

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

(19) World Intellectual Property
Organization

International Bureau

(43) International Publication Date
01 May 2025 (01.05.2025)



(10) International Publication Number
WO 2025/088143 A1

(51) International Patent Classification:

A01N 25/02 (2006.01) *A01N 43/90* (2006.01)
A01N 25/30 (2006.01) *A01N 47/06* (2006.01)
A01N 43/16 (2006.01) *A01N 53/00* (2006.01)
A01P 7/00 (2006.01) *A01N 59/02* (2006.01)
A01P 17/00 (2006.01) *A01N 63/30* (2020.01)
A01N 31/02 (2006.01) *A01P 7/02* (2006.01)
A01N 37/02 (2006.01) *A01P 7/04* (2006.01)
A01N 43/56 (2006.01) *A01N 35/02* (2006.01)

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

(21) International Application Number:

PCT/EP2024/080267

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

(22) International Filing Date:

25 October 2024 (25.10.2024)

Published:

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

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

23206230.7 26 October 2023 (26.10.2023) EP

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

(54) Title: FORMULATION AND METHOD FOR CONTROLLING PESTS

(57) Abstract: The current invention relates to a formulation for use as a pesticide, said formulation comprising (a) between 30 and 85 wt.% of a polyol or a mixture of polyols obtained by hydrogenation of a natural sugar, (b) between 1 and 10 wt.% of one or more alkyl polyglucosides, and (c) between 5 and 69 wt.% of water, wherein said polyol or mixture of polyols consists of more than 90 wt.% of monomeric polyols, based on the total weight of polyols in the formulation.



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FORMULATION AND METHOD FOR CONTROLLING PESTS**FIELD OF THE INVENTION**

5 The present invention relates to formulations for use as a pesticide. In a second aspect, the invention also relates to a method for controlling pests.

BACKGROUND

10 Currently, many pesticides used for agricultural and horticultural crops, including acaricides and insecticides, are products of chemical synthesis. While these agents are cost-effective and potent against a variety of pests, either used alone or in combination, there's a growing issue of pests developing resistance to them, diminishing their overall effectiveness. Furthermore, as consumer awareness about
15 food safety and environmental impact increases, there's a rising demand for pest control agents that are not only safe for humans and animals but also environmentally friendly. This has led to a growing interest in biodegradable, biological, or natural pest control solutions.

20 More environmentally friendly compounds for pest control have been suggested in JP 2001131011 A. In particular JP '011 describes the use of reduced starch saccharified products. However, even though environmental load caused by these reduced starch saccharified products is smaller, the surfactants used in the total formulation are generally more harmful, such as dialkyl sulfosuccinates, silicones or
25 alkylbenzene sulfonic acids. In addition, use of the reduced starch saccharified products as such may have a number of drawbacks. It was for example observed that phytotoxicity was present in some agricultural crops upon treatment.

In order to allow effective treatment with pest control agents at reduced doses, pest
30 control agents may be combined with so-called enhancers. In JP 2014231484 A for example, it is described to combine isopyrazam with alkyl polyglucosides in order to enhance its effectiveness. Isopyrazam is however considered to be harmful to the environment, as are most pest control agents described in JP '848.

35 Several compounds for pest control are disclosed in for example US 2008/318774 A1, which describes herbicidal agrochemical formulations comprising glycerol, an active biocide such as thien carbazon, and an alkyl polyglucoside as a wetting agent. US 2007/191285 A1 describes a pesticide composition comprising hydrogenated

starch hydrolysates and an alkyl polyglucoside derivative as a solubilizing surfactant. WO 2019/104025 A1 discloses an agrochemical composition for plant pest control comprising an insecticide such as clothianidin, an alkyl polyglucoside and glycerol. CN 106417287 A describes low-concentration sugar alcohols as potentially applicable in alkyl polyglucoside containing formulations.

Aspects like the environment and efficacy aside, the search for biodegradable, biological, or natural pest control solutions has recently become even more complex due to strict regulations in some jurisdictions, such as in the United States of America and in Europe.

There thus remains a need in the art for an environmentally-friendly and toxicologically-low pest control solution that is effective even at low concentrations, is in line with strict regulations, poses no harm to plants, humans, or animals.

SUMMARY OF THE INVENTION

The present invention and embodiments thereof serve to provide a solution to one or more of above-mentioned disadvantages. To this end, the present invention relates to a formulation for use as a pesticide according to claim 1.

Preferred embodiments of the formulation are shown in any of the claims 2 to 9.

In a further aspect, the present invention relates to a method for controlling pests according to claim 10. Preferred embodiments of the method are shown in any of the claims 11 to 15.

DESCRIPTION OF FIGURES

Figure 1 shows a SEM image of untreated *Panonychus citri* eggs.

Figure 2 shows a SEM image of *Panonychus citri* eggs treated with a formulation according to the invention.

Figures 3a, 3b and **3c** show SEM images of untreated *Panonychus citri* adults.

Figures 4a, 4b and **4c** show SEM images of a *Panonychus citri* adult treated with a formulation according to the invention.

Figures 5a, and **5b** show SEM images of untreated *Aphis gossypii* adults.

Figures 6a and **6b** show SEM images of an *Aphis gossypii* adult treated with a
5 formulation according to the invention.

Figure 7 shows a graph exemplifying the application of formulations according to some embodiments of the invention on mite adults.

10 **Figures 8a** and **8b** show graphs exemplifying the application of formulations according to some embodiments of the invention on powdery mildew.

DETAILED DESCRIPTION OF THE INVENTION

15 The present invention concerns a formulation for use as a pesticide and a method of controlling pests.

Unless otherwise defined, all terms used in disclosing the invention, including technical and scientific terms, have the meaning as commonly understood by one of
20 ordinary skill in the art to which this invention belongs. By means of further guidance, term definitions are included to better appreciate the teaching of the present invention.

