

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property

Organization

International Bureau

(43) International Publication Date

23 February 2023 (23.02.2023)



(10) International Publication Number

WO 2023/021461 A1

(51) International Patent Classification:

A01N 25/00 (2006.01)

A01N 59/02 (2006.01)

A01N 43/653 (2006.01)

TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

(21) International Application Number:

PCT/IB2022/057750

(22) International Filing Date:

18 August 2022 (18.08.2022)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

202121037709

19 August 2021 (19.08.2021)

IN

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(81) Designated States (unless otherwise indicated, for every

kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every

kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

Declarations under Rule 4.17:

- as to the identity of the inventor (Rule 4.17(i))
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))
- of inventorship (Rule 4.17(iv))

Published:

- with international search report (Art. 21(3))
- in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE

(54) Title: NOVEL PESTICIDAL COMPOSITION

(57) Abstract: The invention particularly relates to a pesticidal composition comprising elemental sulphur in the range of 30% w/w to 90% w/w of the total composition; fluxapyroxad present in the range of 0.01% to 25% w/w of the total composition; and prothioconazole present in the range of 1% to 20% w/w of the total composition and at least one agrochemically acceptable excipient, wherein the composition has a particle size range of 0.1 to 50 microns. The present invention also relates to process of preparation of the pesticidal composition. The invention further relates to a method of controlling fungal disease, crop protection or improving the plant health and yield by treating a plant, plant propagation material, locus or parts thereof, a seed, seedling or surrounding soil with the pesticidal composition.



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## NOVEL PESTICIDAL COMPOSITION

### FIELD OF THE INVENTION

The present invention relates to a pesticidal combination comprising elemental sulphur, fluxapyroxad and prothioconazole. The present invention also relates to a  
5       pesticidal composition comprising elemental sulphur, fluxapyroxad, prothioconazole and at least one agrochemically acceptable excipient. More particularly, the present invention relates to a pesticidal composition comprising elemental sulphur in the range of 30% w/w to 90% w/w of the total composition;  
10       fluxapyroxad in the range of 0.01% w/w to 25% w/w of the total composition; prothioconazole in the range of 1% w/w to 20% w/w of the total composition and at least one agrochemically acceptable excipient, wherein the composition has a particle size range of 0.1 micron to 50 microns.

15       The invention further relates to a process for preparing the pesticidal composition.

The invention furthermore relates to a method of controlling fungal disease, crop protection or improving the plant health and yield by treating a plant, crop, plant propagation material, locus or parts thereof, a seed, seedling or surrounding soil  
20       with the pesticidal composition.

### 1. BACKGROUND OF THE INVENTION

In describing the embodiment of the invention, specific terminology is chosen for  
25       the sake of clarity. However, it is not intended that the invention be limited to the specific terms so selected and it is to be understood that each specific term includes all technical equivalents that operate in a similar manner to accomplish a similar purpose.

30       Use of agrochemicals, in particular chemical fungicides, for protection of crops against fungi and other pests has been an integral component of crop management.

Current fungicides available in the market does not meet the modern-day crop protection requirements, as they:

- lack in providing broad spectrum of action,
- exhibit increased resistance among the pests due to the repeated and prolonged administration of the individual actives or known chemistries at higher dosages,
- lead to environmental pollution and soil toxicity due to leaching of fertilizers and pesticides in soil and groundwater.

In addition, the repeated use of the current pesticidal products also exhibits problems such as pest resurgence, secondary pest outbreak, residue related problems, toxic effect on human beings along with reduced yield.

Hence, there is a clear need for improved pesticidal products, in particular fungicides, which addresses the above drawbacks associated with the known chemistries.

Fluxapyroxad, a pyrazole-carboxamide fungicide, controls fungal growth by inhibiting the succinate dehydrogenase enzyme and exhibits a preventive and therapeutic action simultaneously.

Prothioconazole, a broad-spectrum triazole fungicide, acts as an ergosterol biosynthesis inhibitor and inhibits the demethylation of the precursors of sterols, lanosterol or 24-methylene dihydrogen in the fungus. Prothioconazole exhibits good systemic activity, and offers good protection with a long-lasting effect on pathogens.

The role of sulphur as a fertilizer and pesticide has been long known. Sulphur is considered as organic in nature and is largely available in its elemental form. The benefits of sulphur not only encompasses reduced dependency on use of chemicals as an effective mode of pest and disease control along with nutritional

benefits but being organic in nature it is also environment friendly, increases crop yield, improves food safety, human, animal or plant health and quality of life. The use of sulphur as a fungicide, acaricide, miticide and nutrient is of special importance and has been long used as an environment friendly mode of farming practice.

Two-way combinations of actives namely fluxapyroxad with prothioconazole, and inpyrfluxam with sulphur for controlling pathogens and pests are described in the literature. However, the biological properties of these known combinations are not entirely satisfactory in the areas of pathogenic control, phytotoxicity, and environmental exposure, for example.

US20210084904 relates to pesticidal mixtures containing one or more succinate dehydrogenase inhibitors (SDHIs), preferably inpyrfluxam and one or more sulfur-containing compounds, preferably sulphur for controlling peanut leaf spot.

WO20120016972 relates to a fungicidal composition comprising fluxapyroxad and prothioconazole for controlling phytopathogenic fungi in corn.

WO2018162999 relates to fungicidal combinations comprising a multi-site contact fungicide, a succinate dehydrogenase inhibitor fungicide and a second systemic fungicide and a method using the same. WO'999 discusses thousands of possible three-way fungicidal combinations. WO'999 discloses that the fungicidal composition is effective in control of target pest due to the use of three-way combination.

However, these literatures are silent on the specific combination of elemental sulphur, fluxapyroxad and prothioconazole in a pesticidal effective amount with a specific particle size; and on the efficacy and the synergy of the said combination.

Thus, no fungicidal composition known in the art comprising of specific combination of sulphur, fluxapyroxad and prothioconazole which can be effectively used with broad spectrum pesticidal activity at lower dosage and address the drawbacks discussed above with the known compositions.

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That need is solved according to the present invention by the provision of the present stable and improved pesticidal combination.

### SUMMARY OF THE INVENTION

10 The present invention relates to a synergistic combination comprising elemental sulphur, fluxapyroxad and prothioconazole.

The present invention relates to a synergistic pesticidal composition comprising elemental sulphur, fluxapyroxad, prothioconazole and at least one agrochemically acceptable excipient.

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The present invention relates to a pesticidal composition comprising elemental sulphur in the range of 30% w/w to 90% w/w of the total composition, fluxapyroxad in the range of 0.01% w/w to 25% w/w of the total composition, prothioconazole in the range of 1% w/w to 20% w/w of the total composition, and at least one agrochemically acceptable excipient, wherein the composition has a particle size range of 0.1 micron to 50 microns.

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The present invention further relates to a process for preparation of the pesticidal composition comprising elemental sulphur in the range of 30% w/w to 90% w/w of the total composition; fluxapyroxad in the range of 0.01% w/w to 25% w/w of the total composition; prothioconazole in the range of 1% w/w to 20% w/w of the total composition and at least one agrochemically acceptable excipient, wherein the composition has a particle size range of 0.1 micron to 50 microns.

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The present invention also relates to a method of controlling fungal disease, crop protection or improving the plant health and yield by treating a plant, crop, plant propagation material, locus or parts thereof, a seed, seedling or surrounding soil with the pesticidal composition comprising elemental sulphur, fluxapyroxad, prothioconazole and at least one agrochemically acceptable excipient.

#### 4. DETAILED DESCRIPTION OF THE INVENTION

In describing the embodiment of the invention, specific terminology is chosen for the sake of clarity. However, it is not intended that the invention be limited to the specific terms so selected and it is to be understood that such specific terms include all technical equivalents that operate in a similar manner to accomplish a similar purpose. It is understood that any numerical range recited herein is intended to include all subranges subsumed. Also, unless denoted otherwise, percentage of components in a composition are presented as weight percent.

15

The terms “a” or “an”, as used herein, are defined as one or more than one. The terms “including” and/or “having”, as used herein, are defined as comprising (i.e., open language).

20 The term “Sulphur” used in the composition refers to elemental sulphur obtained through natural sources or synthetic sources. The term includes allotropes of elemental sulfur such as plastic (amorphous) sulfur, monoclinic sulfur, rhombic sulfur composed of S<sub>8</sub> molecules, and other ring molecules such as S<sub>7</sub> and S<sub>12</sub>. The term also comprises sulphur produced through processing and refining of petrochemicals. The term also comprises ‘biosulfur’. The term also comprises  
25 elemental Sulphur produced through microbial processes.

Prothioconazole used in the present invention refers to prothioconazole or its salts or derivatives thereof.

30

The granules refer mainly to water dispersible granules, extruded granules or spheronised granules. As described herein, “GR” refers to extruded granules or spheronised granules. As described herein, “WG” or “WDG” refer to water dispersible granules.

- 5 As described herein, water dispersible granule is defined as a formulation which disperses or dissolves rapidly when added to water to give a fine particle suspension. Water-dispersible granules are formulated as small, easily measured granules by blending and agglomerating ground active ingredients together with surfactants and other formulation excipients which disperses into finer/primary  
10 particles upon addition to water.

According to the invention, the term liquid suspension encompasses “aqueous suspension” or aqueous dispersion” or “suspension concentrates (SC)” composition. Liquid suspension is defined as a composition wherein solid  
15 particles are dispersed or suspended in a liquid. The liquid as a vehicle is water and/or a water miscible solvent.

As defined herein, WP refers to a wettable powder, which is a powder formulation to be applied as a suspension after dispersion in water.

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As defined herein, WS refers to a water dispersible powder for slurry seed treatment.

As defined herein, aqueous suspo-emulsion is essentially a mixture of water-insoluble active constituents dispersed in a water-based solution; where one (or  
25 more) of the active constituents is a solid, formulated as a suspension form (SC) and one (or more) of the actives is an oil, formulated as an emulsion in water (EW).

- 30 The present invention relates to a synergistic combination comprising elemental sulphur, fluxapyroxad and prothioconazole.

The present invention relates to a synergistic combination comprising elemental sulphur in the range of 30% w/w to 90% w/w of the total composition, fluxapyroxad in the range of 0.01% w/w to 25% w/w of the total composition,  
5 prothioconazole in the range of 1% w/w to 20% w/w of the total composition.

The present invention relates to an improved and stable fungicidal composition comprising elemental sulphur in the range of 30% w/w to 90% w/w of the total composition, fluxapyroxad in the range of 0.01% w/w to 25% w/w of the total composition, prothioconazole in the range of 1% w/w to 20% w/w of the total  
10 composition, and at least one agrochemically acceptable excipient, wherein the composition has a particle size in the range of 0.1 micron to 50 microns.

The inventors of the present invention have surprisingly found that the combination comprising elemental sulphur, fluxapyroxad, prothioconazole  
15 demonstrated synergistic pesticidal activity compared to the activity of the individual active ingredient alone.

In addition to the synergistic effect of the composition of the present invention, the inventors surprisingly determined that the composition comprising elemental sulphur in the range of 30% w/w to 90% w/w of the total composition,  
20 fluxapyroxad in the range of 0.01% w/w to 25% w/w of the total composition, prothioconazole in the range of 1% w/w to 20% w/w of the total composition, and at least one agrochemical excipient in the form of solid, liquid, gel or paste provides excellent pest control and improves yield when the particles in the  
25 composition are present in the size range of 0.1 micron to 50 microns.

The inventors of the present invention surprisingly found that the presence of elemental sulphur in the composition of the present invention, not only demonstrates synergistic effect in terms of controlling fungi, but also additionally  
30 provides nutrition to the plant, thus showing a significant enhancement in the yield as well as other crop characteristics such as plant height, root length and



improved foliage, as compared to the individual applications of sulphur, fluxapyroxad and prothioconazole.

Further, the inventors found that the composition of the present invention  
5 manifested significant efficacy when the elemental sulphur was loaded at a concentration of at least 30%w/w. It was also found that the presence of elemental sulphur in the composition at a concentration of at least 30%w/w not only aided in prolonging the pest resistance towards the other actives present in the composition i.e. prothioconazole and fluxapyroxad but also helped reducing the active dose of  
10 fungicides i.e. fluxapyroxad and prothioconazole.

Further, the composition of the present invention was found to not only provide an economical advantage to the farmers at large, but also provide an ecological advantage on account of higher loading of elemental sulphur, which being organic  
15 in nature, does not cause an adverse impact either to the environment or to the human population and further helps in reducing the active dose of chemical/synthetic pesticides used in the composition.

According to an embodiment, elemental sulphur is present in the range of 30%  
20 w/w to 90% w/w of the total composition. According to an embodiment, elemental sulphur is present in the range of 30% w/w to 80% w/w of the total composition. According to an embodiment, elemental sulphur is present in the range of 30% w/w to 70% w/w of the total composition. According to an embodiment, elemental sulphur is present in the range of 30% w/w to 60% w/w of  
25 the total composition. According to an embodiment, elemental sulphur is present in the range of 30% w/w to 50% w/w of the total composition. According to an embodiment, elemental sulphur is present in the range of 40% w/w to 90% w/w of the total composition. According to an embodiment, elemental sulphur is present in the range of 40% w/w to 80% w/w of the total composition. According to an  
30 embodiment, elemental sulphur is present in the range of 40% w/w to 70% w/w of the total composition. According to an embodiment, elemental sulphur is present

in the range of 50% w/w to 90% w/w of the total composition. According to an embodiment, elemental sulphur is present in the range of 50% w/w to 80% w/w of the total composition. According to an embodiment, elemental sulphur is present in the range of 60% w/w to 90% w/w of the total composition.

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According to an embodiment, fluxapyroxad is present in the range of 0.01% to 25% w/w of the total composition. According to an embodiment, fluxapyroxad is present in the range of 0.01% to 20% w/w of the total composition. According to an embodiment, fluxapyroxad is present in the range of 0.01% to 15% w/w of the total composition. According to an embodiment, fluxapyroxad is present in the range of 0.01% to 10% w/w of the total composition. According to an embodiment, fluxapyroxad is present in the range of 0.01% to 5% w/w of the total composition.

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According to an embodiment, prothioconazole is present in the range of 1% to 20% w/w of the total composition. According to an embodiment, prothioconazole is present in the range of 1% to 15% w/w of the total composition. According to an embodiment, prothioconazole is present in the range of 1% to 10% w/w of the total composition.

15

According to an embodiment, the pesticidal composition is in the form of a solid, a liquid or a gel or a paste.

