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(54) Title: PESTICIDAL COMPOSITIONS AND RELATED METHODS

(57) Abstract: A pesticidal composition comprises at least one anionic surfactant and an active ingredient group alpha (AIGA) compound at the weight ratio of anionic surfactant to AIGA compound of at least about 20:1. The pesticidal composition shows an enhanced residue activity of the AIGA compound in soil. A method of controlling a sap-feeding insect on a top part of the plant comprises applying a pesticidally effective amount of such pesticidal composition to soil around a root system of the plant. A method of controlling pests comprises applying a pesticidally effective amount of such pesticidal composition to at least one of: soil, seed of a plant, a portion of a plant, and locus where control of pests is desired.



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PESTICIDAL COMPOSITIONS AND RELATED METHODS

PRIORITY CLAIM

5 This application claims the benefit of the filing date of United States Provisional Patent Application Serial Number 62/141,135, filed March 31, 2015, for “PESTICIDAL COMPOSITIONS AND RELATED METHODS.”

TECHNICAL FIELD

10 Various embodiments relate generally to pesticidal compositions and to methods of using such pesticidal compositions in controlling pests.

BACKGROUND

 Controlling pest population is essential to modern agriculture, food storage, and
15 hygiene. Currently, safer and effective encapsulated pesticide formulations play a significant role in controlling pest populations. Unfortunately, most pesticide formulations, especially liquid based formulations, lose their efficacy relatively soon after application. Such pesticide formulations must, therefore, be reapplied to ensure pest control. Additionally, formulations with a short period of post application activity may result in
20 periods of time during which an area is vulnerable to infestation by pests.

BRIEF DESCRIPTION OF THE DRAWINGS

 FIG. 1 is a graph showing % sulfoxaflor recovery in the inoculated Midwest soil after three days for non-limiting examples of the pesticidal compositions;

25 FIG. 2 is a graph showing % sulfoxaflor recovery after three days for the pesticidal compositions having different amounts of sodium dioctylsulfosuccinate GEROPON® SDS surfactant;

 FIG. 3 is a graph showing % sulfoxaflor recovery at different time intervals after soil application for the pesticidal compositions comprising sodium dioctylsulfosuccinate
30 GEROPON® SDS surfactant;

 FIG. 4 is a graph showing a comparative effect of different antifoaming agents on the % sulfoxaflor recovery;

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FIG. 5 is a graph showing % sulfoxaflor recovery in the inoculated soil from Fresno, California after three days for non-limiting examples of the pesticidal compositions;

FIG. 6 is a graph showing numbers of live green peach aphids (*Myzus persicae*) at 21 days after the soil treatment using different compositions; and

FIG. 7 is a graph showing numbers of live green peach aphids (*Myzus persicae*) at 28 days after the soil treatment using different compositions.

DETAILED DESCRIPTION

The term “pest,” as used herein, means and includes invertebrates, organisms and microorganisms (including pathogens) that negatively affect plants or animals. This includes organisms that spread disease and/or damage the host and/or compete for host nutrients. In addition, plant pests are organisms known to associate with plants and which, as a result of that association, cause a detrimental effect on the health and vigor of plants. Plant pests include but are not limited to fungi, bacteria, insects, arachnids, nematodes, slugs, snails, etc.

The term “pesticide,” as used herein, means and includes any substance that may be used to control agricultural, natural, environmental, and domestic/household pests, such as insects, fungi, bacteria, and viruses.

The terms “control” and “controlling,” as used herein, mean and include killing, eradication, arresting in growth, inhibition, reducing in number and/or imparting sterility.

The term “insecticide,” as used herein, refers to a specific category of pesticides used for controlling insects.

The term “active ingredient,” as used herein, means and includes a material having activity useful in controlling pests, and/or that is useful in helping other materials have better activity in controlling pests, examples of such materials include, but are not limited to, acaricides, algicides, avicides, bactericides, fungicides, herbicides, insecticides, molluscicides, nematocides, rodenticides, virucides, antifeedants, bird repellents, chemosterilants, herbicide safeners, insect attractants, insect repellents, mammal repellents, mating disrupters, plant activators, plant growth regulators, and synergists. Specific examples of such materials may include, but are not limited to, the materials listed in the active ingredient group alpha. Active ingredient group alpha compound has a short soil

half-life, and therefore, its soil stability may be improved using the technology described herein.

The term “active ingredient group alpha” (hereafter “AIGA”), as used herein, means and includes collectively the following materials:

5 (1) Insecticides - acephate, acetamiprid, aldicarb, aldoxycarb, bendiocarb, butocarboxim, carbaryl, cartap hydrochloride, demeton-S-methyl, dimethoate, flonicamid, formothion, heptenophos, imidacloprid, isazofos, methamidophos, methomyl, monocrotophos, nitenpyram, omethoate, oxamyl, oxydemeton-methyl, phorate, sulfoxaflor (preferred), thiacloprid, thiamethoxam, thiocyclam hydrogen oxalate, thiometon, thiometon sulfone, triazamate, and vamidothion;

 (2) Fungicides - carboxin, cymoxanil, dodine, ethirimol, fosetyl-aluminum, fuberidazole, hymexazol, iprobenfos, metalaxyl, metalaxyl-M, metsulfosax, ofurace, oxycarboxin, propamocarb hydrochloride, pyroquilon, and triadimefon.

 The term “initial soil,” as used herein, means soil in its original state without adding anything to it.

 The term “initial soil moisture,” as used herein, means an amount of water in the soil, as described by a weight percent.

 The term “dry soil mass,” as used herein, means a total mass of the dry soil particles without any moisture (as if all of the moisture had evaporated out of it). The dry soil mass may be determined using the following equation:

$$\text{Dry Soil Mass} = \text{Initial Soil Mass} - (\text{Initial Soil Mass} \times \text{Moisture Content } \%)$$

 The term “final soil mixture,” as used herein, means the soil mass after addition of the pesticidal formulation, which may include sulfoxaflor solution, surfactant/adjuvant solution, and/or additional water, to the initial soil.

25 The term “total soil liquid,” as used herein, means a total amount of liquid in soil including the initial soil moisture and the added pesticidal formulation, which may include sulfoxaflor solution, surfactant/adjuvant solution, and/or additional water. The total soil liquid may be determined using the following equation:

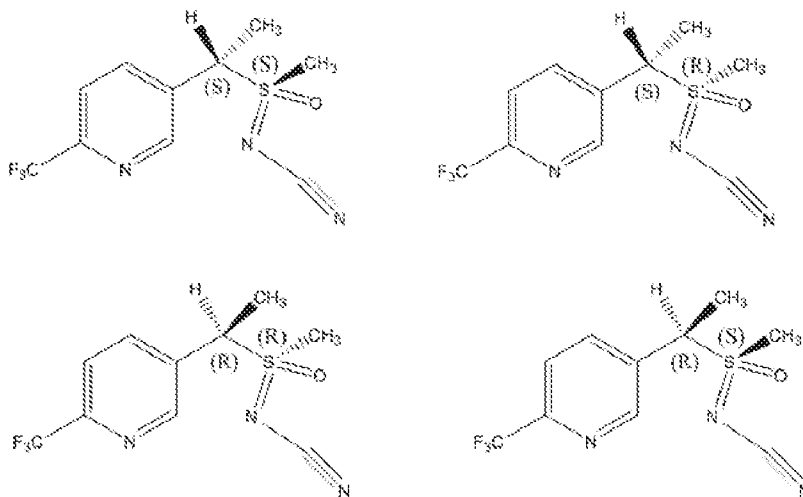
$$\text{Total Soil Liquid} = (\text{Initial Soil Mass} \times \text{Moisture Content } \%) + \text{Mass of Pesticidal Formulation}$$

 The term “ppm,” as used herein, stands for part-per-million, and refers to the amount of a component of interest in micrograms (μg) per one gram of soil sample.

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The term “sulfoxaflor concentrate,” as used herein, refers to a sulfoxaflor concentrate at a sulfoxaflor concentration of 240 grams per liter (g/L) (such as the CLOSER® SC insecticide available from Dow AgroSciences) or a sulfoxaflor concentrate at a sulfoxaflor concentration of 500 grams per kilogram (g/kg) (such as the TRANSFORM® WG insecticide also available from Dow AgroSciences). The sulfoxaflor concentrate may be in the form of an aqueous suspension concentrate formulation (SC), a water dispersible granule formulation (WDG), an oil dispersion formulation (OD), or a suspension emulsion formulation (SE).

As used herein, the term “sulfoxaflor” is the provisionally approved name for [methyl(oxo){1-[6-(trifluoromethyl)-3-pyridyl]ethyl}-λ⁶-sulfanylidene]cyanamide, which is also known as *N*-[methyloxido[1-[6-(trifluoromethyl)-3-pyridinyl]ethyl]-λ⁴-sulfanylidene]cyanamide (CAS Name, CAS registry number 946578-00-3). Sulfoxaflor is a mixture of four possible stereoisomers, the chemical structures of which are as follows:



Sulfoxaflor demonstrates efficacy against a broad spectrum of pests. Sulfoxaflor has demonstrated excellent acute efficacy against a broad spectrum of sap-feeding insects like aphids. Sulfoxaflor has also been shown to have a high level of efficacy against hard to control true bugs, such as Lygus. Additionally, sulfoxaflor possesses high levels of intrinsic activity and controls insect populations resistant to neonicotinoid and other insecticide modes of action including the organophosphates, pyrethroids, and carbamates. For example, foliar application of sulfoxaflor has demonstrated efficacy under field conditions that is equal or superior to neonicotinoid compounds at equivalent or lower use rates, particularly for aphid control.

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However, the residual activity of sulfoxaflor in soil applications is relatively less than desirable because sulfoxaflor degrades very rapidly in soil. The degradation of pesticides in soil may be defined by half-life DT_{50} value. Half-life DT_{50} is an amount of time taken for 50% of the pesticide to disappear from soil by degradation. The degradation processes may be biological processes (biodegradation) or physicochemical processes (hydrolysis, photolysis, etc.). The pesticide having half-life DT_{50} value of less than 20 days is readily degradable in soil.

The average half-life DT_{50} of sulfoxaflor in laboratory soil metabolism studies, conducted in the dark, was less than one day. Degradation was also rapid under field conditions, with an average half-life DT_{50} of four days in field dissipation studies. Improving stability of sulfoxaflor in soil would extend the sulfoxaflor soil half-life making it available for plant uptake to control sap-feeding insects on the top part of the plant for longer periods of time. Therefore, the sulfoxaflor pesticidal composition with improved soil stability is desirable in order to increase the lifetime of sulfoxaflor in soil and to slow the rate of loss due to degradation.

In one particular embodiment, the pesticidal composition comprises at least one anionic surfactant and an active ingredient group alpha (AIGA) compound, wherein the weight ratio of anionic surfactant to AIGA compound is at least about 20:1, and particularly at least about 25:1.

The pesticidal composition includes a unique combination of anionic surfactant and AIGA compound at a selected weight ratio. The pesticidal composition increases the soil half-life of AIGA compound, while maintaining (if not enhancing) the pesticidal activities of AIGA compound.

In some embodiments, the pesticidal composition comprises at least one anionic surfactant and an AIGA compound, wherein the weight ratio of anionic surfactant to AIGA compound is between about 100:1 and about 20:1, more particularly between about 100:1 and about 30:1, and still more particularly between about 100:1 and about 40:1.

In some embodiments, the pesticidal composition comprises at least one anionic surfactant and an AIGA compound, wherein the weight ratio of anionic surfactant to AIGA compound is between about 65:1 and about 20:1, more particularly between about 65:1 and about 25:1, and still more particularly between about 65:1 and about 30:1.

In some embodiments, the pesticidal composition comprises at least one anionic surfactant and an AIGA compound, wherein the weight ratio of anionic surfactant to AIGA

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compound is between about 50:1 and about 20:1, more particularly between about 50:1 and about 25:1, and still more particularly between about 50:1 and about 30:1.

In some further embodiments, the pesticidal composition comprises at least one anionic surfactant and an AIGA compound, wherein the weight ratio of anionic surfactant to AIGA compound is between about 40:1 and about 20:1, and more particularly between about 40:1 and about 30:1.

In yet further embodiments, the pesticidal composition comprises at least one anionic surfactant and an AIGA compound, wherein the weight ratio of anionic surfactant to AIGA compound is between about 30:1 and about 20:1, and more particularly between about 30:1 and about 25:1.

The AIGA compound may include collectively the following materials: (1) an insecticide comprising acephate, acetamiprid, aldicarb, aldoxycarb, bendiocarb, butocarboxim, carbaryl, cartap hydrochloride, demeton-S-methyl, dimethoate, flonicamid, formothion, heptenophos, imidacloprid, isazofos, methamidophos, methomyl, monocrotophos, nitenpyram, omethoate, oxamyl, oxydemeton-methyl, phorate, sulfoxaflor (preferred), thiacloprid, thiamethoxam, thiocyclam hydrogen oxalate, thiometon, thiometon sulfone, triazamate, vamidothion, or mixtures thereof; (2) a fungicide comprising carboxin, cymoxanil, dodine, ethirimol, fosetyl-aluminum, fuberidazole, hymexazol, iprobenfos, metalaxyl, metalaxyl-M, metsulfosax, ofurace, oxycarboxin, propamocarb hydrochloride, pyroquilon, triadimefon, or mixtures thereof; or a mixture of (1) and (2).

In one particular embodiment, the AIGA compound in the pesticidal composition comprises sulfoxaflor. Thus, the pesticidal composition may comprise at least one anionic surfactant and sulfoxaflor, wherein the weight ratio of anionic surfactant to sulfoxaflor is at least about 20:1, and particularly at least about 25:1. In some embodiments, the weight ratio of anionic surfactant to sulfoxaflor is between about 100:1 and about 20:1, more particularly between about 100:1 and about 30:1, and still more particularly between about 100:1 and about 40:1.

Anionic surfactants may include, but are not limited to, sulfonates, lignosulfonates, sulfates, phosphates, carboxylates, or salts thereof. Non-limiting examples of cationic counterions of the anionic surfactants in salt form may include, but are not limited to, alkali metal, alkaline-earth metal, ammonium, or (C1–C6) alkyl ammonium cation.

Sulfonate surfactants may include, but are not limited to, alkylaryl sulfonate surfactants; alkyl sulfonate surfactants; alkyl ether sulfonate surfactants; α -olefin sulfonate

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surfactants such as sodium salt of (C4–C6) α -olefin sulfonate; paraffin sulfonate
surfactants; diphenylsulfonates; α -olefinsulfonates; sulfonates of fatty acids or oils;
sulfonates of ethoxylated alkylphenols; condensed naphthalenesulfonates; sulfonates of
dodecyl- or tridecylbenzenes; naphthalenesulfonates, such as MORWET® DB powder
5 which is sodium *N*-butyl naphthalene sulfonate surfactant available from Akzo Nobel N.V.;
alkylnaphthalene sulfonates; sulfosuccinates; alkyl ether sulfosuccinates;
sulfosuccinamates; isethionates; or taurates such as sodium 2-[methylethanolamino]ethane-
1-sulfonate GEROPON® T 77 surfactant available from Rhodia, Inc.

Non-limiting examples of alkylaryl sulfonate surfactants may include, but are not
10 limited to, calcium branched dodecyl benzenesulfonate (CaDDBS), sodium dodecyl
benzene sulfonate, sodium octadecyl phenyl sulfonate, isopropylamine dodecyl benzene
sulfonate, disodium alkyl diphenyl oxide disulfonates, sodium xylene sulfonate, or sodium
tridecyl benzene sulfonate.

Non-limiting examples of alkyl sulfonate surfactants and alkyl ether sulfonate
15 surfactants may include, but are not limited to, sodium butane sulfonate, sodium pentane
sulfonate, sodium hexane sulfonate, sodium octane sulfonate, sodium decyl sulfonate,
sodium lauryl sulfate, ammonium lauryl sulfate, ammonium laureth sulfate,
triethanolamine laureth sulfate, monoethanolamine laureth sulfate, diethanolamine lauryl
sulfate, diethanolamine laureth sulfate, lauric monoglyceride sodium sulfate, sodium
20 laureth sulfate, potassium lauryl sulfate, potassium laureth sulfate, sodium trideceth sulfate,
or ammonium tridecyl sulfate.

Non-limiting examples of alkyl sulfosuccinate surfactants and alkyl ether
sulfosuccinate surfactants may include, but are not limited to, sodium dioctylsulfosuccinate
GEROPON® SDS surfactant from Rhodia, Inc., or disodium laureth sulfosuccinate.

25 Sulfate surfactants may include, but are not limited to, sulfates of fatty acids or oils
such as sodium dodecyl sulfate (SDS), sulfates of ethoxylated alkylphenols, sulfates of
alcohols, sulfates of ethoxylated alcohols, sulfates of fatty acid esters, or alkyl ether
sulfonates.

Phosphate surfactants may include, but are not limited to, monoalkyl phosphate
30 surfactants; monoalkyl ether phosphate surfactants; dialkyl phosphate surfactants; dialkyl
ether phosphate surfactants; or alkoxyated tristyrylphenol phosphates such as potassium
salt of ethoxylated tristyrylphenol phosphate SOPROPHOR® FLK surfactant from Rhodia,
Inc.

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Carboxylate surfactants may include, but are not limited to, alkyl carboxylate surfactants such as laureth carboxylate; alkyl ether carboxylate surfactants; polycarboxylate surfactants such as AGRILAN® 755 surfactant from Akzo Nobel N.V., which is a hydrophilic comb polymer with PEG methacrylate chains; sodium polycarboxylate, 5 GEROPON® T/36 surfactant from Rhodia, Inc.; alkyl carboxylated alcohol; alkylphenol ethoxylates; glutamates such as sodium *N*-cocoyl L-glutamate; or sarcosinates such as sodium lauryl sarcosinate.

