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ABSTRACT

The present invention relates to a pesticide formulation comprising: pyriproxyfen, a synergist, a surfactant, and optionally a solvent. The invention also relates to a concentrate formulation, an emulsifiable concentrate, a method of preparing a pesticide formulation of the invention, and a method of preventing and/or controlling a pest infestation in a target area using the pesticide formulation of the invention.

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# PESTICIDE FORMULATION COMPRISING PYRIPROXYFEN

## FIELD OF THE INVENTION

This invention relates to a pesticide formulation. In particular, the present invention relates to a pesticide formulation containing pyriproxyfen as an active agent and piperonyl butoxide as a synergist and to methods of preparing and using said formulation. However, it will be appreciated that the invention is not limited to this particular field of use.

## BACKGROUND TO THE INVENTION

Pyriproxyfen is an insect growth regulator, which displays its action as a juvenile hormone mimic with agonistic activity towards juvenile hormone receptors. It has some ovicidal effect, meaning it is also effective during the egg stage. As it mimics the juvenile hormone, pyriproxyfen also has an antimetamorphic effect, preventing transformation to the adult stage by inhibiting the gene regulation required to mature to the adult phase. Pyriproxyfen has some activity during the adult phase, as it is also known to suppress embryogenesis and inhibit reproduction.

Pyriproxyfen is commonly obtained and used as a racemic mixture of two active stereoisomers 4-phenoxyphenyl (*R*)-2-(2-pyridyloxy)propyl ether and 4-phenoxyphenyl (*S*)-2-(2-pyridyloxy)propyl ether. It is commonly used to control insect pests of public health significance, such as flies, beetles, midges and mosquitos, and agriculturally significant pests such as whitefly and thrips. It is generally applied to breeding areas, such

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as swamps and livestock houses, or to agricultural crops such as cotton.

It is a known problem that acaricides and insecticides such as pyriproxyfen, when administered alone, can display reduced efficacy in populations of target pests that are treated multiple times, as the populations tend to build resistance to the active ingredient. One approach to counteract such resistance is to combine the pyriproxyfen with another active ingredient. However, the efficacy of this active ingredient can also diminish over time and with repeated exposure of the population. Accordingly, it would be preferable, and a significant advance in the art, to provide an acaricide composition that does not display reduced efficacy over time or with repeated exposure to a target population.

Notwithstanding the commercial availability of a range of pyriproxyfen formulations, there remains a need for improved pyriproxyfen-based formulations for use in an agricultural setting that overcomes one or more of the inherent limitations of commercially available pyriproxyfen formulations.

It is an object of the present invention to overcome or ameliorate at least one of the disadvantages of the prior art, or to provide a useful alternative.

It is a preferred object of at least one form of the present invention to provide a solvent-free (or substantially solvent-free) pesticide formulation comprising pyriproxyfen, or a solvent-borne pesticide formulation comprising pyriproxyfen, or a pesticide concentrate comprising pyriproxyfen.

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## SUMMARY OF THE INVENTION

In a first aspect, the invention provides a pesticide formulation comprising:

pyriproxyfen;

a synergist;

a surfactant; and

optionally, a solvent.

In a second aspect, the invention provides a concentrate formulation comprising:

pyriproxyfen at a concentration of at least about 100 g/L;

piperonyl butoxide or an analogue or derivative thereof at a concentration of at least about 50 g/L;

a surfactant; and

optionally, a solvent,

wherein the concentrate formulation is an emulsifiable concentrate formulation or a dispersible concentrate formulation.

In one embodiment, the invention provides a concentrate formulation comprising:

pyriproxyfen at a concentration of at least about 300 g/L;

piperonyl butoxide at a concentration of at least about 50 g/L;

a non-ionic surfactant and an anionic surfactant; and

a solvent.

In some embodiments, the surfactant is present in an amount of at least about 40 g/L. More particularly, the surfactant is suitably present in

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an amount ranging between about 40 g/L to about 80 g/L.

Suitably, the surfactant is selected from the group consisting of an alkylphenol, a polyoxyalkylene ether, an alkylbenzene sulphonate, an alkoxylated styryl phenol, an oil ethoxylate and any combination thereof. Preferably, the surfactant is selected from the group consisting of an alkoxylated alkylphenol, an alkyl polyoxyalkalene ether, calcium $C_{10-16}$ alkylbenzyl sulphonate, an ethoxylated tristyryl phenol, a vegetable oil ethoxylate and any combination thereof.

In one embodiment, the solvent is present in an amount of at least about 200 g/L. More particularly, the solvent can be present in an amount ranging between about 250 g/L to about 600 g/L.

Suitably, when present the solvent is selected from the group consisting of a petroleum derivative, a carboxamide, a benzoate, a ketone, a glycol ether and any combination thereof. Preferably, the solvent is selected from the group consisting of a heavy aromatic solvent naphtha (petroleum), 1-butylpyrrolidin-2-one, methyl benzoate, ethyl benzoate, MIBK, isophorone, acetophenone, propylene glycol monomethyl ether and any combination thereof. In one particularly suitable embodiment, the solvent is methyl benzoate.

In some embodiments, the addition of a solvent is not required and is therefore absent, or substantially absent, whereby the pyriproxyfen is at least partially solubilised in the synergist (e.g. piperonyl butoxide). In such embodiments, referred to herein as “solvent-less” formulations, it is understood that the synergist acts as a solvent and at least partially

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solubilises the active agent.

In a third aspect, the invention provides a method of preparing a pesticide formulation including the steps of:

(a) combining pyriproxyfen, a synergist such as piperonyl butoxide, a surfactant and optionally a solvent, wherein pyriproxyfen is present at a of at least 100 g/L; and

(b) mixing the mixture of step (a) to thereby prepare the pesticide formulation.

Suitably, the pesticide formulation is that of the first aspect or the concentrate formulation of the second aspect.

In a fourth aspect, the invention provides a pesticide formulation prepared by the method of the third aspect.

In a fifth aspect, the invention provides a method of preventing and/or controlling a pest infestation in a target area, including the step of applying a pesticidally effective amount of the pesticide formulation of the first or fourth aspects or the concentrate formulation of the second aspect, mixed with water or a water-containing liquid to the target area to thereby prevent and/or control the pest infestation. In some cases, it may be preferable to sequentially, or concurrently apply the inventive pesticide formulation described herein, with the emulsifiable or dispersible concentrate formulations described herein (mixed with water or a water-containing liquid).

In one embodiment, the method of the present aspect further includes the initial step of mixing the pesticide formulation or the

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emulsifiable concentrate formulation with water or the water-containing liquid.

As used herein, except where the context requires otherwise, the term "*comprise*" and variations of the term, such as "*comprising*", "*comprises*" and "*comprised*", are not intended to exclude further elements, components, integers or steps but may include one or more unstated further elements, components, integers or steps.

It will be appreciated that the indefinite articles "*a*" and "*an*" are not to be read as singular indefinite articles or as otherwise excluding more than one or more than a single subject to which the indefinite article refers. For example, "a" surfactant includes one surfactant, one or more surfactants and a plurality of surfactants.

## DETAILED DESCRIPTION OF THE INVENTION

There is an advantage in providing pesticide products in a concentrated liquid form or a highly loaded concentrated liquid form, having relatively high concentrations of active ingredient/s in proportion to other excipients within the formulation, and which are stable in concentrate form but readily dispersible in water when diluted for use. By way of example, the treatment of a given volume of produce or target area (e.g., crop, land, commercial or residential premises etc) can be achieved with a reduced amount of pesticide product being used. As such, these concentrated pesticide products afford a broadly better economic outcome together with reduced costs (e.g., reduced non-active ingredients,

packaging, handling, storage, freight, labour, regulatory licensing and disposal costs) and less environmental impact (e.g., reduced non-active ingredients, such as solvents, surfactants, preservatives, anti-oxidants, dyes and consumption deterrents, and packaging, such as containers, closures, labels/booklets, pallets and pallet liners/boxes/wrapping).

In addition to the above, providing an emulsifiable or dispersible concentrate form of a pesticide product can further alleviate some or all of the deficiencies of other product formulations or preparations of the pesticide in question, such as suspensions or suspoemulsions. To this end, the active ingredient in emulsifiable concentrate formulations and dispersible concentrate formulations (including highly loaded concentrate forms) is not in the solid phase but is dissolved in a liquid phase, and thereby is not subject to settling or physical phase separation of solid from liquid. Furthermore, the selection of appropriate solvents and other excipients typically requires careful consideration so as to achieve a passable emulsifiable or dispersible concentrate formulation, especially at high relative concentrations of active ingredients.

In view of the foregoing, the present invention advantageously provides a pyriproxyfen composition or formulation suitable for the prevention, control or treatment of a range of pest infestations in an agricultural or horticultural setting. Further, the pyriproxyfen formulation may be ready for direct use, or it may be an emulsifiable concentrate or a dispersible concentrate, or it may be a highly loaded concentrate.

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Accordingly, in one broad form the invention resides in a pesticide formulation comprising:

pyriproxyfen;

a synergist;

a surfactant; and

optionally, a solvent.

The term “pyriproxyfen” refers to a racemic mixture of 4-phenoxyphenyl (*R*)-2-(2-pyridyloxy)propyl ether and 4-phenoxyphenyl (*S*)-2-(2-pyridyloxy)propyl ether. By “racemic”, it is meant that the proportions of the two stereoisomers are relatively equivalent (i.e., the (*R*) and (*S*) isomers are each approximately equal, or about 50% (*R*) and about 50% (*S*)) although some variation may occur. It will be appreciated that use of the term “pyriproxyfen” herein can refer to one or both of these stereoisomers, including specific mixtures and/or ratios thereof, such as racemic mixtures.

As generally used herein, the term “highly loaded” means that pyriproxyfen and synergist (e.g., piperonyl butoxide) collectively occupy a substantial portion of the pesticide formulation on a weight by volume (g/L) basis. In the context of liquid pesticide formulations, inclusive of emulsifiable concentrate formulations, for example, “highly loaded” refers to a concentration level of pyriproxyfen pesticide therein on a weight by volume basis (g/L) in the amount from at least about 150 g/L.

The term “synergist” as generally used herein refers to an agent that synergizes the activity of a pesticide or an insecticide, such as an

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insect growth regulator and hormone mimic like pyriproxyfen. Synergists may include any that are known in the art, such as, for instance, piperonyl butoxide (PBO), N-octyl bicycloheptene dicarboximide (MGK-264), piprotal, propyl isome, sesamex, sesamolin, sulfoxide and inclusive of any analogues or derivatives thereof.

It is well established that the use of synergists such as piperonyl butoxide (PBO) can enhance pesticidal, insecticidal, acaricidal, fungicidal, molluscicidal and vermicidal activity *in vitro* and/or *in vivo*, by, for example, inhibiting the activity of certain insect metabolic enzymes involved in detoxification and resistance or by other mechanisms of action (see, e.g., Gunning R.V. et al., "Piperonyl Butoxide", pages 215-225, Academic Press (1998); Benchaoui H.A. et al. J. Pharm. Pharmacol. 1996, 48, 753-759; Wen Z. et al., Pest. Science 1997, 49, 367-371; Zhao J-Z J. Econ. Entomol. 2000, 93,1508-1514; Nishiwaki H. et al., J. Pest. Science 2004, 29,1 10-1 16 and the patent applications DE 4426942, EP 617890). By way of example, piperonyl butoxide is capable of interacting with and inhibiting phase 1 metabolic enzymes, specifically esterases and cytochrome P450s.

The addition of a synergist, such as piperonyl butoxide, to the present pesticide formulation thereby facilitates or potentiates the activity of pyriproxyfen and thus advantageously increases the biological effectiveness thereof, while achieving substantial savings on the cost of the composition formulation. It is understood that whilst piperonyl butoxide does not have any acaricidal activity *per se*, when used in conjunction with

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pyriproxyfen it does slow the affected pest's capacity to degrade and eliminate (that is, metabolise) the pyriproxyfen, thereby amplifying the acaricidal effect of the applied composition, relative to the same amount of pyriproxyfen applied without a synergist such as piperonyl butoxide.

