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(54) Title: AGRICULTURAL ADJUVANT OIL DISPERSIONS

(57) Abstract: The present disclosure is generally directed to stable oil dispersion compositions used in agriculture that comprise high concentrations of particulate agrochemical solids such as ammonium sulfate. The oil dispersion composition is useful as an additive or water conditioning adjuvant in agricultural tank mix applications to improve performance of agrochemicals negatively impacted by the mineral content of water used to dilute agrochemical application mixtures as well as provide other beneficial effects.

AGRICULTURAL ADJUVANT OIL DISPERSIONS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 63/542,258, filed October 3, 2023, the contents of which are incorporated by reference herein in their entirety.

FIELD OF INVENTION

[0002] The present disclosure provides stable oil dispersion compositions used in agriculture that comprise high concentrations of a particulate agrochemical solid such as ammonium sulfate (AMS) in combination with one or more desirable agricultural adjuvant ingredients.

BACKGROUND OF INVENTION

[0003] AMS (ammonium sulfate) is one of the most widely used fertilizers in agriculture, and it is a source of sulfur and nitrogen for plants. It is also used extensively as a water conditioning adjuvant in agricultural tank mix applications to improve performance of herbicides and other agrochemicals that might be negatively impacted by the mineral content of water used to dilute agrochemical application mixtures. When used as a water conditioner, AMS associates with hard water calcium and magnesium ions and provides ammonium ions for improved uptake. However, dried AMS and concentrated aqueous solutions of AMS are difficult to handle and the former presents health hazards associated with airborne particulates.

[0004] To address these problems, oil dispersion (OD) compositions are known and used to form pourable, concentrate formulations of particulate agrochemical solids such as AMS dispersed or suspended in an oily liquid carrier, such as a vegetable oil alkyl ester (e.g., methylated seed oil or MSO). However, oil dispersions often suffer from instability in that the suspended solid can partition and separate from the oil carrier and settle at the bottom of the container in which they are stored. Such settling causes inconsistent and ineffective dosing of the agrochemical solid when poured, mixed and diluted with water prior to application.

[0005] In addition to AMS and other water conditioners, there are a wide variety of other adjuvants commonly used to improve the efficacy of pesticides or impart other beneficial effects either as part of agricultural active formulations or as a separate tank

mix additive. Although beneficial, tank mixing such agricultural adjuvants with herbicides or other agricultural actives is often cumbersome for the end user.

[0006] Accordingly, there remains a need for oil dispersion compositions containing high concentrations of agrochemical solids such as AMS that remain stable for extended periods of time at both high and low temperatures and that provide a useful vehicle for inclusion of other desirable adjuvant ingredients that can be readily delivered as part of an emulsion application mixture formed upon dilution with water.

SUMMARY OF INVENTION

[0007] In various aspects, the present invention relates to a non-aqueous, agrochemical solid in oil dispersion composition. The composition comprises an agricultural oil carrier, a particulate agrochemical solid dispersed in the oil carrier, an emulsifier component, a water-insoluble, nonionic polymeric dispersant and a rheology additive. One or more of the ingredients are preferably agricultural adjuvants selected to improve the efficacy of pesticides with which the composition is mixed or to impart other beneficial effects as part of a tank mix, while also providing a stable dispersion at high and low temperatures.

[0008] In one embodiment, the non-aqueous, agrochemical solid in oil dispersion comprises from about 20 wt.% to about 40 wt.% of an agricultural oil carrier; from about 30 wt.% to about 50 wt.% of a particulate agrochemical solid component dispersed in the oil carrier; from about 10 wt.% to about 30 wt.% of an emulsifier component comprising nonionic emulsifier and an anionic emulsifying surfactant; from about 0.5 wt.% to about 3 wt.% of a water-insoluble, nonionic polymeric dispersant having an HLB no greater than about 10; and from about 0.1 wt.% to about 5 wt.% of a rheology additive comprising an organic derivative of a bentonite clay, fumed silica or combination thereof.

[0009] The present invention also relates to a water-conditioning agricultural adjuvant composition in the form of a non-aqueous, agrochemical solid in oil dispersion. The adjuvant composition comprises from about 26 wt.% to about 36 wt.% of an agricultural oil carrier selected from the group consisting of hydrotreated heavy paraffinic petroleum distillate, non-esterified vegetable oil, methylated seed oil, tall oil and combinations thereof; from about 30 wt.% to about 50 wt.% of a water-conditioning agent selected from the group consisting of ammonium sulfate, citric acid, sodium citrate, potassium citrate and combinations thereof; from about 12 wt.% to about 28

wt.% of an emulsifier component comprising an ethoxylated soybean oil adjuvant and a phosphate ester of polyoxyethylene nonylphenol; from about 1 wt.% to about 2 wt.% of a water-insoluble, nonionic co-polymeric dispersant comprising a random co-polymer based on an alkyd-polyethylene glycol resin comprising a polyisobutylene succinic anhydride oil soluble graft; and from about 0.5 wt.% to about 5 wt.% of a rheology additive comprising a fumed silica.

[0010] The present invention also relates to a method for preparing an agricultural tank mix application mixture. The method comprises mixing an agrochemical formulation comprising an agrochemical with an oil dispersion composition of the present invention and dilution water to form the agricultural tank mix application mixture.

[0011] The details of one or more embodiments of the invention are set forth in the accompanying description below.

[0012] Other features, objects, and advantages of the invention will be apparent from the description, and from the claims.

DETAILED DESCRIPTION OF INVENTION

[0013] In general, the present invention relates to oil dispersion (OD) compositions comprising a particulate agrochemical solid suspended or dispersed in an agricultural oil carrier in combination with one or more desirable agricultural adjuvants. In accordance with the invention, particular dispersants, emulsifiers and rheology additives have been identified that allow the formulation of oil dispersion compositions containing high concentrations of the agrochemical solid suspended in the oil carrier that remain stable over prolonged periods of storage at low and high temperatures. The oil dispersion composition is non-aqueous in that water is not necessary and is not intentionally added to the composition. The oil dispersion composition is formulated and the particulate agrochemical solid and other ingredients are selected such that composition forms an emulsion or microemulsion and the solids dissolve rapidly upon dilution of the oil dispersion composition in water (e.g., in an agricultural spray mixture or tank mix). Further, the selected ingredients include one or more agricultural adjuvants that enhance efficacy or provide other beneficial effects when the oil dispersion composition is tank mixed with an herbicide or other agricultural active ingredient. The oil dispersant composition provides an easy to use agricultural adjuvant package.

[0014] The agrochemical suspended in the oil dispersion composition may include any solid particles that are insoluble in the oil carrier and suitable for dispersion therein. In one embodiment, the particles comprise an agricultural adjuvant solid and are free of any pesticide (e.g., herbicide, insecticide, etc.) active ingredients. For example, the particulate agrochemical solid may include at least one of water conditioners, fertilizers and combinations thereof.

[0015] In one embodiment, the particulate solid includes at least one water conditioner. Water conditioners are used with hard water in agricultural applications to reduce negative interactions between dissolved minerals and agricultural active ingredients such as herbicides that decrease efficacy. In one embodiment, the at least one water conditioner includes ammonium sulfate (AMS). As previously discussed, AMS is one of the most widely used fertilizers in agriculture, and it is a source of sulfur and nitrogen for plants. Further, AMS may help with uptake of certain agricultural active ingredients into a plant. The particulate solid may also include other water conditioners, such as citric acid and sodium or potassium citrate, instead of or in combination with AMS.

[0016] In accordance with the present invention, stable oil dispersion compositions are provided wherein the concentration of the particulate agrochemical solid is quite high. For example, the concentration of the particulate solid may be at least about 20 wt.%, at least about 25 wt.%, at least about 30 wt.%, at least about 35 wt.%, at least about 40 wt.% or higher. In one embodiment, the concentration of the particulate solid is from about 30 wt.% to about 50 wt.%.