As used herein, the following terms have the following meanings:

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"A", "an", and "the" as used herein refers to both singular and plural referents unless the context clearly dictates otherwise. By way of example, "a compartment" refers to one or more than one compartment.

30 "Comprise", "comprising", and "comprises" and "comprised of" as used herein are synonymous with "include", "including", "includes" or "contain", "containing", "contains" and are inclusive or open-ended terms that specifies the presence of what follows e.g. component and do not exclude or preclude the presence of additional, non-recited components, features, element, members, steps, known in the art or
35 disclosed therein.

The recitation of numerical ranges by endpoints includes all numbers and fractions subsumed within that range, as well as the recited endpoints.

The expression "% by weight", "weight percent", "%wt" or "wt.%", here and throughout the description unless otherwise defined, refers to the relative weight of the respective component based on the overall weight of the formulation.

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Whereas the terms "one or more" or "at least one", such as one or more or at least one member(s) of a group of members, is clear *per se*, by means of further exemplification, the term encompasses *inter alia* a reference to any one of said members, or to any two or more of said members, such as, *e.g.*, any ≥ 3 , ≥ 4 , ≥ 5 , ≥ 6 or ≥ 7 etc. of said members, and up to all said members.

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Unless otherwise defined, all terms used in disclosing the invention, including technical and scientific terms, have the meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. By means of further guidance, definitions for the terms used in the description are included to better appreciate the teaching of the present invention. The terms or definitions used herein are provided solely to aid in the understanding of the invention.

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Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment, but may. Furthermore, the particular features, structures or characteristics may be combined in any suitable manner, as would be apparent to a person skilled in the art from this disclosure, in one or more embodiments. Furthermore, while some embodiments described herein include some but not other features included in other embodiments, combinations of features of different embodiments are meant to be within the scope of the invention, and form different embodiments, as would be understood by those in the art.

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In a first aspect, the present invention concerns a formulation for use as a pesticide, said formulation comprising:

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- a. between 30 and 85 wt.% of a polyol or a mixture of polyols obtained by hydrogenation of a natural sugar;
- b. between 1 and 10 wt.% of one or more alkyl polyglucosides; and
- c. between 5 and 69 wt.% of water;

characterized in that, said polyol or mixture of polyols consists of more than 90 wt.% of monomeric polyols, based on the total weight of polyols in the formulation.

In light of the present invention, the term "pesticide" must be interpreted as a substance or mixture of substances specifically formulated to prevent, control, or destroy pests that threaten plants, animals, and/or the environment. Generally, pests may for example include insects, arachnids, weeds, fungi, or rodents.

The term "polyol" reads onto types of organic compounds which comprise multiple hydroxyl (-OH) groups. These compounds often exhibit sweet-tasting properties and are used in various industries, notably in the production of food as sugar substitutes and in the pharmaceutical industry. Common examples include glycerol and erythritol. More in particular, the wording "monomeric polyol" refers to a basic molecular unit of a polyol that has not been linked to any other molecules. Unlike their polymeric counterparts, which consist of long chains of repeating units, monomeric polyols are singular in structure.

In light of the present invention, the term "hydrogenation" reads onto the chemical process wherein hydrogen is added to an unsaturated compound, typically in the presence of a catalyst, converting double or triple bonds into single bonds. This process can be used to solidify liquid fats and oils, and in the case mentioned, to transform natural sugars into polyols.

"Alkyl polyglucosides" or (APGs) are a class of non-ionic surfactants derived from renewable raw materials such as vegetable oil and starch.

By providing a polyol or mixture of polyols consisting of more than 90 wt.% of monomeric polyols, based on the total weight of polyols in the formulation, the inventors have found that the dosage of active ingredients in the formulation may be lowered, meanwhile achieving good results in the treatment of pests. In particular, the combination of between 30 and 85 wt.% of polyols and between 1 and 10 wt.% of one or more alkyl polyglucosides, said polyols consisting of more than 90 wt.% of monomeric polyols, allows to efficiently control pests in an environmentally friendly way, and/or in compliance with stricter legislation and/or regulations in several jurisdictions such as the United States of America and Europe.

By preference, said polyol or mixture of polyols consists of more than 95 wt.% of monomeric polyols, based on the total weight of polyols in the formulation. Even

more by preference, said polyol or mixture of polyols consists of more than 99 wt.% of monomeric polyols, based on the total weight of polyols in the formulation. It was found that by using a higher amount of monomeric polyols in the formulation, pests were efficiently controlled while using still less active ingredient in the formulation.

5

According to a further or another embodiment, said polyol or mixture of polyols is a sugar alcohol or mixture of sugar alcohols.

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In light of the present invention, the wording "sugar alcohol" needs to be interpreted as a type of polyol derived from the hydrogenation of sugars, characterized by the presence of hydroxyl groups (-OH) attached to carbon atoms in a sugar-like structure. Examples of sugar alcohols include xylitol, sorbitol, erythritol, and mannitol.

