtual elimination of Track 1 substances (those that meet all four criteria outlined in the policy, id est, CEPA-toxic or equivalent, predominantly anthropogenic, persistent and bio-accumulative).

During the review process, hydrogen peroxide and its transformation products were assessed in accordance with the PMRA Regulatory Directive DIR99-03[4] and evaluated against the Track 1 criteria. The PMRA has reached the following conclusions:

Hydrogen peroxide does not meet Track 1 criteria, and is not considered a Track 1 substance. See Table 6, Appendix I, for comparison with Track 1 criteria.

Hydrogen peroxide is not expected to form any transformation products that meet all Track 1 criteria.

6.2 Formulants and Contaminants of Health or Environmental Concern

During the review process, contaminants in the technical, and formulants and contaminants in the end-use product are compared against the *List of Pest Control Product Formulants and Contaminants of Health or Environmental Concern* maintained in the *Canada Gazette*[5]. The list is used as described in the PMRA Notice of Intent NOI2005-01[6] and is based on existing policies and regulations including: DIR99-03[1]; and DIR2006-02[7], and taking into consideration the Ozone-depleting Substance Regulations, 1998, of the *Canadian Environmental Protection Act* (substances designated under the Montreal Protocol). The PMRA has reached the following conclusions:

Technical grade hydrogen peroxide, Biosafe M-70 Hydrogen Peroxide Technical Bactericide/Fungicide, and the end-use product ZeroTolR Broad-Spectrum Algaecide/Fungicide do not contain any formulants of health or environmental concern identified in the *Canada Gazette.*

The use of formulants in registered pest control products identified in the *List of Pest Control Product Formulants and Contaminants of Health or Environmental Concern* maintained in the *Canada Gazette*[8] is assessed on an ongoing basis through PMRA formulant initiatives and Regulatory Directive DIR2006-02[9].

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4 DIR99-03, The Pest Management Regulatory Agency's Strategy for Implementing the Toxic Substances Management Policy

5 NOI2005-01, List of Pest Control Product Formulants and Contaminants of Health or Environmental Concern under the New Pest Control Products Act.

6 NOI2005-01, List of Pest Control Product Formulants and Contaminants of Health or Environmental Concern under the New Pest Control Products Act.

7 DIR2006-02, PMRA Formulants Policy.

8 Canada Gazette, Part II, Volume 139, Number 24, SI/2005-114 (2005-11-30) pages 2641–2643: List of Pest Control Product Formulants and Contaminants of Health or Environmental Concern and in the order amending this list in the Canada Gazette, Part II, Volume 142, Number 13, SI/2008-67 (2008-06-25) pages 1611-1613. Part 1 Formulants of Health or Environmental Concern, Part 2 Formulants of Health or Environmental Concern that are Allergens Known to Cause Anaphylactic-Type Reactions and Part 3 Contaminants of Health or Environmental Concern.

9 DIR2006-02, PMRA Formulants Policy.

7.0 Summary

7.1 Human Health and Safety

The toxicology database submitted for hydrogen peroxide is adequate to define the majority of toxic effects that may result from exposure to hydrogen peroxide. Hydrogen peroxide elicits its principal effect (corrosiveness) after an acute exposure. Hydrogen peroxide rapidly decomposes to oxygen and water upon contact with moisture. In subchronic and chronic studies on laboratory animals, the first signs of toxicity were reduced body weight gain and haematological changes. There was no evidence of carcinogenicity in rats or mice after longer-term dosing. Hydrogen peroxide and its metabolites are unlikely to accumulate in mammalian organs or tissue long enough to exert significant effects on reproduction and development or induce neurotoxicity. For risk assessment purposes, the primary hazard is considered to be acute in nature, related to the corrosive properties of hydrogen peroxide to eyes, skin and mucous membranes.

Mixer, loader applicators handling ZeroTolR Broad-Spectrum Algaecide/Fungicide and workers re-entering treated areas including turf, ornamentals and greenhouses are not expected to be exposed to levels of ZeroTolR Broad-Spectrum Algaecide/Fungicide that will result in an unacceptable risk when the ZeroTolR Broad-Spectrum Algaecide/Fungicide is used according to label directions. The personal protective equipment on the product label is adequate to protect workers.

Residential exposure to individuals contacting treated turf is not expected to result in unacceptable risk when ZeroTolR Broad-Spectrum Algaecide/Fungicide is used according to label directions.

7.2 Environmental Risk

Hydrogen peroxide is not persistent in natural soils or natural aquatic environments. Leaching is expected to occur only over short distances and hydrogen peroxide is not expected to leach to groundwater. Volatilization and long range transport are not expected. Accumulation and carry over are not expected.

