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54 Titre : Deterrence of birds from pesticide-treated substances.

57 Abrégé :

This disclosure relates to bird-deterrent compositions and methods of using the same in deterring a bird from ingesting lethal doses of a pesticide- treated substance, such as a pesticide-treated plant seed. The bird-deterrent compositions comprise a bird repellent and/or a visual cue agent. Pesticide- treated substance that have been treated with the bird-deterrent compositions will prevent bird from ingesting lethal doses of the pesticide-treated substance, while not deterring the birds from ingesting non-lethal doses of the same pesticide-treated substances.

TITLE

DETERRENCE OF BIRDS FROM PESTICIDE-TREATED SUBSTANCES

CROSS-REFERENCE TO RELATED APPLICATIONS

5 This application claims priority to U.S. Provisional Patent Application No. 62/796,051, filed on January 23, 2019, the contents of which are incorporated herein in their entirety.

RELATED FEDERALLY SPONSORED RESEARCH

10 The work described in this application was sponsored by the US Department of Agriculture.

FIELD

The field relates to deterrence of birds from ingesting lethal doses of pesticide-treated substance while not preventing birds from ingesting non-lethal doses of the same pesticide-treated substances.

BACKGROUND

15 Pesticides and fungicides have been applied to a variety of substances, including, for example, crop, flower, and vegetable seeds, for protection from insects and plant disease for a long time. The active ingredients used in pesticides and fungicides have been regulated by the
20 Environmental Protection Agency (EPA) in the United States since the inception of the agency. Over the decades, the EPA has judged many of these active ingredients to be harmful to the environment or wildlife and, as a consequence, has removed the more harmful chemicals from the inventory in favor of more benign substances. This trend continues, and today the current list of registered pesticides still has residual negative effect.

25 For example, toxic substances such as Mesurol® (methiocarb) have been used in the past, but now banned by the EPA, to repel birds. Mesurol® has a very low LD₅₀, and thus birds are not repelled by this compound but rather are subject to death if a very small amount is consumed.

30 During planting on commercial grain farms, seed is spilled accidentally. The spilled seed should be buried to prevent wildlife from trying to eat the spilled seed, but there is inevitably some seed that falls from the planting equipment to the ground. Spilled seed is coated with pesticide and/or fungicides that will harm birds even if the animals consume a very small amount.

Pesticides can be lethal to birds in at least two ways. The first is direct lethal outcomes from eating a high enough quantity of pesticide-treated substances such as plant seeds. For example, one imidacloprid-treated corn seed, three to four treated cereal seeds, or four to five treated canola seeds can be lethal to the average bird. Mineau and Palmer, *The Impact of the Nation's Most Widely*
 5 *Used Insecticides on Birds*, American Bird Conservancy, March 2013. The second way a pesticide can be lethal to a bird is through a sublethal effect that can leave a bird disoriented or unable to avoid predators. This effect is a form of toxicosis, and the bird can act inebriated and ultimately die by not being able to protect itself. For example, it has been shown that approximately 72 million birds are killed directly by pesticides each year in the U.S., but sublethal effects are ten times more
 10 prevalent. Mineau and Palmer, *supra*.

The application of full, repellent-level doses of bird repellents prevent the loss of plant seed and but does not allow for the selective prevention of wildlife from consuming less than toxic levels of pesticides. Full, repellent-level doses of bird repellents have been established as being greater than or equal to 80% repellency based on laboratory feeding experiments. *See, e.g.,* Werner *et al.*,
 15 *Appl. Anim. Behav. Sci.* 121:190-96 (2009); Werner *et al.*, *J. Wildl. Manage.* 72:1863-68 (2008); Werner *et al.*, *J. Wildl. Manage.* 72:1007-11 (2008); Werner *et al.* *J. Wildl. Manage.* 71:1676-81 (2007).

What is needed, however, is a substantially lower dose of such repellents that can deter the bird from ingesting only lethal doses of pesticide or fungicide treated substances, but allowing the
 20 birds to accidentally eat non-lethal doses, thus lowering cost and protecting birds from lethal doses of such repellents.

SUMMARY

25 One aspect of the present disclosure is a method of deterring a bird from ingesting lethal doses of one or more pesticide-treated substances in a location, comprising applying to the one or more pesticide-treated substances a bird-deterrent composition comprising: (a) an anthraquinone, an anthrahydroquinone, flutolanil, a benzoquinone, an anthranilate, caffeine, cyhalothrin, methyl phenyl acetate, ethyl phenyl acetate, o-amino acetophenone, 2-amino-4,5-dimethyl acetophenone,
 30 veratryl amine, cinnamic aldehyde, cinnamic acid, cinnamide, chitosan, an essential oil, or a combination thereof; and (b) TiO₂, CaCO₃, or a combination thereof,

thereby forming one or more bird-deterrent pesticide-treated substances whereby less than or equal to about 60% of the bird-deterrent pesticide-treated substances in said location are not ingested by a bird.

Another aspect of the present disclosure is a method of deterring a bird from ingesting a lethal dose of a pesticide-treated substance, comprising applying to the pesticide-treated substance a bird-deterrent composition comprising: (a) about 100 ppm to about 600 ppm of an anthraquinone, an anthrahydroquinone, flutolanil, a benzoquinone, an anthranilate, caffeine, cyhalothrin, methyl phenyl acetate, ethyl phenyl acetate, o-amino acetophenone, 2-amino-4,5-dimethyl acetophenone, veratryl amine, cinnamic aldehyde, cinnamic acid, cinnamide, chitosan, an essential oil, or a combination thereof; and (b) about 100 ppm to about 2000 ppm of TiO_2 , CaCO_3 , or a combination thereof; thereby forming a bird-deterrent pesticide-treated substance.