Lignosulfonate surfactants may include, but are not limited to, sodium lignosulfonate such as POLYFON® H, POLYFON® O, POLYFON® T, and POLYFON® 10 F from MeadWestvaco Corporation.

The pesticidal composition may include a solvent. Non-limiting examples of suitable solvents may include, but are not limited to, acetone and other ketones, alcohols, esters, aromatic hydrocarbons, aliphatic hydrocarbons, ethers, water, or mixtures thereof.

The pesticidal composition may further include at least one inert ingredient. The 15 optional inert ingredient may be any material commonly used in the art of pesticidal formulation as described, *inter alia*, in “McCutcheon’s Detergents and Emulsifiers Annual,” MC Publishing Corp., Ridgewood, New Jersey, 1998 and in the “Encyclopedia of Surfactants,” Vol. I-III, Chemical Publishing Co., New York, 1980-81.

In some embodiments, the pesticidal composition may further include at least one 20 additive that allows the pesticidal composition to be at the required concentration and in an appropriate form, permits ease of application and handling, offers ease and stability during transportation and storage, and/or provides enhanced pesticide activity. By way of non-limiting examples, the additive may include, but are not limited to, an antifoaming agent, antioxidant, a dispersant, a thickener, a preservative, a pH buffer, an antifreezing agent, or 25 a diluent.

Any known antifoaming agents may be used. Non-limiting examples of antifoaming agents may include, but are not limited to, polydialkylsiloxane (e.g., polydimethylsiloxane), hydrocarbon oil, tetramethydecynediol, or dimethyloctynediol.

Non-limiting examples of antioxidants may include, but are not limited to, alkyl 30 phenol (e.g., butylated hydroxytoluene and anisole), alkyl gallate, ascorbic acid, or tocopherol.

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By way of examples and not limitation, the dispersants may include, but are not limited to, a blend of an alkyl naphthalene sulfonate condensate and lignosulfonate, such as MORWET® D-360 powder commercially available from Akzo Nobel N.V.

Any known thickeners may be used. Non-limiting examples of thickeners may include, but are not limited to, a microcrystalline cellulose gel such as AVICEL® CL 611 thickener from FMC Corporation (Philadelphia, PA), or an organic gum such as KELZAN® S xanthan gum from CP Kelco U.S., Inc. (Atlanta, GA), or both.

The pesticidal composition may optionally include at least one preservative. By way of non-limiting example, the preservative may be an aqueous solution of 1,2-benzisothiazolin-3-one, such as PROXEL® GXL preservative from Arch UK Biocides Limited (England).

Non-limiting examples of pH buffer may include, but are not limited to, an aqueous solution of a weak acid and its conjugate base, or a weak base and its conjugate acid such as, for example, citric acid, ascorbic acid, potassium phosphate or sodium phosphate. The buffer solution may be formulated to maintain a desired pH of about 2 to about 6, particularly a pH of about 2 to about 4 of the pesticidal composition.

Suitable antifreezing agents may include, but are not limited to, propylene glycol, ethylene glycol and glycerol, or mixtures thereof.

In some embodiments, the pesticidal composition may further include an adjuvant surfactant to enhance deposition, wetting and/or penetration of the pesticidal composition onto the target soil, crop, or organism. These optional adjuvant surfactants may be employed as one component of the pesticidal composition during the preparation of pesticidal composition. Alternatively, these optional adjuvant surfactants may be mixed (e.g., tank mixed) with the pesticidal composition after the pesticidal composition is prepared. The amount of adjuvant surfactant may vary from about 0.01% to about 1% by volume, based on a spray-volume of water, preferably from about 0.05% to about 0.5% volume. Suitable adjuvant surfactants may include, but are not limited to, ethoxylated nonyl phenols, ethoxylated synthetic or natural alcohols, salts of the esters or sulfosuccinic acids, ethoxylated organosilicones, ethoxylated fatty amines, or blends of surfactants with mineral or vegetable oils.

The pesticidal composition may be prepared by mixing at least one anionic surfactant and an AIGA compound at a predetermined weight ratio of anionic surfactant to AIGA compound, in at least one solvent to form a base formulation. Then, other

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ingredients may be mixed with the base formulation to form the pesticidal composition. Alternatively, the pesticidal composition may be prepared by mixing at least one anionic surfactant, an AIGA compound, and other ingredients in at least one solvent.

In one particular embodiment, the pesticidal composition is prepared by first
5 producing a sulfoxaflor concentrate having a sulfoxaflor concentration of 240 g/L or 500 g/kg, and then mixing (e.g., tank mixing) at least one anionic surfactant with the sulfoxaflor concentrate.

Accordingly, in some embodiments, a method of preparing the pesticidal composition comprises mixing at least one anionic surfactant with a sulfoxaflor
10 concentrate, wherein the sulfoxaflor concentrate has a sulfoxaflor concentration of 240 g/L or a 500 g/kg.

The present disclosure also envisages to a method of controlling pests. The method comprises applying a pesticidally effective amount of the pesticidal composition to at least one of: soil, seed of a plant, a portion of a plant, and locus where control of pests is desired.

Furthermore, the present disclosure also envisages a method of controlling sap-
15 feeding insects on the top part of plants by applying the pesticidal composition to the soil around the root system of the plant. The pesticidal composition may be applied to soil using any suitable methods that ensure the penetration of the pesticidal composition into soil. Non-limiting examples of such applications may include, but are not limited to,
20 nursery tray application, furrow application, soil drenching, soil injection, drip irrigation, or application through sprinklers or central pivot.

Furthermore, the present disclosure envisages a method of controlling pests that comprises applying the pesticidal composition to soil. Upon applying the pesticidal composition to soil, the plant roots may absorb the pesticidal composition from soil and
25 take it up into the foliar portions of the plant to control root and stem feeding pests such as, without limitation, above ground chewing pests and sap-feeding pests.

Furthermore, the present disclosure envisages a method of controlling pests that comprises applying the pesticidal composition to a portion of the plant. By way of non-limiting examples, control of foliar-feeding insects may be achieved by drip irrigation or
30 furrow application, by treating the soil with for example pre- or post-planting soil drench, or by treating the seeds of a plant before planting with the pesticidal composition.

The pesticidal composition may be formulated into various forms for appropriate uses. By way of non-limiting examples, the pesticidal composition may be formulated as a

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concentrated emulsion, an emulsifiable concentrate, a suspension concentrate, a water soluble liquid, an ultralow volume solution, a water dispersible granule, a granule, a gel, a dry flowable and wettable powder, a dust, a tablet, a microencapsulation, a seed treatment, a bait, or a fumigant.

5 The pesticidal composition may be applied as a liquid formulation. By way of non-limiting examples, the liquid formulation may include, but is not limited to, water-soluble formulation, water-emulsifiable formulation, water-dispersible formulation, oil-soluble formulation, or oil-dispersible formulation.

10 The pesticidal composition may be applied as an aqueous suspension or emulsion prepared from a concentrated formulation of the pesticidal composition. Such water-soluble, water-dispersible, or water-emulsifiable formulation may be either solid (usually known as a wettable powder or a water dispersible granule) or liquid (usually known as an emulsifiable concentrate or an aqueous suspension).

15 The pesticidal composition may be applied as a wettable powder. A wettable powder, which may be compacted to form a water dispersible granule, may comprise an intimate mixture of the pesticidal composition, a carrier and, optionally, additional surfactants for facilitating the dispersion in water. Non-limiting examples of the carriers may include, but are not limited to, attapulgite clays, montmorillonite clays, diatomaceous earths, or purified silicates. By way of non-limiting examples, the optional surfactants for
20 facilitating the dispersion in water may include, but are not limited to, sulfonated lignins, condensed naphthalenesulfonates, naphthalenesulfonates, alkylbenzenesulfonates, alkyl sulfates, or nonionic surfactants such as ethylene oxide adducts of alkyl phenols.

25 The pesticidal composition may be applied as an emulsifiable concentrate. An emulsifiable concentrate of the pesticidal composition may comprise the pesticidal composition, such as from about 50 to about 500 g/L of liquid dissolved in a carrier that is either a water-miscible solvent or a mixture of water-immiscible organic solvent and emulsifiers. Non-limiting examples of useful organic solvents may include, but are not limited to, aromatics such as xylenes; petroleum fractions such as the high-boiling naphthalenic; olefinic portions of petroleum such as heavy aromatic naphtha; terpenic
30 solvents such as rosin derivatives; aliphatic ketones such as cyclohexanone; and complex alcohols such as 2-ethoxyethanol. Suitable emulsifiers for emulsifiable concentrate may be chosen from conventional anionic and nonionic surfactants.

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The pesticidal composition may be applied as an aqueous dispersible formulation. An aqueous dispersible formulation may comprise a suspension of water-insoluble pesticidal composition dispersed in an aqueous carrier at a concentration in the range from about 5% to about 50% by weight. Dispersions may be prepared by finely grinding the
5 pesticidal composition and vigorously mixing it into a carrier comprised of water and surfactants. Ingredients, such as inorganic salts and synthetic or natural gum, may also be added, to increase the density and viscosity of the aqueous carrier. It is often most effective to grind and mix the pesticidal composition at the same time by preparing the aqueous mixture and homogenizing it in an implement such as a sand mill, ball mill, or piston-type
10 homogenizer.

The pesticidal composition may be applied as a granular formulation. A granular formulation may contain from about 0.5% to about 10% by weight of the pesticidal composition, based on the total weight of the granular formulation. The pesticidal composition may be dispersed in an inert carrier which consists entirely or in large part of
15 coarsely divided inert material such as attapulgite, bentonite, diatomite, clay or a similar inexpensive substance. In some embodiments, a granular formulation may be prepared by diluting the pesticidal composition in a suitable solvent and applying it to a granular carrier which has been preformed to the appropriate particle size, in the range of from about 0.5 millimeters (mm) to about 3 mm. A suitable solvent is a solvent in which the pesticidal
20 composition is substantially or completely soluble. In some embodiments, granular formulation may be prepared by making a dough or paste of the carrier, the pesticidal composition and solvent, then crushing and drying the dough or paste to obtain the desired granular particles.

The pesticidal composition may be applied as water dispersible granule, or dry
25 flowable formulation. A water dispersible granule may include from about 10% to about 70% by weight of the pesticidal composition, based on the total weight of the water dispersible granule. Such water dispersible granule may be obtained through mixing and/or spraying the pesticidal composition onto a carrier with the addition of a dispersing and/or wetting agent, and combining with water to form a mixture suitable for further
30 processing using known granulation technologies, such as pan granulation, extrusion, spray-drying, fluid bed agglomeration, and the like.

The pesticidal composition may be applied as a dust. In some embodiments, the pesticidal composition may be prepared by intimately mixing the pesticidal composition

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with a suitable dusty agricultural carrier. Non-limiting examples of such dusty agricultural carriers may include, but are not limited to, kaolin clay, ground volcanic rock, and the like. Dust may contain from about 1% to about 10% by weight of the pesticidal composition, based on the total weight of the dust. In some embodiments, dust may be prepared by
5 impregnating the pesticidal composition onto a carrier in a similar manner to that described for granule above.

The pesticidal composition may be applied in the form of a solution in an appropriate organic solvent. By way of non-limiting examples, such organic solvents may include, but are not limited to, petroleum oils or spray oils.

10 In some embodiments, the pesticidal composition may be applied in conjunction with another active formulation that comprises one or more of other insecticides or fungicides or herbicides, in order to obtain control of a wider variety of pests, diseases or weeds. Another active formulation may be one of the components used for formulating the pesticidal composition. Alternatively, another active formulation may be post-added to the
15 pesticidal composition. Furthermore, the pesticidal composition may be applied at the same time as another active formulation, or applied sequentially with another active formulation.

Insecticides that may be employed beneficially in conjunction with the pesticidal composition may include, but are not limited to: AIGA compounds, antibiotic insecticides such as allosamidin and thuringiensin; macrocyclic lactone insecticides such as spinosad,
20 spinetoram, and other spinosyns including the 21-butenyl spinosyns and their derivatives; avermectin insecticides such as abamectin, doramectin, emamectin, eprinomectin, ivermectin and selamectin; milbemycin insecticides such as lepimectin, milbemectin, milbemycin oxime and moxidectin; arsenical insecticides such as calcium arsenate, copper acetoarsenite, copper arsenate, lead arsenate, potassium arsenite and sodium arsenite;
25 biological insecticides such as *Bacillus popilliae*, *B. sphaericus*, *B. thuringiensis subsp. aizawai*, *B. thuringiensis subsp. kurstaki*, *B. thuringiensis subsp. tenebrionis*, *Beauveria bassiana*, *Cydia pomonella granulosus* virus, Douglas fir tussock moth nuclear polyhedrosis virus (NPV), gypsy moth NPV, *Helicoverpa zea* NPV, Indian meal moth granulosus virus, *Metarhizium anisopliae*, *Nosema locustae*, *Paecilomyces fumosoroseus*,
30 *P. lilacinus*, *Photographus luminescens*, *Spodoptera exigua* NPV, trypsin modulating oostatic factor, *Xenorhabdus nematophilus*, and *X. bovienii*; plant incorporated protectant insecticides such as Cry1Ab, Cry1Ac, Cry1F, Cry1A.105, Cry2Ab2, Cry3A, mir Cry3A, Cry3Bb1, Cry34, Cry35, and VIP3A; botanical insecticides such as anabasine,

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azadirachtin, *d*-limonene, nicotine, pyrethrins, cinerins, cinerin I, cinerin II, jasmolin I, jasmolin II, pyrethrin I, pyrethrin II, quassia, rotenone, ryania and sabadilla; carbamate insecticides such as bendiocarb and carbaryl; benzofuranyl methylcarbamate insecticides such as benfuracarb, carbofuran, carbosulfan, decarbofuran and furathiocarb; 5 dimethylcarbamate insecticides dimitan, dimetilan, hyquincarb and pirimicarb; oxime carbamate insecticides such as alanycarb, aldicarb, aldoxycarb, butocarboxim, butoxycarboxim, methomyl, nitrilacarb, oxamyl, tazimcarb, thiocarboxime, thiodicarb and thiofanox; phenyl methylcarbamate insecticides such as allyxycarb, aminocarb, bufencarb, butacarb, carbanolate, cloethocarb, dicresyl, dioxacarb, EMPC, ethiofencarb, fenethacarb, 10 fenobucarb, isoprocab, methiocarb, metolcarb, mexacarbate, promacyl, promecarb, propoxur, trimethacarb, XMC and xylylcarb; dinitrophenol insecticides such as dinex, dinoprop, dinosam and DNOC; fluorine insecticides such as barium hexafluorosilicate, cryolite, sodium fluoride, sodium hexafluorosilicate and sulfluramid; formamidine insecticides such as amitraz, chlordimeform, formetanate and formparanate; fumigant 15 insecticides such as acrylonitrile, carbon disulfide, carbon tetrachloride, chloroform, chloropicrin, *para*-dichlorobenzene, 1,2-dichloropropane, ethyl formate, ethylene dibromide, ethylene dichloride, ethylene oxide, hydrogen cyanide, iodomethane, methyl bromide, methylchloroform, methylene chloride, naphthalene, phosphine, sulfuryl fluoride and tetrachloroethane; inorganic insecticides such as borax, calcium polysulfide, copper 20 oleate, mercurous chloride, potassium thiocyanate and sodium thiocyanate; chitin synthesis inhibitors such as bistrifluoron, buprofezin, chlorfluazuron, cyromazine, diflubenzuron, flucycloxuron, flufenoxuron, hexaflumuron, lufenuron, novaluron, noviflumuron, penfluoron, teflubenzuron and triflumuron; juvenile hormone mimics such as epofenonane, fenoxycarb, hydroprene, kinoprene, methoprene, pyriproxyfen and triprene; juvenile 25 hormones such as juvenile hormone I, juvenile hormone II and juvenile hormone III; moulting hormone agonists such as chromafenozide, halofenozide, methoxyfenozide and tebufenozide; moulting hormones such as alpha-ecdysone and ecdysterone; moulting inhibitors such as diofenolan; precocenes such as precocene I, precocene II and precocene III; unclassified insect growth regulators such as dicyclanil; nereistoxin analogue 30 insecticides such as bensultap, cartap, thiocyclam and thiosultap; nicotinoid insecticides such as flonicamid; nitroguanidine insecticides such as clothianidin, dinotefuran, imidacloprid and thiamethoxam; nitromethylene insecticides such as nitenpyram and nithiazine; pyridylmethylaniline insecticides such as acetamiprid, imidacloprid, nitenpyram