Based on the proposed use pattern and short half-life, hydrogen peroxide is not expected to pose an unacceptable risk to birds, mammals, beneficial arthropods, non-target terrestrial plants or aquatic organisms. However, hydrogen peroxide can enter aquatic environments through spray drift and disposal of waste waters and unused/unwanted product. Risks to algae and amphibians were identified at the screening level and, as a result, spray buffer zones and label statements are required.

7.3 Value

The studies submitted in support of ZeroTolR Broad-Spectrum Algaecide/Fungicide were adequate to demonstrate its efficacy for use as an algaecide/fungicide for greenhouse surfaces and irrigation waters. The availability of ZeroTolR Broad-Spectrum Algaecide/Fungicide will provide the industry with a new product to address algae and fungi problems in greenhouses.

The data submitted to register ZeroTolR Broad-Spectrum Algaecide/Fungicide demonstrates that it will control fusarium leaf spot of dracaena and rhizoctonia aerial blight on Boston fern. ZeroTolR Broad-Spectrum Algaecide/Fungicide will also suppress xanthomonas leaf spot on English ivy and alternaria leaf spot on Schefflera. The claim on these diseases can be extended to other species of ornamental plants susceptible to these pathogens. The data also demonstrates ZeroTolR Broad-Spectrum Algaecide/Fungicide will control anthracnose, brown patch and algae growth on turf.

7.4 Unsupported Uses

Certain uses originally proposed with this application were not supported by efficacy and value data. Unsupported uses are outlined in Table 8 of Appendix 1.

8.0 Regulatory Decision

Health Canada's PMRA, under the authority of the *Pest Control Products Act* and Regulations, has granted conditional registration for the sale and use of Biosafe M-70 Hydrogen Peroxide Technical Bactericide and ZeroTolR Broad-Spectrum Algaecide/Fungicide, containing the technical grade active ingredient hydrogen peroxide, as an algaecide/fungicide for non-porous and wood surfaces in greenhouses, greenhouse irrigation waters, ornamentals in greenhouses and outdoors, as well as on turf.

An evaluation of available scientific information found that, under the approved conditions of use, the product has value and does not present an unacceptable risk to human health or the environment.

Although the risks and value have been found acceptable when all risk-reduction measures are followed, as a condition of these registrations, additional scientific information is being requested from the applicant. For more details, refer to the Section 12 Notice associated with these conditional registrations. The applicant will be required to submit this information within the time frames indicated below.

NOTE: The PMRA will publish a consultation document at the time when there is a proposed decision on applications to convert these conditional registrations to full registrations or on applications to renew the conditional registrations, whichever occurs first.

Value

Claims for ornamental bedding plants and turf are conditionally accepted, therefore, additional data is needed as follows:

- Data from one small-scale trial demonstrating that ZeroTolR Broad-Spectrum Algaecide/Fungicide is effective in controlling xanthomonas leaf spot caused by *Xanthomomas* spp. on ornamental bedding plants.

- Data from one small-scale trial demonstrating that ZeroTolR Broad-Spectrum Algaecide/Fungicide is effective in controlling alternaria leaf spot caused by *Alternaria* spp. on ornamental bedding plants.

- Data from one small-scale trial demonstrating that ZeroTolR Broad-Spectrum Algaecide/Fungicide is effective in controlling rhizoctonia aerial blight caused by *Rhizoctonia* spp. on ornamental bedding plants. An additional trial is required to extend the claim to ornamental shrubs.

- Data from one small-scale trial for each of the listed diseases (anthracnose, brown patch and algal) demonstrating that ZeroTolR Broad-Spectrum Algaecide/Fungicide is effective in controlling anthracnose, brown patch and algal growth on turf.

List of Abbreviations

BAF	bioaccumulation factor
BCF	bioconcentration factor
CAS	Chemical Abstracts Service
cm	centimetres
CEPA	Canadian Environmental Protection Act
DNA	deoxyribonucleic acid
EC_{50}	effective concentration on 50% of the population
ECETOX	European Centre for Ecotoxicology of Chemicals
EEC	Expected environmental concentration
g	gram
h	hour(s)
IUPAC	International Union of Pure and Applied Chemistry
kg	kilogram
K_{oc}	organic-carbon partition coefficient
K_{ow}	*n*–octanol-water partition coefficient
L	litre
LC_{lo}	Lethal Dose-low. Lowest Dose at which lethality occurs
LC_{50}	lethal concentration 50%
LD_{50}	lethal dose 50%
LOC	level of concern
m^2	metre(s) squared
m^3	metre(s) cubed
mg	milligram
mL	millilitre
N/A	not applicable
NOEC	no observed effect concentration
PCPA	*Pest Control Product Act*
p*K*a	dissociation constant
PMRA	Pest Management Regulatory Agency
ppm	parts per million
RQ	risk quotient
TSMP	Toxic Substances Management Policy
USEPA	United States Environmental Protection Agency
UV	ultraviolet