A further aspect of the present disclosure is A pesticide-treated substance comprising: (a) about 100 ppm to about 600 ppm of an anthraquinone, an anthrahydroquinone, flutolanil, a benzoquinone, an anthranilate, caffeine, cyhalothrin, methyl phenyl acetate, ethyl phenyl acetate, o-amino acetophenone, 2-amino-4,5-dimethyl acetophenone, veratryl amine, cinnamic aldehyde, cinnamic acid, cinnamide, chitosan, an essential oil, or a combination thereof; and (b) about 100 ppm to about 2000 ppm of TiO_2 , CaCO_3 , or a combination thereof.

A further aspect of the present disclosure is for a method of deterring a bird from ingesting a pesticide-treated plant seed, comprising contacting the pesticide-treated plant seed with an effective amount of a composition comprising: (a) an anthraquinone, an anthrahydroquinone, flutolanil, a benzoquinone, an anthranilate, caffeine, cyhalothrin, methyl phenyl acetate, ethyl phenyl acetate, o-amino acetophenone, 2-amino-4,5-dimethyl acetophenone, veratryl amine, cinnamic aldehyde, cinnamic acid, cinnamide, chitosan, an essential oil, or a combination thereof; and (b) TiO_2 , CaCO_3 , or a combination thereof, whereby the composition on the pesticide-treated plant seed is effective to deter the bird from ingesting the pesticide-treated plant seed but does not repel the bird from a location comprising the pesticide-treated plant seed.

An additional aspect of the disclosure is for a pesticide-treated plant seed comprising a coating, the coating comprising: (a) about 100 ppm to about 600 ppm of an anthraquinone, an anthrahydroquinone, flutolanil, a benzoquinone, an anthranilate, caffeine, cyhalothrin, methyl phenyl acetate, ethyl phenyl acetate, o-amino acetophenone, 2-amino-4,5-dimethyl acetophenone, veratryl amine, cinnamic aldehyde, cinnamic acid, cinnamide, chitosan, an essential oil, or a

combination thereof; and (b) about 100 ppm to about 2000 ppm of TiO_2 , CaCO_3 , or a combination thereof.

Another aspect of the disclosure is for a method for the deterrence of a bird from a pesticide-treated plant seed, comprising applying to the pesticide-treated plant seed a deterrence effective
 5 amount of a composition comprising: (a) an anthraquinone, an anthrahydroquinone, flutolanil, a benzoquinone, an anthranilate, caffeine, cyhalothrin, methyl phenyl acetate, ethyl phenyl acetate, o-amino acetophenone, 2-amino-4,5-dimethyl acetophenone, veratryl amine, cinnamic aldehyde, cinnamic acid, cinnamide, chitosan, an essential oil, or a combination thereof; and (b) TiO_2 , CaCO_3 , or a combination thereof.

10 Other aspects, objects and advantages will become apparent to those skilled in the art upon reference to the detailed description that hereinafter follows.

DETAILED DESCRIPTION

15 Applicants specifically incorporate the entire contents of all cited references in this disclosure. Further, when an amount, concentration, or other value or parameter is given as either a range or a list of upper values and lower values, this is to be understood as specifically disclosing all ranges formed from any pair of any upper range limit or value and any lower range limit or value, regardless of whether ranges are separately disclosed. Where a range of numerical values is recited
 20 herein, unless otherwise stated, the range is intended to include the endpoints thereof, and all integers and fractions within the range. It is not intended that the scope of the present disclosure be limited to the specific values recited when defining a range.

Definitions

25 In this disclosure, a number of terms and abbreviations are used. The following definitions are provided.

As used herein, the term “about” or “approximately” means within 5%, 4%, 3%, 2%, 1%, 0.9%, 0.8%, 0.7%, 0.6%, 0.5%, 0.4%, 0.3%, 0.2%, or 0.1%, or less of a given value or range.

The term “comprising” is intended to include embodiments encompassed by the terms
 30 “consisting essentially of” and “consisting of”. Similarly, the term “consisting essentially of” is intended to include embodiments encompassed by the term “consisting of”.

The terms “deter”, “detering”, “deterrent”, or “deterrence” mean an amount of bird repellent applied to a substance, such as a plant seed, and in some embodiments a pesticide-treated substance, such as a plant seed, that is sufficient to ward off a bird from ingesting lethal doses of the pesticide treated substance, but is ineffective to repel a bird from ingestion of non-lethal doses of the same substance (as the term “repel” is defined below). This level can vary over different concentrations based on the type of bird. The terms “deter”, “detering”, “deterrent”, or “deterrence” can also mean the use of a bird-deterrent composition comprising a bird repellent and/or a visual cue agent in amounts such that less than or equal to about 60% of available substance in a location is not ingested by a bird. In some embodiments, deterrence can mean that about 59%, about 58%, about 57%, about 56%, about 55%, about 54%, about 53%, about 52%, about 51%, about 50%, about 49%, about 48%, about 47%, about 46%, about 45%, about 44%, about 43%, about 42%, about 41%, about 40%, about 39%, about 38%, about 37%, about 36%, about 35%, about 34%, about 33%, about 32%, about 31%, about 31% or less of a plant seed in a location is not ingested by a bird. Because the amount of bird repellent used is lower than what is required to be a repellent (i.e. greater than or equal to 80%), a treated substance will not be completely safe from ingestion by the bird. However, the amount of treated substance accidentally taken or ingested by the bird will be below the threshold of bird toxicity.

