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(54) Title: FUNGICIDAL COMPOSITION

(57) Abstract: The present disclosure relates to a fungicidal composition. More specifically, the present disclosure relates to fungicidal composition comprising multisite fungicides and systemic 5 fungicides for controlling fungal diseases. The composition of the present disclosure provides an economic composition over conventional formulations.

FUNGICIDAL COMPOSITION

Technical field:

The present disclosure relates to a fungicidal composition. More specifically, the present disclosure relates to fungicidal composition comprising multisite fungicides and systemic fungicides for controlling fungal diseases.

Background:

Fungicides are an integral and important tool wielded by farmers to control diseases, as well as to improve yields and quality of the crops. There are various fungicides that have been developed over the years with many desirable attributes such as specificity, systemicity, curative and eradicant action and high activity at low use rates.

There are various types of fungicides, including multi-site fungicides and systemic fungicides. However, due to the prolonged use of multiple fungicides, the pests develop resistance which leads to increase in the usage of quantity of actives required to enable control of the fungus, which in turn adds to the overall cost.

As development and identification of new pesticide reaches a saturation point, pesticide formulations have come to the fore to increase the effectiveness of existing actives. Formulations enable a small amount of the active ingredients for crop protection to uniformly spread over a large area. This requires that the pesticide formulation be chemically stable and physically uniform under all foreseeable storage conditions so that the minimum effective amount can be accurately applied to target areas.

Solid formulations like water-dispersible granules, or dry flowables are frequently the choice of the formulators as they are relatively safer and more commercially attractive alternatives to wettable powders and suspension concentrates. Water dispersible granules are becoming more popular because of their convenience in packaging and use, free-flowing granules, being non-dusty, which should disperse quickly when added to water in the spray tank. Water dispersible granules are therefore a technological improvement over wettable powders and imitate liquids in handling characteristics.

Increased dose or repeated applications is required for conventional formulations like wettable powder, emulsifiable concentrate, solution etc. to achieve desired bioefficacy. This results in significant increase in the cost for the farmers. In the process of application of the conventional formulations more than 70% of the pesticides flow into the
5 environment. There is a significant trend towards switching over from such conventional formulations using petroleum and organic solvent based constituents to user and environment friendly smart and innovative formulations.

In view the same, there is a need for alternative treatments which are economic and have
10 a broader disease control.

One or more objectives:

An objective of the present disclosure is to provide fungicidal composition comprising a
15 combination of a multi-site fungicide and a systemic fungicide that cause less or no phytotoxicity.

Yet another objective of the present disclosure is to provide a fungicidal composition that results into reduced fungal disease incidence in the crops to which it is applied.
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Another objective of the present disclosure is to provide an economically significant fungicidal composition, particularly water dispersible granules.

Some or all these and other objectives of the disclosure can be achieved by way of the
25 invention described hereinafter.

Summary:

An aspect of the present disclosure provides a fungicidal composition comprising a
30 combination of at least one multisite fungicide and at least one systemic fungicide.

An aspect of the present invention discloses a fungicidal composition comprising:

- i. at least one multi-site fungicide;
- ii. at least one systemic fungicide; and
- iii. at least one agrochemically acceptable excipient.

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An aspect of the present invention discloses a fungicidal composition comprising:

- i. at least one multi-site fungicide; and
- ii. at least one systemic fungicide;

wherein the composition has a cost to benefit ratio in the range from 1:1 to 1:5.

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An aspect of the present invention discloses a fungicidal composition comprising

- i. at least one multi-site fungicide selected from copper fungicides, sulfur fungicides, dithiocarbamate fungicides, phthalimide fungicides, chloronitrile fungicides, sulfamide fungicides, guanidine fungicides, triazines fungicides, quinone fungicides or a combination thereof;
- ii. at least one acylalanine fungicide; and
- iii. at least an agrochemically acceptable excipient

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wherein the composition has a cost to benefit ratio in the range from 1:1 to 1:5.

20 An aspect of the present disclosure provides a method of controlling a fungal disease in a crop or a locus, comprising applying the disclosed fungicidal composition to the crop or to the locus.

An aspect of the present invention discloses a method of controlling fungal diseases comprising applying a composition comprising combination of

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- i. at least one dithiocarbamate fungicide;
- ii. at least one acylalanine fungicide; and
- iii. at least one agrochemically acceptable excipient

wherein the composition has a cost: benefit ratio in the range of 1:1 to 1:5.

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Detailed Description:

The term “fungicides” relates to pesticides that kill or prevent or control the growth of
5 fungi and their spores. Fungicides are used to control fungi that damage plants, including
but not limited to rusts, molds, mildews, and blights.

The term “disease control” as it relates to fungal diseases herein denotes control
(treatment) and prevention of a disease. Controlling effects include deviation from natural
10 development of the disease, for example, killing of the fungal agent, retardation of disease
development, and decrease in amount of the fungal disease.

The term “plant” encompasses all the physical parts of a plant, including for example,
seeds, seedlings, saplings, roots, tubers, stems, stalks, foliage, and fruits.

15 The term “locus” as used herein refers to the vicinity, area, or place in which the plants
are growing, where plant propagation materials of the plants are sown, and/or where the
plant propagation materials of the plants will be placed into the soil.

20 The term “plant propagation material” is understood to denote generative parts of a plant,
such as seeds, vegetative material such as cuttings or tubers, roots, fruits, tubers, bulbs,
rhizomes, and other parts of plants, germinated plants, and/or young plants which are to
be transplanted after germination or emergence from the soil. These young plants may be
protected prior to transplantation by a total or partial immersion treatment/system.

25 As used herein, “effective amount” is an amount of active ingredient which has an
adverse effect on a fungus and/or which prevents a fungal disease in a plant. The adverse
effect can include killing of the fungus (fungicidal), preventing growth of the fungus,
blocking of biosynthetic pathway(s), or a combination thereof.

30 As used herein, an “agriculturally acceptable salt” means a salt which is known and
accepted for use in agricultural or horticultural use.

“Phytotoxicity” refers to a toxic (negative) effect on the growth of a plant.

“Cost to benefit ratio (C: B Ratio)” is a ratio used in a cost-benefit analysis to summarize the overall relationship between the relative costs and benefits of a project. C:B ratio is expressed in monetary terms. A C:B ratio of greater than 1 indicates positive monetary returns in comparison to the cost involved to execute a project.

“Alkyl” as used herein means a straight or branched chain saturated aliphatic hydrocarbon having the specified number of carbon atoms, specifically 1 to 12 carbon atoms, more specifically 1 to 6 carbon atoms. Alkyl groups include, for example, groups having from 1 to 50 carbon atoms (C₁ to C₅₀ alkyl). “Aryl,” means a cyclic moiety in which all ring members are carbon and at least one ring is aromatic, the moiety having the specified number of carbon atoms, specifically 6 to 24 carbon atoms, more specifically 6 to 12 carbon atoms. More than one ring may be present, and any additional rings may be independently aromatic, saturated, or partially unsaturated, and may be fused, pendant, spirocyclic or a combination thereof. “Alkylaryl” means an alkyl group covalently linked to a substituted or unsubstituted aryl group that is linked to a compound.

It has surprisingly been found that the composition of the present invention provides a better cost to benefit ratio as compared to the conventional fungicidal compositions. Conventional fungicidal compositions include but are not limited to wettable powders or suspension concentrate.

An aspect of the present invention discloses a fungicidal composition comprising:

- i. at least one multi-site fungicide; and
- ii. at least one systemic fungicide.

In an embodiment, the multi-site fungicide is a dithiocarbamate fungicide.

In an embodiment, the systemic fungicide is an acylalanine fungicide.

An aspect of the present invention discloses a fungicidal composition comprising:

- i. at least one dithiocarbamate fungicide; and
- ii. at least one acylalanine fungicide.

5 In an embodiment, the multi-site contact fungicides is selected from copper fungicides, sulfur fungicides, dithiocarbamate fungicides, phthalimide fungicides, chloronitrile fungicides, sulfamide fungicides, guanidine fungicides, triazines fungicides, quinone fungicides or a combination thereof.

10 An embodiment of the present invention discloses a fungicidal composition comprising:

a) at least one multi-site fungicide selected from copper fungicides, sulfur fungicides, dithiocarbamate fungicides, phthalimide fungicides, chloronitrile fungicides, sulfamide fungicides, guanidine fungicides, triazines fungicides, quinone fungicides or a combination thereof;

15 b) at least one acylalanine fungicide; and

c) at least an agrochemically acceptable excipient

In an embodiment, the composition has a cost:benefit ratio in the range from 1:1 to 1:5.

