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(71) Applicant: **FMC CORPORATION** [US/US]; 2929 Walnut Street, Philadelphia, PA 19104 (US).

(72) Inventors: **WANG, Guozhi**; 220-43, 77th Avenue, Oakland Gardens, NY 11364 (US). **WOLFF, Elizabeth, G.**; 46 Hornsby Street, Fords, NJ 08863 (US). **JERONIMO, Dario, F. Isauro**; Av. Vallarta 6503 Local A1-6, Colonia Cd. Granja, Zapopan Jalisco, C.P. 4510 (MX).

(74) Agent: **DOBSON, Kevin, S.**; FMC Corporation, 2929 Walnut Street, Philadelphia, PA 19104 (US).

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(54) Title: SOLID FORMULATION OF VALIFENALATE, CYMOXANIL AND MANCOZEB

(57) Abstract: Stable solid fungicidal compositions containing valifenalate, cymoxanil and mancozeb are disclosed. Also disclosed are methods for curing or preventing a fungal disease, including an Oomycete-related disease, using the solid fungicidal compositions.

SOLID FORMULATION OF VALIFENALATE, CYMOXANIL AND MANCOZEB

FIELD OF THE DISCLOSED SUBJECT MATTER

The present invention relates to the field of compositions and methods used to control, treat, cure and prevent fungal diseases in agricultural crops, particularly Oomycete-related diseases.

BACKGROUND OF THE INVENTION

Oomycetes (oomycota) form a distinct phylogenetic lineage of fungus-like eukaryotic microorganisms. They are filamentous, microscopic, absorptive organisms that reproduce both sexually and asexually. Oomycetes occupy both saprophytic and pathogenic lifestyles, and include some of the most notorious pathogens of plants, causing devastating diseases such as late blight of potato and sudden oak death. The oomycetes are also often referred to as water molds, although most oomycetes are terrestrial pathogens.

Many oomycetes species are economically important, aggressive plant pathogens. Although other groups exist, the majority of the plant pathogenic species can be classified into four primary groups: the Phytophthora group; the Pythium group; the downy mildews; and the white blister rusts (Albuginales).

Fungicides are biocidal chemical compounds or biological organisms used to kill fungi or fungal spores. Certain fungicides can be used to protect crops from disease, including oomycetes-related diseases, but an excess of fungicide can be detrimental to a crop and should be avoided. Because of the beneficial nature of fungicides, it is necessary to develop a method that allows for the application of fungicides to high value crops, while avoiding any detrimental effects due to oversaturation.

A wide range of fungicides can be used to treat oomycetes-related diseases, such as for example: copper-based fungicides, mancozeb, cymoxanil, dimethomorph, fosetyl, folpet, cyazyfamid and mandipropamid. Mancozeb, valifenalate, and cymoxanil are each known to be effective in the treatment of oomycetes-related diseases – alone or in combination with other fungicides. Although products exist to control oomycete-related diseases, there is a need for more sustainable fungicidal

products that demonstrate greater efficacy, for example with lower use rate and/ or a broader disease control profile.

For example, current commercial formulations of cymoxanil can include as much as 8 wt% of the active. It can be desirable to reduce the application rate of cymoxanil to reduce the potential for harmful impact that it may have at the higher application rates.

Further, it can be problematic to maintain the stability of fungicidal compositions that include mancozeb and/or cymoxanil due to the sensitivity of mancozeb to air, water and light, and the sensitivity of cymoxanil to water.

It can, therefore, be desirable to obtain fungicidal products in forms that are stable and readily applied to plants or to affected areas using methods that provide greater efficacy in the treatment of oomycetes-related diseases and infestation by fungi.

SUMMARY OF THE INVENTION

The purpose and advantages of the disclosed subject matter will be set forth in and apparent from the description that follows, as well as will be learned by practice of the disclosed subject matter. Additional advantages of the disclosed subject matter will be realized and attained by the methods and systems particularly pointed out in the written description and claims hereof.

In one aspect, the present application describes a solid composition comprising a fungicidal mixture of valifenalate, cymoxanil and mancozeb wherein the cyamoxanil is present in an amount of less than about 7 wt% of the composition.

In another aspect the present application is directed to a solid fungicidal composition comprising or consisting essentially of: (1) an active fungicidal component comprising: (i) valifenalate; (ii) cymoxanil; and, (iii) mancozeb; and
(2) a non-fungicidal component comprising or consisting essentially of: (i) dispersant(s); (ii) anti-caking agent(s); (iii) wetting agent(s); and, optionally, (iv) disintegration aid(s) and (v) water softening aid(s).

In another aspect, the present application describes a water-dispersible solid composition comprising: (1) a fungicidal mixture of valifenalate, cymoxanil and mancozeb; and

(2) a non-fungicidal component comprising (i) dispersant(s); (ii) anti-caking agent(s); (iii) wetting agent(s); and, optionally, (iv) disintegration aid(s) and (v) water softening aid(s).

In another aspect, the present application is directed to a solid fungicidal composition comprising or consisting essentially of:

(1) an active fungicidal component comprising: (i) from about 5.6 to about 8.4 wt% of valifenalate; (ii) from about 4.6 to about 7.0 wt% of cymoxanil; and, (iii) from about 50.4 to about 61.6 wt% of mancozeb; and

(2) from about 23 to about 40 wt% of a non-fungicidal component comprising or consisting essentially of: (i) dispersant(s); (ii) anti-caking agent(s); (iii) wetting agent(s); and, optionally, (iv) disintegration aid(s) and (v) water softening aid(s).

In another aspect, the present application is directed to a solid fungicidal composition consisting essentially of:

(1) an active fungicidal component consisting essentially of: (i) about 7.0 wt% of valifenalate; (ii) about 5.8 wt% of cymoxanil; and, (iii) about 56 wt% of mancozeb; and

(2) from about 23 to about 40 wt% of a non-fungicidal component comprising or consisting essentially of: (i) dispersant(s); (ii) anti-caking agent(s); (iii) wetting agent(s); and, optionally, (iv) disintegration aid(s) and (v) water softening aid(s).

In another aspect, the present application is directed to a solid fungicidal composition comprising or consisting essentially of:

(1) from about 60 to about 77 wt% of an active fungicidal component comprising: (i) valifenalate; (ii) from about 4.6 to about 7.0 wt% of cymoxanil; and, (iii) mancozeb; and

(2) from about 23 to about 40 wt% of a non-fungicidal component comprising or consisting essentially of: (i) dispersant(s); (ii) anti-caking agent(s); (iii) wetting agent(s); and, optionally, (iv) disintegration aid(s) and (v) water softening aid(s).

In another aspect, the present application is directed to a fungicidal water-dispersible granule composition comprising or consisting essentially of:

(1) from about 60 to about 77 wt% of an active fungicidal component comprising: (i) valifenalate; (ii) less than 7.0 wt% of cymoxanil; and, (iii) mancozeb; and

(2) from about 23 to about 40 wt% of a non-fungicidal component comprising or consisting essentially of: (i) at least three dispersants; (ii) anti-caking agent(s); (iii)

wetting agent(s); and, optionally, (iv) disintegration aid(s) and (v) water softening aid(s).

In another aspect the present application is directed to a method of curing a fungal disease or a disease associated with an Oomycete pathogen infestation of a plant, comprising treating said plant with an effective amount of a solid fungicidal composition comprising valifenalate, cymoxanil and mancozeb, wherein said composition further comprises one or more formulation components selected from the group consisting of dispersants, anti-caking agents, wetting agents, disintegration aids and water softening agents.

Another aspect of the invention is directed to a method of preventing a fungal disease or a disease associated with an Oomycete pathogen infestation of a plant, comprising treating said plant with an effective amount of a solid fungicidal composition comprising valifenalate, cymoxanil and mancozeb, wherein said composition further comprises one or more formulation components selected from the group consisting of dispersants, anti-caking agents, wetting agents, disintegration aids and water softening agents.

DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to exemplary embodiments of the disclosed subject matter. The method and corresponding steps of the disclosed subject matter will be described in conjunction with the detailed description of the disclosed invention.

The transitional phrase "consisting essentially of" is used conventionally herein, and excludes those features from the art that can materially affect the basic and novel characteristic(s) of the claimed invention. The novelty of the claimed invention can be defined by the compositional ranges of its various components, and therefore the applicant reserves the right to be lexicographer and to define the composition in any manner to exclude compositions that are known and/or inherently novelty-defeating. The applicants may also exclude features from the prior art that can materially affect the effective use of a solid fungicidal composition comprising valifenalate, cymoxanil and mancozeb as a method of preventing a fungal disease or a disease associated with an Oomycete pathogen infestation of a plant.

In the present application, the term "about" can be used to define the invention by an approximated value. The term "about" as used herein will generally refer to an approximate value that is within plus or minus 20% of the indicated value, or plus or minus 10% of the indicated value. For example, "about 10%" can typically indicate any value within a range of from 9% to 11%, and "about 20" can typically indicate any value within a range of from 18 to 22. Appropriate interpretation of the use of "about" may be indicated by context, such as when "rounding off" is apparent or when an approximate range is provided such as "from about … to about".

"Suspensibility" as defined by the International Pesticides Analytical Council (CIPAC) is the amount of active ingredient suspended after a given time in a column of liquid, of stated height, expressed as a percentage of the amount of active (method MT 15). The FAO (Food and Agriculture Organization of the United Nations) guideline for suspensibility of a water-dispersible granule or a wettable powder in water is >80%.

Chemical and physical stabilities of the compositions described herein are determined using accelerated storage stability test conditions, i.e., samples were stored at 54°C for 2 weeks, and degradations of the active ingredients were within FAO defined limits.