15

One of the advantages of using sugar alcohols is their wide availability. Most of these sugar alcohols occur naturally in nature, and others may be easily obtained by reduction of natural compounds. For example, sorbitol and mannitol are sugar alcohols that are present in many plants, predominantly in the *Rosaceae* family including apples, pears and stone fruits. Sorbitol is a primary end product of photosynthesis and a major translocation sugar, and can make up to 10 wt.% on

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fresh weight basis in fruits of common orchard crops from the *Rosaceae* family. Furthermore, thanks to their chemical characteristics, sugar alcohols are generally highly soluble in water, and are easy to formulate with other adjuvants in a relatively

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simple formulation at a high concentration as a plant protection product. More in particular, sugar alcohols were found to be highly compatible with alkyl polyglucosides, and may enhance the efficacy of the pesticide formulation. Sugar alcohols were also found to be safe for the environment and humans, as well

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as safe for transport, storage and use. Sugar alcohols are present in the soil as has been confirmed in literature, and form part of the trophic chain: soil bacteria like *Lactobacillus* spp. uses and metabolizes sorbitol and other sugar alcohols. Using sugar alcohols for pest control is thus not adding any dangerous, toxic or foreign substance to the environment. Further according to literature, sugar alcohols were found non-toxic on fish, mammals and birds. Sugar alcohols thus represent a safe alternative to conventional chemical pesticides from a natural water perspective, and may support biodiversity. Sugar alcohols are furthermore not classified as dangerous substances for humans according to CLP and GHS regulations, showing that the use

of these substances is safe for humans. As sugar alcohol based products like sorbitol do not self-ignite, are non-oxidizing, non-explosive and not highly flammable, they are considered to be safe products for transport and storage, and are safe to be used by professional farmers, gardeners and non-professional users.

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According to some embodiments, said formulation thus comprises:

- a. between 30 and 85 wt.% of a sugar alcohol or a mixture of sugar alcohols obtained by hydrogenation of a natural sugar;
- b. between 1 and 10 wt.% of one or more alkyl polyglucosides; and
- 10 c. between 5 and 69 wt.% of water;

characterized in that, said sugar alcohol or mixture of sugar alcohols consists of more than 90 wt.% of monomeric sugar alcohols, based on the total weight of sugar alcohols in the formulation.

- 15 By preference, said sugar alcohol or mixture of sugar alcohols consist of more than 90 wt.% of monomeric sugar alcohols, based on the total weight of sugar alcohols in the formulation.

- 20 More by preference, said sugar alcohol or mixture of sugar alcohols consists of more than 95 wt.% of monomeric sugar alcohols, based on the total weight of sugar alcohols in the formulation. Even more by preference, said sugar alcohol or mixture of sugar alcohols consists of more than 99 wt.% of monomeric sugar alcohols, based on the total weight of sugar alcohols in the formulation.

- 25 According to some embodiments, said monomeric polyols are chosen from the group consisting of monomeric erythritol, monomeric xylitol, monomeric mannitol, monomeric maltitol, monomeric lactitol, monomeric isomalt, monomeric glycerol, or combinations thereof. The use of polyols, in particular monomeric polyols, was found advantageous in that said polyols allow a more environmentally friendly formulation
- 30 having high efficacy towards several pests. By preference, said monomeric polyols consist of monomeric sorbitol, in particular monomeric D-sorbitol or monomeric L-sorbitol.

- 35 According to some embodiments, said monomeric sugar alcohols are chosen from the group consisting of monomeric erythritol, monomeric xylitol, monomeric mannitol, monomeric maltitol, monomeric lactitol, monomeric isomalt, or combinations thereof.

By preference, said monomeric sugar alcohols consist of monomeric sorbitol, in particular monomeric D-sorbitol or monomeric L-sorbitol.

5 "D-sorbitol" and "L-sorbitol" are enantiomeric forms of sorbitol. D-sorbitol however is the naturally occurring enantiomer and is the one most commonly referred to when discussing "sorbitol" in commercial and pharmaceutical contexts. While both forms have the same chemical formula and almost identical physical properties, their difference in enantiomeric structure can lead to different biological activities. In nature and in most applications, D-sorbitol is the predominant form.

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Most by preference, said monomeric polyols, in particular said monomeric sugar alcohols, consist of monomeric D-sorbitol. By using monomeric D-sorbitol, the formulation predominantly comprises natural components, such that a more environmentally-friendly and toxicologically-low formulation is achieved having high efficacy towards pest control.

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According to a further or another embodiment, said formulation comprises between 35 and 75 wt.% of said polyol or mixture of polyols. By preference, said formulation comprises between 40 and 70 wt.% of said polyol or mixture of polyols. More by preference, said formulation comprises between 45 and 65 wt.% of said polyol or mixture of polyols. Even more by preference, said formulation comprises between 50 and 60 wt.% of said polyol or mixture of polyols. With increasing preference, it was found that efficacy of the formulation in controlling several pests was further improved.

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Most by preference, said formulation comprises between 50 and 56 wt.% of said polyol or mixture of polyols.

According to a further or another embodiment, said formulation comprises between 30 35 and 75 wt.% of said sugar alcohol or mixture of sugar alcohols. By preference, said formulation comprises between 40 and 70 wt.% of said sugar alcohol or mixture of sugar alcohols. More by preference, said formulation comprises between 45 and 65 wt.% of said sugar alcohol or mixture of sugar alcohols. Even more by preference, said formulation comprises between 50 and 60 wt.% of said sugar alcohol or mixture of sugar alcohols.

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Most by preference, said formulation comprises between 50 and 56 wt.% of said sugar alcohol or mixture of sugar alcohols.

According to a further or another embodiment, said alkyl polyglucosides are chosen from the group consisting of C4 to C14 alkyl polyglucosides.

5 According to some embodiments, said alkyl polyglucosides are chosen from the group consisting of C4 to C7 alkyl polyglucosides. These are typically more water-soluble than the longer-chain alkyl polyglucosides. According to some embodiments, said alkyl polyglucosides are chosen from the group consisting of C8 to C14 alkyl polyglucosides. These longer-chain alkyl polyglucosides tend to be more
10 hydrophobic. They can offer stronger oil or grease dispersion properties and might be preferred in formulations where high oil solubility or specific emulsification characteristics are needed. According to some embodiments, said alkyl polyglucosides are chosen from the group of C15 to C18 alkyl polyglucosides. With even longer hydrophobic chains, these alkyl polyglucosides may be suitable for
15 applications that require very strong oil or grease dispersing properties.