The term “bird-deterrent pesticide-treated substance” means a pesticide-treated substance that comprises, or otherwise to which has been added, a deterrent level of bird repellent composition and/or visual cue agent (a “bird-deterrent composition”), such that a bird will be deterred from ingesting lethal doses of the pesticide-treated substance, but will not be deterred from ingesting non-lethal doses of the same pesticide-treated substance.

The term “effective amount” is an amount of bird repellent plus an amount of visual cue agent on plant seeds, in some embodiments pesticide-treated plant seeds, in a location which results in a significant deterrence of a bird from coated plant seeds in said location in comparison to uncoated control plant seeds in said location (i.e., plant seeds without bird repellent and visual cue agent). The actual effective amount will vary with the particular bird repellent and visual cue agent selected, their formulation(s) (depending on whether the bird repellent and visual cue agent are formulated together or separately), the bird, the plant seed, and environmental factors.

The term “essential oils” refers to aromatic, volatile liquids extracted from plant material. Essential oils are often concentrated hydrophobic liquids containing volatile aroma compounds.

Essential oil chemical constituents can fall within general classes, such as terpenes (e.g., p-cymene, limonene, sabinene, α-pinene, γ-terpinene, β-caryophyllene), terpenoids (e.g., citronellal, thymol, carvacrol, carvone, borneol), and phenylpropanoids (e.g., cinnamaldehyde, eugenol, vanillin, safrole). Essential oils can be natural (i.e., derived from plants) or synthetic.

5 The term “pesticide” means a fungicide, insecticide, nematocide, herbicide, safener, biopesticide, and/or growth regulator. Also contemplated are mixtures of pesticides within one of abovementioned classes and/or mixtures of pesticides from two or more of the abovementioned classes. The skilled worker is familiar with such pesticides, which can be found, for example, in the Pesticide Manual, 16th Ed. (2013), The British Crop Protection Council, London. Exemplary

10 insecticides include carbamates, organophosphates, organochlorine insecticides, phenylpyrazoles, pyrethroids, neonicotinoids, spinosins, avermectins, milbemycins, juvenile hormone analogs, alkyl halides, organotin compounds nereistoxin analogs, benzoylureas, diacylhydrazines, METI acarizides, and insecticides such as chloropicrin, pymetrozin, flonicamid, clofentezin, hexythiazox, etoxazole, diafenthiuron, propargite, tetradifon, chlorofenapyr, DNOC, buprofezine, cyromazine,

15 amitraz, hydramethylnon, acequinocyl, fluacrypyrim, rotenone, or their derivatives. Exemplary fungicides include dinitroanilines, allylamines, anilinopyrimidines, antibiotics, aromatic hydrocarbons, benzenesulfonamides, benzimidazoles, benzisothiazoles, benzophenones, benzothiadiazoles, benzotriazines, benzyl carbamates, carbamates, carboxamides, carboxylic acid diamides, chloronitriles cyanoacetamide oximes, cyanoimidazoles, cyclopropanecarboxamides,

20 dicarboximides, dihydrodioxazines, dinitrophenyl crotonates, dithiocarbamates, dithiolanes, ethylphosphonates, ethylaminothiazolecarboxamides, guanidines, hydroxy-(2-amino)pyrimidines, hydroxyanilides, imidazoles, imidazolinones, inorganic substances, isobenzofuranones, methoxyacrylates, methoxycarbamates, morpholines, N-phenylcarbamates, oxazolidinediones, oximinoacetates, oximinoacetamides, peptidylpyrimidine nucleosides, phenylacetamides,

25 phenylamides, phenylpyrroles, phenylureas, phosphonates, phosphorothiolates, phthalamic acids, phthalimides, piperazines, piperidines, propionamides, pyridazinones, pyridines, pyridinylmethylbenzamides, pyrimidinamines, pyrimidines, pyrimidinonehydrazones, pyrroloquinolinones, quinazolinones, quinolines, quinones, sulfamides, sulfamoyltriazoles, thiazolecarboxamides, thiocarbamates, thiophanates, thiophenecarboxamides, toluamides,

30 triphenyltin compounds, triazines, and triazoles. Exemplary herbicides include acetamides, amides, aryloxyphenoxypropionates, benzamides, benzofuran, benzoic acids, benzothiadiazinones,

bipyridylium, carbamates, chloroacetamides, chlorocarboxylic acids, cyclohexanediones, dinitroanilines, dinitrophenol, diphenyl ether, glycines, imidazolinones, isoxazoles, isoxazolidinones, nitriles, N-phenylphthalimides, oxadiazoles, oxazolidinediones, oxyacetamides, phenoxycarboxylic acids, phenylcarbamates, phenylpyrazoles, phenylpyrazolines, phenylpyridazines, phosphinic acids, phosphoroamidates, phosphorodithioates, phthalamates, pyrazoles, pyridazinones, pyridines, pyridinecarboxylic acids, pyridinecarboxamides, pyrimidinediones, pyrimidinyl(thio)benzoates, quinolinecarboxylic acids, semicarbazones, sulfonylaminocarbonyltriazolinones, sulfonylureas, tetrazolinones, thiadiazoles, thiocarbamates, triazines, triazinones, triazoles, triazolinones, triazolocarboxamides, triazolopyrimidines, triketones, uracils, ureas.

The terms “repel”, “repelling”, or “repellency” mean use of a bird repellent composition in amounts such that greater than or equal to 80% of bird repellent treated substance, such plant seed, and in some embodiments pesticide-treated substances such as plant seed, in a location is not ingested by a bird.