TABLE 1 - FAO Tolerance Limits

Declared content in g/kg at 20 ± 2°C	Tolerance
Up to 25*	±25% for heterogeneous formulations (GR, WG, WP, etc.)
Above 25 up to 100*	±10% of the declared content
Above 100 up to 250*	±6% of the declared content
Above 250 up to 500*	±5% of the declared content
Above 500	±25 g/kg

* includes the upper limit in each range

One aspect of the invention is directed to a stable solid fungicidal composition comprising valifenalate, cymoxanil and mancozeb as active ingredients (AIs). Each AI individually can be present as a free base, a salt, or other known derivatives. Valifenalate is typically present as as a free base. Cymoxanil is typically present as a free base. Mancozeb typically contains both manganese (Mn^{2+}) as well as zinc (Zn^{2+}).

The stable solid fungicidal composition can also consist essentially of valifenalate, cymoxanil and mancozeb. The solid composition can be in the form of a water-dispersible granule or a wettable powder, among other solid formulations.

The fungicidal composition comprises or consists essentially of a fungicidally active component and a non-fungicidally active component. The fungicidally active component is a mixture of valifenalate, cymoxanil and mancozeb. The active component comprises or consists essentially of from about 60 to about 77 wt% of the fungicidal composition.

The fungicidally active mixture of the present invention comprises or consists essentially of about 7.0 wt% of cymoxanil or less, based on the weight of the solid fungicidal composition. In certain embodiments of the present invention, the solid composition comprises from about 4.6 to about 7.0 wt% of cymoxanil, or from about 5.2 to about 6.4 wt% of cymoxanil or about 5.8 wt% of cymoxanil.

The solid fungicidal composition can comprise or consist essentially of from about 5.6 to about 8.4 wt% of valifenalate, or from about 6.3 to about 7.7 wt% of valifenalate, or about 7.0 wt% of valifenalate.

The solid fungicidal composition can comprise or consist essentially of from about 50.4 to about 61.6 wt% of mancozeb, or from about 53.5 to about 58.5 wt% of mancozeb, or about 56.0 wt% of mancozeb.

The solid fungicidal composition further comprises, or consists essentially of, a non-fungicidal component present in an amount of from about 23 wt% to about 40 wt% of the fungicidal composition. The non-fungicidal component comprises one or more formulation components selected from the group consisting of dispersants, anti-caking agents, wetting agents, disintegration aids and water-softening agents. In one embodiment, the solid fungicidal composition comprises at least one dispersant, at least one anti-caking agent, at least one wetting agent, optionally one or more disintegration aids and optionally one or more water softening agents.

The dispersants of the solid fungicidal composition are selected from the group consisting of sodium lignin sulfonates, ammonium lignin sulfonates, polyalkyl naphthalenesulfonates and mixtures of two or more thereof. In one embodiment, the dispersants are selected from sodium lignin sulfonates, polyalkylnapthalenesulfonates, and mixtures of two or more thereof. In another embodiment, the fungicidal composition comprises a mixture of three or more

dispersants selected from sodium lignin sulfonates and polyalkylnapthalenesulfonates. The fungicidal composition comprises from about 9 to about 14 wt% of the dispersant. Alternatively, the dispersant is present in an amount of from about 11 to about 13 wt%.

The anti-caking agent or anti-caking agents of the solid fungicidal composition are selected from the group consisting of silicas and clays. The anti-caking agent is optionally included, and if present can be included in an amount of from about 0.7 to about 2.5 wt%.

The wetting agent or wetting agents of the solid fungicidal composition are selected from the group consisting of: sodium alkyl naphthalensulfonates; sodium alkyl sulfonates; and mixtures thereof. Wetting agents can be included in an amount of from about 1 to about 6 wt%, or from about 1 to about 5 wt% or from about 2 to about 5 wt%, or about 4.5 wt%.

The fungicidal composition optionally comprises a first disintegration aid selected from the group consisting of of sodium and ammonium salts of sulfate, phosphate, acetate, chloride, polyphosphate, and mixtures thereof. The disintegration aid is optional, but if present is in an amount of from about 0.2 wt% to about 2.5 wt%, or about 0.25 to about 2 wt%, or about 0.25 to about 1 wt%.

The fungicidal composition optionally comprises a second disintegrant, which is a water-softening agent selected from the group consisting of citric acid, citrate salts, sodium polyphosphate, and EDTA. The water softening agents are also known as metal chelators with affinity for typical water hardness multivalent ions such as calcium, magnesium, iron, aluminum, and manganese. The water softening agent, if present, is in an amount of from about 1 to about 3.0 wt%, or from about 1 to about 2.5 wt%, or from about 1 to about 2 wt%.

A solid fungicidal composition of the present invention comprises less than 1 wt% water in the dried composition, or less than about 0.6 wt% water.

A solid fungicidal composition of the present invention can be in the form of a water-dispersible granule (WDG). A water-dispersible granule as described herein is a solid granular fungicidal composition that has a suspensibility of at least 80%, as determined according to the FAO standard test.

A solid fungicidal composition of the present invention can be in the form of a wettable powder (WP). A wettable powder as described herein is a solid powdered

fungicidal composition that has a suspensibility of at least 80%, as determined according to the FAO standard test.

Due to the sensitivity of the active components, particularly mancozeb and cymoxanil, to heat, air, and/or water the process for preparing the solid fungicidal mixture requires precautions to avoid decomposition of the active components. The process can require maintaining temperature control and performing the drying process under an inert atmosphere. The appropriate process steps are known and practiced conventionally in the handling of these fungicidal components.

Another aspect of the invention is directed to a method of curing Oomycete pathogen infestation of a plant, comprising treating said plant with an effective amount of a solid fungicidal composition as described herein.

Another aspect of the invention is directed to a method of preventing Oomycete pathogen infestation of a plant, comprising treating said plant with an effective amount of a solid fungicidal composition as described herein.

The compositions disclosed in this application can be applied to cure disease in a crop or prevent disease in a crop. In the present disclosure, to prevent disease in a crop means to apply the composition preventatively, prior to the appearance of any symptoms of disease. To cure disease in a crop means to apply the composition after the appearance of any symptoms of disease in a crop; and thus, to eliminate a disease or infection. The composition can also control disease in a crop such that disease or infection is not eliminated (i.e., the pathogen is not eradicated), but the disease is controlled such that a benefit to the crop accrues.

The compositions disclosed in this application can be applied at the time of transplanting, post transplanting, at the appearance of specific disease symptoms, or when conditions are conducive for disease development. In the present disclosure, "transplanting" refers to the refers to the technique of moving a plant from one location to another. Specifically, this usually takes place when a plant is started from a seed in optimal conditions, such as in a greenhouse or protected nursery bed, then replanting it in another, usually outdoor, growing location. In the present disclosure, "at the time of transplanting" means within three (3) days of transplanting the plant at issue. In the present disclosure, "post transplanting" means more than about 3 days after transplanting, including, but not limited to, about 7, 10, 15, 30, 45, or 60 days after transplanting.

The compositions and methods of the invention can be applied simulataneously with, or sequentially with, other suitable additional or secondary agricultural AIs, or other suitable additional agricultural compositions such as insecticides, herbicides, fungicides, nematicides and plant growth regulators. The compositions and methods can also be applied simultaneously or sequentioally with fertilizers. Suitable additional/secondary insecticides, herbicides, fungicides, nematicides and plant growth regulators can include the following:

Insecticides: A0) various insecticides, including agrigata, al-phosphide, amblyseius, aphelinus, aphidius, aphidoletes, artimisinin, autographa californica NPV, azocyclotin, *Bacillus subtilis, Bacillus thuringiensis- spp. aizawai, Bacillus thuringiensis spp. kurstaki, Bacillus thuringiensis, Beauveria, Beauveria bassiana,* betacyfluthrin, biologicals, bisultap, brofluthrinate, bromophos-e, bromopropylate, Bt-Corn-GM, Bt-Soya-GM, capsaicin, cartap, celastrus-extract, chlorantraniliprole, chlorbenzuron, chlorethoxyfos, chlorfluazuron, chlorpyrifos-e, cnidiadin, cryolite, cyanophos, cyantraniliprole, cyhalothrin, cyhexatin, cypermethrin, dacnusa, DCIP, dichloropropene, dicofol, diglyphus, diglyphus+dacnusa, dimethacarb, dithioether, dodecyl-acetate, emamectin, encarsia, EPN, eretmocerus, ethylene-dibromide, eucalyptol, fatty-acids, fatty-acids/salts, fenazaquin, fenobucarb (BPMC), fenpyroximate, flubrocythrinate, flufenzine, formetanate, formothion, furathiocarb, gamma-cyhalothrin, garlic-juice, granulosis-virus, harmonia, heliothis armigera NPV, inactive bacterium, indol-3-ylbutyric acid, iodomethane, iron, isocarbofos, isofenphos, isofenphos-m, isoprocarb, isothioate, kaolin, lindane, liuyangmycin, matrine, mephosfolan, metaldehyde, metarhizium-anisopliae, methamidophos, metolcarb (MTMC), mineral-oil, mirex, m-isothiocyanate, monosultap, myrothecium verrucaria, naled, neochrysocharis formosa, nicotine, nicotinoids, oil, oleic-acid, omethoate, orius, oxymatrine, paecilomyces, paraffin-oil, parathion-e, pasteuria, petroleum-oil, pheromones, phosphorus-acid, photorhabdus, phoxim, phytoseiulus, pirimiphos-e, plant-oil, plutella xylostella GV, polyhedrosis-virus, polyphenol-extracts, potassium-oleate, profenofos, prosuler, prothiofos, pyraclofos, pyrethrins, pyridaphenthion, pyrimidifen, pyriproxifen, quillay-extract, quinomethionate, rape-oil, rotenone, saponin, saponozit, sodium-compounds, sodium-fluosilicate, starch, steinernema, streptomyces, sulfluramid, sulphur, tebupirimfos, tefluthrin, temephos, tetradifon, thiofanox, thiometon, transgenics