In another embodiment the present invention discloses a fungicidal composition
20 comprising:

a) at least one multi-site fungicide selected from copper fungicides, sulfur fungicides, dithiocarbamate fungicides, phthalimide fungicides, chloronitrile fungicides, sulfamide fungicides, guanidine fungicides, triazines fungicides, quinone fungicides or a combination thereof;

25 b) at least one acylalanine fungicide; and

c) at least an agrochemically acceptable excipient

wherein the composition has a cost to benefit ratio in the range from 1:1 to 1:5.

In another embodiment the present invention discloses a fungicidal composition
30 comprising:

a) at least one multi-site fungicide selected from copper fungicides, sulfur fungicides, dithiocarbamate fungicides, phthalimide fungicides, chloronitrile fungicides, sulfamide fungicides, guanidine fungicides, triazines fungicides, quinone fungicides or a combination thereof;

- 5 b) at least one acylalanine fungicide; and
 c) at least an agrochemically acceptable excipient

wherein the composition has a cost to benefit ratio in the range from 1:1 to 1:5 over conventional formulations.

- 10 In an embodiment, the conventional formulations include but are not limited to wettable powders and suspension concentrate.

In an embodiment, the dithiocarbamate fungicides is selected from dithiocarbamate molecular moiety and include one or more of amobam, asomate, azithiram, carbamorph, 15 cufraneb, cuprobam, disulfiram, ferbam, metam, nabam, tecoram, thiram, urbacide, ziram, dazomet, etem, milneb, mancopper, mancozeb, maneb, metiram, polycarbamate, propineb and zineb.

In an embodiment, the dithiocarbamate fungicide is Mancozeb.

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In an embodiment, the acylalanine fungicides is selected from benalaxyl, benalaxyl-M furalaxyl, metalaxyl, metalaxyl-M.

In an embodiment, the acylalanine fungicides is metalaxyl or metalaxyl-m.

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An agriculturally acceptable salt of a multi-site contact fungicide or a systemic fungicide may also be used.

In an embodiment, the present invention discloses a fungicidal composition comprising:

- 30 i. mancozeb; and
 ii. metalaxyl-m.

An embodiment of the present invention discloses a fungicidal composition comprising:

- i. at least one dithiocarbamate fungicide; and
- ii. at least one acylalanine fungicide;

5 wherein the composition has a cost: benefit ratio in the range from 1:1 to 1:5.

An embodiment of the present invention discloses a fungicidal composition comprising:

- i. at least one dithiocarbamate fungicide;
- ii. at least one acylalanine fungicide; and
- 10 iii. at least an agrochemically acceptable excipient;

wherein the composition has a cost: benefit ratio in the range from 1:1 to 1:5.

An embodiment of the present invention discloses a fungicidal composition comprising:

- i. mancozeb; and
- 15 ii. metalaxyl-m;

wherein the composition has a cost: benefit ratio in the range from 1:1 to 1:5.

An embodiment of the present invention discloses a fungicidal composition comprising:

- i. mancozeb; and
- 20 ii. metalaxyl;

wherein the composition has a cost: benefit ratio in the range from 1:1 to 1:5 over conventional formulations.

In an embodiment, the cost: benefit ratio is in the range from 1:4 to 1:5.

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In an embodiment, the cost: benefit ratio is 1:4.92.

In an embodiment, the cost: benefit ratio is 1:4.96.

30 The cost: benefit ratio is calculated based on application cost of treatments, crop yield and market price of the product.

In an embodiment, the conventional formulations include but are not limited to wettable powders and suspension concentrate.

In another embodiment, said composition further comprises at least one agrochemically acceptable excipient.

An aspect of the present invention discloses a composition comprising:

- i. at least one dithiocarbamate fungicide;
- ii. at least one acylalanine fungicide; and
- 10 iii. at least one agrochemically acceptable excipient.

In an embodiment, the present invention discloses a fungicidal composition comprising:

- i. mancozeb;
- ii. metalaxyl-m; and
- 15 iii. at least one agrochemically acceptable excipient;

wherein the composition has a cost: benefit ratio in the range from 1:1 to 1:5 over conventional formulations.

In an embodiment, the present invention discloses a fungicidal composition comprising:

- 20 i. mancozeb;
- ii. metalaxyl; and
- iii. at least one agrochemically acceptable excipient;

wherein the composition has a cost: benefit ratio in the range from 1:1 to 1:5 over conventional formulations.

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According to an embodiment of the present disclosure the agrochemically acceptable excipients are selected from one or more of dispersants, disintegrant, emulsifiers, wetting agents, binder, glidant, anticaking agents, pH-regulating agents, preservatives, biocides, antifoaming agents, colorants, fillers stabilizers, other formulation aids or combination thereof.

30

Emulsifiers which can be advantageously employed herein can be readily determined by those skilled in the art and include various non-ionic, anionic, cationic, and amphoteric emulsifiers, or a blend of two or more emulsifiers. Examples of nonionic emulsifiers useful in preparing the emulsifiable concentrates include the polyalkylene glycol ethers
5 and condensation products of alkyl and aryl phenols, aliphatic alcohols, aliphatic amines or fatty acids with ethylene oxide, propylene oxides such as the ethoxylated alkyl phenols and carboxylic esters solubilized with the polyol or polyoxyalkylene. Cationic emulsifiers include quaternary ammonium compounds and fatty amine salts. Anionic emulsifiers include the oil-soluble salts (e.g., calcium) of alkylaryl sulfonic acids, oil-soluble salts or
10 sulfated polyglycol ethers and appropriate salts of phosphated polyglycol ether.

In an embodiment, the dispersing agent is selected from a group comprising lignosulfonate blend, Sodium lignosulphonate, calcium lignosulphonate, aluminium lignosulfonate, modified kraft lignosulfonates, sodium naphthalene formaldehyde
15 condensates, sodium salt of phenol formaldehyde condensates, sodium polycarboxylates or combinations thereof.

In an embodiment, colorants may be selected from iron oxide, titanium oxide and Prussian Blue, and organic dyestuffs, such as alizarin dyestuffs, azo dyestuffs, or metal
20 phthalocyanine dyestuffs, and trace elements, such as salts of iron, manganese, boron, copper, cobalt, molybdenum, and zinc.

Another embodiment involves addition of a thickener or binder which may be selected from but not limited to molasses, granulated sugar, alginates, karaya gum, jaguar gum, tragacanth gum, polysaccharide gum, mucilage, xanthan gum or combination thereof. In
25 another embodiment, the binder may be selected from silicates such as magnesium aluminium silicate, polyvinyl acetates, polyvinyl acetate copolymers, polyvinyl alcohols, polyvinyl alcohol copolymers, celluloses, including ethylcelluloses and methylcelluloses, hydroxymethyl celluloses, hydroxypropylcelluloses, hydroxymethylpropyl-celluloses,
30 polyvinylpyrrolidones, dextrans, malto-dextrans, polysaccharides, fats, oils, proteins, gum arabics, shellacs, vinylidene chloride, vinylidene chloride copolymers, calcium lignosulfonates, acrylic copolymers, starches, polyvinylacrylates, zeins, gelatin,

carboxymethylcellulose, chitosan, polyethylene oxide, acrylimide polymers and copolymers, polyhydroxyethyl acrylate, methylacrylimide monomers, alginate, ethylcellulose, polychloroprene and syrups or mixtures thereof; polymers and copolymers of vinyl acetate, methyl cellulose, vinylidene chloride, acrylic, cellulose, 5 polyvinylpyrrolidone and polysaccharide; polymers and copolymers of vinylidene chloride and vinyl acetate-ethylene copolymers; combinations of polyvinyl alcohol and sucrose; plasticizers such as glycerol, propylene glycol, polyglycols.

According to an embodiment, antifoam agent may be selected from 10 Polydimethoxysiloxane, polydimethylsiloxane, Alkyl poly acrylates, Castor Oil, Fatty Acids, Fatty Acids Esters, Fatty Acids Sulfate, Fatty Alcohol, Fatty Alcohol Esters, Fatty Alcohol Sulfate, Foot Olive Oil, Mono & Di Glyceride, Paraffin Oil, Paraffin Wax, Poly Propylene Glycol, Silicones Oil, Vegetable Fats, Vegetable Fats Sulfate, Vegetable Oil, Vegetable Oil Sulfate, Vegetable Wax, Vegetable Wax Sulfate, agents based on silicon or 15 magnesium stearate.

According to an embodiment, examples of suitable solvents are water, aromatic solvents (for example, xylene), paraffins (for example mineral oil fractions such as kerosene or diesel oil), coal tar oils and oils of vegetable or animal origin, aliphatic, cyclic and 20 aromatic hydrocarbons, for example toluene, xylene, paraffin, tetrahydronaphthalene, alkylated naphthalenes or their derivatives, alcohols (for example methanol, butanol, pentanol, benzyl alcohol, cyclohexanol), ketones (for example cyclohexanone, gamma-butyrolactone), pyrrolidones (NMP, NEP, NOP), acetates (glycol diacetate), glycols, fatty acid dimethylamides, fatty acids and fatty acid esters, isophorone and dimethylsulfoxide. 25 In principle, solvent mixtures may also be used.

