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(54) Title: AN AGROCHEMICAL COMBINATION

(57) Abstract: The present disclosure relates to insecticidal combinations comprising two or more insecticides for controlling insect pests in plants. Particularly, the present disclosure provides insecticidal compositions and. method of using the insecticidal combinatiom'composition thereof.

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AN AGROCHEMICAL COMBINATION

FIELD OF THE INVENTION:

[0001] The present disclosure pertains to the field of agrochemicals, particularly agrochemical combinations. More particularly, the present disclosure relates to insecticidal combinations/compositions comprising two or more insecticides, a method for controlling harmful insect pest in crops using said insecticidal combinations/compositions and use of the same thereof.

BACKGROUND OF THE DISCLOSURE:

[0002] Crops are extremely vulnerable to insects, rodents, and diseases that can damage them to cause deterioration of the quality, health, and even death of crops, amounting to significant economic losses. Thus, protection of crops from diseases, pests and weeds plays a decisive role in sustainable agricultural development. Chemical crop protection provides farmers with a cost-effective way of improving the health and the quality of the crops. These are classified as pesticides, insecticides, and herbicides and can be formed by both synthetic and biological compounds. Currently, numerous insecticides are available to prevent crops from being harmed by insect pests. For instance, according to the Royal Society of Chemicals, around 800 chemically active compounds are approved for crop protection treatments globally.

[0003] Insecticides are chemicals used to mitigate, control, or eliminate insects of one or more species. They are classified based on their structure and mode of action. Systemic insecticides become a part of the plant through systematic distribution and insects who then might feed on it, consume the insecticide plants, and are eliminated. Contact insecticides can penetrate the skin of the insects and are toxic to insects when they come in contact with it. Insecticides are also grouped together according to their structure.

[0004] The activity of insecticides can be enhanced in various ways to achieve maximum benefit. One method for improving insecticidal activity is to use a combination of insecticides. However, the effectiveness of a given combination varies depending on the type of insect (pest) to be controlled and the type of plant affected by the pest. For example, different pests affect different crops and respond to different insecticides to varying extents. Also crop sensitivity varies based on the type of insecticides being used. As a result, it is challenging to identify an appropriate insecticidal combination, the application rate of the insecticidal combination, and the ratio of each insecticide in the combination, that is needed to achieve efficacious control of insects and increase the yield and quality of crops.

[0005] While many insecticide compounds belonging to various different chemical classes have been or are being developed for controlling insect pest in agricultural crops, many of these insecticides have one or more drawbacks such as low bio efficacy, high phytotoxicity, high dosage requirements, crop tolerance or exhibiting activity only against particular insect or crop, and the like. Additionally, while methods of using insecticidal combinations or compositions comprising mixtures of different insecticide compounds have also been tried, there nonetheless exists a need in the art for improved combinations and compositions of different insecticides having enhanced activity for controlling insect pest and corresponding methods thereof, that has low phytotoxicity, enhanced bio efficacy, improved health, and improved cost benefit ratio. The present disclosure tries to address said need.

OBJECTIVES OF THE DISCLOSURE:

[0006] It is a primary objective of the present disclosure to provide an insecticidal combination comprising two or more insecticides.

[0007] It is another objective of the present disclosure to provide an insecticidal combination comprising two or more insecticides for controlling insect pest in crops.

[0008] It is another objective of the present disclosure to provide an insecticidal combination comprising two or more insecticides for preventing insect pest in crops.

[0009] It is yet another objective of the present disclosure to provide an insecticidal combination possessing enhanced efficacy over the individual insecticides.

[0010] It is another objective of the present disclosure to provide an insecticidal combination achieving increased yield in the crops to which they are applied.

[0011] It is yet another objective of the present disclosure to provide an insecticidal combination reducing the number of insects in the crops to which they are applied.

SUMMARY OF THE DISCLOSURE:

[0012] In one aspect, the present disclosure provides an insecticidal combination comprising:

(a) at least one spinosyn compound; and

(b) at least one pyrethroid compound.

[0013] In another aspect, the present disclosure provides use of an insecticidal combination comprising at least one spinosyn compound and at least one pyrethroid compound, for controlling insect pests in plants or preventing insect pests in plants or improving crop health.

[0014] Another aspect of the present disclosure provides a method of controlling the growth of harmful insect pests in crops, a method of preventing insect pests in crops, or a method of improving crop health, the method comprising contacting or applying to the plant, or foliage of the plant, or a locus, or a plant propagation material thereof

an effective amount of an insecticidal combination comprising at least one spinosyn compound and at least one pyrethroid compound.

[0015] Various objects, features, aspects, and advantages of the present disclosure will be apparent from the detailed description of preferred embodiments, which illustrates by way of example, the most preferred features of the present disclosure which are not to be construed as limiting the scope of the disclosure described herein.

DETAILED DESCRIPTION OF THE DISCLOSURE:

[0016] The following is a detailed description of embodiments of the present disclosure. The embodiments are in such detail as to clearly communicate the disclosure. However, the amount of detail offered is not intended to limit the anticipated variations of embodiments; on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the present disclosure as defined by the appended claims.

[0017] Unless the context requires otherwise, throughout the specification which follow, the word "comprise" and variations thereof, such as, "comprises", "comprising", "includes" and "including" are to be construed in an open, inclusive sense that is as "including, but not limited to."

[0018] Reference throughout this specification to "one embodiment" or "some embodiments" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment. Thus, the appearances of the phrases "in one embodiment" or "in some embodiments" in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments.

[0019] As used in the description herein and throughout the numbered embodiments or claims that follow, the meaning of "a", "an", and "the" includes plural reference unless the context clearly dictates otherwise.

[0020] In some embodiments, the numbers expressing quantities of ingredients, properties such as concentration, ratio and so forth, used to describe and claim certain embodiments of the disclosure are to be understood as being modified in some instances by the term "about". Accordingly, in some embodiments, the numerical parameters set forth in the written description are approximations that can vary depending upon the desired properties sought to be obtained by a particular embodiment. In some embodiments, the numerical parameters should be construed in light of the number of reported significant digits and by applying ordinary rounding techniques. Notwithstanding that the numerical ranges and parameters setting forth the broad scope of some embodiments of the disclosure are approximations, the numerical values set forth in the specific examples are reported as precisely as practicable.

[0021] The recitation of ranges of values herein is merely intended to serve as a shorthand method of referring individually to each separate value falling within the range. Unless otherwise indicated herein, each individual value is incorporated into the specification as if it were individually recited herein.

[0022] All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., "such as") provided with respect to certain embodiments herein is intended merely to better illustrate the disclosure and does not pose a limitation on the scope of the disclosure otherwise claimed.

[0023] The following discussion provides many exemplary embodiments of the inventive subject matter. Although each embodiment represents a single combination

of inventive elements, the inventive subject matter is considered to include all possible combinations of the disclosed elements. Thus, if one embodiment comprises elements A, B, and C, and a second embodiment comprises elements B and D, then the inventive subject matter is also considered to include other remaining combinations of A, B, C, or D, even if not explicitly disclosed.

[0024] Various terms as used herein are described below. To the extent a term used in a claim is not defined below, it should be given the broadest definition persons in the pertinent art have given that term as reflected in printed publications and issued patents at the time of filing.

[0025] The term "about" or "approximately" as used herein encompasses variations of ±15%, preferably ±10%, and more preferably ±5%, or any such variations that are appropriate for practicing the present disclosure to achieve desired effects.

[0026] The term "locus" as used herein means fields in or on which plants are growing, or where seeds of cultivated plants are sown, or where seed will be placed into the soil. The term also includes the vicinity of a desired crop in which control is desired.

[0027] The term "insects" as used herein, includes all organisms in the class "Insecta".

[0028] The term "crop" shall include a multitude of desired plants or an individual plant growing at a locus. As used herein, the term "plant" and "crop" have been used interchangeably throughout the present disclosure. Said term refers to all physical parts of a plant including foliage/leaves, seeds, seedlings, saplings, roots, tubers, stems, stalks, and fruits.

[0029] The term "plant propagation material" is understood to denote generative parts of a plant, such as seeds, vegetative material such as cuttings or tubers, roots, fruits,

tubers, bulbs, rhizomes and parts of plants, germinated plants and young plants which are to be transplanted after germination or after emergence from the soil. These young plants may be protected before transplantation by a total or partial treatment by immersion.

[0030] The term "seed" as used herein means any resting stage of a plant that is physically detached from the vegetative stage of a plant.

[0031] As used herein, term "maize" is used interchangeably with "corn" and "*Zea mays*" throughout the specification.