(e.g., Cry3Bb1), triazamate, trichoderma, trichogramma, triflumuron, verticillium, vertrine, isomeric insecticides (e.g., kappa-bifenthrin, kappa-tefluthrin), dichoromezotiaz, broflanilide, pyraziflumid; A1) the class of carbamates, including aldicarb, alanycarb, benfuracarb, carbaryl, carbofuran, carbosulfan, methiocarb, methomyl, oxamyl, pirimicarb, propoxur and thiodicarb; A2) the class of organophosphates, including acephate, azinphos-ethyl, azinphos-methyl, chlorfenvinphos, chlorpyrifos, chlorpyrifos-methyl, demeton-S-methyl, diazinon, dichlorvos/DDVP, dicrotophos, dimethoate, disulfoton, ethion, fenitrothion, fenthion, isoxathion, malathion, methamidaphos, methidathion, mevinphos, monocrotophos, oxymethoate, oxydemeton-methyl, parathion, parathion-methyl, phenthoate, phorate, phosalone, phosmet, phosphamidon, pirimiphos-methyl, quinalphos, terbufos, tetrachlorvinphos, triazophos and trichlorfon; A3) the class of cyclodiene organochlorine compounds such as endosulfan; A4) the class of fiproles, including ethiprole, fipronil, pyrafluprole and pyriprole; A5) the class of neonicotinoids, including acetamiprid, clothianidin, dinotefuran, imidacloprid, nitenpyram, thiacloprid and thiamethoxam; A6) the class of spinosyns such as spinosad and spinetoram; A7) chloride channel activators from the class of mectins, including abamectin, emamectin benzoate, ivermectin, lepimectin and milbemectin; A8) juvenile hormone mimics such as hydroprene, kinoprene, methoprene, fenoxycarb and pyriproxyfen; A9) selective homopteran feeding blockers such as pymetrozine, flonicamid and pyrifluquinazon; A10) mite growth inhibitors such as clofentezine, hexythiazox and etoxazole; A11) inhibitors of mitochondrial ATP synthase such as diafenthiuron, fenbutatin oxide and propargite; uncouplers of oxidative phosphorylation such as chlorfenapyr; A12) nicotinic acetylcholine receptor channel blockers such as bensultap, cartap hydrochloride, thiocyclam and thiosultap sodium; A13) inhibitors of the chitin biosynthesis type 0 from the benzoylurea class, including bistrifluron, diflubenzuron, flufenoxuron, hexaflumuron, lufenuron, novaluron and teflubenzuron; A14) inhibitors of the chitin biosynthesis type 1 such as buprofezin; A15) moulting disruptors such as cyromazine; A16) ecdyson receptor agonists such as methoxyfenozide, tebufenozide, halofenozide and chromafenozide; A17) octopamin receptor agonists such as amitraz; A18) mitochondrial complex electron transport inhibitors pyridaben, tebufenpyrad, tolfenpyrad, flufenerim, cyenopyrafen, cyflumetofen,

hydramethylnon, acequinocyl or fluacrypyrim;A19) voltage-dependent sodium channel blockers such as indoxacarb and metaflumizone; A20) inhibitors of the lipid synthesis such as spirodiclofen, spiromesifen and spirotetramat; A21) ryanodine receptor-modulators from the class of diamides, including flubendiamide, the phthalamide compounds (R)-3-Chlor-N1-{2- methyl-4-[1,2,2,2 - tetrafluor-1-(trifluormethyl)ethyl]phenyl}-N2-(1-methyl-2-methylsulfonylethyl)phthalamid and (S)-3-Chlor-N1-{2-methyl-4-[1,2,2,2- tetrafluor-1-(trifluormethyl)ethyl]phenyl}-N2-(1-methyl-2-methylsulfonylethyl)phthalamid, chloranthraniliprole and cyanthraniliprole; A22) compounds of unknown or uncertain mode of action such as azadirachtin, amidoflumet, bifenazate, fluensulfone, piperonyl butoxide, pyridalyl, sulfoxaflor; or A23) sodium channel modulators from the class of pyrethroids, including acrinathrin, allethrin, bifenthrin, cyfluthrin, lambda-cyhalothrin, cypermethrin, alpha-cypermethrin, beta-cypermethrin, zeta-cypermethrin, deltamethrin, esfenvalerate, etofenprox, fenpropathrin, fenvalerate, flucythrinate, tau-fluvalinate, permethrin, silafluofen and tralomethrin.

Fungicides: B0) benzovindiflupyr, anitiperonosporic, ametoctradin, amisulbrom, copper salts (e.g., copper hydroxide, copper oxychloride, copper sulfate, copper persulfate), boscalid, thiflumazide, flutianil, furalaxyl, thiabendazole, benodanil, mepronil, isofetamid, fenfuram, bixafen, fluxapyroxad, penflufen, sedaxane, coumoxystrobin, enoxastrobin, flufenoxystrobin, pyraoxystrobin, pyrametostrobin, triclopyricarb, fenaminstrobin, metominostrobin, pyribencarb, meptyldinocap, fentin acetate, fentin chloride, fentin hydroxide, oxytetracycline, chlozolinate, chloroneb, tecnazene, etridiazole, iodocarb, prothiocarb, *Bacillus subtilis* syn., *Bacillus amyloliquefaciens* (e.g., strains QST 713, FZB24, MBI600, D747), extract from *Melaleuca alternifolia*, extract from *Lupinus albus doce*, BLAD polypeptide, pyrisoxazole, oxpoconazole, etaconazole, fenpyrazamine, naftifine, terbinafine, validamycin, pyrimorph, fthalide, probenazole, isotianil, laminarin, estract from *Reynoutria sachalinensis*, phosphorous acid and salts, teclofthalam, triazoxide, pyriofenone, organic oils, potassium bicarbonate, chlorothalonil, fluoroimide; B1) azoles, including bitertanol, bromuconazole, cyproconazole, difenoconazole, diniconazole, enilconazole, epoxiconazole, fluquinconazole, fenbuconazole, flusilazole, flutriafol, hexaconazole, imibenconazole, ipconazole, metconazole, myclobutanil, penconazole,

propiconazole, prothioconazole, simeconazole, triadimefon, triadimenol, tebuconazole, tetraconazole, triticonazole, prochloraz, pefurazoate, imazalil, triflumizole, cyazofamid, benomyl, carbendazim, thia- bendazole, fuberidazole, ethaboxam, etridiazole and hymexazole, azaconazole, diniconazole-M, oxpoconazol, paclobutrazol, uniconazol, 1-(4-chloro-phenyl)-2-([1 ,2,4]triazol-1-yl)-cycloheptanol and imazalilsulfphate; B2) strobilurins, including azoxystrobin, dimoxystrobin, enestroburin, fluoxastrobin, kresoxim-methyl, methominostrobin, orysastrobin, picoxystrobin, pyraclostrobin, trifloxystrobin, enestroburin, methyl(2-chloro-5-[1-(3-methylbenzyloxyimino)ethyl]benzyl)carbamate, methyl(2-chloro-5-[1-(6-methylpyridin-2-ylmethoxyimino)ethyl]benzyl)carbamate and methyl 2-(ortho-(2,5-dimethylphenyloxymethylene)- phenyl)-3-methoxyacrylate, 2-(2-(6-(3-chloro-2-methyl-phenoxy)-5-fluoro-pyrimidin-4-yloxy)-phenyl)-2-methoxyimino-N-methyl-acetamide and 3-methoxy-2-(2-(N-(4-methoxy-phenyl)-cyclopropanecarboximidoylsulfanylmethyl)-phenyl)-acrylic acid methyl ester; B3) carboxamides, including carboxin, benalaxyl, benalaxyl-M, fenhexamid, flutolanil, furametpyr, mepronil, metalaxyl, mefenoxam, ofurace, oxadixyl, oxycarboxin, penthiopyrad, isopyrazam, thifluzamide, tiadinil, 3,4-dichloro-N-(2-cyanophenyl)isothiazole-5-carboxamide, dimethomorph, flumorph, flumetover, fluopicolide (picobenzamid), zoxamide, carpropamid, diclocymet, mandipropamid, N-(2-(4-[3-(4-chlorophenyl)prop-2-ynyloxy]-3-methoxyphenyl)ethyl)-2-methanesulfonyl-amino-3-methylbutyramide, N-(2-(4-[3-(4-chloro- phenyl)prop-2-ynyloxy]-3-methoxy-phenyl)ethyl)-2-ethanesulfonylamino-3-methylbutyramide, methyl3-(4-chlorophenyl)-3-(2-isopropoxycarbonyl-amino-3-methyl-butyrylamino)propionate, N-(4'-bromobiphenyl-2-yl)-4-difluoromethyl^-methylthiazole-δ-carboxamide, N-(4'-trifluoromethyl-biphenyl-2-yl)-4-difluoromethyl-2-methylthiazole-5-carboxamide, N-(4'- chloro-3'-fluorobiphenyl-2-yl)-4-difluoromethyl-2-methyl-thiazole-5-carboxamide, N-(3\4'-dichloro-4-fluorobiphenyl-2-yl)-3-difluoro-methyl-1-methyl-pyrazole-4-carboxamide, N-(3',4'-dichloro-5-fluorobiphenyl-2-yl)-3-difluoromethyl-1-methylpyrazole-4-carboxamide, N-(2-cyano-phenyl)-3,4-dichloroisothiazole-5-carboxamide, 2-amino-4-methyl-thiazole-5-carboxanilide, 2-chloro-N-(1 ,1 ,3-trimethyl-indan-4-yl)-nicotinamide, N-(2- (1 ,3-dimethylbutyl)-phenyl)-1,3-dimethyl-5-fluoro-1H-pyrazole-4-carboxamide, N-(4'-chloro-3',5-difluoro-biphenyl-2-yl)-3-difluoromethyl-1-methyl-I