[0017] In order to facilitate dispersion of the particulate agrochemical solid in the oil carrier and maintain composition stability, the particle size of the solid may be reduced by grinding or milling either before or after being combined with the other ingredients of the dispersion composition. Suitable dry grinding processes include hammer milling, pin milling, media milling (e.g., ball mill) or media-less milling (e.g., a jet mill). Suitable wet grinding processes include wet media milling or wet media-less milling (e.g., a homogenizer or a high shear mill). In accordance with one embodiment, the agrochemical solid is pre-milled to reduce the average particle size prior to combination with the other ingredients and thereby avoid wet-milling operations. For example, the particle size distribution of the particulate agrochemical solid component may be reduced such that it exhibits a D90 particle size of about 20 μm or about 10 μm. In other embodiments, the agrochemical solid may be unmilled or

coarsely milled prior to being combined with the other ingredients of the dispersion composition.

[0018] The agricultural oil carrier may suitably comprise vegetable oils such as corn oil, soybean oil, linseed oil, cotton seed oil, canola oil and similar oils, tall oils derived from wood pulp manufacture as well as petroleum distillates.

[0019] The vegetable oil may be non-esterified and comprise a mixture of triglycerides. In another embodiment, the vegetable oil is esterified such as methylated seed oil (MSO). Methylated seed oil and similar esterified vegetable oils are often used (and sometimes recommended or required) as an oil-based surfactant adjuvant in combination with post-emergent herbicides to improve penetration into the leaf.

[0020] Petroleum distillates from the heavy distillate fraction of crude petroleum such as mineral oils or white oils may also be used as the agricultural oil carrier. They are typically refined to remove the unsaturated hydrocarbons and improve oxidation stability. Prima 100 is a hydrotreated heavy paraffinic petroleum distillate that is useful as an agricultural oil carrier.

[0021] Although a large variety of dispersants, emulsifiers and rheology additives or structuring aids such as modified silicas have been disclosed in the art for enhancing the stability of and inhibiting settling in non-aqueous, oil dispersion compositions, none have proved suitable for reliably formulating oil dispersions containing high concentrations of dispersed solids. In accordance with the present invention, high concentrations of the particulate agrochemical solid are stably maintained in dispersion in the oil carrier by proper selection of one or more dispersants in combination with a rheology additive and an emulsifier component.

[0022] The dispersants useful in stabilizing the particulate agrochemical solid suspended in the oil carrier of the non-aqueous composition generally include water-insoluble, nonionic, polymeric dispersants having an HLB no greater than about 10, and more typically no greater than about 8. In one particular embodiment, the dispersant comprises a random co-polymer based on an alkyd-polyethylene glycol resin comprising a polyisobutylene succinic anhydride oil soluble graft, such as that sold under the tradename ATLOX 4914, commercially available from Croda Europe Ltd. (East Yorkshire, England). In another particular embodiment, the dispersant comprises an A-B-A block co-polymer based on 12-polyhydroxystearic acid (12 pHSA) and polyethylene glycol, such as that sold under the tradename ATLOX 4912, commercially available from Croda Europe Ltd. (East Yorkshire, England). Low HLB, water-

insoluble, nonionic, polymeric dispersants can be used singularly or in combination and are surprisingly effective at relatively low concentrations. The concentration of the dispersant is typically from about 0.5 wt.% to about 3 wt.%, and more typically from about 1 wt.% to about 2 wt.%.

[0023] The oil dispersion composition further includes a rheology additive or structuring aid comprising bentonite clay, fumed silica or combinations thereof. In one embodiment, the rheology additive is based on bentonite clay. For example, in one particular embodiment, the rheology additive comprises an organic derivative of a bentonite clay such as that sold under the tradename BENTONE 1000, commercially available from Elementis Specialties, Inc. (East Windsor, New Jersey). This highly efficient and cost-effective rheological additive is designed for low- to intermediate polarity organic systems and when combined with the dispersants described herein, is highly effective in stabilizing the oil dispersion composition at lower concentrations. In another embodiment, the rheology additive comprises a fumed silica such as that sold under the tradename AEROSIL 200 or AEROSIL 300, commercially available from Evonik Corporation (Parsippany, New Jersey). In one particular embodiment, the rheology additive comprises a fumed silica surface-treated with polydimethylsiloxane such as that sold under the tradename AEROSIL R 202, also commercially available from Evonik Corporation (Parsippany, New Jersey). The rheology additives identified herein are compatible with various agricultural oil carriers. However, AEROSIL R 202 and similar materials have been found to be particularly flexible as a rheology additive in oil dispersion compositions containing either paraffinic petroleum distillates or vegetable oils as the agricultural oil carrier.

[0024] The concentration of the rheology additive is generally from about 0.1 wt.% to about 5 wt.%. In the case an organic derivative of a bentonite clay such as BENTONE 1000, the concentration is typically from about 0.1 wt.% to about 2 wt.%, and more typically, from about 0.5 wt.% to about 0.75 wt.%. When using a fumed silica rheology additive, the concentration is somewhat higher. For example, the concentration of a fumed silica rheology additive is typically from about 0.5 wt.% to about 5 wt.%, and more typically, from about 2 wt.% to about 4 wt.%.

[0025] In order to effectively form an emulsion or microemulsion upon dilution and mixture with water, the oil dispersion composition further comprises an emulsifier component. In accordance with the present invention, the emulsifier component comprises a combination of a nonionic emulsifier and an anionic emulsifying

surfactant. In accordance with one embodiment, the emulsifier component comprises a nonionic emulsifier adjuvant such as an alkoxylated vegetable oil adjuvant and an anionic emulsifying surfactant such as a phosphate ester surfactant (e.g., an alkoxylated alkyl phosphate ester) or a blend of anionic emulsifying surfactants.

[0026] Suitable alkoxylated vegetable oil adjuvants include ethoxylated soybean oil such as that sold under the tradename AGNIQUE SBO-10, commercially available from BASF Corporation North America, which can be classified as a nonionic surfactant. In addition to its function as an emulsifier, ethoxylated soybean oil is often used to enhance the efficacy or potentiate various herbicides and other agricultural active ingredients. Other nonionic emulsifiers can be suitably employed. In one embodiment, the nonionic emulsifier is selected to have an HLB no greater than about 10, and more typically no greater than about 8.

[0027] Suitable anionic surfactants include calcium dodecylbenzene sulfonate (CDDBS) and phosphate ester surfactants. In one embodiment, the anionic emulsifying surfactant includes a phosphate ester surfactant (e.g., an alkoxylated alkyl phosphate ester) or a blend of phosphate ester surfactants. Suitable examples of alkoxylated alkyl phosphate esters include a polyoxyethylene nonylphenol phosphate ester such as that sold under the tradename NP 9 PE, polyoxyethylene isotridecyl ether phosphate such as that sold under the tradename PE-TDA 6, both commercially available from BASF Corporation North America, as well as combinations thereof. These anionic phosphate ester surfactants assist with emulsifying the oil carrier when mixed with water. In addition to this primary function, the anionic phosphate ester surfactants also aid in dispersing the particulate agrochemical solid in the oil dispersion to ensure composition stability. Further, such phosphate esters can act as an adjuvant in improving the efficacy of certain pesticidal application mixtures.

[0028] Typically, the concentration of the emulsifier component is from about 10 wt.% to about 30 wt.%, or from about 15 wt.% to about 30 wt.% and typically contains an excess of the nonionic emulsifier over the anionic surfactant(s) such that the weight ratio of the nonionic emulsifier to the anionic surfactant is greater than 1:1. In one embodiment, the concentration of the emulsifier component is from about 20 wt.% to about 28 wt.% and the weight ratio of the nonionic emulsifier to the anionic surfactant(s) is greater than 1:1, at least about 2:1, at least about 3:1 or at least about 4:1. In another embodiment, the concentration of the emulsifier component is from about 12 wt.% to about 28 wt.% or from about 12 wt.% to about 20 wt.% and the weight

ratio of the nonionic emulsifier to the anionic surfactant(s) is greater than 1:1, and typically from about 2:1 to about 3:1.