As will be shown herein, it is understood that the emulsifiable concentrates, dispersible concentrates and highly loaded concentrates of the present invention are stabilized as a result of the interaction between the surfactants and solvents present within the formulations. The surfactant(s) and solvent(s) advantageously and surprisingly provide an end product that achieves and maintains homogeneity after manufacture and during storage, even at the equivalent of up to two years of storage under accelerated conditions, even though the active constituents are at or near their solubility limits. The term "solvent" in the context of the present invention is understood to refer to additional solvents added to the composition (such as methyl benzoate or isophorone). Compositions that do not have added solvent, referred to as "solvent-less" formulations, may be stabilised by the interaction between the synergist (such as piperonyl butoxide) and the surfactant(s), whereby the synergist also at least partially solubilises the active agent (such as pyriproxyfen). In other words, in "solvent-less" formulations, the synergist may approximate the action of a solvent or solvents. It will be appreciated that the term "solvent-free", or substantially "solvent-free", neglects any minor amounts of solvent that may be inherently introduced along with the other components of the

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formulation, such as any solvent that may inherently be included with the surfactant.

The solvent of the pesticide formulations herein, when present, may comprise one solvent, or they may comprise two or more solvents. When used, it is understood that at least one of the solvents of the formulation dissolves at least the pyriproxyfen. In some embodiments, the solvent may also dissolve the piperonyl butoxide. In some embodiments, the synergist (such as piperonyl butoxide), alone or in combination with at least one surfactant, may also act as a solvent and solubilise the pyriproxyfen loading to produce an emulsifiable concentrate. Each solvent may be aprotic (i.e., they are unable to donate a hydrogen atom). Each solvent may be polar or it may be non-polar. In some embodiments, an emulsion may be formed between a polar solvent and a non-polar solvent. In some embodiments, additional solvent is not added to the composition as the synergist also acts as a solvent. Embodiments that comprise only an active agent (such as pyriproxyfen), a synergist (such as piperonyl butoxide) and at least one surfactant may be referred to as a “solvent-less” formulation, due to the absence of additional solvent added.

The surfactant of the pesticide formulations herein may comprise one surfactant, or they may comprise two or more surfactants. The surfactant may be an anionic surfactant, or it may be a non-ionic surfactant. In one embodiment, the surfactant of the present invention may comprise both an anionic surfactant and a non-ionic surfactant. It is understood that a surfactant comprises a hydrophobic portion and

hydrophilic portion, whereby an anionic surfactant has a negative charge on the hydrophilic portion, and a non-ionic surfactant has no formal charge. Anionic surfactants are regularly obtained as a salt with a metal cation, such as a sodium, potassium or calcium salt. It is expected that any surfactant suitable for use in pesticide formulations may be suitable for use in the formulations of the present invention. Suitable surfactants may be mixtures. They may be proprietary products.

It is envisaged that the pesticide formulation may take the form of any liquid formulation known in the art. Exemplary liquid formulations include oil-miscible liquids, soluble concentrates, ultra-low-volume (ULV) liquids, dispersible concentrates, emulsifiable concentrates, emulsions including oil-in-water and micro-emulsions, suspension concentrates and suspoemulsions.

In one particular embodiment, the pesticide formulation is or comprises an emulsifiable concentrate.

It will be well understood that the term "emulsifiable concentrate formulation" or “emulsifiable concentrate” (EC) refers to a homogenous liquid formulation or concentrate of an active agent, such as a pesticide, which, on dilution in water or a water-containing liquid, forms an emulsion such as a spontaneous milky white emulsion comprising a dispersed water immiscible phase. By way of example, a water insoluble active ingredient is typically dissolved in a largely water insoluble solvent that upon combination with water or the like and agitation forms an emulsion being a distribution of droplets of the water insoluble solvent and active ingredient

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amongst a water matrix stabilised by surfactants. The term "emulsion", as used herein, refers to a fine dispersion of minute droplets of one liquid in another in which it is not soluble or miscible and includes microemulsions and macroemulsions.

In another particular embodiment, the pesticide formulation is or comprises a dispersible concentrate.

It will be well understood that the term “dispersible concentrate formulation” or “dispersible concentrate” (DC) refers to a homogenous liquid formulation or concentrate of an active agent, such as a pesticide, which, on dilution with water or a water-containing liquid, forms a suspension or a solid dispersion phase within the water-based matrix. In other words, the active agent, which is in liquid form in the dispersible concentrate formulation, precipitates on contact with water or water-containing liquids and is dispersed throughout the water-containing phase as solid particles. By way of example, a water insoluble active ingredient is typically dissolved in a solvent that may be miscible, or at least partially miscible, in water, which when in contact with water or the like and agitated, the solvent mixes and dissolves into the water phase, leaving the water insoluble active ingredient to contact the water and precipitate as solid particles. The solid active ingredient may be dispersed in the water matrix and suspended by action of the surfactant or surfactants also present in the formulation.

In one aspect, the invention provides a concentrate formulation comprising:

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pyriproxyfen at a concentration of at least about 100 g/L;

piperonyl butoxide or an analogue or derivative thereof at a concentration of at least about 50 g/L;

a surfactant; and

optionally, a solvent,

wherein the concentrate formulation is an emulsifiable concentrate formulation or a dispersible concentrate formulation.

In a related aspect, the invention provides a method of preparing a pesticide formulation including the steps of:

(a) combining pyriproxyfen, a synergist such as piperonyl butoxide or an analogue or derivative thereof, a surfactant and optionally a solvent, wherein pyriproxyfen is present at a concentration of at least 100 g/L; and

(b) mixing the mixture of step (a) to thereby prepare the pesticide formulation.

The statements which follow apply equally to the aforementioned aspects of the invention.

For the present invention, pyriproxyfen is suitably present in a concentration (e.g., at least about 100 g/L) that provides a concentrate pesticide formulation, such as an emulsifiable concentrate formulation or a dispersible concentrate, or in a higher concentration (e.g., such as about 300 g/L) that provides a highly loaded pesticide formulation, suitable for use in the effective prevention, control and/or treatment of a pest infestation.

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In relation to liquid pesticide formulations, such as emulsifiable concentrate formulations or dispersible concentrate formulations, or highly loaded formulations, pyriproxyfen may be present in an amount from about 50 g/L to about 500 g/L or any range therein such as, but not limited to, about 100 g/L to about 250 g/L, about 150 g/L to about 350 g/L, or about 300 g/L to about 400 g/L of the liquid pesticide formulation. In particular embodiments of the present invention, pyriproxyfen is present in an amount of about 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120, 125, 130, 135, 140, 145, 150, 155, 160, 165, 170, 175, 180, 185, 190, 195, 200, 205, 210, 215, 220, 225, 230, 235, 240, 245, 250, 255, 260, 265, 270, 275, 280, 285, 290, 295, 300, 305, 310, 315, 320, 325, 330, 335, 340, 345, 350, 355, 360, 365, 370, 375, 380, 385, 390, 395, 400, 405, 410, 415, 420, 425, 430, 435, 440, 445, 450, 455, 460, 465, 470, 475, 480, 485, 490, 495, 500 g/L, or any range therein, of the liquid pesticide formulation. In certain embodiments of the present invention, pyriproxyfen is present in an amount of about 100 g/L to about 425 g/L of the liquid pesticide formulation.

Piperonyl butoxide (PBO) is a well-known insecticide synergist that can enhance the potency of certain pesticides, such as carbamates, pyrethrins, pyrethroids, diphenyl oxazolines, insect growth regulators and rotenone. An analogue or derivative of piperonyl butoxide may be any as are known in the art and include, for example, a range of additional side chains and moieties (e.g., alkyl side chains, alkynyl side chains). Examples of piperonyl butoxide analogues are described in Panini et al.,

Pest Management Science, 2017, v73(2); 371-379 and Philippou et al. (2010), Imperial College London, PhD Thesis (Thesis:519289), which are incorporated by reference herein. Suitably, the piperonyl butoxide analogue or derivative retains at least partly the synergist activity of PBO.

In relation to liquid pesticide formulations, such as emulsifiable concentrate formulations, dispersible concentrate formulations or highly loaded formulations, the synergist (e.g., piperonyl butoxide) may be present in an amount from about 10 g/L to about 600 g/L or any range therein such as, but not limited to, about 25 g/L to about 300 g/L, about 100 g/L to about 500 g/L, or about 200 g/L to about 400 g/L of the liquid pesticide formulation. In particular embodiments of the present invention, piperonyl butoxide is present in an amount of about 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120, 125, 130, 135, 140, 145, 150, 155, 160, 165, 170, 175, 180, 185, 190, 195, 200, 205, 210, 215, 220, 225, 230, 235, 240, 245, 250, 255, 260, 265, 270, 275, 280, 285, 290, 295, 300, 305, 310, 315, 320, 325, 330, 335, 340, 345, 350, 355, 360, 365, 370, 375, 380, 385, 390, 395, 400, 405, 410, 415, 420, 425, 430, 435, 440, 445, 450, 455, 460, 465, 470, 475, 480, 485, 490, 495, 500, 505, 510, 515, 520, 525, 530, 535, 540, 545, 550, 555, 560, 565, 570, 575, 580, 585, 590, 595, 600 g/L, or any range therein, of the liquid pesticide formulation. In certain embodiments of the present invention, piperonyl butoxide is present in an amount of about 50 g/L to about 500 g/L of the liquid pesticide formulation. In other embodiments, piperonyl butoxide is present at a concentration of at least

about 100 g/L, preferably at least about 200 g/L, more preferably at least about 300 g/L and even more preferably at least about 400 g/L of the total weight of the formulation. Embodiments comprising at least 150 g/L collectively of pyriproxyfen and synergist (e.g., piperonyl butoxide) may be considered to be highly loaded formulations. The ratio of pyriproxyfen to synergist (e.g., piperonyl butoxide) may be between about 20:1 and about 1:20 or any range therein, such as between 10:1 and 1:1, or between 5:1 and 1:5, or between 2:1 and 1:10, or between 1:1 and 1:15, or it may be about 20:1, 19:1, 18:1, 17:1, 16:1, 15:1, 14:1, 13:1, 12:1, 11:1, 10:1, 9:1, 8:1, 7:1, 6:1, 5:1, 4:1, 3:1, 2:1, 1.9:1, 1.8:1, 1.7:1, 1.6:1, 1.5:1, 1.4:1, 1.3:1, 1.2:1, 1.1:1, 1:1, 1:1.1, 1:1.2, 1:1.3, 1:1.4, 1:1.5, 1:1.6, 1:1.7, 1:1.8, 1:1.9, 1:2, 1:3, 1:4, 1:5, 1:6, 1:7, 1:8, 1:9, 1:10, 1:11, 1:12, 1:13, 1:14, 1:15, 1:16, 1:17, 1:18, 1:19, 1:20 or any range therein in the liquid pesticide formulation. In certain embodiments of the present invention, the ratio of pyriproxyfen to synergist (e.g., piperonyl butoxide) may be between 1:5 and 10:1.

The term “solvent” refers to any liquid capable of maintaining another substance in solution. Examples of solvents include, but are not limited to, organic solvents. It will be apparent to the skilled artisan that the solvent may include any appropriate solvent as are known in the art. By way of example, the solvent may comprise a petroleum derivative or hydrocarbon, such as a heavy aromatic solvent naphtha (petroleum) (e.g., Recosol 150), a carboxamide having an amidoalkyl structure (i.e., R-CO-NR’R’’ structure wherein R, R’ and R’’ are independent an organic moiety

or hydrogen) inclusive of lactams and pyrrolidones, such as N-substituted pyrrolidones (e.g., N-methyl pyrrolidone, N-butylpyrrolidone and N-octylpyrrolidone), N,N-dimethylformamide and N,N-dimethylacetamide, an acetic acid $C_6$-$C_8$ branched alkyl ester (including the material sold under the trade name Exxate 700), a ketone inclusive of cyclic ketones, aromatic ketones, alkylketones (e.g., isophorone) and arylketones (e.g., acetophenone), a benzoate, inclusive of alkyl benzoates (e.g., methyl benzoate, ethyl benzoate), cyclohexanone, acetone, glycols, inclusive of glycol ethers such as diethylene glycol monomethyl ether (including the material sold under the trade name Carbitol), ethylene glycol monobutyl ethers (including the material sold under the trade name Butyl Glysolv), propylene glycol monomethyl ether (including the material sold under the trade name Glysolv PM), methanol, ethanol, isopropanol, decanol and paraffins.

In one particular embodiment, the solvent is selected from the group consisting of a petroleum derivative, a carboxamide, a benzoate, a ketone, a glycol ether and any combination thereof. More particularly, the solvent is selected from the group consisting of a heavy aromatic hydrocarbon, a pyrrolidone, an alkyl benzoate, an alkyl ketone, a cyclic ketone, a propylene glycol ether and any combination thereof. Even more particularly, the solvent is selected from the group consisting of a heavy aromatic solvent naphtha (petroleum), 1-butylpyrrolidin-2-one, methyl benzoate, ethyl benzoate, MIBK, isophorone, acetophenone, propylene glycol monomethyl ether and any combination thereof.

