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- (71) **Applicants:** **Dow AgroSciences LLC** [US/US]; 9330 Zionsville Road, Indianapolis, IN 46268-1054 (US). **Syngenta Participations AG** [CH/CH]; Schwarzwaldallee 215, 4058 Basel (CH).
- (72) **Inventors:** **WAGNER, Nicole Lynn**; 1660 S. Sandpiper Lane, Midland, MI 48623 (US). **HAYS, Melissa**; 11280 Sarle Road, Freeland, MI 48623 (US). **WUJEK, Dennis**; 440 N. Maple Street, Zionsville, IN 46077 (US). **HOPKINSON, Mike**; Syngenta Crop Protection, Inc., 410 Swing Road, Greensboro, NC 27409 (US).
- (74) **Agent:** **COY, Gregory B.**; Krieg DeVault LLP, One Indiana Square, Ste. 2800, Indianapolis, Indiana 46204 (US).
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(54) **Title:** SEED TREATMENT FORMULATIONS

(57) **Abstract:** A seed treatment mixture useful to produce coated seeds having a combination of good flowability characteristics and good plantability characteristics, while also having low dust-off characteristics, includes an agricultural active component and a binder formulation. The binder formulation includes a latex carrier and a wax, and is substantially free from added inorganic particulate materials. In one embodiment, the latex carrier comprises a styrene-acrylate based copolymer. In various aspects, the invention relates to seed treatment mixtures, binder formulations, methods of treating seeds, and coated seeds produced thereby.



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SEED TREATMENT FORMULATIONS

Cross-Reference to Related Application

The present application claims the benefit of the filing date of U.S. Provisional Application Serial No. 61/640,697 filed on April 30, 2012, which is
5 incorporated herein by reference.

BACKGROUND

The present invention relates generally to the formation of a coating on a seed and seed treatment formulations for same. More particularly, the invention
10 relates to seed treatment formulations that include a latex carrier and a wax, that are substantially free from added inorganic particulate materials, and that are useful to produce coated seeds having a combination of good flowability and plantability characteristics, while also having low dust-off characteristics. Seed treatment formulations having improved flowability, plantability and dust-off
15 features have long been sought; however, multiple challenges have been encountered that detract from each of the formulations heretofore made and used. In various aspects, the invention relates to seed treatment formulations, mixtures of seed treatment formulations with agricultural active ingredients, methods of treating seeds, and coated seeds produced thereby.

20 The use of pesticides to control pests in crops is a widespread practice that has gained a high degree of commercial success because it has been shown to increase crop yield. One approach for delivering pesticides to their desired locus of action that has been developed as a substitute for soil or foliar spraying is the application of pesticides directly to plant seeds. Seed treatment with pesticides
25 has the advantages of providing for the protection of the seeds, while reducing the amount of pesticide that is required (compared to foliar application of pesticides or broad application to soil) and limiting the amount of contact of workers with the pesticide. A common approach for seed treatment has been to use an approach that utilizes a binder formulation of multiple ingredients (also referred
30 to interchangeably herein as a “seed treatment formulation” or “polymer pre-blend”) combined with at least one agricultural active ingredient, often multiple active ingredients, to provide a coating that binds a desired amount of the active

ingredient(s) on the seed. The binder formulation is typically mixed with the active ingredient(s) and diluents water prior to being applied to seeds.

The term "seed treatment" generally refers to application of a material to a seed prior to or during the time it is planted in soil to improve the handling characteristics of the seed, protect the seed prior to germination, support the germination and/or support the growth of the resulting plant. Some seed treatments are employed solely for the purpose of improving the handling characteristics or other physical characteristics of seeds, and include no agricultural active ingredients. Other seed treatments bind one or more active ingredients to seeds for various beneficial purposes. For example, seed treatments that include one or more active ingredients are commonly used to ensure uniform stand establishment by protecting against soilborne diseases and insects. Typical examples include the application of pesticides such as fungicides, insecticides and plant growth regulators. Systemic seed treatments may eliminate, or at least reduce the need for, traditional broadcast sprays of foliar fungicides or insecticides for certain early season airborne diseases and insects.

A number of problems have been encountered in the development of seed treatments. For example, binder formulations that have been developed to date typically have one or more of the following disadvantages: low formulation stability, low seed flowability, high levels of dust- off of the pesticide and other coating ingredients from the seed prior to planting, and poor plantability characteristics. For example, treated seeds prepared from many formulations proposed in the prior art tend to be dusty, presumably as a result of the coating being abraded by the seeds' coming into contact with each other during ordinary drying, handling and planting operations. In addition to being unpleasant for personnel who handle the treated seeds, dustiness increases potential exposure to inherent hazards of the active ingredient(s) present in the coating. Dusting also has the possible effect of reducing the efficacy of the coating due to loss of a portion of the active ingredient(s) from the seed. Another major problem encountered in the development of binder formulations is that various ingredients that have been included in binder formulations in an effort to impart beneficial

properties have an overriding negative effect on the flowability of the coated seeds.

5 A number of seed coating additives have been evaluated for inclusion in binder formulations in an effort to remedy problems such as low seed flowability and excessive dust-off. However, it has been discovered, and has become well known, that a seed coating additive selected to improve flowability and plantability tends to have an adverse effect on dust-off. For example, a typical approach for increasing the flowability and plantability of a treated seed has been to include in the binder formulation substantial amounts of inorganic particulate material, examples of which include talc, titanium dioxide, mica and the like (also
10 sometimes referred to as “pigments” due to the common use of these and other inorganic particulate materials in paints). The use of organic particles, however, particularly in relatively large amounts, has resulted in seeds with unacceptably high dust-off.

15 Attempts to address the problem of unacceptable levels of dust-off have included, for example, the inclusion of ingredients that increase the “stickiness” of a resulting coating. The objective of these attempts has been to more strongly stick the coating materials to a seed, to thereby make the seed less susceptible to dusting, which has been attempted by including materials in the formulation that
20 provide stronger adhesion properties. Such ingredients, however, have been found to cause seeds treated therewith to have unacceptably poor flowability and plantability characteristics. Indeed, the very “stickiness” properties that were considered desirable to hold the coating materials to the seeds, and thereby reduce dust-off, are the same properties that create the flowability problems, because
25 these same ingredients tend to also stick coated seeds together during subsequent storage and/or handling of the coated seeds. This problem, in turn, has been commonly addressed by including additional ingredients in the binder formulation to offset the “stickiness” of the coating to restore better seed flowability characteristics; however, such efforts have had the adverse effect of increasing
30 dust-off.

Accordingly, there is a need in the art for new binder formulations that are effective to produce coated seeds having good flowability and plantability

characteristics and also good (i.e., low) dust-off characteristics. The present application addresses this need and provides additional benefits.

SUMMARY

It has been surprisingly found that inorganic particulate materials can be omitted from a binder formulation without producing unacceptable flowability, plantability or dust-off characteristics by including certain combinations of ingredients. This application addresses the needs discussed above by providing binder formulations that produce coated seeds having advantageous combinations of characteristics while also being substantially free from added inorganic particulate materials. Such formulations are effective to adhere active ingredients to seeds, while producing coated seeds that show good flowability and plantability properties and low dust-off.

In various aspects, the present application provides binder formulations, methods for making and using same to treat seeds, and coated seeds made using same. The binder formulations can have varying amounts of water therein, but are typically provided as a concentrate of the ingredients therein that is suitable for being diluted with water shortly before application to seeds. In another embodiment, the binder formulation is provided as a re-dispersible solids mixture that can be mixed into a predetermined quantity of water shortly before application to seeds. In addition, an active component can be mixed with the binder formulation and water to produce a seed treatment mixture. As used herein, the term "seed treatment mixture" refers to the slurry that is actually applied to seeds in a seed treatment process.

In one embodiment, seed treatment mixtures comprise an active component and a binder formulation that includes a latex carrier and a wax, and that is substantially free from added inorganic particulate materials. The binder formulation and/or the seed treatment mixture optionally also includes other product stabilizing additives. These ingredients when used together provide binder formulations that are storage stable and are suitable for use in normal seed treatment equipment. Seeds treated with the seed treatment mixture have good flowability, plantability and dust-off characteristics.

Further embodiments, forms, features, advantages, aspects, and benefits shall become apparent from the following descriptions.

DETAILED DESCRIPTION

For the purpose of promoting an understanding of the principles of the invention, reference will now be made to various embodiments and specific language will be used to describe the same. It will nevertheless be understood
5 that no limitation of the scope of the invention is thereby intended. Any alterations and further modifications in the described embodiments, and any further applications of the principles of the invention as described herein are contemplated as would normally occur to one skilled in the art to which the invention relates.

- 10 The present application relates to a discovery that certain combinations of ingredients when used together surprisingly enable the elimination of inorganic particulate materials from a binder formulation or seed treatment mixture without detrimental loss of flowability and plantability characteristics of resulting treated seeds, while effectively binding an active ingredient to the treated seeds.
- 15 Moreover, seeds treated with the seed treatment mixtures described herein have low dust-off.