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and thiacloprid; organochlorine insecticides such as bromo-DDT, camphechlor, DDT, pp'-DDT, ethyl-DDD, HCH, gamma-HCH, lindane, methoxychlor, pentachlorophenol and TDE; cyclodiene insecticides such as aldrin, bromocyclen, chlorbicyclen, chlordane, chlordecone, dieldrin, dilor, endosulfan, endrin, HEOD, heptachlor, HHDN, isobenzan, isodrin, kelevan and mirex; organophosphate insecticides such as bromfenvinfos, chlorfenvinfos, crotoxyphos, dichlorvos, dicrotophos, dimethylvinphos, fospirate, heptenophos, methocrotophos, mevinphos, monocrotophos, naled, naftalofos, phosphamidon, propaphos, TEPP and tetrachlorvinphos; organothiophosphate insecticides such as dioxabenzofos, fosmethilan and phenthoate; aliphatic organothiophosphate insecticides such as acethion, amiton, cadusafos, chlorethoxyfos, chlormephos, demephion, demephion-O, demephion-S, demeton, demeton-O, demeton-S, demeton-methyl, demeton-O-methyl, demeton-S-methyl, demeton-S-methylsulphon, disulfoton, ethion, ethoprophos, PSP, isothioate, malathion, methacrifos, oxydemeton-methyl, oxydeprofos, oxydisulfoton, phorate, sulfotep, terbufos and thiometon; aliphatic amide organothiophosphate insecticides such as amidithion, cyanthoate, dimethoate, ethoate-methyl, formothion, mecarbam, omethoate, prothoate, sophamide and vamidothion; oxime organothiophosphate insecticides such as chlorphoxim, phoxim and phoxim-methyl; heterocyclic organothiophosphate insecticides such as azamethiphos, coumaphos, coumithoate, dioxathion, endothion, menazon, morphothion, phosalone, pyraclofos, pyridaphenthion and quinothion; benzothiopyran organothiophosphate insecticides such as dithicrofos and thicrofos; benzotriazine organothiophosphate insecticides such as azinphos-ethyl and azinphos-methyl; isoindole organothiophosphate insecticides such as dialifos and phosmet; isoxazole organothiophosphate insecticides such as isoxathion and zolaprofos; pyrazolopyrimidine organothiophosphate insecticides such as chlorprazophos and pyrazophos; pyridine organothiophosphate insecticides such as chlorpyrifos and chlorpyrifos-methyl; pyrimidine organothiophosphate insecticides such as butathiofos, diazinon, etrimfos, lirimfos, pirimiphos-ethyl, pirimiphos-methyl, primidophos, pyrimitate and tebupirimfos; quinoxaline organothiophosphate insecticides such as quinalphos and quinalphos-methyl; thiadiazole organothiophosphate insecticides such as athidathion, lythidathion, methidathion and prothidathion; triazole organothiophosphate insecticides such as isazofos and triazophos; phenyl organothiophosphate insecticides such as azothoate, bromophos, bromophos-ethyl, carbophenothion, chlorthiophos, cyanophos, cythioate, dicapthon, dichlofenthion, etaphos, famphur, fenchlorphos, fenitrothion,

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fensulfothion, fenthion, fenthion-ethyl, heterophos, jodfenphos, mesulfenfos, parathion, parathion-methyl, phenkapton, phosnichlor, profenofos, prothiofos, sulprofos, temnephos, trichlormetaphos-3 and trifenofos; phosphonate insecticides such as butonate and trichlorfon; phosphonothioate insecticides such as mecarphon; phenyl ethylphosphonothioate insecticides such as fonofos and trichloronat; phenyl phenylphosphonothioate insecticides such as cyanofenphos, EPN and leptophos; phosphoramidate insecticides such as crufomate, fenamiphos, fosthietan, mephosfolan, phosfolan and pirimetaphos; phosphoramidothioate insecticides such as acephate, isocarbophos, isofenphos, methamidophos and propetamphos; phosphorodiamide insecticides such as dimefox, mazidox, mipafox and schradan; oxadiazine insecticides such as indoxacarb; phthalimide insecticides such as dialifos, phosmet and tetramethrin; pyrazole insecticides such as acetoprole, ethiprole, fipronil, pyrafluprole, pyriprole, tebufenpyrad, tolfenpyrad and vanilprole; pyrethroid ester insecticides such as acrinathrin, allethrin, bioallethrin, barthrin, bifenthrin, bioethanomethrin, cyclethrin, cycloprothrin, cyfluthrin, beta-cyfluthrin, cyhalothrin, gamma-cyhalothrin, lambda-cyhalothrin, cypermethrin, alpha-cypermethrin, beta-cypermethrin, theta-cypermethrin, zeta-cypermethrin, cyphenothrin, deltamethrin, dimefluthrin, dimethrin, empenthrin, fenfluthrin, fenpirithrin, fenpropathrin, fenvalerate, esfenvalerate, flucythrinate, fluvalinate, tau-fluvalinate, furethrin, imiprothrin, metofluthrin, permethrin, biopermethrin, transpermethrin, phenothrin, prallethrin, profluthrin, pyresmethrin, resmethrin, bioresmethrin, cismethrin, tefluthrin, terallethrin, tetramethrin, tralomethrin and transfluthrin; pyrethroid ether insecticides such as etofenprox, flufenprox, halfenprox, protrifenbute and silafluofen; pyrimidinamine insecticides such as flufenerim and pyrimidifen; pyrrole insecticides such as chlorfenapyr; tetrionic acid insecticides such as spirotetramat; thiourea insecticides such as diafenthiuron; urea insecticides such as flucofuron and sulcofuron; and unclassified insecticides such as AKD-3088, closantel, crotamiton, cyflumetofen, E2Y45, EXD, fenazaflor, fenazaquin, fenoxacrim, fenpyroximate, FKI-1033, flubendiamide, HGW86, hydramethylnon, IKI-2002, isoprothiolane, malonoben, metaflumizone, metoxadiazone, nifluridide, NNI-9850, NNI-0101, pymetrozine, pyridaben, pyridalyl, Qcide, rafoxanide, rynaxypyr, SYJ-159, triarathene and triazamate and any combinations thereof.

Non-limiting examples of fungicides that may be used beneficially in conjunction with the pesticidal composition may include, but are not limited to: AIGA compound, 2-

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(thiocyanatomethylthio)-benzothiazole, 2-phenylphenol, 8-hydroxyquinoline sulfate, *Ampelomyces quisqualis*, azaconazole, azoxystrobin, *Bacillus subtilis*, benalaxyl, benomyl, benthiavalicarb-isopropyl, benzylaminobenzene-sulfonate (BABS) salt, bicarbonates, biphenyl, bismethiazol, bitertanol, blasticidin-S, borax, Bordeaux mixture, boscalid, 5 bromuconazole, bupirimate, calcium polysulfide, captafol, captan, carbendazim, carboxin, carpropamid, carvone, chloroneb, chlorothalonil, chlozolate, *Coniothyrium minitans*, copper hydroxide, copper octanoate, copper oxychloride, copper sulfate, copper sulfate (tribasic), cuprous oxide, cyazofamid, cyflufenamid, cymoxanil, cyproconazole, cyprodinil, dazomet, debacarb, diammonium ethylenebis-(dithiocarbamate), dichlofluanid, 10 dichlorophen, diclocymet, diclomezine, dichloran, diethofencarb, difenoconazole, difenzoquat ion, diflumentorim, dimethomorph, dimoxystrobin, diniconazole, diniconazole-M, dinobuton, dinocap, diphenylamine, dithianon, dodemorph, dodemorph acetate, dodine, dodine free base, edifenphos, epoxiconazole, ethaboxam, ethoxyquin, etridiazole, famoxadone, fenamidone, fenarimol, fenbuconazole, fenfuram, fenhexamid, fenoxanil, 15 fenpiclonil, fenpropidin, fenpropimorph, fentin, fentin acetate, fentin hydroxide, ferbam, ferimzone, fluazinam, fludioxonil, flumorph, fluopicolide, fluoroimide, fluoxastrobin, fluquinconazole, flusilazole, flusulfamide, flutolanil, flutriafol, folpet, formaldehyde, fosetyl, fosetyl-aluminium, fuberidazole, furalaxyl, furametpyr, guazatine, guazatine acetates, GY-81, hexachlorobenzene, hexaconazole, hymexazol, imazalil, imazalil sulfate, 20 imibenconazole, iminoctadine, iminoctadine triacetate, iminoctadine tris(albesilate), ipconazole, iprobenfos, iprodione, iprovalicarb, isoprothiolane, kasugamycin, kasugamycin hydrochloride hydrate, kresoxim-methyl, mancopper, mancozeb, maneb, mepanipyrim, mepronil, mercuric chloride, mercuric oxide, mercurous chloride, metalaxyl, mefenoxam, metalaxyl-M, metam, metam-ammonium, metam-potassium, metam-sodium, metconazole, 25 methasulfocarb, methyl iodide, methyl isothiocyanate, metiram, metominostrobin, metrafenone, mildiomicin, myclobutanil, nabam, nitrothai-isopropyl, nuarimol, octhilinone, ofurace, oleic acid (fatty acids), orysastrobin, oxadixyl, oxine-copper, oxpoconazole fumarate, oxycarboxin, pefurazoate, penconazole, pencycuron, pentachlorophenol, pentachlorophenyl laurate, penthiopyrad, phenylmercury acetate, 30 phosphonic acid, phthalide, picoxystrobin, polyoxin B, polyoxins, polyoxorim, potassium bicarbonate, potassium hydroxyquinoline sulfate, probenazole, prochloraz, procymidone, propamocarb, propamocarb hydrochloride, propiconazole, propineb, proquinazid, prothioconazole, pyraclostrobin, pyrazophos, pyributicarb, pyrifenoxy, pyrimethanil,

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pyroquilon, quinoclamine, quinoxifen, quintozone, *Reynoutria sachalinensis* extract, silthiofam, simeconazole, sodium 2-phenylphenoxide, sodium bicarbonate, sodium pentachlorophenoxide, spiroxamine, sulfur, SYP-Z071, tar oils, tebuconazole, tecnazene, tetraconazole, thiabendazole, thifluzamide, thiophanate-methyl, thiram, tiadinil, tolclofos-methyl, tolylfluanid, triadimefon, triadimenol, triazoxide, tricyclazole, tridemorph, trifloxystrobin, triflumizole, triforine, triticonazole, validamycin, vinclozolin, zineb, ziram, zoxamide, *Candida oleophila*, *Fusarium oxysporum*, *Gliocladium* spp., *Phlebiopsis gigantea*, *Streptomyces griseoviridis*, *Trichoderma* spp., (RS)-N-(3,5-dichlorophenyl)-2-(methoxymethyl)-succinimide, 1,2-dichloropropane, 1,3-dichloro-1,1,3,3-tetrafluoroacetone hydrate, 1-chloro-2,4-dinitronaphthalene, 1-chloro-2-nitropropane, 2-(2-heptadecyl-2-imidazolin-1-yl)ethanol, 2,3-dihydro-5-phenyl-1,4-dithiane 1,1,4,4-tetraoxide, 2-methoxyethylmercury acetate, 2-methoxyethylmercury chloride, 2-methoxyethylmercury silicate, 3-(4-chlorophenyl)-5-methylrhodanine, 4-(2-nitroprop-1-enyl)phenyl thiocyanate: ampropylfos, anilazine, azithiram, barium polysulfide, Bayer 32394, benodanil, benquinox, bentazon, benzamachl; benzamachl-isobutyl, benzamachl, binapachl, bis(methylmercury) sulfate, bis(tributyltin) oxide, buthiobate, cadmium calcium copper zinc chromate sulfate, carbamachl, CECA, chlobenthiachl, chloranilformethan, chlorfenazole, chlorquinox, climbazole, copper bis(3-phenylsalicylate), copper zinc chromate, cufraneb, cupric hydrazinium sulfate, cuprobam, cyclafuramid, cypendazole, cyprofuram, decafentin, dichlone, dichlozoline, diclobutrazol, dimethirimol, dinocron, dinosulfon, dinoterbon, dipyrithione, ditalimfos, dodicin, drazoxolon, EBP, ESBP, etaconazole, etem, ethirim, fenaminosulf, fenapanil, fenitropan, fluotrimazole, furcarbanil, furconazole, furconazole-cis, furmecyclox, furophanate, glyodine, griseofulvin, halacrinat, Hercules 3944, hexylthiofos, ICIA0858, isopamphos, isovaldione, mebenil, mecarbinzid, metazoxolon, methfuroxam, methylmercury dicyandiamide, metsulfovax, milneb, mucochloric anhydride, myclozolin, N-3,5-dichlorophenyl-succinimide, N-3-nitrophenylitaconimide, natamycin, N-ethylmercurio-4-toluenesulfonanilide, nickel bis(dimethyldithiocarbamate), OCH, phenylmercury dimethyldithiocarbamate, phenylmercury nitrate, phosdiphen, prothiocarb; prothiocarb hydrochloride, pyracarbolid, pyridinitril, pyroxychlor, pyroxyfur, quinacetol; quinacetol sulfate, quinazamid, quinconazole, rabenzazole, salicylanilide, SSF-109, sultropan, tecoram, thiadifluor, thicyofen, thiochlorfenphim, thiophanate, thioquinox, tioxyamid, triamiphos, triarimol, triazbutil, trichlamide, urbacid, XRD-563, and zarilamid, and any combinations thereof.

Herbicides that may be employed in conjunction with the pesticidal composition may include, but are not limited to: amide herbicides such as allidochlor, beflubutamid, benzadox, benzipram, bromobutide, cafenstrole, CDEA, chlorthiamid, cyprazole, dimethenamid, dimethenamid-P, diphenamid, epronaz, etnipromid, fentrazamide, flupoxam, fomesafen, halosafen, isocarbamid, isoxaben, napropamide, naptalam, pethoxamid, propyzamide, quinonamid and tebutam; anilide herbicides such as chloranocryl, cisanilide, clomeprop, cypromid, diflufenican, etobenzanid, fenasulam, flufenacet, flufenican, mefenacet, mefluidide, metamifop, monalide, naproanilide, pentanochlor, picolinafen and propanil; arylalanine herbicides such as benzoylprop, flamprop and flamprop-M; chloroacetanilide herbicides such as acetochlor, alachlor, butachlor, butenachlor, delachlor, diethatyl, dimethachlor, metazachlor, metolachlor, S-metolachlor, pretilachlor, propachlor, propisochlor, prynachlor, terbuchlor, thenylchlor and xylachlor; sulfonanilide herbicides such as benzofluor, perfluidone, pyrimisulfan and profluazol; sulfonamide herbicides such as asulam, carbasulam, fenasulam and oryzalin; antibiotic herbicides such as bilanafos; benzoic acid herbicides such as chloramben, dicamba, 2,3,6-TBA and tricamba; pyrimidinyloxybenzoic acid herbicides such as bispyribac and pyriminobac; pyrimidinylthiobenzoic acid herbicides such as pyriithiobac; phthalic acid herbicides such as chlorthal; picolinic acid herbicides such as aminopyralid, clopyralid and picloram; quinolinecarboxylic acid herbicides such as quinclorac and quinmerac; arsenical herbicides such as cacodylic acid, CMA, DSMA, hexaflurate, MAA, MAMA, MSMA, potassium arsenite and sodium arsenite; benzoylcyclohexanedione herbicides such as mesotrione, sulcotrione, tefuryltrione and tembotrione; benzofuranyl alkylsulfonate herbicides such as benfuresate and ethofumesate; carbamate herbicides such as asulam, carboxazole chlorprocarb, dichlormate, fenasulam, karbutilate and terbucarb; carbanilate herbicides such as barban, BCPC, carbasulam, carbetamide, CEPC, chlorbufam, chlorpropham, CPPC, desmedipham, phenisopham, phenmedipham, phenmedipham-ethyl, propham and swep; cyclohexene oxime herbicides such as alloxydim, butoxydim, clethodim, cloproxydim, cycloxydim, profoxydim, sethoxydim, tepraloxym and tralkoxydim; cyclopropylisoxazole herbicides such as isoxachlortole and isoxaflutole; dicarboximide herbicides such as benzfendazole, cinidon-ethyl, flumezin, flumiclorac, flumioxazin and flumipropyn; dinitroaniline herbicides such as benfluralin, butralin, dinitramine, ethalfluralin, fluchloralin, isopropalin, methalpropalin, nitratin, oryzalin, pendimethalin, prodiamine, profluralin and trifluralin; dinitrophenol herbicides

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such as dinofenat, dinoprop, dinosam, dinoseb, dinoterb, DNOC, etinofen and medinoterb; diphenyl ether herbicides such as ethoxyfen; nitrophenyl ether herbicides such as acifluorfen, aclonifen, bifenox, chlomethoxyfen, chlornitrofen, etniproimid, fluorodifen, fluoroglycofen, fluoronitrofen, fomesafen, furyloxyfen, halosafen, lactofen, nitrofen, nitrofluorfen and oxyfluorfen; dithiocarbamate herbicides such as dazomet and metam; halogenated aliphatic herbicides such as alorac, chloropon, dalapon, flupropanate, hexachloroacetone, iodomethane, methyl bromide, monochloroacetic acid, SMA and TCA; imidazolinone herbicides such as imazamethabenz, imazamox, imazapic, imazapyr, imazaquin and imazethapyr; inorganic herbicides such as ammonium sulfamate, borax, calcium chlorate, copper sulfate, ferrous sulfate, potassium azide, potassium cyanate, sodium azide, sodium chlorate and sulfuric acid; nitrile herbicides such as bromobonil, bromoxynil, chloroxynil, dichlobenil, iodonil, ioxynil and pyraclozil; organophosphorus herbicides such as amiprofos-methyl, anilofos, bensulide, bilanafos, butamifos, 2,4-DEP, DMPA, EBEP, fosamine, glufosinate, glyphosate and piperophos; phenoxy herbicides such as bromofenoxim, clomeprop, 2,4-DEB, 2,4-DEP, difenopenten, disul, erbon, etniproimid, fenteracol and trifopside; phenoxyacetic herbicides such as 4-CPA, 2,4-D, 3,4-DA, MCPA, MCPA-thioethyl and 2,4,5-T; phenoxybutyric herbicides such as 4-CPB, 2,4-DB, 3,4-DB, MCPB and 2,4,5-TB; phenoxypropionic herbicides such as cloprop, 4-CPP, dichlorprop, dichlorprop-P, 3,4-DP, fenoprop, mecoprop and mecoprop-P; aryloxyphenoxypropionic herbicides such as chlorazifop, clodinafop, clofop, cyhalofop, diclofop, fenoxaprop, fenoxaprop-P, fenthiaprop, fluazifop, fluazifop-P, haloxyfop, haloxyfop-P, isoxapyrifop, metamifop, propaquizafop, quizalofop, quizalofop-P and trifop; phenylenediamine herbicides such as dinitramine and prodiamine; pyrazolyl herbicides such as benzofenap, pyrazolynate, pyrasulfotole, pyrazoxyfen, pyroxasulfone and topramezone; pyrazolyliethyl herbicides such as fluazolate and pyraflufen; pyridamine herbicides such as credazine, pyridafol and pyridate; pyridazitiote herbicides such as brompyrazon, chloridazon, dimidazon, flufenpyr, metflurazon, norflurazon, oxapyrazon and pydanon; pyridine herbicides such as aminopyralid, clidinate, clopyralid, dithiopyr, fluoroxypyr, haloxydine, picloram, picolinafen, pyriclor, thiazopyr and triclopyr; pyrimidinediamine herbicides such as iprymidam and tioclorim; quaternary ammonium herbicides such as cyperquat, diethamquat, difenzoquat, diquat, morfamquat and paraquat; thiocarbamate herbicides such as butylate, cycloate, di-allate, EPTC, esprocarb, ethiolate, isopoline, methiobencarb, molinate, orbencarb, pebulate, prosulfocarb, pyributicarb,