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In a particular embodiment, the synergist may also act, alone or in concert with a surfactant, to solubilise the active ingredient. In other words, the synergist may also act as a solvent to form a "solvent-less" emulsifiable concentrate.

Such solvents may be used in isolation or in combination as a mixture of two, three, four, five or more solvents. In one particular embodiment, the solvent comprises first and second solvents. It will be appreciated that the first and second solvents may be or comprise any solvent known in the art.

For the present aspect, the ratio of the first solvent to the second solvent may suitably be between 1 and 15 parts of the first solvent, and between 1 and 15 parts of the second solvent. For example, the ratio may be about 15:1, 14:1, 13:1, 12:1, 11:1, 10:1, 9:1, 8:1, 7:1, 6:1, 5:1, 4:1, 3:1, 2.9:1, 2.8:1, 2.7:1, 2.6:1, 2.5:1, 2.4:1, 2.3:1, 2.2:1, 2.1:1, 2:1, 1.9:1, 1.8:1, 1.7:1, 1.6:1, 1.5:1, 1.4:1, 1.3:1, 1.2:1, 1.1:1, 1:1, 1:1.1, 1:1.2, 1:1.3, 1:1.4:, 1:1.5, 1:1.6, 1:1.7, 1:1.8, 1:1.9, 1:2, 1:2.1, 1:2.2, 1:2.3, 1:2.4, 1:2.5, 1:2.6, 1:2.7, 1:2.8, 1:2.9, 1:3, 1:4, 1:5, 1:6, 1:7, 1:8, 1:9, 1:10, 1:11, 1:12, 1:13, 1:14, 1:15 and any range therein. In one preferred embodiment, the ratio of the first solvent to the second solvent is in the range of about 11:1 to about 1:11.

For the above aspects, the solvent of a liquid pesticide formulation, including an emulsifiable concentrate formulation or a dispersible concentrate formulation or a highly loaded formulation, of the present invention, may be present in an amount up to about 650 g/L or any range

therein such as, but not limited to, about 350 g/L to about 650 g/L, or about 250 g/L to about 550 g/L, or about 100g/L to about 400 g/L, or about 5g/L to about 600 g/L of the liquid pesticide formulation. In particular embodiments of the present invention, the solvent is present in an amount of about 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 310, 320, 330, 340, 350, 360, 370, 380, 390, 400, 410, 420, 430, 440, 450, 460, 470, 480, 490, 500, 510, 520, 530, 540, 550, 560, 570, 580, 590, 600, 610, 620, 630, 640, 650 g/L, or any range therein, of the liquid pesticide formulation. In certain embodiments of the present invention, the solvent is present in an amount of at least about 300 g/L of the liquid pesticide formulation. More particularly, the solvent is present in an amount ranging between about 250 g/L to about 650 g/L of the liquid pesticide formulation.

Further to the above, the solvent provided herein is preferably an agriculturally acceptable solvent. The term "agriculturally acceptable solvent" as used herein refers to a solvent that is not unacceptably damaging to a plant and/or its environment, and/or not unsafe to the user or others that may be exposed to the solvent when used as described herein.

As used herein, the term "surfactant" or surface-active agent refers to an agent, usually an organic chemical compound that is at least partially amphiphilic (i.e., typically containing a hydrophobic tail group and hydrophilic polar head group). Given their structure, surfactants are

generally capable of lowering the surface tension (or interfacial tension) between two liquids or between a liquid and a solid. Further to this, these properties typically allow solubility of the surfactant in organic solvents as well as in water, and allow the surfactant to promote solubilization or at least dispersal of fatty/waxy materials in water and water-containing solutions. In this regard, a surfactant may act as a detergent, a wetting agent, an emulsifying agent, a foaming agent and/or a dispersing agent.

Accordingly, in particular embodiments, the surfactant is or comprises an emulsifying agent. As generally used herein, the term “emulsifying agent” or “emulsifier” refers to a chemical agent, compound, or substance capable of producing an emulsion by reducing the interfacial tension between the two insoluble liquids.

Similar to that for the solvents provided above, the surfactant provided herein is preferably an agriculturally acceptable surfactant. The term "agriculturally acceptable surfactant" as used herein refers to a surfactant that is not unacceptably damaging to a plant and/or its environment, and/or not unsafe to the user or others that may be exposed to the surfactant when used as described herein.

The surfactant, including one or a plurality of surfactants (e.g., 1, 2, 3, 4, 5 etc. surfactants), are suitably present in a high enough concentration that allows for the production of a pyriproxyfen pesticide formulation, such as an emulsifiable concentrate formulation, or dispersible concentrate formulation, or a direct use formulation, or a highly loaded formulation. In this regard, it will be apparent that an amount of the

surfactant of the pesticide formulation can vary, for example, depending on the specific form of the pesticide formulation (e.g., concentrate or highly loaded formulation), the particular active ingredient and/or synergist concentration(s) and the particular surfactant to be included therein.

With regard to liquid pesticide formulations, such as emulsifiable concentrate formulations or dispersible concentrate formulations or highly loaded formulations, the surfactant may be present in an amount from about 20 g/L to about 100 g/L or any range therein such as, but not limited to, about 25 g/L to about 75 g/L, or about 30 g/L to about 70 g/L thereof. In particular embodiments of the present invention, the surfactant is present in an amount of about 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100 g/L, or any range therein, of the liquid pesticide formulation. In certain embodiments of the present invention, the surfactant is present in an amount of at least about 45 g/L of the liquid pesticide formulation. More preferably, the surfactant is present in an amount ranging between about 45 g/L to about 80 g/L of the liquid pesticide formulation.

For the present invention, the surfactant is suitably selected from the group consisting of non-ionic surfactants, anionic surfactants, cationic surfactants, zwitterionic surfactants, cation-anion composite surfactants and any combination thereof. Suitable non-ionic surfactants may include polyoxyethylene alkyl ethers, polyoxyethylene alkyl phenyl ethers, polyoxyethylene polyoxypropylene ethers, polyoxyethylene alkyl esters, polyoxyethylene sorbitan alkyl esters, polyoxyethylene polyoxypropylene block copolymers, sorbitan alkyl esters, higher fatty acid alkanolamides

and any combination thereof. Suitable cationic surfactants may include alkylamine salts, quaternary ammonium salts and combinations thereof. Further, suitable anionic surfactants may include naphthalenesulfonic acid polycondensate, alkenylsulfonate, naphthalenesulfonate, formalin condensate of a naphthalenesulfonate, formadehyde condensate of an alkylnaphthalenesulfonate, lignin sulfonate, alkylarylsulfonate, alkylaryl sulfonate sulfate, polystyrene sulfonate, polycarboxylate, polyoxyethylenealkyl ether sulfate, polyoxyethylenealkylaryl ether sulfate, alkylsulfosuccinate, alkyl sulfate, alkyl ether sulfonate, a higher fatty acid alkali salt and any combination thereof.

In certain preferred embodiments, the one or more surfactants to be included in the pesticide formulation, including the emulsifiable concentrate formulation described herein, the dispersible concentrate described herein or the highly loaded formulation described herein, may comprise an anionic surfactant. As generally used herein, the term “anionic surfactant” refers to a surfactant comprising, as ionic or ionizable groups, only anionic groups. Such anionic groups may include, for example, $-CO_2H$, $-CO_2^-$, $-SO_3H$, $-SO_3^-$, $-OSO_3H$, $-OSO_3^-$, $-H_2PO_3$, $-HPO_3^-$, $-PO_3^{2-}$, $-H_2PO_2$, $=HPO_2$, $-HPO_2^-$, $=PO_2^-$, $=POH$, and $=PO^-$ groups. Suitable anionic surfactants may include those hereinbefore described. Such anionic surfactants may be used alone or in combination as a mixture of two, three, four, five or more anionic surfactants. In certain embodiments, the one or more surfactants to be included in the pesticide formulation, including the emulsifiable concentrate formulation described

herein or the dispersible concentrate formulation described herein, may comprise a non-ionic surfactant. As generally used herein, the term "non-ionic surfactant" refers to a surfactant that does not contain or comprise an ionic or ionizable group. Suitable non-ionic surfactants may include those hereinbefore described. Such non-ionic surfactants may be used alone or in combination as a mixture of two, three, four, five or more non-ionic surfactants. In certain embodiments, the surfactant may comprise a combination of one or more anionic surfactant and one or more non-ionic surfactant. In such embodiments, the ratio by weight of total anionic surfactant to total non-ionic surfactant may be between about 20:1 and about 1:20, or between 10:1 and 1:10, or between 15:1 and 1:1, or between 5:1 and 1:15, or between 5:1 and 1:5, or between 3:1 and 1:1, or between 2:1 and 1:2, or between 2:1 and 1:3, or about 1:1 or any range therein, or it may be about 20:1, 19:1, 18:1, 17:1, 16:1, 15:1, 14:1, 13:1, 12:1, 11:1, 10:1, 9:1, 8:1, 7:1, 6:1, 5:1, 4:1, 3:1, 2.9:1, 2.8:1, 2.7:1, 2.6:1, 2.5:1, 2.4:1, 2.3:1, 2.2:1, 2.1:1, 2:1, 1.9:1, 1.8:1, 1.7:1, 1.6:1, 1.5:1, 1.4:1, 1.3:1, 1.2:1, 1.1:1, 1:1, 1:1.1, 1:1.2, 1:1.3, 1:1.4:, 1:1.5, 1:1.6, 1:1.7, 1:1.8, 1:1.9, 1:2, 1:2.1, 1:2.2, 1:2.3, 1:2.4, 1:2.5, 1:2.6, 1:2.7, 1:2.8, 1:2.9, 1:3, 1:4, 1:5, 1:6, 1:7, 1:8, 1:9, 1:10, 1:11, 1:12, 1:13, 1:14, 1:15, 1:16, 1:17, 1:18, 1:19, 1:20, or any range therein, in the liquid pesticide formulation.

It will be appreciated that the surfactant may be any suitable surfactant know in the art. Exemplary surfactants include an alkylphenol alkoxylate (e.g., Termul 200), a polyoxyalkylene ether (e.g., Termul 203), an alkoxylated oil (e.g., ~54 x ethoxylated (e.g., Termul 1285)), an

alkylphenol alkoxylate (e.g., ~10 x ethoxylated (e.g., TericN10)), an alkoxylated alcohol (Alcohol C12 – C15, ~23 x ethoxylated (e.g. Teric 12A23); Alcohol C12, ~3 x ethoxylated (e.g. Surfactant 12A3)), an alkoxylated polyaryl phenol (e.g., Tristyryl Phenol, ~16 x ethoxylated (e.g. TSP15)), an alkoxylated block co-polymer (Ethoxylate-Propoxylate copolymer (e.g. Teric PE64)), an alkylbenzenesulphonate (e.g., Calcium C10-16 alkylbenzyl sulphonate, branched or linear chain in solvent (e.g. Ninate 60E, NANSA EVM70/2E, Kemmat HF60)), an alcohol ether sulphate (e.g. Toximul TANS-5), an alkylamine ethoxylate (e.g. Toximul TAABS-5), a silicone polymer, inclusive of polysiloxanes (e.g., Evonik Break-Thru OE 446, Evonik Break-Thru AF 9903, Jiangxi Tiansheng QS-302) and silicone glycol copolymers (e.g., Xiameter OFX-5211), a block co-polymer (e.g., Teric PE64), an alkoxylated nonylphenol (e.g., Teric N10), an alkoxylated alcohol (e.g., Teric BL8), an alkyl polyglucoside (e.g., Croda AL-2575), an ethoxylate-propoxylate copolymer, a C10-16 alkylbenzenesulphonate (branched or linear in solvent), a branched alcohol ether sulphate, a tallowamine alkoxylated salt, and a mineral oil (e.g., Rhodoline DF5888).

In particular embodiments, the surfactant is selected from the group consisting of an alkylphenol alkoxylate (e.g., Termul 200), a polyoxyalkylene ether (e.g., Termul 203), an alkylbenzenesulphonate (e.g., Ninate 60E, NANSA EVM70/2E, Kemmat HF60), an alkoxylated styryl phenol (e.g., alkoxylated monostyryl phenols, alkoxylated distyryl phenols, alkoxylated tristyryl phenols, such as Termul 3150), an alkoxylated oil,

such as an alkoxylated vegetable oil (e.g., Termul 1284 and Termul 1285), a glycol ether (e.g., propylene glycol monomethyl ether) and any combination thereof.