In one aspect, the present application provides a binder formulation that includes a latex carrier and a wax, and is substantially free from added inorganic particulate materials. In another aspect, the application provides a seed treatment
20 mixture that includes a binder formulation as described herein, an agricultural active component and water. The agricultural active component includes at least one agricultural active ingredient. Binder formulations having certain combinations of ingredients as described herein have been made and tested and have been discovered to be effective for producing treated seeds that exhibit
25 surprisingly good flowability, plantability and dust-off characteristics compared to seeds coated with seed treatment mixtures made using polymer premix products currently in the marketplace that include significant amounts of inorganic particulate materials.

In one embodiment, the latex carrier in the binder formulation comprises a
30 styrene-acrylate based copolymer. The term "latex" as used herein means a dispersion in an aqueous carrier of polymer particles, in this case, particles of a styrene-acrylate based copolymer. In one embodiment, the copolymer includes at

least two of the following comonomers: styrene comonomers, butyl acrylate comonomers, acrylonitrile comonomers and acrylic acid comonomers. In another embodiment, the copolymer includes at least three of the above comonomers. In yet another embodiment, the copolymer includes all four of these comonomers.

- 5 In still another embodiment, the copolymer includes from about 1% to about 30% styrene comonomers by weight, from about 50% to about 90% butyl acrylate comonomers by weight, from about 1% to about 25% acrylonitrile comonomers by weight and up to about 20% acrylic acid comonomers by weight. In still yet another embodiment, the copolymer includes from about 5% to about 25%
- 10 styrene comonomers by weight, from about 60% to about 80% butyl acrylate comonomers by weight, from about 5% to about 20% acrylonitrile comonomers by weight and from about 1 to about 10% acrylic acid comonomers by weight. Another embodiment includes from about 10% to about 20% styrene comonomers by weight, from about 64% to about 74% butyl acrylate comonomers by weight,
- 15 from about 7% to about 17% acrylonitrile comonomers by weight and about 3 to about 7% acrylic acid comonomers by weight. Yet another embodiment includes from about 13% to about 17% styrene comonomers by weight, from about 67% to about 71% butyl acrylate comonomers by weight, from about 9% to about 15% acrylonitrile comonomers by weight and about 4 to about 6% acrylic acid
- 20 comonomers by weight. Still another embodiment includes about 15% styrene comonomers by weight, about 69% butyl acrylate comonomers by weight, about 12% acrylonitrile comonomers by weight and about 5% acrylic acid comonomers by weight. In one embodiment, the copolymer is a random copolymer.

- The styrene-acrylate based copolymer can be formed by conventional
- 25 emulsion polymerization. The method for producing styrene-acrylate based resins is not particularly limited and a known method can be adopted. For example, the copolymer can be made by emulsifying a mixture of monomers (in predetermined proportions based upon the desired proportions in the resulting polymer), water, surfactant and polymerization catalyst; charging the resulting emulsion into a
- 30 conventional polymerization reactor; and heating the constituents in the reactor to about 60-95° C for about 15 minutes to 8 hours. The resulting polymer can then

be neutralized with ammonia or an amine. Styrene-acrylate based copolymers as described herein are also readily available commercially.

In another embodiment, the latex carrier in the binder formulation comprises a styrene-butadiene latex.

5 As will be appreciated by a person of ordinary skill in the art, a latex carrier as described herein will typically include, in addition to the polymer particles and water, additional ingredients in some amount. For example, the latex carrier may include surfactants and catalysts that are not removed following the polymerization reaction. In addition, the latex can also include other
10 additives. In addition, various amounts of water can be included in the latex carrier. As such, various latexes made or obtained commercially can have varying amounts of polymer solids relative to the total amount of the latex carrier. In one embodiment, the latex carrier includes from about 30% to about 70% polymer solids. In another embodiment, the latex carrier includes from about
15 40% to about 60% polymer solids. In yet another embodiment, the latex carrier includes from about 45% to about 50% polymer solids. For purposes of describing various binder formulations herein, the weight percent values for the latex carrier are based upon the weight of the latex carrier component as supplied. The term "as supplied" is used to refer to the total weight of a given latex carrier
20 ingredient, including the polymer particles, water and other ingredients therein.

 In one embodiment, the copolymer particles have an average particle size of from less than 100 nanometers (nm) to about 400 nm. In another embodiment, the average particle size is from about 100 nm to about 200 nm. In yet another embodiment, the weight average molecular weight is from about 500 g/mol to
25 about 3Mg/mol. The molecular weight can be measured, for example, by gel permeation chromatography using polystyrene as the standard. Particle size can be measured, for example, by dynamic light scattering.

 In one embodiment, the latex carrier (which includes an aqueous suspension of polymer particles) comprises from about 5% to about 50% by
30 weight of the binder formulation. In another embodiment, the latex carrier comprises from about 5% to about 40% by weight of the binder formulation. In yet another embodiment, the latex carrier comprises from about 10% to about

30% by weight of the binder formulation. In still another embodiment, the latex carrier comprises from about 15% to about 25% by weight of the binder formulation. The polymer solids of the latex carrier in various embodiments are from about 2% to about 35% by weight of the binder formulation, from about 3% to about 30% by weight of the binder formulation, from about 5% to about 25% by weight of the binder formulation and about 8% to about 20% by weight of the binder formulation.

The binder formulation also includes a wax. The wax can be, for example, natural wax (e.g., beeswax or lanolin), vegetable wax (e.g., Carnauba), mineral wax (e.g., montan or paraffin), synthetic wax (e.g., polyethylene (polar or nonpolar), polypropylene, Fischer-Tropsch, or polybutene), or another lubricant such as, for example, polytetrafluoroethylene. In one embodiment, the wax is a synthetic wax. In another embodiment, the wax is polyethylene wax. A representative polyethylene wax product that can be employed in the binder formulations described herein is the product named Liquitron 461, which is commercially available from Lubrizol Advanced Materials, Inc. (McCook, Illinois). As with the latex carrier, a synthetic wax will typically include, in addition to the wax solids themselves, additional ingredients in some amount. For example, the wax ingredient may include surfactants, stabilizers and preservatives. In one embodiment, the wax ingredient comprises from about 2% to about 40% by weight of the binder formulation. In another embodiment, the wax ingredient comprises from about 5% to about 35% by weight of the binder formulation. In yet another embodiment, the wax ingredient comprises from about 10% to about 35% by weight of the binder formulation. In still another embodiment, the wax ingredient comprises from about 15% to about 30% by weight of the binder formulation. In one embodiment, wax solids in various embodiments comprise from about 2% to about 40% by weight of the binder formulation, from about 5% to about 35% by weight of the binder formulation, from about 10% to about 35% by weight of the binder formulation and about 15% to about 30% by weight of the binder formulation.

In the present application, an "active ingredient" is a compound that directly exerts a biologically relevant effect. In one embodiment, the active

ingredient exerts a pesticidal effect. In alternative embodiments, the active ingredient can have one or more other effects instead of, or in addition to, a pesticidal effect. For example, the active ingredient may function to provide nutrition or control one or more plant diseases.

5 In one embodiment, the active ingredient comprises a plant pesticide. As used herein, the term “pesticide” is used to refer to an agent that has the purpose or effect of preventing infection of a plant by any pest or of repelling, deterring or destroying the pest or of reducing in another way the damage caused by it. Plant pests can belong to different groups of organisms; the higher animals, in
10 particular insects and acarids, include numerous important pests, as do nematodes and snails; vertebrates, such as mammals and birds, are today of secondary importance in industrialized countries. Numerous groups of microbes, including fungi, bacteria, inclusive of mycoplasmas, viruses and viroids, comprise pests, and even weeds, which compete with useful plants for limited habitat and other
15 resources, can be classed as pests in the broad sense. Pesticides comprise in particular aphicides, acaricides, desiccants, bactericides, chemosterilants, defoliants, antifeedants, fungicides, herbicides, herbicide safeners, insect attractants, insecticides, insect repellents, molluscicides, nematocides, mating disrupters, plant activators, plant growth regulators, rodenticides, mammal
20 repellents, synergists, bird repellents and virucides.

 In one embodiment, the active ingredient is effective to protect the seed and/or the resulting plant against diseases in the soil, which mostly occur in the early stages of plant development. For example and without limitation, the active ingredient can be formulated to target pathogens including *Pythium*, *Tilletia*,
25 *Gerlachia*, *Septoria*, *Ustilago*, *Fusarium*, *Rhizoctonia* (so-called “damping off complex”); Oomycetes such as *Phytophthora*, *Plasmopara*, *Pseudoperonospora*, *Bremia* etc. as well as against the *Botrytis* species, *Pyrenophora*, *Monilinia* and further representatives of the Ascomycetes, Deuteromycetes and Basidiomycetes classes.