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sulfallate, thiobencarb, tiocarbazil, tri-allate and vernolate; thiocarbonate herbicides such as dimexano, EXD and proxan; thiourea herbicides such as methiuron; triazine herbicides such as dipropetryn, triaziflam and trihydroxytriazine; chlorotriazine herbicides such as atrazine, chlorazine, cyanazine, cyprazine, eglinazine, ipazine, mesoprazine, procyazine, 5 proglinazine, propazine, sebuthylazine, simazine, terbuthylazine and trietazine; methoxytriazine herbicides such as atraton, methometon, prometon, secbumeton, simeton and terbumeton; methylthiotriazine herbicides such as ametryn, aziprotryne, cyanatryn, desmetryn, dimethametryn, methoprotryne, prometryn, simetryn and terbutryn; triazinone herbicides such as ametridione, amibuzin, hexazinone, isomethiozin, metamitron and 10 metribuzin; triazole herbicides such as amitrole, cafenstrole, epronaz and flupoxam; triazolone herbicides such as amicarbazone, bencarbazone, carfentrazone, flucarbazone, propoxycarbazone, sulfentrazone and thienicarbazone-methyl; triazolopyrimidine herbicides such as cloransulam, diclosulam, florasulam, flumetsulam, metosulam, penoxsulam and pyroxsulam; uracil herbicides such as butafenacil, bromacil, flupropacil, isocil, lenacil and 15 terbacil; 3-phenyluracils; urea herbicides such as benzthiazuron, cumyluron, cycluron, dichloralurea, diflufenzopyr, isonoruron, isouron, methabenzthiazuron, monisouron and noruron; phenylurea herbicides such as anisuron, buturon, chlorbromuron, chloreturon, chlorotoluron, chloroxuron, daimuron, difenoxuron, dimefuron, diuron, fenuron, fluometuron, fluothiuuron, isoproturon, linuron, methiuron, methylidymron, metobenzuron, 20 metobromuron, metoxuron, monolinuron, monuron, neburon, parafluoron, phenobenzuron, siduron, tetrafluoron and thidiazuron; pyrimidinylsulfonylurea herbicides such as amidosulfuron, azimsulfuron, bensulfuron, chlorimuron, cyclosulfamuron, ethoxysulfuron, flazasulfuron, flucetosulfuron, flupyrsulfuron, foramsulfuron, halosulfuron, imazosulfuron, mesosulfuron, nicosulfuron, orthosulfamuron, oxasulfuron, primisulfuron, pyrazosulfuron, 25 rimsulfuron, sulfometuron, sulfosulfuron and trifloxysulfuron; triazinylsulfonylurea herbicides such as chlorsulfuron, cinosulfuron, ethametsulfuron, iodosulfuron, metsulfuron, prosulfuron, thifensulfuron, triasulfuron, tribenuron, triflusulfuron and tritosulfuron; thiadiazolylurea herbicides such as buthiuron, ethidimuron, tebuthiuron, thiazafluoron and thidiazuron; and unclassified herbicides such as acrolein, allyl alcohol, azafenidin, 30 benazolin, bentazone, benzobicyclon, buthidazole, calcium cyanamide, cambendichlor, chlorfenac, chlorfenprop, chlorflurazole, chlorflurenol, cinmethylin, clomazone, CPMF, cresol, ortho-dichlorobenzene, dimepiperate, endothal, fluoromidine, fluridone, fluorochloridone, flurtamone, fluthiacet, indanofan, methazole, methyl isothiocyanate,

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nipyraclofen, OCH, oxadiargyl, oxadiazon, oxaziclomefone, pentachlorophenol, pentoxazone, phenylmercury acetate, pinoxaden, prosulfalin, pyribenzoxim, pyriftalid, quinoctamine, rhodethanil, sulglycapin, thidiazimin, tridiphane, trimeturon, tripropindan and tritac.

5 The pesticidal composition may be used for controlling a variety of pests.

In a particular embodiment, the pesticidal composition may be used to control pests in the Phyla Nematoda and/or Arthropoda. In another embodiment, the pesticidal composition may be used to control pests in the Subphyla Chelicerata, Myriapoda, and/or Hexapoda. In yet another embodiment, the pesticidal composition may be used to control
10 pests in the Classes of Arachnida, Symphyla, and/or Insecta. In an alternate embodiment, the pesticidal composition may be used to control pests of the Order Homoptera.

In another embodiment, the pesticidal composition may be used to control pests of the Order Anoplura. Non-limiting examples of genera may include, but are not limited to, *Haematopinus* spp., *Hoplopleura* spp., *Linognathus* spp., *Pediculus* spp., and *Polyplax* spp.
15 Non-limiting examples of species may include, but are not limited to, *Haematopinus asini*, *Haematopinus suis*, *Linognathus setosus*, *Linognathus ovillus*, *Pediculus humanus capitis*, *Pediculus humanus humanus*, and *Pthirus pubis*.

In yet another embodiment, the pesticidal composition may be used to control pests in the Order Coleoptera. Non-limiting examples of genera may include, but are not limited
20 to, *Acanthoscelides* spp., *Agriotes* spp., *Anthonomus* spp., *Apion* spp., *Apogonia* spp., *Aulacophora* spp., *Bruchus* spp., *Cerosterna* spp., *Cerotoma* spp., *Ceutorhynchus* spp., *Chaetocnema* spp., *Colaspis* spp., *Ctenicera* spp., *Curculio* spp., *Cyclocephala* spp., *Diabrotica* spp., *Hypera* spp., *Ips* spp., *Lyctus* spp., *Megascelis* spp., *Meligethes* spp., *Otiorhynchus* spp., *Pantomorus* spp., *Phyllophaga* spp., *Phyllotreta* spp., *Rhizotrogus* spp.,
25 *Rhynchites* spp., *Rhynchophorus* spp., *Scolytus* spp., *Sphenophorus* spp., *Sitophilus* spp., and *Tribolium* spp. Non-limiting examples of species may include, but are not limited to, *Acanthoscelides obtectus*, *Agrilus planipennis*, *Anoplophora glabripennis*, *Anthonomus grandis*, *Ataenius spretulus*, *Atomaria linearis*, *Bothynoderes punctiventris*, *Bruchus pisorum*, *Callosobruchus maculatus*, *Carpophilus hemipterus*, *Cassida vittata*, *Cerotoma trifurcata*, *Ceutorhynchus assimilis*, *Ceutorhynchus napi*, *Conoderus scalaris*, *Conoderus stigmosus*, *Conotrachelus nenuphar*, *Cotinis nitida*, *Crioceris asparagi*, *Cryptolestes ferrugineus*, *Cryptolestes pusillus*, *Cryptolestes turcicus*, *Cylindrocopturus adspersus*,
30 *Deporaus marginatus*, *Dermestes lardarius*, *Dermestes maculatus*, *Epilachna varivestis*,

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Faustinus cubae, *Hylobius pales*, *Hypera postica*, *Hypothenemus hampei*, *Lasioderma serricorne*, *Leptinotarsa decemlineata*, *Liogenys fuscus*, *Liogenys suturalis*, *Lissorhoptrus oryzophilus*, *Maecolaspis joliveti*, *Melanotus communis*, *Meligethes aeneus*, *Melolontha melolontha*, *Oberea brevis*, *Oberea linearis*, *Oryctes rhinoceros*, *Oryzaephilus mercator*,
 5 *Oryzaephilus surinamensis*, *Oulema melanopus*, *Oulema oryzae*, *Phyllophaga cuyabana*, *Popillia japonica*, *Prostephanus truncatus*, *Rhyzopertha dominica*, *Sitona lineatus*, *Sitophilus granarius*, *Sitophilus oryzae*, *Sitophilus zeamais*, *Stegobium paniceum*, *Tribolium castaneum*, *Tribolium confusum*, *Trogoderma variabile*, and *Zabrus tenebrioides*.

10 In an alternative embodiment, the pesticidal composition may be used to control pests of the Order Dermaptera.

In another embodiment, the pesticidal composition may be used to control pests of the Order Blattaria. Non-limiting examples of species may include, but are not limited to, *Blattella germanica*, *Blatta orientalis*, *Parcoblatta pennsylvanica*, *Periplaneta americana*,
 15 *Periplaneta australasiae*, *Periplaneta brunnea*, *Periplaneta fuliginosa*, *Pycnoscelus surinamensis*, and *Supella longipalpa*.

In yet another embodiment, the pesticidal composition may be used to control pests of the Order Diptera. Non-limiting examples of genera may include, but are not limited to, *Aedes* spp., *Agromyza* spp., *Anastrepha* spp., *Anopheles* spp., *Bactrocera* spp., *Ceratitis*
 20 spp., *Chrysops* spp., *Cochliomyia* spp., *Contarinia* spp., *Culex* spp., *Dasineura* spp., *Delia* spp., *Drosophila* spp., *Fannia* spp., *Hylemyia* spp., *Liriomyza* spp., *Musca* spp., *Phorbia* spp., *Tabanus* spp., and *Tipula* spp. Non-limiting examples of species may include, but are not limited to, *Agromyza frontella*, *Anastrepha suspensa*, *Anastrepha ludens*, *Anastrepha obliqua*, *Bactrocera cucurbitae*, *Bactrocera dorsalis*, *Bactrocera invadens*, *Bactrocera zonata*, *Ceratitis capitata*, *Dasineura brassicae*, *Delia platura*, *Fannia canicularis*, *Fannia scalaris*, *Gasterophilus intestinalis*, *Gracillia perseae*, *Haematobia irritans*, *Hypoderma lineatum*, *Liriomyza brassicae*, *Melophagus ovinus*, *Musca autumnalis*, *Musca domestica*,
 25 *Oestrus ovis*, *Oscinella frit*, *Pegomya betae*, *Psila rosae*, *Rhagoletis cerasi*, *Rhagoletis pomonella*, *Rhagoletis mendax*, *Sitodiplosis mosellana*, and *Stomoxys calcitrans*.

30 In a particular embodiment, the pesticidal composition may be used to control pests of the Order Hemiptera. Non-limiting examples of genera may include, but are not limited to, *Adelges* spp., *Aulacaspis* spp., *Aphrophora* spp., *Aphis* spp., *Bemisia* spp., *Ceroplastes* spp., *Chionaspis* spp., *Chrysomphalus* spp., *Coccus* spp., *Empoasca* spp., *Lepidosaphes*

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spp., *Lagynotomus* spp., *Lygus* spp., *Macrosiphum* spp., *Nephotettix* spp., *Nezara* spp., *Philaenus* spp., *Phytocoris* spp., *Piezodorus* spp., *Planococcus* spp., *Pseudococcus* spp., *Rhopalosiphum* spp., *Saissetia* spp., *Therioaphis* spp., *Toumeyella* spp., *Toxoptera* spp., *Trialeurodes* spp., *Triatoma* spp. and *Unaspis* spp. Non-limiting examples of species may

5 include, but are not limited to, *Acrosternum hilare*, *Acyrtosiphon pisum*, *Aleyrodes proletella*, *Aleurodicus dispersus*, *Aleurothrixus floccosus*, *Amrasca biguttula biguttula*, *Aonidiella aurantii*, *Aphis gossypii*, *Aphis glycines*, *Aphis pomi*, *Aulacorthum solani*, *Bemisia argentifolii*, *Bemisia tabaci*, *Blissus leucopterus*, *Brachycorynella asparagi*, *Brevinnia rehi*, *Brevicoryne brassicae*, *Calocoris norvegicus*, *Ceroplastes rubens*, *Cimex*

10 *hemipterus*, *Cimex lectularius*, *Dagbertus fasciatus*, *Dichelops furcatus*, *Diuraphis noxia*, *Diaphorina citri*, *Dysaphis plantaginea*, *Dysdercus suturellus*, *Edessa mediatubunda*, *Eriosoma lanigerum*, *Eurygaster maura*, *Euschistus heros*, *Euschistus servus*, *Helopeltis antonii*, *Helopeltis theivora*, *Icerya purchasi*, *Idioscopus nitidulus*, *Laodelphax striatellus*, *Leptocoris oratorius*, *Leptocoris varicornis*, *Lygus hesperus*, *Maconellicoccus hirsutus*,

15 *Macrosiphum euphorbiae*, *Macrosiphum granarium*, *Macrosiphum rosae*, *Macrosteles quadrilineatus*, *Mahanarva frimbiolata*, *Metopolophium dirhodum*, *Mictis longicornis*, *Myzus persicae*, *Nephotettix cinctipes*, *Neurocolpus longirostris*, *Nezara viridula*, *Nilaparvata lugens*, *Parlatoria pergandii*, *Parlatoria ziziphi*, *Peregrinus maidis*, *Phylloxera vitifoliae*, *Physokermes piceae*, *Phytocoris californicus*, *Phytocoris relativus*,

20 *Piezodorus guildinii*, *Poecilocapsus lineatus*, *Psallus vaccenicola*, *Pseudacysta perseae*, *Pseudococcus brevipes*, *Quadraspidotus perniciosus*, *Rhopalosiphum maidis*, *Rhopalosiphum padi*, *Saissetia oleae*, *Scaptocoris castanea*, *Schizaphis graminum*, *Sitobion avenae*, *Sogatella furcifera*, *Trialeurodes vaporariorum*, *Trialeurodes abutiloneus*, *Unaspis yanonensis*, and *Zulia entrerriana*.

25 In another embodiment, the pesticidal composition may be used to control pests of the Order Hymenoptera. Non-limiting examples of genera may include, but are not limited to, *Acromyrmex* spp., *Atta* spp., *Camponotus* spp., *Diprion* spp., *Formica* spp., *Monomorium* spp., *Neodiprion* spp., *Pogonomyrmex* spp., *Polistes* spp., *Solenopsis* spp., *Vespula* spp., and *Xylocopa* spp. Non-limiting examples of species may include, but are not

30 limited to, *Athalia rosae*, *Atta texana*, *Iridomyrmex humilis*, *Monomorium minimum*, *Monomorium pharaonis*, *Solenopsis invicta*, *Solenopsis geminata*, *Solenopsis molesta*, *Solenopsis richteri*, *Solenopsis xyloni*, and *Tapinoma sessile*.

In an alternative embodiment, the pesticidal composition may be used to control pests of the Order Isoptera. Non-limiting examples of genera may include, but are not limited to, *Coptotermes* spp., *Cornitermes* spp., *Cryptotermes* spp., *Heterotermes* spp., *Kalotermes* spp., *Incisitermes* spp., *Macrotermes* spp., *Marginitermes* spp.,
 5 *Microcerotermes* spp., *Procornitermes* spp., *Reticulitermes* spp., *Schedorhinotermes* spp., and *Zootermopsis* spp. Non-limiting examples of species may include, but are not limited to, *Coptotermes curvignathus*, *Coptotermes frenchi*, *Coptotermes formosanus*, *Heterotermes aureus*, *Microtermes obesi*, *Reticulitermes banyulensis*, *Reticulitermes grassei*, *Reticulitermes flavipes*, *Reticulitermes hageni*, *Reticulitermes hesperus*,
 10 *Reticulitermes santonensis*, *Reticulitermes speratus*, *Reticulitermes tibialis*, and *Reticulitermes virginicus*.