[0029] The oil dispersion composition can optionally contain a variety of other ingredients, including anti-foam agents, anti-drift agents as well as other useful adjuvants. In one embodiment, the oil dispersion composition contains an anti-drift agent such as the polyterpene resin described in U.S. Patent No. 9,578,874 B2 (Crosby et al.) and sold under the tradename PICCOLYTE A 25, commercially available from Pinova, Inc. (Brunswick, GA) or SYLVARES TRA 25, commercially available from Kraton Corporation (Houston, TX).

[0030] The oil dispersion compositions described herein can be prepared using techniques and equipment well known in the art. Although the order of addition is not critical, typically, the liquid ingredients are combined and mixed first followed by addition of the particulate agrochemical solid(s). As noted above, the oil dispersion composition is non-aqueous in that water is not necessary and is not intentionally added to the composition. Accordingly, the mixing equipment is dried prior to use and water is intentionally excluded from the composition including minimizing any extraneous water content in the ingredients to be mixed. In this manner, the oil dispersion compositions are substantially free of water and typically have a water content of 0.1 wt.% or less. The solids are advantageously pre-milled to the desired particle size as described above to reduce later batch milling requirements. The ingredients can be suitably combined and mixed in an overhead mixer equipped with a Cowles dispersion blade impeller. The batch can then be milled in a vertical ball mill while monitoring the viscosity and temperature of the batch. Alternatively, a homogenizer can be used in place of a ball mill to further reduce the particle size of the dispersed agrochemical solids. High shear milling can assist with activation of a bentonite clay rheology additive as well as other ingredients such as polymeric alkyd-polyethylene glycol resin dispersants (e.g., ATLOX 4914). Generally, the temperature of the batch is maintained below about 120°F (49°C) and the batch is milled until a viscosity of at least about 700 cP, at least about 1000 cP, at least about 1500 cP, at least about 2000 cP, or at least about 2500 cP is achieved. Compositions having a viscosity of at least about 1000 cP are generally associated with better stability and resistance to settling, while viscosities in excess of about 3000 cP may present the end user farmer with handling difficulties. Accordingly, in one embodiment, the batch oil dispersion compositions are milled until the viscosity is from about 1000 to about 3000 cP or from about 1500 to about 3000 cP.

[0031] As noted, the oil dispersion composition is intended as an additive or water conditioning adjuvant in agricultural tank mix applications to improve performance of herbicides and other agrochemicals that might be negatively impacted by the mineral content of water used to dilute agrochemical application mixtures as well as provide other beneficial effects.

[0032] The agrochemicals with which the oil dispersion composition may be advantageously mixed include pesticides (e.g., herbicides, insecticides, fungicides, etc.) as well as fertilizers. The agrochemicals mixed with the oil dispersion composition may be of any conventional formulation type, including without limitation, solids and various conventional liquid formulations such as solution concentrates containing water-soluble agrochemical salts, emulsion concentrates, microemulsion concentrates and suspension concentrates.

[0033] Representative and non-limiting examples of herbicides include acetyl CoA carboxylase (ACCase) inhibitors, acetolactate synthase (ALS) inhibitors, acetohydroxy acid synthase (AHAS) inhibitors, photosystem II inhibitors, photosystem I inhibitors, protoporphyrinogen oxidase (PPO or Protox) inhibitors, carotenoid biosynthesis inhibitors, enolpyruvyl shikimate-3-phosphate (EPSP) synthase inhibitor, glutamine synthetase inhibitor, dihydropteroate synthetase inhibitor, mitosis inhibitors, nucleic acid inhibitors; and auxins herbicides; salts and esters thereof; racemic mixtures and resolved isomers thereof; and combinations thereof.

[0034] Representative examples of ACCase inhibitors include clethodim, clodinafop, fenoxaprop-P, fluazifop-P, quizalofop-P, and sethoxydim.

[0035] Representative examples of ALS or AHAS inhibitors include flumetsulam, imazamethabenz-m, imazamox, imazapic, imazapyr, imazaquin, imazethapyr, metsulfuron, prosulfuron, and sulfosulfuron.

[0036] Representative examples of photosystem I inhibitors include diquat and paraquat.

[0037] Representative examples of photosystem II inhibitors include atrazine, cyanazine, diuron, and metibuzin.

[0038] Representative examples of PPO inhibitors include acifluorofen, butafenacil, carfentrazone-ethyl, flufenpyr-ethyl, fluthiacet, flumiclorac, flumioxazin, fomesafen, lactofen, oxadiazon, oxyfluorofen, and sulfentrazone.

[0039] Representative examples of carotenoid biosynthesis inhibitors include aclonifen, amitrole, diflufenican, mesotrione, and sulcotrione.

[0040] A representative example of an EPSP inhibitor is N-phosphonomethyl glycine (glyphosate). Commercially available sources of glyphosate, and its agriculturally acceptable salts, include those products sold under the trade names DURANGO® DMA®, HONCHO PLUS®, ROUNDUP POWERMAX®, ROUNDUP WEATHERMAX®, TRAXION®, and TOUCHDOWN®.

[0041] A representative example of a glutamine synthetase inhibitor is glufosinate.

[0042] A representative example of a dihydropteroate synthetase inhibitor is asulam.

[0043] Representative examples of mitosis inhibitors include acetochlor, alachlor, dithiopyr, S-metolachlor, and thiazopyr.

[0044] Representative examples of nucleic acid inhibitors include difenzoquat, fosamine, metham, and pelargonic acid.

[0045] Representative examples of auxin herbicides include dicamba (3,6-dichloro-2-methoxybenzoic acid) and 2,4-D (2,4-dichlorophenoxyacetic acid).

[0046] In accordance with one embodiment, the oil dispersion compositions of the present invention are suitable as an additive or water conditioning adjuvant in agricultural tank mix applications for herbicides selected from the group consisting of glyphosate, glufosinate, clethodim, 2,4-D, dicamba, mesotrione, topramezone, tembotrione, fomesafen, bromoxanil, bicyclopryone, gramoxone and mixtures thereof.

[0047] The quantity of the oil dispersion composition mixed with the agrochemical is not narrowly critical and will depend on various factors including the agrochemical(s) present in the tank mix, mineral content of the dilution water and spray conditions. The concentration of the oil dispersion composition in the tank upon dilution on a volume basis is typically at least about 0.01%, at least about 0.02%, at least about 0.04%, at least about 0.08%, or at least about 0.1% and up to about 10%, up to about 8% or up to about 5%. Typically, for water conditioning applications, wherein the particulate solid comprises AMS and/or other water conditioners, such as citric acid and sodium or potassium citrate, the concentration of the oil dispersion composition in the tank upon dilution on a volume basis is at least about 0.5%, at least about 1%, at least about 1.5%, at least about 2%, at least about 2.5%, at least about 3%, at least about 3.5%, or at least about 4%. For example, the concentration of the oil dispersion composition in the tank upon dilution on a volume basis may range from about 0.5% to about 10%, from about 1% to about 5% or from about 2% to about 4%.

[0048] As is known in the art, AMS present in the oil dispersion composition can be used to potentiate or improve the effectiveness of certain herbicides such as glutamine synthetase inhibitors (e.g., glufosinate) and mesotrione. Typically, in such applications, the oil dispersion composition is included in the tank mix in an amount so as to provide an AMS application rate of at least about 0.5 lb/acre (0.56 kg/ha), at least about 0.75 lb/acre (0.84 kg/ha), at least about 1 lb/acre (1.12 kg/ha), at least about 1.25 lb/acre (1.40 kg/ha), at least about 1.5 lb/acre (1.68 kg/ha) or higher and according to the herbicide manufacturer's recommendation.

[0049] The following non-limiting examples are provided to further illustrate the present invention.

EXAMPLES

EXAMPLE 1: FORMULATIONS AND PROPERTIES

[0050] The exemplary oil dispersion compositions in accordance with the present invention set forth in Tables 1-29, 11A, 14B, 15B, and 16B were prepared. Tables 14A and 15A describe formulations used in scale up batches. Tables 1A-8A, 11B, 14C, 15C, and 16C provide stability and other measured properties of the oil dispersion compositions.