Appendix I Tables and Figures

Table 1 Fate and behaviour of hydrogen peroxide in the terrestrial environment

Property	Value	Transformation products	Comments
Abiotic transformation			
Hydrolysis	N/A	O_2 & H_2O	
Phototransformation on soil	N/A	N/A	
Phototransformation in air	20 hours	·OH & HO_2	
Biotransformation			
Biotransformation in aerobic soil	< 1 hour	O_2 & H_2O	Non-Persistant
Biotransformation in anaerobic soil	N/A	N/A	
Mobility			
Adsorption / desorption in soil	Koc = 0.813	O_2 & H_2O	Highly Mobile
Soil leaching (GUS)	- 8.348	O_2 & H_2O	Non-Leacher
Volatilization Vapour pressure at 20°C	706.8 – 933.26 Pa	Not applicable	Non-volitile from water
Field studies			
Field dissipation	N/A	O_2 & H_2O	
Field leaching	N/A	O_2 & H_2O	

Table 2 Fate and behaviour of hydrogen peroxide in the aquatic environment

Study type	Value	Transformation products	Comments
Abiotic transformation			
Hydrolysis	0.04 - 2.5 days	O_2 & H_2O	Non-Persistant
Phototransformation in water	10 days	O_2 & H_2O	Non-persistant
Biotransformation			
Biotransformation in aerobic water systems	< 1 – 2.5 days	O_2 & H_2O	Non-Persistant
Biotransformation in anaerobic water systems	N/A	O_2 & H_2O	Non-Persistant
Partitioning			
Adsorption / desorption in sediment	Koc = 0.831	N/A	Mobile
Field studies			
Field dissipation	N/A	Non-Persistant	

Table 3 Toxicity to Non-Target Species

Organism	Exposure	Endpoint value	Degree of toxicity[a]
Freshwater species			
Invertebrates: *Daphnia pulex*	48h-Acute	NOEC = 1.0 mg/L LC50 = 2.4 mg/L	Moderately Toxic
Fish: *Pimephales promelas*	96h-Acute	NOEC = 5.0 mg/L LC50 = 16.4 mg/L	Slightly Toxic
Algae: *Chlorella vulgaris*	72h-Acute	NOEC = 0.1 mg/L EC50 = 2.5 mg/L	
Marine species			
Fish *Kuhila sandvicenis*	Not reported	NOEC = 20 mg/L	

Organism	Exposure	Endpoint value	Degree of toxicity[a]
Marine alga *Sceletonema costatum*	72h-Acute	NOEC = 0.63 mg/L EC50 = 1.38 mg/L	
Algae: *Nitzchia closterium*	Acute (duration not reported)	EC50 = 0.85 mg/L	

a US EPA classification, where applicable

Table 4 Screening Level Risk Assessment on Non-target Species

Organism	Exposure	Endpoint value	Water Depth	EEC (mg/L)	RQ	Level of Concern Exceeded
Freshwater species						
Freshwater invertebrates (*Daphnia pulex)*	Acute 48h-LC_{50}	1.2 mg/L	80 cm	0.8	0.67	No
Freshwater fish *(Pimephales promelas)*	Acute 96h-LC_{50}	1.64 mg/L	80 cm	0.8	0.48	No
Freshwater Algae *(Chlorella vulgaris)*	Acute 72h-EC_{50}	1.25 mg/L	80 cm	0.8	0.64	No
Amphibians	Acute 1/10 96h-LC_{50}	1.64 mg/L	15 cm	4.3	2.6	Yes
Marine species						
Saltwater algae (*Nitzchia closterium)*	Acute EC_{50}	0.425 mg/L	80 cm	0.8	1.9	Yes

Table 5 Refined Risk Assessment on Non-Target Species

Organism	Exposure	Endpoint value (mg/L)	Water Depth	EEC (mg/L)	RQ	Level of Concern Exceeded
Freshwater species						
Amphibians	Acute	1.64	15 cm	0.3	0.18	No
Marine species						
Saltwater algae *(Nitzchia closterium)*	Acute	0.425	80 cm	0.0	0	No