According to an embodiment, the liquid pesticidal composition is in the form of suspension concentrate (SC) or aqueous suspension or a liquid suspension, oil dispersion (OD), flowable concentrate (FC), seed dressing, suspo-emulsion (SE), suspension concentrate for seed treatment (FS), Ultra-Low-Volume (ULV).

20

According to an embodiment, the liquid pesticidal composition is preferably in the form of a suspension concentrate or aqueous suspension or a liquid suspension.

25

According to an embodiment, the solid pesticidal composition is in the form of powders, granules or dust.

According to an embodiment, the pesticidal composition is in the form of powders  
5 including wettable powders (WP), Water Dispersible powders for slurry seed treatment (WS), Dustable powder (DP), Powders for dry seed treatment (DS), water disintegrable tablet.

According to an embodiment, the pesticidal composition is in the form of granules  
10 including broadcast granules, pellets, extruded granules, water dispersible granules (WG), water disintegrable granules.

According to an embodiment, the pesticidal composition is preferably in the form of water dispersible granules.

15

According to an embodiment, the pesticidal composition in the form of water dispersible granules is in the size range of 0.05 mm to 3 mm. According to an embodiment, the pesticidal composition in the form of water dispersible granules is in the size range of 0.05 mm to 2.5 mm. According to an embodiment, the  
20 pesticidal composition in the form of water dispersible granules is in the size range of 0.05 mm to 2.0 mm. According to an embodiment, the pesticidal composition in the form of water dispersible granules is in the size range of 0.05 mm to 1.5 mm.

25 According to an embodiment, the pesticidal composition in the form of water dispersible granules or suspension concentrates can comprise particles in the size range of 0.1 micron to 50 microns. According to an embodiment, the pesticidal composition in the form of water dispersible granules can comprise particles in the size range of 0.1 micron to 40 microns. According to an embodiment, the  
30 pesticidal composition in the form of water dispersible granules can comprise particles in the size range of 0.1 micron to 30 microns. According to an

embodiment, the pesticidal composition in the form of water dispersible granules can comprise particles in the size range of 0.1 micron to 25 microns. According to an embodiment, the pesticidal composition in the form of water dispersible granules can comprise particles in the size range of 0.1 micron to 20 microns.

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According to an embodiment, the pesticidal composition comprises at least one agrochemically acceptable excipient.

According to a further embodiment, the agrochemically acceptable excipient is present in the range of from 0.1% w/w to 70% w/w of the total composition. According to a further embodiment, the agrochemically acceptable excipient is present in the range of from 0.1% w/w to 60% w/w of the total composition. According to a further embodiment, the agrochemically acceptable excipient is present in the range of from 0.1% w/w to 50% w/w of the total composition. According to a further embodiment, the agrochemically acceptable excipient is present in the range of from 0.1% w/w to 40% w/w of the total composition. According to a further embodiment, the agrochemically acceptable excipient is present in the range of from 0.1% w/w to 35% w/w of the total composition.

According to further embodiment, the agrochemically acceptable excipient comprises at least one of surfactants, wetting agents, dispersing agents, emulsifiers, binders or binding agents, disintegrating agents, fillers or carriers or diluents, coating agents, buffers or pH adjusters or neutralizing agents, antifoaming agents or defoamers, penetrants, ultraviolet absorbents, UV ray scattering agents, stabilizers, pigments, colorants, structuring agents, chelating or complexing or sequestering agents, thickeners, suspending agents or suspension aid agents or anticaking agents or anti-settling agents, viscosity modifiers or rheology modifiers, tackifiers, humectants, sticking agents, anti-freezing agent or freeze point depressants, solvents, preservatives or bactericides or anti-fungal agents or biocides or anti-microbial agents or antioxidants and mixtures thereof. However, those skilled in the art will appreciate that it is possible to utilize

additional agrochemically acceptable excipients without departing from the scope of the present invention.

According to an embodiment, the pesticidal composition in the form of water dispersible or spheronised granules further comprises at least one agrochemical excipient which includes disintegrating agent, surfactant, binders or fillers or carriers or diluent, antifoaming agent, ultraviolet absorbents, UV ray scattering agents, anticaking agent or anti-settling or suspension aid or suspending agent, penetrating agent, sticking agent, tackifier, pigments, colorants, stabilizers, dispersing agents. However, those skilled in the art will appreciate that it is possible to utilize additional agrochemically acceptable excipients without departing from the scope of the present invention.

According to an embodiment, the liquid pesticidal composition further comprises at least one agrochemical excipient which includes at least one structuring agent, surfactant, humectants, water miscible solvents, suspending agents or suspension aid or anticaking agent or anti-settling, penetrating agent, sticking agents, ultraviolet absorbents, UV ray scattering agents, buffer or pH adjuster or neutralizing agent, stabilizer, antifreezing agent or freeze point depressants, antifoaming agents,. However, those skilled in the art will appreciate that it is possible to utilize additional agrochemically acceptable excipients without departing from the scope of the present invention.

However, those skilled in the art will appreciate that it is possible to utilize additional agrochemically acceptable excipients without departing from the scope of the present invention. The agrochemically acceptable excipients are commercially manufactured and available through various companies.

According to an embodiment, the surfactants include one or more of emulsifiers, wetting agents and dispersing agents. According to an embodiment, the

surfactants which are used in the pesticidal composition include one or more of anionic, cationic, non-ionic, amphoteric and polymeric surfactants.

The anionic surfactants include one or more of, but not limited to a salt of fatty acid, a benzoate, a polycarboxylate, a salt of alkylsulfuric acid ester, alkyl ether sulfates, an alkyl sulfate, an alkylarylsulfate, an alkyl diglycol ether sulfate, a salt of alcohol sulfuric acid ester, an alkyl sulfonate, an alkylaryl sulfonate, an aryl sulfonate, a lignin sulfonate, an alkyl diphenyl ether disulfonate, a polystyrene sulfonate, a salt of alkylphosphoric acid ester, an alkylaryl phosphate, a styrylaryl phosphate, sulfonate docusates, a salt of polyoxyethylene alkyl ether sulfuric acid ester, a polyoxyethylenealkylaryl ether sulfate, alkyl sarcosinates, alpha olefin sulfonate sodium salt, alkyl benzene sulfonate or its salts, sodium lauroylsarcosinate, sulfosuccinates, polyacrylates, polyacrylates – free acid and sodium salt, salt of polyoxyethylenealkylaryl ether sulfuric acid ester, a polyoxyethylene alkyl ether phosphate, a salt of polyoxyethylenealkylaryl phosphoric acid ester, sulfosuccinates -mono and other diesters, phosphate esters, alkyl naphthalene sulfonate-isopropyl and butyl derivatives, alkyl ether sulfates – sodium and ammonium salts; alkyl aryl ether phosphates, ethylene oxides and its derivatives, a salt of polyoxyethylene aryl ether phosphoric acid ester, mono-alkyl sulphosuccinates, aromatic hydrocarbon sulphonates, 2-acrylamido-2-methylpropane sulfonic acid, ammonium laurylsulphate, ammonium perfluorononanoate, Docusate, Disodium cocoamphodiacetate, Magnesium laurethsulfate, Perfluorobutanesulfonic acid, Perfluorononanoic acid, carboxylates, Perfluorooctanesulfonic acid, Perfluorooctanoic acid, Phospholipid, Potassium lauryl sulfate, Soap, Soap substitute, Sodium alkyl sulfate, Sodium dodecyl sulfate, Sodium dodecylbenzenesulfonate, Sodium laurate, Sodium laurethsulfate, Sodium lauroylsarcosinate, Sodium myrethsulfate, Sodium nonanoyloxybenzenesulfonate, alkyl carboxylates, Sodium stearate, alpha olefin sulphonates, naphthalene sulfonate salts, alkyl naphthalene sulfonate fatty acid salts, naphthalene sulfonate condensates–sodium salt, fluoro carboxylate, fatty alcohol sulphates, alkyl naphthalene sulfonate condensates–sodium salt, a

naphthalene sulfonic acid condensed with formaldehyde or a salt of alkylnaphthalene sulfonic acid condensed with formaldehyde; or salts, derivatives thereof.

- 5 The non-ionic surfactants include one or more of but not limited to polyol esters, polyol fatty acid esters, polyethoxylated esters, polyethoxylated alcohols, ethoxylated and propoxylated fatty alcohols, ethoxylated and propoxylated alcohols, Ethylene oxide (EO)/ Propylene oxide (PO) copolymers; EO and PO block copolymers, di, tri-block copolymers; block copolymers of polyethylene glycol and polypropylene glycol, poloxamers, polysorbates, alkyl polysaccharides
- 10 such as alkyl polyglycosides and blends thereof, amine ethoxylates, sorbitan fatty acid ester, glycol and glycerol esters, glucosidyl alkyl ethers, sodium tallowate, polyoxyethylene glycol, sorbitan alkyl esters, sorbitan derivatives, fatty acid esters of sorbitan (Spans) and their ethoxylated derivatives (Tweens), and
- 15 sucrose esters of fatty acids, Cetostearyl alcohol, Cetyl alcohol, Cocamide diethanolamine (DEA), Cocamide monoethanolamine (MEA), Decyl glucoside, Decylpolyglucose, Glycerol monostearate, Lauryl glucoside, Maltosides, Monolaurin, Narrow-range ethoxylate, Nonidet P-40, Nonoxynol-9, Nonoxynols, Octaethylene glycol monododecyl ether, N-Octyl beta-D-thioglucopyranoside,
- 20 Octyl glucoside, Oleyl alcohol, PEG-10 sunflower glycerides, Pentaethylene glycol monododecyl ether, Polidocanol, Poloxamer, Poloxamer 407, Polyethoxylated tallow amine, Polyglycerol polyricinoleate, Polysorbate, Polysorbate 20, Polysorbate 80, Sorbitan, Sorbitanmonolaurate, Sorbitanmonostearate, Sorbitantristearate, Stearyl alcohol, Surfactin, glyceryl
- 25 laureate, lauryl glucoside, nonylphenolpolyethoxyethanols, nonyl phenol polyglycol ether, castor oil ethoxylate, polyglycol ethers, polyadducts of ethylene oxide and propylene oxide, block copolymer of polyalkylene glycol ether and hydroxystearic acid, tributylphenoxypolyethoxy ethanol, octylphenoxypolyethoxy ethanol, etho-propoxylatedtristylphenols, ethoxylated alcohols, polyoxy ethylene
- 30 sorbitan, fatty acid polyglyceride, a fatty acid alcohol polyglycol ether, acetylene glycol, acetylene alcohol, an oxyalkylene block polymer, polyoxyethylene alkyl

- ether, polyoxyethylenealkylaryl ether, a polyoxyethylenestyrylaryl ether, a polyoxyethylene glycol alkyl ether, polyethylene glycol, a polyoxyethylene fatty acid ester, a polyoxyethylenesorbitan fatty acid ester, a polyoxyethyleneglycerin fatty acid ester, Alcohol ethoxylates- C6 to C16/18 alcohols, linear and branched,
- 5 Alcohol alkoxyates- various hydrophobes and EO/PO contents and ratios, Fatty acid esters-mono and diesters; lauric, stearic and oleic; Glycerol esters- with and without EO; lauric, stearic, cocoa and tall oil derived, Ethoxylated glycerine, Sorbitan esters- with and without EO; lauric, stearic and oleic based; mono and trimesters, Castor oil ethoxylates-5 to 200 moles EO; non-hydrogenated and
- 10 hydrogenated, Block polymers, Amine oxides- ethoxylated and non-ethoxylated; alkyl dimethyl, Fatty amine ethoxylates- coco, tallow, stearyl, oleyl amines, a polyoxyethylene hydrogenated castor oil or a polyoxypropylene fatty acid ester; salts or derivatives thereof.
- 15 Amphoteric or Zwitterionic surfactants include one or more of, but not limited to one or more of betaine, coco and lauryl amidopropyl betaines, Coco Alkyl Dimethyl Amine Oxides, alkyl dimethyl betaines; C8 to C18, Alkyl dipropionates -sodium lauriminodipropionate, Cocoamidopropyl hydroxyl sulfobetaine, imidazolines, phospholipids phosphatidylserine, phosphatidylethanolamine,
- 20 phosphatidylcholine, and sphingomyelins, Lauryl Dimethylamine Oxide, alkyl amphotoacetates and propionates, alkyl Ampho(di)acetates, and di-propionates, lecithin and ethanolamine fatty amides; or salts, derivatives thereof.
- Surfactants that are commercially available under the trademark but are not
- 25 limited to one or more of Atlas G5000, TERMUL 5429, TERMUL 2510, ECOTERIC®, EULSOGEN® 118, Genapol®X, Genapol®OX -080, Genapol® C 100, Emulsogen® EL 200, Arlacel P135, Hypermer 8261, Hypermer B239, Hypermer B261, Hypermer B246sf, Solutol HS 15, Promulgen™ D, Soprophor 7961P, Soprophor TSP/461, Soprophor TSP/724, Croduret 40, Etocas 200,
- 30 Etocas 29, Rokacet R26, Cetomacrogol 1000, CHEMONIC OE-20, Triton N-101, Triton X-100, Tween 20, 40, 60, 65, 80, Span20, 40, 60, 80, 83, 85, 120,



Brij®, Atlox 4912, TERMUL 3512, TERMUL 3015, TERMUL 5429, TERMUL 2510, ECOTERIC® T85, ECOTERIC® T20, TERIC 12A4, IGEPAL CA-630 and Isoceteth-20.

- 5 However, those skilled in the art will appreciate that it is possible to utilize other conventionally known surfactants (ionic or non ionic surfactants) without departing from the scope of the present invention. The surfactants are commercially manufactured and available through various companies.
- 10 According to an embodiment, the solvent is selected from water miscible solvents including but not limited to 1, 4-Dioxane, Ethylene glycol, N-Methyl-2-pyrrolidone, 1,3-Propanediol, 1,5-Pentanediol, Propylene glycol, Triethylene glycol, 1,2-Butanediol, 1,3-Butanediol, 1,4-Butanediol, Dimethylformamide, Dimethoxyethane, Dimethyloctanamide, glycerol, Dimethyldecanamide.
- 15 However, those skilled in the art will appreciate that it is possible to utilize other water miscible solvents without departing from the scope of the present invention.