30 The following list of pesticides which can be used in a seed treatment mixture as described herein is intended to illustrate possible active ingredients, but not to impose any limitation:

Typical fungicidal ingredients include Captan (N-trichloromethyl)thio-4-cyclohexane-1,2-dicarboximide), Thiram (tetramethylthioperoxydicarbonic diamide; commercially available under the tradename Proseed), Metalaxyl (methyl N-(2,6-dimethylphenyl)-N-(methoxyacetyl)-DL-alaninate), Fludioxonil
5 (4-(2,2-difluoro-1,3-benzodioxol-4-yl)-1-H-pyrrol-3-carbonitril; commercially available in a blend with mefenoxam under the tradename Maxim XL), difenoconazole (commercially available under the tradename Dividend 3FS), carbendazim iprodione (commercially available under the tradename Rovral.RTM.), ipconazole, mefenoxam (commercially available under the
10 tradename Apron XL), tebuconazole, carboxin, thiabendazole, azoxystrobin, prochloraz, and Oxadixyl (N-(2,6-dimethylphenyl)-2-methoxy-N-(2-oxo-3-oxazolidinyl) acetamide).

Typical bactericidal ingredients include streptomycin, penicillins, tetracyclines, ampicillin, and oxolinic acid.

15 Typical insecticidal ingredients include pyrethroids, organophosphates, caramoyloximes, pyrazoles, amidines, halogenated hydrocarbons, neonicotinoids, and carbamates and derivatives thereof. Particularly suitable classes of insecticides include organophosphates, phenylpyrazoles and pyrethroids. Preferred
insecticides are those known as terbufos, chlorpyrifos, fipronil, chlorethoxyfos,
20 tefluthrin, carbofuran, imidacloprid, and tebupirimfos. Commercially available insecticides include imidacloprid (commercially available under the tradename Gaucho™), and clothianidin (commercially available from Bayer under the tradename Poncho®), thiomethoxam (commercially available from Syngenta
under the tradename Cruiser®) and fipronil (commercially available from BASF
25 under the tradename Regent®).

Commercially available nematocidal ingredients include abamectin (commercially available from Syngenta under the tradename Avicta®) thiodicarb (commercially available from Bayer under the tradename Aeris®).

In one embodiment, the active component of the seed treatment mixture
30 includes at least one fungicidal ingredient. Fungicidal ingredients are employed in a fungicidally effective amount in the mixture. One representative fungicide that can be employed is Maxim Quattro, which is commercially available from

Syngenta. The fungicidal ingredient can be included in the seed treatment mixture, for example, in an amount of from about 1% to about 60% by weight, based on the total weight of the seed treatment mixture.

5 Mixtures of one or more of the foregoing fungicidally active compounds also are usable together as an active component in the seed treatment mixture. In one embodiment, mixtures of at least one ambient liquid fungicide (for example, a phenylamide, such as R-metalaxyl) and at least one ambient solid fungicide (for example, a phenylpyrrole such as fludioxonil) are employed.

10 In another embodiment, the active component in the seed treatment mixture includes at least one insecticidal ingredient. Insecticidal ingredients are employed in an insecticidally effective amount in the formulation. One representative insecticide that can be employed is Cruiser 5FS, which is commercially available from Syngenta. The insecticide can be included in the seed treatment mixture, for example, in an amount of 1% to about 60% by weight,
15 based on the total weight of the seed treatment mixture.

In yet another embodiment, the active component includes both a fungicidal ingredient and an insecticidal ingredient. In another embodiment, the active component includes at least one fungicidal ingredient, at least one insecticidal ingredient and at least one nematicidal ingredient, which can be
20 incorporated as individual ingredients or as pre-mixed ingredients. For example, the commercial product Avicta Duo 300 is a combination nematicide/insecticide product that can be employed to provide these ingredients to for the active component. In yet another embodiment the active component further includes other active ingredients.

25 As will be appreciated by a person of ordinary skill in the art, an active component as described herein, which can include one active ingredient or a mixture of active ingredients, may include, in addition to the one or more active ingredients, additional non-active ingredients in some amount. For example, the active component may include surfactants, solvents (e.g., water and/or other
30 solvents), thickeners, preservatives (including bactericides and other biocides), humectants, antifreeze ingredients, antifoam ingredients and if appropriate colorants, or other additives. As such, various active components made or

obtained commercially can have varying amounts of active ingredients (i.e., active compounds) relative to the other, non-active, ingredients in the active component, including a wide variety of diluted forms, all of which are included within the meaning of the term “active component” herein. For purposes of
5 describing various seed treatment mixture herein, the weight percent values for the active component are based upon the weight of the active component as supplied. The term “as supplied” is used to refer to the total weight of a given active component, including the active ingredients and any non-active ingredients that may be present therein.

10 The exact amount of an active ingredient included in the seed treatment mixture can vary depending upon the size and other characteristics (e.g., surface structure, etc.) of the seed to be coated and other considerations. The active component of the seed treatment mixture should not inhibit germination of the seed and should be efficacious in protecting the seed and/or the plant during that
15 time in the target pest's life cycle in which it causes injury to the seed or plant. In one embodiment, the seed treatment mixture applied to a seed is operable to form a coating having an active ingredient therein that remains efficacious for up to about 120 days after sowing. In another embodiment, the coating applied to a seed is operable to remain efficacious for up to about 60 days after sowing.

20 The seed treatment mixture can also comprise or may be applied together and/or sequentially with further active compounds. These further compounds can be fertilizers or micronutrient donors or other preparations that influence plant growth, such as inoculants.

While additional polymers are not needed in the binder formulation, the
25 binder formulation of the present application can include one or more additional polymers so long as the inclusion of the additional polymer does not unduly interfere with the flowability, dust-off and plantability characteristics of a coated seed made using the formulation. Additional binders that can be included, either alone or in combination, include, for example, polyesters, polyether esters,
30 polyanhydrides, polyester urethanes, polyester amides; polyvinyl acetates; polyvinyl acetate copolymers; polyvinyl alcohols and tylose; polyvinyl alcohol copolymers; polyvinylpyrrolidones; polysaccharides, including starches, modified

starches and starch derivatives, dextrans, maltodextrins, alginates, chitosanes and celluloses, cellulose esters, cellulose ethers and cellulose ether esters including ethylcelluloses, methylcelluloses, hydroxymethylcelluloses, hydroxypropylcelluloses and carboxymethylcellulose; fats; oils; proteins, including casein, gelatin and zeins; gum arabics; shellacs; vinylidene chloride and vinylidene chloride copolymers; lignosulfonates, in particular calcium lignosulfonates; polyacrylates, polymethacrylates and acrylic copolymers; polyvinylacrylates; polyethylene oxide; polybutenes, polyisobutenes, polystyrene, polybutadiene, polyethyleneamines, polyethylenamides; acrylamide polymers and copolymers; polyhydroxyethyl acrylate, methylacrylamide monomers; and polychloroprene. Copolymers of the polymers listed above are also envisioned, one suitable example being polystyrene-polybutadiene copolymers.

In one embodiment, the amount of additional binder or combination of binders does not exceed 10% by weight of the binder formulation. In another embodiment, it does not exceed 5% by weight and, in yet another embodiment, 1% by weight, based on the weight of the binder formulation. According to a particular embodiment, the binder formulation does not include significant amounts of additional binders, i.e. they contain no additional binder or the amount is below 0.5% by weight and preferably below 0.1% by weight, based on the weight of the binder formulation.

In addition to a latex carrier and a wax, the binder formulations, and thus the seed treatment mixtures, of the present application optionally also include other auxiliary ingredients that are customary in agrochemical formulations and do not unduly interfere with the flowability, dust-off and plantability characteristics of a coated seed made using the formulation. The selection of auxiliaries to be included can depend on the particular active ingredient selected for inclusion or the type of seed being treated, for example. Examples for suitable auxiliary ingredients include solvents, carriers, protective colloids, organic and inorganic thickeners, preservatives (including bactericides and other biocides), humectants, antifreeze ingredients, antifoam ingredients and if appropriate colorants.

In one embodiment, a surfactant or other wetter or dispersant is present in the binder formulation in an amount of from 0 to about 10% by weight. In other embodiments, the amount of the surfactant or other wetter or dispersant in the binder formulation is from 0 to about 5% by weight and from 0 to about 2% by weight. The phrase "surfactant or other wetter or dispersant" is used herein to refer to compounds that lower the surface tension of a liquid, the interfacial tension between two liquids, or that between a liquid and a solid. A wide variety of suitable surfactant and other wetter or dispersant ingredients are known and commercially available that can be used in accordance with the present application.

In one embodiment, the binder formulation includes at least one product stabilizing ingredient. In one embodiment, the product stabilizing ingredient is selected from the group consisting of an antifoam ingredient, a thickener, an antifreeze ingredient, a preservative, and combinations thereof. In another embodiment, the binder formulation includes a product stabilizing ingredient selected from the group consisting of an antifreeze ingredient, a thickener, an antifoam ingredient and a preservative.