In another embodiment, the pesticidal composition may be used to control pests of the Order Lepidoptera. Non-limiting examples of genera may include, but are not limited to, *Adoxophyes* spp., *Agrotis* spp., *Argyrotaenia* spp., *Cacoecia* spp., *Caloptilia* spp., *Chilo*
 15 spp., *Chrysodeixis* spp., *Colias* spp., *Crambus* spp., *Diaphania* spp., *Diatraea* spp., *Earias* spp., *Ephestia* spp., *Epimecis* spp., *Feltia* spp., *Gortyna* spp., *Helicoverpa* spp., *Heliothis* spp., *Indarbela* spp., *Lithocolletis* spp., *Loxagrotis* spp., *Malacosoma* spp., *Peridroma* spp., *Phyllonorycter* spp., *Pseudaletia* spp., *Sesamia* spp., *Spodoptera* spp., *Synanthedon* spp., and *Yponomeuta* spp. Non-limiting examples of species may include, but are not limited to,
 20 *Achaea janata*, *Adoxophyes orana*, *Agrotis ipsilon*, *Alabama argillacea*, *Amorbia cuneana*, *Amyelois transitella*, *Anacamptodes defectaria*, *Anarsia lineatella*, *Anomis sabulifera*, *Anticarsia gemmatilis*, *Archips argyrospila*, *Archips rosana*, *Argyrotaenia citrana*, *Autographa gamma*, *Bonagota cranaodes*, *Borbo cinnara*, *Bucculatrix thurberiella*, *Capua reticulana*, *Carposina niponensis*, *Chlumetia transversa*, *Choristoneura rosaceana*,
 25 *Cnaphalocrocis medinalis*, *Conopomorpha cramerella*, *Cossus cossus*, *Cydia caryana*, *Cydia funebrana*, *Cydia molesta*, *Cydia nigricana*, *Cydia pomonella*, *Darna diducta*, *Diatraea saccharalis*, *Diatraea grandiosella*, *Earias insulana*, *Earias vittella*, *Ecdytolopha aurantianum*, *Elasmopalpus lignosellus*, *Ephestia cautella*, *Ephestia elutella*, *Ephestia kuehniella*, *Epinotia aporema*, *Epiphyas postvittana*, *Erionota thrax*, *Eupoecilia ambiguella*, *Euxoa auxiliaris*, *Grapholita molesta*, *Hedylepta indicata*, *Helicoverpa armigera*, *Helicoverpa zea*, *Heliothis virescens*, *Hellula undalis*, *Keiferia lycopersicella*, *Leucinodes orbonalis*, *Leucoptera coffeella*, *Leucoptera malifoliella*, *Lobesia botrana*,
 30 *Loxagrotis albicosta*, *Lymantria dispar*, *Lyonetia clerkella*, *Mahasena corbetti*, *Mamestra*

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brassicae, *Maruca testulalis*, *Metisa plana*, *Mythimna unipuncta*, *Neoleucinodes elegantalis*, *Nymphula depunctalis*, *Operophtera brumata*, *Ostrinia nubilalis*, *Oxydia vesulia*, *Pandemis cerasana*, *Pandemis heparana*, *Papilio demodocus*, *Pectinophora gossypiella*, *Peridroma saucia*, *Perileucoptera coffeella*, *Phthorimaea operculella*,
 5 *Phyllocnistis citrella*, *Pieris rapae*, *Plathypena scabra*, *Plodia interpunctella*, *Plutella xylostella*, *Polychrosis viteana*, *Prays endocarpa*, *Prays oleae*, *Pseudaletia unipuncta*, *Pseudoplusia includens*, *Rachiplusia nu*, *Scirpophaga incertulas*, *Sesamia inferens*, *Sesamia nonagrioides*, *Setora nitens*, *Sitotroga cerealella*, *Sparganothis pilleriana*, *Spodoptera exigua*, *Spodoptera frugiperda*, *Spodoptera eridania*, *Thecla basilides*, *Tineola*
 10 *bisselliella*, *Trichoplusia ni*, *Tuta absoluta*, *Zeuzera coffeae*, and *Zeuzera pyrina*.

In a particular embodiment, the pesticidal composition may be used to control pests of the Order Mallophaga. Non-limiting examples of genera may include, but are not limited to, *Anaticola* spp., *Bovicola* spp., *Chelopistes* spp., *Goniodes* spp., *Menacanthus* spp., and *Trichodectes* spp. Non-limiting examples of species may include, but are not limited to,
 15 *Bovicola bovis*, *Bovicola caprae*, *Bovicola ovis*, *Chelopistes meleagridis*, *Goniodes dissimilis*, *Goniodes gigas*, *Menacanthus stramineus*, *Menopon gallinae*, and *Trichodectes canis*.

In another embodiment, the pesticidal composition may be used to control pests of the Order Orthoptera. Non-limiting examples of genera may include, but are not limited to,
 20 *Melanophus* spp., and *Pterophylla* spp. Non-limiting examples of species may include, but are not limited to, *Anabrus simplex*, *Gryllotalpa africana*, *Gryllotalpa australis*, *Gryllotalpa brachyptera*, *Gryllotalpa hexadactyla*, *Locusta migratoria*, *Microcentrum retinerve*, *Schistocerca gregaria*, and *Scudderella furcata*.

In yet another embodiment, the pesticidal composition may be used to control pests
 25 of the Order Siphonaptera. Non-limiting examples of species may include, but are not limited to, *Ceratophyllus gallinae*, *Ceratophyllus niger*, *Ctenocephalides canis*, *Ctenocephalides felis*, and *Pulex irritans*.

In an alternative embodiment, the pesticidal composition may be used to control pests of the Order Thysanoptera. Non-limiting examples of genera may include, but are not
 30 limited to, *Caliothrips* spp., *Frankliniella* spp., *Scirtothrips* spp., and *Thrips* spp. Non-limiting examples of species may include, but are not limited to, *Frankliniella fusca*, *Frankliniella occidentalis*, *Frankliniella schultzei*, *Frankliniella williamsi*, *Heliothrips haemorrhoidalis*, *Rhipiphorothrips cruentatus*, *Scirtothrips citri*, *Scirtothrips dorsalis*, and

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Taeniothrips rhopalantennalis, *Thrips hawaiiensis*, *Thrips nigropilosus*, *Thrips orientalis*, *Thrips tabaci*.

In another embodiment, the pesticidal composition may be used to control pests of the Order Thysanura. Non-limiting examples of genera may include, but are not limited to,
5 *Lepisma* spp. and *Thermobia* spp.

In yet another embodiment, the pesticidal composition may be used to control pests of the Order Acarina. Non-limiting examples of genera may include, but are not limited to, *Acarus* spp., *Aculops* spp., *Boophilus* spp., *Demodex* spp., *Dermacentor* spp., *Eptrimerus* spp., *Eriophyes* spp., *Ixodes* spp., *Oligonychus* spp., *Panonychus* spp., *Rhizoglyphus* spp.,
10 and *Tetranychus* spp. Non-limiting examples of species may include, but are not limited to, *Acarapis woodi*, *Acarus siro*, *Aceria mangiferae*, *Aculops lycopersici*, *Aculus pelekassi*, *Aculus schlechtendali*, *Amblyomma americanum*, *Brevipalpus obovatus*, *Brevipalpus phoenicis*, *Dermacentor variabilis*, *Dermatophagoides pteronyssinus*, *Eotetranychus carpini*, *Notoedres cati*, *Oligonychus coffeae*, *Oligonychus ilicis*, *Panonychus citri*,
15 *Panonychus ulmi*, *Phyllocoptruta oleivora*, *Polyphagotarsonemus latus*, *Rhipicephalus sanguineus*, *Sarcoptes scabiei*, *Tegolophus perseafloae*, *Tetranychus urticae*, and *Varroa destructor*.

In a particular embodiment, the pesticidal composition may be used to control pest of the Order Symphyla. Non-limiting examples of species may include, but are not limited
20 to, *Scutigereella immaculata*.

In another embodiment, the pesticidal composition may be used to control pests of the Phylum Nematoda. Non-limiting examples of genera may include, but are not limited to, *Aphelenchoides* spp., *Belonolaimus* spp., *Criconemella* spp., *Ditylenchus* spp., *Heterodera* spp., *Hirschmanniella* spp., *Hoplolaimus* spp., *Meloidogyne* spp., *Pratylenchus*
25 spp., and *Radopholus* spp. Non-limiting examples of species may include, but are not limited to, *Dirofilaria immitis*, *Heterodera zea*, *Meloidogyne incognita*, *Meloidogyne javanica*, *Onchocerca volvulus*, *Radopholus similis*, and *Rotylenchulus reniformis*.

The pesticidal composition may improve the stability of AIGA compound in soil and enhance the residue activities of AIGA compound in soil, while maintaining (if not
30 enhancing) the pesticidal efficacy of AIGA compound. Enhancing the soil residues of AIGA compound in soil may depend on at least two factors: the types of anionic surfactant, and the weight ratio of AIGA compound to anionic surfactant.

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Accordingly, in one particular embodiment, a method of controlling pests comprises applying a pesticidal composition to soil, wherein the pesticidal composition comprises at least one anionic surfactant and an AIGA compound. The weight ratio of anionic surfactant to AIGA compound is at least about 20:1, particularly at least about 25:1.

It is understood that the weight ratio of anionic surfactant to AIGA compound in the pesticidal composition may be varied depending on various factors, such as application need, use rate, desired level of pesticidal efficacies, mode of application, type of pests to be controlled, etc.

The pesticidal compositions of **EXAMPLES 1–6**, *infra*, were prepared by mixing at least one anionic surfactant with a sulfoxaflor concentrate (240 g/L or 500 g/kg). It is understood that the sulfoxaflor concentrate itself may contain a small amount of anionic surfactant; therefore, the anionic surfactant added to the sulfoxaflor concentrate may be considered as the “additional” anionic surfactant. It is further understood that although the pesticidal compositions of **EXAMPLES 1–6** use sulfoxaflor as the AIGA compound, other AIGA compounds may be used instead of sulfoxaflor, or may be used in combination with sulfoxaflor.

As shown in **EXAMPLES 1–6**, the pesticidal compositions (prepared by mixing an “additional” anionic surfactant with a sulfoxaflor concentrate) show enhanced sulfoxaflor stability in soil, compared to a composition that contains sulfoxaflor concentrate but not an additional anionic surfactant. After an application to soil, the percentage of sulfoxaflor recovery of the pesticidal compositions in soil is much higher than that of a composition containing no additional anionic surfactant. Thus, the pesticidal compositions provide improved residue bioactivities in soil, compared to the similar composition that lacks the additional anionic surfactant.

It is surprising and unexpected that a significantly enhanced sulfoxaflor stability in soil may be achieved by the pesticidal compositions. As shown in **EXAMPLE 3**, the pesticidal compositions may be effective and available for root uptake by the plant for a period of at least two weeks (14 days) after their application to soil, with the amount of pesticide equivalent to about 31% of that at the time immediately after application.

The present disclosure also envisages a method of controlling sap-feeding insects on the top part of plants by applying the pesticidal composition to the soil around the root system of the plant. **EXAMPLE 6** shows the pesticidal activities against green peach aphid

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(*Myzus persicae*) when the soil around the root system of the plant is treated with the pesticidal compositions. As shown in **FIGs. 6 and 7**, the pesticidal compositions (prepared by mixing a sulfoxaflor concentrate with an additional anionic surfactant) provide comparable pesticidal activities against green peach aphid (*Myzus persicae*) as a commercial imidacloprid pesticide (PROVADO® 1.6 pesticide from Bayer CropScience LP).

Furthermore, **TABLES 6–8 of EXAMPLE 7** shows that the pesticidal compositions may provide a synergistic pesticidal effect between the additional anionic surfactant and sulfoxaflor against green peach aphid (*Myzus persicae*) on the top part of plants, when the pesticidal compositions are applied to the soil around the root system of the plants.

The following examples serve to explain embodiments of the present disclosure in more detail. These examples are not to be construed as being exhaustive or exclusive as to the scope of this disclosure.

EXAMPLES

EXAMPLE 1. Effects of Anionic Surfactants on Sulfoxaflor Stability in Inoculated Midwest Soil

Inoculated Midwest field soil was used for the study, and the soil moisture therein was measured by Mettler LJ16 Moisture Analyzer (15 minutes and 100 °C). For a consistent test protocol, the soil was dried at room temperature to about 8% initial soil moisture level. Then, the dry soil mass was calculated based on soil moisture. For Midwest soil, moisture between 26 and 30% is normally recommended. Therefore, 26% (i.e., 260,000 ppm) soil moisture was used for the tests.

Sulfoxaflor concentrates used in the study were CLOSER® SC insecticide from Dow AgroSciences, which has a sulfoxaflor concentration of 240 g/L (about 20% active sulfoxaflor); and TRANSFORM® WG insecticide also from Dow AgroSciences, which is a sulfoxaflor water dispersible granule formulation (WDG) having a sulfoxaflor concentration of 500 g/kg. A 500 ppm sulfoxaflor active solution was prepared by diluting the CLOSER® SC insecticide (240 g/L sulfoxaflor SC) or the TRANSFORM® WG insecticide (500 g/kg sulfoxaflor WDG) with deionized water.

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Sulfoxaflor dose of about 6.25 ppm of sulfoxaflor active per gram of the final soil mixture (8.44 ppm of sulfoxaflor active per gram of dry soil mass) was used as standard application rate for **EXAMPLE 1**.

Surfactant dose of about 384 ppm per gram of final soil mixture was tested (384 μ g surfactant per gram of final soil mixture; 1500 ppm of surfactant per gram of total soil liquid; 526 μ g of surfactant per gram of dry soil mass).

A control composition was the composition that included the sulfoxaflor concentrate (CLOSER® SC insecticide or TRANSFORM® WG insecticide) but not additional surfactants.

A control soil sample was the soil sample treated with the control composition. The control soil sample was run with each test for comparison and was recorded as “No Surfactant” sample.

All tests were measured under the following conditions:

About 15 grams of inoculated Midwest field soil was measured by Mettler AE20 Analytical Balance and added into a 30 milliliter (mL) Nalgene Wide-Mouth HDPE plastic bottle. The sulfoxaflor active solution, various surfactant solutions (as shown in **TABLE 1**), and additional water were added into the plastic bottle to achieve 6.25 ppm of sulfoxaflor active, 384 ppm of surfactant, and 260,000 ppm water per gram of final soil mixture.

TABLE 1. Various anionic surfactants used in the study

Anionic Surfactant	Description
CaDDBS	Calcium branched dodecyl benzenesulfonate
GEROPON® SDS	Sodium dioctyl sulfosuccinate from Rhodia, Inc.
GEROPON® T/36	Sodium polycarboxylate from Rhodia, Inc.
GEROPON® T 77	Sodium 2-[methyleoleoylamino]ethane-1-sulfonate (also known as sodium <i>N</i> -methyl- <i>N</i> -oleyl taurate) from Rhodia, Inc.
MORWET® DB	Sodium <i>N</i> -butyl naphthalene sulfonate powder from Akzo Nobel N.V.
POLYFON® F	Sodium lignosulfonate from MeadWestvaco Corporation
SDS	Sodium dodecyl sulfate from Sigma-Aldrich Co LLC
SOPROPHOR® FLK	Potassium salt of ethoxylated tristyrylphenol phosphate from Rhodia

Each of the tested soil samples (including the control soil sample) was left under the same conditions for three days. After three days, the % sulfoxaflor recovery in the tested soils was determined using the following extraction procedure:

5 Sulfoxaflor was extracted from soil by adding 10 mL of acetonitrile with 0.01% formic acid. Two 12 mm glass beads were placed into the plastic bottle which was then shaken by hand until it was roughly homogeneous. The bottle was then shaken on high speed with a horizontal shaker for one hour (Eberbach Reciprocating Shaker 6010). About 10 mL of the extract was centrifuged for 7 minutes at 3000 rpm (Beckman J2-MI). The
10 supernatant was filtered with a 0.2 micron filter (Pall PTFE). About 750 microliters (μL) of the filtered extract and 25 μL of 4-ethylphenol (0.323 mg/mL of methanol) was added to a 2 mL glass autosampler vial with a micropipette (Evol by SGE Analytical).

FIG. 1 shows the % sulfoxaflor recovery after three days for each of the soil samples treated with the pesticidal compositions that included about 6.25 ppm sulfoxaflor per final soil mixture and about 384 ppm of various surfactants (as shown in **TABLE 1**)
15 per final soil mixture. For comparison, **FIG.1** also shows the % sulfoxaflor recovery for the control soil sample (the soil sample treated with the control composition; “No Surfactant” sample).

As shown in **FIG. 1**, about 36% of sulfoxaflor was recovered in the control soil
20 sample (“No Surfactant” sample). The soil samples treated with the pesticidal compositions (containing both sulfoxaflor and anionic surfactant) provided a higher % sulfoxaflor recovery, compared to the control “No Surfactant” sample. Furthermore, the enhancement in % sulfoxaflor recovery depended on the types of surfactants used in the pesticidal composition. For example, when the pesticidal composition included about 6.25 ppm of
25 sulfoxaflor and about 384 ppm of sodium dodecyl sulfate (SDS) surfactant or sodium dioctylsulfosuccinate GEROPON® SDS surfactant, the % sulfoxaflor recovery after three days was about 71%, which was about twice the % sulfoxaflor recovery in the control “No Surfactant” sample. When the pesticidal composition included about 6.25 ppm of sulfoxaflor and about 384 ppm of calcium branched dodecyl benzenesulfonate (CaDDBS)
30 surfactant, the % sulfoxaflor recovery after three days was about 68%, which was almost 1.9 times higher than the % sulfoxaflor recovery in the control “No Surfactant” sample. When the pesticidal composition included about 6.25 ppm of sulfoxaflor and about 384

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ppm of sodium *N*-butyl naphthalene sulfonate (MORWET® DB powder) surfactant, the % sulfoxaflor recovery after three days was about 1.6 times higher than the % sulfoxaflor recovery in the control “No Surfactant” sample. When the pesticidal composition included about 6.25 ppm of sulfoxaflor and about 384 ppm of sodium lignosulfonate (POLYFON® F) surfactant, the % sulfoxaflor recovery after three days was about 49%, which was about 1.4 times higher than that the 36% sulfoxaflor recovery for the control “No Surfactant” sample.

EXAMPLE 2. Effect of Different Concentrations of Sodium Diocylsulfosuccinate GEROPON® SDS Surfactant on the Sulfoxaflor Stability in Inoculated Midwest Soil

Inoculated Midwest field soil was treated with the pesticidal compositions using the same protocol as described in **EXAMPLE 1**.

TABLE 2. Comparative % sulfoxaflor recovery for inoculated Midwest soils treated with the pesticidal compositions containing different amounts of sodium diocylsulfosuccinate GEROPON® SDS surfactant

Tested Soil Sample	Amount in Pesticidal Composition (ppm per Final Soil Mixture)		% Sulfoxaflor recovery after three days
	Sulfoxaflor	GEROPON® SDS surfactant	
0 ppm Sample (Control)	6.25 ppm	0 ppm	40%
128 ppm Sample	6.25 ppm	128 ppm	53%
256 ppm Sample	6.25 ppm	256 ppm	64%
384 ppm Sample	6.25 ppm	384 ppm	71%

Four pesticidal compositions were prepared, each containing about 6.25 ppm of sulfoxaflor per final soil mixture but different amounts of sodium diocylsulfosuccinate GEROPON® SDS surfactant (as shown in **TABLE 2**): 0 ppm (control “No Surfactant”), 128 ppm, 256 ppm, and 384 ppm per final soil mixture. The four pesticidal compositions were used for treatment of the inoculated Midwest soil, and the % sulfoxaflor recovery was determined after three days.