[0032] The term "control" or "controlling" or "preventing" a pest refers to inhibiting or reducing the growth, reducing the ability of pest to grow or reproduce or proliferate or spread, including killing (e.g. , causing the morbidity or mortality, or reduced fecundity) of pest. Controlling effects include all deviation from natural development, for example: killing or retardation of the pest or decrease and treatment of the disease.

[0033] The term "pest" refers to an organism, and in particular an insect, which is detrimental to the growth, reproduction, and/or viability of a plant, a portion of the plant or a plant seed. In one aspect, the pest is an insect.

[0034] The term "insecticides" as used herein, refer to chemicals used to control insects by killing them or preventing them from engaging in undesirable or destructive behaviors. Insecticides are classified based on their structure and mode of action. The Insecticide Resistance Action Committee (IRAC) classifies the various insecticides according to their mode of action.

[0035] The term "insecticidal" as used herein, refers to the ability of an insecticide to increase mortality or inhibit growth rate of insects.

[0036] As used herein, the term "insecticidal combination" refers to a mixture of more than one insecticide, mixed and intended to be applied onto plants with and without further dilution.

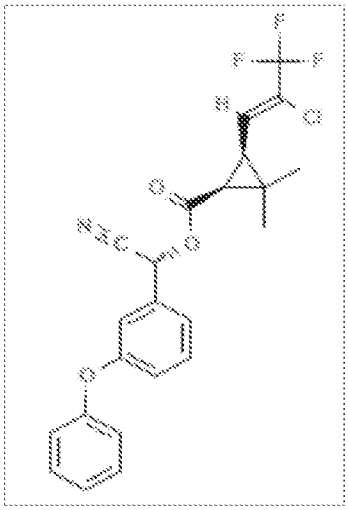
[0037] The term "insecticidally effective amount" means the amount of the insecticidal combination/composition needed to achieve an observable adverse effect on growth, including the effects of necrosis, death, retardation, prevention, and removal, destruction, insect pest mortality, insect pest weight loss, insect pest reduced plant defoliation, and other behavioural and physical changes of an insect pest after feeding and exposure for an appropriate length of time.

[0038] As used herein, the term "increased yield" of an agricultural plant means that the yield of a product of the respective plant is increased by a measurable amount over the yield of the same product of the plant produced under the same conditions, but without the application of the combination/composition described herein. According to the present disclosure, it is preferred that the crop yield be increased by at least 0.5 %, preferably at least 2%, more preferably at least 5%, upon application of the combination/composition described herein. The combination/composition also increases the vigour/yield of the plant.

[0039] The Spinosyns are a large family of compounds produced from fermentation in two species of *Saccharopolyspora*. In particular, spinosad (a type of spinosyn) is an insecticide based on chemical compounds found in the bacterial species *Saccharopolyspora spinosa*. Spinosad acts as a nicotinic acetylcholine receptor (nAChR) allosteric modulator insecticide, which falls in the IRAC group 4. Spinosad is highly active, by both contact and ingestion and the mode of action of spinosad insecticides is by neural mechanism. The specific mode of action of spinosad is to alter the function of nicotinic and gamma-aminobutyric acid (GABA)-gated ion channels,

causing rapid excitation of the insect nervous system, leading to involuntary muscle contractions, tremors, paralysis, and death.

[0040] Lambda-cyhalothrin is an insecticide belonging to a group of compounds called pyrethroids. Lambda-cyhalothrin affects the nervous system of an organism and acts by disrupting the gating mechanism of sodium channels that engage in the generation and conduction of nerve impulses. Lambda-cyhalothrin acts as a sodium channel modulator insecticide, which falls in the IRAC group 3. It is chemically known as [(*R*)-cyano-(3-phenoxyphenyl)methyl](1*S*,3*S*)-3-[(*Z*)-2-chloro-3,3,3-trifluoroprop-1-enyl]-2,2-dimethylcyclopropane-1-carboxylate and represented as follows:



[0041] It was found by the inventors of the present invention that a combination of a spinosyn compound (nicotinic acetylcholine receptor (nAChR) allosteric activator insecticide) and a pyrethroid compound (sodium channel modulator insecticide) result in enhancement of insecticidal efficacy, reduction in plant disease incidence and enhanced pest control in comparison to the efficacy seen with the insecticides alone. For instance, the combination of a spinosyn compound such as spinosad and a pyrethroid compound such as lambda-cyhalothrin effectively controls insect pest in crops, with reduced phytotoxicity and improved crop health. As will be demonstrated

in the examples below, the enhanced effect of the present insecticidal combination/composition thereof in controlling insect pests in crops is far superior to similar combinations/compositions of the prior art. Therefore, these unexpected advantages of the insecticidal combination of the present disclosure in controlling insect pest in crops have been attributed to the enhanced efficacy between the two insecticides.

[0042] Accordingly in an embodiment, the present disclosure provides an insecticidal combination. The present disclosure provides an insecticidal combination comprising at least two insecticides. In an embodiment, the present disclosure provides an insecticidal combination comprising two or more insecticides. In some embodiments, the insecticidal combinations of the present disclosure are effective in controlling insect pests in crops.

[0043] Accordingly in an embodiment, the present disclosure provides an insecticidal combination comprising:

(a) at least one spinosyn compound; and

(b) at least one pyrethroid compound.

[0044] As used throughout the disclosure, the spinosyn compound, or other active ingredients for example pyrethroid compound, include their salts, esters, ethers, polymorphs including solvates and hydrates. A salt includes salts that retain the biological effectiveness and properties of the active ingredient, and which are not biologically or otherwise undesirable, and include derivatives of the disclosed compounds in which the parent compound is modified by making inorganic and organic, non-toxic, acid or base addition salts thereof. The salts can be synthesized from the parent compound by conventional chemical methods.

[0045] In some embodiments, the spinosyn compound is selected from spinosad, spinetoram, or combinations thereof. In a preferred embodiment, the spinosyn compound is spinosad. In a preferred embodiment, the spinosyn compound is spinetoram.

[0046] In some embodiments, the pyrethroid compound is selected from the group comprising lambda-cyhalothrin, acrinathrin, allethrin, bioallethrin, esdepallethrin, barthrin, bifenthrin, kappa bifenthrin, bioethanomethrin, brofenvalerate, brofluthrinate, bromethrin, butethrin, chlorempenthrin, cyclethrin, cyclprothrin, cyfluthrin, beta-cyfluthrin, cyhalothrin, gamma-cyhalothrin, cypermethrin, alpha-cypermethrin, beta-cypermethrin, theta-cypermethrin, zeta-cypermethrin, cyphenothrin, deltamethrin, dimefluthrin, dimethrin, empenthrin, d-fanshiluquebingjuzhi, chloroprallethrin, fenfluthrin, fenpirithrin, fenpropathrin, fenvalerate, esfenvalerate, flucythrinate, fluvalinate, tau-fluvalinate, furamethrin, furethrin, heptafluthrin, imiprothrin, japothrins, kadethrin, methothrin, metofluthrin, epsilon-metofluthrin, momfluorothrin, epsilon-momfluorothrin, pentmethrin, permethrin, biopermethrin, transpermethrin, phenothrin, prallethrin, profluthrin, proparthrin, pyresmethrin, renofluthrin, meperfluthrin, resmethrin, bioresmethrin, cismethrin, tefluthrin, kappa-tefluthrin, terallethrin, tetramethylfluthrin, tralocythrin, transfluthrin, valerate, or combinations thereof.

[0047] In another embodiment, the pyrethroid compound is selected from lambda-cyhalothrin, cyhalothrin, gamma-cyhalothrin, or combinations thereof. In a preferred embodiment, the pyrethroid compound is lambda-cyhalothrin.

[0048] In some embodiments, the present disclosure provides an insecticidal combination for controlling insect pest in crops, the combination comprising:

(a) at least one spinosyn compound selected from the group comprising spinosad, spinetoram, or combinations thereof; and

(b) at least one pyrethroid compound selected from the group comprising lambda-cyhalothrin, acrinathrin, allethrin, bioallethrin, esdepallethrin, barthrin, bifenthrin, kappa bifenthrin, bioethanomethrin, brofenvalerate, brofluthrinate, bromethrin, butethrin, chlorempenthrin, cyclethrin, cyclprothrin, cyfluthrin, beta-cyfluthrin, cyhalothrin, gamma-cyhalothrin, cypermethrin, alpha-cypermethrin, beta-cypermethrin, theta-cypermethrin, zeta-cypermethrin, cyphenothrin, deltamethrin, dimefluthrin, dimethrin, empenthrin, d-fanshiluquebingjuzhi, chloroprallethrin, fenfluthrin, fenpirithrin, fenpropathrin, fenvalerate, esfenvalerate, flucythrinate, fluvalinate, tau-fluvalinate, furamethrin, furethrin, heptafluthrin, imiprothrin, japothrins, kadethrin, methothrin, metofluthrin, epsilon-metofluthrin, momfluorothrin, epsilon-momfluorothrin, pentmethrin, permethrin, biopermethrin, transpermethrin, phenothrin, prallethrin, profluthrin, proparthrin, pyresmethrin, renofluthrin, meperfluthrin, resmethrin, bioresmethrin, cismethrin, tefluthrin, kappa-tefluthrin, terallethrin, tetramethylfluthrin, tralocythrin, transfluthrin, valerate, or combinations thereof.