The term “lethal dose(s)” means a dose or amount of a substance that is lethal to a bird when ingested by that bird. The term is inclusive of sublethal doses which although in quantity may not directly cause death upon ingestion, a sublethal dose has an effect that can leave a bird disoriented or unable to avoid predators. This effect is a form of toxicosis which ultimately leads to death because the bird cannot protect itself from harm.

The term “non-lethal dose(s)” means a dose or amount of a substance that is not lethal or sublethal to a bird when ingested by that bird.

Methods

Applicants have solved the problem of birds ingesting lethal doses of pesticide-treated substances through development of pesticide-treated substances having deterrent, not repellent, levels of a combination of a bird repellent and visual cue agent. Thus, the further problem of birds accidentally ingesting spilled or scattered pesticide-treated substances is also solved as such birds are deterred from ingesting spilled or scattered pesticide-treated substances when such substances are coated with the compositions disclosed herein at the deterrent, not repellent, levels taught herein.

The major difference in the use of repellents and deterrents is thus the present objective. If the objective, as is known in the art, is to protect pesticide-treated substances, such as plant seed,

from loss to a bird, then a repellent-level concentration (i.e. 80% or greater repellency) of the bird repellent / visual cue composition must be used (see, e.g., US20160157477, incorporated herein by reference in its entirety). However, as disclosed herein, if the objective is to merely *deter* birds from ingesting pesticide-treated substances, then a lower level of the bird repellent / visual cue

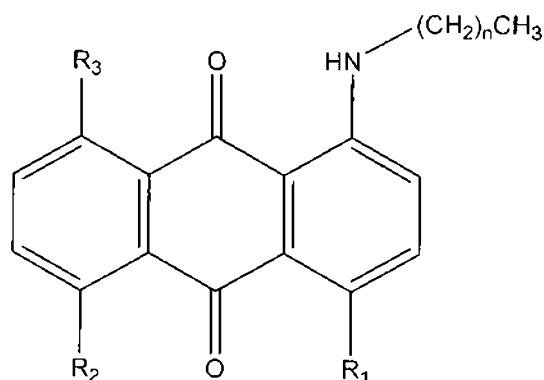
composition (i.e., 60% repellency or less) should be used. A deterrence level of the bird repellent / visual cue composition is an amount of bird repellent that is ineffective as a repellent, but effective as a deterrent to prohibit birds from ingesting lethal doses of a pesticide-treated substance, but does not prohibit ingestion of non-lethal doses of the same pesticide-treated substance as would occur when using repellent level concentrations of the bird repellent / visual cue composition. The cumulative consumption of the deterrent level pesticide-treated substance is managed below the levels of toxicity and behavioral change that would threaten the bird.

Some embodiments of the present disclosure are directed to a method of deterring a bird from ingesting lethal doses of a pesticide-treated substance, in some embodiments a pesticide-treated plant seed, but does not prohibit ingestion of non-lethal doses of the same pesticide-treated substance. The method of this embodiment comprising applying to the pesticide-treated substance a deterrent effective amount of a bird repellent composition comprising a bird repellent and a visual cue agent.

In some embodiments, the bird repellent is an anthraquinone, an anthrahydroquinone, flutolanil, a benzoquinone, an anthranilate, caffeine, cyhalothrin, methyl phenyl acetate, ethyl phenyl acetate, o-amino acetophenone, 2-amino-4,5-dimethyl acetophenone, veratryl amine, cinnamic aldehyde, cinnamic acid, cinnamide, chitosan, an essential oil, or a combination thereof.

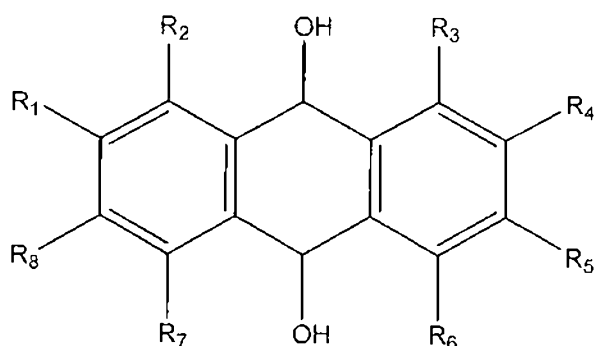
In embodiments where an anthraquinone is present, the anthraquinone can be, e.g., 9,10-anthraquinone, 1,4-anthraquinone, 1,2-anthraquinone, 2,6-anthraquinone, 1-nitroanthraquinone, 1-chloroanthraquinone, 1-aminoanthraquinone, 1-hydroxyanthraquinone, 2-hydroxyanthraquinone, 2-aminoanthraquinone, 2-chloroanthraquinone, 1,5-dihydroxyanthraquinone, 2,6-dihydroxyanthraquinone, 1,8-dihydroxyanthraquinone, 1,4-diaminoanthraquinone, 2-methylanthraquinone, 2-ethylanthraquinone, 2-amylanthraquinone, 2-t-butylanthraquinone, 2-(4-methyl-pentyl) anthraquinone, 2-(4-methylpentenyl)anthraquinone, 1-methoxyanthraquinone, 1,5-dimethoxyanthraquinone, 2-(N,N-dimethylamino)anthraquinone, 1,4-bis((ethenylphenyl)amino)-9,10-anthraquinone, 1,8-bis((ethenylphenyl)amino)-9,10-anthraquinone, 1-((ethenylphenyl)amino)-9,10-anthraquinone, 1-ethenylphenyl amino-4-hydroxy-9,10-anthraquinone, 1-