In one embodiment, an antifreeze ingredient is present in the binder formulation at a concentration of from about 1 to about 20% by weight. In another embodiment, the concentration of the antifreeze ingredient in the binder formulation is from about 1 to about 10. Antifreeze ingredients that can be employed in an aqueous composition include those substances which lead to a depression of the melting point of water. Suitable antifreeze ingredients include, for example and without limitation, ethylene glycol, 1,2-propylene glycol, 1,3-propylene glycol, 1,2-butanediol, 1,3-butanediol, 1,4-butanediol, 1,4-pentanediol, 3-methyl-1,5-pentanediol, 2,3-dimethyl-2,3-butanediol, trimethylol propane, mannitol, sorbitol, glycerol, pentaerythritol, 1,4-cyclohexanedimethanol, xyleneol, bisphenols such as bisphenol A or the like. In addition, ether alcohols such as diethylene glycol, triethylene glycol, tetraethylene glycol, polyoxyethylene or polyoxypropylene glycols of molecular weight up to about 4000, diethylene glycol monomethylether, diethylene glycol monoethylether, triethylene glycol monomethylether, butoxyethanol, butylene glycol monobutylether,

dipentaerythritol, tripentaerythritol, tetrapentaerythritol, diglycerol, triglycerol, tetraglycerol, pentaglycerol, hexaglycerol, heptaglycerol, octaglycerol and combinations thereof.

In one embodiment, a thickener is present in the binder formulation in an amount of from about 1 to about 25% by weight. In another embodiment, the amount of the thickener in the binder formulation is from about 1 to about 10% by weight. The term "thickener" is used herein to refer to compounds that impart a modified flowability to formulations, including, for example, certain viscosity characteristics. In one embodiment the thickener is a compound that imparts an increased viscosity under static conditions and a lower viscosity during agitation.

Examples of suitable thickeners include polysaccharides and organic clays. In one embodiment, the thickener is a water-soluble polymer that exhibits pseudoplastic properties in an aqueous medium, such as, for example, gum arabic, gum karaya, gum tragacanth, guar gum, locust bean gum, xanthan gum, carrageenan, alginate salt, casein, dextran, pectin, agar, 2-hydroxyethyl starch, 2-aminoethyl starch, 2-hydroxy ethyl cellulose, methyl cellulose, carboxymethyl cellulose salt, cellulose sulfate salt, polyacrylamide, alkali metal salts of the maleic anhydride copolymers, alkali metal salts of poly(meth)acrylate, and the like. This list is not intended to be exhaustive, however, and a wide variety of other thickeners can be employed. A wide variety of thickeners are available commercially, including, for example, Kelzan® (CP Kelco, U.S.A.), Rhodopol® 23 (Rhodia, France).

In one embodiment, an antifoam ingredient is present in the binder formulation in an amount up to about 2% by weight. In another embodiment, an antifoam ingredient is present in an amount of from about 0.01 to about 1% by weight. Antifoam ingredients that can be employed include those substances that inhibit the development of foam, a variety of which are conventionally used for formulating agrochemical active ingredients. Examples of antifoam ingredients that can be employed include silicone emulsions (such as e.g. Silikon® SRE, Wacker, Germany or Rhodorsil®, Rhodia, France), long chain alcohols, fatty acids, salts of fatty acids, fluoroorganic compounds and mixtures thereof. For example, suitable anti-foaming ingredients include polyethylene glycol, glycerine,

mineral oil defoamers, silicone defoamers, non-silicone defoamers (such as polyethers, polyacrylates), dimethylpolysiloxanes (silicone oils), arylalkyl modified polysiloxanes, and polyether siloxane copolymer containing fumed silica. Silicone antifoam emulsions are particularly suitable and are included as the antifoam ingredient in one embodiment. In another embodiment, the antifoam ingredient comprises magnesium stearate.

One or more preservatives (e.g., antimicrobial agents or other biocidal agents) may also be included for preservation and stabilization of the binder formulation. In one embodiment, a preservative is present in the binder formulation in an amount up to about 2% by weight. In another embodiment, a preservative is present in an amount of from about 0.01 to about 1% by weight. Examples of suitable bactericides include those based on dichlorophene and benzylalcohol hemi formal (Proxel® from ICI or Acticide® RS from Thor Chemie and Kathon® MK from Dow Chemical) and isothiazolinone derivatives such as alkylisothiazolinones and benzisothiazolinones (Acticide® MBS from Thor Chemie). As further examples, suitable preservatives include MIT (2-methyl-4-isothiazolin-3-one), BIT (1,2-benzisothiazolin-3-one, which can be obtained from Avecia, Inc. as Proxel GXL as a solution in sodium hydroxide and dipropylene glycol), 5-chloro-2-(4-chlorobenzyl)-3(2H)-isothiazolone, 5-chloro-2-methyl-2H-isothiazol-3-one, 5-chloro-2-methyl-2H-isothiazol-3-one-hydrochloride, 4,5-dichloro-2-cyclohexyl-4-isothiazolin-3-one, 4,5-dichloro-2-octyl-2H-isothiazol-3-one, 2-methyl-2H-isothiazol-3-one, 2-methyl-2H-isothiazol-3-one-calcium chloride complex, 2-octyl-2H-isothiazol-3-one and benzyl alcohol hemiformal.

In other embodiments, additional ingredients can be included in a binder formulation as described herein. Examples of additional ingredients include humectants, colorants and the like.

In an embodiment including a colorant, the colorant can be, for example, an organic pigment or a soluble dye. The colorant can be included in the binder formulation, can be included in an active component, or can subsequently be mixed as an independent ingredient with a binder formulation and an active component to form a seed treatment mixture including the colorant.

Of course, in alternative embodiments, the colorant can be omitted entirely. One advantage of having a colorant (also referred to as a “coloring ingredient”) included in the seed treatment mixture is so that an observer can immediately determine that the seeds treated therewith are treated seeds. Another potential
5 advantage is that a color coding system can be employed to convey information regarding the specific type of coating present on a treated seed. A dye can also be useful to indicate to the user the degree of uniformity of the coating applied.

Colorants that can be employed in a seed treatment mixture as described herein include a wide variety of dyes that are conventionally used for such
10 purposes, and that do not interfere with the flowability, dust-off and plantability characteristics of a coated seed made using the formulation. A wide variety of suitable colorants are available commercially and can readily be selected and used by a person of ordinary skill in the art in view of the present disclosure. In one embodiment, a colorant is used that is also active as repellents for warm-blooded
15 animals. Examples of such colorants include anthraquinone dyes, azo dyes and metal phthalocyanine dyes. This list is provided only to set forth some examples of colorants that can be employed, it being understood that a wide variety of alternative colorants are known and available commercially that can be included as alternatives to, or in addition to, the above, and such are expressly
20 contemplated by the present application.

In one embodiment, the amount of colorant (including individual colorants or combinations of colorants) is from 0% to about 10% by weight of the binder formulation or of the seed treatment mixture. In another embodiment, the amount of colorant is from 0 to about 5% by weight of the binder formulation or of the
25 seed treatment mixture.

The binder formulations and seed treatment mixtures described herein are substantially free from added inorganic particulate materials. As used in the preceding sentence, the term “added” means that the identified materials are not added to the binder formulation or the seed treatment mixture as an ingredient. It
30 is understood, however, that some quantities of one or more of these materials may be present in other ingredients, and that such quantities are not considered “added” ingredients as that term is used herein. For example, a latex carrier

ingredient, a stabilizing ingredient, and possibly the wax or other ingredient included in a binder formulation described herein, may include some amount of one or more inorganic particulate material as a portion of that ingredient. These amounts that are included in other components or ingredients are not considered

5 “added inorganic particulate materials” as defined herein. In addition, the term “substantially free from” does not mean that the identified materials are necessarily completely absent from the binder formulation or seed treatment mixture, but rather that such materials are not added in large enough quantities to materially affect the flowability, dust-off and/or plantability characteristics of a

10 coated seed made using the seed treatment mixture. In one embodiment, the binder formulation includes less than 1% of added inorganic particulate materials by weight. In another embodiment, the binder formulation includes less than 0.5% of added inorganic particulate materials by weight.

The binder formulation embodiments described above can be diluted with

15 water to provide a diluted binder formulation that is itself used as a seed treatment mixture, i.e., to provide a coating on a seed that has good flowability, low dust-off and good plantability features. Coating with a diluted binder formulation (i.e., without an added active component) may be desired, for example, in the case of a seed that is so small or irregularly shaped that it would benefit from having a

20 coating provided thereon to increase the overall mass of the seed or otherwise improve the physical properties of the seed for more uniform planting. Coating with a diluted binder formulation (i.e., without an added active component) may also be desired, for example, to provide an over-coating on a seed that has previously been treated with an active ingredient or a prior coating of some kind

25 that has poor characteristics, i.e., poorer flowability or plantability characteristics and/or poorer dust-off characteristics. In this embodiment, the previously treated seed can be enveloped with an over-coating comprising a binder formulation as described herein. Thus, in one embodiment, the binder formulation is itself used as a seed treatment mixture, either in an initially prepared form or in a more

30 diluted form.