H-pyrazole-4-carboxamide, N-(4'-chloro-3',5-difluoro-biphenyl-2-yl)-3-trifluoromethyl-1 -methyl-1H-pyrazole-4-carboxamide, N-(3',4'- dichloro-5-fluoro-biphenyl-2-yl)-3-trifluoromethyl-1-methyl-1H-pyrazole-4-carboxamide, N-(3',5-difluoro-4'-methyl-biphenyl-2-yl)-3-difluoromethyl-1-methyl-1H-pyrazole-4-carboxamide, N-(3',5-difluoro-4'-methyl-biphenyl-2-yl)-3-trifluoromethyl-1-methyl-1H-pyrazole-4-carboxamide, N- (cis-2-bicyclopropyl-2-yl-phenyl)-3-difluoromethyl-1 -methyl-1H-pyrazole-4-carboxamide, N-(trans-2-bicyclopropyl-2-yl-phenyl)-3-difluoro-methyl-1-methyl-1 H-pyrazole-4-carboxamide, fluopyram, N-(3-ethyl-3,5-5-trimethyl-cyclohexyl)-3-formylamino-2-hydroxy-benzamide,oxytetracyclin, silthiofam, N-(6-methoxy-pyridin-3-yl) cyclopropanecarboxamide, 2-iodo-N-phenyl-benzamide, N-(2-bicyclo-propyl-2-yl-phenyl)-3-difluormethyl-1-methylpyrazol-4-ylcarboxamide, N-(3',4',5'-trifluorobiphenyl-2-yl)-1,3-dimethylpyrazol-4-ylcarboxamide, N-(3',4',5'-trifluorobiphenyl-2-yl)-1,3-dimethyl-5-fluoropyrazol-4-yl-carboxamide, N-(3',4',5'-trifluorobiphenyl-2-yl)-5-chloro-1,3-dimethyl-pyrazol-4-ylcarboxamide, N-(3',4',5'-trifluorobiphenyl-2-yl)-3- fluoromethyl-1-methylpyrazol-4-ylcarboxamide, N-(3',4',5'-trifluorobiphenyl-2-yl)-3-(chlorofluoromethyl)-1-methylpyrazol-4-ylcarboxamide,N-(3',4',5'-trifluorobiphenyl-2-yl)-3-difluoromethyl-1-methylpyrazol-4- ylcarboxamide, N-(3',4',5'-trifluorobiphenyl-2-yl)-3-difluoromethyl-5-fluoro-1-methylpyrazol-4-ylcarboxamide, N-(3',4',5'-trifluorobiphenyl-2- yl)-5-chloro-3-difluoromethyl-1 -methylpyrazol-4-ylcarboxamide, N-(3',4',5'-trifluorobiphenyl-2-yl)-3-(chlorodifluoromethyl)-1-methylpyrazol-4-ylcarboxamide, N-(3',4',5'-trifluorobiphenyl-2-yl)-1-methyl-3-trifluoromethylpyrazol-4-ylcarboxamide, N-(3',4',5'-trifluorobiphenyl-2-yl)-5-fluoro-1-methyl-3-trifluoromethylpyrazol-4-ylcarboxamide, N-(3',4',5'-trifluorobiphenyl-2-yl)-5-chloro-1-methyl-3-trifluoromethylpyrazol-4-ylcarboxamide, N-(2',4',5'-trifluorobiphenyl-2-yl)-1 ,3-dimethylpyrazol-4-ylcarboxamide, N-(2',4',5'-trifluorobiphenyl-2-yl)- 1 ,3-dimethyl-5-fluoropyrazol-4-ylcarboxamide, N-(2',4',5'- trifluorobiphenyl-2-yl)-5-chloro-1 ,3-dimethylpyrazol-4-ylcarboxamide,N-(2',4',5'-trifluorobiphenyl-2-yl)-3-fluoromethyl-1-methylpyrazol-4-ylcarboxamide, N-(2',4',5'-trifluorobiphenyl-2-yl)-3-(chlorofluoromethyl)-1-methylpyrazol-4-ylcarboxamide,N-(2',4',5'-trifluorobiphenyl-2-yl)-3-difluoromethyl-1-methylpyrazol-4-ylcarboxamide,

N-(2',4',5'-trifluorobiphenyl-2-yl)-3-difluoromethyl-5-fluoro-1-methylpyrazol-4-ylcarboxamide, N-(2',4',5'-trifluorobiphenyl-2- yl)-5-chloro-3-difluoromethyl-1 -methylpyrazol-4-ylcarboxamide, N-(2',4',5'-trifluorobiphenyl-2-yl)-3-(chlorodifluoromethyl)-1-methylpyrazol-4-ylcarboxamide, N-(2',4',5'-trifluorobiphenyl-2-yl)-1-methyl-3-trifluoromethylpyrazol-4-ylcarboxamide,N-(2',4',5'-trifluorobiphenyl-2-yl)-5-fluoro-1-methyl-3-trifluoromethylpyrazol-4-ylcarboxamide, N-(2',4',5'-trifluorobiphenyl-2-yl)-5-chloro-1-methyl-3-trifluoromethylpyrazol-4-ylcarboxamide, N-(3',4'-dichloro-3-fluorobiphenyl-2-yl)-1 -methyl-3-trifluoromethyl-1H-pyrazole-4-carboxamide,N-(3',4'-dichloro-3-fluorobiphenyl-2-yl)-1 -methyl-3-difluoromethyl-1 H-pyrazole-4-carboxamide, N-(3',4'-difluoro-3-fluorobiphenyl-2-yl)-1-methyl-3-trifluoromethyl-1H-pyrazole-4-carboxamide, N-(3',4'-difluoro-3-fluorobiphenyl-2-yl)-1-methyl-S-difluoromethyl-1 H-pyrazole-4-carboxamide, N-(3'-chloro-4'- fluoro-3-fluorobiphenyl-2-yl)-1-methyl-3-difluoromethyl-1 H-pyrazole-4-carboxamide, N-(3',4'-dichloro-4-fluorobiphenyl-2-yl)-1-methyl-3-trifluoromethyl-1 H- pyrazole-4-carboxamide, N-(3',4'-difluoro-4-fluorobiphenyl-2-yl)-1 - methyl-S-trifluoromethyl-I H-pyrazole-4-carboxamide, N-(3',4'-dichloro-4- fluorobiphenyl-2-yl)-1 -methyl-3-difluoromethyl-1 H-pyrazole-4-carboxamide, N-(3',4'-difluoro-4-fluorobiphenyl-2-yl)-1-methyl-3-difluoromethyl-1 H- pyrazole-4-carboxamide, N-(3'-chloro-4'-fluoro-4-fluorobiphenyl-2-yl)-1-methyl-S-difluoromethyl-I H-pyrazole-4-carboxamide, N-(3',4'-dichloro-5- fluorobiphenyl-2-yl)-1-methyl-3-trifluoromethyl-1 H-pyrazole-4- carboxamide, N-(3',4'-difluoro-5-fluorobiphenyl-2-yl)-1-methyl-3-trifluoromethyl-1 H- pyrazole-4-carboxamide, N-(3',4'-dichloro-5-fluorobiphenyl-2-yl)-1-methyl-S-difluoromethyl-IH-pyrazole-carboxamide, N-(3',4'-difluoro-5- fluorobiphenyl-2-yl)-1 -methyl-3-difluoromethyl-1 H-pyrazole-4-carboxamide, N-(3',4'-dichloro-5-fluorobiphenyl-2-yl)-1,3-dimethyl-1 H-pyrazole-4-carboxamide, N-(3'-chloro-4'-fluoro-5-fluorobiphenyl-2-yl)-1-methyl-3- difluoromethyl-1 H-pyrazole-4-carboxamide, N-(4'-fluoro-4-fluorobiphenyl-2-yl)-1-methyl-3-trifluoromethyl-1H-pyrazole-4-carboxamide, N-(4'-fluoro-5-fluorobiphenyl-2-yl)-1-methyl-3-trifluoromethyl-1H-pyrazole-4-carboxamide,N-(4'-chloro-5-fluorobiphenyl-2-yl)-1-methyl-3-trifluoromethyl-1H-pyrazole-4-carboxamide, N-(4'-methyl-5-fluorobiphenyl-2-yl)-1-methyl-3-trifluoromethyl-1 H-pyrazole-4-carboxamide, N-(4'-fluoro-5- fluorobiphenyl-2-yl)-1,3-dimethyl-1 H-pyrazole-4-carboxamide, N-(4'- chloro-5-fluorobiphenyl-2-yl)-