((ethenylphenyl)amino)-4-((4-methylphenyl)amino)-9,10-anthraquinone, 1,4-bis((allyloxyethylphenyl)amino)-9,10-anthraquinone, 1-(allyloxymethylphenyl)amino-4-hydroxy-9,10-anthraquinone, 1-(allyloxyethylphenyl)amino-4-hydroxy-9,10-anthraquinone, 1-(4-(2-(allylaminocarbonyloxy)ethyl)phenylamino)-4-hydroxyanthraquinone, 1-(4-(2-methacryloyloxyethyl)phenyl)amino-hydroxy-9,10-anthraquinone, 2,6-dihydroxy-9,10-anthraquinone, 1,5-dimethyl-2,6-dihydroxy-9,10-anthraquinone, 2,3,6,7-tetrahydroxy-9,10-anthraquinone, 1,3,5,7-tetrahydroxy-2,4,6,8-tetramethyl-9,10-anthraquinone, 2,7-dihydroxy-1,8-dimethyl-9,10-anthraquinone, or a combination thereof. In some embodiments, the anthraquinone has the structure:



wherein one of R_1 , R_2 , and R_3 is $--NH--(CH_2)_m--CH_3$, and the other two are each independently selected from hydrogen or C_{1-4} alkyl group; and n and m are each independently an integer from 4 to 17 (US2018/0327603, incorporated herein by reference).

In embodiments where an anthrahydroquinone is present, the anthrahydroquinone can be, e.g., 9,10-dihydroanthrahydroquinone, 1,4-dihydroanthrahydroquinone, 1,4,4a,9a-tetrahydroanthrahydroquinone, or any combination thereof. In some embodiments, the anthrahydroquinone has the structure:



wherein R_{1-8} are, independently, a hydrogen atom or an alkyl group having 1-6 carbon atoms.

In embodiments where a benzoquinone is present, the benzoquinone can be, e.g., 1,4-benzoquinone, 1,2-benzoquinone, or a combination thereof.

In embodiments where an anthranilate is present, the anthranilate can be, e.g., methyl anthranilate, ethyl anthranilate, dimethyl anthranilate, diethyl anthranilate, or a combination thereof.

In embodiments where an essential oil is present, the essential oil can be, e.g., peppermint oil, citronella, garlic oil, lavender oil, juniper oil, cinnamon oil, rosemary oil, eucalyptus oil, basil oil, clove oil, lemongrass oil, thyme oil, oregano oil, lemon oil, geranium oil, rosewood oil, or a combination thereof.

In some embodiments, the visual cue agent is TiO_2 , $CaCO_3$, or a combination thereof. In embodiments where TiO_2 is present, the TiO_2 can be, e.g., rutile, ilmenite, anatase, or brookite sourced. In embodiments where $CaCO_3$ is present, the $CaCO_3$ can be, e.g., calcite, aragonite, or vaterite sourced. Thus, some embodiments are directed to combinations of bird repellent and visual cue agent such as an anthraquinone and TiO_2 , $CaCO_3$, or a combination thereof; an anthrahydroquinone and TiO_2 , $CaCO_3$, or a combination thereof; flutolanil and TiO_2 , $CaCO_3$, or a combination thereof; a benzoquinone and TiO_2 , $CaCO_3$, or a combination thereof; an anthranilate and TiO_2 , $CaCO_3$, or a combination thereof; caffeine and TiO_2 , $CaCO_3$, or a combination thereof; cyhalothrin and TiO_2 , $CaCO_3$, or a combination thereof; methyl phenyl acetate and TiO_2 , $CaCO_3$, or a combination thereof; ethyl phenyl acetate and TiO_2 , $CaCO_3$, or a combination thereof; o-amino acetophenone and TiO_2 , $CaCO_3$, or a combination thereof; 2-amino-4,5-dimethyl acetophenone and TiO_2 , $CaCO_3$, or a combination thereof; veratryl amine and TiO_2 , $CaCO_3$, or a combination thereof; cinnamic aldehyde and TiO_2 , $CaCO_3$, or a combination thereof; cinnamic acid and TiO_2 , $CaCO_3$, or a combination thereof; cinnamide and TiO_2 , $CaCO_3$, or a combination thereof; chitosan and TiO_2 , $CaCO_3$, or a combination thereof; an essential oil and TiO_2 , $CaCO_3$, or a combination thereof; or any of the aforementioned bird repellents in any combination with and TiO_2 , $CaCO_3$, or a combination thereof.

Additional methods, in other embodiments, relate to methods of deterring a bird from ingesting lethal doses of a pesticide-treated substance, such as a pesticide-treated plant seed, comprising contacting the pesticide-treated substance with a deterrent effective amount of a composition comprising an anthraquinone, an anthrahydroquinone, flutolanil, a benzoquinone, an anthranilate, caffeine, cyhalothrin, methyl phenyl acetate, ethyl phenyl acetate, o-amino

acetophenone, 2-amino-4,5-dimethyl acetophenone, veratryl amine, cinnamic aldehyde, cinnamic acid, cinnamide, chitosan, an essential oil, or a combination thereof; and TiO_2 , CaCO_3 , or a combination thereof, whereby application of deterrent levels of the composition on the pesticide-treated substance is effective to deter the bird from ingesting lethal doses of the pesticide-treated substance, but does not repel the bird from a location comprising the pesticide-treated substance.