According to some preferred embodiments, said alkyl polyglucosides are chosen from the group consisting of C8 alkyl polyglucoside, C9 alkyl polyglucoside, C10 alkyl polyglucoside, or combinations thereof. These have a moderate chain length and
20 represent a balance between water and oil solubility. They are preferably chosen for the formulation of the invention as they offer good wetting and spreading on leaf surfaces while also effectively solubilizing various active ingredients.

The combination of good wetting and spreading, as well as effectively solubilizing
25 various active ingredients is particularly advantageous for the present invention, in that the formulation allows forming a thin membrane on pest organisms, which significantly contributes to their control. For example, aphids and mites may be suffocated by applying the formulation of the invention, as the formation of the thin membrane makes breathing significantly more difficult. It was found by the inventors
30 that proper formulation was thus very beneficial for the effect on aphids and mites.

According to a further or another embodiment, said formulation comprises between 1,5 and 7,5 wt.% of said alkyl polyglucosides. By preference, said formulation comprises between 2 and 5 wt.% of said alkyl polyglucosides. More by preference,
35 said formulation comprises between 2,5 and 4,5 wt.% of said alkyl polyglucosides.

Most by preference, said formulation comprises between 3 and 4,5 wt.% of said alkyl polyglucosides. With increasing preference, it was found that the balance between

good wetting and spreading of the formulation, and effectively solubilizing various active ingredients was further optimized.

5 The formulation according to some embodiments of the invention comprises between 32,5 and 75 wt.% of water. By having an amount of water in the disclosed range, the formulation was found to be more easy to handle, and was in optimal form for further dilution, e.g. for spraying applications. By preference, said formulation comprises between 35 and 70 wt.% of water. More by preference, said formulation comprises between 37,5 and 60 wt.% of water. Even more by preference, said
10 formulation comprises between 40 and 50 wt.% of water. Most by preference, said formulation comprises between 40,5 and 47 wt.% of water.

The use of sugar alcohols in the formulation was found beneficial, as sugar alcohols are easily dissolved in water for spraying at high concentration, without blocking the
15 nozzles in the application equipment. Furthermore, once dissolved sugar alcohols have been shown to be stable in the spray water for a substantial amount of time, with no or minimal requirement for agitation.

According to a preferred embodiment, said formulation comprises:

- 20 a. between 50 and 56 wt.% of said polyol or mixture of polyols, by preference said sugar alcohol or mixture of sugar alcohols;
- b. between 3 and 4,5 wt.% of C8 alkyl polyglucoside, C9 alkyl polyglucoside, C10 alkyl polyglucoside, or combinations thereof;
- c. between 0,1 and 1 wt.% of one or more co-formulants, and
25 d. between 38,5 and 46,9 wt.% of water;

wherein said polyol or mixture of polyols, by preference said sugar alcohol or mixture of sugar alcohols, consists of more than 90 wt.% of monomeric D-sorbitol, based on the total weight of polyols, by preference sugar alcohols, in the formulation.

30 The preferred embodiment as disclosed has proved to provide optimal balance between wetting characteristics, solubilizing characteristics, and was found to be very effective in controlling various pests, both after a first application and after repeated application. The formulation according to the preferred embodiment furthermore allows said effective control at substantially low dosages, and was found
35 to be substantially unharmed to the environment.

The term "co-formulant" reads onto an ingredient added to a formulation that is not the active ingredient but enhances the product's performance, stability, or other

properties. Co-formulants play a supportive role in ensuring the effective delivery and functionality of the main component in the formulation.

5 Furthermore, by providing one or more co-formulants in the formulation, stability of the formulation was improved, and both wetting and solubilizing characteristics were further optimized.

10 According to a further or another embodiment, said co-formulant is chosen from the group consisting of surfactants, wetting agents, anti-foam agents, or combinations thereof.

15 According to some embodiments, said co-formulant comprises a surfactant chosen from the group consisting of anionic surfactants, nonionic surfactants, cationic surfactants, amphoteric surfactants, or combinations thereof. According to some embodiments, said anionic surfactants are chosen from the group of alkyl sulfates, alkylbenzene sulfonates, alkyl sulfosuccinate sodium salts, or combinations thereof. According to some embodiments, said nonionic surfactants are chosen from the group of alkyl polyglucosides, fatty alcohol ethoxylates, or combinations thereof. According to some embodiments, said cationic surfactants are quaternary ammonium compounds. According to some embodiments, said amphoteric surfactants are betaines.

20 According to a preferred embodiment, said co-formulant comprises an anionic surfactant. By preference, said anionic surfactant is a alkyl sulfosuccinate sodium salt. More by preference, said alkyl sulfosuccinate sodium salts is dioctyl sulfosuccinate sodium salt.

30 According to a further or another embodiment, said co-formulant comprises a wetting agent chosen from the group of alkyl naphthalene sulfonates, polyethylene oxides, alkyl sulfosuccinate sodium salts, or combinations thereof. By preference, said wetting agent is an alkyl sulfosuccinate sodium salt. More by preference, said alkyl sulfosuccinate sodium salt is dioctyl sulfosuccinate sodium salt.

35 According to a further or another embodiment, said co-formulant comprises an anti-foam agent chosen from the group of silicone-based anti-foam agents, oil-based anti-foam agents, water-based anti-foam agents, ethylene oxide (EO)/propylene oxide (PO) block co-polymers, or combinations thereof. By preference, said anti-foam agent is an oil-based anti-foam agent, more by preference a fatty acid or

mixture of fatty acids. Even more by preference, fatty acid or mixture of fatty acids comprises C8 to C18 fatty acids.