- According to an embodiment, the disintegrating agents which are used in the agricultural composition include, but not limited to one or more of inorganic water
- 20 soluble salts e.g. sodium chloride, nitrate salts; water soluble organic compounds such as agar, hydroxypropyl starch, carboxymethyl starch ether, tragacanth, gelatin, casein, microcrystalline cellulose, cross-linked sodium carboxymethyl cellulose, carboxymethyl cellulose, carboxymethyl cellulose calcium, sodium tripolyphosphate, sodium hexametaphosphate, metal stearates, a cellulose powder,
- 25 dextrin, methacrylate copolymer, Polyplasdone® XL-10 (crosslinked polyvinylpyrrolidone), poly(vinylpyrrolidone),, sulfonated styrene-isobutylene-maleic anhydride copolymer, salts of polyacrylates of methacrylates, starch-polyacrylonitrile graft copolymer, sodium or potassium bicarbonates/ carbonates or their mixtures or salts with acids such as citric and fumaric acid or salts,
- 30 derivatives thereof. However, those skilled in the art will appreciate that it is possible to utilize different disintegrating agents without departing from the scope

of the present invention. The disintegrating agents are commercially manufactured and available through various companies.

According to an embodiment, the binding agents or binders which are used in the  
5 agricultural composition include, but not limited to one or more of proteins, ,  
gums, maltodextrin, carbohydrates such as monosaccharides, disaccharides,  
oligosaccharides and polysaccharides, complex organic substance, synthetic  
organic polymers or derivatives and combinations thereof. However, those skilled  
in the art will appreciate that it is possible to utilize different binding agents  
10 without departing from the scope of the present invention. The binding agents are  
commercially manufactured and available through various companies.

According to an embodiment, the carriers which are used in the agricultural  
composition include, but are not limited to one or more of solid carriers or fillers  
15 or diluents. According to another embodiment, the carriers include mineral  
carriers, plant carriers, synthetic carriers, water-soluble carriers. However, those  
skilled in the art will appreciate that it is possible to utilize different carriers  
without departing from the scope of the present invention. The carriers are  
commercially manufactured and available through various companies.

20

The solid carriers include natural minerals like clay such as china clay, acid clay,  
kaolin such as kaolinite, dickite, nacrite, and halloysite, serpentines such as  
chrysotile, lizardite, antigorite, and amesite, synthetic and diatomaceous silicas,  
montmorillonite minerals such as sodium montmorillonite, smectites, such as  
25 saponite, hectorite, sauconite, and hyderite, micas, such as pyrophyllite, talc,  
agalmatolite, muscovite, phengite, sericite, and illite, silicas such as  
cristobalite and quartz, such as attapulgite and sepiolite; vermiculite, laponite,  
pumice, bauxite, hydrated aluminas, perlite, sodium bicarbonate, volclay,  
vermiculites, limestone, natural and synthetic silicates, charcoal, silicas, wet  
30 process silicas, dry process silicas, calcined products of wet process silicas,  
surface-modified silicas, mica, zeolite, diatomaceous earth, derivatives thereof;.

chalks (Omya ®), fuller's earth, loess, mirabilite, white carbon, slaked lime, synthetic silicic acid, starch, modified starch (Pineflow, available from Matsutani Chemical industry Co., Ltd.), cellulose, plant carriers such as cellulose, chaff, wheat flour, wood flour, starch, rice bran, wheat bran, and soyabean flour, tobacco powder, a vegetable powder polyethylene, polypropylene, poly(vinylidene chloride), , casein sodium, sucrose, salt cake, potassium pyrophosphate, sodium tripolyphosphate, maleic acid, fumaric acid, and malic acid or derivatives or mixtures thereof. Commercially available Silicates are Aerosil brands, Sipemat brands as Sipernat ® 50S and CALFLO E, and kaolin 1777. However, those skilled in the art will appreciate that it is possible to utilize different solid carriers without departing from the scope of the present invention. The solid carriers are commercially manufactured and available through various companies.

According to an embodiment, the pigments and colorants are selected from but not limited to synthetic chemicals obtained from various manufacturers. The pigments and colorants can be water soluble or water insoluble, in the form of lakes. Dyes can be solvent dyes, acid dyes or basic dyes. Examples of such products include, but not limited to Agrocere Red 112, Agrocere Blue 153, Agrocere Green 007, Agrocere Yellow 001, Agrocere violet 023, Unisperse black 0058, Unisperse Red 3855, Pigmosol Agro Red 3785.

According to an embodiment, the antifoaming agents or defoamers which are used in the agricultural composition include, but not limited to one or more of silica, siloxane, silicon dioxide, polydimethyl siloxane, alkyl polyacrylates, ethylene oxide/propylene oxide copolymers, polyethylene glycol, Silicone oils and magnesium stearate or derivatives thereof. Preferred antifoaming agents include silicone emulsions (such as, e.g., Silikon® SRE, Wacker or Rhodorsil® from Rhodia), long-chain alcohols, fatty acids, fluoro-organic compounds. However, those skilled in the art will appreciate that it is possible to utilize other conventionally known antifoaming agents without departing from the scope of the

present invention. The antifoaming agents are commercially manufactured and available through various companies.

According to an embodiment, the pH-adjusters or buffers or neutralizing agents  
5 which are used in the agricultural composition include both acids and bases of the organic or inorganic type and mixtures thereof. According to further embodiment, pH-adjusters or buffers or neutralizing agents include, but not limited to one or more of organic acids, inorganic acids and alkali metal compounds or salts, derivatives thereof. According to an embodiment, the organic acids include, but  
10 not limited to one or more of citric, malic, adipic, fumaric, maleic, succinic, and tartaric acid, or salts, derivatives thereof; and the mono-, di-, or tribasic salts of these acids or derivatives thereof. Alkali metal compounds include, but not limited to one or more of hydroxides of alkali metals such as sodium hydroxide and potassium hydroxide, carbonates of alkali metals such as sodium carbonate,  
15 hydrogen carbonates of alkali metals such as sodium hydrogen carbonate and alkali metal phosphates such as sodium phosphate and mixtures thereof. According to an embodiment, the salts of inorganic acids include, but not limited to one or more of alkali metal salts such as lithium chloride, sodium chloride, potassium chloride, , sodium nitrate, potassium nitrate, sodium sulfate, potassium  
20 sulfate, sodium monohydrogen phosphate, potassium monohydrogen phosphate, sodium dihydrogen phosphate, potassium dihydrogen phosphate and the like. Mixtures can also be used to create a pH-adjusters or buffers or neutralizing agents. However, those skilled in the art will appreciate that it is possible to utilize other conventionally known pH-adjusters or buffers or neutralizing agents without  
25 departing from the scope of the present invention. The pH-adjusters or buffers or neutralizing agents are commercially manufactured and available through various companies.

According to an embodiment, the spreading agents which are used in the  
30 agricultural composition include, but not limited to one or more of cellulose powder, dextrin, modified starch, crosslinked poly(vinylpyrrolidone), a copolymer

of maleic acid with a styrene compound, a (meth)acrylic acid copolymer, a half ester of a polymer consisting of polyhydric alcohol with dicarboxylic anhydride, a water-soluble salt of polystyrene sulfonic acid, fatty acids, latex, aliphatic alcohols, vegetable oils such as cottonseed, or inorganic oils, petroleum distillates, modified trisiloxanes, polyglycol, polyethers, clathrates. However, those skilled in the art will appreciate that it is possible to utilize other conventionally known spreading agents without departing from the scope of the present invention. The spreading agents are commercially manufactured and available through various companies.

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According to an embodiment, the sticking agents which are used in the agricultural composition include, but not limited to one or more of paraffin, a polyamide resin, polyacrylate, polyoxyethylene, wax, polyvinyl alkyl ether, an alkylphenol-formalin condensate, fatty acids, latex, aliphatic alcohols, vegetable oils such as cottonseed, or inorganic oils, petroleum distillates, modified trisiloxanes, polyglycol, polyethers, clathrates, a synthetic resin emulsion. However, those skilled in the art will appreciate that it is possible to utilize other conventionally known sticking agents without departing from the scope of the present invention. The sticking agents are commercially manufactured and available through various companies.

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According to an embodiment, the stabilizers which are used in the agricultural composition include, but not limited to one or more of peroxide compounds such as hydrogen peroxide and organic peroxides, alkyl nitrites such as ethyl nitrite and alkyl glyoxylates such as ethyl glyoxylate, zeolite, antioxidants such as phenol compounds, phosphoric acid compounds, EDTA, sodium sulphites, citric acid, citrates and the like. However, those skilled in the art will appreciate that it is possible to utilize other conventionally known stabilizers without departing from the scope of the present invention. The stabilizers are commercially manufactured and available through various companies.

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According to an embodiment, the preservatives which are used in the agricultural composition include but not limited to, one or more of bactericides, anti-fungal agents, biocides, anti-microbial agents, and antioxidant. Non limiting examples of preservatives include one or more of paraben, its esters and salts, propionic acid  
 5 and its salts, 2,4-hexadienoic acid (sorbic acid) and its salt, formaldehyde and paraformaldehyde, 2-hydroxybiphenyl ether and its salts, inorganic sulfites and bisulfites, sodium iodate, chlorobutanol, dehydrazacetic acid, formic acid, 1,6-bis(4-amidino-2-bromophenoxy)-n-hexane and its salts, 5-amino-1,3-bis(2-ethylhexyl)-5-methylhexahydropyrimidine, 5-bromo-5-nitro-1,3-dioxane, 2-  
 10 bromo-2-nitropropane-1,3-diol, 2,4-dichlorobenzyl alcohol, N-(4-chlorophenyl)-N'-(3,4-dichlorophenyl) urea, 4-chloro-m-cresol, 2,4,4'-trichloro-2'-hydroxy diphenyl ether, 4-chloro-3,5-dimethyl phenol, 1,1'-methylene-bis(3-(1-hydroxy methyl-2,4-di-oximidazolidin-5-yl)urea), poly(hexamethylenediguanide) hydrochloride, 2-phenoxyethanol, hexamethylenetetramine, 1-(3-chloroallyl)-  
 15 3,5,7-triaza-1-azonia-adamantane chloride, 1(4-chlorophenoxy)-1-(1H-imidazol-1-yl)-3,3-dimethyl-2-butanone, 1,3-bis(hydroxymethyl)-5,5-dimethyl-2,4-imidazolidinedione, benzyl alcohol, octopirox, 1,2-dibromo-2,4-dicyanobutane, 2,2'-methylenebis(6-bromo-4-chlorophenol), bromochlorophene, dichlorophene, 2-benzyl-4-chlorophenol, 2-chloroacetamide, chlorhexidine, chlorhexidine  
 20 acetate, chlorhexidine gluconate, chlorhexidine hydrochloride, 1-phenoxypropan-2-ol, N-alkyl(C12-C22)trimethylammonium bromide and chloride, 4,4-dimethyl-1,3-oxazolidine, N-hydroxymethyl-N-(1,3-di(hydroxymethyl)-2,5-dioxoimidazolidin-4-yl)-N'-hydroxymethylurea, 1,6-bis(4-amidinophenoxy)-n-hexane and its salts, glutaraldehyde, 5-ethyl-1-aza-3,7-dioxabicyclo(3.3.0)octane,  
 25 3-(4-chlorophenoxy)propane-1,2-diol, Hyamine, alkyl(C8-C18)dimethylbenzyl ammonium chloride, alkyl(C8-C18)dimethylbenzylammonium bromide, alkyl(C8-C18)dimethylbenzylammoniumsaccharinate, benzyl hemiformal, 3-iodo-2-propynyl butylcarbamate, sodium hydroxymethylaminoacetate, cetyltrimethylammonium bromide, cetylpyridinium chloride, and derivatives of  
 30 2H isothiazol-3-one (so-called isothiazolone derivatives) such as alkylisothiazolones (for example 2-methyl-2H-isothiazol-3-one, MIT; chloro-2-

methyl-2H-isothiazol-3-one, CIT), benzoisothiazolones (for example 1,2-benzoisothiazol-3(2H)-one, BIT, commercially available as Proxel® types from ICI) or 2-methyl-4,5-trimethylene-2H-isothiazol-3-one (MTIT), C1-C4-alkyl para-hydroxybenzoate, an dichlorophene, Proxel® from ICI or Acticide® RS  
 5 from Thor Chemie and Kathon® MK from Rohm & Haas, Bacto-100, thimerosal, Sodium Propinoate, Sodium Benzoate, Propyl Paraben, Propyl Paraben Sodium, Potassium Sorbate, Potassium Benzoate, Phenyl Mercuric Nitrate, Phenyl Ethyl Alcohol, Sodium, Ethylparaben, Methylparaben, Butylparaben, Bezyla Alcohol, Benzothonium Chloride, Cetylpyridinium Chloride, Benzalkonium Chloride, 1,2-  
 10 benzothiazol-3-one, Preventol® (Lanxess®), Butylhydroxytoluene, potassium sorbate, iodine-containing organic compounds such as 3-bromo-2,3-diiodo-2-propenyl ethyl carbonate, 3-iodo-2-propynyl butyl carbamate, 2,3,3-triiodo allyl alcohol, and parachlorophenyl-3-iodopropargylformal; benzimidazole compounds and benzthiazole compounds such as 2-(4-thiazolyl)benzimidazole and 2-  
 15 thiocyanomethylthiobenzo-thiazole; triazole compounds such as 1-(2-(2',4'-dichlorophenyl)-1,3-dioxolane-2-ylmethyl)-1H-1,2,4-triazole, 1-(2-(2',4'-dichlorophenyl)-4-propyl-1,3-dioxolane-2-ylmethyl)-1H-1,2,4-triazole, and  $\alpha$ -(2-(4-chlorophenyl) ethyl)- $\alpha$ -(1,1-dimethyl ethyl)-1H-1,2,4-triazole-1-ethanol; and naturally occurring compounds such as 4-isopropyl tropolone (hinokitiol) and  
 20 borax. Antioxidants includes but not limited to one or more of imidazole and imidazole derivatives (e.g. urocanic acid), 4,4'-thiobis-6-t-butyl-3-methylphenol, 2,6-di-t-butyl-p-cresol (BHT), penta erythrityl tetrakis[3-(3,5-di-t-butyl-4-hydroxyphenyl)] propionate; amine antioxidants such as N,N'-di-2-naphthyl-p-phenylenediamine; hydroquinoline antioxidants such as 2,5-di(t-  
 25 amyl)hydroquinoline; phosphorus-containing antioxidants such as triphenyl phosphate, carotenoids, carotenes (e.g.  $\alpha$ -carotene,  $\beta$ -carotene, lycopene) and derivatives thereof, lipoic acid and derivatives thereof (e.g. dihydrolipoic acid), aurothioglucose, propylthiouracil and further thio compounds (e.g. thioglycerol, thiosorbitol, thioglycolic acid, thioredoxin, N-acetyl, methyl, ethyl, propyl, amyl,  
 30 butyl, lauryl, palmitoyl, oleyl,  $\gamma$ -linoleyl, cholesteryl and glyceryl esters thereof), and salts thereof, dilaurylthiodipropionate, distearylthiodipropionate,

thiodipropionic acid and derivatives thereof (esters, ethers, lipids, nucleotides, nucleosides and salts), and sulfoximine compounds (e.g. buthioninesulfoximines, homocysteine sulfoximine, buthionine sulfones, penta-, hexa-, heptathioninesulfoximine) in very low tolerated doses (e.g. pmol/kg to pmol/kg),