[0049] In some embodiments, the present disclosure provides an insecticidal combination for controlling insect pest in crops, the combination comprising:

(a) at least one spinosyn compound selected from the group comprising spinosad, spinetoram, or combinations thereof; and

(b) at least one pyrethroid compound selected from the group comprising lambda-cyhalothrin, cyhalothrin, gamma-cyhalothrin, or combinations thereof.

[0050] In some embodiments, the present disclosure provides an insecticidal combination comprising:

(a) spinosad; and

(b) lambda-cyhalothrin.

[0051] In another embodiment, the present disclosure provides an insecticidal combination for controlling insect pest in crops comprising two or more insecticides each with different mode of actions. In some embodiments, at least one of the insecticides is a nicotinic acetylcholine receptor (nAChR) competitive modulator insecticide. In some embodiments, at least one of the insecticides is a sodium channel modulator insecticide.

[0052] In some embodiments, at least one of the insecticides in the insecticidal combination for controlling insect pest in crops is a nicotinic acetylcholine receptor (nAChR) competitive modulator insecticide and is selected from the group comprising spinosad, spinetoram, or combinations thereof.

[0053] In some embodiments, at least one of the insecticides in the insecticidal combination for controlling insect pest in crops is a sodium channel modulator insecticide and is selected from the group comprising lambda-cyhalothrin, cyhalothrin, gamma-cyhalothrin, or combinations thereof.

[0054] In some embodiments, the insecticidal combination for controlling insect pest in crops comprises:

(a) at least one nicotinic acetylcholine receptor (nAChR) competitive modulator insecticide; and

(b) at least one sodium channel modulator insecticide.

[0055] According to an embodiment, the insecticidal combination comprises:

(a) at least one spinosyn compound;

(b) at least one pyrethroid compound; and

(c) at least one additional insecticide.

[0056] According to an embodiment, the insecticidal combination comprises:

(a) spinosad;

(b) lambda-cyhalothrin; and

(c) at least one additional insecticide.

[0057] In some embodiments, the additional insecticide may be selected from the group comprising chordotonal organ modulators, nicotinic acetylcholine receptor (nAChR) competitive modulators; acetylcholinesterase (AChE) inhibitors, GABA-gated chloride channel blockers, sodium channel modulators, nicotinic acetylcholine receptor (nAChR) allosteric modulators–site I, glutamate-gated chloride channel (GluCl) allosteric modulators, juvenile hormone mimics, miscellaneous nonspecific (multi-site) inhibitors, chordotonal organ transient receptor potential vanilloid (TRPV) channel modulators, mite growth inhibitors affecting chitin synthase 1 (CHS1), microbial disruptors of insect midgut membranes, Inhibitors of mitochondrial adenosine triphosphate (ATP) synthase, uncouplers of oxidative phosphorylation via disruption of the proton gradient, nicotinic acetylcholine receptor (nAChR) channel blockers, inhibitors of chitin biosynthesis affecting CHS1, inhibitors of chitin biosynthesis, type 1, moulting disruptors, dipteran, ecdysone receptor agonists, octopamine receptor agonists, mitochondrial complex III electron transport inhibitors, mitochondrial complex I electron transport inhibitors, voltage-dependent sodium channel blockers, inhibitors of acetyl coenzyme A (CoA) carboxylase, mitochondrial complex IV electron transport inhibitors, mitochondrial complex II electron transport inhibitors, ryanodine receptor modulators, GABA-gated chloride channel allosteric modulators, unknown mode of action compounds, or combinations thereof.

[0058] In some embodiments, the additional insecticide may be selected from the group comprising alkyl halide insecticides, aminopyrimidine insecticides, aminotriazene insecticides, antibiotic insecticides, aromatic hydrocarbon insecticides, arylpyrrole insecticides, benzimidazole insecticides, benzoylurea insecticides, beta-ketonitrile insecticides, botanical insecticides, carbamate insecticides, diacylhydrazine

insecticides, diamide insecticides, dinitrophenol insecticides, dithiolane insecticides, formamidine insecticides, fumigant insecticides, inorganic insecticides, isoxazoline insecticides, juvenile hormone mimics, juvenile hormones, macrocyclic lactone insecticides, meta-diamide insecticides, methoxyacrylate insecticides, neonicotinoid insecticides, nereistoxin analogue insecticides, organochlorine insecticides, organophosphorus insecticides, oxadiazine insecticides, oxadiazolone insecticides, perfluoroalkyl sulfonamide insecticides, phenol insecticides, precocenes, pyrazole insecticides, pyrethrin insecticides, pyrethroid compounds, pyridine azomethine insecticides, pyrimidinamine insecticides, pyropene insecticides, RNA1 insecticides, salicylanilide insecticides, semicarbazone insecticides, steroid insecticides, tetramic acid insecticides, tetronic acid insecticides, thiocarbonate insecticides, thiourea insecticides, urea insecticides, unclassified insecticides, or combinations thereof.

[0059] According to an embodiment, the concentration of the spinosyn compound ranges from about 1 g/L to about 500 g/L, preferably from about 10 g/L to about 450 g/L, more preferably from about 100 g/L to about 400 g/L.

[0060] In a preferred embodiment, the concentration of the spinosyn compound is about 300 g/L. In a preferred embodiment, the concentration of spinosad is about 300 g/L.

[0061] According to an embodiment, the concentration of the pyrethroid compound ranges from about 1 g/L to about 300 g/L, preferably from about 10 g/L to about 250 g/L, more preferably from about 50 g/L to about 300 g/L.

[0062] In a preferred embodiment, the concentration of the pyrethroid compound is about 100 g/L. In a preferred embodiment, the concentration of lambda-cyhalothrin is about 100 g/L.

[0063] According to an embodiment, the insecticidal combination of the present disclosure comprises:

(a) at least one spinosyn compound; and

(b) at least one pyrethroid compound;

wherein the concentration of the spinosyn compound is from about 1 g/L to about 500 g/L; and the concentration of the pyrethroid compound is from about 1 g/L to about 300 g/L.

[0064] In another embodiment, the insecticidal combination of the present disclosure comprises:

(a) at least one spinosyn compound; and

(b) at least one pyrethroid compound;

wherein the concentration of the spinosyn compound is about 300 g/L and the concentration of the pyrethroid compound is about 100 g/L.

[0065] In a preferred embodiment, the insecticidal combination of the present disclosure comprises:

(a) spinosad; and

(b) lambda-cyhalothrin;

wherein the concentration of spinosad is about 300 g/L and the concentration of lambda-cyhalothrin is about 100 g/L.

[0066] According to an embodiment, a weight ratio of the spinosyn compound to the pyrethroid compound is from about 100:1 to about 1:100. In a preferred embodiment, the weight ratio of the spinosyn compound to the pyrethroid compound is selected from ratios comprising 1:1, 10:1, 20:1, 30:1, 40:1, 50:1, 60:1, 70:1, 80:1, 90:1 and 100:1. In a preferred embodiment, the weight ratio of the spinosyn compound to the pyrethroid compound is selected from ratios comprising 1:1, 1:10, 1:20, 1:30, 1:40, 1:50, 1:60, 1:70, 1:80, 1:90 and 1:100.

[0067] In some embodiments, the present disclosure provides an insecticidal combination comprising:

(a) at least one spinosyn compound; and

(b) at least one pyrethroid compound;

wherein the spinosyn compound and the pyrethroid compound are present in a weight ratio from about 1:10 to about 10:1.

[0068] In some embodiments, the insecticidal combination of the present disclosure comprises:

(a) at least one spinosyn compound; and

(b) at least one pyrethroid compound;

wherein the spinosyn compound and the pyrethroid compound are present in a weight ratio from about 1:5 to about 5:1.

[0069] In some embodiments, the insecticidal combination of the present disclosure comprises:

(a) at least one spinosyn compound; and

(b) at least one pyrethroid compound;

wherein the spinosyn compound and the pyrethroid compound are present in a weight ratio from about 1:4 to about 4:1.