[0051] The following ingredients were used in these compositions.

Ingredients	Function
Prima 100 hydrotreated heavy paraffinic petroleum distillate	Agricultural oil carrier/adjuvant
100 SN (chemically similar to Prima 100)	Agricultural oil carrier/adjuvant
65 SUS paraffinic petroleum distillate (similar to Prima 100)	Agricultural oil carrier/adjuvant
Methylated seed oil (MSO)	Agricultural oil carrier/adjuvant
B 99.9 (also a methylated seed oil)	Agricultural oil carrier/adjuvant
AGNIQUE SBO-10 ethoxylated soybean oil (POE 10)	Nonionic Emulsifier/adjuvant
Ammonium sulfate (AMS) as a water conditioner and fertilizer	Water conditioner/fertilizer/adjuvant
Citric acid	Water conditioner
ATLOX 4912	Oil dispersant
ATLOX 4914 polyisobutylene succinic anhydride-polyethylene glycol (alkyd-PEG resin)	Non-aqueous polymeric dispersant

Ingredients	Function
Stepflow 2000 polyisobutylene succinic anhydride-polyethylene glycol (alkyd-PEG resin) (chemical equivalent to ATLOX 4914)	Non-aqueous polymeric dispersant
BENTONE 1000 organic derivative of a bentonite clay	Non-aqueous rheology additive
NP 6 nonylphenol ethoxylate POE (6)	Nonionic surfactant/emulsifier
NP 9 PE polyoxyethylene nonylphenol phosphate ester (POE 9)	Anionic emulsifying surfactant and dispersing aid
PE-TDA 6 polyoxyethylene isotridecyl ether phosphate (POE 6)	Anionic emulsifying surfactant and dispersing aid
Branched calcium dodecylbenzene sulfonate (CDDBS), 60%	Anionic emulsifier
PICCOLYTE A 25 polyterpene resin	Retention aid/sticker or anti-drift additive
Silvares 25 polyterpene resin (similar to Piccolyte A 25)	Retention aid/sticker or anti-drift additive
Antifoam 8830 IND 30% polydimethylsiloxane emulsion	Antifoam for batch mixing
AEROSIL R202 fumed silica surface-treated with polydimethylsiloxane	Rheology additive
Aerosil 200 fumed silica	Rheology additive
Aerosil 300 fumed silica	Rheology additive
IDA 6 iso decyl alcohol with 6 mol of EO	Wetting agent/penetrant

[0052] An overhead mixer equipped with a Cowles dispersion blade impeller was used to mix all of the liquid ingredients first followed by the particulate agrochemical solids, which were pre-milled to the desired particle size in order to reduce later batch milling requirements. Then the entire batch was milled with a vertical ball mill while monitoring the viscosity and temperature of the batch until a viscosity of from about 2,000-3,000 cP was achieved. The temperature was maintained below 120°F (49°C). Alternatively, a homogenizer can be used in place of a ball mill to activate the bentonite clay rheology additive and further reduce the particle size of the dispersed agrochemical solids.

[0053] The results reported in Table 1A were determined with respect to the oil dispersion in Table 1 as prepared without aging. The results in Table 2A to 8A include both initial properties as well as properties determined after aging at varying

temperatures. The results reported in Tables 11B, 14C, 15C, and 16C were determined with respect to the corresponding oil dispersions in Tables 11A, 14B, 15B, and 16B as prepared without aging. Top Separation refers to the percentage of the oil dispersion composition that separates as a liquid at the top of the composition. The pH was measured as a 1% by volume dilution of the oil dispersion composition in distilled water. The Draves Wetting (@3%) was determined in accordance with a procedure similar to that described in ASTM E1116-98. The freeze-thaw testing of the oil dispersion composition was conducted at -15°C for 24 hours followed by thawing at room temperature for 24 hours (1 cycle). Viscosities were measured using a Brookfield LV spindle 2 at 20 rpm. Emulsion testing was carried out using World Health Organization Standard Hard Water at 34 ppm, 342 ppm and 1000 ppm and 3% by volume dilution. The diluted 100 ml sample mixture was inverted 10 times at room temperature and allowed to set for approximately two hours before observation. The observation "no cream" means there was no separation of cream of oil from the resulting emulsion, while the observation "x ml top" means x ml of cream was observed at the top of the sample separated from the resulting emulsion.

Table 1: AMS/MSO OD

Component	Weight (%)	Weight (g)
Prima 100	25.15	880.25
MSO	10.00	350
SBO-10	20.00	700
ATLOX 4914	2	70
NP 9 PE	5	175
Antifoam 8830 IND	0.1	3.5
AMS	37	1295
BENTONE 1000	0.75	26.25
Total	**100**	**3500**

Table 1A: AMS/MSO OD Measured Properties

TEST	RESULTS
SPECIFIC GRAVITY	1.119
PH (1%)	3.28
APPEARANCE	Off white / beige colored viscous liquid
EMULSION (@ 3% FOR 2 HRS 34, 342, & 1000 PPM)	0 ml cream all waters
REMIX (AFTER 2 HRS)	0 ml cream all waters
VISCOSITY	1700 cP
DRAVES WETTING (@3%)	12 s

Table 2: AMS/ Prima 100 OD

Component	**Weight (%)**	**Weight (g)**
Prima 100	35.15	1230.25
SBO-10	14.00	490
IDA 6	6.00	210
ATLOX 4914	2	70
NP 9 PE	5	175
Antifoam 8830 IND	0.1	3.5
AMS	37	1295
BENTONE 1000	0.75	26.25
Total	**100**	**3500**

Table 2A: AMS/ Prima 100 OD Measured Properties

		5 cycle freeze thaw	1 Month Storage			
	Initial	**-15°C**	**-12°C**	**4°C**	**20°C**	**50°C**
Top Separation	none	5% top	3% top	3% top	5% top	6% top
1% pH	3.15	3.75	3.67	3.67	3.65	3.63
Draves Wetting @ 3%	>4 min	ND	ND	ND	ND	ND
Viscosity (cP)	2940	ND	1810	1690	2450	7600
Emulsion @ 3% for 2 hrs						
34 ppm	no cream	13 ml top	10 ml top	5 ml top	10 ml top	5 ml top
342 ppm	no cream	13 ml top	5 ml top	5 ml top	5 ml top	5 ml top
1000 ppm	no cream	5 ml top	3 ml top	5 ml top	3 ml top	5 ml top
Specific Gravity	1.109	ND	ND	ND	ND	ND

*ND = Not Determined

Table 3: AMS/Citric Acid + MSO

Component	**Weight (%)**	**Weight (g)**
Prima 100	18.40	644
MSO	10.00	350
SBO-10	20.00	700
ATLOX 4914	2	70
NP 9 PE	5	175
Antifoam 8830 IND	0.1	3.5
Citric Acid	7	245
AMS	37	1295
BENTONE 1000	0.50	17.5
Total	**100**	**3500**

Table 3A: AMS/Citric Acid + MSO Measured Properties

	Initial	5 cycle freeze thaw	1 Month Storage			
		-15°C	-12°C	4°C	20°C	50°C
Top Separation	none	4% top	3% top	6% top	7% top	25% top
1% pH	2.78	3.06	2.96	2.88	2.91	2.96
Draves Wetting @ 3%	ND	ND	ND	ND	ND	ND
Viscosity (cP)	1150	2900	1880	1950	2100	5200
Emulsion @ 3% for 2 hrs						
34 ppm	no cream	no cream	no cream	no cream	no cream	no cream
342 ppm	no cream	no cream	no cream	no cream	no cream	no cream
1000 ppm	no cream	no cream	no cream	no cream	no cream	no cream
Specific Gravity	1.162	ND	ND	ND	ND	ND

*ND = Not Determined

Table 4: AMS/Citric Acid + Crop Oil Concentrate (COC) OD

Component	Weight (%)	Weight (g)
Prima 100	28.40	284
IDA 6	6.00	60
SBO-10	14.00	140
ATLOX 4914	2	20
NP 9 PE	5	50
Antifoam 8830 IND	0.1	1
Citric Acid	7	70
AMS	37	370
BENTONE 1000	0.50	5
Total	**100**	**1000**