Table 6 Toxic Substances Management Policy Considerations-Comparison to TSMP

Track 1 Criteria				
TSMP Track 1 Criteria	**TSMP Track 1 Criterion value**		**Active Ingredient Endpoints**	**Transformation Products Endpoints**
CEPA toxic or CEPA toxic equivalent[1]	Yes		Yes	-
Predominantly anthropogenic[2]	Yes		No	-
Persistence[3]:	Soil	Half-life ≥ 182 days	< 1 Day	-
	Water	Half-life ≥ 182 days	2.5-10 Days	-
	Sediment	Half-life ≥ 365 days	< 10 Days	-
	Air	Half-life ≥ 2 days or evidence of long range transport	Half-life and volatilisation are not important routes of dissipation and long-range atmospheric transport is unlikely to occur.	-
Bioaccumulation[4]	Log $K_{OW} \geq 5$		No	-
	BCF ≥ 5000		not available	-
	BAF ≥ 5000		not available	-
Is the chemical a TSMP Track 1 substance (all four criteria must be met)?			No, does not meet TSMP Track 1 criteria.	-

1 All pesticides will be considered CEPA-toxic or CEPA toxic equivalent for the purpose of initially assessing a pesticide against the TSMP criteria. Assessment of the CEPA toxicity criteria may be refined if required (i.e., all other TSMP criteria are met).

2 The policy considers a substance "predominantly anthropogenic" if, based on expert judgement, its concentration in the environment medium is largely due to human activity, rather than to natural sources or releases.

3 If the pesticide and/or the transformation product(s) meet one persistence criterion identified for one media (soil, water, sediment or air) than the criterion for persistence is considered to be met.

4 Field data (e.g., BAFs) are preferred over laboratory data (e.g., BCFs) which, in turn, are preferred over chemical properties (e.g., log K_{OW}).

Table 7 Alternative Products

Products registered	PCP #	Active ingredients	Label claims
Floralife Formula	20397	n-Alkyl (40% C12, 50% C14, 10% C16) dimethyl benzyl ammonium chloride (QAC) at 5.0%	Greenhouse or agricultural hard-surfaces use.
Effersan	25087	Sodium dichloro-s-triazinetrione (SDT) 30%	
Heritage Fungicide	26155	Azoxystrobin 500 g/kg	Anthracnose and brown patch on turf
Banner® MAXX	27003	Propiconazole 14.3%	
Banner 130EC	23693	Propiconazole 130 g/L	
Insignia EG	28859	Pyraclostrobin 20%	
COMPASS 50 WG	27527	Trifloxystrobin 50%	
Chipco Triton	29109	Triticonazole 19.2%	
Premis 200F	28387	Triticonazole 200 g/L	
Daconil ® 2787 Flowable		Chlorothalonil 40.4%	Anthracnose and brown patch on turf, fusarium leaf spot on Dracaena
CAPTAN 50 W	14823	Captan 50%	Brown patch on turf
MAESTRO 80DF	26408	Captan 80%	
Quintozene 75WP	27416	Quintozene 75%	
Terraclor Flowable	27691	Quintozene 40%	
Rovral	15213	Iprodione 500 g/kg	
Chipco Aliette	28299	Fosetyl AL 80%	Anthracnose on turf

Table 8 Use (label) Claims Proposed by Applicant Which are Not Supported

Proposed uses	Proposed rates
Evaporative coolers: Treat existing algae and slime contaminated surfaces with a 1:100 dilution.	1:500 or 2 mL for every litre of cooler water
Treatment of turf: Brown Spot, Dollar Spot, Copper Spot, Summer Patch, Stripe Smut, Take All Patch, Fairy Ring, Pink Snow Mold, Pythium, Phytophthora, Slime Molds and Scum.	**Curative:** 200-400 mL per 100 m^2. Use 11-19 litres per 100 m^2. **Preventative:** 70-200 mL per 100 m^2. Apply at 7-day intervals.
Treatment of turf: Anthracnose, Leaf Spot, Fusarium Blight, Rhizoctonia and Algae.	**Preventative:** 70-200 mL per 100 m^2. Apply at 7-day intervals.
Mist propagation of cuttings and plugs.	Inject using 1:1000 to 1:5000 dilutions.
Pre-plant dip treatment.	Use 1 litre in 100 litres of water, a dilution of 1:100.

Proposed uses	Proposed rates
Soil or media drench.	**Curative:** use a dilution of 1:100 or 12 mL per litre of clean water. **Preventative:** use a rate of 1:500 or 2 mL for every litre of water.
Foliar spray treatment of ornamentals in greenhouses and field.	**Preventative:** use a dilution of 1:300 or 4 mL per litre of clean water.
Foliar spray treatment of ornamentals in greenhouses and field: pseudomonas leaf spot on impatiens and phytophthora stem rot on zebra plants	**Curative:** use a dilution of 1:100 or 12 mL per litre of clean water. **Preventative:** use a rate of 1:300 or 4 mL for every litre of water.
Cut flowers.	Apply as a post harvest treatment. Use a dilution of 1:500 or 2 mL per litre of clean water.
Bareroot nursery stock.	Use a dilution of 1:100 or 12 mL per litre of water. Dip plants or spray until dripping wet.
Seed bed treatment.	Use a dilution of 1:50 or 20 mL per litre of clean water.
Chemigation System.	