In another embodiment, the binder formulation is combined with an agriculture active component, water, and optionally other ingredients, such as

colorants, to provide a seed treatment mixture usable in a seed treatment process. As will be appreciated by a person skilled in the art, because the proportions of ingredients (i.e., weight percentages and weight percent ranges) described above in connection with a binder formulation relate only to the binder formulation component of a seed treatment mixture, the ingredients in the binder formulation will become diluted when the binder formulation is combined with an active component and/or other components and/or additional water. The amount of the active component that is included in the seed treatment mixture can vary depending upon the type of seed, the desired amount of active ingredient loading per seed and other considerations. In one embodiment, the amount of active component included in the seed treatment mixture is based on an amount of the active ingredient or ingredients necessary to be pesticidally effective when present in a seed coating. One advantage of the binder formulations described herein is that they are capable of binding a significant amount of an active component to a seed when mixed therewith. In one embodiment, a seed treatment mixture includes from about 20% to about 70% by weight of an active component and from about 20% to about 60% by weight of a binder formulation as described herein, with the balance, if any, including water and optionally other ingredients. In another embodiment, a seed treatment mixture includes from about 30% to about 60% by weight of an active component and from about 25% to about 45% by weight of a binder formulation. These weight percent values are based on the "as added" amounts of the active component and binder formulation, respectively. As discussed above, these components can, and typically do, include various amounts of solvents and other formulary ingredients.

25 In one embodiment, the viscosity of the binder formulation is from about 50 to about 2000 mPas when measured with a BROOKFIELD viscometer with spindle 3 at 30 rpm and 25 ° C. In another embodiment, the viscosity is from about 100 to about 1000 mPas. In one embodiment, a binder formulation as described herein is stable and maintains its viscosity and homogeneity within

30 desirable parameters for at least 12 months at 25° C.

 In one embodiment, a seed treatment mixture includes from about 30% to about 60% by weight of an active component comprising a fungicide and a

pesticide; from about 30% to about 40% by weight of a binder formulation; from about 0.1% to about 2% by weight of a colorant; and from about 0% to about 50% by weight of added water. In one embodiment, the pesticide portion of the active component comprises from about 35% to about 55% of the seed treatment mixture and the fungicide portion comprises from about 2% to about 10% of the seed treatment mixture. In one embodiment, the pesticide is a combination of a nematocide, an insecticide and a fungicide. For example and without limitation, the nematocide and insecticide can be provided in the form of the commercial product Avicta Duo, which is a mixture of abamectin and thiamethoxam commercially available from Syngenta, and the fungicide can be provided in the form of the commercial product Maxim Quattro, which is a mixture of mefenoxam, fludioxonil, azoxystrobin and thiabendazole commercially available from Syngenta.

In one embodiment, the binder formulation includes from about 15% to about 25% by weight of a latex (as added, including, e.g., about 40% to 50% solids) comprising a styrene-acrylate based copolymer; and from about 15% to about 30% by weight of a polyethylene wax. A suitable polyethylene wax, for example, is the commercial product Liquitron 420 or the commercial product Liquitron 461, each of which is commercially available from Lubrizol Advanced Materials, Inc. (McCook, Illinois). In one embodiment, the polyethylene wax is substantially free from alkyl phenol ethoxylates (APE). In another embodiment, the binder formulation includes from about 15% to about 25% by weight of a latex (as added) comprising styrene-butadiene; and from about 15% to about 30% by weight of a polyethylene wax.

In another embodiment, the binder formulation further includes from about 2% to about 6% propylene glycol; from about 8% to about 14% xanthan gum gel (about 2% solids); from about 0 to about 10% surfactant or other wetter or dispersant; from about 0.01 to about 0.1% silicone emulsion (such as, for example, Antifoam 1500, which is commercially available from Dow Corning, Midland, Michigan); and from about 0.02% to about 0.15% 1,2-benzisothiazolin-3-one in glycol (such as, for example, Proxel GXL, which is commercially

available from Avecia, Inc.). In another embodiment, the binder formulation further includes from about 0% to about 40% of added water.

The binder formulation can be prepared by blending the various ingredients together. In one manner of making a binder formulation embodiment, a first component is prepared by introducing a predetermined amount of the antifreeze ingredient and a predetermined amount of the antifoam ingredient into a 3-pronged mixer and mixed at 500 rpm for five minutes, followed by 750 rpm for 5 minutes to provide a first component. (Each "predetermined amount" is based upon the desired ratios in the final binder formulation). A second component is made by introducing a predetermined amount of the thickener and a predetermined amount of the preservative into a 3-pronged mixer and mixed at 500 rpm for five minutes. The first component is then introduced, together with a predetermined amount of a wax and a predetermined amount of water, into a Caframo High Speed Mixer and mixed using a paddle mixing blade. The second component and a predetermined amount of the latex carrier, together with predetermined amounts of any other ingredients to be included in the binder formulation, are then added to the contents of the Caframo High Speed Mixer, and the resulting mixture is then mixed with a 3-pronged mixer at 500 rpm for five minutes to provide a binder formulation.

The binder formulation can then be used individually (i.e., after dilution with water) for coating seeds, or can be further blended with a predetermined amount of an active component, water, and optionally a colorant, to provide a seed treatment mixture. The seed treatment mixture can be prepared immediately following preparation of the binder formulation or, alternatively, the binder formulation can be stored, or optionally packaged and shipped, for future use in preparing a seed treatment mixture. For example, the blending of the binder formulation with the active component can be done immediately prior to application of the seed treatment mixture to seeds.

In another embodiment, the binder formulation can be provided in the form of a re-dispersible solids mixture of the binder formulation ingredients. A seed treatment mixture can be made using this type of binder formulation by diluting the solids mixture with water, and optionally with an active component

and/or a colorant, prior to application to seeds. This embodiment can be advantageous, for example, in situations where the application of a seed treatment mixture to seeds does not occur at the same location as the manufacture of the binder formulation. Due to the need for shipment or transportation of the binder formulation to the location of application, the lower volume and mass of the re-dispersible solids mixture reduces the cost of such transportation. At the location where the formulation is to be applied to seeds, water, and optionally other ingredients to be included in the seed treatment mixture, can be mixed with the re-dispersible solids mixture in amounts to provide a seed treatment mixture having desired properties for application to seeds. As will be appreciated by persons skilled in the art in view of the present descriptions, a re-dispersible solids mixture will typically include all non-water ingredients in the same proportions to one another as desired in the final seed treatment mixture.

The seed treatment mixture can be applied to a seed in a variety of manners conventional in the seed treating art, including but not limited to mixing in a container (e.g., a bottle, bag or tumbler), mechanical application, tumbling, spraying, and immersion, followed by drying. Examples of seed coating techniques and machines that can be employed include fluidized bed techniques, the roller mill method, rotary seed treaters, drum coaters, side vended pan, tumble mixers and spouted beds. The seeds may be pre-sized before coating. In one embodiment, the seed treatment mixture is applied to seeds in a Hege seed treater, which rotates as the formulation is being added to the seeds. Mixing is preferably continued until the seed treatment mixture is distributed uniformly on the seed (i.e., uniform coatings over all of the seeds to be treated and an even coating on each individual seed). The seed treatment mixture can be applied to seeds in a batch treatment process or in a continuous treatment process. In one representative batch treatment process, the seeds to be treated are introduced to a batch treatment tank and the seed treatment mixture is then added and mixed with the seeds. Alternatively a continuous treatment process can be used to apply the seed treatment mixture to seeds in which a stream of seeds are introduced into a receptacle containing the seed treatment slurry and, after contacting the formulation, recovered from the receptacle for drying. A stream of seed treatment

mixture can continuously flow into the receptacle as well to replenish quantities of the mixture that are removed with treated seeds.

After application of the seed treatment mixture (whether in a batch process or a continuous process) the seeds are allowed a period of time to dry. For example, the seeds can be spun in a bowl for a period of time, for example, at least 15 seconds, to allow for drying. Different time periods may be needed to allow for variability in drying conditions due to weather or different seed sizes. Moreover, heat can be provided, if desired, to increase drying times, for example, in the form of a heated stream of air. After drying, the coated seeds can undergo a size separation or classification process.

As used herein, the term "seed" denotes any resting stage of a plant that is physically detached from the vegetative stage of a plant and/or may be stored for prolonged periods of time and/or can be used to re-grow another plant individual of the same species. Here, the term "resting" refers to a state wherein the plant retains viability, within reasonable limits, in spite of the absence of light, water and/or nutrients essential for the vegetative (i.e. non-seed) state. In particular, the term refers to true seeds but does not embrace plant propagules such as suckers, corms, bulbs, fruit, tubers, grains, cuttings and cut shoots.

In one embodiment, the seeds treated as described herein include seeds of corn, wheat, barley, oat, rye, spelt, soybeans, rape, rice, sugar beet, cotton, millet varieties such as sorghum, sun flowers, beans, peas, oil plants such as canola, rape, soybeans, cabbages, tomatoes, eggplants (aubergines), pepper and other vegetables and spices as well as ornamental shrubs and flowers. Suitable target crops also include transgenic crop plants of the foregoing. In one embodiment, the seed is from corn, wheat, barley, soybeans, or rape.