Examples of the solid carrier or filler used in the formulation include but are not limited to fine powders or granules such as minerals such as Aluminium silicate, kaolin clay, attapulgite clay, bentonite, montmorillonite, acid white clay, pyrophyllite, talc, 30 diatomaceous earth and calcite; natural organic materials such as corn rachis powder and walnut husk powder; synthetic organic materials such as urea; salts such as calcium

carbonate and ammonium sulfate; synthetic inorganic materials such as synthetic hydrated silicon oxide.

5 Examples of the surfactant include but are not limited to anionic surfactants such as alkyl sulfate ester salts, alkylaryl sulfonate salts, dialkyl sulfosuccinate salts, polyoxyethylene alkylaryl ether phosphate ester salts, lignosulfonate salts and naphthalene sulfonate formaldehyde polycondensates; and nonionic surfactants such as polyoxyethylene alkylaryl ethers, polyoxyethylene alkylpolyoxypropylene block copolymers and sorbitan fatty acid esters and cationic surfactants such as alkyltrimethylammonium salts.

10

Examples of the other auxiliary agents that can be included in the composition include water-soluble polymers such as polyvinyl alcohol and polyvinylpyrrolidone, polysaccharides such as Arabic gum, alginic acid and the salt thereof, CMC (carboxymethyl-cellulose), Xanthan gum, inorganic materials such as aluminium
15 magnesium silicate and alumina sol, preservatives, coloring agents and stabilization agents such as PAP (acid phosphate isopropyl) and BHT.

In an embodiment, the composition may further include herbicides, insecticides, miticides, acaricide, fertilizers, plant growth regulators, and biocides.

20

The amount of a composition according to the disclosure to be applied, will depend on various factors, such as the subject of the treatment, for example plants, soil or seeds; the application of treatment, for example spraying, dusting or seed dressing; the purpose of the treatment, for example prophylactic or therapeutic disease control; in case of disease
25 control the type of fungi to be controlled or the application time. This amount of the combinations of the present invention to be applied can be readily deduced by a skilled agronomist.

An embodiment of the present invention discloses a fungicidal composition comprising:

- 30
- i. at least one dithiocarbamate fungicide;
 - ii. at least one acylalanine fungicide;
 - iii. at least one dispersant;

- iv. at least one emulsifier;
- v. at least one wetting agent; and
- vi. optionally at least one agrochemically acceptable excipient;

- 5 In an embodiment, the composition has a cost: benefit ratio in the range from 1:1 to 1:5 over conventional formulations.

An embodiment of the present invention discloses a fungicidal composition comprising:

- i. at least one dithiocarbamate fungicide;
 - 10 ii. at least one acylalanine fungicide;
 - iii. at least one dispersant;
 - iv. at least one emulsifier;
 - v. at least one wetting agent; and
 - vi. optionally at least one agrochemically acceptable excipient;
- 15 wherein the composition has a cost: benefit ratio in the range from 1:1 to 1:5 over conventional formulations.

An embodiment of the present invention discloses a water dispersible granule composition comprising:

- 20 i. at least one dithiocarbamate fungicide;
 - ii. at least one acylalanine fungicide;
 - iii. at least one dispersant;
 - iv. at least one emulsifier;
 - v. at least one wetting agent; and
 - 25 vi. optionally at least one agrochemically acceptable excipient;
- wherein the composition has a cost: benefit ratio in the range from 1:1 to 1:5 over conventional formulations.

- In an embodiment, the concentration of dithiocarbamate fungicide is in the range from
30 about 1% w/w to about 99% w/w of the total weight of the composition.

In an embodiment, the concentration of dithiocarbamate fungicide is in the range from about 1% w/w to about 90% w/w of the total weight of the composition.

5 In an embodiment, the concentration of dithiocarbamate fungicide is in the range from about 1% w/w to about 80% w/w of the total weight of the composition.

In an embodiment, the concentration of dithiocarbamate fungicide is in the range from about 1% w/w to about 70% w/w of the total weight of the composition.

10 In an embodiment, the concentration of dithiocarbamate fungicide is in the range from about 50 % w/w to about 70% w/w of the total weight of the composition.

In an embodiment, the concentration of dithiocarbamate fungicide is in the range from about 60 % w/w to about 70% w/w of the total weight of the composition.

15 In an embodiment, the concentration of dithiocarbamate fungicide is in the range from about 60 % w/w to about 67% w/w of the total weight of the composition.

20 In an embodiment, the concentration of acylalanine fungicide is in the range from about 1% w/w to about 99% w/w of the total weight of the composition.

In an embodiment, the concentration of acylalanine fungicide is in the range from about 1% w/w to about 50% w/w of the total weight of the composition.

25 In an embodiment, the concentration of acylalanine fungicide is in the range of from about 1% w/w to about 40% w/w of the total weight of the composition.

In an embodiment, the concentration of acylalanine fungicide is in the range from about 1% w/w to about 30% w/w of the total weight of the composition.

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In an embodiment, the concentration of acylalanine fungicide is in the range from about 1% w/w to about 20% w/w of the total weight of the composition.

5 In an embodiment, the concentration of acylalanine fungicide is in the range from about 1% w/w to about 10% w/w of the total weight of the composition.

In an embodiment, the concentration of acylalanine fungicide is in the range from about 1% w/w to about 5% w/w of the total weight of the composition.

10 In an embodiment, the ratio of acylalanine fungicide: multisite fungicide is in the range from 1:1 to 1:20.

In an embodiment, multisite fungicide is a dithiocarbamate fungicide.

15 In an embodiment, the ratio of acylalanine fungicide: dithiocarbamate fungicide is in the range from 1:1 to 1:20.

In an embodiment, the ratio of metalaxyl-m: mancozeb is in the range from 1:1 to 1:20.

20 In another embodiment, the ratio of metalaxyl-m: mancozeb is in the range from 1:4 to 1:16.

In another embodiment, the ratio of metalaxyl-m: mancozeb is in the range from 1:8 to 1:16.

25 An embodiment of the present invention discloses a fungicidal composition comprising:

- i. mancozeb;
- ii. metalaxyl-m;
- iii. at least one dispersant;
- iv. at least one emulsifier;
- 30 v. at least one wetting agent; and
- vi. optionally at least one agrochemically acceptable excipient;

wherein the composition has a cost: benefit ratio in the range from 1:1 to 1:5.

An embodiment of the present invention discloses a fungicidal composition comprising:

- i. mancozeb;
 - 5 ii. metalaxyl-m;
 - iii. at least one dispersant;
 - iv. at least one emulsifier;
 - v. at least one wetting agent; and
 - vi. optionally at least one agrochemically acceptable excipient;
- 10 wherein the composition has a cost: benefit ratio in the range from 1:1 to 1:5 over conventional formulations.

In an embodiment, the conventional formulations include but are not limited to wettable powders and suspension concentrate.

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An aspect of the present invention discloses a fungicidal composition comprising:

- i. mancozeb;
- ii. metalaxyl;
- iii. at least one dispersant;
- 20 iv. at least one emulsifier;
- v. at least one wetting agent; and
- vi. optionally at least one agrochemically acceptable excipient.

In an embodiment, the dispersant is selected from sodium lignosulfonate, salts of naphthalenesulphonic acid/formaldehyde condensates, salts of condensates of naphthalenesulphonic acid, phenolsulphonic acid and formaldehyde, and salts of lignosulphonic acid, modified sodium lignosulfonate, polyethylene oxide/polypropylene oxide block copolymers, polyethylene glycol ethers of linear alcohols, Potassium polycarboxylate, Modified styrene acrylic polymer or combinations thereof.

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In a preferred embodiment, the dispersant is sodium lignosulfonate or salts thereof

In an embodiment, the wetting agent is selected from sodium diisopropyl naphthalene sulphonate, sodium lauryl sulphate, sodium alkyl naphthalene sulfonate, dioctyl sulfosuccinate, alkylbenzene sulfonates, Dioctyl Sodium Sulfosuccinate, Sodium lauryl sulfate, Sodium lauryl ether sulfate, Sodium alkyl benzene sulfate, or combinations thereof..

In a preferred embodiment, the wetting agent is sodium diisopropyl naphthalene sulphonate.

In an embodiment, the emulsifier is selected from sulphated polyarylphenol ethoxylate, ammonium salt, ethoxylated tristyrylphenol sulfate or phosphate, ethoxylated fat alcohol, ethoxylated alkylphenol, ethoxylated tristyrylphenol ethoxylated polyethylene glycol and polypropylene glycol and copolymers thereof, ethoxylated tristyrylphenol derivative, polyethylene oxide/polypropylene oxide block copolymers, copolymers of polyvinyl alcohol and polyvinylpyrrolidone, copolymers of (meth)acrylic acid and (meth)acrylic esters, polyarylphenyl ether sulphate ammonium salt, Tristyrylphenol Ethoxylate Phosphate Ester or combinations thereof.