TABLE 2 and **FIG. 2** show the % sulfoxaflor recovery after three days for each of the soil samples treated with the pesticidal compositions containing different amounts of sodium diocylsulfosuccinate GEROPON® SDS surfactant.

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As shown in **TABLE 2** and **FIG. 2**, the % sulfoxaflor recovery after three days was enhanced when the pesticidal composition included sodium dioctylsulfosuccinate GEROPON® SDS surfactant. Furthermore, a higher % sulfoxaflor recovery was observed when a higher amount of sodium dioctylsulfosuccinate GEROPON® SDS surfactant was included in the pesticidal composition. For example, when the pesticidal composition included about 6.25 ppm of sulfoxaflor and about 384 ppm of sodium dioctylsulfosuccinate GEROPON® SDS surfactant, the % sulfoxaflor recovery after three days was about 71%, which was about 2 times higher than the 40% sulfoxaflor recovery in the control “No Surfactant” sample.

10

EXAMPLE 3. Effect of Sodium Dioctylsulfosuccinate GEROPON® SDS Surfactant on Sulfoxaflor Stability in Inoculated Midwest Soil at Different Time Intervals

Inoculated Midwest field soil was treated with the pesticidal compositions using the same protocol as described in **EXAMPLE 1**. The pesticidal compositions included about 6.25 ppm sulfoxaflor and about 384 ppm sodium dioctylsulfosuccinate GEROPON® SDS surfactant per final soil mixture. The control sample (“No Surfactant” sample) was the soil sample treated with the control composition (i.e., the composition that contained about 6.25 ppm sulfoxaflor per final soil mixture and did not contain additional anionic surfactant).

The % sulfoxaflor recovery was determined at different time intervals after treating the soil with the pesticidal compositions: 0 day (immediately after treating the soil with the pesticidal compositions), 3 days, 5 days, 7 days (one week after treating the soil with the pesticidal compositions), 10 days, 12 days, and 14 days (two weeks after treating the soil with the pesticidal compositions).

As shown in **FIG. 3**, the % sulfoxaflor recovery increased when the pesticidal compositions included sodium dioctylsulfosuccinate GEROPON® SDS surfactant along with sulfoxaflor. After one week (7 days) of applying the pesticidal compositions to the soil, the control soil sample (“No Surfactant” sample) showed only 6% sulfoxaflor recovery; whereas, the 45% sulfoxaflor recovery was observed for the soil sample treated with pesticidal compositions containing sodium dioctylsulfosuccinate GEROPON® SDS surfactant. Thus, by including sodium dioctylsulfosuccinate GEROPON® SDS surfactant in the pesticidal compositions, the % sulfoxaflor recovery after one week could enhance almost eight (8) times compared to the control “No Surfactant” composition.

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After two weeks (14 days) of applying the pesticidal compositions to the soil, only 2% sulfoxaflor recovery was detected in the control soil sample, while about 31% sulfoxaflor recovery was found for the soil sample treated with the pesticidal composition containing sodium dioctylsulfosuccinate GEROPON® SDS surfactant. Therefore, about 5 31% of the sulfoxaflor still left in the soil at two weeks after the application, while basically no sulfoxaflor left in the soil treated with the control composition. Thus, sodium dioctylsulfosuccinate GEROPON® SDS surfactant enhanced sulfoxaflor stability in soil more than 15 times compared to when the control composition was used.

10 **EXAMPLE 4. Effect of Different Antifoaming Agents on the Sulfoxaflor Stability in Inoculated Midwest Soil**

Inoculated Midwest field soil was treated with the pesticidal compositions using the same protocol as described in **EXAMPLE 1**. Five pesticidal compositions were prepared as shown in **TABLE 3**, and the % sulfoxaflor recovery was determined after three days. 15 For the pesticidal compositions containing surfactant, the pesticidal compositions included about 6.25 ppm sulfoxaflor and about 384 ppm sodium dioctylsulfosuccinate GEROPON® SDS surfactant per final soil mixture.

As shown in **TABLE 3**, three different types of antifoaming agents were used for the study: DOW CORNING® Medical Antifoam C Emulsion from Dow Corning 20 Corporation, which is a food grade, water-dilutable silicone defoamer containing about 30% polydimethylsiloxane; SILFOAM® SC 203 antifoaming agent from Wacker Chemie AG, which is a food grade, 100% actives solvent dispersible silicone compound; and SILFOAM® SC 200 antifoaming agent from Wacker Chemie AG, which is a food grade, 13% active silicone defoamer emulsion. When the antifoaming agent was included in the 25 pesticidal compositions, the amount of antifoaming agent was about 66 ppm based on the total soil liquid.

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TABLE 3. Comparative % sulfoxaflor recovery for the soils treated with the pesticidal compositions containing sulfoxaflor with or without sodium dioctylsulfosuccinate GEROPON® SDS Surfactant, and with or without antifoaming agent

5

Tested Soil Sample	Amount in Pesticidal Composition (ppm per Final Soil Mixture)			% Sulfoxaflor recovery after three Days
	Sulfoxaflor	GEROPON® SDS Surfactant	Antifoaming Agent	
No Surfactant, No Antifoaming Agent (Control Sample)	6.25 ppm	0 ppm	None	54%
Surfactant, No Antifoaming Agent	6.25 ppm	384 ppm	None	86%
Surfactant (+) DOW CORNING® Antifoaming Agent	6.25 ppm	384 ppm	DOW CORNING® Antifoam C Emulsion	82%
Surfactant (+) SILFOAM® 203 Antifoaming Agent	6.25 ppm	384 ppm	SILFOAM® 203 Antifoaming Agent	87%
Surfactant (+) SILFOAM® 200 Antifoaming Agent	6.25 ppm	384 ppm	SILFOAM® 200 Antifoaming Agent	84%

TABLE 3 and **FIG. 4** show the % sulfoxaflor recovery after three days for each of the tested soil samples. The soils treated with the pesticidal compositions including about 6.25 ppm sulfoxaflor and about 384 ppm sodium dioctylsulfosuccinate GEROPON® SDS surfactant per final soil mixture, showed about 86% sulfoxaflor recovery after three days, which was about 1.6 times higher than the 54% sulfoxaflor recovery for the control soil sample (i.e., the soil sample that was treated with the control composition having about 6.25 ppm sulfoxaflor but no sodium dioctylsulfosuccinate GEROPON® SDS surfactant). Thus, as discussed previously, the presence of sodium dioctylsulfosuccinate GEROPON® SDS surfactant in the pesticidal compositions enhanced sulfoxaflor stability in soil.

Furthermore, as shown in **TABLE 3** and **FIG. 4**, the presence of the antifoaming agent in the pesticidal compositions along with sodium dioctylsulfosuccinate GEROPON® SDS surfactant, did not appear to impact the % sulfoxaflor recovery (i.e., the stability of sulfoxaflor in soil).

EXAMPLE 5. Effect of Sodium Dioctylsulfosuccinate GEROPON® SDS Surfactant on the Sulfoxaflor Stability in Inoculated Soil from Fresno, California

Soil from the Fresno field station (Fresno, California) was inoculated, and then
5 treated with the pesticidal compositions using the same protocol as described in
EXAMPLE 1. The sulfoxaflor solution, sodium dioctylsulfosuccinate GEROPON® SDS
surfactant solution, and additional water were added into the plastic bottle to achieve 6.25
ppm of sulfoxaflor active, 384 ppm of sodium dioctylsulfosuccinate GEROPON® SDS
surfactant, and 260,000 ppm water per gram of final soil mixture. Each of the tested soil
10 samples (including the control soil sample) were left under the same conditions for three
days. After three days, the % sulfoxaflor recovery in the soil samples was determined.

As shown in **FIG. 5**, about 28% of sulfoxaflor was recovered in the control soil
sample. When the pesticidal composition included about 6.25 ppm of sulfoxaflor and about
384 ppm of sodium dioctylsulfosuccinate GEROPON® SDS surfactant, the % sulfoxaflor
15 recovery after three days was about 100%, which was about 3.6 times higher than the
sulfoxaflor recovery in the control “No Surfactant” sample. **FIG. 5** shows that when the
inoculated soil from California was treated with the pesticidal composition containing
about 6.25 ppm of sulfoxaflor and about 384 ppm sodium dioctylsulfosuccinate
GEROPON® SDS surfactant, sulfoxaflor was stable in the soil even three days after the
20 application.

EXAMPLE 6. Pesticidal Activities Against Green Peach Aphid (*Myzus persicae*)

Preparation of Tested Compositions

25 Each tested compositions was prepared by mixing a predetermined amount of the
CLOSER® SC insecticide (a sulfoxaflor concentrate having a sulfoxaflor concentration of
240 g/L) with a predetermined amount of sodium dioctylsulfosuccinate GEROPON® SDS
anionic surfactant in an aqueous medium.

30 **TABLE 4. Amounts of sulfoxaflor and sodium dioctylsulfosuccinate
GEROPON® SDS anionic surfactant in the tested compositions**

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Tested Composition (as labeled in FIG. 6)	Amount in the Tested Component (%weight based on total composition weight)	
	Sulfoxaflor	GEROPON® SDS Anionic Surfactant
Sulfoxaflor at 100 ppm	0.043%	None
Sulfoxaflor at 25 ppm	0.011%	None
Sulfoxaflor at 6.25 ppm	0.003%	None
Sulfoxaflor at 100 ppm + GEROPON®	0.043%	0.225%
Sulfoxaflor at 25 ppm + GEROPON®	0.011%	0.225%
Sulfoxaflor at 6.25 ppm + GEROPON®	0.003%	0.225%

The compositions containing different amounts of sulfoxaflor and sodium dioctylsulfosuccinate GEROPON® SDS surfactant were prepared as shown in **TABLE 4**. For example, the “Sulfoxaflor at 100 ppm” composition contained about 0.043% weight of sulfoxaflor based on the total weight of the composition (i.e., 100 ppm of sulfoxaflor per one gram of final soil mixture). “Sulfoxaflor at 100 ppm + GEROPON®” composition contained about 0.043% weight of sulfoxaflor based on the total weight of the composition (i.e., 100 ppm of sulfoxaflor per one gram of final soil mixture), and about 0.225% weight of sodium dioctylsulfosuccinate GEROPON® SDS surfactant based on the total weight of the composition (i.e., 384 ppm per one gram of the final soil mixture; 1500 ppm per one gram of the total soil liquid).

The imidacloprid pesticide PROVADO® 1.6 from Bayer CropScience LP (North Carolina, USA) was used as a standard commercial pesticidal composition for aphid control. The imidacloprid pesticide PROVADO® 1.6 was tested at three different loadings: 100 ppm, 25 ppm, and 6.25 ppm per gram of final soil mixture. In this **EXAMPLE 6**, water was tested as a control composition. Furthermore, an aqueous solution of sodium dioctylsulfosuccinate GEROPON® SDS anionic surfactant was tested.

Determination of Pesticidal Activities Against Green Peach Aphid

Cabbage plants (*Brassica oleracea capitata* L) of uniform size (two new leaf stage) infested with green peach aphids (*Myzus persicae*) (“GPA”) were used as the study models according to the following procedure:

Cabbage seeds were planted in 3-inch pots containing a peat-based METRO MIX 360® potting soil available from SUN GRO® Horticulture Canada, Ltd. The seeds were propagated in greenhouse zone G4, located in the R&D building of Dow AgroSciences

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(Indianapolis, Indiana, USA), at 26 °C with a relative humidity of 53%. Natural light was supplemented with 1,000-watt metal halide overhead lamps with an average illumination of about 500 $\mu\text{E}/\text{m}^2\cdot\text{s}$ photosynthetic active radiation for 16 consecutive hours each day.

TABLE 5. Components of the Midwest soil used for the study

Component	Amount
Organic Matter	3.9% by L.O.I.
Available Phosphorus	22 ppm (M)
Potassium	1.1%; 84 ppm (L)
Magnesium	28.5%; 670 (VH)
Calcium	68.9%; 2500 (H)
Hydrogen	1.5%
Sands	35%
Silt	35%
Clay	30%

5

Each of the 1-ounce clear cups was filled with about 30 grams of the inoculated Midwest field soil having the components as shown in **TABLE 5**. The Midwest soil was a silt loam soil that was collected from the Fowler Field Station (Fowler, Indiana), and had a pH of about 6.9. The soil moisture of the Midwest field soil was about 15% as measured by
10 Mettler LJ16 Moisture Analyzer (15 minutes and 100 °C).

The Midwest field soil in each selected 1-ounce cup was treated with about 9 mL of the selected composition using a 10 mL pipette. Deionized water was used as a control. The remainders of the 1-ounce cups were capped, and a small hole was poked into each lid to provide air flow. The remainders of the 1-ounce cups were stored in a controlled
15 environment at 26 °C and covered with a black plastic bag to prevent any light from entering, until being used for the test.

Cabbage plants were gently removed from the 3-inch pots, and the plant roots were washed with water to remove any excess soil. Then, the cabbage plant was transplanted into the 1-ounce cup containing the treated Midwest field soil (one cabbage plant per one
20 1-ounce cup). The plants were watered as needed after being transplanted.

At the selected number of days after treating the Midwest field soil with the composition (i.e., numbers of days after the soil treatment, "DAT"), the cabbage plant in each 1-ounce cup was infested with GPA by placing a piece of squash leaf infested with

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about 25 aphids on each cabbage plant. The plants were then placed in a controlled environment at 26 °C for three days.

Five different evaluation times were performed: DAT of 0, 7, 14, 21, or 28 days. For example, for the DAT of zero (0) day, the cabbage plant was infested with GPA on the same day that it was transplanted into the treated Midwest field soil. Likewise, for the DAT of 14 days, the cabbage plant was infested with GPA 14 days after it was transplanted to the treated Midwest field soil. Each DAT evaluation time was replicated five times.

The pesticidal activity against GPA was determined three days after infestation, by counting the number of live GPA aphids present on each cabbage plant.

FIG. 6 showed the pesticidal activity against GPA at DAT of 21 days. The cabbages in the Midwest soil treated with the “Sulfoxaflor at 100 ppm” composition showed no live GPA aphid at DAT of 21 days; whereas, the cabbages in the Midwest soil treated with the “Sulfoxaflor at 6.25 ppm” composition showed about 38 live GPA aphids at DAT of 21 days. Thus, at the DAT of 21 days, the soil treated with 100 ppm sulfoxaflor showed a nearly complete control of GPA, while the soil treated with only 6.25 ppm sulfoxaflor showed insufficient control of GPA.

When sodium dioctylsulfosuccinate GEROPON® SDS anionic surfactant was included along with sulfoxaflor in the composition for the soil treatment, the cabbages in the treated soils showed no live GPA aphid at DAT of 21 days, regardless of the loading amount of sulfoxaflor in the composition (i.e., 100 ppm, 25 ppm, or 6.25 ppm). Thus, by including an anionic surfactant in the pesticidal composition along with sulfoxaflor for the soil treatment, the pesticidal activity against GPA was enhanced to almost 100% control at DAT of 21 days.

The cabbages in the soils treated with the commercial PROVADO® 1.6 pesticide showed no live GPA aphid at DAT of 21 days, regardless of the loading amounts (i.e., 100 ppm, 25 ppm, or 6.25 ppm). Thus, the pesticidal compositions comprising sulfoxaflor and additional anionic surfactant showed the same level of pesticidal activity against GPA as the commercial PROVADO® 1.6 pesticide (i.e., almost 100% control) at DAT of 21 days.

Furthermore, the cabbages in the soils treated with the compositions containing sodium dioctylsulfosuccinate GEROPON® SDS anionic surfactant but not sulfoxaflor (i.e., the “GEROPON®” composition in **FIG. 6**) and the cabbages in the soil treated with only water (i.e., the “Water” composition in **FIG. 6**) showed insufficient control of GPA at DAT of 21 days (about 30 to 40 live GPA were found at DAT of 21 days).

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FIG. 7 showed the pesticidal activity against GPA at DAT of 28 days. The cabbages in the Midwest soil treated with the “Sulfoxaflor at 100 ppm” composition showed no live GPA aphid; whereas, the cabbages in the Midwest soils treated with lower amount of sulfoxaflor (i.e., “Sulfoxaflor at 25 ppm” and “Sulfoxaflor at 6.25 ppm”) did not show 100% control of GPA.

At DAT of 28 days, the soil treated with the pesticidal composition comprising sulfoxaflor and sodium dioctylsulfosuccinate GEROPON® SDS anionic surfactant showed 100% GPA control for all of the tested sulfoxaflor loadings (100 ppm, 25 ppm, and 6.25 ppm). This level of pesticidal activity against GPA was about the same as that of commercial PROVADO® 1.6 pesticide, which also provided 100% GPA control at DAT of 28 days regardless of the amount of pesticidal loading.

Determination of Synergistic Effect of Sulfoxaflor and Anionic Surfactant for the Soil Treatment Against Green Peach Aphid (*Myzus persicae*)

The method described in Colby S. R., *Calculating Synergistic and Antagonistic Responses of Herbicide Combinations*, Weeds, 1967, 15, 20–22 was used to determine an existence of synergistic effect between sulfoxaflor and anionic surfactant in the composition for the soil treatment. In this method, the percent insect control of the composition as observed in the study was compared to the "expected" percent control (E) as calculated by equation (1) (hereinafter “Colby’s equation”) below:

$$E = X + Y - \left(\frac{XY}{100} \right) \quad (1)$$

where

X is the percentage of control with sulfoxaflor at a given rate (p),

Y is the percentage of control with anionic surfactant at a given rate (q), and

E is the expected control by the sulfoxaflor and the anionic surfactant at a rate of p+q.