1,3-dimethyl-1 H-pyrazole-4-carboxamide, N-(4'-methyl-5-fluorobiphenyl-2-yl)-1,3-dimethyl-1 H-pyrazole-4-carboxamide, N-(4'-fluoro-6-fluorobiphenyl-2-yl)-1-methyl-3-trifluoromethyl-1 H- pyrazole-4-carboxamide, N-(4'-chloro-6-fluorobiphenyl-2-yl)-1-methyl-3- trifluoromethyl-1 H-pyrazole-4-carboxamide, N-[2-(1 ,1 ,2,3,3,3- hexafluoropropoxy)-phenyl]-3-difluoromethyl-1-methyl-1H-pyrazole-4 carboxamide, N-[4'-(trifluoromethylthio)-biphenyl-2-yl]-3-difluoromethyl-1-methyl-1 H-pyrazole-4-carboxamide and N-[4'-(trifluoromethylthio)-biphenyl-2-yl]-1-methyl-3-trifluoromethyl-1-methyl-1H-pyrazole-4-carboxamide; B4) heterocyclic compounds, including fluazinam, pyrifenox, bupirimate, cyprodinil, fenarimol, ferimzone, mepanipyrim, nuarimol, pyrimethanil, triforine, fenpiclonil, fludioxonil, aldimorph, dodemorph, fenpropimorph, tridemorph, fenpropidin, iprodione, procymidone, vinclozolin, famoxadone, fenamidone, octhilinone, proben- azole, 5-chloro-7-(4-methyl-piperidin-1-yl)-6-(2,4,6-trifluorophenyl)-[1,2,4]triazolo[1,5-a]pyrimidine, anilazine, diclomezine, pyroquilon, proquinazid, tricyclazole, 2-butoxy-6-iodo-3-propylchromen-4-one, acibenzolar-S-methyl, captafol, captan, dazomet, folpet, fenoxanil, quinoxyfen, N,N-dimethyl-3-(3-bromo-6-fluoro-2-methylindole-1-sulfonyl)-[1,2,4]triazole-1-sulfonamide,5-ethyl-6-octyl-[1,2,4]triazolo[1 ,5-a]pyrimidin-2,7-diamine, 2,3,5,6-tetrachloro-4-methanesulfonyl-pyridine,3,4,5-trichloro-pyridine-2,6-di-carbonitrile, N-(1-(5-bromo-3-chloro-pyridin-2-yl)-ethyl)-2,4-dichloro-nicotinamide, N-((5-bromo-3-chloro pyridin-2-yl)-methyl)-2,4-dichloro-nicotinamide, diflumetorim, nitrapyrin, dodemorphacetate, fluoroimid, blasticidin-S, chinomethionat, debacarb, difenzoquat, difenzoquat-methylsulphat, oxolinic acid and piperalin; B5) carbamates, including maneb, metam, methasulphocarb, metiram, ferbam, propineb, thiram, zineb, ziram, diethofencarb, iprovalicarb, benthiavalicarb, propamocarb, propamocarb hydrochlorid, 4-fluorophenyl N-(1-(1-(4-cyanophenyl)- ethanesulfonyl)but-2-yl)carbamate, methyl 3-(4-chloro-phenyl)-3-(2-isopropoxycarbonylamino-3-methyl-butyrylamino)propanoate; or B6) other fungicides, including guanidine, dodine, dodine free base, iminoctadine, guazatine, antibiotics: kasugamycin, oxytetracyclin and its salts, streptomycin, polyoxin, validamycin A, nitrophenyl derivatives: binapacryl, dinocap, dinobuton, sulfur-containing heterocyclyl compounds: dithianon, isoprothiolane, organometallic compounds: fentin salts,

organophosphorus compounds: edifenphos, iprobenfos, fosetyl, fosetyl-aluminum, phosphorous acid and its salts, pyrazophos, tolclofos- methyl, organochlorine compounds: dichlofluanid, flusulfamide, hexachloro- benzene, phthalide, pencycuron, quintozene, thiophanate, thiophanate-methyl, tolylfluanid, others: cyflufenamid, dimethirimol, ethirimol, furalaxyl, metrafenone and spiroxamine, guazatine-acetate, iminoc- tadine-triacetate, iminoctadine-tris(albesilate), kasugamycin hydrochloride hydrate, dichlorophen, pentachlorophenol and its salts, N-(4- chloro-2-nitro-phenyl)-N-ethyl-4-methyl-benzenesulfonamide, dicloran, nitrothal-isopropyl, tecnazen, biphenyl, bronopol, diphenylamine, mildiomycin, oxincopper, prohexadione calcium, N- (cyclopropylmethoxyimino-(6-difluoromethoxy-2,3-difluoro-phenyl)- methyl)-2-phenyl acetamide, N'-(4-(4-chloro-3-trifluoromethyl-phenoxy)-2,5-dimethyl-phenyl)-N-ethyl-N-methyl formamidine, N'-(4-(4-fluoro-3-trifluoromethyl-phenoxy)-2,5-dimethyl-phenyl)-N-ethyl-N-methyl formamidine, N'-(2-methyl-5-trifluormethyl-4-(3-trimethylsilanyl-propoxy)-phenyl)-N-ethyl-N-methylformamidine and N'-(5-difluormethyl-2-methyl-4-(3-trimethylsilanyl-propoxy)-phenyl)-N-ethyl-N-methyl formamidine.

Herbicides: C1) acetyl-CoA carboxylase inhibitors (ACC), for example cyclohexenone oxime ethers, such as alloxydim, clethodim, cloproxydim, cycloxydim, sethoxydim, tralkoxydim, butroxydim, clefoxydim or tepraloxydim; phenoxyphenoxypropionic esters, such as clodinafop-propargyl, cyhalofop-butyl, diclofop-methyl, fenoxaprop-ethyl, fenoxaprop-P-ethyl, fenthiapropethyl, fluazifop-butyl, fluazifop-P-butyl, haloxyfop-ethoxyethyl, haloxyfop-methyl, haloxyfop-P-methyl, isoxapyrifop, propaquizafop, quizalofop-ethyl, quizalofop-P-ethyl or quizalofop-tefuryl; or arylaminopropionic acids, such as flamprop-methyl or flamprop-isopropyl; C2 acetolactate synthase inhibitors (ALS), for example imidazolinones, such as imazapyr, imazaquin, imazamethabenz-methyl (imazame), imazamox, imazapic or imazethapyr; pyrimidyl ethers, such as pyrithiobac-acid, pyrithiobac-sodium, bispyribac-sodium. KIH-6127 or pyribenzoxym; sulfonamides, such as florasulam, flumetsulam or metosulam; or sulfonylureas, such as amidosulfuron, azimsulfuron, bensulfuron-methyl, chlorimuron-ethyl, chlorsulfuron, cinosulfuron, cyclosulfamuron, ethametsulfuron-methyl, ethoxysulfuron, flazasulfuron, halosulfuron-methyl, imazosulfuron, metsulfuron-methyl, nicosulfuron, primisulfuron-methyl, prosulfuron, pyrazosulfuron-ethyl, rimsulfuron,

sulfometuron-methyl, thifensulfuron-methyl, triasulfuron, tribenuron-methyl, triflusulfuron-methyl, tritosulfuron, sulfosulfuron, foramsulfuron or iodosulfuron; C3) amides, for example allidochlor (CDAA), benzoylprop-ethyl, bromobutide, chiorthiamid. diphenamid, etobenzanidibenzchlomet), fluthiamide, fosamin or monalide; C4) auxin herbicides, for example pyridinecarboxylic acids, such as clopyralid or picloram; or 2,4-D or benazolin; C5) auxin transport inhibitors, for example naptalame or diflufenzopyr; C6) carotenoid biosynthesis inhibitors, for example benzofenap, clomazone (dimethazone), diflufenican, fluorochloridone, fluridone, pyrazolynate, pyrazoxyfen, isoxaflutole, isoxachlortole, mesotrione, sulcotrione (chlormesulone), ketospiradox, flurtamone, norflurazon or amitrol; C7) enolpyruvylshikimate-3-phosphate synthase inhibitors (EPSPS), for example glyphosate or sulfosate; C8) glutamine synthetase inhibitors, for example bilanafos (bialaphos) or glufosinate-ammonium; C9) lipid biosynthesis inhibitors, for example anilides, such as anilofos or mefenacet; chloroacetanilides, such as dimethenamid, S-dimethenamid, acetochlor, alachlor, butachlor, butenachlor, diethatyl-ethyl, dimethachlor, metazachlor, metolachlor, S-metolachlor, pretilachlor, propachlor, prynachlor, terbuchlor, thenylchlor or xylachlor; thioureas, such as butylate, cycloate, di-allate, dimepiperate, EPTC. esprocarb, molinate, pebulate, prosulfocarb, thiobencarb (benthiocarb), tri-allate or vemolate; or benfuresate or perfluidone; C10) mitosis inhibitors, for example carbamates, such as asulam, carbetamid, chlorpropham, orbencarb, pronamid (propyzamid), propham or tiocarbazil; dinitroanilines, such as benefin, butralin, dinitramin, ethalfluralin, fluchloralin, oryzalin, pendimethalin, prodiamine or trifluralin; pyridines, such as dithiopyr or thiazopyr; or butamifos, chlorthal-dimethyl (DCPA) or maleic hydrazide; C11) protoporphyrinogen IX oxidase inhibitors, for example diphenyl ethers, such as acifluorfen, acifluorfen-sodium, aclonifen, bifenox, chlomitrofen (CNP), ethoxyfen, fluorodifen, fluoroglycofen-ethyl, fomesafen, furyloxyfen, lactofen, nitrofen, nitrofluorfen or oxyfluorfen; oxadiazoles, such as oxadiargyl or oxadiazon; cyclic imides, such as azafenidin, butafenacil, carfentrazone-ethyl, cinidon-ethyl, flumiclorac-pentyl, flumioxazin, flumipropyn, flupropacil, fluthiacet-methyl, sulfentrazone or thidiazimin; or pyrazoles, such as ET-751.JV 485 or nipyraclofen; C12) photosynthesis inhibitors, for example propanil, pyridate or pyridafol; benzothiadiazinones, such as bentazone; dinitrophenols, for example bromofenoxim,