In a preferred embodiment, the emulsifier is sulphated polyarylphenol ethoxylate, ammonium salt.

In an embodiment, the concentration of dispersant is in the range from about 1% w/w to about 30% w/w of the total weight of the composition.

In an embodiment, the concentration of dispersant is in the range from about 1% w/w to about 20% w/w of the total composition.

In an embodiment, the concentration of dispersant is in the range from about 1% w/w to about 15% w/w of the total weight of the composition.

In a preferred embodiment, the concentration of dispersant is in the range from about 8% w/w to about 15% w/w of the total weight of the composition.

In an embodiment, the concentration of emulsifier is in the range from about 0.01 w/w to about 10 % w/w of the total weight of the composition.

- 5 In an embodiment, the concentration of emulsifier is in the range from about 0.5% to about 5% w/w of the total weight of the composition.

In an embodiment, the concentration of emulsifier is in the range from about 0.5% to about 3% w/w of the total weight of the composition.

10

In a preferred embodiment, the concentration of emulsifier is in the range from about 0.5% to about 2.5% w/w of the total weight of the composition.

- 15 In an embodiment, the concentration of wetting agent is in the range from about 0.1% w/w to about 10 % w/w of the total weight of the composition.

In an embodiment, the concentration of wetting agent is in the range from about 1% to about 6% w/w of the total weight of the composition.

- 20 In an embodiment, the concentration of wetting agent is in the range from about 1% to about 4% w/w of the total weight of the composition.

In a preferred embodiment, the concentration of wetting agent is in the range from about 1% w/w to about 3.5% w/w of the total weight of the composition.

25

In an embodiment, dosage of the composition is in the range from about 500 g/ha to about 3000 g/ha.

- 30 In another embodiment, dosage of the composition is in the range from about 500 g/ha to about 2500 g/ha.

In another embodiment, dosage of the composition is in the range from about 500 g/ha to about 2000 g/ha.

In an embodiment, the composition of the present invention exhibits no phytotoxicity.

5

According to a preferred embodiment, the fungicidal composition is in the form of water dispersible granules.

The compositions according to the present disclosure are effective for the controlling and preventing the plant diseases described below:

10

Diseases in rice include Blast (*Magnaporthe grisea*), Helminthosporium leaf spot (*Cochliobolus miyabeanus*), sheath blight (*Rhizoctonia solani*), and bakanae disease (*Gibberella fujikuroi*).

15

Diseases in wheat include powdery mildew (*Erysiphe graminis*), Fusarium head blight (*Fusarium graminearum*, *F. avenacerum*, *F. culmorum*, *Microdochium nivale*), rust (*Puccinia striiformis*, *P. graminis*, *P. recondita*), pink snow mold (*Micronectriella nivale*), Typhula snow blight (*Typhula sp.*), loose smut (*Ustilago tritici*), bunt (*Tilletia caries*), eyespot (*Pseudocercospora herpotrichoides*), leaf blotch (*Mycosphaerella graminicola*), glume blotch (*Stagonospora nodorum*), septoria, and yellow spot (*Pyrenophora tritici-repentis*).

20

Diseases of barley include powdery mildew (*Erysiphe graminis*), Fusarium head blight (*Fusarium graminearum*, *F. avenacerum*, *F. culmorum*, *Microdochium nivale*), rust (*Puccinia striiformis*, *P. graminis*, *P. hordei*), loose smut (*Ustilago nuda*), scald (*Rhynchosporium secalis*), net blotch (*Pyrenophora teres*), spot blotch (*Cochliobolus sativus*), leaf stripe (*Pyrenophora graminea*), and Rhizoctonia damping-off (*Rhizoctonia solani*).

25

30

Diseases in corn include smut (*Ustilago maydis*), brown spot (*Cochliobolus heterostrophus*), copper spot (*Gloeocercospora sorghi*), southern rust (*Puccinia*

polysora), gray leaf spot (*Cercospora zeae-maydis*), white spot (*Phaeosphaeria mydis* and/or *Pantoea ananatis*) and Rhizoctonia damping-off (*Rhizoctonia solani*).

Diseases of citrus include melanose (*Diaporthe citri*), scab (*Elsinoe fawcetti*), penicillium
5 rot (*Penicillium digitatum*, *P. italicum*), and brown rot (*Phytophthora parasitica*,
Phytophthora citrophthora).

Diseases of apple include blossom blight (*Monilinia mali*), canker (*Valsa ceratosperma*),
powdery mildew (*Podosphaera leucotricha*), Alternaria leaf spot (*Alternaria alternata*
10 apple pathotype), scab (*Venturia inaequalis*), powdery mildew, bitter rot (*Colletotrichum*
acutatum), crown rot (*Phytophthora cactorum*), blotch (*Diplocarpon mali*), and ring rot
(*Botryosphaeria berengeriana*).

Diseases of pear include scab (*Venturia nashicola*, *V. pirina*), powdery mildew, black
15 spot (*Alternaria alternata* Japanese pear pathotype), rust (*Gymnosporangium*
haraeanum), and phytophthora fruit rot (*Phytophthora cactorum*).

Diseases of peach include brown rot (*Monilinia fructicola*), powdery mildew, scab
(*Cladosporium carpophilum*), and phomopsis rot (*Phomopsis* sp.).
20

Diseases of grape include anthracnose (*Elsinoe ampelina*), ripe rot (*Glomerella*
cingulata), powdery mildew (*Uncinula necator*), rust (*Phakopsora ampelopsidis*), black
rot (*Guignardia bidwellii*), botrytis, and downy mildew (*Plasmopara viticola*).

25 Diseases of Japanese persimmon include anthracnose (*Gloeosporium kaki*), and leaf spot
(*Cercospora kaki*, *Mycosphaerella nawae*).

Diseases of gourd include anthracnose (*Colletotrichum lagenarium*), powdery mildew
(*Sphaerotheca fuliginea*), gummy stem blight (*Mycosphaerella melonis*), Fusarium wilt
30 (*Fusarium oxysporum*), downy mildew (*Pseudoperonospora cubensis*), Phytophthora rot
(*Phytophthora* sp.), and damping-off (*Pythium* sp.).

Diseases of tomato include early blight (*Alternaria solani*), leaf mold (*Cladosporium fulvum*), and late blight (*Phytophthora infestans*).

Diseases of eggplant include brown spot (*Phomopsis vexans*), and powdery mildew
 5 (*Erysiphe cichoracearum*) Diseases of cruciferous vegetables: *Alternaria* leaf spot (*Alternaria japonica*), white spot (*Cercospora brassicae*), clubroot (*Plasmodiophora brassicae*), and downy mildew (*Peronospora parasitica*).

Diseases of onion include rust (*Puccinia allii*), and downy mildew (*Peronospora*
 10 *destructor*).

Diseases of soybean include purple seed stain (*Cercospora kikuchii*), sphaceloma scab (*Elsinoe glycines*), pod and stem blight (*Diaporthe phaseolorum* var. *sojae*), septoria brown spot (*Septoria glycines*), frog-eye leaf spot (*Cercospora sojae*), rust (*Phakopsora*
 15 *pachyrhizi*, *Phakopsora meibomia*), Yellow rust, brown stem rot (*Phytophthora sojae*), and Rhizoctonia damping-off (*Rhizoctonia solani*).

Diseases of kidney bean include anthracnose (*Colletotrichum lindemthianum*). Diseases of peanut: leaf spot (*Cercospora personata*), brown leaf spot (*Cercospora arachidicola*)
 20 and southern blight (*Sclerotium rolfsii*).

Diseases of garden pea include powdery mildew (*Erysiphe pisi*), and root rot (*Fusarium solani* f. sp. *pisi*).

25 Diseases of potato include early blight (*Alternaria solani*), late blight (*Phytophthora infestans*), pink rot (*Phytophthora erythroseptica*), and powdery scab (*Spongospora subterranean* f. sp. *subterranea*).

Diseases of strawberry include powdery mildew (*Sphaerotheca humuli*), and anthracnose
 30 (*Glomerella cingulata*).

Diseases of tea include net blister blight (*Exobasidium reticulatum*), white scab (*Elsinoe leucospila*), gray blight (*Pestalotiopsis sp.*), and anthracnose (*Colletotrichum theae-sinensis*).

- 5 Diseases of tobacco include brown spot (*Alternaria longipes*), powdery mildew (*Erysiphe cichoracearum*), anthracnose (*Colletotrichum tabacum*), downy mildew (*Peronospora tabacina*), and black shank (*Phytophthora nicotianae*).