If the observed percent control of the composition is greater than E, there is a synergistic effect between sulfoxaflor and anionic surfactant in the composition for the soil treatment. If the observed percent control of the composition is equaled to or less than E, there is no synergistic effect between sulfoxaflor and anionic surfactant in the composition for the soil treatment.

TABLE 6. Pesticidal activities against green peach aphids (*Myzus persicae*) at 21 days after the soil treatment using Sulfoxaflor loading of 6.25 ppm, with or without sodium dioctylsulfosuccinate GEROPON® SDS surfactant

Soil Treatment	Dose Rate (ppm)	% Control at DAT of 21 days
Sulfoxaflor	6.25	0
GEROPON® SDS Surfactant	384	0
Sulfoxaflor + GEROPON® SDS Surfactant	6.25 + 384	100
Colby's Expected Action	6.25 + 384	0
Differences: Observed vs. Expected	6.25 + 384	100

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TABLE 6 shows the percent control of GPA when the Midwest field soil was treated with different compositions at DAT of 21 days. When the composition comprising about 6.25 ppm of sulfoxaflor and about 384 ppm of sodium dioctylsulfosuccinate GEROPON® SDS anionic surfactant (i.e., 1500 ppm per one gram of total soil liquid) was used for the soil treatment, the % control against GPA was determined as the “Observed” action, and compared to those obtained from the soil treatment using either 6.25 ppm of sulfoxaflor alone, or 384 ppm of sodium dioctylsulfosuccinate GEROPON® SDS anionic surfactant alone. The “Colby’s Expected Action” was calculated using Colby’s equation as discussed previously.

As shown in **TABLE 6**, no control against GPA at DAT of 21 days when the soils were treated with either sulfoxaflor (at 6.25 ppm) alone or sodium dioctylsulfosuccinate GEROPON® SDS anionic surfactant alone. Thus, the expected percentage control according to Colby’s equation was calculated to be zero (0). Surprisingly and unexpectedly, about 100% control against GPA was observed when the soil was treated with a composition comprising both sulfoxaflor and sodium dioctylsulfosuccinate GEROPON® SDS surfactant. Thus, sulfoxaflor and sodium dioctylsulfosuccinate GEROPON® SDS anionic surfactant showed a synergistic effect against GPA when used together in the composition for the soil treatment.

TABLE 7. Pesticidal activities against green peach aphids (*Myzus persicae*) at 28 days after the soil treatment using sulfoxaflor loading of 6.25 ppm, with or without sodium dioctylsulfosuccinate GEROPON® SDS surfactant

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Soil Treatment	Dose Rate (ppm)	% Control at DAT of 28 days
Sulfoxaflor	6.25	0
GEROPON® SDS Surfactant	384	0
Sulfoxaflor + GEROPON® SDS Surfactant	6.25 + 384	98.57
Colby's Expected Action	6.25 + 384	0
Differences: Observed vs. Expected	6.25 + 384	98.57

As shown in **TABLE 7**, about 100% control against GPA was observed at DAT of 28 days when the soil was treated with a composition comprising both sulfoxaflor and sodium dioctylsulfosuccinate GEROPON® SDS anionic surfactant, while no control (0%) was found when the soil was treated with sulfoxaflor (at 6.25 ppm) alone or sodium dioctylsulfosuccinate GEROPON® SDS anionic surfactant alone. Thus, sulfoxaflor and sodium dioctylsulfosuccinate GEROPON® SDS anionic surfactant showed a synergistic effect against GPA when used together in the composition for the soil treatment.

TABLE 8. Pesticidal activities against green peach aphids (*Myzus persicae*) at 28 days after the soil treatment using sulfoxaflor loading of 25 ppm, with or without sodium dioctylsulfosuccinate GEROPON® SDS surfactant

Soil Treatment	Dose Rate (ppm)	% Control at DAT of 28 days
Sulfoxaflor	25	36.39
GEROPON® SDS Surfactant	384	0
Sulfoxaflor + GEROPON® SDS Surfactant	25 + 384	100
Colby's Expected Action	25 + 384	36.4
Differences: Observed vs. Expected	25 + 384	63.6

TABLE 8 showed that about 100% control against GPA was observed at the DAT of 28 days when the soil was treated with a composition comprising both sulfoxaflor and sodium dioctylsulfosuccinate GEROPON® SDS anionic surfactant. This was about 2.75 times higher than the expected percentage control according to Colby's equation (36.4%). It was surprising and unexpected that not only there was a synergistic effect against GPA between sulfoxaflor and sodium dioctylsulfosuccinate GEROPON® SDS anionic

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surfactant in the composition for the soil treatment, but also the large magnitude of such synergistic effect.

While the present disclosure may be susceptible to various modifications and alternative forms, specific embodiments have been described by way of example in detail
5 herein. However, it should be understood that the present disclosure is not intended to be limited to the particular forms disclosed. Rather, the present disclosure is to cover all modifications, equivalents, and alternatives falling within the scope of the present disclosure as defined by the following appended claims and their legal equivalents

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CLAIMS

We claim:

- 5 1. A pesticidal composition comprising at least one anionic surfactant and an active ingredient group alpha (AIGA) compound, wherein the weight ratio of anionic surfactant to AIGA compound is at least about 20:1.
2. The pesticidal composition of claim 1, wherein the weight ratio of anionic
10 surfactant to AIGA compound is at least about 25:1.
3. The pesticidal composition of claim 1, wherein the weight ratio of anionic surfactant to AIGA compound is between about 100:1 and 20:1.
- 15 4. The pesticidal composition of claim 1, wherein the weight ratio of anionic surfactant to AIGA compound is between about 65:1 and 20:1.
5. The pesticidal composition of claim 1, wherein the AIGA compound comprises at least one of the following compounds:
20 an insecticide comprising acephate, acetamiprid, aldicarb, aldoxycarb, bendiocarb, butocarboxim, carbaryl, cartap hydrochloride, demeton-S-methyl, dimethoate, flonicamid, formothion, heptenophos, imidacloprid, isazofos, methamidophos, methomyl, monocrotophos, nitenpyram, omethoate, oxamyl, oxydemeton-methyl, phorate, sulfoxaflo, thiacloprid, thiamethoxam, thiocyclam hydrogen oxalate, thiometon, thiometon sulfone, triazamate, or vamidothion; and
25 a fungicide comprising carboxin, cymoxanil, dodine, ethirimol, fosetyl-aluminum, fuberidazole, hymexazol, iprobenfos, metalaxyl, metalaxyl-M, metsulfosax, ofurace, oxycarboxin, propamocarb hydrochloride, pyroquilon, or triadimefon.
- 30 6. The pesticidal composition of claim 1, wherein the anionic surfactant comprises a surfactant selected from the group consisting of sulfonates, lignosulfonates, sulfates, phosphates, carboxylates, and salts thereof.

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7. The pesticidal composition of claim 1, wherein the anionic surfactant comprises a surfactant selected from the group consisting of sulfonates, sulfates, and a mixture thereof.

5 8. The pesticidal composition of claim 1, further comprising at least one of insecticide, fungicide and herbicide.

9. The pesticidal composition of claim 1, wherein the AIGA compound comprises sulfoxaflor.

10

10. The pesticidal composition of claim 9, wherein the weight ratio of anionic surfactant to sulfoxaflor is at least about 20:1.

11. The pesticidal composition of claim 9, wherein the weight ratio of anionic
15 surfactant to sulfoxaflor is between about 100:1 and 20:1.

12. A method of preparing the pesticidal composition of claim 9, wherein the method comprises mixing at least one anionic surfactant and a sulfoxaflor concentrate wherein the sulfoxaflor concentrate has a sulfoxaflor concentration of 240 g/L or 500 g/kg.

20

13. A method of controlling soil-dwelling pest, soil-borne pathogen or both, wherein the method comprises applying a pesticidal effective amount of the pesticidal composition of claim 1 to soil.

25 14. A method of controlling a sap-feeding insect on a top part of a plant, wherein the method comprises applying a pesticidally effective amount of the pesticidal composition of claim 1 to soil around a root system of the plant.

15 15. The method of claim 14, wherein the sap-feeding insect comprises a green peach aphid (*Myzus persicae*).

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16. A method of controlling a sap-feeding insect on a top part of a plant, wherein the method comprises applying a pesticidally effective amount of the pesticidal composition of claim 9 to soil around a root system of the plant.

5 17. A method of controlling pests, comprising:
 applying a pesticidally effective amount of a pesticidal composition to at least one
 of: soil, seed of a plant, a portion of a plant, and locus where control of pests is desired,
 wherein the pesticidal composition comprises at least one anionic surfactant and an
 active ingredient group alpha (AIGA) compound, and
10 wherein the weight ratio of anionic surfactant to AIGA compound is at least about
 20:1.

 18. The method of claim 17, wherein the weight ratio of anionic surfactant to
 AIGA compound is between about 100:1 and about 20:1.
15

 19. The method of claim 17, wherein the anionic surfactant comprises a
 surfactant selected from the group consisting of sulfonates, lignosulfonates, sulfates,
 phosphates, carboxylates, and salts thereof.

20 20. The method of claim 17, wherein the AIGA compound comprises
 sulfoxaflor.

 21. The method of claim 20, further comprising mixing at least one anionic
 surfactant and a sulfoxaflor concentrate to provide the pesticidal composition,
25 wherein the sulfoxaflor concentrate has a sulfoxaflor concentration of 240 g/L or a
 500 g/kg, and
 wherein the pesticidal composition has the weight ratio of anionic surfactant to
 sulfoxaflor of at least about 20:1.

30 22. The method of claim 17, further comprising applying another active
 formulation to at least one of: soil, seed of a plant, a portion of a plant, and locus where
 control of pests is desired, wherein the another active formulation comprises at least one of
 insecticide, fungicide and herbicide.

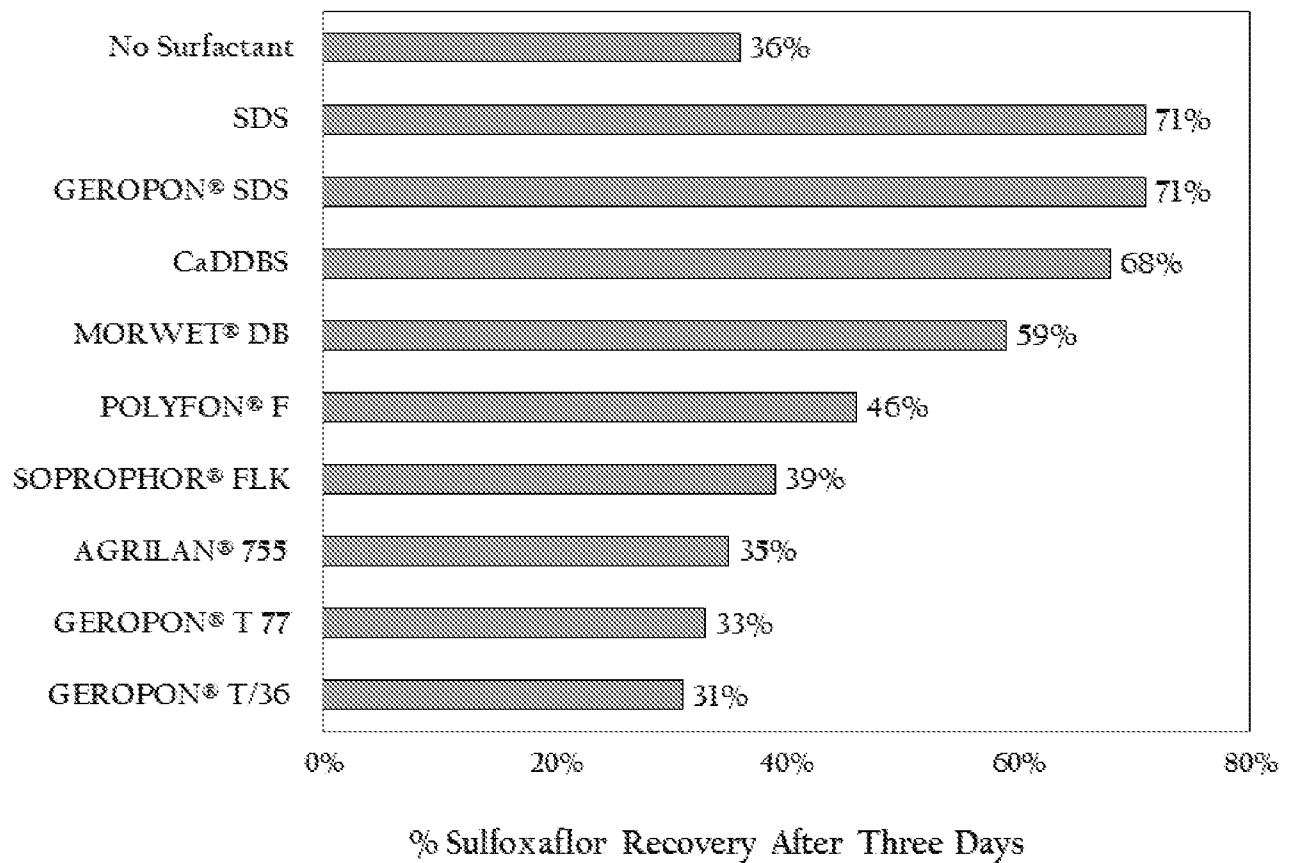
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23. The method of claim 22, wherein the pesticidal composition and the another active formulation are applied at the same time.

5 24. The method of claim 22, wherein the pesticidal composition is applied before or after the another active formulation is applied.

25. The method of claim 17, wherein the pests comprise a sap-feeding insect.

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**FIG. 1**

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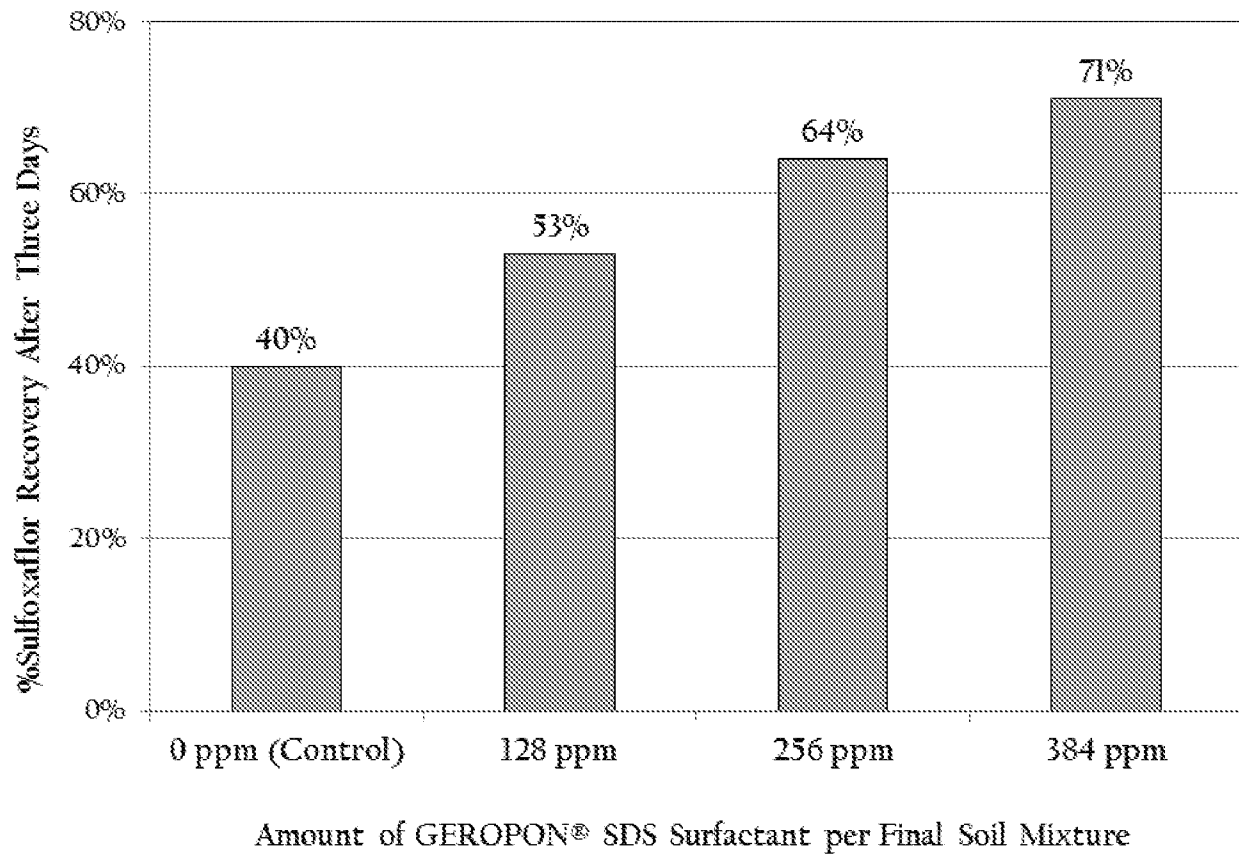