5  $\alpha$ -hydroxy acids (e.g. citric acid, lactic acid, malic acid), humic acids, gallic esters (e.g. propyl, octyl and dodecyl gallate), unsaturated fatty acids and derivatives, hydroquinone and derivatives thereof (e.g. arbutin), ubiquinone and ubiquinol, and derivatives thereof, ascorbyl palmitate, stearate, di-palmitate, acetate, Mg ascorbyl phosphates, disodium ascorbyl phosphate and sulfate, potassium

10 ascorbyltocopheryl phosphate, isoascorbic acid and derivatives thereof, the coniferyl benzoate of benzoin resin, rutin, rutinic acid and derivatives thereof, disodium rutinyldisulfate, dibutylhydroxytoluene, 4,4-thiobis-6-tert-butyl-3-methylphenol, butylhydroxy anisole, p-octylphenol, mono-(di- or tri-) methyl benzylphenol, 2,6-tert-butyl-4-methylphenol, pentaerythritol-tetrakis 3-(3,5-di-

15 tert-butyl-4-hydroxyphenyl)propionate, butylhydroxyanisole, nordihydroguaiacic acid, nordihydroguaiaretic acid, trihydroxybutyrophenone, uric acid and derivatives thereof, mannose and derivatives thereof, selenium and selenium derivatives (e.g. selenomethionine), stilbenes and stilbene derivatives (e.g. stilbene oxide, trans-stilbene oxide). However, those skilled in the art will

20 appreciate that it is possible to utilize other conventionally known preservatives without departing from the scope of the present invention. The preservatives are commercially manufactured and available through various companies.

According to an embodiment, the structuring agents which are used in the

25 agricultural composition include, but not limited to one or more of thickeners, viscosity modifiers, tackifiers, suspension aids, rheological modifiers or anti-settling agents. A structuring agent prevents sedimentation of the active ingredient particles after prolonged storage.

30 According to an embodiment, the structuring agents which are used in the aqueous suspension composition include, but not limited to one or more polymers such as



polyacrylics, polyacrylamides, polysaccharides, hydrophobically modified cellulose derivatives, co-polymers of cellulose derivatives, carboxyvinyl or polyvinyl pyrrolidones, polyethylenes, polyethylene oxide, polyvinyl alcohol and derivatives; clays such as bentonite clays, kaolin, smectite, attapulgites, attaclays  
5 with high surface area silica and natural gums such as guar gum, xanthan gum, gum arabic, gum tragacanth, rhamsan gum, locust bean gum, carageenan, welan gum, veegum, gelatin, dextrin, collagen; polyacrylic acids and their sodium salts; the polyglycol ethers of fatty alcohols and polyethylene oxide or polypropylene oxide condensation products and mixtures thereof and include ethoxylated alkyl  
10 phenols (also designated in the art as alkylaryl polyether alcohols); ethoxylated aliphatic alcohols (or alkyl polyether alcohols); ethoxylated fatty acids (or polyoxyethylene fatty acid esters); ethoxylated anhydrosorbitol esters (or polyethylene sorbitan fatty acid esters), long chain amine and cyclic amine oxides which are nonionic in basic solutions; long chain tertiary phosphine oxides; and  
15 long chain dialkyl sulfoxides, fumed silica, mixture of fumed silica and fumed aluminium oxide, swellable polymers, polyamides or its derivatives; polyols such as glycerine, poly(vinyl acetate), sodium polyacrylate, poly(ethylene glycol), phospholipid (for example, cephalin, and the like); stachyose, fructo-oligosaccharides, amylose, pectins, alginates, hydrocolloids and mixtures thereof.  
20 Also, celluloses such as hemicellulose, carboxymethylcellulose, ethylcellulose, hydroxyethylcellulose, hydroxy-methyl ethyl cellulose, hydroxyl ethyl propyl cellulose, methylhydroxyethylcellulose, methylcellulose; starches such, starch acetates, starch hydroxyethyl ethers, ionic starches, long-chain alkyl starches, dextrans, maltodextrin, corn starch, amine starches, phosphates starches, and  
25 dialdehyde starches; plant starches such as corn starch and potato starch; other carbohydrates such as pectin, dextrin, amylopectin, xylan, glycogen, agar, gluten, alginic acid, phycocolloids, or derivatives thereof. However, those skilled in the art will appreciate that it is possible to utilize other conventionally known structuring agents without departing from the scope of the present invention.

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Preferred structuring agents include one or more of xanthan gum, guar gum, aluminum silicate, methyl cellulose and its derivatives, polysaccharide, alkaline earth metal silicate, and polyvinyl alcohol. The structuring agents are commercially manufactured and available through various companies.

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According to an embodiment, the anticaking agents or anti-settling agent or suspending agents used include one or more of, but not limited to polysaccharides such as starch, mannose, galactose, cellulose derivatives such as sodium carboxymethyl cellulose, hydroxyethyl cellulose, hydroxypropyl cellulose, 10 hydroxypropylmethyl cellulose and methyl cellulose; gums such as agar, carrageenan, alginates, arabic, tragacanth, karaya, ghatti, guar, dextran, starches including pregelatinized and modified starches, poly(vinylpyrrolidone), fumed silica (white carbon), ester gum, a petroleum resin, Foammaster® Soap L sodium stearate, Brij® 700 polyoxyethylene (100) stearylether, Aerosol® OT-B sodium 15 dioctyl sulfosuccinate, Silwet® L-77 silicone-polyether copolymer, sodium acetate, sodium metasilicate, sodium alkylsulfosuccinates, salts or derivatives thereof. However, those skilled in the art will appreciate that it is possible to utilize different anti caking agents without departing from the scope of the present invention. anticaking agents or anti-settling agent or suspending agents or 20 suspension aids are commercially manufactured and available through various companies.

According to an embodiment, the antifreezing agents or freezing point depressants used in the aqueous suspension composition include, but are not limited to one or 25 more of polyhydric alcohols such as ethylene glycol, diethylene glycol, dipropylene glycol, propylene glycol, butyrolactone, N,N-dimethyl-formamide, glycerol, monohydric or polyhydric alcohols, glycol ethers, glycol ethers, glycol monoethers such as the methyl, ethyl, propyl and butyl ether of ethylene glycol, diethylene glycol, propylene glycol and dipropylene glycol, glycol diethers such 30 as methyl and ethyl diethers of ethylene glycol, diethylene glycol and dipropylene glycol or urea, glycerol, isopropanol, propylene glycol monomethyl

ether, di- or tripropylene glycol monomethyl ether or cyclohexanol, carbohydrates such as glucose, mannose, fructose, galactose, sucrose, lactose, maltose, xylose, arabinose, sorbitol, mannitol, trehalose, raffinose or derivatives thereof. However, those skilled in the art will appreciate that it is possible to utilize different  
5 antifreezing agents without departing from the scope of the present invention. The antifreezing agents are commercially manufactured and available through various companies. According to an embodiment, the antifreezing agent is present an amount of from 0.1% to 20% w/w of the total composition.

10 According to an embodiment, the penetrant which is used in the composition include, but not limited to one or more of alcohol, glycol, glycol ether, ester, amine, alkanolamine, amine oxide, quaternary ammonium compound, triglyceride, fatty acid ester, fatty acid ether, N-methyl pyrrolidone, dimethyl formamide, dimethyl acetamide, or dimethyl sulfoxide, polyoxyethylene  
15 trimethylol propane monooleate, polyoxyethylene trimethylol propanedioleate, polyoxyethylene trimethylol propanetrioleate, polyoxyethylene sorbitan monooleate, polyoxyethylene sorbitol hexaoleate. However, those skilled in the art will appreciate that it is possible to utilize different penetrants without departing from the scope of the present invention.

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According to an embodiment, the ultraviolet absorbent is selected from, but not limited to one or more of 2-(2'-hydroxy-5'-methylphenyl) benzotriazole, 2-ethoxy-2'-ethyloxazalic acid bisanilide, succinic acid dimethyl-1-(2-hydroxyethyl)-4-hydroxy-2,2,6,6-tetramethylpiperidine polycondensate, benzotriazole compounds  
25 such as 2-(2'-hydroxy-5'-methylphenyl)benzotriazole and 2-(2'-hydroxy-4'-n-octoxyphenyl)benzotriazole; benzophenone compounds such as 2-hydroxy-4-methoxybenzophenone and 2-hydroxy-4-n-octoxybenzophenone; salicylic acid compounds such as phenyl salicylate and p-t-butylphenyl salicylate; 2-ethylhexyl 2-cyano-3,3-diphenyl acrylate, 2-ethoxy-2'-ethyl oxalic bisanilide, and dimethyl  
30 succinate-1-(2-hydroxyethyl)-4-hydroxy-2,2,6,6-tetramethyl piperidine polycondensate or derivatives or the like. However, those skilled in the art will

appreciate that it is possible to utilize different ultraviolet absorbents, without departing from the scope of the present invention. Such ultraviolet absorbents are commercially manufactured and available through various companies.

5 According to an embodiment, the UV ray scattering agents include, but not limited to titanium dioxide or the like may be used. However, those skilled in the art will appreciate that it is possible to utilize different UV ray scattering agents or mixtures thereof without departing from the scope of the present invention. Such UV ray scattering agents are commercially manufactured and available through  
10 various companies.

According to an embodiment, the humectant is selected from, but not limited to one or more of polyoxyethylene/polyoxypropylene copolymers, particularly block copolymers, such as the Synperonic PE series of copolymers available from  
15 Uniqema or salts, derivatives thereof. Other humectants are propylene glycol, monoethylene glycol, hexylene glycol, butylene glycol, ethylene glycol, diethylene glycol, poly (ethylene glycol), poly (propylene glycol), glycerol and the like; polyhydric alcohol or derivatives thereof. Also, other humectants include  
20 glyceryl triacetate, honey, calcium chloride, etc. The non-ionic surfactants mentioned above also act as humectants. However, those skilled in the art will appreciate that it is possible to utilize other conventionally known humectants without departing from the scope of the present invention. The humectants are commercially manufactured and available through various companies.

25 According to an embodiment, the pesticidal composition includes at least one further active ingredient selected from one or more of pesticidal active ingredients, fertilizers, micronutrients, macronutrients, biostimulants, organic acids, plant growth regulators, algae or mixtures thereof.

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According to a further embodiment, the pesticidal active is one or more of insecticides, fungicides, herbicides, miticides, acaricides, nematocides, pheromones, algicides, antifeedants, avicides, bactericides, bird repellents, biopesticides, insect repellents, ovicides, rodenticides, etc. However, those skilled  
5 in the art will appreciate that it is possible to utilize other active ingredients without departing from the scope of the present invention.

It has been surprisingly found that the pesticidal composition of the present invention has enhanced and improved physical properties of dispersibility,  
10 suspensibility, wettability, viscosity, pourability, provides ease of handling and also reduces the loss of material while handling the product at the time of packaging as well as during field application.

Wettability is the condition or the state of being wettable and is defined as the  
15 degree to which a solid is wetted by a liquid, measured by the force of adhesion between the solid and liquid phases. The wettability of the granular composition is measured using the Standard CIPAC Test MT-53 which describes a procedure for the determination of the time of complete wetting of wettable formulations. A weighed amount of the granular composition is dropped on water in a beaker from  
20 a specified height and the time for complete wetting was determined. According to another embodiment, the pesticidal composition in the form of water dispersible granules or spheronised granules has wettability of less than 2 minutes. According to another embodiment, the pesticidal composition has wettability of less than 1 minute. According to another embodiment, the pesticidal composition  
25 has wettability of less than 30 seconds. According to another embodiment, the pesticidal composition has wettability of less than 15 seconds.

The spheronised granular composition is formulated in a manner such that it is imparted with sufficient hardness which prevents the granules from crumbling  
30 during storage and transportation. The hardness exhibited by the granules is estimated by hardness testers such as the ones provided by Shimadzu, Brinell

Hardness (AKB-3000 Model), Mecmesin, Agilent, Vinsyst, Ametek and Rockwell. According to an embodiment, the hardness exhibited by the granules is less than 100 Newton. According to an embodiment, the hardness exhibited by the granules is less than 90 Newton. According to an embodiment, the hardness exhibited by the granules is less than 80 Newton. According to an embodiment, the hardness exhibited by the granules is less than 70 Newton. According to an embodiment, the hardness exhibited by the granules is less than 60 Newton. According to an embodiment, the hardness exhibited by the granules is less than 50 Newton.

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According to an embodiment, the pesticidal composition in the form of water dispersible granule or liquid suspension passes the wet sieve retention test. The test is used to determine the amount of non-dispersible material in formulations that are applied as dispersions in water. The wet sieve retention value of the agrochemical composition in the form of liquid suspension and granules is measured by using the Standard CIPAC Test MT-185 which describes a procedure for measuring the amount of material retained on the sieve. A sample of the formulation is dispersed in water and the suspension formed is transferred to a sieve and washed. The amount of the material retained on the sieve is determined by drying and weighing

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According to an embodiment, the pesticidal composition in the form of water dispersible granule or liquid suspension has a wet sieve retention value on a 75-micron sieve of less than 0.5%. According to an embodiment, the pesticidal composition has a wet sieve retention value on a 75-micron sieve of less than 0.2%. According to an embodiment, the pesticidal composition has a wet sieve retention value on a 75-micron sieve of less than 0.1%. The wet sieve retention value of less than 0.5% indicate that the pesticidal composition helps in easy application of the formulation preventing clogging of the nozzles or filter equipment.

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According to an embodiment, the pesticidal composition in the form of liquid suspension does not sediment or settle on storage and is easily pourable. This property is measured in terms of viscosity of the fluid which is a measure of its resistance to gradual deformation by shear stress or tensile stress.