Although the seed treatment methods described herein can be applied to a seed in any physiological state, it is preferred that the seed be in a sufficiently durable state that it incurs no significant damage during the treatment process. Typically, the seed is a seed that has been harvested from a field; removed from the plant; and/or separated from the fruit and any cob, pod, stalk, outer husk, and surrounding pulp or other non-seed plant material. The seed is preferably also biologically stable to the extent that the treatment would cause no biological

damage to the seed. In one embodiment, for example, the treatment can be applied to seed that has been harvested, cleaned and dried to a moisture content below about 15% by weight. In an alternative embodiment, the seed can be one that has been dried and then primed with water and/or another material and then re-dried before or during the treatment with a seed treatment mixture as described herein. In one embodiment, the seed to be treated is thus substantially dry. “Substantially dry” is used herein to refer to a seed that has a moisture content which results if the seed is allowed to equilibrate in an air atmosphere at 20 to 30° C and 30-90% relative humidity, e.g. at 25 ° C and 50% relative humidity.

10 The seed treatment mixture can be applied to the seed at any time from the harvest of the seed to the sowing of the seed in the ground for the purpose of germination and growth of the plant. For example, the treatment may be carried out several weeks or months, for example up to 12 months, before planting the seed, for example in the form of a seed dressing treatment, without a substantially reduced efficacy being observed. Seeds can be treated, for example, at a central location and then dispersed for planting. This permits the person who plants the seeds to avoid the handling and use of active ingredients and to merely handle and plant the treated seeds in a manner that is conventional for regular untreated seeds, which reduces human exposure.

20 In yet a further aspect, the present application is directed to a coated seed comprising a seed and a coating, which coating comprises a styrene-acrylate based copolymer, a wax and optionally also one or more active ingredient and/or additional stabilizing ingredient. Such a coated seed may be prepared using the seed treatment mixtures described herein. The coated seeds advantageously exhibit favorable surface properties that impart good flowability, plantability and dust-off characteristics. In another aspect, a coated seed comprises a seed and a coating, which coating comprises styrene-butadiene, a wax and optionally also one or more active ingredient and/or additional stabilizing ingredient.

25 One excellent feature of the seed treatment mixtures described herein is that they are effective to make coated seeds with good dust-off characteristics, which has the effect of reducing or eliminating of related dust problems, and with good flowability characteristics, which reduces the problems associated with seed

bridging in seed handling equipment, such as those including hopper-type features, while being substantially free from inorganic particulate materials. The excellent dust-off characteristics reduces or eliminates the health hazards to those who work with treated seeds, such as processing plant employees, truck drivers, warehouse workers, and farmers, compared to coated seeds having poor dust-off characteristics. The excellent flowability characteristics reduces or eliminates the problems associated with seed bridging that result from seed coatings that have a tendency to stick together during storage or during handling operations, such as, for example, removal from storage the seeds at the bottom of a hopper-style storage container, including delays, inconveniences and hazards associated with same.

As will be appreciated by a person skilled in the art in view of the above descriptions, in one aspect of the present application, there is provided an aqueous seed treatment mixture that includes: (i) an agricultural active component; and (ii) a binder formulation. The binder formulation includes: (a) from about 5% to about 50% of a latex carrier by weight; and (b) from about 1% to about 40% of a wax by weight. The seed treatment mixture is substantially free from added inorganic particulate materials. In one embodiment, the latex carrier comprises a styrene-acrylate based copolymer. In another embodiment, the latex carrier comprises styrene-butadiene. In one embodiment, the mixture comprises from about 20% to about 60% of said binder formulation by weight.

In one embodiment, the binder formulation includes from about 10% to about 40% of a latex carrier by weight and from about 5% to about 30% of a wax by weight. In another embodiment, the binder formulation includes from about 15% to about 25% of a latex carrier by weight and from about 10% to about 35% of a wax by weight. In yet another embodiment, the binder formulation includes from about 18% to about 24% of a latex carrier by weight and from about 15% to about 30% of a wax by weight.

In one embodiment, the latex carrier comprises from about 30 to about 60% by weight of a styrene-acrylate based copolymer. In another embodiment, the copolymer is a random copolymer comprising styrene comonomers, butyl acrylate comonomers, acrylonitrile comonomers and acrylic acid comonomers. In

yet another embodiment, the copolymer comprises from about 5% to about 25% styrene comonomers by weight, from about 60% to about 80% butyl acrylate comonomers by weight, from about 5% to about 20% acrylonitrile comonomers by weight and about 1 to about 10% acrylic acid comonomers by weight. In still
5 another embodiment, the copolymer comprises from about 10% to about 20% styrene comonomers by weight, from about 64% to about 74% butyl acrylate comonomers by weight, from about 7% to about 17% acrylonitrile comonomers by weight and about 3 to about 7% acrylic acid comonomers by weight. In still yet another embodiment, the copolymer comprises from about 13% to about 17%
10 styrene comonomers by weight, from about 67% to about 71% butyl acrylate comonomers by weight, from about 9% to about 15% acrylonitrile comonomers by weight and about 4 to about 6% acrylic acid comonomers by weight. In yet still another embodiment, the copolymer comprises about 15% styrene comonomers by weight, about 69% butyl acrylate comonomers by weight, about
15 12% acrylonitrile comonomers by weight and about 5% acrylic acid comonomers by weight. In another embodiment, the latex carrier comprises from about 30 to about 60% by weight of styrene-butadiene. In another embodiment, the copolymer has an average molecular weight of from about 5000 g/mol to about 3 Mg/mol.

20 In one embodiment, the agricultural active component comprises a pesticidal ingredient. In another embodiment, the pesticidal ingredient is selected from the group consisting of an insecticide, a fungicide and combinations thereof.

In one embodiment, the wax is selected from the group consisting of natural wax, vegetable wax, mineral wax and synthetic wax. In another
25 embodiment, the wax comprises polyethylene wax.

In one embodiment, the binder formulation further comprises at least one stabilizing ingredient. In yet another embodiment, the at least one stabilizing ingredient is selected from the group consisting of a colorant, a surfactant, a wetter, an antifoam ingredient, a thickener (rheology modifier), an antifreeze
30 ingredient, a preservative and combinations thereof.

In another aspect, the present application provides a seed treated with a seed treatment mixture embodiment described herein. In one embodiment, the

seed is of a plant selected from the group consisting of corn, wheat, barley, oat, rye, spelt, soybeans, rape, rice, sugar beet, cotton, sorghum, sun flowers, beans, peas, canola, rape, cabbages, tomatoes, eggplants, peppers, other vegetables and spices, ornamental shrubs and flowers. In another embodiment, the seed has a
5 coating thereon comprising a styrene-acrylate based copolymer, a wax and an agricultural active component. In yet another embodiment, the seed has a coating thereon comprising styrene-butadiene, a wax and an agricultural active component.

In yet another aspect, the present application provides a method for
10 protecting a seed from pests that includes applying to a viable seed an effective amount of a seed treatment mixture in accordance with any of the embodiments described herein. In one embodiment, the method includes: (i) applying a seed treatment mixture as described above onto a seed; and (ii) allowing the mixture applied to the seed to dry to form a coated seed.

In still another aspect, the present application provides an aqueous seed treatment mixture consisting essentially of: (i) an agricultural active component; (ii) a binder formulation including: (a) from about 5% to about 50% of a latex carrier by weight; (b) from about 2% to about 40% of a wax by weight; (c) from about 0 to about 10% of a surfactant by weight; (d) from about 0 to about 2% of
20 an antifoam ingredient by weight; (e) from about 0 to about 30% of a thickener by weight; (f) from about 0 to about 20% of an antifreeze ingredient by weight; (g) from about 0 to about 1% of a preservative by weight; (h) from about 0 to about 5% of a suspending aid by weight; and (i) from about 0 to about 5% of a humectant by weight; and (iii) from about 0 to about 3% of a colorant by weight.
25 In one embodiment, the latex carrier comprises a styrene-acrylate based copolymer. In another embodiment, the latex carrier comprises styrene-butadiene.

Reference will now be made to the following Examples, which describe experimental work directed to the subject matter of the present application. It is
30 understood that no limitation to the scope of the application is intended thereby. The Examples are intended to be illustrative, are provided solely to promote a full understanding of the concepts embodied in the application, and are not intended

to be limiting or otherwise restrictive as to the nature and scope of the inventions set forth herein.

EXAMPLES

The data set forth below show that coated seeds made using seed treatment mixtures prepared as described in the present application exhibit better overall characteristics involving dust-off, flowability and plantability compared to a leading commercially available seed coating material named FloRite 1197.

EXAMPLE ONE

Preparation of a Representative Binder formulation

Information regarding the ingredients used to make the binder formulations discussed in these Examples is set forth in Table 1. Multiple binder formulations were made by blending the ingredients set forth in Table 1 in the proportions identified in Table 2, with the remainder of each sample binder formulation being water.