[0070] In some embodiments, the insecticidal combination of the present disclosure comprises:

(a) at least one spinosyn compound; and

(b) at least one pyrethroid compound;

wherein the spinosyn compound and the pyrethroid compound are present in a weight ratio from about 1:3 to about 3:1.

[0071] In some embodiments, the spinosyn compound and the pyrethroid compound are present in a weight ratio of about 3:1.

[0072] In a preferred embodiment, the insecticidal combination comprises: spinosad and lambda-cyhalothrin; wherein spinosad and lambda-cyhalothrin are present in a weight ratio of about 3:1.

[0073] In another embodiment, in the insecticidal combination of the present disclosure, the spinosyn compound is present in higher amount/concentration as compared to the pyrethroid compound. In a preferred embodiment, in the insecticidal combination of the present disclosure, spinosad is present in higher amount/concentration as compared to the pyrethroid compound.

[0074] In another embodiment, in the insecticidal combination of the present disclosure, the pyrethroid compound is present in reduced amount or lower concentration as compared to the spinosyn compound. In a preferred embodiment, in the insecticidal combination of the present disclosure, lambda-cyhalothrin is present in reduced amount or lower concentration as compared to spinosad.

[0075] The inventors of the present invention found that the pyrethroid compound when employed at a lower concentration or a reduced amount as compared to the spinosyn compound in the insecticidal combination of the present disclosure resulted in a more effective/improved control of insect pest in crops. This is a significant observation since the pyrethroid compound is conventionally practiced being used at higher concentrations/amounts.

[0076] More particularly, the inventors of the present invention found that lambda-cyhalothrin when employed at a lower concentration or reduced amount as compared to spinosad in the insecticidal combination of the present disclosure resulted in a more

effective/improved control of insect pests in crops. This is a significant observation since lambda-cyhalothrin compound is conventionally practiced being used at higher concentrations/amounts.

[0077] According to some embodiments, insecticides of the combination as disclosed above, may be mixed at the time of application or on the point of application. The point of application refers to the locus of application of the said insecticides. The said locus could be an infected plant, or a seed, or any other plant propagation material, or an area adjacent to the said infected plant or a seed or any other plant propagation material, or locus of the infestation, and/or foliage.

[0078] The insecticidal combinations according to the present disclosure can be applied before or after infection of the plants, or a locus, or a propagation material thereof, by the insect pest.

[0079] In some embodiments, the present disclosure provides an insecticidal composition comprising:
(a) at least one spinosyn compound;
(b) at least one pyrethroid compound; and
(c) at least one agrochemically acceptable excipient.

[0080] In some embodiments, the insecticidal composition comprises:
(a) spinosad;
(b) lambda-cyhalothrin; and
(c) optionally at least one agrochemically acceptable excipient.

[0081] In some embodiments, the agrochemically acceptable excipient is selected from the group comprising one or more solvent(s), carrier(s), surfactant(s), dispersing

agent(s), wetting agent(s), antifoam agent(s), stabilizing agent(s), pH modifier(s), or combinations thereof.

[0082] In some embodiments, the insecticidal composition comprises:

(a) at least one spinosyn compound;

(b) at least one pyrethroid compound;

(c) at least one additional insecticide; and

(d) optionally at least one agrochemically acceptable excipient.

[0083] In another aspect, the present disclosure provides a process for preparation of the insecticidal combination/composition, described herein.

[0084] In some embodiments, the present disclosure provides an insecticidal composition comprising:

(a) at least one spinosyn compound;

(b) at least one pyrethroid compound; and

(c) optionally at least one agrochemically acceptable excipient;

wherein the insecticidal composition is present in a form of a tank mix or a pre-formulated (pre-mix)/ready-mix formulation.

[0085] The present disclosure further relates to a method of controlling the growth of harmful insect pest in crops or a method of improving crop health in crops susceptible to insect pest, said method comprising contacting or applying to seeds, foliage, or at the locus of crops, an effective amount of an insecticidal combination or insecticidal composition, as described above.

[0086] In some embodiments, the method of controlling the growth of harmful insect pest in crops, and method of improving crop health comprises contacting or applying

to seeds, foliage, or at the locus of crop an effective amount of an insecticidal combination or an insecticidal composition, comprising:

(a) at least one spinosyn compound; and

(b) at least one pyrethroid compound.

[0087] In some embodiments, the present disclosure provides a method for controlling insects by applying to a plant or a locus thereof, an insecticidal combination comprising:

(a) at least one spinosyn compound; and

(b) at least one pyrethroid compound.

[0088] According to an embodiment of the present disclosure, the insecticidal composition provides a formulation which allows the active compounds to be taken up by the target pests/insects. According to another embodiment, the insecticidal composition of the present disclosure is found to be highly active against a wide variety of chewing, boring and sucking insects in crops.

[0089] In an embodiment, the crops can be selected from, but not limited to, cereals, such as wheat, oats, barley, spelt, triticale, rye, maize, corn, millet, rice; crops such as sugarcane, soybean, sunflower, rape, canola, tobacco, sugar beet, fodder beet; tuber crops such as potatoes, sweet potatoes, etc.; crops such as asparagus, hops, etc.; fruit plants such as apples, pears; stone- fruits such as, for example, peaches, nectarines, cherries, plums, apricots; citrus fruits such as oranges, grapefruit, limes, lemons, kumquats, mandarins, satsumas; nuts such as pistachios, almonds, walnuts, pecan nuts; tropical fruits such as mango, papaya, pineapple, dates, bananas etc.; grapes; vegetables such as endives, lettuce, fennel, globe and loose-leaf salad, chard, spinach, chicory, cauliflower, broccoli, Chinese cabbage, kale (winter kale or curly kale), kohlrabi, Brussel sprouts, red cabbage, white cabbage and savoy; fruiting vegetables such as aubergines, cucumbers, paprika, marrow, tomatoes, courgettes, sweetcorn; root

vegetables such as celeriac, turnip, carrots, swedes, radishes, horseradish, beetroot, salsify, celery; pulses such as peas, beans, etc.; bulb vegetables such as leeks, onions, etc.; oil crops such as mustard, poppy, olives, sunflowers, coconut, castor oil plants, cocoa beans, groundnuts; fibre crops such as cotton, jute, flex, hemp; crops such as tea, coffee, rubber; ornamentals including shrubs and flowering plants; vines; rangeland; and pastures.

[0090] In an embodiment, the target insect pest is a Lepidopteran, a Coleopteran, an orthopteran, a Thysanopteran, a Hemipteran, a Homopteran, or combinations thereof.

[0091] In an embodiment, Lepidopteran pest species which negatively impact agriculture include, but are not limited to, *Achoea janata, Adoxophyes spp., Adoxophyes orana, Agrotis spp.* (cutworms), *Agrotis ipsilon* (black cutworm), *Alabama argillacea* (cotton leafworm), *Amorbia cuneana, Amyelosis transitella* (navel orangeworm), *Anacamptodes defectaria, Anarsia lineatella* (peach twig borer), *Anomis sabulifera* (jute looper), *Anticarsia gemmatalis* (velvetbean caterpillar), *Archips argyrospila* (fruittree leafroller), *Archips rosana* (rose leaf roller), *Argyrotaenia* spp. (tortricid moths), *Argyrotaenia citrana* (orange tortrix), *Autographa gamma, Bonagota cranaodes, Borbo cinnara* (rice leaf folder), *Bucculatrix thurberiella* (cotton leafperforator), *Caloptilia spp.* (leaf miners), *Capua reticulana, Carposina niponensis* (peach fruit moth), *Chilo spp., Chlumetia transversa* (mango shoot borer), *Choristoneura rosaceana* (obliquebanded leafroller), *Chrysodeixis spp., Cnaphalocerus medinalis* (grass leafroller), *Colias spp., Conpomorpha cramerella, Cossus cossus* (carpenter moth), *Crambus spp.* (Sod webworms), *Cydia funebrana* (plum fruit moth), *Cydia molesta* (oriental fruit moth), *Cydia nignicana* (pea moth), *Cydia pomonella* (codling moth), *Darna diducta, Diaphania spp.* (stem borers), Diatraea *spp.* (stalk borers), *Diatraea saccharalis* (sugarcane borer), *Diatraea graniosella* (southwester corn borer), *Earias spp.* (bollworms), *Earias insulata* (Egyptian bollworm), *Earias vitella* (rough northern bollworm), *Ecdytopopha*