Table 4A: AMS/Citric Acid + COC OD Measured Properties

		5 cycle freeze thaw	1 Month Storage			
	Initial	**-15°C**	**-12°C**	**4°C**	**20°C**	**50°C**
Top Separation	none	3% top	3% top	4% top	9% top	33% top
1% pH	2.78	2.95	2.95	2.90	2.89	2.99
Draves Wetting @ 3%	15 sec	15 sec	20 sec	25 sec	11 sec	44 sec
Viscosity (cP)	3720	5440	4800	4890	5090	>6000
Emulsion @ 3% for 2 hrs	0					
34 ppm	no cream	1 ml top	no cream	no cream	2 ml top	no cream
342 ppm	no cream	no cream	1 ml top	3 ml top	2 ml top	no cream
1000 ppm	no cream	no cream	no cream	3 ml top	2 ml top	no cream
Specific Gravity	1.163	ND	ND	ND	ND	ND

*ND = Not Determined

Table 5: AMS/Citric Acid + MSO + Resin

Component	**Weight (%)**	**Weight (g)**
Prima 100	22.40	784
MSO	10.00	350
PICCOLYTE A 25	2.00	70
SBO-10	15.00	525
ATLOX 4914	1	35
NP 9 PE	5	175
Antifoam 8830 IND	0.1	3.5
Citric Acid	7	245
AMS - Pre-milled	37	1295
BENTONE 1000	0.50	17.5
Total	**100**	**3500**

Table 5A: AMS/Citric Acid + MSO + Resin Measured Properties

		5 cycle freeze thaw	1 Month Storage			
	Initial	**-15°C**	**-12°C**	**4°C**	**20°C**	**50°C**
Top Separation	none	8% top	16% top	16% top	18% top	23% top
1% pH	2.87	2.98	2.90	2.92	2.91	2.84
Draves Wetting @ 3%	ND	ND	ND	ND	ND	ND
Viscosity (cP)	750	3280	3050	2860	2490	>6000
Emulsion @ 3% for 2 hrs						
34 ppm	no cream	no cream	no cream	no cream	no cream	3 ml top
342 ppm	no cream	no cream	no cream	no cream	no cream	3 ml top
1000 ppm	no cream	no cream	no cream	no cream	no cream	3 ml top
Specific Gravity	1.134	ND	ND	ND	ND	ND

*ND = Not Determined

Table 6: AMS/Citric Acid + COC + Resin

Component	**Weight (%)**	**Weight (g)**
Prima 100	26.40	924
IDA 6	7.00	245
PICCOLYTE A 25	2.00	70
SBO-10	14.00	490
ATLOX 4914	1	35
NP 9 PE	5	175
Antifoam 8830 IND	0.1	3.5
Citric Acid	7	245
AMS - Pre-milled	37	1295
BENTONE 1000	0.50	17.5
Total	**100**	**3500**

Table 6A: AMS/Citric Acid + COC + Resin Measured Properties

		5 cycle freeze thaw	1 Month Storage			
	Initial	**-15°C**	**-12°C**	**4°C**	**20°C**	**50°C**
Top Separation	none	none	none	none	9% top	27% top
1% pH	2.96	3.32	3.05	2.96	2.86	2.96
Draves Wetting @ 3%	10 sec	9 sec	9 sec	13 sec	8 sec	36 sec
Viscosity (cP)	3840	3930	3740	3670	3730	>6000
Emulsion @ 3% for 2 hrs						
34 ppm	no cream	no cream	no cream	no cream	no cream	no cream
342 ppm	no cream	no cream	no cream	no cream	no cream	no cream
1000 ppm	no cream	no cream	no cream	no cream	no cream	no cream
Specific Gravity	1.169	ND	ND	ND	ND	ND

*ND = Not Determined

Table 7: AMS + MSO + Resin

Component	Weight (%)	Weight (g)
Prima 100	24.40	854
MSO	10.00	350
PICCOLYTE A 25	2.00	70
SBO-10	20.00	700
ATLOX 4914	1	35
NP 9 PE	5	175
Antifoam 8830 IND	0.1	3.5
AMS - Pre-milled	37	1295
BENTONE 1000	0.50	17.5
Total	**100**	**3500**

Table 7A: AMS + MSO + Resin Measured Properties

		5 cycle freeze thaw	1 Month Storage			
	Initial	**-15°C**	**-12°C**	**4°C**	**20°C**	**50°C**
Top Separation	none	30% top	none	25% top	43% top	49% top
1% pH	3.34	3.55	3.49	3.53	3.50	3.25
Draves Wetting @ 3%	ND	ND	ND	ND	ND	ND
Viscosity (cP)	537	375	475	400	325	635
Emulsion @ 3% for 2hrs	0					
34 ppm	no cream	no cream	no cream	no cream	no cream	no cream
342 ppm	no cream	no cream	no cream	no cream	no cream	no cream
1000 ppm	no cream	no cream	no cream	no cream	no cream	no cream
Specific Gravity	1.111	ND	ND	ND	ND	ND

*ND = Not Determined

Table 8: AMS + COC + Resin + Wetting

Component	**Weight (%)**	**Weight (g)**
Prima 100	33.40	1169
IDA 6	7.00	245
PICCOLYTE A 25	2.00	70
SBO-10	14.00	490
ATLOX 4914	1	35
NP 9 PE	5	175
Antifoam 8830 IND	0.1	3.5
AMS - Pre-milled	37	1295
BENTONE 1000	0.50	17.5
Total	**100**	**3500**

Table 8A: AMS + COC + Resin + Wetting Measured Properties

	Initial	5 cycle freeze thaw	1 Month Storage			
		-15°C	-12°C	4°C	20°C	50°C
Top Separation	none	41% top	32% top	33% top	43% top	41% top
1% pH	3.37	3.55	3.55	3.55	3.54	3.54
Draves Wetting @ 3%	10 sec	10 sec	9 sec	8 sec	11 sec	13 sec
Viscosity (cP)	530	1228	1128	1080	920	807
Emulsion @ 3% for 2hrs	0					
34 ppm	no cream	no cream	no cream	no cream	no cream	no cream
342 ppm	no cream	no cream	no cream	no cream	no cream	no cream
1000 ppm	no cream	no cream	no cream	no cream	no cream	no cream
Specific Gravity	1.103	ND	ND	ND	ND	ND

*ND = Not Determined

Table 9: AMS + MSO + Silica

Component	Weight (%)
MSO	35.90
SBO-10	18.00
ATLOX 4914	2
NP 9 PE	5
Antifoam 8830 IND	0.1
AMS - Pre-milled	37
AEROSIL R202	2.00
Total	**100**

Table 10: AMS/MSO (Pre-milled AMS)

Component	Actual %	Target (g)
MSO	34.55	241.85
SBO-10	14.25	99.75
ATLOX 4914	1	7
NP 9 PE	5	35
Antifoam 8830 IND	0.1	0.7
AMS – Pre-milled	43	301
Aerosil R 202	2.10	14.7
Total	100	700

Table 11: AMS + NIS OD plus wetting

Component	Actual %	Target (g)
Prima 100	30.90	8.652
SBO-10	12.50	3.5
IDA 6	4.00	1.12
Silvares 25	2	0.56
NP 9 PE	5	1.4
Antifoam 8830 IND	0.1	0.028
AMS	44	12.32
Aerosil R202	1.50	0.42
Total	100	28

Table 11A: AMS + NIS OD plus wetting

Component	Actual %	Target (g)	Actual (g)
100 SN	26	780	852.18
SBO-10	12.5	375	375.1
IDA 6	4	120	120.11
Piccolyte A 25	4	120	300.05
NP 9 PE	5	150	150.03
Stepflow 2000	2	60	60
Antifoam 8830 IND	0.1	3	3.1
AMS	44	1320	1320.12
Aerosil 200	2	60	60.15
Total	100	3000	

*Table 11A describes a slightly different, but chemically similar variation of the composition of Table 11.