Table 1

Component	Chemical Composition
Latex carrier (47% polymer solids)	Random copolymer of the following comonomers: styrene (15 wt%), butyl acrylate (69 wt%), acrylonitrile (12 wt%) and acrylic acid (5 wt%)
Liquitron 420	Polyethylene wax $D[4,3]^* = 6.96 \mu\text{m}$ $D_{(v,0.50)}^{**} = 4.92 \mu\text{m}$ $D_{(v,0.90)}^{***} = 20.5 \mu\text{m}$
Liquitron 461****	Polyethylene wax $D[4,3] = 2.95 \mu\text{m}$ $D_{(v,0.50)} = 0.30 \mu\text{m}$ $D_{(v,0.90)} = 15.3 \mu\text{m}$

(* particle size diameter based on mean volume)

(** volume mean diameter where 50% of the distribution is above and 50% is below)

(*** volume mean diameter where 10% of distribution is above and 90% is below)

(**** particle size distribution was strongly bimodal with a submicron component)

Table 2

Batch No.	Amount of Latex Carrier (wt%)	Wax Ingredient and Amount (wt%)
1	20.0%	Liquitron 420 --- 5.0%
2	20.0%	Liquitron 461 --- 5.0%
3	15.0%	Liquitron 461 --- 5.0%
4	24.0%	Liquitron 461 --- 5.0%
5	18.9%	Liquitron 461 --- 8.9%
6	20.0%	Liquitron 461 -- 10.0%
7	25.0%	Liquitron 461 -- 11.6%
8	15.0%	Liquitron 461 -- 14.0%
9	21.6%	Liquitron 461 -- 15.0%

EXAMPLE TWO5 Application of Binder Formulations to Seeds

Seeds were coated with seed treatment mixtures prepared by diluting the binder formulations 1-9 having the compositions set forth in Example One with water and then applying the seed treatment mixtures to seeds using a Hege seed treater. Each of the nine batches of seed treatment mixtures and one comparative
 10 seed treatment mixture made by diluting a commercially available polymer premix (FloRite 1197, available from Becker Underwood), was applied to a quantity of a new lot of corn seed characterized as "medium flats." The seed treatment mixtures were applied to the seeds in an amount effective to provide a coating on each seed in an average amount of about 1.25 mg of coating per seed.

15

EXAMPLE THREEEvaluation of Properties of Coated Seeds

The coated seeds prepared as described in Example Two were subjected to
 20 several performance measurements as described below.

Wet Flow/Dry Flow Experiments

Wet Flow and Dry Flow are measured as the amount of time (in seconds) required for 360 grams of coated seeds to pass through a plastic funnel. This measurement is performed (i) while the seeds are still wet from the seed treatment
 25 process to score Wet Flow characteristics, and (ii) after drying for 24 hours to

score Dry Flow characteristics. The shorter the period of time that is required for a batch of seeds to flow through the funnel, the better the flowability characteristics of the coated seed.

Down Energy/Up Energy Experiments

- 5 Down Energy and Up Energy are measured by inserting a force probe into a vessel of seeds and then withdrawing the probe, measuring the energy in millijoules (mJ) exerted on the probe as it is moved down into the seeds (Down Energy) and again measuring the force exerted on the probe as it is withdrawn (Up Energy). Down energy is the force required to reach a steady-state
10 downward movement of the probe as it is inserted, and Up Energy is the force required to reach a steady-state upward movement of the probe as it is withdrawn. In each case, a lower amount of energy required to reach steady-state movement is correlated to improved flowability and plantability characteristics.

Build Up/Rinse Experiments

- 15 Before the seeds are coated on the Hege seed treater, three pre-weighed stainless steel coupons are placed into the equipment. Following use of the treater to apply a selected seed treatment mixture to a quantity of seeds, these coupons are re-weighed. The mass (in mg) of treatment formulation remaining on this coupon is referred to as the Build Up. The three coupons are then rinsed, allowed
20 to dry overnight, and then re-weighed again to provide the Rinse measurement, which is associated with the amount of residue remaining on the coupons after rinsing. These measurements provide an indication of the amount of formulation that accumulates in coating equipment, as well as the ease with which the accumulated formulation material can be rinsed from the coating equipment.

Dust-off Experiments

- 25 Dust-off experiments were carried out using a Type I Heubach Dust Meter. A known mass of sample is tumbled at a constant speed and purged with air at a specified flow rate, for a specific time period. Dust produced during this process is carried away by the air stream and collected on a piece of filter. The
30 amount of dust thus produced is calculated and recorded in grams per 100 kilogram of seed or in milligrams per 200 grams seed.

The results of the above tests for each of the identified binder formulations, and also the results of similar tests for the commercial FloRite 1197 product, are provided in Table 3.

5

Table 3

Test Formulation	Wet Flow	Dry Flow	Down Energy	Up Energy	Build Up	Rinse
FR 1197 ¹	4.57	3.07	553	293	1.03	0.43
Batch 1	5.11	2.90	547	270	0.60	0.33
Batch 2	5.57	3.03	538	*256*	1.10	0.60
Batch 3	4.90	3.02	515	255	1.10	0.60
Batch 4	5.28	2.84	*475*	*266*	1.13	0.63
Batch 5	5.30	3.03	*449*	*244*	0.90	0.57
Batch 6	5.57	2.93	*487*	292	1.07	0.63
Batch 7	5.08	*2.71*	*414*	*245*	1.27	0.83
Batch 8	4.75	2.79	*439*	*249*	1.17	0.63
Batch 9	5.13	2.87	*478*	*258*	1.10	0.67

(¹FR 1197 is the commercial polymer premix product named FloRite 1197)

In Table 3, asterisks are used to identify values that are statistically superior to the performance measurements obtained for the commercial FloRite 1197 product. Values without asterisks were not statistically different from the corresponding measurements for FloRite 1197.

As is evident from the above data, multiple binder formulations including a latex carrier and a wax, without any added inorganic particulate materials, produced seeds exhibiting performance that was as good or better than seeds coated using the commercial FloRite 1197 product. This is a surprising result in view of the widespread belief that inorganic particulate materials are critical to the flowability characteristics of a binder formulation. Moreover, the above data show that the performance of the binder formulations tend to increase as the proportional amount of wax in the mixture is increased.

While multiple embodiments of the invention have been described in detail in the foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the selected embodiments have been described and that all changes, modifications and equivalents that come within the spirit of the invention as defined herein or by any of the following claims are desired to be protected. Any theory, mechanism of operation, proof, or finding stated herein is meant to further enhance understanding of the present application and is not intended to make the present application in any way dependent upon such theory, mechanism of operation, proof, or finding. It should be understood that any use of the word preferable, preferably or preferred in the description above indicates that the feature so described may be more desirable, it nonetheless may not be necessary and embodiments lacking the same may be contemplated as within the scope of the invention, that scope being defined by the claims that follow. In reading the claims it is intended that when words such as “a,” “an,” “at least one,” “at least a portion” are used there is no intention to limit the claim to only one item unless specifically stated to the contrary in the claim. Further, when the language “at least a portion” and/or “a portion” is used the item may include a portion and/or the entire item unless specifically stated to the contrary. All patents, patent applications, and publications references herein are hereby incorporated by reference, each in its entirety.

WHAT IS CLAIMED IS:

1. An aqueous seed treatment mixture comprising:
an agricultural active component; and
5 a binder formulation, said binder formulation comprising:
from about 5% to about 50% of a latex carrier by weight; and
from about 1% to about 40% of a wax by weight;
wherein said binder formulation is substantially free from added inorganic
particulate materials;
10 wherein said latex carrier comprises a styrene-acrylate based copolymer.
2. The mixture in accordance with claim 1 wherein said binder
formulation comprises:
from about 10% to about 40% of a latex carrier by weight; and
15 from about 5% to about 30% of a wax by weight.
3. The mixture in accordance with claim 1 wherein said binder
formulation comprises:
from about 15% to about 25% of a latex carrier by weight; and
20 from about 10% to about 35% of a wax by weight.
4. The mixture in accordance with claim 1 wherein said binder
formulation comprises:
from about 18% to about 24% of a latex carrier by weight; and
25 from about 15% to about 30% of a wax by weight.
5. The mixture in accordance with claim 1 wherein said latex carrier
comprises from about 30 to about 60% by weight of said styrene-acrylate based
copolymer.
30
6. The mixture in accordance with claim 1 wherein said mixture
comprises from about 20% to about 50% of said binder formulation by weight.

7. The mixture in accordance with claim 1 wherein said copolymer is a random copolymer comprising styrene comonomers, butyl acrylate comonomers, acrylonitrile comonomers and acrylic acid comonomers.

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8. The mixture in accordance with claim 7 wherein said copolymer comprises from about 5% to about 25% styrene comonomers by weight, from about 60% to about 80% butyl acrylate comonomers by weight, from about 5% to about 20% acrylonitrile comonomers by weight and about 1 to about 10% acrylic acid comonomers by weight.