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According to an embodiment, viscosity of the liquid composition is determined as per CIPAC MT-192. A sample is transferred to a standard measuring system. The measurement is carried out under different shear conditions and the apparent viscosities are determined. During the test, the temperature of the liquid is kept

10

constant.

According to an embodiment, the pesticidal composition has a viscosity at 25° C. of about 10 cps to about 3000 cps. According to an embodiment, the pesticidal composition has a viscosity at 25° C. of about 10 cps to about 2500 cps.

15

According to an embodiment, the pesticidal composition has a viscosity at 25° C. of about 10 cps to about 2000 cps. According to an embodiment, the pesticidal composition has a viscosity at 25° C. of about 10 cps to about 1500 cps.

According to an embodiment, the pesticidal composition has a viscosity at 25° C. of about 10 cps to about 1200 cps. According to an embodiment, the pesticidal

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composition has viscosity at 25° C. of about 10 cps to about 500 cps. According to an embodiment, the pesticidal composition has a viscosity at 25° C. of about less than 500 cps. According to an embodiment, the pesticidal composition has viscosity at 25° C. of about 10 cps to about 400 cps. According to an embodiment, the pesticidal composition has viscosity at 25° C. of about 10 cps to about 300

25

cps.

According to an embodiment, the liquid suspension composition of the present invention is easily pourable. The pourability is the measure of percent of residue.

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According to an embodiment, the pourability of the pesticidal composition is determined as per CIPAC MT-148.1 by allowing the liquid suspension to stand

for 24-hour and the amount remaining in the container after a standardized pouring procedure is determined. The container is rinsed and the amount then remaining is determined and the maximum residue in percent is calculated. According to a further embodiment, the pourability of the pesticidal composition  
5 is less than 5% residue. According to further embodiment, the pourability of the pesticidal composition is preferably less than 2.5% residue. According to further embodiment, the pourability of the pesticidal composition is more preferably less than 2.0% residue.

10 Dispersibility of the pesticidal composition in the form of water dispersible or spheronised granule is a measure of percent dispersion. Dispersibility is calculated by the minimum percent dispersion. Dispersibility is defined as the ability of the granules to disperse upon addition to a liquid such as water or a solvent. Dispersibility of the granular composition of the present application, was  
15 determined as per the standard CIPAC test, MT 174. A known amount of the granular composition was added to a defined volume of water and mixed by stirring to form a suspension. After standing for a short period, the top nine-tenths are drawn off and the remaining tenth dried and determined gravimetrically. The method is virtually a shortened test of suspensibility and is appropriate for  
20 establishing the ease with which the granular composition dispersed uniformly in water.

According to an embodiment, the pesticidal composition has a dispersibility of at least 30%. According to an embodiment, the pesticidal composition has a  
25 dispersibility of at least 40%. According to an embodiment, the pesticidal composition has a dispersibility of at least 50%. According to an embodiment, the pesticidal composition has a dispersibility of at least 60%. According to an embodiment, the pesticidal composition has a dispersibility of at least 70%. According to an embodiment, the pesticidal composition has a dispersibility of at  
30 least 80%. According to an embodiment, the pesticidal composition has a dispersibility of at least 90%. According to an embodiment, the pesticidal



composition has a dispersibility of at least 99%. According to an embodiment, the pesticidal composition has a dispersibility of 100%.

According to an embodiment, the pesticidal composition in the form of water dispersible granule exhibits almost instantaneous dispersion.

According to an embodiment, the pesticidal composition in the form of spheronised granule makes the actives available instantaneously and also over a longer period which may extend throughout the crop cycle, providing an immediate and sustained release of actives eventually strengthening and protecting the crop at each and every stage of the crop cycle.

According to an embodiment, the pesticidal composition in the form of water dispersible granules, liquid suspension exhibits good suspensibility. Suspensibility is defined as 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 ingredient in the original suspension. The water dispersible granules is tested for suspensibility as per the CIPAC Handbook, "MT 184 Test for Suspensibility" whereby a suspension of known concentration of the composition in CIPAC Standard Water was prepared and placed in a prescribed measuring cylinder at a constant temperature, and allowed to remain undisturbed for a specified time. The top 9/10ths were drawn off and the remaining 1/10th was then assayed chemically, gravimetrically, or by solvent extraction, and the suspensibility was calculated.

The suspensibility of the liquid suspension 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 ingredient in the original suspension. The suspensibility of liquid suspension concentrate is determined as per CIPAC MT-161 by preparing 250 ml of diluted suspension, allowing it to stand in a measuring cylinder under defined conditions, and removing the top nine-tenths. The

remaining tenth is then assayed chemically, gravimetrically or by solvent extraction, and the suspensibility is calculated.

According to an embodiment, the pesticidal composition has a suspensibility of at least 30%. According to an embodiment, the pesticidal composition has suspensibility of at least 40%. According to an embodiment, the pesticidal composition has a suspensibility of at least 50%. According to an embodiment, the pesticidal composition has a suspensibility of at least 60%. According to an embodiment, the pesticidal composition has a suspensibility of at least 70%. According to an embodiment, the pesticidal composition has a suspensibility of at least 80%. According to an embodiment, the pesticidal composition has a suspensibility of at least 90%. According to an embodiment, the pesticidal composition has a suspensibility of at least 99%. According to an embodiment, the pesticidal composition has a suspensibility of 100%.

According to an embodiment, the pesticidal composition in the form of water dispersible granule or spheronised granule, liquid suspension demonstrates superior stability in terms of suspensibility under accelerated storage condition (ATS). According to an embodiment, the pesticidal composition demonstrates suspensibility of more than 90% under ATS. According to an embodiment, the pesticidal composition demonstrates suspensibility of more than 80% under ATS. According to an embodiment, the pesticidal composition demonstrates suspensibility of more than 70% under ATS. According to an embodiment, the pesticidal composition demonstrates suspensibility of more than 60% under ATS. According to an embodiment, the pesticidal composition demonstrates suspensibility of more than 50% under ATS. According to an embodiment, the pesticidal composition demonstrates suspensibility of more than 40% under ATS. According to an embodiment, the pesticidal composition demonstrates suspensibility of more than 30% under ATS.

According to an embodiment, the pesticidal composition demonstrates dispersibility of more than 90% under ATS. According to an embodiment, the pesticidal composition demonstrates dispersibility of more than 80% under ATS. According to an embodiment, the pesticidal composition demonstrates dispersibility of more than 70% under ATS. According to an embodiment, the pesticidal composition demonstrates dispersibility of more than 60% under ATS. According to an embodiment, the pesticidal composition demonstrates dispersibility of more than 50% under ATS. According to an embodiment, the pesticidal composition demonstrates dispersibility of more than 40% under ATS. According to an embodiment, the pesticidal composition demonstrates dispersibility of more than 30% under ATS.

According to an embodiment, the pesticidal composition demonstrates superior stability towards heat, light, temperature and caking. The composition does not form a hard cake and exhibits enhanced stability even at extended storage under higher temperatures which in turn results in superior field performance. According to further embodiment, the stability exhibited by the pesticidal composition is at least 3 years. According to further embodiment, the stability exhibited by the pesticidal composition is at least 2 years. According to further embodiment, the stability exhibited by the pesticidal composition is at least 1 year. According to further embodiment, the stability exhibited by the pesticidal composition is at least 6 months.

According to an embodiment, the present invention relates to a process for preparing pesticidal composition of the present invention comprising elemental sulphur in the range of 30% w/w to 90% w/w of the total composition; fluxapyroxad in the range of 0.01% w/w to 25% w/w of the total composition; prothioconazole in the range of 1% w/w to 20% w/w of the total composition and at least one agrochemically acceptable excipient, wherein the composition has particles in the size range of 0.1 micron to 50 microns.

According to a further embodiment the present invention relates to a process for preparing pesticidal composition in the form of water dispersible granules, spheronised granules, liquid suspension, wettable powder, suspo-emulsion, water dispersible powder for seed coating (WS), and suspension concentrate for seed  
5 coating (FS).

According to further embodiment, the pesticidal composition in the form of water dispersible granules or spheronised granules, is made by various techniques such as spray drying, fluidized bed granulation, disc pelletization, pan granulation, pin  
10 agglomerator, spheronizer, freeze drying or combinations. The granules can also be extruded through the extruder to obtain extruded granules.

The invention also relates to a process for preparing the pesticidal composition in the form of water dispersible granules, the process comprising: a) milling blend of  
15 elemental sulphur, fluxapyroxad and prothioconazole with at least one agrochemical excipient to obtain a slurry or wet mix, wherein the particles are in the size range of 0.1 to 50 microns and b) drying the wet mix, sieving the dried mix remove the undersized and oversized granules to obtain water dispersible granules; wherein the granules of the composition comprise of granules in size  
20 range of 0.05mm to 3mm.

The invention also relates to a process for preparing the granular pesticidal composition, the process comprising:

- a) milling blend of elemental sulphur, fluxapyroxad and prothioconazole  
25 with at least one agrochemical excipient to obtain a slurry or wet mix, wherein the particles are in the size range of 0.1 to 50 microns;
- b) drying the wet mix to obtain dried mix; and
- c) water is added to the dried mix and blended to obtain a dough or paste, which is then extruded through an extruder to obtain the extruded granules  
30 in a size range of 0.05 mm to 6 mm; or

agglomerating the wet mix or dried mix obtained in step (b) in an agglomerator to obtain spheronised granular composition in a size range of 0.05 mm to 6 mm.

- 5 The wet mix obtained is dried, for instance in a spray dryer, fluid bed dryer or any suitable granulating equipment, followed by sieving to remove the undersized and oversized granules to obtain granules.

The invention relates to a process for preparing a wettable powder (WP) or  
10 'wetable powder for seed coat (WS)' composition, wherein the process involves mixing effective amount of fluxapyroxad with required diluents and inert ingredients to obtain a first mixture. The process involves mixing effective amount of prothioconazole with required diluents and inert ingredients to obtain a second mixture. Elemental sulphur is then mixed with the surfactants to obtain a  
15 third mixture. The three mixtures are then mixed using a suitable mass mixer for 30 minutes and passed through an air jet mill to obtain a wettable powder composition with the desired particle size range of 0.1 micron to 50 microns. Alternatively, the wettable powder composition is prepared by mixing effective amount of fluxapyroxad, prothioconazole, Elemental sulphur with required  
20 diluents and inert ingredients using a suitable mass mixer for 30 minutes and then passed through an air jet mill to obtain a wettable powder composition with the desired particle size range of 0.1 micron to 50 microns.

The invention relates to a process for preparing the liquid suspension or  
25 'Suspension concentrate for seed treatment (FS)' composition, the process comprising: homogenizing mixture of elemental sulphur in the range of 30% w/w to 90% w/w of the total composition; fluxapyroxad in the range of 0.01% w/w to 25% w/w of the total composition; prothioconazole in the range of 1% w/w to 20% w/w of the total composition and at least one agrochemically acceptable  
30 excipient to obtain a suspension; and wet milling the obtained suspension to provide composition with a particle size range of 0.1 micron to 50 microns.

The process of preparing the liquid suspension, involves homogenization of one or more of excipients by feeding them into a vessel provided with stirring facilities. Elemental sulphur, fluxapyroxad and prothioconazole are added to the  
5 homogenized blend and stirred continuously for about 5 to 10 minutes until the total mixture becomes homogeneous. Subsequently, the suspension obtained is passed through the wet mill to obtain a desired particle size in the range of 0.1 to 50 microns. Then, requisite quantity of the structuring agent is added to the obtained suspension, under continuous homogenization. However, those skilled in  
10 the art will appreciate that it is possible to modify or alter or change the process or process parameters to obtain liquid suspension composition without departing from the scope of the present invention.

The invention relates to a process for preparation of a suspoemulsion pesticidal  
15 composition, the process comprising dissolving wetting agent and dispersing agents in water to obtain a mixture followed by addition of humectant, antifoam agent, if required, elemental sulphur and fluxapyroxad to obtain a homogenized suspension, which is further milled to obtain desired particle size (First fraction). Dissolve prothioconazole in an oil or a solvent, followed by addition of surfactant  
20 to prepare a concentrated emulsion with required agrochemical excipients to obtain a second fraction. The two fractions obtained are then mixed using a homogenizer for 30 minutes to obtain the suspoemulsion composition with the desired particle size of 0.1 to 50 microns.

25 According to an embodiment, the composition of the present invention is at least one of a pesticide composition, a crop protection composition, a crop strengthener composition, a yield enhancer composition.

According to an embodiment, the invention also relates to a method of controlling  
30 fungal disease, crop protection or improving the plant health and yield by treating a plant, plant propagation material, locus or parts thereof, a seed, seedling or

surrounding soil with the pesticidal composition comprising elemental sulphur in the range of 30% w/w to 90% w/w of the total composition; fluxapyroxad in the range of 0.01% w/w to 25% w/w of the total composition; prothioconazole in the range of 1% w/w to 20% w/w of the total composition and at least one  
5 agrochemically acceptable excipient. The composition may be sprayed directly to the plant, such as its foliage or applied to the plant propagation material, before it is sown or planted, or to the locus thereof.

The composition is applied through a variety of methods. Methods of applying to  
10 the soil include any suitable method, which ensures that the composition penetrates the soil, for example nursery tray application, in furrow application, soil drenching, soil injection, drip irrigation, sprinkler irrigation, seed treatment, seed painting and such other methods. The composition also is applied in the form of a foliar spray.

15 The rates of application or the dosage of the composition depends on the type of use, the type of crops, or the specific active ingredients in the composition but is such that the pesticidal active ingredient, is in an effective amount to provide the desired action (such as crop protection, crop yield).

20 It was observed that the composition of the present invention provides good control on fungal pest as compared to application of individual actives. Further such composition helps in improving the crop yield as well as in enhancing the crop physiological characteristics etc. Thus, it has been observed that the  
25 compositions of the present invention, demonstrate enhanced, efficacious and superior behavior in the fields at reduced dosage.

From the foregoing, it will be observed that numerous modifications and variations is effectuated without departing from the true spirit and scope of the  
30 novel concepts of the present invention. It is to be understood that no limitation

with respect to the specific embodiments illustrated is intended or should be inferred.

#### A. PREPARATION EXAMPLES:

5 The following examples illustrate the basic methodology and versatility of the composition of the invention. It should be noted that this invention is not limited to these exemplifications and is extrapolated to overall claimed concentration range of the components.