References

A. List of Studies/Information Submitted by Registrant

1.0 Chemistry

1384170 2000, Preliminary Analysis and Enforcement, DACO: 2.13.1,2.13.2,2.13.3 CBI

1384171 2000, Waiver for Not Submitting Chemical and Physical Property Protocols and Certain Studies, DACO: 2.14.1,2.14.10,2.14.11, 2.14.12, 2.14.13,2.14.2, 2.14.3,2.14.4,2.14.5,2.14.6,2.14.7,2.14.8,2.14.9,2.15 CBI

1384175 Manufacturing Methods for the TGAI, Kirk-Othmer Encyclopedia of Chemical Technology (3rd Ed.). John Wiley and Sons, Inc., New York, NY, pp. 12-38, DACO: 2.11.1 CBI

1384177 Detailed Production Process Description, DACO: 2.11.3 CBI

1384178 Discussion of Formation of Impurities, DACO: 2.11.4 CBI

1384179 Specifications: Establishing Certified Limits DACO: 2.12.1, 2.12.2 CBI

1384180 Preliminary Analysis, DACO: 2.13.1,2.13.2,2.13.3,2.13.4 CBI

1059353 2000, Description of Starting Materials, DACO: 3.2.1 CBI

1059354 2000, Description of the Formulation Process, DACO: 3.2.2 CBI

1059356 1994, Determination of Free Hydrogen Peroxide Content, DACO: 3.4.1 CBI

1059357 1996, Zero Tolerance Preliminary Analysis and Precision and Accuracy of Analytical Method to Validate Certified Limits, DACO: 3.4.1 CBI

1059360 2000, Chemical and Physical Properties: Waiver Request, DACO: 3.5 CBI

1059361 1997, ZeroTol-Measurement of Physio-Chemical Properties, DACO: 3.5 CBI

2.0 Value

1417990 Mode of action and pest problem

1402983 Hard surface decontamination of bacteria and fungi

1616744 AOAC use-dilution method
1616743 Germicidal and detergent sanitizing action of disinfectants Test Organism Salmonella enterica

1616746 AOAC fungicidal product test for Oxidate

1616747 Additional AOAC disinfectant testing of oxidate in the presence of 5% blood serum and 400 ppm $CaCO_3$ hard water

1616748 AOAC disinfectant testing of oxidate in the presence of 5% blood serum and 400 ppm $CaCO_3$ hard water

1616749 1616743: Germicidal and detergent sanitizing action of disinfectants Test Organism Escherichia coli, Staphylococcus aureus

1616750 Comparison study on the efficacy of Zerotol when compared to traditional greenhouse sanitation agents such as Sodium hypochlorite and Quaternary ammonium compounds

1616751 Evaluating algaecidal effect of Storox in water treatment systems

1616752 Evaluation of Storox as a water treatment in dump tanks

1616759 Test the effectiveness of Zerotol when used as a water sanitation agent

1616760 Black root rot on your plug trays?

1662703 Zerotol: Mode of action

1334955 2006, A Summary of ZeroTol Studies to Support Its Use as a Broad Spectrum Algaecide and Fungicide, DACO: 10.1, 10.2.3.1, 10.3.1.

1334969 2006, Biofungicides Show Success Controlling Dollar Spot on Golf Courses, DACO: 10.2.3.2.

1616753 2000, Fungicide Tests for Control of Foliar Diseases Caused by Botrytis, Cornynespora, Fusarium and Powdery Mildew on Ornamentals, DACO: 10.2.3.3

1616754 2000, Bacterial Disease Control on Ornamentals Using Aliette, Kocide Greenshield and ZeroTol, DACO: 10.2.3.3

1616755 1996, Efficacy of Fungicides for Control of Botrytis kin in Petunias, DACO: 10.2.3.3

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1616757 1999, Fungicide for Rhizoctonia control on Ornamentals- 1999, DACO: 10.2.3.3

1616761 1999, 1999 Fungicide trials for the control of Alternaria, Helminthosporium, Phytophthora and Rhizoctonia diseases of ornamentals, DACO: 10.2.3.3

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B. Additional Information Considered

i) Published Information

1.0 Environment

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