More particularly, the surfactant can be selected from the group consisting of an alkoxylated alkylphenol (e.g., Termul 200), an alkyl polyoxyalkalene ether (e.g., Termul 203), calcium C10-16 alkylbenzyl sulphonate (branched or linear chain in solvent) (e.g., Ninate 60E, NANSA EVM70/2E, Kemmat HF60), an ethoxylated tristyryl phenol (e.g., Termul 3150), a propylene glycol ether (e.g., propylene glycol monomethyl ether) and any combination thereof.

In particular embodiments, the ratio by weight of the total amount of solvent to the total amount of surfactant may be between about 15:1 and about 1:1, or between about 10:1 and about 3:1, or between about 10:1 and about 5:1 or any range therein, or it may be about 15:1, 14:1, 13:1, 12:1, 11:1, 10:1, 9:1, 8:1, 7:1, 6:1, 5:1, 4.9:1, 4.8:1, 4.7:1, 4.6:1, 4.5:1, 4.4:1, 4.3:1, 4.2:1, 4.1:1, 4:1, 3.9:1, 3.8:1, 3.7:1, 3.6:1, 3.5:1, 3.4:1, 3.3:1. 3.2:1, 3.1:1. 3:1, 2:1, 1:1 or any range therein.

It will be apparent in light of the foregoing that one or more surfactants may be introduced into the formulation of the invention as a soluble concentration in a further solvent (e.g., calcium dodecylbenzene sulfonate in ethyl hexanol) and the latter may equate, for example, to amounts up to about 10 g/L to about 30 g/L or more of the formulation. Given the above, it will be appreciated that such amounts of the further solvent may make little or no contribution to the solvency of pyriproxyfen

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within the formulation of the invention.

One or more additional auxiliary agents, such as adjuvants, preservatives, colouring agents (e.g., dyes), odourants, embittering agents and other deterrents and the like, as are known in the art, can also be added where desired to modify the properties of the pesticide formulation, including the emulsifiable concentrate formulation, as required.

It will be understood that it is desirable for liquid forms of the pesticide formulation, including the emulsifiable concentrate formulation, dispersible concentrate formulation or highly loaded formulation, provided herein to be readily or easily pumped or poured from a storage vessel. Preferably, the liquid pesticide formulation has a viscosity at room temperature (i.e., 20°C) of no more than 2000 cPs (e.g., 1, 5, 10, 20, 30, 40, 50, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200, 1300, 1400, 1500, 1600, 1700, 1800, 1900, 2000 cPs and any range therein), as viscosities above this typically make it difficult or impractical to pump or pour the formulation. Preferably, the liquid pesticide formulation of the invention has a viscosity at room temperature of about or less than 400 cPs.

With respect to the aforementioned aspect of preparing pesticide formulation of pyriproxyfen, it will be appreciated that this method may be performed using methods and commercially available equipment, such as formulation vessels and the like, known in the art.

In another aspect, the invention provides a pesticide formulation prepared by the method of the aforementioned aspect.

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In a further aspect, the invention resides in a method of preventing and/or controlling a pest infestation in a target area, including the step of applying a pesticidally effective amount of the pesticide formulation of the first mentioned aspect or the concentrate formulation of the second mentioned aspect mixed with water or a water-containing liquid to the target area to thereby prevent and/or control the pest infestation.

Suitably, the method of this aspect further includes the initial step of mixing the pesticide formulation or the emulsifiable concentrate pyriproxyfen formulation or the dispersible concentrate pyriproxyfen formulation or the highly loaded formulation with water or the water-containing liquid.

The terms “treat”, “treating” and “treatment” are broadly intended to include preventing or controlling a pest infestation. Treating the pest infestation preferably results in at least maintaining, more preferably maintaining or reducing, and even more preferably reducing the degree or severity of the pest infestation in a target area. In one embodiment, treatment with the pesticide formulation or the emulsifiable concentrate formulation, or the dispersible concentrate formulation, or the highly loaded formulation provided herein is able to substantially eradicate an existing pest infestation.

As used herein, “preventing” (or “prevent” or “prevention”) refers to a course of action (such as administering an effective amount of the pesticide formulation or the emulsifiable concentrate formulation described herein) initiated prior to the onset of a symptom, aspect, or characteristic

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of the pest infestation (e.g., plant or crop damage) so as to prevent, reduce or delay the symptom, aspect, or characteristic thereof. It is to be understood that such preventing need not be absolute to be beneficial to a plant, crop or the like.

As generally used herein, “control” (or “controlled” or “controlling”) refers to an intervention with the pesticide formulation or the emulsifiable concentrate formulation or dispersible concentrate formulation that reduces or ameliorates a symptom, aspect, or characteristic of the pest infestation after it has begun to develop. The term “ameliorating”, with reference to a pest infestation, refers to any observable beneficial effect thereto as a result of the administration of the pesticide formulation or the emulsifiable concentrate formulation or the dispersible concentrate formulation. The beneficial effect can be determined using any methods or standards known to the ordinarily skilled artisan. Accordingly, these terms are meant to include any lethal (i.e., pesticidal) or inhibitory (i.e., pestistatic) activities of the pesticide formulation or the emulsifiable concentrate formulation or the dispersible concentrate formulation or the highly loaded formulation against a given pest, including those hereinafter described.

Herein, the terms “target area”, "locus" or "space" refer to any area, location or habitat where the prevention, control and/or eradication of a pest infestation is needed or expected to be needed.

As used herein, the terms “effective amount”, “pesticidally effective amount” and “insecticidally effective amount” refer to an amount of the

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pesticide formulation or the emulsifiable concentrate formulation or dispersible concentrate formulation that is effective to cause such prevention, control, and/or eradication of the pest infestation. By way of example, an effective amount means an amount necessary to produce an observable pesticidal and/or pestistatic effect on unwanted pests (e.g., insects), including the effects of death, growth inhibition, reproduction inhibition, inhibition of proliferation, maturation inhibition and removal, destruction, or otherwise diminishing the occurrence and activity of these unwanted pests. An effective amount of the pesticide formulation or the emulsifiable concentrate formulation, dispersible concentrate formulation or highly loaded formulation of the invention may vary according to the prevailing conditions such as desired pesticidal and/or pestistatic effect and duration, weather, target species, habitat, mode of application, and the like.

In particular embodiments, an effective amount is the amount of the pesticide formulation or the emulsifiable concentrate formulation, dispersible concentrate formulation or highly loaded formulation of the invention that has an adverse effect (e.g., reproduction inhibition, knockdown and/or death) on at least 25% (e.g., 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 100% or any range therein) of the pests treated or contacted therewith, more preferably at least 50% of the pests treated or contacted therewith, and even more preferably at least 70% or greater of the pests treated or contacted therewith.

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The efficacy of the pesticide formulation or the emulsifiable concentrate formulation or dispersible concentrate formulation of the present invention may be monitored by determining the mortality of or adverse effect upon treated pests (e.g., insects). This includes inhibition or modulation of pest growth, inhibition of pest reproduction by slowing or arresting its proliferation, or complete destruction/death of the pest. The actual value of an effective amount for the pesticide formulation or the emulsifiable concentrate formulation or dispersible concentrate formulation is preferably determined by routine screening procedures employed to evaluate pesticidal activity and efficacy, such as those methods well known in the art.

With respect to the above, an effective amount of the pesticide formulation or the emulsifiable concentrate formulation, dispersible concentrate formulation or highly loaded formulation described herein is preferably administered to the target area or locus of the pest infestation. By way of example, to prevent or control pest-related damage to a plant or crop, an effective amount of a pesticide formulation or an emulsifiable concentrate formulation or dispersible concentrate formulation or highly loaded formulation comprising pyriproxyfen is administered to an area adjacent and/or including the plant or crop. As such, a pest, and in particular insects, can be readily contacted with an effective amount of the pesticide formulation or the emulsifiable concentrate formulation or dispersible concentrate formulation or the highly loaded formulation of the invention.

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The pest infestation to be prevented and/or controlled by the method of the present aspect may be in respect of any pest, and more particularly any insect or insects, as are well known in the art. Nonlimiting examples of pests, and in particular insects, that may be treated by application of the pesticide formulation of the invention include grasshoppers, locusts, earwigs, crickets, millipedes, slaters, ants, aphids, flies, mites, beetles, bugs, moths, springtails, caterpillars, loopers, bruchids, fleas, mealybugs, midges, thrips, weevils, butterflies, mosquitos and cockroaches, which can cause significant damage to, for example, a wide range of agricultural and horticultural crops and plants, or can be pests of significance to public health.

In specific embodiments, the pest or pest infestation to be targeted, prevented and/or controlled by the method for the present aspect are pests relevant to public health, such as flies, beetles, midges, mosquitos or which are agricultural pests, such as whitefly, scale and thrips.

The pesticide formulation or the emulsifiable concentrate formulation or dispersible concentrate formulation or highly loaded concentrate of the invention may be applied to the target crop or plant, or to the breeding sites of interest (such as swamps or livestock housing), to a part thereof, or to surroundings thereof. Methods and techniques for applying the pesticide formulation or the emulsifiable concentrate formulation or the dispersible concentrate or the highly loaded formulation are known in the art and may include, for example, ground or aerial spraying.

In one embodiment, liquid forms of the pesticide formulation or the emulsifiable concentrate formulation or dispersible concentrate formulation or the highly loaded formulation are applied at a rate of about 250 to 3750mL per hectare (e.g., about 250mL, 255mL, 260mL, 265mL, 270mL, 275mL, 280mL, 285mL, 290mL, 295mL, 300mL, 305mL, 310mL, 315mL, 320mL, 325mL, 330mL, 335mL, 340mL, 345mL, 350mL, 355mL, 360mL, 365mL, 370mL, 375mL, 380mL, 385mL, 390mL, 395mL, 400mL, 405mL, 410mL, 415mL, 420mL, 425mL, 430mL, 435mL, 440mL, 445mL, 450mL, 455mL, 460mL, 465mL, 470mL, 475mL, 480mL, 485mL, 490mL, 495mL, 500mL, 510mL, 520mL, 530mL, 540mL, 550mL, 560mL, 570mL, 580mL, 590mL, 600mL, 620mL, 640mL, 660mL, 680mL, 700mL, 720mL, 740mL, 760mL, 780mL, 800mL, 820mL, 840mL, 860mL, 880mL, 900mL, 920mL, 940mL, 960mL, 980mL, 1000mL, 1025mL, 1050mL, 1075mL, 1100mL, 1150mL, 1200mL, 1250mL, 1300mL, 1400mL, 1500mL, 1600mL, 1700mL, 1800mL, 1900mL, 2000mL, 2100mL, 2200mL, 2300mL, 2400mL, 2500mL, 2600mL, 2700mL, 2800mL, 2900mL, 3000mL, 3100mL, 3200mL, 3300mL, 3400mL, 3500mL, 3600mL, 3700mL, 3750mL per hectare and any range therein) and more preferably at a rate of about 250mL to about 1100mL per hectare subsequent to dilution thereof in a suitable spray liquid. Obviously, the amount of the pesticide formulation or the emulsifiable concentrate or the dispersible concentrate or highly loaded formulation to be applied per hectare will depend, at least in part, upon the concentration of pyriproxyfen therein, the particular pest

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infestation to be targeted and the type of target crop or breeding site to which the formulation is to be applied.

Throughout the specification the aim has been to describe the preferred embodiments of the invention without limiting the invention to any one embodiment or specific collection of features. It will therefore be appreciated by those of skill in the art that, in light of the instant disclosure, various modifications and changes can be made in the particular embodiments exemplified without departing from the scope of the present invention.

With respect to the terms "comprising", "consisting of", and "consisting essentially of", where one of these three terms is used herein, the presently disclosed and claimed subject matter may include the use of either of the other two terms. Thus, in some embodiments not otherwise explicitly recited, any instance of "comprising" may be replaced by "consisting of" or, alternatively, by "consisting essentially of".

In the foregoing paragraphs, various ratios of components have been disclosed. It will be appreciated that the following ratios of components can be combined in any disclosed combination, namely:

- the ratio of pyriproxyfen to piperonyl butoxide may be between about 20:1 and about 1:20 or any range therein, and
- the ratio of the first solvent to the second solvent (when present) may be between about 3:1 and about 1:3 or any range therein, and

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- the ratio of the total anionic surfactant to total non-ionic surfactant may be between about 20:1 and about 1:20 or any range therein, and
- the ratio by weight of the total amount of solvent (when present) to the total amount of surfactant may be between about 15:1 and about 1:1 or any range therein.