Table 11B: AMS + NIS OD plus wetting Measured Properties (for the composition of Table 11A)

pH	3.50
Viscosity	2@20 – 1500 cP
Emulsion	0 mL in all waters (initial testing at room temperature)
Density	1.170 g/mL
Draves wetting =>	1 min

*2@20 indicates spindle type and speed used on the viscometer.

Table 12: AMS/Citric Acid + MSO (37% AMS, 7% citric, 10% MSO)

Component	Actual %	Target (g)
MSO	31.80	38.16
SBO-10	13.00	15.6
ATLOX 4914	2	2.4
NP 9 PE	5	6
Antifoam 8830 IND	0.1	0.12
Citric Acid	3	3.6
AMS	43	51.6
Aerosil R202	2.10	2.52
Total	100	120

Table 13: AMS/Citric Acid + COC OD Plus Wetting

Component	Actual %	Target (g)
Prima 100	28.90	809.2
IDA 6	4.00	112
SBO-10	11.50	322
ATLOX 4914	2	56
NP 9 PE	5	140
Antifoam 8830 IND	0.1	2.8
Citric Acid	3	84
AMS	44	1232
Aerosil R202	1.50	42
Total	100	2800

Table 14: AMS/Citric Acid + NIS + Resin (44% AMS, 3% Citric, 4% Piccolyte + Wetting)

Component	Actual %	Target (g)
65 SUS	28.40	85.2
IDA 6	3.00	9
Silvares 25	4.00	12
SBO-10	10.00	30
Stepflow 2000	2	6
NP 9 PE	4	12
Antifoam 8830 IND	0.1	0.3
Citric Acid	3	9
AMS - Pre-milled	44	132
Aerosil R202	1.50	4.5
Total	100	300

Table 14A: AMS/Citric Acid + COC + Resin (44% COC, 3% Citric, 2% Piccolyte + Wetting) Scale Up Batch

Component	Actual (%)	Target (g)	Target (lbs)
Prima 100	31.65	316.5	316.5
IDA 6	3.00	30	30
Piccolyte A 25	2.00	20	20
SBO-10	10.00	100	100
ATLOX 4914	1	10	10
NP 9 PE	4	40	40
Antifoam 8830 IND	0.1	1	1
Citric Acid	3	30	30
AMS	44	440	440
Aerosil R202	1.25	12.5	12.5
Total	100	1000	1000

*Approximate specific gravity = 1.179 g/ml – 1.179 g/L; Lb/gal = 9.84 lbs/gal.

**Table 14A describes a slightly different, but chemically similar variation of the composition of Table 14.

Table 14B: AMS/Citric Acid + NIS + Resin (44% AMS, 3% Citric, 4% Piccolyte + Wetting)

Component	Actual %	Target (g)	Actual (g)
100 SN	27.9	837	837.05
IDA 6	3	90	90.01
Piccolyte A 25	4	120	120.1
SBO-10	10	300	300.05
Stepflow 2000	2	60	62.38
NP 9 PE	4	120	122.31
Antifoam 8830 IND	0.1	3	3.12
Citric Acid	3	90	90.12
AMS - Pre-milled	44	1320	1320.2
Aerosil R202	2	60	60.17
Total	100	3000	

Table 14C: AMS/Citric Acid + NIS + Resin (44% AMS, 3% Citric, 4% Piccolyte + Wetting) Measured Properties (for the composition of Table 14B)

pH	3.00
Viscosity	14,000 cP (3@5 rpm)
Emulsion at 1 hr	2 ml 34 ppm, 1 ml 342 ppm, 1 ml 1000 ppm (initial testing at room temperature)
Density	1.180 g/ml
Draves wetting =>	1 min

*3@5 indicates spindle type and speed used on the viscometer.

Table 15: AMS/Citric Acid + MSO + Resin (44% AMS, 3% Citric, 2% Piccolyte)

Component	Actual %	Target (g)
B 99.9	32.80	984
Piccolyte A 25	2.00	60
SBO-10	12.00	360
Stepflow 2000	1	30
NP 9 PE	4	120
Antifoam 8830 IND	0.1	3
Citric Acid	3	90
AMS - Pre-milled	43	1290
Aerosil R202	2.10	63
Total	100	3000

Table 15A: AMS/Citric Acid + MSO + Resin (44% AMS, 3% Citric, 2% Piccolyte) Scale Up Batch

Component	Actual %	Target (g)	Target (lbs)
MSO	32.40	324	324
Piccolyte A 25	2.00	20	20
SBO-10	12.00	120	120
ATLOX 4914	1	10	10
NP 9 PE	4	40	40
Antifoam 8830 IND (SAG 1572 or Clear 30)	0.1	1	1
Citric Acid	3	30	30
AMS	43	430	430
Aerosil R202	2.50	25	25
Total	100	1000	1000

*Specific gravity = 1.190 g/ml – 1190 g/L; Lb/gal = 9.93 lbs/gal.

Table 15B: AMS/Citric Acid + MSO + Resin (44% AMS, 3% Citric, 2% Piccolyte)

Component	Actual %	Target (g)	Actual (g)
MSO	32.9	987	987.1
Piccolyte A 25	2	60	60.1
SBO-10	12	360	360.05
Stepflow 2000	1	30	37
NP 9 PE	4	120	120.1
Antifoam 8830 IND	0.1	3	3.1
Citric Acid	3	90	90.5
AMS - Pre-milled	43	1290	1291.15
Aerosil R202	2	60	61.15
Total	100	3000	

Table 15C: AMS/Citric Acid + MSO + Resin (44% AMS, 3% Citric, 2% Piccolyte) Measured Properties (for composition of Table 15B)

pH	3.15
Viscosity	1500 cP (2@20)
Emulsion	1 ml in all waters after 1 hr (initial testing at room temperature)
Density	1.180 g/ml

*2@20 indicates spindle type and speed used on the viscometer.

Table 16

Component	Actual %	Target (g)
B 99.9 or MSO	33.55	40.26
Silvares 25	2.00	2.4
SBO-10	13.25	15.9
Stepflow 2000	1	1.2
NP 9 PE	5	6
Antifoam 8830 IND	0.1	0.12
AMS - Pre-milled	43	51.6
Aerosil R202	2.10	2.52
Total	100	120

Table 16B

Component	Actual %	Target (g)	Actual (g)
MSO	33.65	1009.5	1009.6
Piccolyte A 25	2	60	60.2
SBO-10	13.25	397.5	397.51
Stepflow 2000	1	30	30.05
NP 9 PE	5	150	150.06
Antifoam 8830 IND	0.1	3	3.02
AMS - Pre-milled	43	1290	1290.25
Aerosil R202	2	60	60.15
Total	100	3000	

Table 16C: Measured Properties (for composition of Table 16B)

pH	3.50
Viscosity	2@20 = 1200 cP
Emulsion	1 ml at 1 hr in all waters (initial testing at room temperature)
Density	1.170 g/ml

*2@20 indicates spindle type and speed used on the viscometer.

Table 17: AMS + COC + Resin + Wetting (37% AMS, 10% MSO, 2% Piccolyte)

Component	Actual %	Target (g)
Prima 100	29.40	35.28
IDA 6	4.00	4.8
Piccolyte A 25	2.00	2.4
SBO-10	12.00	14.4
ATLOX 4914	2	2.4
NP 9 PE	5	6
Antifoam 8830 IND	0.1	0.12
AMS - Pre-milled	44	52.8
Aerosil R202	1.50	1.8
Total	100	120

Table 18: AMS/Prima 100 OD

Component	Actual %
Prima 100	35.00
SBO-10	13.90
IDA 6	5.00
ATLOX 4914	2
PE-TDA 6	5
Antifoam 8830 IND	0.1
AMS	37
Bentone 1000	2.00
Total	100

*Failed to form emulsion at 342 ppm and 3% by volume dilution after 1 hour at room temperature.