Further, some embodiments are directed to methods for the prohibiting a bird from ingesting lethal doses of a pesticide-treated substance, such as a pesticide-treated plant seed, comprising applying to the pesticide-treated substance a deterrence effective amount of a composition comprising an anthraquinone, an anthrahydroquinone, flutolanil, a benzoquinone, an anthranilate, caffeine, cyhalothrin, methyl phenyl acetate, ethyl phenyl acetate, o-amino acetophenone, 2-amino-4,5-dimethyl acetophenone, veratryl amine, cinnamic aldehyde, cinnamic acid, cinnamide, chitosan, an essential oil, or a combination thereof; and TiO_2 , CaCO_3 , or a combination thereof.

The bird repellent, visual cue agent, or both can, in some embodiments, be formulated with a suitable inert carrier as is known in the art. Formulations of the bird repellent and the visual cue agent can vary with the particular target and method of application. The agents may, for example, be formulated as solutions, emulsions, emulsifiable concentrates, suspension concentrates, wettable powders, dusts, granules, adherent dusts or granules, and/or aerosols. In particular, the carrier can be agronomically acceptable and suitable for application onto structures, agricultural fields or crops, seeds, seedlings, orchards, vineyards, livestock feed, fertilizers, pesticides, animal or insect baits, and combinations thereof. The particular carrier can be a liquid or solid phase carrier, including but not limited to water, aqueous surfactant mixtures, alcohols, ethers, hydrocarbons, halogenated hydrocarbons, glycols, ketones, esters, oils (natural or synthetic), clays, kaolinite, silicas, cellulose, rubber, talc, vermiculate, and synthetic polymers. The bird repellent and the visual cue agent can also be formulated in a single composition or formulated in different compositions and applied separately. The bird repellent and/or the visual cue agent can also be formulated in admixture with other agriculturally beneficial agents, including but not limited to, ultraviolet stabilizers, antioxidants, baits, adjuvants, herbicidal agents, fertilizers, and pesticides including insecticides and fungicides.

In some embodiments, the application step results in about 100 ppm to about 600 ppm, about 100 ppm to about 550 ppm, about 100 ppm to about 500 ppm, about 100 ppm to about 450 ppm, about 100 ppm to about 400 ppm, about 100 ppm to about 350 ppm, about 100 ppm to about 300

ppm, about 100 ppm to about 250 ppm, about 100 ppm to about 200 ppm, about 100 ppm to about 150 ppm, about 150 ppm to about 600 ppm, about 200 ppm to about 600 ppm, about 250 ppm to about 600 ppm, about 300 ppm to about 600 ppm, about 350 ppm to about 600 ppm, about 400 ppm to about 600 ppm, about 450 ppm to about 600 ppm, about 500 ppm to about 600 ppm, about 550 ppm to about 600 ppm, about 100 ppm to about 600 ppm, about 200 ppm to about 500 ppm, about 200 ppm to about 450 ppm, about 200 ppm to about 400 ppm, about 200 ppm to about 350 ppm, about 200 ppm to about 300 ppm, about 200 ppm to about 250 ppm, about 250 ppm to about 500 ppm, about 300 ppm to about 500 ppm, about 350 ppm to about 500 ppm, about 400 ppm to about 500 ppm, about 450 ppm to about 500 ppm, about 300 ppm to about 400 ppm, about 300 ppm to about 450 ppm, or about 350 ppm to about 400 ppm of the bird repellent composition applied to the pesticide-treated substance. In some embodiments, the pesticide-treated substance comprises about 100, about 105, about 110, about 115, about 125, about 130, about 135, about 140, about 145, about 150, about 155, about 160, about 165, about 170, about 175, about 180, about 185, about 190, about 195, about 200, about 205, about 210, about 215, about 220, about 225, about 230, about 235, about 240, about 245, about 250, about 255, about 260, about 265, about 270, about 275, about 280, about 285, about 295, about 300, about 305, about 310, about 315, about 325, about 330, about 335, about 340, about 345, about 350, about 355, about 360, about 365, about 370, about 375, about 380, about 385, about 390, about 395, about 400, about 405, about 410, about 415, about 425, about 430, about 435, about 440, about 445, about 450, about 455, about 460, about 465, about 470, about 475, about 480, about 485, about 490, about 495, about 500, about 505, about 510, about 515, about 525, about 530, about 535, about 540, about 545, about 550, about 555, about 560, about 565, about 570, about 575, about 580, about 585, about 590, about 595, or about 600 ppm of the bird repellent composition.

In some embodiments, the application step results in about 100 ppm to about 2000 ppm, about 100 ppm to about 1950 ppm, about 100 ppm to about 1900 ppm, 100 ppm to about 1850 ppm, 100 ppm to about 1800 ppm, 100 ppm to about 1750 ppm, 100 ppm to about 1700 ppm, 100 ppm to about 1650 ppm, 100 ppm to about 1600 ppm, 100 ppm to about 1550 ppm, 100 ppm to about 1500 ppm, 100 ppm to about 1450 ppm, 100 ppm to about 1400 ppm, 100 ppm to about 1350 ppm, 100 ppm to about 1300 ppm, 100 ppm to about 1250 ppm, 100 ppm to about 1200 ppm, 100 ppm to about 1150 ppm, 100 ppm to about 1100 ppm, 100 ppm to about 1050 ppm, 100 ppm to about 1000 ppm, 100 ppm to about 950 ppm, 100 ppm to about 900 ppm, 100 ppm to about 850 ppm, 100 ppm

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about 1940, about 1950, about 1960, about 1970, about 1980, about 1990, or about 2000 of the visual cue agent.