Any reference to publications cited in this specification is not an admission that the disclosures constitute common general knowledge in Australia.

In order that the invention may be more readily understood and put into practice, one or more preferred embodiments thereof will now be described, by way of example only.

**Example 1: Embodiments of a Pyriproxyfen Emulsifiable Concentrate and Dispersible Concentrate Formulations**

A number of embodiments of emulsifiable concentrate formulations, dispersible concentrate formulations, or highly loaded formulations across a range of pyriproxyfen concentrations, a range of overall pyriproxyfen and piperonyl butoxide concentrations/proportions, and a range of solvents and surfactants are provided below.

**Embodiment 1** - Recipe for an emulsifiable concentrate combining 350g/L Pyriproxyfen and 50g/L Piperonyl Butoxide. The concentrate is produced as below in Table 1 and, as shown in Table 2, has been determined via

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assay as having: 1) adequate active ingredient concentration, even after accelerated aging; 2) acceptable emulsion properties upon dilution in water prior to application; and 3) physical and chemical stability (including at cold temperatures of 2°C for 7 days), at the point of manufacturing and again after accelerated aging to approximately two years of shelf life.

Composition of embodiment 1 is as follows in Table 1:

**Table 1:**

| Ingredient | Role | Concentration |
|---|---|---|
| Pyriproxyfen (CAS# 95737-68-1, Technical material, 99.5%) | Active insecticidal ingredient | 361.1g/L (yields 359.3g/L Pyriproxyfen) |
| Piperonyl butoxide (CAS# 51-03-6, Technical material, 92.0%) | Insecticidal synergist | 52.9g/L (yields 48.7g/L Piperonyl butoxide) |
| Alkoxylated alkylphenol (CAS# 37251-69-7, e.g. Termul 200, Antarox 724/P) | Surfactant | 30.0g/L |
| Alkyl polyoxyalkylene ether (CAS# Proprietary, e.g. Termul 203) | Surfactant | 10.2g/L |
| Alkylbenzenesulfonic acid, calcium salt in 2-ethylhexanol (CAS# 68584-23-6, 104-76-7, e.g. Ninate 60E) | Surfactant | 30.0g/L |
| Solvent naphtha (petroleum), heavy aromatic (CAS# 64742-94-5, e.g. Recosol 150) | Solvent | 509.9g/L (to 994g/L total) |

Chemical and physical parameters of embodiment 1 is as follows in Table 2:

**Table 2:**

| Test | As manufactured | Accelerated Aged Result |
|---|---|---|
| Presentation | Clear, brown coloured liquid | Clear, brown coloured liquid |
| Assay:<br>Require 333g/L ≤ Pyriproxyfen ≤ 367g/L | 360.4g/L | 361.9g/L |
| Assay:<br>Require 45g/L ≤ Piperonyl butoxide ≤ 55g/L | 48.9g/L | 48.0g/L |
| pH1%<br>Nominally: 5.5 to 9.5 | 7.1 | 6.7 |
| Persistent foaming<br>Require: ≤60mL foam after 1 min | 1mL | 6mL |
| Emulsion characteristics<br>Require: ≤2mL cream after 30 min, ≤trace of oil after 30 min and complete re-emulsion after 24h | No cream;<br>No oil;<br>Re-emulsifies/24h | Trace of cream;<br>No oil;<br>Re-emulsifies/24h |

**Embodiment 2** - Recipe for an emulsifiable concentrate combining 300g/L Pyriproxyfen and 300g/L Piperonyl Butoxide. The concentrate is produced as below in Table 3 and, as shown in Table 4, has been determined via assay as having: 1) adequate active ingredient concentration, even after accelerated aging; 2) acceptable emulsion and dispersion properties upon dilution in water prior to application; and 3) physical and chemical stability (including at cold temperatures of 2°C for 7 days), at the point of manufacturing and again after accelerated aging to approximate two years of shelf life.

Composition of embodiment 2 is as follows in Table 3:

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**Table 3:**

| Ingredient | Role | Concentration |
|---|---|---|
| Pyriproxyfen (CAS# 95737-68-1, Technical material, 99.5%) | Active insecticidal ingredient | 303.4g/L (yields 301.9g/L Pyriproxyfen) |
| Piperonyl butoxide (CAS# 51-03-6, Technical material, 92.0%) | Insecticidal synergist | 326.0g/L (yields 299.9g/L Piperonyl butoxide) |
| Alkoxylated alkylphenol (CAS# 37251-69-7, e.g. Termul 200, Antarox 724/P) | Surfactant | 30.0g/L |
| Alkyl polyoxyalkylene ether (CAS# Proprietary, e.g. Termul 203) | Surfactant | 10.0g/L |
| Alkylbenzenesulfonic acid, calcium salt in 2-ethylhexanol (CAS# 68584-23-6, 104-76-7, e.g. Ninate 60E) | Surfactant | 30.1g/L |
| Methyl benzoate (CAS# 93-58-3) | Solvent | 403.9g/L (to 1103g/L total) |

Chemical and physical parameters of embodiment 2 is as follows in Table 4:

**Table 4:**

| Test | As manufactured | Accelerated Aged Result |
|---|---|---|
| Presentation | Clear, brown coloured liquid | Clear, brown coloured liquid |
| Assay: Require 285g/L ≤ Pyriproxyfen ≤ 315g/L | 297.1g/L | 295.2g/L |
| Assay: Require 285g/L ≤ Piperonyl butoxide ≤ 315g/L | 297.4g/L | 296.9g/L |
| pH1% Nominally: 5.5 to 9.5 | 7.0 | 6.9 |
| Persistent foaming Require: ≤60mL foam after 1 min | 9mL | 5mL |
| Emulsion characteristics Require: ≤2mL cream after 30 min, ≤trace of oil after 30 min and complete re-emulsion after 24h | Trace of cream; No oil; Re-emulsifies/24h | No cream; No oil; Re-emulsifies/24h |

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**Embodiment 3** - Recipe for an emulsifiable concentrate combining 300g/L Pyriproxyfen and 300g/L Piperonyl Butoxide. The concentrate is produced as below in Table 5 and, as shown in Table 6, has been determined via assay as having: 1) adequate active ingredient concentration, even after accelerated aging; 2) acceptable emulsion and dispersion properties upon dilution in water prior to application; and 3) physical and chemical stability (including at cold temperatures of 2°C for 7 days), at the point of manufacturing and again after accelerated aging to approximate two years of shelf life.

Composition of embodiment 3 is as follows in Table 5:

**Table 5:**

| Ingredient | Role | Concentration |
|---|---|---|
| Pyriproxyfen (CAS# 95737-68-1, Technical material, 99.5%) | Active insecticidal ingredient | 303.6g/L (yields 302.1g/L Pyriproxyfen) |
| Piperonyl butoxide (CAS# 51-03-6, Technical material, 92.0%) | Insecticidal synergist | 326.1g/L (yields 300.0g/L Piperonyl butoxide) |
| Alkoxylated alkylphenol (CAS# 37251-69-7, e.g. Termul 200, Antarox 724/P) | Surfactant | 29.9g/L |
| Alkyl polyoxyalkylene ether (CAS# Proprietary, e.g. Termul 203) | Surfactant | 10.0g/L |
| Alkylbenzenesulfonic acid, calcium salt in 2-ethylhexanol (CAS# 68584-23-6, 104-76-7, e.g. Ninate 60E) | Surfactant | 30.1g/L |
| Ethyl benzoate (CAS# 93-89-0) | Solvent | 388.7g/L (to 1088g/L total) |

Chemical and physical parameters of embodiment 3 is as follows in Table 6:

**Table 6:**

| Test | As manufactured | Accelerated Aged Result |
|---|---|---|
| Presentation | Clear, brown coloured liquid | Clear, brown coloured liquid |
| Assay:<br>Require 285g/L ≤ Pyriproxyfen ≤ 315g/L | 299.8g/L | 297.4g/L |
| Assay:<br>Require 285g/L ≤ Piperonyl butoxide ≤ 315g/L | 303.6g/L | 299.3g/L |
| pH1%<br>Nominally: 5.5 to 9.5 | 6.7 | 7.1 |
| Persistent foaming<br>Require: ≤60mL foam after 1 min | 11mL | 12mL |
| Emulsion characteristics<br>Require: ≤2mL cream after 30 min, ≤trace of oil after 30 min and complete re-emulsion after 24h | Trace of cream;<br>No oil;<br>Re-emulsifies/24h | Trace of cream;<br>No oil;<br>Re-emulsifies/24h |

**Embodiment 4** - Recipe for an emulsifiable concentrate combining 300g/L Pyriproxyfen and 300g/L Piperonyl Butoxide. The concentrate is produced as below in Table 7 and, as shown in Table 8, has been determined via assay as having: 1) adequate active ingredient concentration, even after accelerated aging; 2) acceptable emulsion and dispersion properties upon dilution in water prior to application; and 3) physical and chemical stability (including at cold temperatures of 2°C for 7 days), at the point of manufacturing and again after accelerated aging to approximate two years of shelf life.

Composition of embodiment 4 is as follows in Table 7:

**Table 7:**

| Ingredient | Role | Concentration |
|---|---|---|
| Pyriproxyfen (CAS# 95737-68-1, Technical material, 99.5%) | Active insecticidal ingredient | 308.9g/L (yields 307.4g/L Pyriproxyfen) |
| Piperonyl butoxide (CAS# 51-03-6, Technical material, 92.0%) | Insecticidal synergist | 319.2g/L (yields 293.7g/L Piperonyl butoxide) |
| Alkoxylated alkylphenol (CAS# 37251-69-7, e.g. Termul 200, Antarox 724/P) | Surfactant | 30.0g/L |
| Alkyl polyoxyalkylene ether (CAS# Proprietary, e.g. Termul 203) | Surfactant | 10.1g/L |
| Alkylbenzenesulfonic acid, calcium salt in 2-ethylhexanol (CAS# 68584-23-6, 104-76-7, e.g. Ninate 60E) | Surfactant | 30.4g/L |
| Acetophenone (CAS# 98-86-2) | Solvent | 375.4g/L (to 1074g/L total) |

Chemical and physical parameters of embodiment 4 is as follows in Table 8:

**Table 8:**

| Test | As manufactured | Accelerated Aged Result |
|---|---|---|
| Presentation | Clear, brown coloured liquid | Clear, brown coloured liquid |
| Assay: Require 285g/L ≤ Pyriproxyfen ≤ 315g/L | 303.5g/L | 307.1g/L |
| Assay: Require 285g/L ≤ Piperonyl butoxide ≤ 315g/L | 291.0g/L | 292.0g/L |
| pH1% Nominally: 5.5 to 9.5 | 7.1 | 6.8 |
| Persistent foaming Require: ≤60mL foam after 1 min | 7mL | 12mL |
| Emulsion characteristics Require: ≤2mL cream after 30 min, ≤trace of oil after 30 min and complete re-emulsion after 24h | No cream; No oil; Re-emulsifies/24h | Trace of cream; No oil; Re-emulsifies/24h |

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**Embodiment 5** - Recipe for an emulsifiable concentrate combining 300g/L Pyriproxyfen and 300g/L Piperonyl Butoxide. The concentrate is produced as below in Table 9 and, as shown in Table 10, has been determined as having: 1) adequate active ingredient concentration, even after accelerated aging; 2) acceptable emulsion and dispersion properties upon dilution in water prior to application; and 3) physical and chemical stability (including at cold temperatures of 2°C for 7 days), at the point of manufacturing and again after accelerated aging to approximate two years of shelf life.