aurantianum, Elasmopalpus lignosellus (lesser *cornstalk borer), Epiphysias postruttana* (light brown apple moth), *Ephestia spp.* (flour moths), *Ephestia cautella* (almond moth), *Ephestia elutella* (tobbaco moth), *Ephestia kuehniella* (Mediterranean flour moth), *Epimeces spp., Epinotia aporema, Erionota thrax* (banana skipper), *Eupoecilia ambiguella* (grape berry moth), *Euxoa auxiliaris* (army cutworm), *Feltia spp. (*cutworms), *Gortyna spp.* (stemborers), *Grapholita molesta* (oriental fruit moth), *Hedylepta indicata* (bean leaf webber), *Helicoverpa spp.* (noctuid moths), *Helicoverpa armigera* (cotton bollworm), *Helicoverpa zea* (bollworm/corn earworm), *Heliothis spp.* (noctuid moths), *Heliothis virescens* (tobacco budworm), *Hellula undalis* (cabbage webworm), *Indarbela spp.* (root borers), *Keiferia lycopersicella* (tomato pinworm), *Leucinodes orbonalis* (eggplant fruit borer), *Leucoptera malifoliella, Lithocollectis spp., Lobesia botrana* (grape fruit moth), *Loxagrotis spp.* (noctuid moths), *Loxagrotis albicosta* (western bean cutworm), *Lymantria dispar* (gypsy moth), *Lyonetia clerkella* (apple leaf miner), *Mahasena corbetti* (oil palm bagworm), *Malacosoma spp.* (tent caterpillars), *Mamestra brassicae* (cabbage armyworm), *Maruca testulalis* (bean pod borer), *Metisa plana* (bagworm), *Mythimna unipuncta* (true armyworm), *Neoleucinodes elegantalis* (small tomato borer), *Nymphula depunctalis* (rice caseworm), *Operophthera brumata* (winter moth), *Ostrinia nubilalis* (European corn borer), *Oxydia vesulia, Pandemis cerasana* (common currant tortrix), *Pandemis heparana* (brown apple tortrix), *Papilio demodocus, Pectinophora gossypiella* (pink bollworm), *Peridroma spp.* (cutworms), *Peridroma saucia* (variegated cutworm), *Perileucoptera coffeella* (white coffee leafminer), *Phthorimaea operculella* (potato tuber moth), *Phyllocnisitis citrella, Phyllonorycter spp.* (leafminers), *Pieris rapae* (imported cabbageworm), *Plathypena scabra, Plodia interpunctella* (Indian meal moth), *Plutella xylostella* (diamondback moth), *Polychrosis viteana* (grape berry moth), *Prays endocarpa, Prays oleae* (olive moth), *Pseudaletia spp.* (noctuid moths), *Pseudaletia unipunctata* (armyworm), *Pseudoplusia includens* (soybean looper), *Rachiplusia nu, Scirpophaga incertulas, Sesamia spp.* (stemborers), *Sesamia inferens* (pink rice stem borer), *Sesamia nonagrioides, Setora*

nitens, *Sitotroga cerealella* (Angoumois grain moth), *Sparganothis pilleriana*, *Spodoptera cosmioides* (lepidoptera), *Spodoptera spp.* (armyworms), *Spodoptera exigua* (beet armyworm), *Spodoptera fugiperda* (fall armyworm), *Spodoptera oridania eridania* (southern armyworm), *Spodoptera littoralis*, *Diaphania nitidalis*, Synanthedon *spp.* (root borers), *Thecla basilides*, *Thermisia gemmatalis*, *Tineola bisselliella* (webbing clothes moth), *Trichoplusia ni* (cabbage looper), *Tuta absoluta*, *Yponomeuta spp.*, *Zeuzera coffeae* (red branch borer) and *Zeuzera pyrina* (leopard moth).

[0092] In yet another embodiment, the insect pests are of the order Orthoptera, such as *Anabrus simplex* (Mormon cricket), *Gryllotalpidae* (mole crickets), *Locusta migratoria*, *Melanoplus spp.* (grasshoppers), *Microcentrum retinerve* (angularwinged katydid), *Pterophylla spp.* (kaydids), *Chistocerca* gregaria, *Scudderia furcata* (forktailed bush katydid) and *Valanga nigricorni*.

[0093] In yet another embodiment, the insect pests are of the order Thysanoptera, such as *Frankliniella fusca* (tobacco thrips), *Frankliniella occidentalis* (western flower thrips), *Frankliniella shultzei Frankliniella williamsi* (corn thrips), *Heliothrips haemorrhaidalis* (greenhouse thrips), *Riphiphorothrips cruentatus*, *Scirtothrips spp.*, *Scirtothrips citri* (citrus thrips), *Scirtothrips dorsalis* (yellow tea thrips), *Taeniothrips rhopalantennalis* and *Thrips spp. Diloboderus abderus* (coleoptera) and *Diabrotica speciosa* (coleoptera).

[0094] In an embodiment, Coleopteran insect pests may be selected from but not limited to *Acanthoscelides spp. (weevils), Acanthoscelides obtectus (common bean weevil), Agrilus planipennis (emerald ash borer), Agriotes spp. (wireworms), Anoplophora glabripennis (Asian longhorned beetle), Anthonomus spp. (weevils), Anthonomus grandis (boll weevil), Aphidius spp., Apion spp. (weevils), Apogonia spp. (grubs), Ataenius spretulus (Black Turgrass Ataenius), Atomaria linearis (pygmy*

mangold beetle), Aulacophore spp., Bothynoderes punctiventris (beet root weevil), Bruchus spp. (weevils), Bruchus pisorum (pea weevil), Cacoesia spp., Callosobruchus maculatus (southern cow pea weevil), Carpophilus hemipteras (dried fruit beetle), Cassida vittata, Cerosterna spp, Cerotoma spp. (chrysomeids), Cerotoma trifurcata (bean leaf beetle), Ceutorhynchus spp. (weevils), Ceutorhynchus assimilis (cabbage seedpod weevil), Ceutorhynchus napi (cabbage curculio), Chaetocnema spp. (chrysomelids), Colaspis spp. (soil beetles), Conoderus scalaris, Conoderus stigmosus, Conotrachelus nenuphar (plum curculio), Cotinus nitidis (Green June beetle), Crioceris asparagi (asparagus beetle), Cryptolestes ferrugineus (rusty grain beetle), Cryptolestes pusillus (flat grain beetle), Cryptolestes turcicus (Turkish grain beetle), Ctenicera spp. (wireworms), Curculio spp. (weevils), Cyclocephala spp. (grubs), Cylindrocpturus adspersus (sunflower stem weevil), Deporaus marginatus (mango leaf-cutting weevil), Dermestes lardarius (la rder beetle), Dermestes maculates (hide beetle), Diloboderus abderus (coleoptera), Diabrotica speciosa (coleoptera), Diabrotica spp. (chrysolemids), Epilachna varivestis (Mexican bean beetle), Faustinus cubae, Hylobius pales (pales weevil), Hypera spp. (weevils), Hypera postica (alfalfa weevil), Hyperdoes spp. (Hyperodes weevil), Hypothenemus hampei (coffee berry beetle), Ips spp. (engravers), Lasioderma serricorne (cigarette beetle), Leptinotarsa decemlineata (Colorado potato beetle), Liogenys futscus, Liogenys suturalis, Lissorhoptrus oryzophilus (rice water weevil), Lyctus spp. (wood beetles/powder post beetles), Maecolaspis joliveti, Megascelis spp., Melanotus communis, Meligethes spp., Meligethes aeneus (blossom beetle), Melolontha melolontha (common European cockchafer), Oberea brevis, Oberea linearis, Oryctes rhinoceros (date palm beetle), Oryzaephilus mercator (merchant grain beetle), Oryzaephilus surinamensis (sawtoothed grain beetle), Otiorhynchus spp. (weevils), Oulema melanopus (cereal leaf beetle), Oulema oryzae, Pantomorus spp. (weevils), Phyllophaga spp. (May/June beetle), Phyllophaga cuyabana, Phyllotreta spp. (chrysomelids), Phynchites spp., Popillia japonica (Japanese beetle), Prostephanus truncates (larger grain borer), Rhizopertha dominica (lesser grain borer), Rhizotrogus spp. (Eurpoean chafer),

Rhynchophorus spp. (weevils), Scolytus spp. (wood beetles), Shenophorus spp. (Billbug), Sitona lineatus (pea leaf weevil), Sitophilus spp. (grain weevils), Sitophilus granaries (granary weevil), Sitophilus oryzae (rice weevil), Stegobium paniceum (drugstore beetle), Tribolium spp. (flour beetles), Tribolium castaneum (red flour beetle), Tribolium confusum (confused flour beetle), Trogoderma variabile (warehouse beetle) and Zabrus tenebioides.