dinoseb, dinoseb-acetate, dinoterb or DNOC; dipyridylenes, such as cyperquat-chloride, difenzoquat-methylsulfate, diquat or paraquat-dichloride; ureas, such as chlorbromuron, chlorotoluron, difenoxuron, dimefuron, diuron, ethidimuron, fenuron, fluometuron, isoproturon, isouron, linuron, methabenzthiazuron, methazole, metobenzuron, metoxuron, monolinuron, neburon, siduron or tebuthiuron; phenols, such as bromoxynil or ioxynil; chloridazon; triazines, such as ametryn, atrazine, cyanazine, desmein, dimethamethryn, hexazinone, prometon, prometryn, propazine, simazine, simetryn, terbumeton, terbutryn, terbutylazine or trietazine; triazinones, such as metamitron or metribuzin; uracils, such as bromacil, lenacil or terbacil; or biscarbamates, such as desmedipham or phenmedipham; C13) synergists, for example oxiranes, such as tridiphane; C14) CIS cell wall synthesis inhibitors, for example isoxaben or dichlobenil; C15) various other herbicides, for example dichloropropionic acids, such as dalapon; dihydrobenzofurans, such as ethofumesate; phenylacetic acids, such as chlorfenac (fenac); or aziprotryn, barban, bensulide, benzthiazuron, benzofluor, buminafos, buthidazole, buturon, cafenstrole, chlorbufam, chlorfenprop-methyl, chloroxuron, cinmethylin, cumyluron, cycluron, cyprazine, cyprazole, dibenzyluron, dipropetryn, dymron, eglinazin-ethyl, endothall, ethiozin, flucabazone, fluorbentranil, flupoxam, isocarbamid, isopropalin, karbutilate, mefluidide, monuron, napropamide, napropanilide, nitralin, oxaciclomefone, phenisopham, piperophos, procyazine, profluralin, pyributicarb, secbumeton, sulfallate (CDEC), terbucarb, triaziflam, triazofenamid or trimeturon; or their environmentally compatible salts.

Nematicides or bionematicides: Benomyl, cloethocarb, aldoxycarb, tirpate, diamidafos, fenamiphos, cadusafos, dichlofenthion, ethoprophos, fensulfothion, fosthiazate, heterophos, isamidofof, isazofos, phosphocarb, thionazin, imicyafos, mecarphon, acetoprole, benclothiaz, chloropicrin, dazomet, fluensulfone, 1,3-dichloropropene (telone), dimethyl disulfide, metam sodium, metam potassium, metam salt (all MITC generators), methyl bromide, biological soil amendments (e.g., mustard seeds, mustard seed extracts), steam fumigation of soil, allyl isothiocyanate (AITC), dimethyl sulfate, furfual (aldehyde).

Suitable plant growth regulators of the present invention include the following Plant Growth Regulators: Dl) Antiauxins, such as clofibric acid, 2,3,5-tri-iodobenzoic acid; D2) Auxins such as 4-CPA, 2,4-D, 2,4-DB, 2,4-DEP, dichlorprop, fenoprop , IAA, IBA, naphthaleneacetamide, a-naphthaleneacetic acids, 1-naphthol,

naphthoxyacetic acids, potassium naphthenate, sodium naphthenate, 2,4,5-T; D3) cytokinins, such as 2iP, benzyladenine, 4-hydroxyphenethyl alcohol, kinetin, zeatin; D4) defoliants, such as calcium cyanamide, dimethipin, endothal, ethephon, merphos, metoxuron, pentachlorophenol, thidiazuron, tribufos; D5) ethylene inhibitors, such as aviglycine, 1-methylcyclopropene; D6) ethylene releasers, such as ACC, etacelasil,ethephon, glyoxime; D7) gametocides, such as fenridazon, maleic hydrazide; D8) gibberellins, such as gibberellins, gibberellic acid; D9) growth inhibitors, such as abscisic acid, ancymidol, butralin, carbaryl, chlorphonium, chlorpropham, dikegulac, flumetralin, fluoridamid, fosamine, glyphosine, isopyrimol, jasmonic acid, maleic hydrazide, mepiquat, piproctanyl, prohydrojasmon, propham, tiaojiean, 2,3,5-tri-iodobenzoic acid; D10) morphactins, such as chlorfluren, chlorflurenol, dichlorflurenol, flurenol; D11) growth retardants, such as chlormequat, daminozide, flurprimidol, mefluidide, paclobutrazol, tetcyclacis, uniconazole; D12) growth stimulators, such as brassinolide, brassinolide-ethyl, DCPTA, forchlorfenuron, hymexazol, prosuler, triacontanol; D13) unclassified plant growth regulators, such as bachmedesh, benzofluor, buminafos, carvone, choline chloride, ciobutide, clofencet, cyanamide, cyclanilide, cycloheximide, cyprosulfamide, epocholeone, ethychlozate, ethylene, fuphenthiourea, furalane, heptopargil, holosulf, inabenfide, karetazan, lead arsenate, methasulfocarb, prohexadione, pydanon, sintofen, triapenthenol, trinexapac.

The crop can be, for example, potato, tomato, cucurbits, onion, and leafy vegetables. Leafy vegetables can include, among others, lettuces, spinach, Swiss chard, kale, collards, turnip greens, mustard greens, broccoli, broccoli rabbe, and cabbage. The crop can include other high-value vegetable crops as well. In a preferred embodiment, the crop is potato.

The disease can be, for example, downy mildew, Bremia, alternaria leaf spot, cercospora blight and leaf spot, eastern filbert blight, gummy stem, late blight, leaf scorch, rust, target spot, cercospora leaf spot, eye spot, late leaf spot, northern leaf blight, shot hole, web blotch, brown rot blossom blight, downy spot, frogeye leaf spot, leaf and glume blotch, pecan scab, southern leaf blight, white mold, brown spot, early leaf spot, gray leaf spot, leaf rust, soybean rust, zonate leaf spot, charcoal rot, foliar disease, anthracnose, or powdery mildew. In a preferred embodiment, the disease is late blight, downy mildew, Bremia or other Oomycete-related diseases.

EXAMPLES

The following Examples are included to provide guidance to one of ordinary skill in the art for practicing representative embodiments of the presently disclosed subject matter. In light of the present invention and the general level of skill in the art, those of skill can appreciate that the following Examples are intended to be representative or exemplary only.

The following chemical stability data of representative examples demonstrate that the current solid formulations are stable and meet FAO requirements under accelerated aging conditions.

TABLE 2 – Accelerated Aging of Fungicides

Sample ID	Sample 1	Sample 1	Sample 2	Sample 2	Sample 3	Sample 3
Conditions	Initial	After 2wks @ 54°C	Initial	After 2wks @ 54°C	Initial	After 2wks @ 54°C
Cymoxanil	6.01%	5.68%	6.00%	5.82%	5.84%	5.83%
Valifenalate	6.86%	6.84%	6.78%	7.04%	7.08%	7.10%
Mancozeb	55.0%	56.0%	55.1%	55.6%	56.0%	56.6%

Thus, "stable" or "stability" as used herein is defined as falling within the FAO tolerance limits following accelerated aging testing (2 weeks at 54°C) as described in the above table.

Example 1. Preparation of a WDG formulation of 7.0% Valifenalate, 5.8% Cymoxanil and 56% Mancozeb:

TABLE 3 -- COMPOSITION 1

Ingredients	Wt.%	assay	CAS#	Description
Cymoxanil (98%)	5.92%	5.8%	57966-95-7	Active ingredient
Valifenalate (98%)	7.14%	7.0%	283159-90-0	Active ingredient
Marasperse AG[1]		5.5%	8061-51-6	Dispersant
Supragil MNS 88[2]		1.1%	81065-5-2	Dispersant
Polyfon F[3]		5.0%	8061-51-6	Dispersant
Sipernate 22S[4]		0.9%	112926-00-8	Anti-caking agent
Supragil WP[5]		4.6%	1322-93-6	Wetting agent
Sodium citrate-2H2O		2.3%	6132-04-3	disintegration aid, Complexing agent (water softener)
Ammonium sulfate		1.1%	7783-20-4	disintegration aid
Mancozeb (85%)	65.9	56.0%	8018-01-7	Active ingredient
water	0.56%			Moisture retained after drying

[1]Sodium ligninsulfonate
[2]sodium polyalkyl naphthalene sulfonate
[3]sodium ligninsulfonate
[4]silica
[5]sodium diisopropyl naphthalene sulfonate

All ingredients except for Mancozeb were mixed and air milled to a particle size < 10 um (average particle size, or D50) to form a manufacturing use product ("MUP"). The MUP was thoroughly mixed with solid Mancozeb using a ribbon blender, a tumbler or a shaker to form a homogeneous powder mixture. Preferably, mixing is performed under an inert atmosphere or at lower temperature (< 15 °C) to avoid decomposition of the air-sensitive Mancozeb. The powder was sprayed with water (about 15 - 18 weight%), and the wet powder was extruded through a 1 mm orifice to produce granules. The granules were dried at 50 °C for ca. 10-15 min (moisture retained after drying (loss on drying, LOD) < 1.2%) Holding the dry powder in air for an extended period time, e.g. 24 hr or longer, should be avoided, unless inert atmosphere and/or low temperature mixing is applied. Further, after spraying water on the dry powder, the wet cake should be extruded and dried immediately to minimize hydrolytic decomposition of Cymoxanil and/or Mancozeb.

High temperature drying (greater than 60°C) is to be avoided due to the heat sensitivity of Mancozeb.