5 According to some embodiments, the formulation comprises said polyol or mixture of polyols and said one or more alkyl polyglucosides in a weight ratio of between 3:1 and 85:1. Said weight ratio forms an independent inventive aspect of the present invention. Hence, a second aspect of the invention relates to a formulation for use as a pesticide, said formulation comprising:

- 10 a. a polyol or a mixture of polyols obtained by hydrogenation of a natural sugar;
- b. one or more alkyl polyglucosides; and
- c. water;

15 characterized in that, said polyol or mixture of polyols consists of more than 90 wt.% of monomeric polyols, based on the total weight of polyols in the formulation, and that said polyol or mixture of polyols and said one or more alkyl polyglucosides in a weight ratio of between 3:1 and 85:1.

By providing said polyol or mixture of polyols consisting of more than 90 wt.% of monomeric polyols, based on the total weight of polyols in the formulation, and by specifically providing said polyol or mixture of polyols and said one or more alkyl polyglucosides in a weight ratio of between 3:1 and 85:1, the inventors have found that the dosage of active ingredients in the formulation may be lowered, meanwhile achieving good results in the treatment of pests. Moreover, it was found that the formulation allows to efficiently control pests in an environmentally friendly way, and/or in compliance with stricter legislation and/or regulations in several jurisdictions such as the United States of America and Europe.

By preference, said polyol or mixture of polyols and said one or more alkyl polyglucosides in a weight ratio of between 10:1 and 25:1. More by preference, said polyol or mixture of polyols and said one or more alkyl polyglucosides in a weight ratio of between 11:1 and 23:1. Even more by preference, said polyol or mixture of polyols and said one or more alkyl polyglucosides in a weight ratio of between 12:1 and 20:1. Most by preference, said polyol or mixture of polyols and said one or more alkyl polyglucosides in a weight ratio of between 13:1 and 19:1.

35 According to a further or another embodiment, said polyol or mixture of polyols is a sugar alcohol or mixture of sugar alcohols.

According to some embodiments, said formulation thus comprises:

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- a. a sugar alcohol or a mixture of sugar alcohols obtained by hydrogenation of a natural sugar;
- b. one or more alkyl polyglucosides; and
- c. water;

5 characterized in that, said sugar alcohol or mixture of sugar alcohols consists of more than 90 wt.% of monomeric sugar alcohols, based on the total weight of sugar alcohols in the formulation, and that said sugar alcohol or mixture of sugar alcohols and said one or more alkyl polyglucosides in a weight ratio of between 3:1 and 85:1

10 By preference, said sugar alcohol or mixture of sugar alcohols and said one or more alkyl polyglucosides are present in a weight ratio of between 10:1 and 25:1. More by preference, said sugar alcohol or mixture of sugar alcohols and said one or more alkyl polyglucosides are present in a weight ratio of between 11:1 and 23:1. Even more by preference, said sugar alcohol or mixture of sugar alcohols and said one or
15 more alkyl polyglucosides are present in a weight ratio of between 12:1 and 20:1. Most by preference, said sugar alcohol or mixture of sugar alcohol and said one or more alkyl polyglucosides are present in a weight ratio of between 13:1 and 19:1.

According to some embodiments, the formulation complies with one or more of the
20 further, other and/or preferred embodiments of the first aspect of the invention.

A third aspect of the present invention concerns a method of controlling pests, said method comprising:

providing a formulation comprising

- 25
- a. between 30 and 85 wt.% of a polyol or a mixture of polyols obtained by hydrogenation of a natural sugar;
 - b. between 1 and 10 wt.% of one or more alkyl polyglucosides; and
 - c. between 5 and 69 wt.% of water;

applying said formulation to a crop plant susceptible to said pests, a habitat of a crop
30 plant susceptible to said pests, or a combination thereof, wherein said polyol or mixture of polyols consists of more than 90 wt.% of monomeric polyols, based on the total weight of polyols in the formulation.

By preference, said formulation is a formulation according to any of the embodiments
35 of the first or second aspect of the invention.

According to a further or another embodiment, applying said formulation comprises diluting said formulation to a start dilution, said start dilution comprising between

0,5 (v/v)% and 5 (v/v)% of said formulation. By preference, said start dilution comprises between 0,6 (v/v)% and 2,5 (v/v)%. More by preference, said start dilution comprises between 0,7 (v/v)% and 2 (v/v)%. Even more by preference, said start dilution comprises between 0,8 (v/v)% and 1,5 (v/v)%. Most by preference, said diluted form comprises between 0,9 (v/v)% and 1,1 (v/v)%.

According to a further or another embodiment, applying said formulation comprises applying a spray or application dilution, said spray or application dilution comprising 1 L of start dilution per 100 L of application or spray dilution, said application or spray dilution being applied at an application rate of between 200 and 1500 L/ha. By preference, said application or spray dilution is applied at an application rate of between 300 and 1400 L/ha, more by preference of between 400 and 1300 L/ha, of between 500 and 1200 L/ha, or of between 600 and 1100 L/ha. Even more by preference, said application or spray dilution is applied at an application rate of between 900 and 1100 L/ha, even more by preference of between 950 and 1050 L/ha. Most by preference, said application or spray dilution is applied at an application rate of between 990 and 1010 L/ha.

According to a further or another embodiment, applying said formulation comprises applying between 1 and 15 kg of AI/ha of said polyol or mixture of polyols, by preference said sugar alcohol or mixture of sugar alcohols. "AI" herein means "active ingredient". By preference, applying said formulation comprises applying between 1 and 13 kg of AI/ha of said polyol or mixture of polyols, by preference said sugar alcohol or mixture of sugar alcohols. More by preference, applying said formulation comprises applying between 1,1 and 12 kg of AI/ha of said polyol or mixture of polyols, by preference said sugar alcohol or mixture of sugar alcohols. Even more by preference, applying said formulation comprises applying between 1,2 and 11 kg of AI/ha of said polyol or mixture of polyols, by preference said sugar alcohol or mixture of sugar alcohols. Most by preference, applying said formulation comprises applying between 1,3 and 9,7 kg of AI/ha of said polyol or mixture of polyols, by preference said sugar alcohol or mixture of sugar alcohols.