10 **Example 1: Wettable powder formulation of 90% elemental sulphur, 3% Fluxapyroxad and 1% prothioconazole.**

Wettable powder formulation was prepared by mixing 1 part of prothioconazole, 3 parts of fluxapyroxad, 90 parts of sulphur, 1.5 parts of sodium lauryl sulphate and 4 parts of sodium lignin sulphonate and 0.5 parts of clay in a mass mixer for 30  
15 minutes and then passed through an air jet mill to get the wettable powder composition with desired particle size.

The composition had average particle size of about 10 microns. The composition had a suspensibility of 76%, wettability of less than 20 seconds. The composition further demonstrated suspensibility of about 71% and wettability of  
20 about 22 seconds under accelerated storage condition.

**Example 2: Wettable powder formulation of 30% elemental sulphur, 25% Fluxapyroxad and 20 % prothioconazole.**

Wettable powder formulation was prepared by mixing 20 part of prothioconazole,  
25 25 parts of fluxapyroxad, 30 parts of sulphur, 2 parts of Geroxon® T77, 3 parts of Geroxon® SC 213, 3 parts of calcium lignin sulphonate, and 17 parts of clay were then blended in a mass mixer for 30 minutes and then passed through an air jet mill to get the wettable powder composition with desired particle size.

The composition had average particle size of about 6.7 microns. The  
30 composition had a suspensibility of 82%, wettability of less than 11 seconds. The



composition further demonstrated suspensibility of about 78% and wettability of about 15 seconds under accelerated storage condition.

**Example 3: Wettable powder formulation of 40% elemental sulphur, 5.3% Fluxapyroxad and 5.1 % prothioconazole.**

Wettable powder formulation was prepared by mixing 5.1 part of prothioconazole, 5.3 parts of fluxapyroxad, 40 parts of sulphur, 2 parts of alkyl naphthalene sulphonate condensate, 3 parts of Morwet® D450, 3 parts of Tamol® DN, 41.6 parts of soapstone in a mass mixer for 30 minutes and then passed through an air jet mill to get the wettable powder composition with desired particle size.

The composition had average particle size of about 12.6 microns. The composition had a suspensibility of 69%, wettability of less than 6 seconds. The composition further demonstrated suspensibility of about 67% and wettability of about 7 seconds under accelerated storage condition.

**Example 4: Water dispersible granule of 80% elemental sulphur, 1.5% Fluxapyroxad and 1 % prothioconazole.**

Water dispersible granules were prepared by taking water in a beaker and surfactants including 5 part of alkylnaphthalenesulfonate condensate, 8 parts of lignin sulphonate sodium, 4.5 parts of clay were added to the beaker one after the other and stirred till the surfactants dissolved completely. Further 80 parts of sulphur was added and stirred to disperse well. Thereafter 1.5 parts of fluxapyroxad and 1 part of prothioconazole was added one after other and mixed using a homogenizer for 15 minutes to obtain a slurry. The slurry was then passed through a wet mill to obtain the desired particle size range. The milled slurry was then spray dried using a suitable spray drying equipment. The composition had an average particle size of about 7.2 microns and granule size of 0.1 mm to 2.5 mm.

The composition disperses almost instantaneously and has a dispersibility of 94%, suspensibility of 88%, wettability of less than 11 seconds and wet sieve retention value of 0.09%. The composition further demonstrated dispersibility of

92%, wettability of less than 9 seconds and suspensibility of about 85% under accelerated storage condition. The composition does not exhibit any hardness.

**Example 5: Water dispersible granule of 40% elemental sulphur, 5.3% Fluxapyroxad and 5.1 % prothioconazole.**

Water dispersible granules were prepared by taking water in a beaker and surfactants including 5 part of polycarboxylate potassium, 5 parts of reax 88A, 10 parts of lactose and 29.6 parts of clay were added to the beaker one after the other and stirred till the surfactants dissolved completely. Further 40 parts of sulphur was added and stirred to disperse well. Thereafter 5.3 parts of fluxapyroxad and 5.1 part of prothioconazole was added one after other and mixed using a homogenizer for 15 minutes to obtain a slurry. The slurry was then passed through a wet mill to obtain the desired particle size range. The milled slurry was then spray dried using a suitable spray drying equipment. The composition had an average particle size of about 5.3 microns and granule size of 0.05 mm to 1.5 mm.

The composition disperses almost instantaneously and has a dispersibility of 98%, suspensibility of 96%, wettability of less than 7 seconds and wet sieve retention value of 0.08%. The composition further demonstrated dispersibility of 95%, wettability of less than 9 seconds and suspensibility of about 95% under accelerated storage condition. The composition does not exhibit any hardness.

**Example 6: Water dispersible granule of 30% elemental sulphur, 2% Fluxapyroxad and 20 % prothioconazole.**

Water dispersible granules were prepared by taking water in a beaker and surfactants including 2 part of supragil WP, 5 parts of Stepserse DF 500, 12 parts of sodium citrate and 29 parts of clay were added to the beaker one after the other and stirred till the surfactants dissolved completely. Further 30 parts of sulphur was added and stirred to disperse well. Thereafter 2 parts of fluxapyroxad and 20 part of prothioconazole was added one after other and mixed using a homogenizer for 15 minutes to obtain a slurry. The slurry was then passed through a wet mill to obtain the desired particle size range. The milled slurry was then spray dried using

a suitable spray drying equipment. The composition had an average particle size of about 6 microns and granule size of 0.1 mm to 2.5 mm.

The composition disperses almost instantaneously and has a dispersibility of 99%, suspensibility of 99%, wettability of less than 7 seconds and wet sieve retention value of 0.08%. The composition further demonstrated dispersibility of 99%, wettability of less than 8 seconds and suspensibility of about 97% under accelerated storage condition. The composition does not exhibit any hardness.

**Example 7: Wettable powders for slurry seed treatment (WS) formulation of 85% elemental sulphur, 3% Fluxapyroxad and 3% prothioconazole.**

WS formulation was prepared by mixing 3 part of prothioconazole, 3 parts of fluxapyroxad, 85 parts of sulphur, 4 parts of naphthalene sulphonate, 2 parts sticker, 1 part of Morwet EFW and 2 parts of pigment violet in a mass mixer for 30 minutes and then passed through an air jet mill to get the Water dispersible powders for slurry seed treatment composition with desired particle size.

The composition had average particle size of about 6.5 microns. The composition had a suspensibility of 82.89%, wettability of less than 20 seconds. The composition further demonstrated suspensibility of about 81.42% and wettability of about 26 seconds under accelerated storage condition.

20

**Example 8: Dustable powder formulation of 40% elemental sulphur, 5.3% Fluxapyroxad and 5% prothioconazole.**

Dustable powder formulation was prepared by mixing 5.1 part of prothioconazole, 5.3 parts of fluxapyroxad, 40 parts of sulphur in a mass mixer followed by addition of talc (q.s) and mixed to obtain uniform blend. The obtained blend is then passed through a jet mill to get the dustable powder composition with desired particle size.

The composition had a dry sieve retention value on a 75-micron sieve of less than 0.5% and less than 0.52% under accelerated storage condition.

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**Example 9: Granules (GR) of 40% elemental sulphur, 5.3% Fluxapyroxad and 5.1% prothioconazole.**

GR formulation was prepared by mixing 5.1 part of prothioconazole, 5.3 parts of fluxapyroxad, 40 parts of sulphur, 3 parts of naphthalene sulphonate condensate, 1.5 parts of polyvinyl pyrrolidone, 4.3 parts of sodium sulphate in a mass mixer for 30 minutes and then passed through an air jet mill to get the wettable powder. Wet the obtained powder using water and add kaolin (sufficient quantity) to get wet mass which is then passed through extruder to obtain wet extrudate. The extrudate is then spheronised using a spheronizer to obtain spherical granules. The granules are dried in a fluid bed dryer to obtain granules of 40% elemental sulphur, 5.3% Fluxapyroxad and 5.1% prothioconazole.

The composition had average particle size of about 23.2 microns and granule size of 5-6 mm. The composition has disintegration time of 25 minutes. The composition further demonstrated average particle size of about 24 microns and disintegration time of 31 minutes under accelerated storage condition.

**Example 10: Granules (GR) of 30% elemental sulphur, 5.3% Fluxapyroxad and 5.1% prothioconazole.**

GR formulation was prepared by mixing 5.1 part of prothioconazole, 5.3 parts of fluxapyroxad, 30 parts of sulphur, 3 parts of naphthalene sulphonate condensate, 1.5 parts of polyvinyl pyrrolidone, 4.3 parts of sodium sulphate in a mass mixer for 30 minutes and then passed through an air jet mill to get the wettable powder. Wet the obtained powder using water and add kaolin (sufficient quantity) to get wet mass which is then passed through extruder to obtain wet extrudate. The extrudate is then spheronised using a spheronizer to obtain spherical granules. The granules are dried in a fluid bed dryer to obtain granules of 40% elemental sulphur, 5.3% Fluxapyroxad and 5.1% prothioconazole.

The composition had average particle size of about 23 microns and granule size of 5-6 mm. The composition has disintegration time of less than 5 minutes. The composition further demonstrated average particle size of about 24 microns and disintegration time of 5 minutes under accelerated storage condition.

**Example 11: Water disintegrable tablet of 40% elemental sulphur, 5.3% Fluxapyroxad and 5.1% prothioconazole.**

Water disintegrable tablet formulation was prepared by mixing 5.1 part of prothioconazole, 5.3 parts of fluxapyroxad, 40 parts of sulphur in a mass mixer for 3 minutes. The mixture was then milled (jet mill), wherein the particles in the mixture had size of less than 50 microns. The milled mixture was mixed with mannitol (q.s) (direct compression grade), followed by mixing with 2 parts of sodium naphthalene sulphonate condensate, 3 parts of naphthalene sulphonate, 5 parts of croscarmellose sodium, 0.1 parts of colloidal silicon dioxide, 3 parts of polyvinyl pyrrolidone. Further, 0.5 parts of magnesium stearate was added and mixed for 5 minutes to obtain blend. The obtained blend is compressed into tablets.

The composition had a wet sieve retention value on a 75-micron sieve of less than 0.2%. The composition has suspensibility of 75% and persistent foam of 10 ml. Further, the composition had a wet sieve retention value on a 75-micron sieve of less than 0.23%, suspensibility of 68% and persistent foam of 11 ml under accelerated storage condition.

**Example 12: Suspension concentrate composition of 55% elemental sulphur, 1.5% Fluxapyroxad and 1 % prothioconazole.**

Suspension concentrate composition was prepared by taking water (quantity sufficient) in a beaker and adding 5 parts of glycerol, 3 parts of silicone alcohol ethoxylate, 3 parts of powerblox SN, 0.1 parts of benzisothiazolinone, 0.2 part of antifoam agent. The components were mixed well to obtain a mixture and 55 parts of elemental sulphur, 1.5 parts of Fluxapyroxad and 1 part of prothioconazole were added to the mixture. The resulting mixture was stirred well and milled to get desired particle size. Then, 0.12 parts of xanthan gum was added under continuous homogenization to obtain the suspension concentrate.

The resulting formulation had an average particle size of 3.3 microns, suspensibility of 96%. The composition has a viscosity of about 520 cps. The

composition has suspensibility of about 95% and viscosity of about 340 cps under accelerated storage condition.

**Example 13: Suspension concentrate composition of 40% elemental sulphur, 5.3% Fluxapyroxad and 5.1 % prothioconazole.**

Suspension concentrate composition was prepared by taking water (quantity sufficient) in a beaker and adding 3 parts of calcium chloride, 3.5 parts of Soprophor FL, 2.5 parts of Morwet D425, 0.3 parts of potassium sorbate, 0.11 parts of antifoam agent. The components were mixed well to obtain a mixture and 40 parts of elemental sulphur, 5.3 parts of Fluxapyroxad and 5.1 part of prothioconazole were added to the mixture. The resulting mixture was stirred well and milled to get desired particle size. Then, 0.14 parts of xanthan gum was added under continuous homogenization to obtain the suspension concentrate.

The resulting formulation had an average particle size of 4.1 microns, suspensibility of 94%. The composition has a viscosity of about 610 cps. The composition has suspensibility of about 91% and viscosity of about 585 cps under accelerated storage condition.

**Example 14: Suspension concentrate composition of 30% elemental sulphur, 5% Fluxapyroxad and 20 % prothioconazole.**

Suspension concentrate composition was prepared by taking water (quantity sufficient) in a beaker and adding 2 parts of sodium lactate, 3 parts of Soprophor 3D33, 3 parts of Teresperse 2020, 0.75 parts of silica, precipitated, 0.17 parts of antifoam agent. The components were mixed well to obtain a mixture and 30 parts of elemental sulphur, 5 parts of Fluxapyroxad and 20 part of prothioconazole were added to the mixture. The resulting mixture was stirred well and milled to get desired particle size. Then, 0.1 parts of xanthan gum was added under continuous homogenization to obtain the suspension concentrate.

The resulting formulation had an average particle size of 4.8 microns, suspensibility of 98%. The composition has a viscosity of about 550 cps. The

composition has suspensibility of about 96% and viscosity of about 560 cps under accelerated storage condition.

**Example 15: Suspoemulsion composition of 30% elemental sulphur, 5% Fluxapyroxad and 3.5 % prothioconazole.**

To a sufficient quantity of water in a beaker, 5 parts of glycerol, 1 part of polyacrylate surfactant, 3.8 parts of polysorbate 20, 0.1-part Benzisothiazolinone and 0.16 parts of antifoam agent was added to obtain a mixture. 30 parts of sulphur and 5 parts of fluxapyroxad were then added to the mixture and the suspension obtained was uniformly mixed using a homogenizer and then passed through a wet mill to get the desired particle size range. In another beaker, 20 parts of xylene 3.2 parts of linear alkylbenzenesulfonate were mixed together and 3.5 parts of prothioconazole was then added and stirred till it dissolved. This solution was added to the milled sulphur suspension and homogenized. Further 0.12 parts of xanthan gum was added to get the desired viscosity.

The composition has average particle size of about 3.2 microns, pourability of about 2.7%, complete initial and 24-hour dispersion stability. Further, the composition has particle size of about 3.4 microns, pourability of about 3.5%, complete initial and 24-hour dispersion stability under accelerated storage condition.

**Example 16: Suspension concentrate for seed treatment (FS) composition of 40% elemental sulphur, 5.3% Fluxapyroxad and 5.1% prothioconazole.**

FS composition was prepared by taking water (quantity sufficient) in a beaker and adding 6 parts of humectant B70, 3.5 parts of Soprophor FL, 2.5 parts of Morwet D425, 0.3 parts of potassium sorbate, 2.5 parts of agrocer red 112, 0.18 parts of antifoam agent. The components were mixed well to obtain a mixture and 40 parts of elemental sulphur, 5.3 parts of Fluxapyroxad and 5.1 part of prothioconazole were added to the mixture. The resulting mixture was stirred well and milled to get desired particle size. Then, 0.14 parts of xanthan gum was added under continuous homogenization to obtain the FS composition.