Composition of embodiment 5 is as follows in Table 9:

**Table 9:**

| Ingredient | Role | Concentration |
|---|---|---|
| Pyriproxyfen (CAS# 95737-68-1, Technical material, 99.5%) | Active insecticidal ingredient | 303.6g/L (yields 302.1g/L Pyriproxyfen) |
| Piperonyl butoxide (CAS# 51-03-6, Technical material, 92.0%) | Insecticidal synergist | 326.4g/L (yields 300.3g/L Piperonyl butoxide) |
| Ethyl benzoate (CAS# 93-89-0) | Solvent | 187.3g/L |
| Alkoxylated alkylphenol (CAS# 37251-69-7, e.g. Termul 200, Antarox 724/P) | Surfactant | 30.1g/L |
| Alkyl polyoxyalkylene ether (CAS# Proprietary, e.g. Termul 203) | Surfactant | 10.2g/L |
| Alkylbenzenesulfonic acid, calcium salt in 2-ethylhexanol (CAS# 68584-23-6, 104-76-7, e.g. Ninate 60E) | Surfactant | 30.0g/L |
| Acetophenone (CAS# 98-86-2) | Solvent | 196.1g/L (to 1084g/L total) |

Chemical and physical parameters of embodiment 5 is as follows in Table 10:

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**Table 10:**

| Test | As manufactured | Accelerated Aged Result |
|---|---|---|
| Presentation | Clear, brown coloured liquid | Clear, brown coloured liquid |
| Assay:<br>Require 285g/L ≤ Pyriproxyfen ≤ 315g/L | 301.2g/L | 301.6g/L |
| Assay:<br>Require 285g/L ≤ Piperonyl butoxide ≤ 315g/L | 307.8g/L | 302.2g/L |
| pH1%<br>Nominally: 5.5 to 9.5 | 6.8 | 6.85 |
| Persistent foaming<br>Require: ≤60mL foam after 1 min | 9mL | 14mL |
| Emulsion characteristics<br>Require: ≤2mL cream after 30 min, ≤trace of oil after 30 min and complete re-emulsion after 24h | Trace of cream;<br>No oil;<br>Re-emulsifies/24h | Trace of cream;<br>No oil;<br>Re-emulsifies/24h |

**Embodiment 6** - Recipe for an emulsifiable concentrate combining 300g/L Pyriproxyfen and 300g/L Piperonyl Butoxide. The concentrate is produced as below in Table 11 and, as shown in Table 12, has been determined via assay as having: 1) adequate active ingredient concentration, even after accelerated aging; 2) acceptable emulsion and dispersion properties upon dilution in water prior to application; and 3) physical and chemical stability (including at cold temperatures of 2°C for 7 days), at the point of manufacturing and again after accelerated aging to approximate two years of shelf life.

Composition of embodiment 6 is as follows in Table 11:

**Table 11:**

| Ingredient | Role | Concentration |
|---|---|---|
| Pyriproxyfen (CAS# 95737-68-1, Technical material, 99.5%) | Active insecticidal ingredient | 303.0g/L (yields 301.5g/L Pyriproxyfen) |
| Piperonyl butoxide (CAS# 51-03-6, Technical material, 92.0%) | Insecticidal synergist | 326.0g/L (yields 299.9g/L Piperonyl butoxide) |
| 1-Butylpyrrolidin-2-one (CAS# 3470-98-2, e.g. Genagen NBP) | Solvent | 112.4g/L |
| Alkoxylated alkylphenol (CAS# 37251-69-7, e.g. Termul 200, Antarox 724/P) | Surfactant | 30.4g/L |
| Alkyl polyoxyalkylene ether (CAS# Proprietary, e.g. Termul 203) | Surfactant | 10.0g/L |
| Alkylbenzenesulfonic acid, calcium salt in 2-ethylhexanol (CAS# 68584-23-6, 104-76-7, e.g. Ninate 60E) | Surfactant | 30.2g/L |
| Acetophenone (CAS# 98-86-2) | Solvent | 262.4g/L (to 1074g/L total) |

Chemical and physical parameters of embodiment 6 is as follows in Table 12:

**Table 12:**

| Test | As manufactured | Accelerated Aged Result |
|---|---|---|
| Presentation | Clear, brown coloured liquid | Clear, brown coloured liquid |
| Assay: Require 285g/L ≤ Pyriproxyfen ≤ 315g/L | 295.4g/L | 299.3g/L |
| Assay: Require 285g/L ≤ Piperonyl butoxide ≤ 315g/L | 300.8g/L | 301.0g/L |
| pH1% Nominally: 5.5 to 9.5 | 6.9 | 7.0 |
| Persistent foaming Require: ≤60mL foam after 1 min | 8mL | 14mL |
| Emulsion characteristics Require: ≤2mL cream after 30 min, ≤trace of oil after 30 min and complete re-emulsion after 24h | Trace of cream; No oil; Re-emulsifies/24h | Trace of cream; No oil; Re-emulsifies/24h |

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**Embodiment 7** - Recipe for an emulsifiable concentrate combining 200g/L Pyriproxyfen and 500g/L Piperonyl Butoxide. The concentrate is produced as below in Table 13 and, as shown in Table 14, has been determined via assay as having: 1) adequate active ingredient concentration, even after accelerated aging; 2) acceptable emulsion and dispersion properties upon dilution in water prior to application; and 3) physical and chemical stability (including at cold temperatures of 2°C for 7 days), at the point of manufacturing and again after accelerated aging to approximate two years of shelf life.

Composition of embodiment 7 is as follows in Table 13:

**Table 13:**

| Ingredient | Role | Concentration |
|---|---|---|
| Pyriproxyfen (CAS# 95737-68-1, Technical material, 99.5%) | Active insecticidal ingredient | 205.9g/L (yields 204.9g/L Pyriproxyfen) |
| Piperonyl butoxide (CAS# 51-03-6, Technical material, 92.0%) | Insecticidal synergist | 532.1g/L (yields 489.5g/L Piperonyl butoxide) |
| Alkoxylated alkylphenol (CAS# 37251-69-7, e.g. Termul 200, Antarox 724/P) | Surfactant | 37.0g/L |
| Alkyl polyoxyalkylene ether (CAS# Proprietary, e.g. Termul 203) | Surfactant | 10.5g/L |
| Alkylbenzenesulfonic acid, calcium salt in 2-ethylhexanol (CAS# 68584-23-6, 104-76-7, e.g. Ninate 60E) | Surfactant | 30.1g/L |
| Acetophenone (CAS# 98-86-2) | Solvent | 253.0g/L (to 1069g/L total) |

Chemical and physical parameters of embodiment 7 is as follows in Table 14:

**Table 14:**

| Test | As manufactured | Accelerated Aged Result |
|---|---|---|
| Presentation | Clear, brown coloured liquid | Clear, brown coloured liquid |
| Assay:<br>Require 188g/L ≤ Pyriproxyfen ≤ 212g/L | 203.4g/L | 203.8g/L |
| Assay:<br>Require 475g/L ≤ Piperonyl butoxide ≤ 525g/L | 487.6g/L | 490.3g/L |
| pH1%<br>Nominally: 5.5 to 9.5 | 7.1 | 6.7 |
| Persistent foaming<br>Require: ≤60mL foam after 1 min | 9mL | 11mL |
| Emulsion characteristics<br>Require: ≤2mL cream after 30 min, ≤trace of oil after 30 min and complete re-emulsion after 24h | Trace of cream;<br>No oil;<br>Re-emulsifies/24h | Trace of cream;<br>No oil;<br>Re-emulsifies/24h |

**Embodiment 8** - Recipe for an emulsifiable concentrate combining 200g/L Pyriproxyfen and 500g/L Piperonyl Butoxide. The concentrate is produced as below in Table 15 and, as shown in Table 16, has been determined via assay as having: 1) adequate active ingredient concentration, even after accelerated aging; 2) acceptable emulsion and dispersion properties upon dilution in water prior to application; and 3) physical and chemical stability (including at cold temperatures of 2°C for 7 days), at the point of manufacturing and again after accelerated aging to approximate two years of shelf life.

Composition of embodiment 8 is as follows in Table 15:

**Table 15:**

| Ingredient | Role | Concentration |
|---|---|---|
| Pyriproxyfen (CAS# 95737-68-1, Technical material, 99.5%) | Active insecticidal ingredient | 206.0g/L (yields 205.0g/L Pyriproxyfen) |
| Piperonyl butoxide (CAS# 51-03-6, Technical material, 92.0%) | Insecticidal synergist | 532.0g/L (yields 489.4g/L Piperonyl butoxide) |
| Alkoxylated alkylphenol (CAS# 37251-69-7, e.g. Termul 200, Antarox 724/P) | Surfactant | 30.6g/L |
| Alkyl polyoxyalkylene ether (CAS# Proprietary, e.g. Termul 203) | Surfactant | 10.0g/L |
| Alkylbenzenesulfonic acid, calcium salt in 2-ethylhexanol (CAS# 68584-23-6, 104-76-7, e.g. Ninate 60E) | Surfactant | 30.2g/L |
| Acetophenone (CAS# 98-86-2) | Solvent | 260.1g/L (to 1069g/L total) |

Chemical and physical parameters of embodiment 8 is as follows in Table 16:

**Table 16:**

| Test | As manufactured | Accelerated Aged Result |
|---|---|---|
| Presentation | Clear, brown coloured liquid | Clear, brown coloured liquid |
| Assay: Require 188g/L ≤ Pyriproxyfen ≤ 212g/L | 205.0g/L | 203.1g/L |
| Assay: Require 475g/L ≤ Piperonyl butoxide ≤ 525g/L | 488.2g/L | 487.7g/L |
| pH1% Nominally: 5.5 to 9.5 | 7.4 | 7.0 |
| Persistent foaming Require: ≤60mL foam after 1 min | 9mL | 10mL |
| Emulsion characteristics Require: ≤2mL cream after 30 min, ≤trace of oil after 30 min and complete re-emulsion after 24h | 0.2mL of cream; No oil; Re-emulsifies/24h | 0.2mL of cream; No oil; Re-emulsifies/24h |

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**Embodiment 9** - Recipe for an emulsifiable concentrate combining 100g/L Pyriproxyfen and 250g/L Piperonyl Butoxide. The concentrate is produced as below in Table 17 and, as shown in Table 18, has been determined via assay as having: 1) adequate active ingredient concentration, even after accelerated aging; 2) acceptable emulsion and dispersion properties upon dilution in water prior to application; and 3) physical and chemical stability (including at cold temperatures of 2°C for 7 days), at the point of manufacturing and again after accelerated aging to approximate two years of shelf life.

Composition for embodiment 8 is as follows in Table 17:

**Table 17:**

| Ingredient | Role | Concentration |
|---|---|---|
| Pyriproxyfen (CAS# 95737-68-1, Technical material, 99.5%) | Active insecticidal ingredient | 103.1g/L (yields 102.6g/L Pyriproxyfen) |
| Piperonyl butoxide (CAS# 51-03-6, Technical material, 92.0%) | Insecticidal synergist | 266.2g/L (yields 244.9g/L Piperonyl butoxide) |
| Alkoxylated alkylphenol (CAS# 37251-69-7, e.g. Termul 200, Antarox 724/P) | Surfactant | 30.0g/L |
| Alkyl polyoxyalkylene ether (CAS# Proprietary, e.g. Termul 203) | Surfactant | 10.3g/L |
| Alkylbenzenesulfonic acid, calcium salt in 2-ethylhexanol (CAS# 68584-23-6, 104-76-7, e.g. Ninate 60E) | Surfactant | 30.0g/L |
| Acetophenone (CAS# 98-86-2) | Solvent | 603.5g/L (to 1043g/L total) |

Chemical and physical parameters of embodiment 8 is as follows in Table 18:

**Table 18:**

| Test | As manufactured | Accelerated Aged Result |
|---|---|---|
| Presentation | Clear, brown coloured liquid | Clear, brown coloured liquid |
| Assay:<br>Require 90g/L ≤ Pyriproxyfen ≤ 110g/L | 102.0g/L | 104.0g/L |
| Assay:<br>Require 235g/L ≤ Piperonyl butoxide ≤ 265g/L | 242.4g/L | 245.2g/L |
| pH1%<br>Nominally: 5.5 to 9.5 | 7.2 | 6.8 |
| Persistent foaming<br>Require: ≤60mL foam after 1 min | 3mL | 9mL |
| Emulsion characteristics<br>Require: ≤2mL cream after 30 min, ≤trace of oil after 30 min and complete re-emulsion after 24h | No cream;<br>No oil;<br>Re-emulsifies/24h | Trace of cream;<br>No oil;<br>Re-emulsifies/24h |

**Embodiment 10** - Recipe for a dispersible concentrate combining 100g/L Pyriproxyfen and 400g/L Piperonyl Butoxide. The concentrate is produced as below in Table 19 and, as shown in Table 20, has been determined via assay as having: 1) adequate active ingredient concentration, even after accelerated aging; 2) acceptable emulsion and dispersion properties upon dilution in water prior to application; and 3) physical and chemical stability (including at cold temperatures of 2°C for 7 days), at the point of manufacturing and again after accelerated aging to approximate two years of shelf life.