[0095] In an embodiment, the insect pests are of the order Hemiptera, such as *Acrosternum hilare (green stink bug), Blissus leucopterus (chinch bug), Calocoris norvegicus (potato mind), Cimex hemipterus (tropical bed bug), Cimex lectularius (bed bug), Diaphorina citri e Tibraca limbativentris (hemiptera), Dagbertus fasciatus, Dichelops furcatus, Dichelops melacanthus, Dysdercus suturellus (cotton stainer), Edessa meditabunda, Eurygaster maura (cereal bug), Euschistus heros, Euschistus servus (brown stink bug), Helopeltis antonii, Helopeltis theivora (tea blight plantbug), Lagynotomus spp. (stink bugs), Leptocorisa oratorius, Leptocorisa varicornis, Lygus spp. (plant bugs), Lygus hesperus (western tarnished plant bug), Maconellicoccus hirsutus, Neurocolpus longirostris, Nezara viridula (southern green stink bug), Paratrioza cockerelli, Phytocoris spp. (plant bugs), Phytocoris californicus, Phytocoris relativus, Piezodorus guildinii, Poecilocapsus lineatus (fourlined plant bug), Psallus vaccinicola, Pseudacysta perseae, Scaptocoris castanea and Triatoma spp.* (bloodsucking conenose bugs/kissing bugs).

[0096] In an embodiment, the insect pests are of the order Homoptera, such as *Acrythosiphon pisum (pea aphid), Adelges spp. (adelgids), Aleurodes proletella (cabbage whitefly), Aleurodicus disperses, Aleurothrixus floccosus (woolly whitefly), Aluacaspis spp., Amrasca bigutella, Aphrophora spp. (leafhoppers), Aonidiella aurantii (California red scale), Aphis spp. (aphids), Aphis gossypii (cotton aphid), Aphis pomi (apple aphid), Aulacorthum solani (foxglove aphid), Bemisia spp. (whiteflies), Bemisia argentifolii, Bemisia tabaci (sweet potato whitefly), Brachycolus*

noxius (Russian aphid), Brachycorynella asparagi (asparagus aphid), Brevennia rehi, Brevicoryne brassicae (cabbage aphid), Ceroplastes spp. (scales), Ceroplastes rubens (red bawax scale), Chionaspis spp. (scales), Chrysomphalus spp. (scales), Coccus spp. (scales), Dalbulius maidis (homóptera), substituir Mahanarva fimbriolata, por Mahanarva sp., Dysaphis plantaginea (rosy apple aphid), Empoasca spp. (leafhoppers), Eriosoma lanigerum (woolly apple aphid), Icerya purchasi (cottony cushion scale), Idioscopus nitidulus (mango leafhopper), Laodelphax striatellus (smaller brown planthopper), Lepidosaphes spp., Macrosiphum spp., Macrosiphum euphorbiae (potato aphid), Macrosiphum granarium (English grain aphid), Macrosiphum rosae (rose aphid), Macrosteles quadrilineatus (aster leafhopper), Mahanarva frimbiolata, Metopolophium dirhodum (rose grain aphid), Mictis longicornis, Myzus persicae (green peach aphid), Nephotettix spp. (leafhoppers), Nephotettix cinctipes (green leafhopper), Nilaparvata lugens (brown planthopper), Parlatoria pergandii (chaff scale), Parlatoria ziziphi (ebony scale), Peregrinus maidis (corn delphacid), Philaenus spp. (spittlebugs), Phylloxera vitifoliae (grape phylloxera), Physokermes piceae (spruce bud scale), Planococcus spp. (mealybugs), Pseudococcus spp. (mealybugs), Pseudococcus brevipes (pine apple mealybug), Quadraspidiotus perniciosus (San Jose scale), Rhapalosiphum spp. (aphids), Rhapalosiphum maida (corn leaf aphid), Rhapalosiphum padi (oat bird-cherry aphid), Saissetia spp. (scales), Saissetia oleae (black scale), Schizaphis graminum (greenbug), Sitobion avenae (English grain aphid), Sogatella furcifera (white-backed planthopper), Therioaphis spp. (aphids), Toumeyella spp. (scales), Toxoptera spp. (aphids), Trialeurodes spp. (whiteflies), Trialeurodes vaporariorum (greenhouse whitefly), Trialeurodes abutiloneus (bandedwing whitefly), Unaspis spp. (scales), Unaspis yanonensis (arrowhead scale) and Zulia entreriana.

[0097] In another embodiment, the insects are selected from *Spodoptera* genus comprising *Spodoptera frugiperda, Spodoptera abyssinia, Spodoptera albula, Spodoptera androgea, Spodoptera angulata, Spodoptera apertura, Spodoptera cilium,*

Spodoptera compta, Spodoptera connexa, Spodoptera depravata, Spodoptera dolichos, Spodoptera eridania, Spodoptera evanida, Spodoptera excelsa, Spodoptera exempta, Spodoptera exigua, Spodoptera fasciculata, Spodoptera hipparis, Spodoptera latifascia, Spodoptera littoralis, Spodoptera litura, Spodoptera malagasy, Spodoptera marima, Spodoptera mauritia, Spodoptera ochrea, Spodoptera ornithogalli, Spodoptera pecten, Spodoptera pectinicornis, Spodoptera peruviana, Spodoptera picta, Spodoptera praefica, Spodoptera pulchella, Spodoptera roseae, Spodoptera semiluna, Spodoptera sebastian, Spodoptera teferii, Spodoptera triturata, Spodoptera umbraculata, or combinations thereof.

[0098] In a preferred embodiment, the insect comprises *Spodoptera frugiperda*. In another embodiment, the insecticidal combination controls *Spodoptera frugiperda* in maize, corn, or combinations thereof.

[0099] In some embodiments, the present invention provides a method of controlling fall armyworm (*Spodoptera frugiperda*) in maize/corn; said method comprises contacting or applying to seeds, foliage, or at the locus of maize/corn crop an effective amount of an insecticidal combination or an insecticidal composition, comprising:
(a) spinosad; and
(b) lambda-cyhalothrin.

[00100] In some embodiments of the method of controlling fall armyworm (*Spodoptera frugiperda*) in maize/corn; said method comprises contacting or applying to seeds, foliage, or at the locus of maize/corn crop an effective amount of an insecticidal combination, comprising:
(a) spinosad; and
(b) lambda-cyhalothrin;
wherein spinosad and lambda-cyhalothrin are present in a weight ratio from about 1:10 to about 10:1.

[00101] In some embodiments of the method of controlling fall armyworm (*Spodoptera frugiperda*) in maize/corn; and said method comprises contacting or applying to seeds, foliage, or at the locus of maize/corn crop an effective amount of an insecticidal combination, comprising:

(a) spinosad; and

(b) lambda-cyhalothrin;

wherein spinosad and lambda-cyhalothrin are present in a weight ratio of about 3:1.

[00102] The methods of the present disclosure can be carried out in agricultural lands such as fields, lawns and orchards, or in non-agricultural lands. The present methods may be used to control diseases in agricultural lands for cultivating the crops without any phytotoxicity to the crop. The insecticidal combinations and compositions of the present disclosure do not show any sign or symptoms of any phytotoxicity and are safe at different growth stages of crops.

[00103] In some embodiments, the combinations or compositions of the present disclosure may be applied by various conventional treating techniques and machines, such as sprayers, fluidized bed techniques, the roller mill method, drones, roto static seed treaters, and drum coaters, spouted beds, etc. Pre-and post-coating procedures such as sizing etc., may also be carried out. Such procedures are known in the art. It is readily understood that plant propagation material will typically be treated only once it is removed from the plant and is ready to be re-sown.

[00104] In some embodiments, the treatment may occur before sowing of the plant propagation material so that the sown material has been pre-treated with the present insecticidal combination or composition. In particular, seed coating or seed pelleting are preferred in the treatment of the present insecticidal combination or composition according to the disclosure. As a result of the treatment, the active ingredients in the

combination and/or composition are adhered on to the seed and therefore available for disease control.

[00105] The present disclosure further relates to the use of the insecticidal combination or insecticidal composition described herein, for controlling insect pest in crops. The present disclosure also relates to the use of the insecticidal combination or insecticidal composition described herein, for preventing insect pest in crops. The present disclosure additionally relates to the use of the insecticidal combination or insecticidal composition described herein, for improving crop health.

[00106] In some embodiments, the present disclosure relates to the use of the insecticidal combination comprising: (a) at least one spinosyn compound, and (b) at least one pyrethroid compound, for controlling insect pest in maize/corn.