- 10 Diseases of rapeseed include sclerotinia rot (*Sclerotinia sclerotiorum*), and Rhizoctonia damping-off (*Rhizoctonia solani*). Diseases of cotton: Rhizoctonia damping-off (*Rhizoctonia solani*).

- 15 Diseases of sugar beet include Cercospora leaf spot (*Cercospora beticola*), leaf blight (*Thanatephorus cucumeris*), Root rot (*Thanatephorus cucumeris*), and Aphanomyces root rot (*Aphanomyces cochlioides*).

- 20 Diseases of rose include black spot (*Diplocarpon rosae*), powdery mildew (*Sphaerotheca pannosa*), and downy mildew (*Peronospora sparsa*). Diseases of chrysanthemum and asteraceous plants: downy mildew (*Bremia lactucae*), leaf blight (*Septoria chrysanthemi-indici*), and white rust (*Puccinia horiana*).

- 25 Diseases of various groups include diseases caused by Pythium spp. (*Pythium aphanidermatum*, *Pythium debarianum*, *Pythium graminicola*, *Pythium irregulare*, *Pythium ultimum*), gray mold. (*Botrytis cinerea*), and Sclerotinia rot (*Sclerotinia sclerotiorum*).

Disease of Japanese radish include Alternaria leaf spot (*Alternaria brassicicola*).

- 30 Diseases of turfgrass include dollar spot (*Sclerotinia homeocarpa*), and brown patch and large patch (*Rhizoctonia solani*).

Disease of banana include Black sigatoka (*Mycosphaerella fijiensis*), Yellow sigatoka (*Mycosphaerella musicola*).

Disease of sunflower include downy mildew (*Plasmopara halstedii*).

5

Seed diseases or diseases in the early stages of the growth of various plants caused by *Aspergillus* spp., *Penicillium* spp., *Fusarium* spp., *Gibberella* spp., *Tricoderma* spp., *Thielaviopsis* spp., *Rhizopus* spp., *Mucor* spp., *Corticium* spp., *Phoma* spp., *Rhizoctonia* spp. and *Diplodia* spp.

10

Viral diseases of various plants mediated by *Polymixa* spp. or *Olpidium* spp.

The compositions of the present disclosure can be used in agricultural lands such as fields, paddy fields, lawns, and orchards or in non-agricultural lands. The present disclosure may be used to control diseases in agricultural lands for cultivating the plants without any phytotoxicity to the plant.

Examples of the crops on which the present compositions may be used include but are not limited to corn, rice, wheat, barley, rye, oat, sorghum, cotton, soybean, peanut, buckwheat, beet, rapeseed, sunflower, sugar cane, tobacco; vegetables: solanaceous vegetables such as eggplant, tomato, pimento, pepper, potato, cucurbit vegetables such as cucumber, pumpkin, zucchini, water melon, melon, squash, cruciferous vegetables such as radish, white turnip, horseradish, kohlrabi, Chinese cabbage, cabbage, leaf mustard, broccoli, cauliflower, asteraceous vegetables such as burdock, crown daisy, artichoke, lettuce, liliaceous vegetables such as green onion, onion, garlic, and asparagus, ammiaceous vegetables such as carrot, parsley, celery, parsnip, chenopodiaceous vegetables such as spinach, Swiss chard, lamiaceous vegetables such as *Perilla frutescens*, mint, basil, strawberry, sweet potato, *Dioscorea japonica*, colocasia, flowers, foliage plants, turf grasses, fruits: pome fruits such as apple, pear, quince, etc, stone fleshy fruits such as peach, plum, nectarine, *Prunus mume*, cherry fruit, apricot, prune, citrus fruits such as orange, lemon, lime, grapefruit, nuts such as chestnuts, walnuts, hazelnuts, almond, pistachio, cashew nuts, macadamia nuts, berries such as blueberry, cranberry,

- blackberry, raspberry, grape, kaki fruit, olive, plum, banana, coffee, date palm, coconuts, trees other than fruit trees; tea, mulberry, flowering plant, trees such as ash, birch, dogwood, Eucalyptus, Ginkgo biloba, lilac, maple, Quercus, poplar, Judas tree, Liquidambar formosana, plane tree, zelkova, Japanese arborvitae, fir wood, hemlock,
- 5 juniper, Pinus, Picea, and Taxus cuspidate.

In an embodiment, the composition of the present invention is used to control fungal diseases at a locus.

- 10 In an embodiment, the present disclosure provides methods of controlling fungal diseases comprising applying a composition comprising combination of
- i. at least one dithiocarbamate fungicide; and
 - ii. at least one acylalanine fungicide.

- 15 In an embodiment, the present disclosure provides methods of controlling fungal diseases comprising applying a composition comprising combination of
- i. at least one dithiocarbamate fungicide; and
 - ii. at least one acylalanine fungicide.

wherein the composition has a cost: benefit ratio in the range of 1:1 to 1:5.

- 20 In an embodiment, the present disclosure provides methods of controlling fungal diseases comprising applying a composition comprising combination of
- i. at least one multisite fungicide;
 - ii. at least one systemic fungicide; and
 - iii. at least one agrochemically acceptable excipients.

25

In an embodiment, the present disclosure provides method of controlling fungal diseases comprising applying a composition comprising combination of

- i. mancozeb; and
- ii. metalaxyl-m.

30

In an embodiment, the present disclosure provides methods of controlling fungal diseases comprising applying a composition comprising combination of

- i. mancozeb;
- ii. metalaxyl-m; and
- 5 iii. at least one agrochemically acceptable excipient.

In an embodiment, the present disclosure provides methods of controlling fungal diseases comprising applying a composition comprising:

- i. at least one multi-site fungicide;
- 10 ii. at least one systemic fungicide;
- iii. at least one dispersant;
- iv. at least one emulsifier;
- v. at least one wetting agent; and
- vi. optionally at least one agrochemically acceptable excipient.

15

In an embodiment, the present disclosure provides methods of controlling fungal diseases comprising applying a composition comprising:

- i. at least one multi-site fungicide;
- 20 ii. at least one systemic fungicide;
- iii. at least one dispersant;
- iv. at least one emulsifier;
- v. at least one wetting agent; and
- vi. optionally at least one agrochemically acceptable excipient.

25 wherein the composition has a cost to benefit ratio in the range from 1:1 to 1:5.

In an embodiment, the constituents of the composition of the present disclosure are tank mixed and sprayed at the locus of the infection or are alternatively be mixed with surfactants and then sprayed.

30

In an embodiment, the constituents of the composition of the present disclosure may be used for foliar application, ground or applications to plant propagation materials.

In an embodiment, the composition is applied at a rate in the range from about 500 litres/hectare to 2500 litres/hectare.

- 5 In another embodiment, the composition is applied at a rate in the range from about 1000 litres/hectare to about 2000 litres/hectare.

The composition of the present disclosure maybe applied simultaneously as a tank mix or formulation or the multisite fungicide and at least one systemic fungicides may be applied
10 sequentially. Alternatively, the application may be a post-emergent application. The application may be made to the soil before emergence of the plants, either pre-planting or post-planting. The application may be made as a foliar spray at different timings during crop development, with either one or two applications early or late post-emergence.

- 15 The compositions according to this disclosure can be applied before or after infection of the plants or the propagation material thereof by the fungi.

The at least one multisite fungicide and at least one systemic fungicides may be provided individually as separate parts of a kit and may be mixed together before spraying. At least
20 one adjuvant may also be included with the kit and mixed together with the multisite fungicide and at least three systemic fungicides. Alternatively, the kit may contain a mixture of the multisite fungicide and at least one systemic fungicides and at least one separate adjuvant such that the mixture and the at least one adjuvant are tank mixed before spraying.

25

One or more advantages of the present disclosure over conventional formulations:

- i. The composition of the present invention is economical as compared to the conventional formulations like wettable powders.
- 30 ii. No dust and inhalation hazard during application in comparison with the WP formulation .
- iii. Easy and safe packing and transportation in comparison with WP.

- iv. Reduced wastage during packaging in comparison with WP, optimum application to the crops as per the recommended dose.
- v. During application spreadability and adhesion is good in comparison with the WP formulation, leads to good efficacy.
- 5 vi. Quick wetting in comparison with WP formulation.
- vii. High loading is possible in WG formulation in comparison with SC formulation.

While the foregoing written description of the disclosure enables one of ordinary skill to make and use, what is considered presently to be the best mode thereof, those of ordinary skill will understand and appreciate the existence of variations, combinations, and equivalents of the specific embodiment, method, and examples herein. The disclosure should therefore not be limited by the above-described embodiment, method, and examples, but by all embodiments and methods within the scope and spirit of the invention.