The resulting formulation had an average particle size of 8.4 microns, suspensibility of 91.4%. The composition has a viscosity of about 564 cps. The composition has suspensibility of about 88.9%, average particle size of 8.7 microns and viscosity of about 593 cps under accelerated storage condition.

5

#### A. FIELD STUDY:

**Field trial 1: To study effect of elemental sulphur, fluxapyroxad and prothioconazole against Powdery Mildew in Cucumber.**

- 10 The field trials were carried out to study the effect of the composition of elemental sulphur, fluxapyroxad and prothioconazole against Powdery Mildew in Cucumber. The trial was carried out by Randomized Block Design (RBD) with Thirteen treatments including untreated control, replicated four times. The test product sample, sulphur, prothioconazole, fluxapyroxad alone and in combination in
- 15 prescribed dosages were applied at foliar application. The cucumber in trial field was raised following good agricultural practice.

#### Details of experiment

Trial location	Indore, MP
Crop:	Cucumber
Trial Design	RBD, 04 replications
Date of sowing	11.07.2021
Type of application	Foliar application at 3-5 % diseases incidence
Water volume used:	500 L/ha
Date of application	18.10.2021 & 28.10.2021
Time of application	Early in the morning
Target Pathogen	Powdery mildew ( <i>Erysiphe cichoracearum</i> )
Plot size	5 m x 6 m = 30 sq.m
Assessment	Disease severity Index
Yield	At harvest

- 20 The observation on crop damage caused by *Powdery mildew (Erysiphe cichoracearum)* were recorded November 8, 2021 was at 10 days interval after 2<sup>nd</sup>



application (10DAA2SP) after planting of the cucumber plant from each plot and the percentage control was calculated using following formula:

$$\text{Control (\%)} = [\text{Damage in control plot} - \text{Damage in treated plot}] / \text{Damage in control plot} \times 100$$

- 5 The mean data on control against the fungus along with the cucumber yield was recorded at harvest and is presented in the Tables 1-3.

“Synergy” is as defined by Colby S. R. in an article entitled “Calculation of the synergistic and antagonistic responses of herbicide combinations” published in  
10 Weeds, 1967, 15, p. 20-22. The action expected for a given combination of two active components is calculated as follows:

$$E = X + Y - (XY/100)$$

Where,

E= Expected % effect by mixture of two products X and Y in a defined dose.

- 15 X= Observed % effect by product A

Y= Observed % effect by product B

The action expected for a given combination of three active components is calculated as follows:

20 
$$E = (X + Y + Z) - (XY + YZ + XZ / 100) + (XYZ/10000)$$

Where,

E= Expected % effect by mixture of three products X, Y and Z in a defined dose.

X= Observed % effect by product A

Y= Observed % effect by product B

- 25 Z= Observed % effect by product C

The synergy factor (SF) is calculated by Abbott's formula (Eq.(2))(Abbott, 1925).

SF= Observed effect /Expected effect

- 30 Where, SF >1 for Synergistic reaction; SF<1 for antagonistic reaction; SF=1 for additive reaction.

- When the percentage of yield effect observed (E) for the combination is greater than the expected percentage, synergistic effect of the combination is inferred.
- When the percentage of yield effect observed for the combination is equal to the expected percentage, merely an additive effect may be inferred, and wherein the
- 5 percentage of yield effect observed for the combination is lower than the expected percentage, an antagonistic effect of the combinations is inferred.

Table 1: Effect of WG composition comprising elemental sulphur, fluxapyroxad and prothioconazole for controlling powdery Mildew in Cucumber

Treatment No.	Composition	Active ingredient (g.a.i/ha)			% Mean Disease Index (PDI) (Observed at (10DAA2SP))	% Reduction of disease over control	Yield (Qtl/ha)	% Increase in yield over control
		Sulphur	Fluxapyroxad	Prothioconazole				
T1	Sulphur 40% + Fluxapyroxad 5.3% + Prothioconazole 5.1% WG @ 3750 g/ha according to an embodiment of the present invention.	1500	199	191	1.7	92 *(78.94)	159	77 *(42.54)
T2	Sulphur 80% WDG @ 1875 g/ha	1500	--	--	13	41	109	21
T3	Fluxapyroxad 26.55 % SC @ 750 g/ha	--	199	--	11.1	50	106	18
T4	Prothioconazole 25% EC @ 764 g/ha	--	--	191	15	32	101	12
T5	Sulphur 50% + Fluxapyroxad 15% + Prothioconazole 14.5% WG @ 1325 g/ha according to an embodiment of the present invention.	662.5	199	191	1.4	94 *(82.34)	150.00	67 *(50.21)
T6	Sulphur 80% WDG @ 828 g/ha	662.5	--	--	10.8	51	118.00	31
T7	Fluxapyroxad 26.55 % SC @ 750 g/ha	--	199	--	11.1	50	106	18
T8	Prothioconazole 25% EC @ 764 g/ha	--	--	191	15	32	101	12
T9	Sulphur 90% + Fluxapyroxad 2.43% + Prothioconazole 2.34% WG @ 8200 g/ha according to an embodiment of the present invention.	7380	199	192	1.2	95 *(84)	150	67 *(50)

Treatment No.	Composition	Active ingredient (g.a.i/ha)			% Mean Disease Index (PDI) (Observed at (10DAA2SP))	% Reduction of disease over control	Yield (Qt/ha)	% Increase in yield over control
		Sulphur	Fluxa-pyroxad	Prothio-conazole				
T10	Sulphur 80% WDG @9225 g/ha	7380	--	--	10	55	118	31
T11	Fluxapyroxad 26.55 % SC @ 750 g/ha	--	199	--	11.1	50	106	18
T12	Prothioconazole 25% EC @ 764 g/ha	--	--	192	15	32	101	12
T13	Untreated check	NA	NA	NA	22	--	90	0

WG: Water dispersible granule; \* Synergy calculation, 10DAA2SP: 10 days interval after 2<sup>nd</sup> application

It is seen from table 1 that the application of Treatment 1 (T1) with Sulphur 40% + Fluxapyroxad 5.3% + Prothioconazole 5.1% WG @ 3750 g/ha as per the embodiment of present invention, Treatment 5 (T5) with Sulphur 50% + Fluxapyroxad 15% + Prothioconazole 14.5% WG @ 1325 g/ha as per the embodiment of present invention; and Treatment 9 (T9) with Sulphur 90% + Fluxapyroxad 2.43% + Prothioconazole 2.34% WG @ 8200 g/ha as per the embodiment of present invention were highly effective in controlling the powdery mildew disease in cucumber after application as compared to the individual treatments of sulphur (T2, T6, T10), fluxapyroxad (T3, T7 and T11) and prothioconazole (T4, T8 and T12). It is seen that Treatments T1, T5 and T9 showed 92%, 94% and 95% respectively reduction in disease over the untreated control and showed better reduction of the fungal disease as compared to individual treatments with sulphur, fluxapyroxad and prothioconazole. The surprising synergistic result of treatments T1, T5 and T9 is attributed to the composition of sulphur, fluxapyroxad and prothioconazole as per the embodiments of the invention, where all three actives are present in a single composition at a specific concentration. The enhanced efficacy is further attributed to the form of the composition, i.e. water dispersible composition as shown in the present study, which includes particles in the size range of 0.1 micron to 50 microns.

Further, the composition as per the embodiment of the present invention, on account of significant control of the fungus and due to the presence of sulphur in the composition, not only assists in controlling the fungi, but also additionally provides nutrition to the plant, thus showing a significant enhancement in the yield as well as other crop characteristics such as plant height, root length and improved foliage, as compared to the yield observed with individual applications of sulphur, fluxapyroxad and prothioconazole.

Table 2: Effect of synergistic combinations of elemental sulphur, fluxapyroxad and prothioconazole formulated as WP, SC, GR, SE for controlling powdery Mildew in Cucumber

Treatment No.	Composition	Active ingredient (g.a.i/ha)			% Mean Disease Index (PDI) (Observed at 10DAA2SP)	% Reduction of disease over control	Yield (Qtl/ha)	% Increase in yield over control
		Sulphur	Fluxapyroxad	Prothioconazole				
T1	Sulphur 90% + Fluxapyroxad 3% + Prothioconazole 2.87% WP @ 6650 g/ha according to an embodiment of the present invention.	5985	199	191	1.20	93 *(82)	144	69 *(51%)
T2	Sulphur 80% WDG @ 7480 g/ha	5985	--	--	12	33	108	27
T3	Fluxapyroxad 26.55 % SC @ 750 g/ha	--	199	--	8	56	102	20
T4	Prothioconazole 25% EC @ 764 g/ha	--	--	191	11	39	98	15
T5	Sulphur 40% + Fluxapyroxad 5.3% + Prothioconazole 5.1% SC @ 3750 g/ha according to an embodiment of the present invention.	1500	199	191	1.5	92 *(82)	136	60 *(42)
T6	Sulphur 80% WDG @ 1875 g/ha	1500	--	--	11	39	103	21
T7	Fluxapyroxad 26.55 % SC @ 750 g/ha	--	199	--	7.3	59	98	15
T8	Prothioconazole 25% EC @ 764 g/ha	--	--	191	13.2	27	96	13
T9	Sulphur 50% + Fluxapyroxad 20.45% + Prothioconazole 19.7% GR @ 975 g/ha according to an embodiment of the present invention.	487	199	192	2.4	87 *(81)	124	46 *(35)
T10	Sulphur 80% WDG @ 609 g/ha	487	--	--	14	22	99	16

Treatment No.	Composition	Active ingredient (g.a.i/ha)			% Mean Disease Index (PDI) (Observed at 10DAA2SP)	% Reduction of disease over control	Yield (Qtl/ha)	% Increase in yield over control
		Sulphur	Fluxapyroxad	Prothioconazole				
T11	Fluxapyroxad 26.55 % SC @ 750g/ha	--	199	--	10	44	94	11
T12	Prothioconazole 25% EC @ 764 g/ha	--	--	192	8	56	96	13
T13	Sulphur 30% + Fluxapyroxad 1.66% + Prothioconazole 1.6% SE @ 12000 g/ha according to an embodiment of the present invention.	3600	199	192	1.1	94 *(88)	130	53*(34)
T14	Sulphur 80% WDG @4500 g/ha	3600	--	--	11	39	99	16
T15	Fluxapyroxad 26.55 % SC @ 750 g/ha	--	199	--	7	61	95	12
T16	Prothioconazole 25% EC @ 764 g/ha	--	--	192	9	50	94	11
T17	Untreated check	NA	NA	NA	18	--	85	0

WP: Wettable Powder; SC: Suspension Concentrate; GR: Granule; SE: Suspoemulsion; \* Synergy calculation; 10DAA2SP: 10 days interval after 2nd application

It is seen from table 2 that the application of Treatments T1, T5, T9 and T13 with combinations of Sulphur, Fluxapyroxad and Prothioconazole in various formulation types prepared as per the embodiment of present invention were highly effective in controlling the powdery mildew disease in cucumber after application as compared to the individual treatments of sulphur (T2, T6, T10, T14), fluxapyroxad (T3, T7, T11, T15) and prothioconazole (T4, T8, T12, T16). The surprising synergistic result of treatments T1, T5, T9 and T13 is attributed to the composition of sulphur, fluxapyroxad and prothioconazole as per the embodiments of the invention, where all three actives are present in a single composition at a specific concentration. The enhanced efficacy is further attributed to the form of the composition, i.e. WP, SC, GR, SE as shown in the present study, which includes particles in the size range of 0.1 micron to 50 microns.

Further, the composition as per the embodiment of the present invention, on account of significant control of the fungus and due to the presence of sulphur in the composition, not only assists in controlling the fungi, but also additionally provides nutrition to the plant, thus showing a significant enhancement in the yield as well as other crop characteristics such as plant height, root length and improved foliage, as compared to the yield observed with individual applications of sulphur, fluxapyroxad and prothioconazole.



Table 3: Comparison of synergistic effect of composition comprising elemental sulphur, fluxapyroxad and prothioconazole; known 2-way combinations of actives and individual actives for controlling powdery Mildew in Cucumber

Treatment No.	Composition	Active ingredient (g.a.i/ha)			% Mean Disease Index (PDI) (observed at 10DAA2SP)	% Reduction of disease over control	Yield (Qtl/ha)	% Increase in yield over control	Crop Phytotoxicity
		Sulphur	Fluxapyroxad	Prothioconazole					
T1	Sulphur 40% + Fluxapyroxad 5.3% + Prothioconazole 5.1% WG @ 3750 g/ha according to an embodiment of the present invention.	1500	199	191	1.7	92 *(79.94)	159	77 *(42.99)	0
T2	Sulphur 40% + Fluxapyroxad 5.3% WG @ 3750 g/ha (combination as per prior art)	1500	199	--	6.8	69	119	32	0
T3	Fluxapyroxad 5.3% + Prothioconazole 5.1% WG @ 3750 g/ha	--	199	191	8	64	112	24	0
T4	Sulphur 40% + Prothioconazole 5.1% WG @ 3750 g/ha	1500	--	191	7.9	64	120	33	0
T5	Sulphur 80% WDG @ 1875 g/ha	1500	--	--	13	41	109	21	0
T6	Fluxapyroxad 26.55 % SC @ 750 g/ha	--	199	--	11.1	50	106	18	0
T7	Prothioconazole 25% EC @ 764 g/ha	--	--	191	15	32	101	12	0
T8	Untreated check	NA	NA	NA	22	0	90	0	0

WG: Water Dispersible granule; \* Synergy calculation; Crop Phytotoxicity: 0 =No virus disease on leaf and plant; 1=<1% leaf & plan showed virus disease; 10DAA2SP: 10 days interval after 2nd application

It is seen from table 3 that the application of Treatments T1 with combination of Sulphur, Fluxapyroxad and Prothioconazole prepared as per the embodiment of present invention was highly effective in controlling the powdery mildew disease in cucumber after application and demonstrated increased yield of cucumber as compared to the two-way combination treatments (T2, T3 and T4), and individual treatments of sulphur (T5), fluxapyroxad (T6) and prothioconazole (T7). The surprising synergistic result of treatment T1 is attributed to the composition of sulphur, fluxapyroxad and prothioconazole as per the embodiments of the invention, where all three actives are present in a single composition at a specific concentration. The enhanced efficacy is further attributed to the form of the composition Water dispersible granules as shown in the present study, which includes particles in the size range of 0.1 micron to 50 microns.