According to a further or another embodiment, applying said formulation comprises applying between 1 and 15 kg of AI/ha of said polyol or mixture of polyols, by preference said sugar alcohol or mixture of sugar alcohols, and said alkyl polyglucosides. "AI" herein means "active ingredient". By preference, applying said formulation comprises applying between 1,1 and 14 kg of AI/ha of said polyol or mixture of polyols, by preference said sugar alcohol or mixture of sugar alcohols,

and said alkyl polyglucosides. More by preference, applying said formulation comprises applying between 1,2 and 13 kg of AI/ha of said polyol or mixture of polyols, by preference said sugar alcohol or mixture of sugar alcohols, and said alkyl polyglucosides. Even more by preference, applying said formulation comprises
5 applying between 1,3 and 12 kg of AI/ha of said polyol or mixture of polyols, by preference said sugar alcohol or mixture of sugar alcohols, and said alkyl polyglucosides. Most by preference, applying said formulation comprises applying between 1,4 and 10,6 kg of AI/ha of said polyol or mixture of polyols, by preference said sugar alcohol or mixture of sugar alcohols, and said alkyl polyglucosides. With
10 increasing preference, said application dosages allow improved control of a variety of pests, in an environmentally friendly way.

According to a further or another embodiment, said pests are chosen from the group consisting of bacteria, molds, fungi, insects, such as whiteflies or aphids, arachnids,
15 such as mites, or combinations thereof. By preference, said pests are chosen from the group consisting of whiteflies, aphids, mites, or combinations thereof. According to some other embodiments, said pests are chosen from the group consisting of molds and/or fungi, such as *Sphaerotheca fuliginea*.

20 "Aphids" are small sap-sucking insects that belong to the family *Aphididae*. According to some embodiments, said aphids are selected from the group consisting of Green Peach Aphid (*Myzus persicae*), Potato Aphid (*Macrosiphum euphorbiae*), Black Bean Aphid (*Aphis fabae*), Cotton Aphid or Melon Aphid (*Aphis gossypii*), Rose Aphid (*Macrosiphum rosae*), Grain Aphid (*Sitobion avenae*), Corn Root Aphid (*Aphis maidiradicis*), Bird Cherry-Oat Aphid (*Rhopalosiphum padi*),, or combinations thereof. The invention may, according to some embodiments, be used on other
25 species of aphids as well.

"Mites" are tiny arthropods belonging to the class *Arachnida*, closely related to
30 spiders and ticks. They can be free-living, parasitic, or plant-feeding. According to some embodiments, said mites are selected from the group consisting of Two-spotted Spider Mite (*Tetranychus urticae*), Citrus Red Mite (*Panonychus citri*), Southern Red Mite (*Oligonychus ilicis*), European Red Mite (*Panonychus ulmi*), Banks Grass Mite (*Oligonychus pratensis*), Strawberry Spider Mite (*Tetranychus turkestanii*), Pacific Spider Mite (*Tetranychus pacificus*), or combinations thereof. The
35 invention may, according to some embodiments, be used on other species of mites as well.

“Whiteflies” are white, moth-like insects due to the powdery wax on their wings and bodies. They feed on plant sap using their piercing-sucking mouthparts, similar to aphids. Like aphids, whiteflies excrete a sugary substance called honeydew, which can lead to the growth of sooty mold on plant surfaces. Whiteflies cause damage by directly feeding on plants and also act as vectors for many plant viruses. Their feeding can lead to plant stress, yellowing, and dropping of leaves. They can infest a wide range of host plants, from ornamental to agricultural crops. According to some embodiments, said whiteflies are selected from the group consisting of Silverleaf Whitefly (*Bemisia tabaci*), Greenhouse Whitefly (*Trialeurodes vaporariorum*), or combinations thereof. The invention may, according to some embodiments, be used on other species of whiteflies as well.

The several formulations as herein described may offer control of different pest species at the same time, in contrast to new insecticides which are often very specific on a pest or family of pests. It is very usual that different pest are present at the same time in a crop, forcing the farmer to use different products in tank mix. This may increase the cost of treatment, and may not be recommended due to added toxicities towards the environment or humans. Alternatively, a farmer would need to do several applications on different days for different pest, increasing even more the cost and time, and increasing the carbon footprint.

Conventional chemical insecticides may often have a negative impact on pollinators and non-target arthropods: these insecticides control the pest but generally are not innocuous for honeybees, bumble bees, wild bees and other pollinators, as well as for beneficial insects like ladybirds, lacewings, predatory mites, wasp, etc. Several projects have been launched in Europe by the EU Commission to preserve, protect and restore these pollinators.

No negative effects of the several formulation described herein on bees and beneficial insects have been demonstrated. After having conducted several studies following official guidelines on honeybees on acute toxicity, chronic toxicity on larvae and on adults, the conclusion is that this type of product has absolutely no negative effect. Also on non-target arthropods several studies have been carried out following official guidelines on various species showing no negative effect.

According to some embodiments, said formulation is applied in a single application. According to some other embodiments, said formulation is applied in blocks of 2 to 15 consecutive applications per crop cycle. The number of applications may be chosen depending on the type of crop. By preference, said formulation is applied in

blocks of 2 to 10 consecutive applications, more by preference in blocks of 2 to 4 consecutive applications. According to a further or another embodiment, said consecutive applications may each be spaced apart by an interval which ranges between 3 to 10 days.

5

According to a further or another embodiment, said crop is chosen from the group consisting of fruit crops, vegetable crops, cereal crops, vine crops, ornamental crops, or combinations thereof.

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It is furthermore noted that sugar alcohol based products showed excellent selectivity on crops. Use thereof was found to be safe in a variety of crops, either vegetables, ornamentals, trees, nuts, vines, or other crops. Tests in many different crops, varieties and different weather conditions have revealed that selectivity on the crop was always sufficient, without the occurrence of phytotoxicity symptoms.