In some embodiments, the ratio of visual cue agent to bird repellent composition applied to the pesticide-treated substance can be about 0.1:1 to about 10:1. In some embodiments, the ratio of visual cue agent to bird repellent applied to the pesticide-treated substance can be about 0.1:1, about 0.2:1, about 0.3:1, about 0.4:1, about 0.5:1, about 0.6:1, about 0.7:1, about 0.8:1, about 0.9:1, about 1:1, about 1.1:1, about 1.2:1, about 1.3:1, about 1.4:1, about 1.5:1, about 1.6:1, about 1.7:1, about 1.8:1, about 1.9:1, about 2:1:1, about 2.2:1, about 2.3:1, about 2.4:1, about 2.5:1, about 2.6:1, about 2.7:1, about 2.8:1, about 2.9:1, about 3.0:1, about 3.1:1, about 3.2:1, about 3.3:1, about 3.4:1, about 3.5:1, about 3.6:1, about 3.7:1, about 3.8:1, about 3.9:1, about 4:1, about 4.1:1, about 4.2:1, about 4.3:1, about 4.4:1, about 4.5:1, about 4.6:1, about 4.7:1, about 4.8:1, about 4.9:1, about 5:1, about 5.1:1, about 5.2:1, about 5.3:1, about 5.4:1, about 5.5:1, about 5.6:1, about 5.7:1, about 5.8:1, about 5.9:1, about 6:1, about 6.1:1, about 6.2:1, about 6.3:1, about 6.4:1, about 6.5:1, about 6.6:1, about 6.7:1, about 6.8:1, about 6.9:1, about 7:1, about 7.1:1, about 7.2:1, about 7.3:1, about 7.4:1, about 7.5:1, about 7.6:1, about 7.7:1, about 7.8:1, about 7.9:1, about 8:1, about 8.1:1, about 8.2:1, about 8.3:1, about 8.4:1, about 8.5:1, about 8.6:1, about 8.7:1, about 8.8:1, about 8.9:1, about 9:1, about 9.1:1, about 9.2:1, about 9.3:1, about 9.4:1, about 9.5:1, about 9.6:1, about 9.7:1, about 9.8:1, about 9.9:1, or about 10:1.

In some embodiments, the bird can be, e.g., a perching bird from the order Passeriformes, e.g., sapayoa, ovenbirds, antbirds, ground antbirds, gnateaters, antpittas, tapaculos, tyrant flycatchers, tityras, contigas, manakins, sharpbills, shrikes, vireos, jays, crows, magpies, ravens, larks, swallows, martins, chickadees, titmice, penduline tits, bushtits, nuthatches, treecreepers, wrens, gnatcatchers, dippers, bulbuls, kinglets, leaf-warblers, Old World warblers, reed-warblers, donacobius, grassbirds, Old World flycatchers, starlings, mynas, thrushes, mockingbirds, thrashers, accentors, wagtails, pipits, waxwings, silky-flycatchers, palmchats, olive warblers, longspurs, wood-warblers, tanagers, American sparrows, towhees, juncos, cardinals, grosbeaks, blackbirds, meadowlarks, cowbirds, grackles, orioles, finches, Old World sparrows, weavers, estrildid finches, or whydahs.

Pesticide-treated substances include any substance that is treated with any pesticide, and particularly, levels of pesticide that can be lethal to birds of ingested. Some examples include, but are not limited to crops, seeds, seedlings, orchards, vineyards, livestock feed, fertilizers, and animal

or insect baits. Seeds include, but are not limited to plant seeds such as seeds of corn, fruit, grains, grasses, legumes, lettuce, millet, oats, rice, row crops, sorghum, sunflower, tree nuts, turf, vegetables, or wheat.

The composition of the present disclosure comprising a bird repellent and a visual cue agent can be applied to the pesticide-treated substance by any method known to the skilled artisan. For example, a bird repellent and/or a visual cue agent can be applied to the pesticide-treated substance by spraying the composition on the pesticide-treated substance or by immersing the pesticide-treated substance in a liquid dispersion of the bird repellent and/or visual cue composition or a liquid solution of the precursor thereof. In some embodiments, the process of coating the pesticide-treated substances, and in particular, pesticide-treated seeds, involves the use of a "seed box" in which the seeds are stirred, while spraying on the liquid coating containing the bird repellent and/or visual cue agent composition or precursors thereof. Fine droplets of the treating dispersion can be sprayed at a rate such that the seeds remain free-flowing. The treating material can also be sprayed onto the pesticide-treated substances while they are fluidized in air. Bird repellents and/or a visual cue agents and precursors thereof can be applied in this manner. Pesticide-treated substances can also, in some embodiments, be coated by immersion in the treating solution, noting that this method involves intensive drying. So long as the coating is sufficient to provide an effective amount of the composition comprising a bird repellent and a visual cue agent, further coating thickness is not needed.

The bird repellent coating can be formulated such that both compositions (i.e., bird repellent and visual cue agent) are simultaneously applied to the pesticide-treated substance, or the coating can be applied stepwise, in that either the bird repellent or the visual cue agent is first applied to the pesticide-treated substance followed by the other component. The order of which of the bird repellent or visual cue agent, if applied separately, is not particularly important so long as the resultant, coated pesticide-treated substance deters birds from ingesting lethal doses thereof. Furthermore, if the bird repellent and visual cue agent are applied separately, the initial coating (i.e., either the bird repellent or the visual cue agent) can be allowed to partially or fully dry prior to the second coating with the other component. In some embodiments, the initial coating may be rapidly followed by the second coating, where no drying of the initial coating occurs.