Table 19: AMS/Prima 100 OD

Component	Actual %
Prima 100	35.00
NP 6	13.90
NP 9 PE	5.00
ATLOX 4914	2
PE-TDA 6	5
Antifoam 8830 IND	0.1
AMS	37
Bentone 1000	2.00
Total	100

* Failed to form emulsion at 342 ppm and 3% by volume dilution after 1 hour at room temperature.

Table 20: AMS/MSO OD

Component	Actual %
MSO	35.00
NP 6	13.90
NP 9 PE	5.00
ATLOX 4914	2
PE-TDA 6	5
Antifoam 8830 IND	0.1
AMS	37
Bentone 1000	2.00
Total	100

* Failed to form emulsion at 342 ppm and 3% by volume dilution after 1 hour at room temperature.

Table 21: AMS/MSO OD (increased MSO content)

Component	Actual %
MSO	10.00
Prima 100	30.50
SBO-10	13.90
ATLOX 4914	2
NP 9 PE	5
Antifoam 8830 IND	0.1
AMS	37
Bentone 1000	1.50
Total	100

Table 22: AMS/MSO OD (rheology adjustment)

Component	Actual %
MSO	37.00
SBO-10	18.40
ATLOX 4914	2
NP 9 PE	5
Antifoam 8830 IND	0.1
AMS	37
Bentone 1000	0.50
Total	100

Table 23: AMS/MSO OD (rheology adjustment)

Component	Actual %
MSO	35.00
SBO-10	19.90
ATLOX 4914	2
NP 9 PE	5
Antifoam 8830 IND	0.1
AMS	37
Aerosil R202	1.00
Total	100

Table 24: AMS/MSO OD (rheology adjustment)

Component	Actual %
MSO	35.00
SBO-10	19.90
ATLOX 4914	2
NP 9 PE	5
Antifoam 8830 IND	0.1
AMS	37
Aerosil 200	1.00
Total	100

Table 25: AMS/MSO OD (rheology adjustment)

Component	Actual %
MSO	35.00
SBO-10	19.90
ATLOX 4912	2
NP 9 PE	5
Antifoam 8830 IND	0.1
AMS	37
Aerosil 300	1.00
Total	100

Table 26: AMS/MSO OD

Component	Actual %
MSO	35.00
SBO-10	19.90
ATLOX 4914	2
Branched CDDBS	5
Antifoam 8830 IND	0.1
AMS	37
Bentone 1000	1.00
Total	100

* Failed to form emulsion at 342 ppm and 3% by volume dilution after 1 hour at room temperature.

Table 27: AMS/MSO OD

Component	Actual %
MSO	35.00
SBO-10	19.90
Stepflow 2000	2
Branched CDDBS	5
Antifoam 8830 IND	0.1
AMS	37
Bentone 1000	1.00
Total	100

EXAMPLE 2: FIELD TESTING

[0054] Field plots consisting of various weed species, including *Amaranthus palmeri* (Palmer pigweed - AMAPA), *Ipomoea hederacea* (Ivyleaf morningglory - IPOHE), *Abutilon theophrastii* (Velvetleaf - ABUTH), *Setaria viridis* (green foxtail - SETVI) and *Kochia scoparia* (Kochia - KOSC) were grown and established. Field plots for all weed species except Kochia were established at Agricenter International (Memphis, TN, USA). The soil is a Memphis silt loam, (19.7% sand, 74.8% silt, 5.4% clay, 1.6% organic matter) managed with conventional tillage. The Kochia plot was a natural population found growing in Kansas, USA. Plot size was 6.3 feet wide and 20 feet long. The experimental design was a randomized complete block with 3 replications. Plots were sprayed with 15 gallons per acre spray solution through AIXR 8002 nozzles (Spraying Solutions Inc.).

[0055] Herbicide spray mixes including glufosinate, glufosinate in combination with 2,4-D choline salt, and glyphosate in combination with mesotrione along with various conventional adjuvants or an oil dispersion (OD) composition of the present invention were prepared as detailed below and applied at the 6-8 inch height of plant growth.

[0056] Results for observed plant control are reported in Tables 28 to 31 below.

Table 28: Adjuvant effect on % weed control of 4 weed species 14 days after treatment (DAT) with glufosinate 280 SL herbicide

Herbicide	AMAPA	IPOHE	ABUTH	SETVI	Average
None	0	0	0	0	0
Glufosinate 280SL + AMS liquid 2.5% + MSO (1 qt/A)	46.7	70	46.7	50	53.4
Glufosinate 280SL + OD of Table 10	46.7	70	73.3	46.7	59.2

Table 29: Adjuvant effect on % weed control of 3 weed species 14 days after treatment (DAT) with glufosinate 280 SL herbicide plus 2,4-D choline salt

Herbicide	AMAPA	ABUTH	SETVI	Average
None	0	0	0	0
2,4-D choline 32 oz/A + glufosinate 280SL 32 oz/A	50	51.7	46.7	49.5
Herb + OD of Table 11	53.3	51.7	51.7	52.2
Herb + OD of Table 15	51.7	56.7	46.7	51.7
Herb + OD of Table 14	56.7	60	48.3	55.0
Herb + OD of Table 16	53.3	51.7	46.7	50.6
Herb + AMS liquid (2.5%) + MSO 1 qt/A	58.3	58.3	50	55.3

Table 30: Adjuvant effect on % weed control of Kochia 14 days after treatment (DAT) with glyphosate and mesotrione herbicides

Herbicide	KOSC
Glyphosate + Mesotrione + AMS + COC	22
Glyphosate + Mesotrione + OD of Table 14	25
Glyphosate + Mesotrione + OD of Table 11	25

Table 31: Adjuvant effect on % weed control of Palmer Amaranth 14 days after treatment (DAT) with glufosinate herbicide

Herbicide	AMAPA
Glufosinate + AMS + MSO	53
Glufosinate + OD of Table 15	57

[0057] The results reported in Tables 28 to 31 demonstrate that the oil dispersion compositions of the present invention provided comparable and sometimes superior weed control as compared with herbicides mixed with conventional adjuvants. Accordingly, the oil dispersion compositions of the present invention provide the end user with an effective tank mix adjuvant combined with greater ease of use.

[0058] Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention pertains. Although methods and materials similar or equivalent to those described herein can be used to practice the invention, suitable methods and materials are described below. All publications, patent applications, patents, and other references mentioned herein are incorporated by reference in their entirety. In case of conflict, the present specification, including definitions, will control. In addition, the materials, methods, and examples are illustrative only and not intended to be limiting.

[0059] When introducing elements of the present invention or the preferred embodiments(s) thereof, including the appended claims, the singular articles "a", "an", "the" and "said" are intended to mean that there are one or more of the elements. The terms "comprising", "including" and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements.

[0060] In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

[0061] It is to be understood that while the invention has been described in conjunction with the detailed description thereof, the preceding description is intended to illustrate and not limit the scope of the invention, which is defined by the scope of the appended claims. Other aspects, advantages, and modifications are within the scope of the following claims.

WHAT IS CLAIMED IS:

1. A non-aqueous, agrochemical solid in oil dispersion composition, the composition comprising:

from about 20 wt.% to about 40 wt.% of an agricultural oil carrier;

from about 30 wt.% to about 50 wt.% of a particulate agrochemical solid component dispersed in the oil carrier;

from about 10 wt.% to about 30 wt.% of an emulsifier component comprising a nonionic emulsifier and an anionic emulsifying surfactant;

from about 0.5 wt.% to about 3 wt.% of a water-insoluble, nonionic polymeric dispersant having an HLB no greater than about 10; and

from about 0.1 wt.% to about 5 wt.% of a rheology additive selected from the group consisting of an organic derivative of a bentonite clay, fumed silica and combinations thereof.

2. The dispersion composition of claim 1, wherein the agricultural oil carrier is selected from the group consisting of hydrotreated heavy paraffinic petroleum distillate, non-esterified vegetable oil, methylated seed oil, tall oil and combinations thereof.

3. The dispersion composition of claim 1, wherein the agricultural oil carrier comprises methylated seed oil.

4. The dispersion composition of claim 1, wherein the agricultural oil carrier comprises a hydrotreated heavy paraffinic petroleum distillate.