Composition of embodiment 10 is as follows in Table 19:

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**Table 19:**

| Ingredient | Role | Concentration |
|---|---|---|
| Pyriproxyfen (CAS# 95737-68-1, Technical material, 99.5%) | Active insecticidal ingredient | 103.1g/L (yields 102.6g/L Pyriproxyfen) |
| Piperonyl butoxide (CAS# 51-03-6, Technical material, 92.0%) | Insecticidal synergist | 427.2g/L (yields 393.0g/L Piperonyl butoxide) |
| Vegetable oil ethoxylate (CAS# 61791-12-6, e.g. Termul 1285) | Surfactant | 35.6g/L |
| Alkyl polyoxyalkylene ether (CAS# Proprietary, e.g. Termul 203) | Surfactant | 10.0g/L |
| Propylene glycol monomethyl ether (CAS# 107-98-2) | Solvent | 429.2g/L (to 1005g/L total) |

Chemical and physical parameters of embodiment 10 is as follows in Table 20:

**Table 20:**

| Test | As manufactured | Accelerated Aged Result |
|---|---|---|
| Presentation | Clear, brown coloured liquid | Clear, brown coloured liquid |
| Assay: Require 90g/L ≤ Pyriproxyfen ≤ 110g/L | 102.8g/L | 103.4g/L |
| Assay: Require 380g/L ≤ Piperonyl butoxide ≤ 420g/L | 395.6g/L | 399.8g/L |
| pH1% Nominally: 5.5 to 9.5 | 7.2 | 6.9 |
| Persistent foaming Require: ≤60mL foam after 1 min | 1mL | 5mL |
| Dispersion stability Require: ≤2mL cream after 30 min, ≤trace of oil after 30 min and complete re-emulsion after 24h | 2.0mL of cream; No oil; Re-emulsifies/24h | 2.0mL of cream; No oil; Re-emulsifies/24h |

**Embodiment 11** - Recipe for an emulsifiable concentrate combining 100g/L Pyriproxyfen and 400g/L Piperonyl Butoxide. The concentrate is

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produced as below in Table 21 and, as shown in Table 22, has been determined via assay as having: 1) adequate active ingredient concentration, even after accelerated aging; 2) acceptable emulsion and dispersion properties upon dilution in water prior to application; and 3) physical and chemical stability (including at cold temperatures of 2°C for 7 days), at the point of manufacturing and again after accelerated aging to approximate two years of shelf life.

Composition of embodiment 11 is as follows in Table 21:

**Table 21:**

| Ingredient | Role | Concentration |
|---|---|---|
| Pyriproxyfen (CAS# 95737-68-1, Technical material, 99.5%) | Active insecticidal ingredient | 103.1g/L (yields 102.6g/L Pyriproxyfen) |
| Piperonyl butoxide (CAS# 51-03-6, Technical material, 92.0%) | Insecticidal synergist | 437.9g/L (yields 402.9g/L Piperonyl butoxide) |
| Alkoxylated alkylphenol (CAS# 37251-69-7, e.g. Termul 200, Antarox 724/P) | Surfactant | 39.9g/L |
| Alkylbenzenesulfonic acid, calcium salt in 2-ethylhexanol (CAS# 68584-23-6, 104-76-7, e.g. Ninate 60E) | Surfactant | 30.2g/L |
| Methyl isobutyl ketone (CAS# 108-10-1) | Solvent | 348.1g/L (to 959g/L total) |

Chemical and physical parameters of embodiment 11 is as follows in Table 22:

**Table 22:**

| Test | As manufactured | Accelerated Aged Result |
|---|---|---|
| Presentation | Clear, brown coloured liquid | Clear, brown coloured liquid |
| Assay:<br>Require 90g/L ≤ Pyriproxyfen ≤ 110g/L | 104.0g/L | 100.5.9g/L |
| Assay:<br>Require 380g/L ≤ Piperonyl butoxide ≤ 420g/L | 404.1g/L | 409.9g/L |
| pH1%<br>Nominally: 5.5 to 9.5 | 7.2 | 6.9 |
| Persistent foaming<br>Require: ≤60mL foam after 1 min | 10mL | 14mL |
| Emulsion characteristics<br>Require: ≤2mL cream after 30 min, ≤trace of oil after 30 min and complete re-emulsion after 24h | Trace of cream;<br>No oil;<br>Re-emulsifies/24h | Trace of cream;<br>No oil;<br>Re-emulsifies/24h |

**Embodiment 12** - Recipe for an emulsifiable concentrate combining 100g/L Pyriproxyfen and 400g/L Piperonyl Butoxide. The concentrate is produced as below in Table 23 and, as shown in Table 24, has been determined via assay as having: 1) adequate active ingredient concentration, even after accelerated aging; 2) acceptable emulsion and dispersion properties upon dilution in water prior to application; and 3) physical and chemical stability (including at cold temperatures of 2°C for 7 days), at the point of manufacturing and again after accelerated aging to approximate two years of shelf life.

Composition of embodiment 12 is as follows in Table 23:

**Table 23:**

| Ingredient | Role | Concentration |
|---|---|---|
| Pyriproxyfen (CAS# 95737-68-1, Technical material, 99.5%) | Active insecticidal ingredient | 102.8g/L (yields 102.3g/L Pyriproxyfen) |
| Piperonyl butoxide (CAS# 51-03-6, Technical material, 92.0%) | Insecticidal synergist | 426.3g/L (yields 392.2g/L Piperonyl butoxide) |
| Alkoxylated alkylphenol (CAS# 37251-69-7, e.g. Termul 200, Antarox 724/P) | Surfactant | 30.1g/L |
| Tristyrylphenol ethoxylate (CAS# 99734-09-5, e.g. Termul 3150) | Surfactant | 10.0g/L |
| Alkylbenzenesulfonic acid, calcium salt in 2-ethylhexanol (CAS# 68584-23-6, 104-76-7, e.g. Ninate 60E) | Surfactant | 30.1g/L |
| Isophorone (CAS# 78-59-1) | Solvent | 410.4g/L (to 1010g/L total) |

Chemical and physical parameters of embodiment 12 is as follows in Table 24:

**Table 24:**

| Test | As manufactured | Accelerated Aged Result |
|---|---|---|
| Presentation | Clear, brown coloured liquid | Clear, brown coloured liquid |
| Assay: Require 90g/L ≤ Pyriproxyfen ≤ 110g/L | 102.3g/L | 100.1g/L |
| Assay: Require 380g/L ≤ Piperonyl butoxide ≤ 420g/L | 387.7g/L | 387.5g/L |
| pH1% Nominally: 5.5 to 9.5 | 7.4 | 7.0 |
| Persistent foaming Require: ≤60mL foam after 1 min | 8mL | 11mL |
| Emulsion characteristics Require: ≤2mL cream after 30 min, ≤trace of oil after 30 min and complete re-emulsion after 24h | Trace of cream; No oil; Re-emulsifies/24h | Trace of cream; No oil; Re-emulsifies/24h |

**Embodiment 13** - Recipe for an emulsifiable concentrate combining 100g/L Pyriproxyfen and 400g/L Piperonyl Butoxide. The concentrate is produced as below in Table 25 and, as shown in Table 26, has been determined via assay as having: 1) adequate active ingredient concentration, even after accelerated aging; 2) acceptable emulsion and dispersion properties upon dilution in water prior to application; and 3) physical and chemical stability (including at cold temperatures of 2°C for 7 days), at the point of manufacturing and again after accelerated aging to approximate two years of shelf life.

Composition of embodiment 13 is as follows in Table 25:

**Table 25:**

| Ingredient | Role | Concentration |
|---|---|---|
| Pyriproxyfen (CAS# 95737-68-1, Technical material, 99.5%) | Active insecticidal ingredient | 103.0g/L (yields 102.5g/L Pyriproxyfen) |
| Piperonyl butoxide (CAS# 51-03-6, Technical material, 92.0%) | Insecticidal synergist | 426.3g/L (yields 392.2g/L Piperonyl butoxide) |
| Alkoxylated alkylphenol (CAS# 37251-69-7, e.g. Termul 200, Antarox 724/P) | Surfactant | 30.1g/L |
| Alkyl polyoxyalkylene ether (CAS# Proprietary, e.g. Termul 203) | Surfactant | 10.0g/L |
| Alkylbenzenesulfonic acid, calcium salt in 2-ethylhexanol (CAS# 68584-23-6, 104-76-7, e.g. Ninate 60E) | Surfactant | 30.0g/L |
| Acetophenone (CAS# 98-86-2) | Solvent | 454.7g/L (to 1054g/L total) |

Chemical and physical parameters of embodiment 13 is as follows in Table 26:

**Table 26:**

| Test | As manufactured | Accelerated Aged Result |
|---|---|---|
| Presentation | Clear, brown coloured liquid | Clear, brown coloured liquid |
| Assay:<br>Require 90g/L ≤ Pyriproxyfen ≤ 110g/L | 103.8g/L | 102.8g/L |
| Assay:<br>Require 380g/L ≤ Piperonyl butoxide ≤ 420g/L | 391.6g/L | 386.9g/L |
| pH1%<br>Nominally: 5.5 to 9.5 | 7.3 | 7.0 |
| Persistent foaming<br>Require: ≤60mL foam after 1 min | 7mL | 7mL |
| Emulsion characteristics<br>Require: ≤2mL cream after 30 min, ≤trace of oil after 30 min and complete re-emulsion after 24h | Trace of cream;<br>No oil;<br>Re-emulsifies/24h | Trace of cream;<br>No oil;<br>Re-emulsifies/24h |

**Embodiment 14** - Recipe for a solvent-less emulsifiable concentrate combining 425g/L Pyriproxyfen and 525g/L Piperonyl Butoxide. The concentrate is produced as below in Table 27 and, as shown in Table 28, has been determined via assay as having: 1) adequate active ingredient concentration, even after accelerated aging; 2) acceptable emulsion and dispersion properties upon dilution in water prior to application; and 3) physical and chemical stability (including at cold temperatures of 2°C for 7 days), at the point of manufacturing and again after accelerated aging to approximate two years of shelf life.

Composition of embodiment 14 is as follows in Table 27:

**Table 27:**

| Ingredient | Role | Concentration |
|---|---|---|
| Pyriproxyfen (CAS# 95737-68-1, Technical material, 99.5%) | Active insecticidal ingredient | 428.5g/L (yields 426.4g/L Pyriproxyfen) |
| Alkoxylated alkylphenol (CAS# 37251-69-7, e.g. Termul 200, Antarox 724/P) | Surfactant | 39.6g/L |
| Alkyl polyoxyalkylene ether (CAS# Proprietary, e.g. Termul 203) | Surfactant | 13.9g/L |
| Alkylbenzenesulfonic acid, calcium salt in 2-ethylhexanol (CAS# 68584-23-6, 104-76-7, e.g. Ninate 60E) | Surfactant | 40.3g/L |
| Piperonyl butoxide (CAS# 51-03-6, Technical material, 92.0%) | Insecticidal synergist | 573.8g/L (yields 527.9g/L Piperonyl butoxide) (to 1096g/L total) |

Chemical and physical parameters of embodiment 14 is as follows in Table 28.

**Table 28:**

| Test | As manufactured | Accelerated Aged Result |
|---|---|---|
| Presentation | Clear, yellow to brown liquid | Clear, yellow to brown liquid |
| Assay: Require 404g/L ≤ Pyriproxyfen ≤ 446g/L | 425.0g/L | 429.0g/L |
| Assay: Require 500g/L ≤ Piperonyl butoxide ≤ 550g/L | 525.0g/L | 528.0g/L |
| pH1% Nominally: 5.5 to 9.5 | 7.6 | 7.4 |
| Persistent foaming Require: ≤60mL foam after 1 min | 10mL | 12mL |
| Emulsion characteristics Require: ≤2mL cream after 30 min, ≤trace of oil after 30 min and complete re-emulsion after 24h | 0.2mL of cream; No oil; Re-emulsifies/24h | 0.3mL of cream; No oil; Re-emulsifies/24h |

**Example 2: Pyriproxyfen 300 g/L + Piperonyl butoxide 300 g/L EC**

**Raw Material Identities**

An example formulation combining 300g/L Pyriproxyfen and 300g/L Piperonyl Butoxide is provided below in Table 27, which includes the purity (where known), source and technical details of the components. The Pyriproxyfen technical and Piperonyl Butoxide technical are the same as that used in the formulations of Example 1.