10

9. The mixture in accordance with claim 7 wherein said copolymer comprises from about 10% to about 20% styrene comonomers by weight, from about 64% to about 74% butyl acrylate comonomers by weight, from about 7% to about 17% acrylonitrile comonomers by weight and about 3 to about 7% acrylic acid comonomers by weight.

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10. The mixture in accordance with claim 7 wherein said copolymer comprises from about 13% to about 17% styrene comonomers by weight, from about 67% to about 71% butyl acrylate comonomers by weight, from about 9% to about 15% acrylonitrile comonomers by weight and about 4 to about 6% acrylic acid comonomers by weight.

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11. The mixture in accordance with claim 7 wherein said copolymer comprises about 15% styrene comonomers by weight, about 69% butyl acrylate comonomers by weight, about 12% acrylonitrile comonomers by weight and about 5% acrylic acid comonomers by weight.

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12. The mixture in accordance with claim 1 wherein said copolymer has an average molecular weight of from about 500 g/mol to about 3 Mg/mol.

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13. The mixture in accordance with claim 1 wherein the agricultural active component comprises a pesticidal ingredient.

14. The mixture in accordance with claim 13 wherein the pesticidal ingredient is selected from the group consisting of an insecticide, a fungicide and combinations thereof.

15. The mixture in accordance with claim 1 wherein the wax is selected from the group consisting of natural wax, vegetable wax, mineral wax and synthetic wax.

16. The mixture in accordance with claim 15 wherein the wax comprises polyethylene wax.

17. The mixture in accordance with claim 1 wherein said binder formulation further comprises at least one stabilizing ingredient.

18. The mixture in accordance with claim 17 wherein said at least one stabilizing ingredient is selected from the group consisting of a colorant, a surfactant, a wetter, an antifoam ingredient, a thickener (rheology modifier), an antifreeze ingredient, a preservative and combinations thereof.

19. A seed treated with a mixture in accordance with claim 1.

20. The seed in accordance with claim 19 wherein the seed is of a plant selected from the group consisting of corn, wheat, barley, oat, rye, spelt, soybeans, rape, rice, sugar beet, cotton, sorghum, sun flowers, beans, peas, canola, rape, cabbages, tomatoes, eggplants, peppers, other vegetables and spices, ornamental shrubs and flowers.

21. The seed in accordance with claim 19 wherein the seed has a coating thereon comprising a styrene-acrylate based copolymer, a wax and an agricultural active component.

5 22. A method for protecting a seed from pests comprising applying to a viable seed an effective amount of a mixture in accordance with claim 1.

23. The method in accordance with claim 22, comprising:
applying a seed treatment mixture in accordance with claim 1 onto a seed;
10 and
allowing the mixture applied to the seed to dry to form a coated seed.

24. An aqueous seed treatment mixture consisting essentially of:
an agricultural active component;
15 a binder formulation, said binder formulation comprising:
from about 5% to about 50% of a latex carrier by weight;
from about 2% to about 40% of a wax by weight;
from about 0 to about 10% of a surfactant by weight;
from about 0 to about 1% of an antifoam ingredient by weight;
20 from about 0 to about 30% of a thickener by weight;
from about 0 to about 20% of an antifreeze ingredient by weight;
from about 0 to about 1% of a preservative by weight;
from about 0 to about 5% of a suspending aid by weight; and
from about 0 to about 5% of a humectant by weight; and
25 from about 0 to about 3% of a colorant by weight;
wherein said latex carrier comprises a styrene-acrylate based copolymer.

25. An aqueous seed treatment mixture comprising:
an agricultural active component; and
30 a binder formulation, said binder formulation comprising:
from about 5% to about 50% of a latex carrier by weight; and
from about 1% to about 40% of a wax by weight;

wherein said binder formulation is substantially free from added inorganic particulate materials;

wherein said latex carrier comprises styrene-butadiene.

5 26. The mixture in accordance with claim 25 wherein said binder formulation comprises:

from about 10% to about 40% of a latex carrier by weight; and
from about 5% to about 30% of a wax by weight.

10 27. The mixture in accordance with claim 25 wherein said binder formulation comprises:

from about 15% to about 25% of a latex carrier by weight; and
from about 10% to about 25% of a wax by weight.

15 28. The mixture in accordance with claim 25 wherein said binder formulation comprises:

from about 18% to about 24% of a latex carrier by weight; and
from about 15% to about 25% of a wax by weight.

20 29. The mixture in accordance with claim 25 wherein said latex carrier comprises from about 30 to about 60% by weight of said styrene-butadiene.

30. The mixture in accordance with claim 25 wherein said mixture comprises from about 20% to about 60% of said binder formulation by weight.

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31. The mixture in accordance with claim 25 wherein said copolymer has an average molecular weight of from about 500 g/mol to about 3 Mg/mol.

32. The mixture in accordance with claim 25 wherein the agricultural
30 active component comprises a pesticidal ingredient.

33. The mixture in accordance with claim 32 wherein the pesticidal ingredient is selected from the group consisting of an insecticide, a fungicide and combinations thereof.

5 34. The mixture in accordance with claim 25 wherein the wax is selected from the group consisting of natural wax, vegetable wax, mineral wax and synthetic wax.

 35. The mixture in accordance with claim 34 wherein the wax
10 comprises polyethylene wax.

 36. The mixture in accordance with claim 25 wherein said binder formulation further comprises at least one stabilizing ingredient.

15 37. The mixture in accordance with claim 36 wherein said at least one stabilizing ingredient is selected from the group consisting of a colorant, a surfactant, a wetter, an antifoam ingredient, a thickener (rheology modifier), an antifreeze ingredient, a preservative and combinations thereof.

20 38. A seed treated with a mixture in accordance with claim 25.

 39. The seed in accordance with claim 38 wherein the seed is of a plant selected from the group consisting of corn, wheat, barley, oat, rye, spelt, soybeans, rape, rice, sugar beet, cotton, sorghum, sun flowers, beans, peas,
25 canola, rape, cabbages, tomatoes, eggplants, peppers, other vegetables and spices, ornamental shrubs and flowers.

 40. The seed in accordance with claim 38 wherein the seed has a coating thereon comprising styrene-butadiene, a wax and an agricultural active
30 component.

41. A method for protecting a seed from pests comprising applying to a viable seed an effective amount of a mixture in accordance with claim 25.

42. The method in accordance with claim 22, comprising:
5 applying a seed treatment mixture in accordance with claim 25 onto a seed; and
allowing the mixture applied to the seed to dry to form a coated seed.

43. An aqueous seed treatment mixture consisting essentially of:
10 an agricultural active component;
a binder formulation, said binder formulation comprising:
from about 5% to about 50% of a latex carrier by weight;
from about 2% to about 40% of a wax by weight;
from about 0 to about 10% of a surfactant by weight;
15 from about 0 to about 2% of an antifoam ingredient by weight;
from about 0 to about 30% of a thickener by weight;
from about 0 to about 20% of an antifreeze ingredient by weight;
from about 0 to about 1% of a preservative by weight;
from about 0 to about 5% of a suspending aid by weight; and
20 from about 0 to about 5% of a humectant by weight; and
from about 0 to about 3% of a colorant by weight;
wherein said latex carrier comprises styrene-butadiene.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US13/38860

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A01N 25/00; A01N 25/02 (2013.01)

USPC - 504/100; 504/101

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)

IPC(8): A01N 25/00; A01N 25/02 (2013.01)

USPC: 504/100; 504/101

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

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

MicroPatent (US-G, US-A, EP-A, EP-B, WO, JP-bib, DE-C,B, DE-A, DE-T, DE-U, GB-A, FR-A); Dialog Pro; Google Scholar; IP.com; seed*, treat*, spray*, dispers*, soak*, immers*, activ*, component*, pesticid*, insecticid*, fungicid*, latex*, styrene*, acrylat*, butadiene*, particl*, particulat*, granul*, free*, without, acrylonitril*, cyanoethene*, vinylcyanide*, *propenenitrile

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 2009/0143447 A1 (ARTHUR KS, et al.) 04 June 2009; abstract; table A; paragraphs [0009], [0016]-[0017], [0019]-[0021], [0025], [0032]-[0033], [0037]-[0038], [0054]-[0055], [0064], [0068], [0071], [0073], [0080]-[0082], [0086], [0090], [0097]-[0099], [0100]-[0107], [0110]-[0111], [0114], [0116]-[0117], [0126]-[0127], [0133], [0148]	1-2, 12-26, 31-43 --- 3-11, 27-30
Y	US 2010/0273897 A1 (GOTTSCHER R, et al.) 28 October 2010; paragraphs [0012]-[0014], [0020]-[0023], [0035]	7-11
Y	US 2012/0065060 A1 (REUS HA, et al.) 15 March 2012; paragraphs [0023]-[0024]	5-6, 29-30
Y	US 2011/0039694 A1 (ROSA FC, et al.) 17 February 2011; paragraph [0018]	3-4, 27-28



Further documents are listed in the continuation of Box C.



* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

12 September 2013 (12.09.2013)

Date of mailing of the international search report

17 SEP 2013

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-3201

Authorized officer:

Shane Thomas

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774