15

It will be understood that the specification and examples are illustrative but not limitative of the present disclosure and that other embodiments within the spirit and scope of the disclosure will suggest themselves to those skilled in the art. Other embodiments can be practiced that are also within the scope of the present disclosure. The following examples illustrate the disclosure, but by no means intend to limit the scope of the claims:

20

EXAMPLES

Example 1- Mancozeb + Metalaxyl-M WG

25

Table 1

Sr. No.	Ingredients	Amount % w/w
1	Mancozeb	61.50 to 66.50
2	Metalaxyl-M	3.51 to 4.29
3	Sodium ligno sulphonate	8 to 15

4	Sodium Di isopropyl naphthalene sulphonate	1 to 3.5
5	Sulphated Polyarylphenol Ethoxylate, Ammonium salt	0.5 to 2.5
6	Aqueous Emulsion with Polysiloxane and Emulsifier	0.1 to 1.0
7	Aluminium silicate	(Q.S.)
Total		100

Process for preparing the composition:

Metalaxyl-M premix preparation was done with required quantity of Metalaxyl-M technical and sulphated polyarylphenol thoxylate, ammonium salt with high speed mixing. A slurry was prepared with required quantity of water, surfactant, mancozeb technical, metalaxyl-m premix and other ingredients. The mixture was then sieved to remove any lumps before the spray drying process. Granulation was done by spray drying process. The wet granules obtained after spray drying were dried at $50\pm 5^{\circ}\text{C}$ in a fluidized bed dryer (FBD) to obtain moisture content of less than 2%. The dried granules were then sieved through required sieve size. The final product was evaluated as per standard specification and was packed in the approved pack sizes.

EXAMPLE 2 – Mancozeb 64% + Metalaxyl-M 3.9% WG

Table 2

Sr. No.	Ingredients	Amount % w/w
1	Mancozeb	64
2	Metalaxyl-M	3.9
3	Sodium ligno sulphonate	9
4	Sodium Di isopropyl naphthalene sulphonate	1.5

5

5	Sulphated Polyarylphenol Ethoxylate, Ammonium salt	0.5
6	Aqueous Emulsion with Polysiloxane and Emulsifier	0.5
7	Aluminium silicate	q.s.
Total		100

Physicochemical stability of Mancozeb 64 % + Metalaxyl-M 3.9 % WG

10

Table 3

Sr. No.	Parameter	Specification	Results of Analysis					
			0 Day	6 Month	12 Month	18 Month	24 Month	30 Month
1	Appearance	Greyish yellow to olive brown granules free from any extraneous matter.	Complies	Complies	Complies	Complies	Complies	Complies
2	Active content as (g/kg) Mancozeb	615 to 665	642.1	638.5	637.2	637.5	635.6	632.3
	Active content as (g/kg) Metalaxyl-M	35.10 to 42.90	41.8	411	40.8	40.38	40.5	39.4
3	Suspensibility as (%w/w) as Mancozeb	Minimum 60.0	93.6	90.5	88.5	88.25	87.9	84.4
	Suspensibility as (%w/w) as Metalaxyl - M	Minimum 60.0	99.2	98.25	98.05	97.9	98.02	99.5
4	LOD (% w/w)	Maximum 2.0 (Target-1.7)	1.65	1.59	1.62	1.55	1.59	1.65
5	pH (1% aqueous dispersion)	6.00 to 9.00	7.06	7.00	7.00	7.15	7.21	7.36
6	Wettability (seconds)	Maximum 60.0	20	18	19	20	22	25
7	Wet Sieve Test (Material passing through 75 µm test Sieve) %w/w	Minimum 99.0	99.85	99.75	99.75	99.75	99.74	99.7
8	Persistent foam (in mL after 1 minute)	Maximum 60.0	4	15	15	15	15	15

The above data establishes Mancozeb 64 % + Metalaxyl-M 3.9 % WG formulation complies as per the specification up to 30 months in shelf-life study.

5 Example 3

Bioefficacy data of the fungicidal composition of Metalaxyl M 3.9% + Mancozeb 64% WG

10 Methodology:

The fungicidal treatments were applied to grape plants as foliar spray with knapsack sprayer fitter with hollow cone nozzle. The first spray was given at about 88 days after pruning on the appearance of downy mildew and anthracnose disease, followed by second and third spray at 10 days interval. Bio-efficacy observations were recorded before first spray and 10 days after each spray.

Treatment:

Table 4

T. No.	Treatments	Dosage/ha
		Formulation (g/L)
1	Metalaxyl-M 3.9% + Mancozeb 64% WG	2
2	Metalaxyl-M 3.9% + Mancozeb 64% WG	2.5
3	Metalaxyl-M 3.9% + Mancozeb 64% WG	3
4	Mancozeb 75% WP	2
5	Metalaxyl-M 4% + mancozeb 64% WP (Comparative)	2.5
6	Control	-

Percent of disease Index (PDI):

In each plot from disease infection stage to berry development stage 50 bunches were
 5 randomly selected and Downy mildew (caused by *Plasmopara viticola*) and anthracnose
 (caused by *Elsinoe ampelina*) disease were recorded before first spray and 10 days after
 each spray based on the following score and Percent Disease Index (PDI) was calculated
 using formula of Wheeler (1969) as given below:

$$PDI = \frac{\text{Sum of all numerical ratings}}{\text{Number of samples graded}} \times \frac{100}{\text{Maximum disease grade}}$$

10

Downy mildew severity assessment scale

Downy mildew disease severity was rated based on the most heavily infected leaves
 (Cadle Davidson, 2008 & Prajongjai et al., 2013), and classified into 10 classes, 1 to 10,
 15 based on the estimated percentage of infected leaf area:

1 = No visible disease symptom

2 = 1 to 10% of the area covered by lesions

3 = 11 to 20% of the area covered by lesions

20 4 = 21 to 30% of the area covered by lesions

5 = 31 to 40% of the area covered by lesions

6 = 41 to 50% of the area covered by lesions

7 = 51 to 60% of the area covered by lesions

8 = 61 to 70% of the area covered by lesions

25 9 = 71 to 80% of the area covered by lesions

IO=> 80% of the area covered by lesions from downy mildew infection.

Anthracnose disease incidence scale

30 The per cent disease incidence was recorded based on 0-9 scale, where:

0 = No disease infection

- 1 = 1 to 5% disease infection
 3 = 6-10% disease infection
 5 = 11-25% disease infection
 7 = 26-50% disease infection
 5 9 = > 50% disease infection

Yield

In order to record the yield, the fruits were harvested from the individual plots and yield
 10 was recorded and expressed as q/ha.

Experimental Results:

Bio-efficacy of Metalaxyl-M 3.9% + Mancozeb 64% WG on downy mildew and
 15 anthracnose of grape (var. Bangalore blue) was taken under field conditions. The
 composition was tested at three different doses (0.20%, 0.25% and 0.30%) along with
 standard check fungicides viz., Mancozeb 75% WP @2000 g/ha, Metalaxyl M 4% +
 Mancozeb 64% WP @0.25%.

20 Downy Mildew disease control

Table 5

Treatments	Formulations (g/ha)	Percentage Disease Index (PDI)			Mean PDI	% reduction in disease over control
		10 days after 1 st spray	10 days after 2 nd spray	10 days after 3 rd spray		
Metalaxyl-M 3.9% + Mancozeb 64% WG	0.20%	6.14 (14.35)	9.01 (17.47)	11.24 (19.57)	8.80	49.47
Metalaxyl-M 3.9% + Mancozeb 64% WG	0.25%	4.50 (12.24)	5.55 (13.63)	6.66 (14.96)	5.57	68.01

Metalaxyl-M 3.9% + Mancozeb 64% WG	0.30%	3.96 (11.48)	4.89 (12.77)	5.87 (14.02)	4.91	71.82
Mancozeb 75% WP	2000	6.34 (14.59)	9.74 (18.17)	12.11 (20.35)	9.39	46.04
Metalaxyl-M 4% + mancozeb 64% WP	0.25%	6.05 (14.23)	7.94 (16.37)	9.96 (18.39)	7.98	54.14
Control	--	10.11 (18.53)	16.52 (23.98)	25.60 (30.38)	17.41	-
CD at 5%		0.89	1.04	1.75		

Figures in the bracket are arcsine transformed values.

Before spray the downy mildew disease PDI ranged from 3.72 to 4.31. Application of the Metalaxyl-M 3.9% + Mancozeb 64% WG @ 0.30% was found highly effective in controlling Downy mildew disease of grapes with PDI of 3.96, 4.89 and 5.87 at all three observations time, followed by the Metalaxyl-M 3.9% + Mancozeb 64% WG @ 0.25% g with PDT of 4.50, 5.55 and 6.66 with PDI of 5.33, 6.82 and 8.61 at 1st, 2nd and 3rd observations respectively. Metalaxyl M 4% + Mancozeb 64% WP@ 0.25% was recorded PDT of 6.05, 7.94 and 9.96 which was on par with treatment Metalaxyl-M 3.9% + Mancozeb 64% WG @ 0.20% with PDI of 6.14, 9.01 and 11.24 at all three observations time and Mancozeb 75% WP@ 2000 g/ha with PDI of 6.34, 9.74 and 12.11. Control was recorded highest PDT of 10.11, 16.52 and 25.60 (Table 5).