Using FAO guidelines, the following specifications for the above WDG formulation were set:

Ingredients	Nominal	Min.	Max.
Valifenalate	7.0%	6.3%	7.7%
Cymoxanil	5.8%	5.2%	6.4%
Mancozeb	56%	53.5%	58.5%
ETU(ethylene thiourea)			0.5%
Suspensibility	>80%		
Persistent foaming	< 55 ml		

Physical characterization of the WDG formulation of Example 1 was performed according to CIPAC methods. Physical properties of the above WDG were as follows:

TABLE 4 – Physical Properties of Composition 1 WDG

Example 1 WDG	Specification	Initial	2wks @ 54°C
pH of 1% solution		7.94	7.97
200 wet sieve		0.00	0.00%
0.5 ave particle size		0.150	0.584
Suspensibility, water	>80%	94.3%	83.0%
Dispersibility	>90%	97%	90%
Persistant foam	<55 ml	0	0
LOD%		0.74	0.72

Example 2. Comparative Example which fails physical property specification.

TABLE 5 – Composition 2 (Comparative Example)

Ingredients	Assay	wt%	Description
Cymoxanil (98%)	7.54%	7.69%	Active ingredient
Valifenalate (98%)	6.20%	6.33%	Active ingredient
Polyfon F		6.49%	Dispersant
Polyfon H		3.03%	Dispersant
Supragil WP		4.55%	Wetting agent
citric acid		1.17%	Disintegration aid
Mancozeb (85%)	59.72%	70.26%	Active ingredient
water		0.49%	

Procedure:

All ingredients except for Mancozeb were air-milled (MUP 1)

MUP1 was thoroughly blended with Mancozeb to provide a uniform powder

Powder was sprayed with 48g water (17.7%)

Extruded through 1mm holes

Dried at 50°C for ca 10 min (LOD <1.0%)

Suspensibility does not meet FAO guidelines: 62.8%

Example 3. Comparative Example which fails physical property specification.

TABLE 6 – Composition 3 (Comparative Example)

Ingredients	Assay	wt%	Description
Cymoxanil (98%)	7.21%	7.36%	Active ingredient
Valifenalate (98%)	6.04%	6.16%	Active ingredient
Borresperse AM320		3.92%	Dispersant
Supragil MNS 90		3.46%	Dispersant
Polyfon F		5.26%	Dispersant
Sipernate 22S		1.06%	Anticaking agent
Supragil WP		1.06%	Wetting agent
Sodium citrate-2H20		2.30%	disintegration aid
Ammonium sulfate		0.23%	disintegration aid
Mancozeb (85%)	57.98%	68.21%	Active ingredient
water		0.98%	

Procedure:

All ingredients except for Mancozeb were air-milled (MUP 1)

MUP1 was thoroughly blended with Mancozeb to provide a uniform powder

Powder was sprayed with 48g water (17.7%)

Extruded through 1mm holes

Dried at 50°C for ca 10 min (LOD <1.0%)

Suspensibility does not meet FAO guidelines: 76.0%

Example 4. Comparative Example which fails physical property specification.

TABLE 7 – Composition 4 (Comparative Example)

Ingredients	Assay	wt%	Description
Cymoxanil (98%)	8.03%	8.19%	Active ingredient
Valifenalate (98%)	6.64%	6.77%	Active ingredient
Borresperse AM320		4.31%	Dispersant
Supragil MNS 90		3.80%	Dispersant
Polyfon F		5.76%	Dispersant
Sipernate 22S		1.17%	Anticaking agent
Supragil WP		1.17%	Wetting agent
Sodium citrate-2H20		2.53%	disintegration aid
Ammonium sulfate		0.25%	disintegration aid
Mancozeb (85%)	55.37%	65.14%	Active ingredient
water		0.94%	

Procedure:

All ingredients except for Mancozeb were air-milled (MUP 1)

MUP1 was thoroghly blended with Mancozeb to provide a uniform powder

Powder was sprayed with 48g water (17.7%)

Extruded through 1mm holes

Dried at 50°C for ca 10 min (LOD <1.0%)

Suspensibility does not meet FAO guidelines: 54.0%

Example 5. Comparative Example which fails physical property specification.

TABLE 8 – Composition 5 (Comparative Example)

Ingredients	assay	CAS#	Description
Cymoxanil (98%)	5.8%	57966-95-7	Active ingredient
Valifenalate (98%)	7.0%	283159-90-0	Active ingredient
Marasperse AG	9.3%	8061-51-6	Dispersant
Supragil MNS 88	1.1%	81065-5-2	Dispersant
Polyfon F	0.0%	8061-51-6	Dispersant
Sipernate 22S	1.9%	112926-00-8	Anticaking agent
Supragil WP	2.1%	1322-93-6	Wetting agent
Sodium citrate-2H20	2.7%	6132-04-3	disintegration aid
Ammonium sulfate	2.3%	7783-20-4	disintegration aid
Mancozeb (85%)	56.0%	8018-01-7	Active ingredient
water	0.4%		

Procedure:

All ingredients except for Mancozeb were air-milled (MUP 1)

MUP1 was thoroghly blended with Mancozeb to provide a uniform powder

Powder was sprayed with 48g water (17.7%)

Extruded through 1mm holes

Dried at 50°C for ca 10 min (LOD <1.0%)

Suspensibility does not meet FAO guidelines: 70.20%

It is clear from the above comparative examples (Examples 2-5) that, especially in regard to suspensibility, providing a water-dispersible granule or wettable powder formulation which would be acceptable to the agricultural industry and the grower is not a trivial or straightforward task.

Examples 6A-C. Field Data in Various Crops

A set of field trials was carried out in key areas of Mexico to evaluate product performance controlling Oomycetes diseases (Phytopthora infestans on potato and tomato, and Pseudoperonospora cubensis in cucurbits) using the WDG formulation of Example 1 in foliar sprays under an application program having an interval of 7-10 days.

In the following examples, commercial fungicides were used in comparative testing. The commercial fungicides used have the following combination of active ingredients:

Trade Name	**Active Ingredients**
Curzate M-8	Cymoxanil + Mancozeb
Acrobat CTL	Dimethomorph + Chlorotalonil
Ridomil gold	Metalaxyl + Chlorotalonil
Consento	Fenamidone + Propamocarb

Example 6A. Disease severity with the formulation of Example 1 (COMPOSITION 1) at different rates in different evaluation periods to control Phytothora infestans on potato crop (Fiana) under an application program with 7-10 days application interval, at Guarachanillo Michoacan 2016.

TABLE 9 –Treatment of Phytothora infestans on Potato using Composition 1

No	Treatments	Rate	Unit	7DA (A)*		7 DA (B)*		7 DA (C)*		7DA (D)*		AUDPC **		% Control	
1	UNTREATED			21.7	a	31.9	a	84.8		93.4	a	1426	a	0	
2	COMPOSITION 1	1.5	kg/ha	3.6	b	1	c	14.1	ab	29.8	bc	260	bcd	82	bcd
3	COMPOSITION 1	2.0	kg/ha	4.5	b	0.6	c	12.3	abc	22.1	cd	218	cde	85	abc
4	COMPOSITION 1	2.5	kg/ha	2.3	b	0.4	c	5.8	c	15.8	d	130	e	91	a
5	CURZATE M8®	2.5	kg/ha	9.6	b	3.6	b	11.4	abc	29.1	bc	311	bc	78	cd
6	ACROBAT CT®	2.5	L/ha	5.9	b	4.6	b	6.4	c	19.8	d	230	cde	84	bc
7	RIDOMIL GOLD BRAVO	2.5	L/ha	6.7	b	3.6	b	16.1	a	33.8	b	351	b	75	d
8	CONSENTO®	3.0	L/ha	4.6	b	0.3	c	8.3	bc	21.3	cd	176	de	88	ab

*DA(A,B,C,D) = days after spray A, B,C, or D; **AUDPC – area under disease pressure after cure applied

Results indicate that the formulation of Example 1 (COMPOSITION 1) at 2.0 and 2.5 Kg/Ha provide better control than Curzate M8® at 2.5 Kg/Ha and Ridomil Gold Bravo® at 2.5 L/Ha. The formulation of Example 1 at 2.0 Kg/Ha provided similar control to Acrobat® at 2.5 L/Ha, and the high rate of the formulation of Example 1 was similar to Consento® at 3.0 L/Ha.

Example 6B. Disease severity with the formulation of Example 1 (COMPOSITION 1) at different rates in different evaluation periods to control

Phytothora infestans on tomato crop in greenhouse production under an application program of 7-10 days application interval, at Chignahuapan Puebla 2016.

TABLE 10 –Treatment of Phytothora infestans on Tomato using Composition 1

No	Treatments	Rate	Unit	7 DA (A)*		7 DA (B)*		7 DA (C)*		7 DA (D)*		AUDPC **	
1	UNTREATED			5.9	a	7	a	4.3	a	6.5	a	251.4	a
2	COMPOSITION 1	1.5	kg/ha	2.4	c	1.1	bc	1.2	bc	1.5	bc	75.1	c
3	COMPOSITION 1	2.0	kg/ha	2.3	c	0.8	c	0.9	c	0.9	cd	62	cd
4	COMPOSITION 1	2.5	kg/ha	1.8	c	0.5	c	0.7	c	0.7	d	50.7	d
5	CURZATE M8®	2.5	kg/ha	1.8	c	0.6	c	1	bc	1.3	bc	67.7	c
6	ACROBAT CT®	2.5	L/ha	2.1	c	0.6	c	1.1	bc	1	cd	68.7	c
7	RIDOMIL GOLD BRAVO®	2.5	L/ha	3.8	b	1.8	b	1.8	b	2.1	b	118.1	b
8	CONSENTO®	3.0	L/ha	2.5	bc	0.7	c	0.9	c	0.8	cd	64.1	c

*DA(A,B,C,D) = days after spray A, B,C, or D; **AUDPC – area under disease pressure after cure applied

Even though the disease severity was not as high as the potato trial, the formulation of Example 1 at 2.0 and 2.5 Kg/Ha was more effective than lower application rates. In this trial the formulation of Example 1 at 2.5 K/Ha provided the best control of late blight. The rates of 1.5 and 2.0 kg of formulation of Example 1 were similar to Curzate M8® and Acrobat®.