[00107] In some embodiments, the present disclosure relates to the use of the insecticidal combination or the insecticidal composition comprising (a) spinosad and (b) lambda-cyhalothrin, for controlling fall armyworm (*Spodoptera frugiperda*) in maize/corn.

[00108] In some embodiments, the present disclosure relates to the use of the insecticidal combination comprising spinosad and lambda-cyhalothrin for controlling fall armyworm (*Spodoptera frugiperda*) in maize/corn, wherein spinosad and lambda-cyhalothrin are present in a weight ratio of about 3:1.

[00109] In some embodiments, the present disclosure relates to the use of the insecticidal combination or the insecticidal composition comprising (a) at least one spinosyn compound, and (b) at least one pyrethroid compound for preventing insect pest infestation in crops.

[00110] In some embodiments, the present disclosure relates to the use of the insecticidal combination or the insecticidal composition comprising (a) spinosad and (b) lambda-cyhalothrin for preventing insect pest infestation by fall armyworm (*Spodoptera frugiperda*) in maize/corn.

[00111] In some embodiments, the present disclosure relates to the use of the insecticidal combination or the insecticidal composition comprising (a) at least one spinosyn compound, and (b) at least one pyrethroid compound for improving crop health where crop is maize/corn and is susceptible to insect pest.

[00112] In some embodiments, the present disclosure relates to the use of the insecticidal combination or the insecticidal composition comprising (a) spinosad and (b) lambda-cyhalothrin for improving crop health where crop is maize/corn and is susceptible to fall armyworm (*Spodoptera frugiperda*).

[00113] In an embodiment, the insecticidal combination is applied jointly, or separately, or sequentially, or simultaneously to a plant or locus thereof to control from about 60% to about 90% of the insects.

[00114] According to an embodiment of the present disclosure, a kit of parts comprising an insecticidal composition is provided. The kit comprises a plurality of components, each of which components may include at least one or more of the ingredients of the insecticidal composition of the present disclosure.

[00115] In an aspect, the present disclosure provides a kit-of-parts comprising:
(a) at least one spinosyn compound;
(b) at least one pyrethroid compound; and
and optionally further comprises:
(c) instructions for use.

[00116] In an aspect, the present disclosure provides a kit-of-parts comprising:
(a) at least one spinosyn compound;
(b) at least one pyrethroid compound;
(c) at least one agrochemically acceptable excipient; and
and optionally further comprises:
(d) instructions for use.

[00117] In an aspect, the present disclosure provides a kit-of-parts comprising:
(a) at least one spinosyn compound;
(b) at least one pyrethroid compound;
(c) at least one additional insecticide;
(d) at least one agrochemically acceptable excipient; and
and optionally further comprises:
(e) instructions for use.

[00118] In one embodiment of the present disclosure, the kits may include one or more, including all, components that may be used to prepare the insecticidal composition. E.g., kits may include a spinosyn compound and a pyrethroid compound. One or more of the components may already be combined or pre-formulated. In those embodiments where more than two components are provided in a kit, the components may already be combined and as such are packaged in a single container such as a vial, bottle, can, pouch, bag or canister.

[00119] In view of the above, it will be seen that the several advantages of the disclosure are achieved, and other advantageous results attained. Although the present disclosure has been disclosed in full, it will be understood that numerous additional modifications and variations could be made thereto without departing from the scope

of the disclosure. The embodiments may be combined together for better understanding of the disclosure, without departing from the scope of the disclosure.

[00120] In another embodiment, alternative or multiple embodiments of the disclosure disclosed herein are not to be construed as limitations. Each embodiment can be referred to and claimed individually or in any combination with other embodiments of the disclosure. One or more embodiments of the disclosure can be included in, or deleted from, the disclosure for reasons of convenience and/or patentability.

EXAMPLES:

[00121] While the foregoing description discloses various embodiments of the disclosure, other and further embodiments of the disclosure may be devised without departing from the basic scope of the disclosure. The disclosure is not limited to the described embodiments, versions, or examples, which are included to enable a person having ordinary skill in the art to make and use the disclosure when combined with information and knowledge available to the person having ordinary skill in the art.

Example 1: Bio-efficacy study for leaf damage rating in corn

Trials were performed to evaluate the leaf damage caused by fall armyworm (*Spodoptera frugiperda*) in maize/corn (*Zea Mays*). The components of the combination were applied at a dose rate (spray volume) of about 500 L/ha.

Methodology: The first spray (A) was at the stage of 1 larva/plant and the following sprays (B) were at 3, 7 and 10 days after first application (DA-A). The concentration of spinosad is 300 g/L and the concentration of lambda-cyhalothrin is 100 g/L. Therefore, the ratio of spinosad to lambda-cyhalothrin is about 3:1. The leaf damage rating observed in corn is disclosed in Table 1.

Table 1: Leaf damage rating in corn

Sr. No.	Treatment Name	Concentration (g/L)	Amount of active (g a.i./ha)	Leaf damage Rating Scale*		
				3 DA-A	7 DA-A	10 DA-A
1	Untreated	-	-	3.27	5.10	7.03
2	Spinosad + Lambda-cyhalothrin	300 + 100	90 + 30	0.00	0.37	1.30
3	Spinosad	480	50	0.00	0.87	2.33
4	Lambda-cyhalothrin	250	30	0.43	1.93	5.60

**Leaf damage rating scale: Visual rating scales for screening whorl stage corn for resistance to fall armyworm (Davis and Williams, 1992)*

There was no phytotoxicity observed in maize/corn for treatment with the insecticidal combination of the present disclosure. It was observed that the combination of spinosad and lambda-cyhalothrin showed a leaf damage rating scale of 1.30 at 10 DA-A, which corresponds to only pin-hole damage. Untreated and solo treatment of lambda-cyhalothrin disclosed a leaf damage rating scale of more than 5, which corresponds to several large, elongated lesions greater than 2.5 cm in length. The solo treatment of spinosad disclosed a leaf damage rating scale of more than 2, which corresponds to pin hole and small circular hole damage to leaves.

Example 2: Bio-efficacy study for percentage (%) larval control of fall armyworm (*Spodoptera frugiperda*)

Trials were performed to evaluate the insecticidal efficacy of the present combination for larval control of fall armyworm (*Spodoptera frugiperda*) and is disclosed in Table 2.

Table 2: % Larval Control of fall armyworm

Sr. No.	Treatment Name	Concentration (g/L)	Amount of active (g a.i./ha)	% Larval Control	
				10 DA-A	15 DA-A
1	Untreated	-	-	0.00	0.00
2	Spinosad + Lambda-cyhalothrin	300 + 100	90 + 30	87	63
3	Spinosad	480	50	77	40
4	Lambda-cyhalothrin	250	30	34	27

Therefore, the insecticidal combination comprising spinosad and lambda-cyhalothrin showed improved % larval control of fall armyworm.

Example 3: Bio-efficacy study for percentage control of fall armyworm (*Spodoptera frugiperda*)

Trials were performed to evaluate the insecticidal efficacy of the present combination for control of fall armyworm (*Spodoptera frugiperda*). The components of the combination were applied at a dose rate (spray volume) of about 500 L/ha. The % control observed in fall armyworm is disclosed in Table 3.

Table 3: % Control of fall armyworm

Sr. No.	Treatment Name	Concentration (g/L)	Amount of active (g a.i./ha)	% Control		
				3 DA-A	7 DA-A	10 DA-A
Post 1st Application						
1	Untreated	-	-	0.00	0.00	0.00

2	Spinosad + Lambda-cyhalothrin	300 + 100	65 + 21	64.2	72.7	75.4
3	Spinosad + Lambda-cyhalothrin	300 + 100	75 + 25	71.2	77	81.9
4	Spinosad + Lambda-cyhalothrin	300 + 100	80 + 26	73.9	85.5	86.9
Post 2nd application						
1	Untreated	-	-	0.00	0.00	0.00
2	Spinosad + Lambda-cyhalothrin	300 + 100	65 + 21	77.4	77.9	79.6
3	Spinosad + Lambda-cyhalothrin	300 + 100	75 + 25	83.2	84.7	85.1
4	Spinosad + Lambda-cyhalothrin	300 + 100	80 + 26	87.8	89.8	90.8

It was observed that the combination of spinosad and lambda-cyhalothrin in a ratio of about 3:1 discloses better % control of fall armyworm.

ADVANTAGES OF THE PRESENT DISCLOSURE:

[00122] The advantages of the insecticidal combination are:

- controlling insect pests in plants in a sustained and effective manner;
- preventing insect pests in plants;

- improving the yield of plants;
- reducing phytotoxicity in plants; and
- enhancing insecticidal efficacy of the combination due to higher amount of spinosad as compared to lambda-cyhalothrin.