Anthracnose disease control

15

Table 6

Treatments	Formulations (g/ha)	Percentage Disease Index (PDI)			Mean PDI	% reduction in disease over control
		10 days after 1 st spray	10 days after 2 nd spray	10 days after 3 rd spray		
Metalaxyl-M 3.9% +	2000	5.68 (13.78)	7.04 (15.35)	7.65 (16.04)	6.79	67.20

Mancozeb 64% WG						
Metalaxyl-M 3.9% + Mancozeb 64% WG	2500	3.58 (10.87)	4.57 (12.33)	5.19 (13.14)	4.44	78.53
Metalaxyl-M 3.9% + Mancozeb 64% WG	3000	3.21 (10.29)	3.33 (10.51)	4.07 (11.61)	3.54	82.90
Mancozeb 75% WP	2000	6.91 (15.22)	9.01 (17.37)	10.62 (19.01)	8.85	57.26
Metalaxyl-M 4% + mancozeb 64% WP	2500	5.80 (13.89)	6.67 (14.93)	7.16 (15.51)	6.54	68.39
Control	--	14.20 (22.12)	20.25 (26.71)	27.65 (31.71)	20.70	-
CD at 5%		1.96	2.68	2.13		

Figures in the bracket are arcsine transformed values.

Before spray the anthracnose disease PDI ranged from 3.02 to 4.29. Application of
 5 Metalaxyl-M 3.9% + Mancozeb 64% WG @ 3000 g/ha was found highly effective in
 controlling Anthracnose disease of grapes with POI of 3.21, 3.33 and 4.07 at all three
 observations time, followed by Metalaxyl-M 3.9% + Mancozeb 64% WG @ 2500 g/ha
 with PDT of 3.58, 4.57 and 5.19 with PDI of 5.19, 6.05 and 6.67 at 1st, 2nd and 3rd
 observations respectively. Metalaxyl M 4% + Mancozeb 64% WP@ 2500 g/ha was
 10 recorded PDT of 5.80, 6.67 and 7.16 which was on par with treatment Metalaxyl-M 3.9%
 + Mancozeb 64% WG @ 2000 g/ha with PDT of 5.68, 7.04 and 7.65 at three observations

time followed by Mancozeb 75% WP @ 2000 g/ha with PDI of 6.91, 9.0 I and 10.62. Control was recorded highest POI of 14.20, 20.25 and 27.65 (Table 6).

Yield:

- 5 Application of Metalaxyl-M 3.9% + Mancozeb 64% WG @ 0.30% g recorded highest fruit yield (357.50 q/ha), followed by Metalaxyl-M 3.9% + Mancozeb 64% WG @ 0.25% (349.38 q/ha). Metalaxyl M 4% + Mancozeb 64% WP @ 2500 g/ha was recorded fruit yield of 308.19 q/ha which was on par with treatment Metalaxyl-M 3.9% + Mancozeb 64% @ 0.20% (318.94 q/ha) followed by Mancozeb 75% WP@ 2000 g/ha (283.69 q/ha).
- 10 Control was recorded lowest fruit yield of 191.16 q/ha. Metalaxyl-M 3.9% + Mancozeb 64% @ 0.30% was recorded highest% increase in fruit yield over control (46.53%) (Table 7).

Table 7

Treatments	Formulations (g/ha)	Yield (q/ha)	% increase in fruit yield over control
Metalaxyl-M 3.9% + Mancozeb 64% WG	0.20%	318.94	40.06
Metalaxyl-M 3.9% + Mancozeb 64% WG	0.25%	349.38	45.29
Metalaxyl-M 3.9% + Mancozeb 64% WG	0.30%	357.50	46.53
Mancozeb 75% WP	2000	283.69	32.62
Metalaxyl-M 4% + mancozeb	0.25%	308.19	37.97

64% WP			
Control	-	191.16	-

Conclusion:

- Based on the studies Metalaxyl M 3.9% + Mancozeb 64% WG @ 0.30% and 0.25% was found effective to control the downy mildew disease and anthracnose disease incidence on grapes. Hence the use of Metalaxyl M 3.9% + Mancozeb 64% WG @ 0.25% is suggested for the effective management of downy mildew and anthracnose diseases of grapes.

Example 4

Cost: Benefit ratio

- The Cost: Benefit ratio was calculated based on application cost of treatments, crop yield and price of the product. It was observed that the composition of Metalaxyl-M + Mancozeb WG @ 3.0 g/L & @ 2.5 g/L recorded higher cost benefit ratio of 1 :4.96 and 1 :4.92 in comparison to all other treatment (Table 8).

Table 8

Treatments	Dosage/ha	Yield	Price (Rs./q)	Gross return	Average cost of other inputs and sprays	Cost of fungicide	Total cost	Net return	C:B ratio
	Formulations (g or ml/L)								
Metalaxyl-M 3.9% + Mancozeb 64% WG	2.0	182.60	4000	730400	151200	6300	157500	572900	1: 3.63
Metalaxyl-M 3.9% + Mancozeb 64% WG	2.5	235.58	4000	942320	151200	7875	159075	783245	1: 4.92

Metalaxyl-M 3.9% + Mancozeb 64% WG	3.0	239.37	4000	957480	151200	9450	160650	796830	1: 4.96
Metalaxyl-M 4% + mancozeb 64% WP	2.5	223.83	4000	895320	151200	9750	160950	734370	1: 4.56
Control	--	109.20	4000	436800	151200	0	151200	285600	1: 1.88

Price:

Metalaxyl-M 3.9% + Mancozeb 64% WG @ Rs 1050/Kg,

Mancozeb 75% WP @ Rs 500/Kg,

- 5 Metalaxyl M 4% + Mancozeb 64% WP @ Rs 1300/Kg.

We claim:

1. A fungicidal composition comprising:
 - a) at least one multi-site fungicide selected from copper fungicides, sulfur fungicides, dithiocarbamate fungicides, phthalimide fungicides, chloronitrile fungicides, sulfamide fungicides, guanidine fungicides, triazines fungicides, quinone fungicides or a combination thereof;
 - b) at least one acylalanine fungicide; and
 - c) at least an agrochemically acceptable excipient.
2. The composition as claimed in claim 1, wherein the composition has a cost to benefit ratio in the range from 1:1 to 1:5.
3. The composition as claimed in claim 1, wherein the multisite fungicide is selected from copper fungicides, sulfur fungicides, dithiocarbamate fungicides, phthalimide fungicides, chloronitrile fungicides, sulfamide fungicides, guanidine fungicides, triazines fungicides, quinone fungicides or a combination thereof.
4. The composition as claimed in claim 3, wherein dithiocarbamate fungicide is mancozeb.
5. The composition as claimed in claim 1, wherein dithiocarbamate fungicide is present in a concentration in the range from about 50 % w/w to 70% w/w of the total weight of the composition.
6. The composition as claimed in claim 1, wherein the acylalanine fungicide is selected from metalaxyl, metalaxyl-M or a combination thereof.
7. The composition as claimed in claim 1, wherein acylalanine fungicide is present in a concentration in the range from about 1% w/w to about 10% w/w of the total weight of the composition.
8. The composition as claimed in claim 1, wherein the agrochemically acceptable excipient is selected from dispersant, disintegrant, emulsifiers, wetting agents, binder, glidant, anticaking agents, pH-regulating agents, preservatives, biocides, antifoaming agents, colorants, fillers stabilizers, other formulation aids or combination thereof.
9. The composition as claimed in claim 8, wherein the dispersant is selected from sodium lignosulfonate, salts of naphthalenesulphonic acid/formaldehyde condensates, salts of condensates of naphthalenesulphonic acid, phenolsulphonic acid and formaldehyde, and salts of lignosulphonic acid, modified sodium lignosulfonate, polyethylene oxide/polypropylene oxide block copolymers, polyethylene glycol ethers

of linear alcohols, potassium polycarboxylate, modified styrene acrylic polymer or combinations thereof.

10. The composition as claimed in claim 9, wherein the dispersant is sodium lignosulfonate or salts thereof.

11. The composition as claimed in claim 10, wherein the dispersant concentration is in the range from about 1% w/w to 30% w/w of the total composition.

12. The composition as claimed in claim 8, wherein the wetting agent is selected from sodium diisopropyl naphthalene sulphonate, sodium lauryl sulphate, sodium alkyl naphthalene sulfonate, dioctyl sulfosuccinate, alkylbenzene sulfonates, dioctyl sodium sulfosuccinate, sodium lauryl sulfate, sodium lauryl ether sulfate, sodium alkyl benzene sulfate, or combinations thereof.