**Table 27:**

| Component | Source | Composition (g/L) |
|---|---|---|
| Pyriproxyfen 99.5% technical | Pyriproxyfen (CAS# 95737-68-1)<br><br>Manufactured/marketed by; Rudong Zhongyi Chemical Co Ltd, Second Haibin Road, Coastal Economic Development Zone, Rudong, Jiangsu, China | 303.4 |
| Piperonyl Butoxide 92% technical | Piperonyl butoxide (CAS# 51-03-6)<br><br>Manufactured/marketed by: Feicheng Qingfeng Chemical Co Ltd, Xiazhang Economic Development Zone, Taian, Shandong, PR China | 326.0 |
| Methyl benzoate | Methyl benzoate (CAS# 93-58-3)<br><br>Manufactured/marketed by: Sigma-Aldrich | 403.9 |
| Alkyl polyoxyalkylene ether (e.g. Termul 203) | Proprietary Name = Termul 203 (CAS# 37251-69-7)<br><br>Manufactured/marketed by: Huntsman Corporation Australia Pty Limited | 10.0 |
| Alkoxylated alkylphenol (e.g. Termul 200) | Proprietary Name = Termul 200 (CAS# 37251-69-7)<br><br>Manufactured/marketed by: Huntsman Corporation Australia Pty Limited | 30.0 |
| Alkyl (C10-C16) alkylbenzenesulfonic acid, calcium salt in 2-ethylhexanol (e.g. Ninate 60E) | Proprietary Name = Ninate 60E (CAS# 68584-23-6 in 104-76-7)<br><br>Manufactured/marketed by: Stepan via Orica Australia | 30.1 |

**Example 3: Method of Manufacture of Pyriproxyfen Emulsifiable Concentrate Formulation**

Formulation of a 1,000L batch of product, inclusive of quality control measures, is as follows:

***Formulation Procedure***

1. Ensure formulation vessel is empty and clean
2. Charge solvent component(s), holding a small proportion back (e.g. ~10%) for subsequent addition, to the formulation vessel with the agitator operating
3. Charge active ingredients (pyriproxyfen and synergists, e.g. piperonyl butoxide) to the formulation vessel with continuous agitation
4. Charge the surfactant(s) and other excipients clearing residual components from any pumps or process lines used with the remaining complement of solvent
5. Continue agitating for a minimum of 30 minutes following the last ingredient's addition

***Quality Control Procedure***

1. Sample approximately 1L of product, ensuring it is representative
2. Sub-sample 250mL from the original 1L sample, and subject it to the following testing regime.

2.1. Specific gravity (CIPAC MT3.1)

If specific gravity is within the bounds of the acceptable range listed in the specification, record the value and proceed to the next test. If specific gravity is outside of the bounds of the acceptable range listed

in the specification, agitate the formulation charge until specific gravity is constant. If still outside of the bounds of the acceptable range, quarantine batch for further investigations and possible rework.

2.2. pH 1% aqueous (CIPAC MT75.3)

If pH 1% aqueous is satifactory, record results and proceed to the next test. If pH 1% aqueous is outside the bounds of the acceptable range listed in the specification, quarantine the batch for further investigations and possible rework.

2.3. Emulsion characteristics (CIPAC MT36.1)

If emulsion stability in standard hard water is satifactory, record results and proceed to the next test. If emulsion stability is outside the bounds of the acceptable range listed in the specification, adjust the contents of surfactants. After suitable agitation time to ensure homogeneity, resample and retest. Repeat adjustment process until emulsion stability is within the bounds of the acceptable range.

2.4. Persistent foam (CIPAC MT47.2)

If persistent foaming characteristics are satifactory, record results and proceed to the next test. If persistent foaming characteristics are outside the bounds of the acceptable range quarantine the batch for further investigations and possible rework.

2.5. Active constituent (pyriproxyfen) content (appropriately validated method: specificity; linearity of response with correlation coefficient R>0.99; accuracy of mean measured assay as a proportion

of true content 100±2%; reproducibility of response ≤ 2% relative standard deviation).

If active constituent level is satifactory, record results. If active constituent level is outside the bounds of the acceptable range listed in the specification, adjust the level accordingly by adding additional solvent and/or surfactants and/or other excipients (for a high active constituent content), or additional pyriproxyfen technical (for a low active content). After suitable agitation time to ensure homogeneity, resample and retest. Repeat adjustment process until active constituent levels are within the bounds of the acceptable range.

2.6. Active constituent (synergist, e.g. Piperonyl butoxide) content (appropriately validated method: specificity; linearity of response with correlation coefficient R>0.99; accuracy of mean measured assay as a proportion of true content 100±2%; reproducibility of response ≤ 2% relative standard deviation).

If active constituent level is satifactory, record results. If active constituent level is outside the bounds of the acceptable range listed in the specification, adjust the level accordingly by adding additional solvent and/or surfactants and/or other excipients (for a high active constituent content), or additional synergist (for a low active constituent content). After suitable agitation time to ensure homogeneity, resample and retest. Repeat adjustment process until active constituent levels are within the bounds of the acceptable range.

3. Catalogue and store a retention sample of approximately 200mL
4. Generate a certificate of analysis noting results of testing
5. Issue quality clearance giving authority to package goods
6. Package the finished goods ensuring both the batch number and manufacturing date is noted on the label.

**Example 4: Method of Manufacture of Pyriproxyfen Dispersible Concentrate Formulation**

Formulation of a 1,000L batch of product, inclusive of quality control measures, is as follows:

***Formulation Procedure***

1. Ensure formulation vessel is empty and clean
2. Charge solvent component(s), holding a small proportion back (e.g. ~10%) for subsequent addition, to the formulation vessel with the agitator operating
3. Charge active ingredients (pyriproxyfen and synergist, e.g. piperonyl butoxide) to the formulation vessel with continuous agitation
4. Charge the surfactant(s) and other excipients clearing residual components from any pumps or process lines used with the remaining complement of solvent
5. Continue agitating for a minimum of 30 minutes following the last ingredient's addition

***Quality Control Procedure***

1. Sample approximately 1L of product, ensuring it is representative

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2. Sub-sample 250mL from the original 1L sample, and subject it to the following testing regime.

2.1. Specific gravity (CIPAC MT3.1)

If specific gravity is within the bounds of the acceptable range listed in the specification, record the value and proceed to the next test. If specific gravity is outside of the bounds of the acceptable range listed in the specification, agitate the formulation charge until specific gravity is constant. If still outside of the bounds of the acceptable range, quarantine batch for further investigations and possible rework.

2.2. pH 1% aqueous (CIPAC MT75.3)

If pH 1% aqueous is satifactory, record results and proceed to the next test. If pH 1% aqueous is outside the bounds of the acceptable range listed in the specification, quarantine the batch for further investigations and possible rework.

2.3. Dispersion stability (CIPAC MT180)

If dispersion stability in standard hard water is satifactory, record results and proceed to the next test. If dispersion stability is outside the bounds of the acceptable range listed in the specification, adjust the contents of surfactants. After suitable agitation time to ensure homogeneity, resample and retest. Repeat adjustment process until dispersion stability is within the bounds of the acceptable range.

2.4. Persistent foam (CIPAC MT47.2)

If persistent foaming characteristics are satifactory, record results and proceed to the next test. If persistent foaming characteristics are

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outside the bounds of the acceptable range quarantine the batch for further investigations and possible rework.

2.5. Active constituent (pyriproxyfen) content (appropriately validated method: specificity; linearity of response with correlation coefficient R>0.99; accuracy of mean measured assay as a proportion of true content 100±2%; reproducibility of response ≤ 2% relative standard deviation).

If active constituent level is satifactory, record results. If active constituent level is outside the bounds of the acceptable range listed in the specification, adjust the level accordingly by adding additional solvent and/or surfactants and/or other excipients (for a high active constituent content), or additional pyriproxyfen technical (for a low active content). After suitable agitation time to ensure homogeneity, resample and retest. Repeat adjustment process until active constituent levels are within the bounds of the acceptable range.

2.6. Active constituent (Synergist, e.g. Piperonyl butoxide) content (appropriately validated method: specificity; linearity of response with correlation coefficient R>0.99; accuracy of mean measured assay as a proportion of true content 100±2%; reproducibility of response ≤ 2% relative standard deviation).

If active constituent level is satifactory, record results. If active constituent level is outside the bounds of the acceptable range listed in the specification, adjust the level accordingly by adding additional solvent and/or surfactants and/or other excipients (for a high active

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constituent content), or additional Synergist (for a low active constituent content). After suitable agitation time to ensure homogeneity, resample and retest. Repeat adjustment process until active constituent levels are within the bounds of the acceptable range.

3. Catalogue and store a retention sample of approximately 200mL
4. Generate a certificate of analysis noting results of testing
5. Issue quality clearance giving authority to package goods
6. Package the finished goods ensuring both the batch number and manufacturing date is noted on the label.

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CLAIMS

1. A pesticide formulation comprising:

pyriproxyfen;

a synergist;

a surfactant; and

optionally, a solvent.

2. A concentrate formulation comprising:

pyriproxyfen at a concentration of at least about 100 g/L;

piperonyl butoxide at a concentration of at least about 50 g/L;

a surfactant; and

optionally, a solvent,

wherein the concentrate formulation is an emulsifiable concentrate formulation or a dispersible concentrate formulation.

3. The concentrate formulation of Claim 2, comprising:

pyriproxyfen at a concentration of at least about 300 g/L;

piperonyl butoxide at a concentration of at least about 50 g/L;

a non-ionic surfactant and/or an anionic surfactant; and

a solvent.

4. The concentrate formulation of Claims 2 or Claim 3, wherein the surfactant is present in an amount of at least about 40 g/L.

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5. The concentrate formulation of Claim 4, wherein the surfactant is present in an amount ranging between about 40 g/L to about 80 g/L.

6. The concentrate formulation of any one of Claims 2 to 5, wherein the surfactant is selected from the group consisting of an alkylphenol, a polyoxyalkylene ether, an alkylbenzene sulphonate, an alkoxylated styryl phenol, an oil ethoxylate and any combination thereof.

7. The concentrate formulation of Claim 6, wherein the surfactant is selected from the group consisting of an alkoxylated alkylphenol, an alkyl polyoxyalkalene ether, calcium $C_{10-16}$ alkylbenzyl sulphonate, an ethoxylated tristyryl phenol, a vegetable oil ethoxylate and any combination thereof.

8. The concentrate formulation of any one of Claims 2 to 7, wherein the solvent is present in an amount of at least about 200 g/L.

9. The concentrate formulation of Claim 8, wherein the solvent is present in an amount ranging between about 250 g/L to about 600 g/L.

10. The concentrate formulation of any one of Claims 2 to 9, wherein the solvent is selected from the group consisting of a petroleum derivative, a carboxamide, a benzoate, a ketone, a glycol ether and any combination

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thereof.

11. The concentrate formulation of Claim 10, wherein the solvent is selected from the group consisting of a heavy aromatic hydrocarbon, a pyrrolidone, an alkyl benzoate, an alkyl ketone, a cyclic ketone, a propylene glycol ether and any combination thereof.

12. The concentrate formulation of Claim 10 or Claim 11, wherein the solvent is selected from the group consisting of a heavy aromatic solvent naphtha (petroleum), 1-Butylpyrrolidin-2-one, methyl benzoate, ethyl benzoate, MIBK, isophorone, acetophenone, propylene glycol monomethyl ether and any combination thereof.

13. The emulsifiable concentrate of claim 2, wherein the solvent comprises methyl benzoate.

14. An emulsifiable concentrate, comprising:

pyriproxyfen at a concentration of at least about 300 g/L;

piperonyl butoxide at a concentration of at least about 50 g/L;

a non-ionic surfactant comprising an alkyl polyoxyalkylene ether and an alkoxylated alkylphenol;

an anionic surfactant comprising a calcium salt of an alkylbenzene sulfonate; and

a solvent comprising methyl benzoate.

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15. A method of preparing a pesticide formulation including the steps of:

(a) combining pyriproxyfen, a synergist such as piperonyl butoxide, a surfactant and optionally a solvent, wherein pyriproxyfen is present at a concentration of at least 100 mg/L; and

(b) mixing the mixture of step (a) to thereby prepare the pesticide formulation.

16. The method of Claim 15, wherein the pesticide formulation is the concentrate formulation of any one of Claims 2 to 14.

17. A pesticide formulation prepared by the method of Claim 15 or Claim 16.

18. A method of preventing and/or controlling a pest infestation in a target area, including the step of applying a pesticidally effective amount of the pesticide formulation of Claim 1 or Claim 17 or the concentrate formulation of any one of Claims 2 to 14 mixed with water or a water-containing liquid, to the target area to thereby prevent and/or control the pest infestation.