15

This is particularly advantageous to farmers, who may apply the formulation at great confidence, and without the need for pre-testing. Due to the high number of new varieties developed in fruit trees and in vegetables, the farmers commonly need to test a product in some tree or plant before applying it on the whole field to confirm proper selectivity when using the product for the first time. Additionally, they may need to spend time looking for the compatibility information on the seed or breeder website, information that is not usually updated due to the high amount of new varieties. This is even more applicable to ornamental plants producers due to the large number of varieties and cultivars. Even with common products which are considered to be safe, extreme weather conditions after the application may have negative effect on the plants causing damage to leaves and flowers. This disadvantageous effect has never been observed with the formulations of the invention.

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The invention is further described by the following non-limiting examples which further illustrate the invention, and are not intended to, nor should they be interpreted to, limit the scope of the invention.

30

EXAMPLES

Example 1. Exemplary embodiments of formulations according to the invention.

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Table 1. Exemplary formulations according to the invention.

	<i>Polyols</i>	<i>Alkyl polyglucoside</i>	<i>Co-formulant</i>	<i>Water</i>
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IN A	54 wt.% polyols of which 91 wt.% monomeric D-sorbitol	3 wt.% C8, C9 and C10 alkyl polyglucoside	0,4 wt.% surfactant 0,4 wt.% anti-foam	42,2 wt.%
IN B	61 wt.% polyols of which 93 wt.% monomeric mannitol	4,0 wt.% C9 and C10 alkyl polyglucoside	0,7 wt.% surfactant	34,3 wt.%
IN C	45 wt.% polyols of which 95 wt.% monomeric erythritol	2,5 wt.% C8, C9, C10 and C11 alkyl polyglucoside	-	52,5 wt.%

Example 2. Application of formulations according to some embodiments of the invention on mite eggs.

- 5 Adults of *Panonychus citri* were inoculated on citrus leaf discs, placed in petri dishes with wet paper and kept in proper conditions for their development. Two days after inoculation, it was confirmed by a magnifying glass that eggs were laid on the citrus leaf discs. Subsequently, a formulation according to an embodiment of the invention, in particular formulation A as defined in Example 1, was diluted in water to 1 (v/v)%
- 10 and applied by a hand sprayer to the citrus leaf discs and eggs, in an application volume of 30 mL/m². After drying, the treated citrus leaf discs were freeze dried. The eggs on the citrus leaf disc were observed by a scanning electron microscope (SEM).
- 15 Reference is made to FIG. 1, which shows a SEM image of untreated *Panonychus citri* eggs. The eggs 1 of *Panonychus citri* comprise a breathing hair 2. In FIG. 2, a SEM image of a *Panonychus citri* egg treated with a formulation of the invention is shown. It can be seen that the breathing hair 2 of the egg 1 is now covered by a thin membrane 3. This confirms that the product once dried creates a coating that
- 20 hinders or blocks breathing of the egg, thereby causing asphyxia.

Example 3. Application of formulations according to some embodiments of the invention on mite adults.

- 25 Adults of *Panonychus citri* were inoculated on citrus leaf discs, placed in petri dishes with wet paper and kept in proper conditions for their development. Two days after inoculation, it was confirmed by a magnifying glass that the adults were alive on the citrus leaf discs. Subsequently, a formulation according to an embodiment of the invention, in particular formulation A as defined in Example 1, was diluted in water

to 1 (v/v)% and applied by a hand sprayer to the citrus leaf discs and adults, in an application volume of 30 mL/m². After drying, the treated citrus leaf discs were freeze dried. The adults on the citrus leaf disc were observed by a scanning electron microscope (SEM).

5

Reference is made to FIGs. 3a, 3b and 3c, which show SEM images of untreated *Panonychus citri* adults. The adult 4 of *Panonychus citri* comprises a spiracle 5. In FIGs. 4a, 4b and 4c, a SEM image of a *Panonychus citri* adult treated with a formulation of the invention is shown. It can be seen that the spiracle 5 of the adult 4 is now covered by a thin membrane 3. This confirms that the product once dried creates a coating that hinders or blocks breathing of the adult, thereby causing asphyxia.

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Example 4. Topical application of formulations according to some embodiments of the invention on mite adults.

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The present example aims at comparing the effect of formulations according to the invention when applied on different parts of *Tetranychus urticae* adults. In particular formulation A as defined in Example 1 was applied on the spiracles of *Tetranychus urticae*, on the whole body or on the abdomen while avoiding covering the spiracles. A comparison was made between no treatment, application of water and application with the formulation of the invention.

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Plants of French beans were cultivated in pots with a diameter of 9 cm. The plants were maintained in greenhouse conditions until the second and third leaf stage, and leaf discs with a diameter of 3 cm were taken. The leaf discs were fixed on a wet paper with the upper side down. Twenty adults were inoculated on each leaf disc and each adult was treated with a test dilution comprising either water, or the formulation according to the invention, by micro capillary tubes. The capillary tubes (As One, Ring Caps 10 µL 1/2 scale) were stretched by fire heating in order to create needles for the treatment with test dilution. The capillary tube filled with test dilution was inserted into a pipette tip (As One, 521010Y 2-200 µL) and attached to the tip of a rubber tube. Each connecting part was masked with Parafilm (Bemis, PM-996). At application time, exhaled air was blown into the rubber tube and the test dilution was applied on the different parts of the insects under a microscope (Leica, M165C), either placing the drop on the spiracle, abdomen or on the whole body at the dose detailed in Table 2.

Three replications were done per treatment. Leaf discs were maintained at a temperature of 25 °C and at a relative humidity of 60 % in light conditions of 16 light hours and 8 darkness hours.