Example 6C. Summary of disease severity with the formulation of Example 1 (COMPOSITION 1) at different rates in different evaluation periods to control *Pseudoperonospora cubensis* on cucumber crop (Zapata) under an application program using 7-10 days application interval, at Zamora Michoacan 2016.

TABLE 11 –Treatment of *Pseudoperonospora cubensis* on Cucumber using Composition 1

No	Treatments	Rate	Unit	7DA (A)*		7DA (B)*		7DA (C)*		7DA (D)*		AUDPC**		% Control	
1	UNTREATED			3.6	a	46.1	a	75.7	a	94.9	a	1284	a	0	e
2	COMPOSITION 1	1.5	kg/ha	0.2	b	7.6	bc	26.3	b	26	b	354	b	72	cd
3	COMPOSITION 1	2.0	kg/ha	0.1	b	2.9	cd	12.3	bcd	15.1	bc	181	cd	86	ab
4	COMPOSITION 1	2.5	kg/ha	0	b	1.7	d	8.7	d	12.1	c	130	d	90	a
5	CURZATE M8®	2.5	kg/ha	0.1	b	10.5	b	17.5	bcd	16.6	bc	283	bc	76	bcd
6	ACROBAT CT®	2.5	L/ha	0.1	b	6.2	bc	16	bcd	18.1	bc	239	bc	80	a-d
7	RIDOMIL GOLD BRAVO® SC	2.5	L/ha	0.3	b	9	bc	22.6	bc	23.4	b	359	b	70	d
8	CONSENTO®	3.0	L/ha	0.1	b	7	bc	10.7	cd	15.5	bc	211	bc	83	abc

*DA(A,B,C,D) -- days after spray A, B,C, or D; **AUDPC – area under disease pressure after cure applied

Non-statistically significant differences were observed when disease severity was low. Significant differences between results from the same spray are indicated in the tables by different letters (a, b, c or d). There is no significant difference

between the results of the trials having the same letters within the same spray (i.e., in the same column). Differences between treatments were more marked at high disease severity. The formulation of Example 1 at 2.0 and 2.5 Kg/Ha was more consistent and provided better control than Curzate M8® at 2.5 Kg/Ha or Ridomil Gold Bravo® at 2.5 L/Ha, and control was similar to Acrobat® at 2.5 L/Ha or Consento® 3.0 L/Ha.

Overall, the formulation of Example 1 at 1.5 Kg/Ha was similar to Curzate M8® at 2.5 Kg/Ha and Ridomil Gold Bravo© at 2.0 L/Ha, meanwhile the formulation of Example 1 at 2.0 Kg/Ha was similar to Acrobat® at 2.5 L/Ha and the formulation of Example 1 at 2.5 Kg/Ha was similar to Consento© at 3.0 L/Ha. Comparing rate by rate versus known products, the formulation of Example 1 was more effective than products already available in the commercial market.

The exemplary ranges and dimensions are provided herein merely for purposes of illustration and not limitation. Moreover, although individual features of one embodiment of the disclosed subject matter may be discussed herein in regard to one embodiment and not in other embodiments, it should be apparent that individual features of one embodiment may be combined with one or more features of another embodiment or features from a plurality of embodiments.

In addition to the specific embodiments claimed below, the disclosed subject matter is also directed to other embodiments having any other possible combination of the dependent features claimed below and those disclosed above. As such, the particular features presented in the dependent claims and disclosed above can be combined with each other in other manners within the scope of the disclosed subject matter such that the disclosed subject matter should be recognized as also specifically directed to other embodiments having any other possible combinations. Thus, the foregoing description of specific embodiments of the disclosed subject matter has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosed subject matter to those embodiments disclosed.

CLAIMS

What is claimed is:

1. A solid fungicidal composition comprising: (1) an active fungicidal component comprising valifenalate, cymoxanil and mancozeb, wherein the cyamoxanil is present in an amount of about 7 wt% or less of the composition; and (2) a non-fungicidal component.

2. The composition of claim 1 wherein the non-fungicidal component (2) comprises: (i) dispersant(s); (ii) anti-caking agent(s); (iii) wetting agent(s); and, optionally, (iv) a first disintegration aid and (v) a second water softening disintegration aid.

3. The solid fungicidal composition of any of the preceding claims wherein the fungicidal component comprises from about 60 to about 77 wt% of the composition, and the non-fungicidal component comprises from about 23 to about 40 wt% of the composition.

4. The solid fungicidal composition of any of the preceding claims, wherein the fungicidal component comprises 5.6 to 8.4 wt% of valifenalate, 4.6 to 7.0 wt% of cymoxanil and 50.4 to 61.6 wt% of mancozeb based on the weight of the composition.

5. The solid fungicidal composition of any one of the preceding claims wherein the fungicidal component comprises from about 5.2 to about 6.4 wt% of cymoxanil.

6. The solid fungicidal composition of any one of the preceding claims wherein the fungicidal component comprises from about 5.8 wt% of cymoxanil.

7. The solid fungicidal composition of any one of the preceding claims wherein the fungicidal component comprises from about 6.3 to about 7.7 wt% of valifenalate.

8. The solid fungicidal composition of any one of the preceding claims wherein the fungicidal component comprises about 7.0 wt% of valifenalate.

9. The solid fungicidal composition of any one of the preceding claims wherein the fungicidal component comprises from about 53.5 to about 58.5 wt% of mancozeb.

10. The solid fungicidal composition of any one of the preceding claims wherein the fungicidal component comprises about 56.0 wt% of mancozeb.

11. The solid fungicidal composition of any of claims 2 to 10, wherein said dispersants are selected from the group consisting of sodium lignin sulfonates,

ammonium lignin sulfonates, polyalkyl naphthalenesulfonates and mixtures of two or more thereof.

12. The solid fungicidal composition of any of claims 2 to 11 wherein the non-fungicidal component comprises three or more dispersants.

13. The solid fungicidal composition of any one of claims 2 to 12 wherein the dispersant component is present in an amount of from about 9 to about 14 wt% of the composition.

14. The solid fungicidal composition of any one of claims 2 to 13 wherein the dispersant is present in an amount of from about 11 to about 13 wt% of the composition.

15. The solid fungicidal composition of any one of claims 2 to 14 wherein the wetting agent is selected from the group consisting of: sodium alkyl naphthalensulfonates; sodium alkyl sulfonates; and mixtures thereof.

16. The solid fungicidal composition of any one of claims 2 to 15 wherein the wetting agent is present in an amount of from about 1 to about 6 wt% of the composition.

17. The solid fungicidal composition of any one of claims 2 to 16 wherein the wetting agent is present in an amount of from about 1 to about 5 wt% of the composition.

18. The solid fungicidal composition of any one of claims 2 to 17 wherein the wetting agent is present in an amount of from about 2 to about 5 wt% of the composition.

19. The solid fungicidal composition of any one of claims 2 to 18 wherein the wetting agent is present in an amount of about 4.5 wt% of the composition.

20. The solid fungicidal composition of any one of claims 2 to 19 wherein the composition further comprises said first disintegration aid selected from the group consisting of sodium and ammonium salts of sulfate, phosphate, acetate, chloride, polyphosphate, and mixtures thereof.

21. The solid fungicidal composition of any one of claims 2 to 20 wherein the composition further comprises said second disintegration aid selected from the group consisting of citric acid, citrate salts, sodium polyphosphate, and EDTA.

22. The solid fungicidal composition of any one of claims 1 to 21, wherein said composition is a water-dispersible granule.

23. The solid fungicidal composition of any one of claims 1 to 21 wherein said composition is a wettable powder.

24. A method of curing Oomycete pathogen infestation of a plant, comprising treating said plant with an effective amount of a solid fungicidal composition of claim 22.

25. A method of preventing Oomycete pathogen infestation of a plant, comprising treating said plant with an effective amount of a solid fungicidal composition of claim 23.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 17/68449

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A01N 43/56, A01P 3/00, C07D 231/38 (2018.01)
CPC - A01N 25/10, A01N 43/56

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)
See Search History Document

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 2006/0159772 A1 (GARAVAGLIA et al) 20 July 2006 (20.07.2006), para [0001], [0008], [0059], [0125]-[0134].	1 ------- 2, 3
Y	US 5,474,971 A (SANDELL et al) 12 December 1995 (12.12.1995), col 1 ln 37, col 2 ln 2-19, col 4 ln 28, col 11 ln 1-40,col 13 ln 60-67, col 14 ln 13-49, col 15 ln 23-59.	2, 3
A	'FRAC recommendations for fungicide mixtures designed to delay resistance evolution', Fungicide Resistance Action Committee, 31 January 2010 (31.01.2010), [accessed via the internet on 16 February 2018 (16.02.2018) at http://www.frac.info/docs/default-source/publications/frac-recommendations-for-fungicide-mixtures/frac-recommendations-for-fungicide-mixtures---january-2010.pdf]	1
A	'Curzate M WG fungicide' product label, Du Pont (UK) Ltd Crop Protection Products, 20 October 2015 (20.10.2015), [accessed via the internet on 16 February 2018 (16.02.2018) at http://www.dupont.co.uk/content/dam/dupont/tools-tactics/crop/UK-label-msds/documents/Curzate%20M%20WG%20New%20CLP%20version%202015.pdf]	1
A	US 6,448,228 B1 (FILIPPINI et al), 10 September 2002 (10.09.2002), entire document.	1-3

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 February 2018	12 MAR 2018
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 17/68449

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 4-25
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.