FIG. 2

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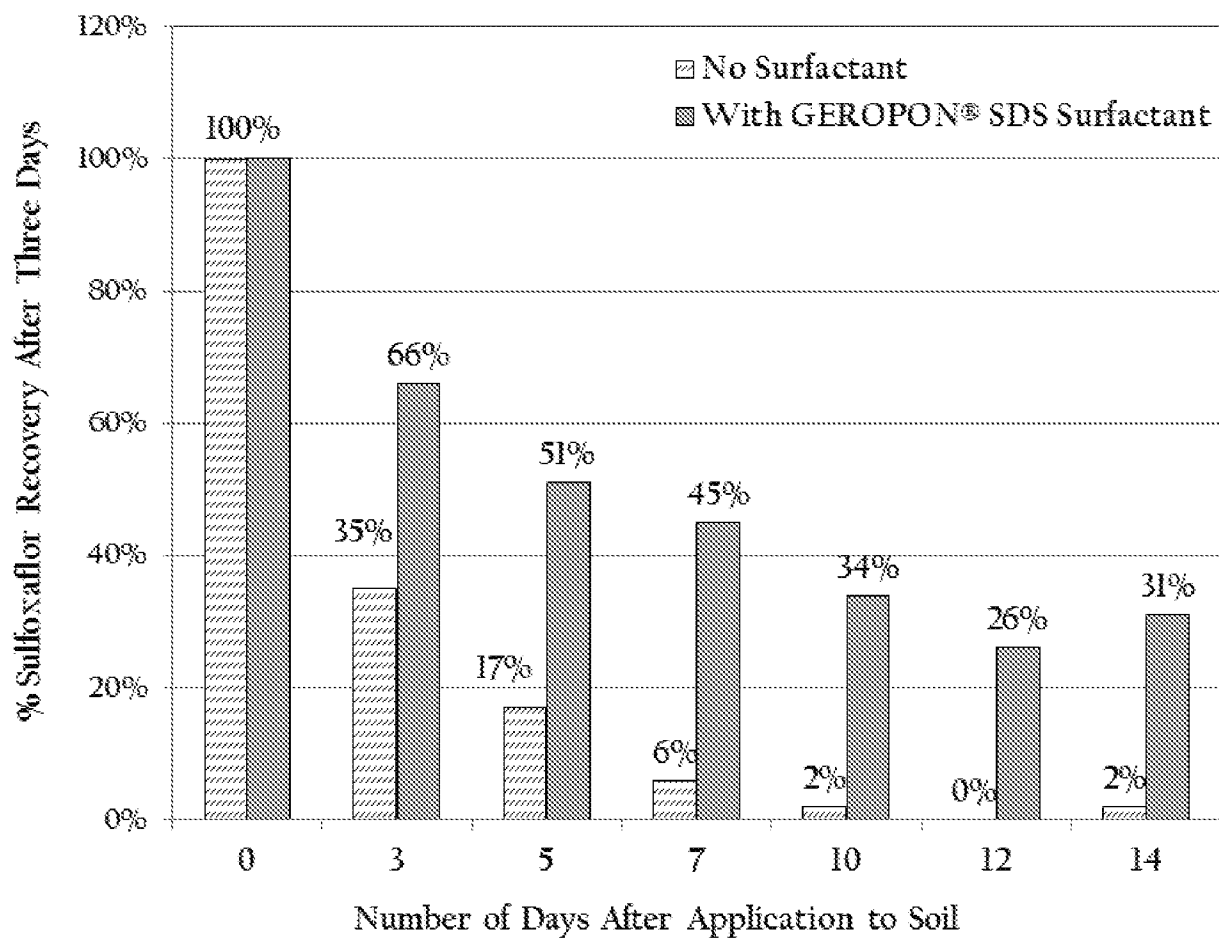


FIG. 3

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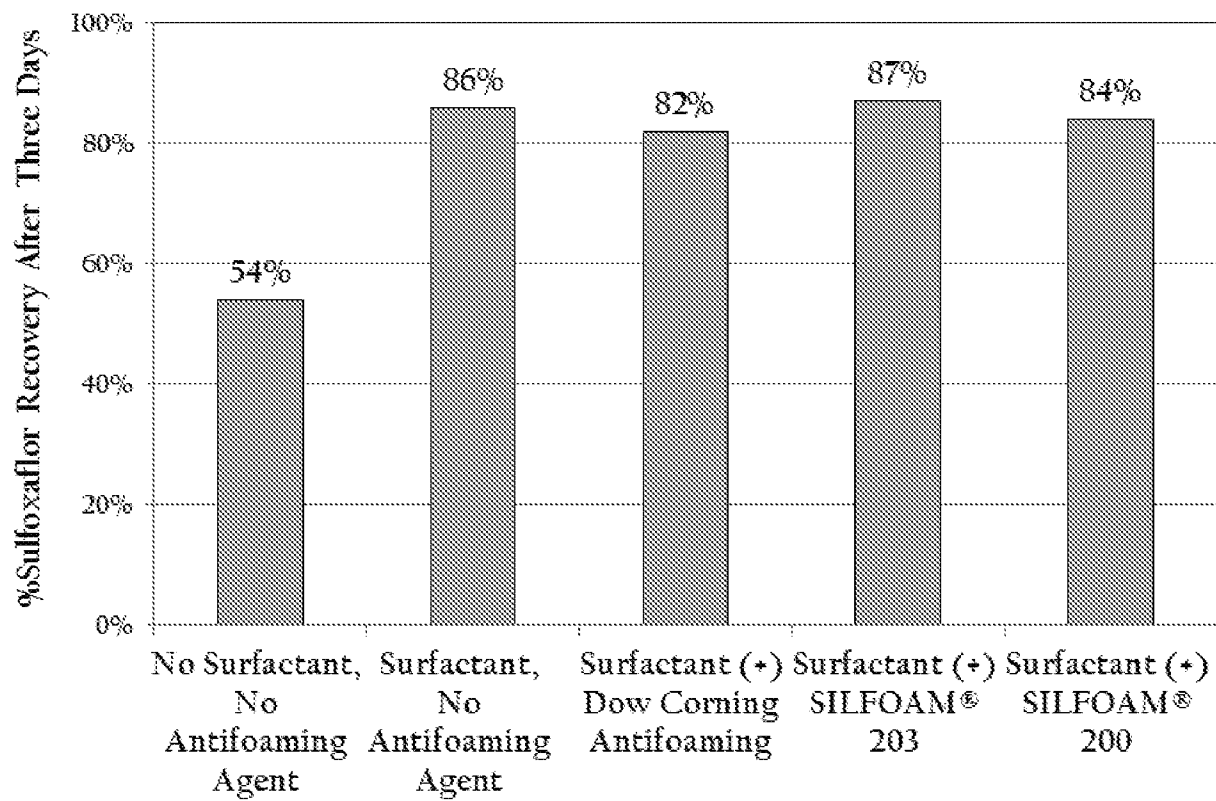


FIG. 4

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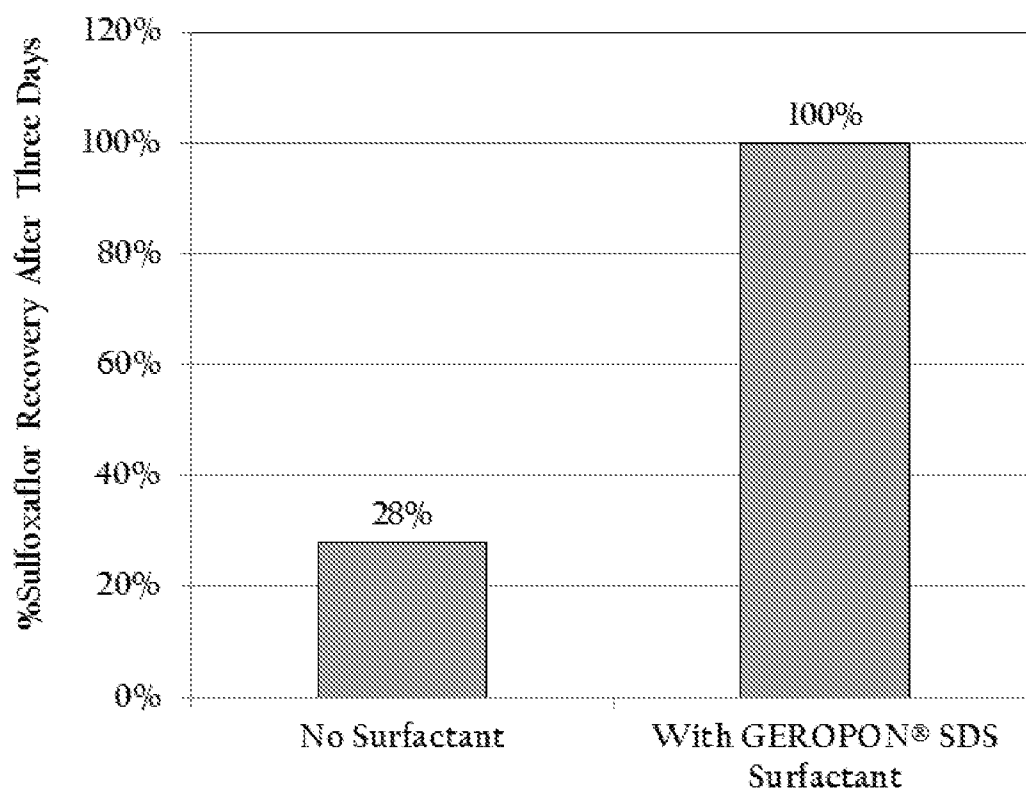


FIG. 5

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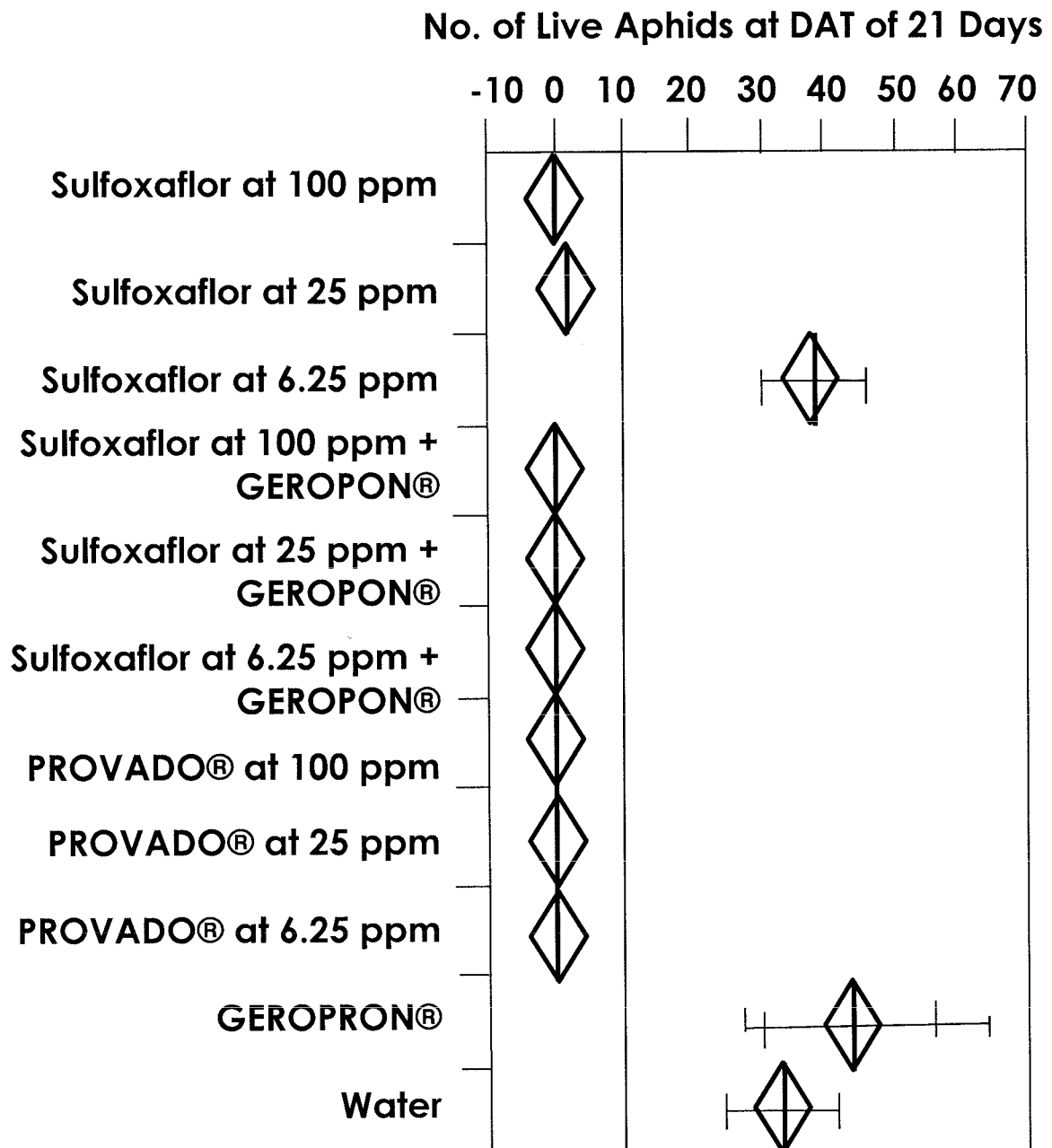


FIG. 6

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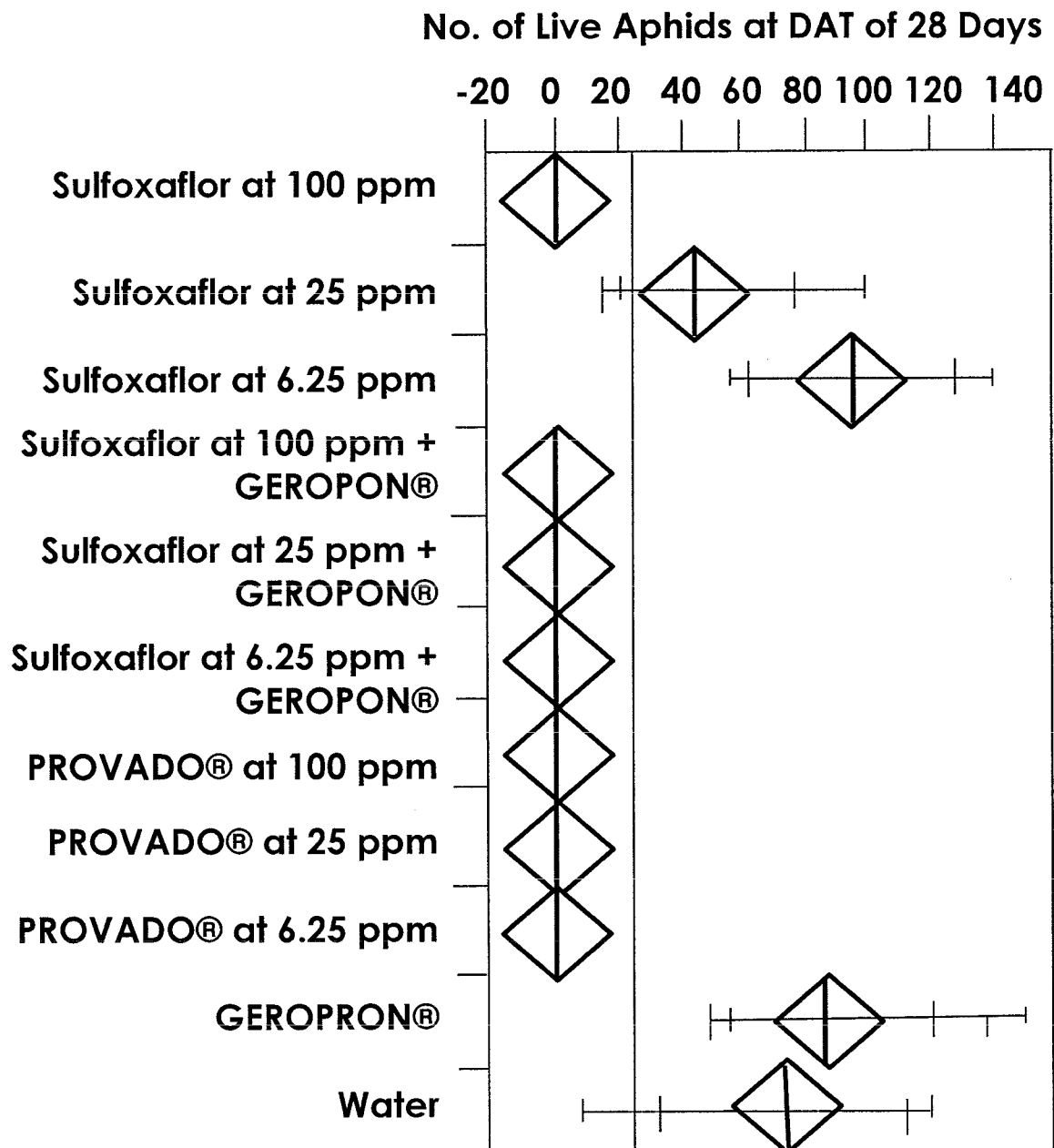


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/025096**A. CLASSIFICATION OF SUBJECT MATTER****C11D 1/12(2006.01)i, A01N 31/02(2006.01)i, A01N 33/10(2006.01)i, A01N 33/02(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C11D 1/12; A01N 57/16; A01P 5/00; A01N 43/88; A01N 25/12; A01N 59/18; C05G 3/00; A01N 43/40; A01N 31/02; A01N 33/10; A01N 33/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: sulfoxafloor, pest, insect, ionic surfactant

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011-0319262 A1 (SCHADE, MICHAEL et al.) 29 December 2011 See abstract; paragraphs [0005]-[0007], [0059], [0119]-[0122], [0127], [0128]; and claims 1, 2, 11.	1-25
A	US 2012-0195974 A1 (YADAV, MAYANK et al.) 02 August 2012 See abstract; paragraph [0036]; and claims 1, 2.	1-25
A	US 2011-0086848 A1 (STORK, ANDREAS et al.) 14 April 2011 See abstract; paragraph [0118]; and claims 1-11.	1-25
A	US 2011-0150957 A1 (WIRTH, WOLFGANG et al.) 23 June 2011 See abstract; paragraph [0166]; and claims 1, 9.	1-25
A	US 2014-0329678 A1 (DOW AGROSCIENCES LLC) 06 November 2014 See abstract; and claims 1-15.	1-25



Further documents are listed in the continuation of Box C.



See patent family annex.

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Name and mailing address of the ISA/KR

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Information on patent family members

International application No.

PCT/US2016/025096

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