Pesticide-treated plant seeds comprising deterrent levels of the bird repellent composition of the present disclosure can be planted by any known method. For example, in some embodiments,

the seeds are direct seeded into the soil or scattered over the soil. Direct seeding can be accomplished, e.g., by broadcasting (random spreading over target area), row planting (measured distance between seed rows), or sowing (e.g., hand sowing or open-field sowing). Because of the deterrent nature of the coated seeds, spilled or scattered seed is acceptable with the present methods

5 because such spilled or scattered seeds will deter birds from ingesting the seeds.

EXAMPLES

Example 1

10 For the purpose of protecting wild birds from crops seeds (for example corn, rice, soybean) treated with pesticides such as insecticides or fungicides. Table 1 comparatively summarizes recommended anthraquinone application rates (fluid ounces per hundredweight of seed) for the repellency and deterrence of wild birds from consuming an amount of seed such that the toxic level of the pesticide is reached in the bird. A repellency rate would require a higher dose with the

15 objective of protecting the crop seed from loss to the bird where less than 5% of the crop seed is lost. This translates to a repellency rate of $\geq 80\%$ in caged bird trials. By comparison, deterrence describes $\leq 60\%$ repellency. Far below the necessary dose to keep the birds from being repelled but sufficient to keep birds from accidental toxicosis.

20 **Table 1**

Species	AQ + TiO2 Repellency Formulation has 13.6% AQ and 36.4% TiO2	AQ + TiO2 Deterrence Formulation has 13.6% AQ and 36.4% TiO2
Birds /Corn Seed	10 fl oz/cwt 1230 ppm AQ 3299 ppm TiO2	1 fl oz/cwt 123 ppm AQ 330 ppm TiO2
Birds/Rice Seed	14 fl oz/cwt 1726 ppm AQ 4618 ppm TiO2	2 fl oz/cwt 246 ppm AQ 660 ppm TiO2

CLAIMS

1. A method of deterring a bird from ingesting lethal doses of one or more pesticide-treated substances in a location, comprising applying to the one or more pesticide-treated substances a bird-deterrent composition comprising:

(a) an anthraquinone, an anthrahydroquinone, flutolanil, a benzoquinone, an anthranilate, caffeine, cyhalothrin, methyl phenyl acetate, ethyl phenyl acetate, o-amino acetophenone, 2-amino-4,5-dimethyl acetophenone, veratryl amine, cinnamic aldehyde, cinnamic acid, cinnamide, chitosan, an essential oil, or a combination thereof; and

(b) TiO_2 , CaCO_3 , or a combination thereof,

thereby forming one or more bird-deterrent pesticide-treated substances whereby less than or equal to about 60% of the bird-deterrent pesticide-treated substances in said location are not ingested by a bird.

2. A method of deterring a bird from ingesting a lethal dose of a pesticide-treated substance, comprising applying to the pesticide-treated substance a bird-deterrent composition comprising:

(a) about 100 ppm to about 600 ppm of an anthraquinone, an anthrahydroquinone, flutolanil, a benzoquinone, an anthranilate, caffeine, cyhalothrin, methyl phenyl acetate, ethyl phenyl acetate, o-amino acetophenone, 2-amino-4,5-dimethyl acetophenone, veratryl amine, cinnamic aldehyde, cinnamic acid, cinnamide, chitosan, an essential oil, or a combination thereof; and

(b) about 100 ppm to about 2000 ppm of TiO_2 , CaCO_3 , or a combination thereof; thereby forming a bird-deterrent pesticide-treated substance.

3. The method of claim 1 or 2, wherein component (a) of the bird-deterrent composition comprises an anthraquinone.

4. The method of claim 3, wherein the pesticide-treated substance comprises about 160 ppm anthraquinone.

5. The method of any one of claims 1-3, wherein component (b) of the bird-deterrent composition is TiO_2 .
- 5 6. The method of claim 5, wherein the pesticide-treated substance comprises about 400 ppm TiO_2 .
7. The method of any one of claims 1-3, wherein component (b) of the bird-deterrent composition is CaCO_3 .
- 10 8. The method of claim 7, wherein the pesticide-treated substance comprises about 160 ppm CaCO_3 .
9. A pesticide-treated substance comprising:
- 15 (a) about 100 ppm to about 600 ppm of an anthraquinone, an anthrahydroquinone, flutolanil, a benzoquinone, an anthranilate, caffeine, cyhalothrin, methyl phenyl acetate, ethyl phenyl acetate, o-amino acetophenone, 2-amino-4,5-dimethyl acetophenone, veratryl amine, cinnamic aldehyde, cinnamic acid, cinnamide, chitosan, an essential oil, or a combination thereof; and
- (b) about 100 ppm to about 2000 ppm of TiO_2 , CaCO_3 , or a combination thereof.
- 20 10. The pesticide-treated substance of claim 9, wherein component (a) is an anthraquinone.

TITLE

DETERRENCE OF BIRDS FROM PESTICIDE-TREATED SUBSTANCES

ABSTRACT

5 This disclosure relates to bird-deterrent compositions and methods of using the same in
detering a bird from ingesting lethal doses of a pesticide-treated substance, such as a pesticide-
treated plant seed. The bird-deterrent compositions comprise a bird repellent and/or a visual cue
agent. Pesticide-treated substance that have been treated with the bird-deterrent compositions will
prevent bird from ingesting lethal doses of the pesticide-treated substance, while not deterring the
10 birds from ingesting non-lethal doses of the same pesticide-treated substances.