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We Claim:

1. An insecticidal combination comprising:
   (a) at least one spinosyn compound; and
   (b) at least one pyrethroid compound;
   wherein the spinosyn compound and the pyrethroid compound are present in a weight ratio from about 1:10 to about 10:1.

2. The combination as claimed in claim 1, wherein the spinosyn compound is selected from spinosad, spinetoram, or combinations thereof.

3. The combination as claimed in claim 1, wherein the pyrethroid compound is selected from lambda-cyhalothrin, cyhalothrin, gamma-cyhalothrin, or combinations thereof.

4. The combination as claimed in claim 1, wherein the spinosyn compound and the pyrethroid compound are present in a weight ratio of about 3:1.

5. The combination as claimed in claim 1, wherein the spinosyn compound is present in a range from about 1 g/L to about 500 g/L.

6. The combination as claimed in claim 1, wherein the pyrethroid compound is present in a range from about 1 g/L to about 300 g/L.

7. The combination as claimed in claim 1, wherein the spinosyn compound is present in higher amount/concentration as compared to the pyrethroid compound.

8. The combination as claimed in claim 1, wherein the combination comprises:
   (a) spinosad; and
   (b) lambda-cyhalothrin

wherein spinosad and lambda-cyhalothrin are present in a weight ratio of about 3:1.

9. A method for controlling insects by applying to a plant or a locus thereof, an insecticidal combination comprising:
(a) at least one spinosyn compound; and
(b) at least one pyrethroid compound.

10. The method as claimed in claim 9, wherein the insects are selected from *Spodoptera* genus comprising *Spodoptera frugiperda*, *Spodoptera abyssinia*, *Spodoptera albula*, *Spodoptera androgea*, *Spodoptera angulata*, *Spodoptera apertura*, *Spodoptera cilium*, *Spodoptera compta*, *Spodoptera connexa*, *Spodoptera depravata*, *Spodoptera dolichos*, *Spodoptera eridania*, *Spodoptera evanida*, *Spodoptera excelsa*, *Spodoptera exempta*, *Spodoptera exigua*, *Spodoptera fasciculata*, *Spodoptera hipparis*, *Spodoptera latifascia*, *Spodoptera littoralis*, *Spodoptera litura*, *Spodoptera malagasy*, *Spodoptera marima*, *Spodoptera mauritia*, *Spodoptera ochrea*, *Spodoptera ornithogalli*, *Spodoptera pecten*, *Spodoptera pectinicornis*, *Spodoptera peruviana*, *Spodoptera picta*, *Spodoptera praefica*, *Spodoptera pulchella*, *Spodoptera roseae*, *Spodoptera semiluna*, *Spodoptera sebastian*, *Spodoptera teferii*, *Spodoptera triturata*, *Spodoptera umbraculata*, or combinations thereof.

11. The method as claimed in claim 9, wherein the combination is applied jointly, or separately, or sequentially, or simultaneously to a plant or locus thereof to control from about 60% to about 90% of the insects.

12. The method as claimed in claim 9, wherein the combination controls *Spodoptera frugiperda* in maize, corn, or combinations thereof.

13. Use of an insecticidal combination for controlling insects, the combination comprising:
    (a) at least one spinosyn compound; and
    (b) at least one pyrethroid compound.

14. An insecticidal composition comprising:
    (a) at least one spinosyn compound;
    (b) at least one pyrethroid compound; and
    (c) at least one agrochemically acceptable excipient.

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2024/056197

A. CLASSIFICATION OF SUBJECT MATTER
INV. A01N43/22
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A01N

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 102 349 502 A (GUANGXI TIANYUAN BIOCHEMISTRY) 15 February 2012 (2012-02-15) paragraph [0077]; claim 7	1-3,5,6, 9,11,13, 14
X	CN 103 535 371 A (JIANGSU ROTAM CHEMISTRY CO LTD) 29 January 2014 (2014-01-29) claims 1-2; examples 1-17; table 1	1-11,13, 14
X	CN 102 342 291 A (SHANDONG HAILIR CHEMICAL CO LTD) 8 February 2012 (2012-02-08) tables 2-3	1-3,5-7, 9-11,13, 14
X	WO 03/011031 A1 (SYNGENTA LTD [GB]; CLOUGH MARTIN STEPHEN [CH]) 13 February 2003 (2003-02-13) table II	1-3,5-7, 9-11,13, 14

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 September 2024	07/10/2024

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2024/056197

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2010/030501 A2 (DOW AGROSCIENCES LLC [US]; QIN KUIDE [US] ET AL.) 18 March 2010 (2010-03-18) page 14, lines 25-26; examples 1-2	1,2,5-7, 9,10, 12-14
X	CN 102 669 149 A (ZHEJIANG WELL DONE CHEMICAL CO LTD) 19 September 2012 (2012-09-19) table 2	1-11,13, 14
X	T. A. Lambkin, M. J. Furlong: "(PDF) Application of Spinosad Increases the Susceptibility of Insecticide-Resistant Alphitobius diaperinus (Coleoptera: Tenebrionidae) to Pyrethroids", , 1 August 2014 (2014-08-01), XP093208386, Retrieved from the Internet: URL:https://www.researchgate.net/publication/264428667_Application_of_Spinosad_Increases_the_Susceptibility_of_Insecticide-Resistant_Alphitobius_diaperinus_Coleoptera_Tenebrionidae_to_Pyrethroids "discussion"; tables 1-2	1-3,5-7, 9,11,13, 14
X	WO 2022/249204 A1 (RAJDHANI PETROCHEMICALS PRIVATE LTD [IN]) 1 December 2022 (2022-12-01) page 20, line 3; claim 7	1-3,7,9, 10,12-14

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2024/056197

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 102349502 A	15-02-2012	NONE	
CN 103535371 A	29-01-2014	NONE	
CN 102342291 A	08-02-2012	NONE	
WO 03011031 A1	13-02-2003	AP 1669 A	20-10-2006
		AR 034881 A1	24-03-2004
		AU 2002345228 B2	14-08-2008
		BR 0211298 A	14-09-2004
		CA 2452515 A1	13-02-2003
		CA 2758173 A1	13-02-2003
		CN 1541064 A	27-10-2004
		CN 1736200 A	22-02-2006
		CN 1736201 A	22-02-2006
		CN 101099472 A	09-01-2008
		CN 101268782 A	24-09-2008
		CO 5560519 A2	30-09-2005
		EA 200400221 A1	24-06-2004
		EP 1414304 A1	06-05-2004
		EP 2087791 A2	12-08-2009
		EP 2260708 A2	15-12-2010
		IL 159825 A	17-05-2010
		IL 193603 A	31-03-2014
		JP 4427322 B2	03-03-2010
		JP 2004536874 A	09-12-2004
		KR 20040018509 A	03-03-2004
		KR 20090031794 A	27-03-2009
		MA 26129 A1	01-04-2004
		MX 337223 B	18-02-2016
		MX PA04000661 A	05-04-2004
		MY 135255 A	31-03-2008
		OA 12644 A	16-06-2006
		PL 366828 A1	07-02-2005
		TW I321037 B	01-03-2010
		US 2005233986 A1	20-10-2005
		US 2010081714 A1	01-04-2010
		WO 03011031 A1	13-02-2003
		ZA 200400490 B	12-10-2004
WO 2010030501 A2	18-03-2010	AR 075269 A1	23-03-2011
		AU 2009292044 A1	18-03-2010
		BR PI0919048 A2	18-08-2015
		CA 2736209 A1	18-03-2011
		CL 2009001847 A1	24-09-2010
		CN 102215694 A	12-10-2011
		CO 6341528 A2	21-11-2011
		DK 2334187 T3	08-01-2018
		EP 2334187 A2	22-06-2011
		ES 2645751 T3	07-12-2017
		IL 211640 A	31-07-2016
		JP 5559795 B2	23-07-2014
		JP 2012502098 A	26-01-2012
		KR 20110055723 A	25-05-2011
		PL 2334187 T3	30-03-2018
		TW 201014530 A	16-04-2010
		US 2010069314 A1	18-03-2010
		WO 2010030501 A2	18-03-2010

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2024/056197

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		ZA 201101729 B	27-06-2012
CN 102669149 A	19-09-2012	NONE	
WO 2022249204 A1	01-12-2022	BR 112023024843 A2	20-02-2024
		US 2024237648 A1	18-07-2024
		WO 2022249204 A1	01-12-2022