5. The dispersion composition of claim 1, wherein the particulate agrochemical solid component comprises a water-conditioning agent.

6. The dispersion composition of claim 5, wherein the water-conditioning agent is selected from the group consisting of ammonium sulfate, citric acid and combinations thereof.

7. The dispersion composition of any one of claims 1 to 6 wherein the particulate agrochemical solid component comprises ammonium sulfate.

8. The dispersion composition of any one of claims 1 to 6, wherein the particulate agrochemical solid component is pre-milled.

9. The dispersion composition of any one of claims 1 to 6, wherein the particulate agrochemical solid component has a D90 particle size of about 20 μm or about 10 μm.

10. The dispersion composition of any one of claims 1 to 6, wherein the co-polymeric dispersant comprises a random co-polymer based on an alkyd-polyethylene glycol resin comprising a polyisobutylene succinic anhydride oil soluble graft.

11. The dispersion composition of any one of claims 1 to 6, wherein the co-polymeric dispersant comprises an A-B-A block co-polymer based on 12-polyhydroxystearic acid and polyethylene glycol.

12. The dispersant composition of any one of claims 1 to 6, wherein the nonionic emulsifier of the emulsifier component is selected to have an HLB no greater than about 10, or no greater than about 8.

13. The dispersion composition of any one of claims 1 to 6, wherein the nonionic emulsifier of the emulsifier component comprises an alkoxylated nonionic emulsifier.

14. The dispersion composition of any one of claims 1 to 6, wherein the nonionic emulsifier of the emulsifier component comprises an alkoxylated vegetable oil adjuvant.

15. The dispersion composition of any one of claims 1 to 6, wherein the anionic emulsifying surfactant of the emulsifier component comprises calcium dodecylbenzene sulfonate.

16. The dispersion composition of any one of claims 1 to 6, wherein the anionic emulsifying surfactant of the emulsifier component comprises an alkoxylated alkyl phosphate ester selected from the group consisting of a polyoxyethylene nonylphenol phosphate ester, polyoxyethylene isotridecyl ether phosphate and combinations thereof.

17. The dispersion composition of any one of claims 1 to 6, wherein the concentration of the emulsifier component is from about 10 wt.% to about 30 wt.%, from about 15 wt.% to about 30 wt.%, from about 20 wt.% to about 28 wt.%, from about 12 wt.% to about 28 wt.%, or from about 12 wt.% to about 20 wt.%.

18. The dispersion composition of any one of claims 1 to 6, wherein the weight ratio of the nonionic emulsifier to the anionic emulsifying surfactant(s) is greater than 1:1, at least about 2:1, at least about 3:1 or at least about 4:1.

19. The dispersion composition of any one of claim 1 to 6, wherein the concentration of the agricultural oil carrier is from about 26 wt.% to about 36 wt.%.

20. The dispersion composition of any one of claims 1 to 6, wherein the concentration of the water-insoluble, nonionic co-polymeric dispersant is from about 1 wt.% to about 2 wt.%.

21. The dispersion composition of any one of claims 1 to 6, wherein the rheology additive comprises an organic derivative of a bentonite clay and the concentration of the rheology additive is from about 0.1 wt.% to about 2 wt.%, or from about 0.5 wt.% to about 0.75 wt.%.

22. The dispersion composition of any one of claims 1 to 6, wherein the rheology additive comprises a fumed silica and the concentration of the rheology additive is from about 0.5 wt.% to about 5 wt.%, or from about 2 wt.% to about 4 wt.%.

23. The dispersion composition of any one of claims 1 to 6, further comprising at least one of a spray drift control agent and an antifoam component.

24. A non-aqueous, agrochemical solid in oil dispersion composition, the composition comprising:

from about 26 wt.% to about 36 wt.% of an agricultural oil carrier selected from the group consisting of hydrotreated heavy paraffinic petroleum distillate, non-esterified vegetable oil, methylated seed oil, tall oil and combinations thereof;

from about 30 wt.% to about 50 wt.% of a water-conditioning agent selected from the group consisting of ammonium sulfate, citric acid, sodium citrate, potassium citrate and combinations thereof;

from about 12 wt.% to about 28 wt.% of an emulsifier component comprising an ethoxylated soybean oil adjuvant and a phosphate ester of polyoxyethylene nonylphenol;

from about 1 wt.% to about 2 wt.% of a water-insoluble, nonionic co-polymeric dispersant comprising a random co-polymer based on an alkyd-polyethylene glycol resin comprising a polyisobutylene succinic anhydride oil soluble graft; and

from about 0.5 wt.% to about 5 wt.% of a rheology additive comprising a fumed silica.

25. A method for preparing an agricultural tank mix application mixture, comprising:

mixing an agrochemical formulation comprising an agrochemical with an oil dispersion composition of any one of claims 1 to 6 or 24 and dilution water to form the agricultural tank mix application mixture.

26. The method of claim 25, wherein the agrochemical is selected from the group consisting of pesticides and fertilizers.

27. The method of claim 26, wherein the agrochemical is a pesticide selected from the group consisting of herbicides, insecticides, fungicides and combinations thereof.

28. The method of claim 25, wherein the agrochemical formulation is in the form of a solid, solution concentrate, emulsion concentrate, microemulsion concentrate or suspension concentrate.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2024/049486

A. CLASSIFICATION OF SUBJECT MATTER

IPC: ***A01N 25/12*** (2024.01); ***A01N 25/02*** (2024.01); *A01N 63/00* (2024.01)

CPC: ***A01N 25/12; A01N 25/02;*** *A01N 63/00*

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History Document

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

See Search History Document

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

See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	US 2017/0105411 A1 (CRODA INTERNATIONAL PLC) 20 April 2017 (20.04.2017)	
X	para [0001], [0021], [0098], [0107]-[0108], [0112], [0116], [0126], [0128]-[0129], [0131]-[0140], [0158]-[0159], [0161]-[0163], [0178], [0180]-[0181], [0183], [0186]-[0187], [0189], [0201]-[0202], [0205], [0221], [0223], [0230]	1-8, 12-15, 17-23, (25-28)/(1-6)
Y	para [0001], [0021], [0098], [0107]-[0108], [0112], [0116], [0126], [0128]-[0129], [0131]-[0140], [0158]-[0159], [0161]-[0163], [0178], [0180]-[0181], [0183], [0186]-[0187], [0189], [0201]-[0202], [0205], [0221], [0223], [0230]	9-11, 16, 24, (25-28)/24
	US 2021/0153503 A1 (UPL LTD.) 27 May 2021 (27.05.2021)	
Y	para [0001], [0067], [0106]-[0107]	9
	US 2010/0130364 A1 (CASANA GINER et al.) 27 May 2010 (27.05.2010)	
Y	para [0090]; claim 1	10-11
	WO 2021/151143 A1 (NUFARM AUSTRALIA LIMITED) 05 August 2021 (05.08.2021)	
Y	para [0007], [0035]	16
	US 2006/0166898 A1 (CHEN) 27 July 2006 (27.07.2006)	
Y	para [0003], [0037]-[0040], [0042]	24, (25-28)/24

☑ 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
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 October 2024 (30.10.2024)	**12 December 2024 (12.12.2024)**

Name and mailing address of the ISA/US	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2024/049486

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6,936,649 B1 (GROGAN et al.) 30 August 2005 (30.08.2005) col 7 ln 24	4
A	US 2020/0275649 A1 (LEVY et al.) 03 September 2020 (03.09.2020) see entire document	1-28
A	US 2020/0236929 A1 (WINFIELD SOLUTIONS, LLC) 30 July 2020 (30.07.2020) see entire document	1-28
A	US 2016/0165885 A1 (FINE AGROCHEMICALS LIMITED) 16 June 2016 (16.06.2016) see entire document	1-28
A	CRODA, "Crop Care. Product Guide. Nature & technology in harmony", 2013, retrieved from the Internet: [http://www.williams.com.uy/biblioteca/cadm_sis/download.php?t=nov&i=80]; see entire document, especially, pg 10	1, 12