Further, the composition as per the embodiment of the present invention, on account of significant control of the fungus and due to the presence of sulphur in the composition, not only assists in controlling the fungi, but also additionally provides nutrition to the plant, thus showing a significant enhancement in the yield as well as other crop characteristics such as plant height, root length and improved foliage, as compared to the yield observed with individual applications of sulphur, fluxapyroxad and prothioconazole.

**Field Trial Data 2:** To study the effect of composition comprising elemental sulphur, fluxapyroxad and prothioconazole with a specific particle size for controlling Anthracnose disease in Chili.

The field trials were carried out to study the effect of composition comprising elemental sulphur, fluxapyroxad and prothioconazole with a specific particle size for controlling Anthracnose disease in Chili. The trial was laid out during August to January in Randomized Block Design (RBD) with four treatments including untreated control, replicated five times. The test product sample with specific particle size was compared with untreated control. The treatments were applied as

foliar application at 50-70 days after transplanting of Chili in trial plot. The Chili crop was raised in trial field following good agricultural practice.

Details of experiment

- a) Trial Location : Guntur, Andhra Pradesh
- 5 b) Crop : Chili (Teja variety)
- c) Trial Design : RBD
- d) Replications : Five
- e) Treatment : Four
- f) Plot size : 6 m x 10 m
- 10 g) Date of sowing :20.08.2021
- h) Date of Application: 10.10.2021 & 25.10.2021
- i) Method of application: Two Foliar applications at 15 days interval
- j) Date of Harvesting : 20.1.2022

15

Table 4: Effect of composition comprising elemental sulphur, fluxapyroxad and prothioconazole with a specific particle size for controlling Anthracnose disease in Chili

Treatme nt No.	Composition	Range of Particle size of the composit ion	Active ingredient (g.a.i/ha)			% Mean Diseas e Index (PDI) Observed at 10DA A2SP)	% Reducti on of disease over control	Yiel d (Qt/ha)	% Increas e in yield over control
			Sulphu r	Fluxap yroxad	Prothioc onazole				
T1	Sulphur 40% + Fluxapyroxad 5.3% + Prothioconazole 5.1% WG @ 3750 g/ha according to an embodiment of the present invention.	0.1 to 50 microns	1500	199	191	1.1	94	157	65
T2	Sulphur 40% + Fluxapyroxad 5.3% + Prothioconazole 5.1% WG @ 3750 g/ha according to an embodiment of the present invention.	50 to 100 microns				5.5	69	128	35
T3	Sulphur 40% + Fluxapyroxad 5.3% + Prothioconazole 5.1% WG @ 3750 g/ha according to an embodiment of the present invention.	100 to 150 microns				6.2	66	122	28
T4	Untreated check		NA	NA	NA	18	-	95	-

WG: Water Dispersible granule; 10DAA2SP: 10 days interval after 2nd application

It is observed from Table 4, that treatment 1 (T1) having particle size distribution in the range of 0.1 to 50 microns showed improved yield and improved fungicidal effect against Anthracnose disease in Chili as compared to treatment 2 (T2) having particle size range of 50 to 100 microns, and treatment 3 (T3) having particle size distribution in the range of 100 to 150 microns and untreated control.

Further, Treatment 1 having particle size of 0.1 to 50 microns; Treatment 2 having particle size of 50 to 100 microns; and Treatment 3 having particle size of 50 to 100 microns applied to Chili crop at a dose of 3750 g/ha, exhibited about 65%, 35% and 28% increase in yield respectively over the control.

Thus, it was surprisingly noted that even amongst the WDG formulations, superior efficacy was observed with WDG formulation having specific particle size distribution of 0.1 to 50 microns in comparison to WDG formulations having different particle sizes in varied ranges.

**Field Trial Data 3:** To study the effect of composition comprising elemental sulphur, fluxapyroxad and prothioconazole with varying concentration of elemental sulphur in controlling Anthracnose disease in Chili (Sitara variety).

The field trials were carried out to study the effect of composition comprising elemental sulphur, fluxapyroxad and prothioconazole with a specific particle size for controlling Anthracnose disease in Chili. The trial was laid out during August to January in Randomized Block Design (RBD) with four treatments including untreated control, replicated five times. The test product sample was compared with untreated control. The treatments were applied as foliar application at 50-70 days after transplanting of Chili in trial plot. The Chili crop was raised in trial field following good agricultural practice.

Details of experiment

- a) Trial Location : Khandwa, Madhya Pradesh
- b) Crop : Chili (Sitara Variety)

- c) Trial Design : RBD
- d) Replications : Five
- e) Treatment : Four
- f) Plot size : 6 m x 10 m
- 5 g) Date of sowing : 18.08.2021
- h) Date of Application: 8.10.2021 & 23.10.2021
- i) Method of application: Two Foliar applications at 15 days interval
- j) Date of Harvesting : 18.1.2022

Table 5: Effect of composition comprising elemental sulphur, fluxapyroxad and prothioconazole with varying concentration of elemental sulphur for controlling Anthracnose disease in Chili

Treatme nt No.	Composition	Active ingredient (g.a.i/ha)			% Mean Diseas e Index (PDI) (obser ved at 10DA A2SP)	% Reducti on of disease over control	Yiel d (Qtl/ ha)	% Increas e in yield over control	
		Sulphu r	Fluxapy roxad	Prothio conazol e					
T1	Sulphur 40% + Fluxapyroxad 5.3% + Prothioconazole 5.1% WG @ 3750 g/ha according to an embodiment of the present invention.	1500	199	191	1.1	94	156	64	
T2	Sulphur 20% + Fluxapyroxad 5.3% + Prothioconazole 5.1% WG @ 3750 g/ha according to an embodiment of the present invention.	750	199	191	6	67	136	43	
T3	Sulphur 10% + Fluxapyroxad 5.3% + Prothioconazole 5.1% WG @ 3750 g/ha according to an embodiment of the present invention.	375	199	191	7.8	57	132	39	
T4	Untreated check	NA	NA	NA	18	-	95	-	
WG:	Water	Dispersible	granule;	10DA A2SP:	10	days	interval	after	2nd application

It is observed from Table 5, that treatment 1 (T1) WG of Sulphur 40% + Fluxapyroxad 5.3% + Prothioconazole 5.1% showed better yield and fungicidal effect against Anthracnose disease in Chili (Sitara variety) as compared to treatment 2 (T2) having 20% elemental sulphur, and treatment 3 (T3) having 10% elemental sulphur and untreated control. However, it is noted from the comparative efficacy data, that the composition with less than 30% elemental sulphur does not exhibit the desired result i.e. better control of Anthracnose disease in Chili, and % yield increase when compared to the composition of the present invention.

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From the foregoing, it will be observed that numerous modifications and variations is effectuated without departing from the true spirit and scope of the novel concepts of the present invention. It is to be understood that no limitation with respect to the specific embodiments illustrated is intended or should be inferred.

15



**CLAIMS:**

We claim,

1. The synergistic pesticidal combination, comprising: elemental sulphur in the  
5 range of 30% w/w to 90% w/w of the total composition; fluxapyroxad in the range of 0.01% w/w to 25% w/w of the total composition; prothioconazole in the range of 1% w/w to 20% w/w.
2. A pesticidal composition, comprising:  
10 elemental sulphur in the range of 30% w/w to 90% w/w of the total composition;  
fluxapyroxad in the range of 0.01% w/w to 25% w/w of the total composition;  
prothioconazole in the range of 1% w/w to 20% w/w; and at least one agrochemically acceptable excipient; wherein the particle size of the  
15 composition is in the range of 0.1 micron to 50 microns.
3. The pesticidal composition as claimed in claim 2, wherein the composition is in the form of a solid or a liquid or a gel.
- 20 4. The pesticidal composition as claimed in claim 3, wherein the solid composition is in the form granules including spheronised granules, extruded granules, water disintegrable granules, wettable powders, water dispersible granules, dustable powder (DP), powders for dry seed treatment (DS), water disintegrable tablet or Water Dispersible powders for slurry seed treatment  
25 (WS).
5. The pesticidal composition as claimed in claim 3, wherein the liquid pesticidal composition is in the form of liquid suspension or suspension concentrate (SC); suspoemulsion (SE), oil dispersion (OD), flowable concentrate (FC), or a  
30 suspension concentrate for seed treatment (FS), Ultra-Low-Volume (ULV).

6. The pesticidal composition as claimed in claim 4, wherein the water dispersible granules are in the size range of 0.05mm to 3 mm.
7. The pesticidal composition as claimed in claim 4, wherein the granules are in the size range of 0.05mm to 6 mm.
8. The pesticidal composition as claimed in claim 2, wherein the composition further comprises at least one active ingredient selected from pesticidal actives, fertilizers, macronutrients, micronutrients, biostimulants, organic acids, plant growth regulators, algae and mixtures thereof.
9. The pesticidal composition as claimed in claim 2, wherein the agrochemically acceptable excipient is selected from at least one of surfactants, binders or binding agents, wetting agents, emulsifiers, fillers or carriers or diluents, coating agents, buffers or pH adjusters or neutralizing agents, antifoaming agents or defoamers, penetrants, UV protecting agents, UV absorbents, UV rays scattering agents, stabilizers, pigments, colorants, structuring agents, chelating or complexing or sequestering agent thickeners, suspending agents or suspension aid agents or anticaking agents or anti-settling agents, viscosity modifiers or rheology modifiers, tackifiers, humectants, spreading agents, sticking agents, anti-freezing agent or freeze point depressants, solvents, preservatives or bactericides or anti-fungal agents or biocides or anti-microbial agents or antioxidants, polymers, monomers, cross-linking agents, permeability enhancing agents, protective colloids and mixtures thereof.
10. The pesticidal composition as claimed in claim 5, wherein the liquid composition has viscosity of 10 cps to 3000cps.
11. The pesticidal composition as claimed in claim 5, wherein the liquid composition has pourability of less than 5% residue.

12. The pesticidal composition as claimed in claim 4, wherein the dispersibility of the composition is at least 30%.
13. The pesticidal composition as claimed in claim 4, wherein the suspensibility of the composition is at least 30%.
14. The pesticidal composition as claimed in claim 4, wherein the dispersibility of the composition is at least 30% under accelerated storage conditions.
15. The pesticidal composition as claimed in claim 4, wherein the suspensibility of the composition is at least 30% under accelerated storage conditions.
16. The process for preparation of pesticidal composition in the form of water dispersible granules as claimed in claim 4, comprises:
  - a) milling a blend of elemental sulphur, fluxapyroxad, prothioconazole in water with at least one agrochemical excipient to obtain a slurry or wet mix, wherein the particles are in the size range of 0.1 to 50 microns; and
  - b) drying the wet mix, sieving the dried mix remove the undersized and oversized granules to obtain water dispersible granules;wherein the granules of the composition comprise of granules in size range of 0.05mm to 3mm.
17. The process for preparation of pesticidal composition in the form of granules as claimed in claim 4, comprises:
  - a) milling blend of elemental sulphur, fluxapyroxad, prothioconazole in water with at least one agrochemical excipient to obtain a slurry or wet mix, wherein the particles are in the size range of 0.1 to 50 microns;
  - b) drying the wet mix to obtain the dry mix; wherein the granules of the composition comprise of granules in size range of 0.05 to 3mm and

- c) water is added to the dry mix and blended to obtain a dough or paste, which is then extruded through an extruder to obtain the extruded granules in a size range of 0.05 mm to 6 mm; or  
agglomerating the wet mix or dry mix obtained in step (b) in an  
5 agglomerator to obtain spheronised granular composition in a size range of 0.05 mm to 6 mm.
18. The process for preparation of pesticidal composition in the form of wettable powder or wettable powder for seed coat as claimed in claim 4, comprises:
- 10 a) mixing elemental sulphur, fluxapyroxad and prothioconazole with at least one agrochemical excipient;
- b) milling the obtained mixture of step a) to obtain wettable powder; wherein the particles are in the size range of 0.1 to 50 microns.
- 15 19. The process for preparation of pesticidal composition in the form of liquid suspension as claimed in claim 5, wherein the process comprises:
- a) homogenizing mixture of elemental sulphur, fluxapyroxad and prothioconazole with at least one agrochemical excipient to obtain a suspension; and
- 20 b) wet milling the obtained suspension to provide composition with a particle size range of 0.1 micron to 50 microns.
20. The process for preparation of pesticidal composition in the form of suspoemulsion as claimed in claim 5, wherein the process comprises:
- 25 a) homogenizing mixture of elemental sulphur and fluxapyroxad with at least one agrochemical excipient to obtain a suspension; and wet milling the obtained suspension to provide suspension concentrate of elemental sulphur and fluxapyroxad with a particle size range of 0.1 to 50 microns;
- b) dissolving prothioconazole in oil or solvent and at least one  
30 agrochemically acceptable excipient to obtain emulsion concentrate of prothioconazole;

- c) mixing the suspension concentrate of step a) and emulsion concentrate of step b) to obtain suspoemulsion composition with a particle in the size range of 0.1 to 50 microns.

5 21. A method of controlling fungal disease, crop protection or improving the plant health and yield comprising treating at least one of a plant, crop, plant propagation material, locus, parts thereof or seed, seedling and soil with the pesticidal composition as claimed in claim 2.

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/IB2022/057750

## A. CLASSIFICATION OF SUBJECT MATTER

A01N25/00, A01N43/653, A01N59/02 Version=2022.01

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)

A01N

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

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

PatSeer, IPO Internal Database

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2018/162999 A1 (UPL LTD [IN]) 13 September, 2018 page 5: lines 19-22; page 6: line 26; page 7: lines 1-2; page 11: line 26; page 13: line 16; page 123: lines 28-29; page 127: line 28; page 153: lines 3-7; page 154: lines 1-13, 29	1-21
Y	WO 2012/016972 A2 (BAYER CROPSCIENCE AG [DE]) 09 February, 2012 page 1: lines 2-4; page 3: lines 20-24	1-21
Y	WO 2012/101660 A1 (SHAH DEEPAK PRANJIVANDAS [IN]) 02 August, 2012 page 2: line 40 - page 3: line 2; page 8: lines 14-25	1-21



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

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Date of the actual completion of the international search

21-11-2022

Date of mailing of the international search report

21-11-2022

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Information on patent family members

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PCT/IB2022/057750

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