13. The composition as claimed in claim 12, wherein the wetting agent is sodium diisopropyl naphthalene sulphonate.

14. The composition as claimed in claim 12, wherein the wetting agent concentration is in the range from about 0.1% w/w to about 10 % w/w of the total composition.

15. The composition as claimed in claim 8, wherein the emulsifier is selected from sulphated polyarylphenol ethoxylate, ammonium salt, ethoxylated tristyrylphenol sulfate or phosphate, ethoxylated fat alcohol, ethoxylated alkylphenol, ethoxylated tristyrylphenol ethoxylated polyethylene glycol and polypropylene glycol and copolymers thereof, ethoxylated tristyrylphenol derivative, polyethylene oxide/polypropylene oxide block copolymers, copolymers of polyvinyl alcohol and polyvinylpyrrolidone, copolymers of (meth)acrylic acid and (meth)acrylic esters, polyarylphenyl ether sulphate ammonium salt, tristyrylphenol ethoxylate phosphate ester or combinations thereof.

16. The composition as claimed in claim 15, wherein the emulsifier is sulphated polyarylphenol ethoxylate, ammonium salt.

17. The composition as claimed in claim 15, wherein the emulsifier concentration is in the range from about 0.01 w/w to about 10 % w/w of the total composition.

18. The composition as claimed in claim 1, wherein the composition is a water dispersible granule.

19. The composition as claimed in claim 1, wherein acylalanine fungicide and multisite fungicide are used in a ratio in the range from 1:1 to 1:20.

20. A fungicidal composition comprising:

- a. at least one dithiocarbamate fungicide;

- b. at least one acylalanine fungicide;
- c. at least one dispersant;
- d. at least one emulsifier;
- e. at least one wetting agent; and

5 f. optionally at least one agrochemically acceptable excipient.

21. A method of controlling fungal diseases comprising applying a composition comprising combination of

- a. at least one dithiocarbamate fungicide;
- b. at least one acylalanine fungicide; and
- 10 c. at least one agrochemically acceptable excipient

wherein the composition has a cost to benefit ratio in the range of 1:1 to 1:5.

22. The method as claimed in claim 21, wherein dithiocarbamate fungicide is mancozeb and acylalanine fungicide is metalaxyl or metalaxyl-m.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2024/050198

A. CLASSIFICATION OF SUBJECT MATTER

A01N 47/14 (2006.01) A01N 25/14 (2006.01) A01N 25/30 (2006.01) A01N 37/46 (2006.01) A01P 3/00 (2006.01)

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)

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

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

Databases: PATENW, EspaceNet, Google Search/Patents/Scholar, CAPLUS, REGISTRY, CASFORMLTNS, CABA, AGRICOLA**IPC/CPC symbols:** A01N (25/14, 25/30, 37/46, 47/14)**Key words:** Dithiocarbamate, acylalanine, mancozeb, metalaxyl-M, sodium lignosulfonate, sodium diisopropyl naphthalene sulfonate, sulfated polyarylphenol ethoxylate ammonium salt and like terms**Applicant/Inventor(s):** UPL LIMITED, Pradeep SAPKALE, Vikas OLTIKAR

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	



Further documents are listed in the continuation of Box C



See patent family annex

* "A" "D" "E" "L" "O" "P"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance document cited by the applicant in the international application earlier application or patent but published on or after the international filing date 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) document referring to an oral disclosure, use, exhibition or other means document published prior to the international filing date but later than the priority date claimed	"T" "X" "Y" "&"	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 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 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
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Date of the actual completion of the international search 29 April 2024	Date of mailing of the international search report 29 April 2024
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaaustralia.gov.au	Authorised officer Stefanie-Ann Zavras AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. +61 2 6283 2069

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:
the subject matter listed in Rule 39 on which, under Article 17(2)(a)(i), an international search is not required to be carried out, including
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.:
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:

See Supplemental Box for Details

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.:
1-22 (as they relate to fungicidal compositions comprising at least one multi-site fungicide selected from dithiocarbamate fungicides and at least one acylalanine fungicide)

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.

Supplemental Box

Continuation of: Box III

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

- **Invention 1:** Claims 1-19 (in part) are directed to a fungicidal composition. The feature of the combination of (a) at least one multi-site fungicide selected from **copper fungicides**; (b) at least one acylalanine fungicide; and (c) at least one agrochemically acceptable excipient, is specific to this group of claims.
- **Invention 2:** Claims 1-19 (in part) are directed to a fungicidal composition. The feature of the combination of (a) at least one multi-site fungicide selected from **sulfur fungicides**; (b) at least one acylalanine fungicide; and (c) at least one agrochemically acceptable excipient, is specific to this group of claims.
- **Invention 3:** Claims 1-19 (in part) and 20-22 (in full) are directed to a fungicidal composition. The feature of the combination of (a) at least one multi-site fungicide selected from **dithiocarbamate fungicides**; (b) at least one acylalanine fungicide; and (c) at least one agrochemically acceptable excipient, is specific to this group of claims.
- **Invention 4:** Claims 1-19 (in part) are directed to a fungicidal composition. The feature of the combination of (a) at least one multi-site fungicide selected from **phthalimide fungicides**; (b) at least one acylalanine fungicide; and (c) at least one agrochemically acceptable excipient, is specific to this group of claims.
- **Invention 5:** Claims 1-19 (in part) are directed to a fungicidal composition. The feature of the combination of (a) at least one multi-site fungicide selected from **chloronitrile fungicides**; (b) at least one acylalanine fungicide; and (c) at least one agrochemically acceptable excipient, is specific to this group of claims.
- **Invention 6:** Claims 1-19 (in part) are directed to a fungicidal composition. The feature of the combination of (a) at least one multi-site fungicide selected from **sulfamide fungicides**; (b) at least one acylalanine fungicide; and (c) at least one agrochemically acceptable excipient, is specific to this group of claims.
- **Invention 7:** Claims 1-19 (in part) are directed to a fungicidal composition. The feature of the combination of (a) at least one multi-site fungicide selected from **guanidine fungicides**; (b) at least one acylalanine fungicide; and (c) at least one agrochemically acceptable excipient, is specific to this group of claims.
- **Invention 8:** Claims 1-19 (in part) are directed to a fungicidal composition. The feature of the combination of (a) at least one multi-site fungicide selected from **triazine fungicides**; (b) at least one acylalanine fungicide; and (c) at least one agrochemically acceptable excipient, is specific to this group of claims.
- **Invention 9:** Claims 1-19 (in part) are directed to a fungicidal composition. The feature of the combination of (a) at least one multi-site fungicide selected from **quinone fungicides**; (b) at least one acylalanine fungicide; and (c) at least one agrochemically acceptable excipient, is specific to this group of claims.

Unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. A special technical feature is one which makes a contribution over the prior art (see PCT Rule 13.2). When there is no special technical feature common to all the claimed inventions there is no unity of invention.

In the above groups of claims, the identified features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. The only feature common to all of the claimed inventions is the combination of *at least one multi-site fungicide, at least one acylalanine fungicide and at least one agrochemically acceptable excipient*.

However, this feature does not make a contribution over the prior art because it is disclosed in:

US 6514959 B2 (NUNINGER et al.) 4 Feb 2003

INTERNATIONAL SEARCH REPORT	International application No. PCT/IN2024/050198
Supplemental Box	
<p>Therefore, in the light of this document this common feature cannot be a special technical feature. And because there is no special technical feature common to all the claimed inventions the requirements for unity of invention are consequently not satisfied <i>a posteriori</i>.</p> <p>The search and examination for the additional inventions will each require more than negligible additional search and examination effort over that for the first invention and each other. This is because it will require the identification of all members of each multi-site fungicide class; and searching these in combination with each and every acylalanine fungicide. Consequently, the number of fungicidal combinations encompassed by claim 1 is considerable in size. The scope of claim 1 broadens further given the scope of the term ‘<i>agrochemically acceptable excipient</i>’.</p> <p>Because no additional search fees were paid, I have restricted the International Search Report and the Written Opinion of the International Searching Authority to those parts of the international application which relate to what appears to be the “main invention” (see paragraph 10.75 of the PCT Guidelines).</p> <p>Given all the examples in the specification are directed to combinations of mancozeb (a dithiocarbamate fungicides) and metalaxyl-M (an acylalanine fungicide), I have construed to the “main invention” to be Invention 3 (see above).</p>	
Form PCT/ISA/210 (Supplemental Box) (July 2019)	

INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/IN2024/050198	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/IN2024/050198	
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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

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INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/IN2024/050198	
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Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	Publication Date	Publication Number	Publication Date
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End of Annex			
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.			