- 5 The number of dead and alive adults on the leaf discs was counted at 3, 6, 24 and 30 hours after application of the test dilutions. Mortality was calculated following the Henderson-Tilton formula (Henderson and Tilton, 1955). The Henderson-Tilton formula is used in the field of entomology, particularly in pest management. It's a formula for calculating the percentage of control or efficacy achieved in a given pest
- 10 treatment when comparing treated and untreated groups. Results are shown in Table 2. In the "treatment" column, U denotes untreated, W denotes water and IN denotes the formulation of the invention. In the "part" column, B denotes whole body, S denotes spiracle, and NS denotes non-spiracle area.
- 15 Table 2. Treatment of *Tetranychus urticae* with a formulation according to the invention.

Treatment	Dilution	Droplet (nL)	Part	Mortality (%)			
				3 h	6 h	24 h	30 h
U	-	-	-	0	0	0	0
W	-	100	B	0	0	0	0
		30	S	18	18	18	18
		30	NS	8	8	8	8
IN A	1 (v/v)%	100	B	93	93	93	93
		30	S	80	80	82	82
		30	NS	3	3	13	13

- The application of water alone showed very slight mortality on the *Tetranychus urticae* adults, though only when it was applied around the spiracle. When observing
- 20 treatment with the formulation of the invention, mortality was high when applied around the spiracle, and lower when applied on a non-spiracle area. When the formulation of the invention was applied in the whole body of the adult, the efficacy slightly increased over application in the spiracle area only.
- 25 These results indicate that the formulation of the invention provides good control of *Tetranychus urticae* when applied on the spiracles, and hence confirm that the main path of action seems to be by suffocation, i.e. blocking the spiracles or coating the tracheoles in them.

Example 5. Application of formulations according to some embodiments of the invention on aphid adults.

5 Adults of *Aphis gossypii* were inoculated on cucumber leaf discs, placed in petri dishes with wet paper and kept in proper conditions for their development. Two days after inoculation, it was confirmed by a magnifying glass that the adults were alive on the cucumber leaf discs. Subsequently, a formulation according to an embodiment of the invention, in particular formulation A as defined in Example 1, was diluted in
10 water to 1 (v/v)% and applied by a hand sprayer to the cucumber leaf discs and adults, in an application volume of 30 mL/m². After drying, the treated cucumber leaf discs were freeze dried. The adults on the cucumber leaf disc were observed by a scanning electron microscope (SEM).

15 Reference is made to FIGs. 5a and 5b, which show SEM images of untreated *Aphis gossypii* adults. The adult 4 of *Aphis gossypii* comprises spiracle 5. In FIGs. 6a and 6b, a SEM image of a *Aphis gossypii* adult treated with a formulation of the invention is shown. It can be seen that a thin membrane 3 is covering the body of the adult 4, however no blockage of the spiracle 5 is observed. This in contrast with the findings
20 in mites, and could be due to the difference in insect shape and size, as well as due to the size, number and position of spiracles. Mortality was however observed, which may be due to the thin membrane penetrating the tracheal system through the spiracle overture and coating the tracheoles.

25 Example 6. Topical application of formulations according to some embodiment of the invention on aphid adults.

The present example aims at comparing the effect of formulations according to the invention when applied on different parts of *Aphis gossypii* adults. In particular
30 formulation A as defined in Example 1 was applied on the spiracles of *Aphis gossypii*, on the whole body or on the abdomen while avoiding covering the spiracles. A comparison was made between no treatment, application of water and application with the formulation of the invention.

35 Plants of cucumber were cultivated in pots with a diameter of 9 cm. The plants were maintained in greenhouse conditions until the second and third leaf stage, and leaf discs with a diameter of 7 cm were taken. The leaf discs were fixed on 0,7 % agar with the upper side down. Ten adults were inoculated on each leaf disc and each

adult was treated with a test dilution comprising either water, or the formulation according to the invention, by micro capillary tubes. The test dilutions were applied on the different parts of the insects under a microscope (Leica, M165C), either placing the drop on the spiracle, abdomen or on the whole body at the dose detailed in Table 2. Leaf discs were maintained at a temperature of 25 °C and at a relative humidity of 60 % in light conditions of 16 light hours and 8 darkness hours.

The number of dead and alive adults on the leaf discs was counted at 3, 6, 24 and 30 hours after application of the test dilutions. Mortality was calculated following the Henderson-Tilton formula (Henderson and Tilton, 1955). The Henderson-Tilton formula is used in the field of entomology, particularly in pest management. It's a formula for calculating the percentage of control or efficacy achieved in a given pest treatment when comparing treated and untreated groups. Results are shown in Table 3. In the "treatment" column, U denotes untreated, W denotes water and IN denotes the formulation of the invention. In the "part" column, B denotes whole body, S denotes spiracle, and NS denotes non-spiracle area.

Table 3. Treatment of *Aphis gossypii* with a formulation according to the invention.

Treatment	Dilution	Droplet (nL)	Part	Mortality (%)			
				3 h	6 h	24 h	30 h
U	-	-	-	0	0	0	0
W	-	900	B	0	0	0	0
IN A	1 (v/v)%	900	B	30	30	30	30
		500	S	10	20	20	20
		500	NS	0	0	0	0

The application of the formulation of the invention to the non-spiracle area had no effect on the adults of *Aphis gossypii*, while the application on the whole body and around the spiracle had a certain efficacy. This suggest that the action of the formulation of the invention is by blocking the spiracles or the tracheoles inside them. The somewhat lower efficacy of the formulation of the invention towards *Aphis gossypii* in comparison to *Tetranychus urticae* could be due to a higher water repellency of the adult body, it was observed in the microscope that this aphid specie is covered with a hydrophobic wax layer, which clearly difficults the control by the invention. Therefore, it may be preferred that *Aphis gossypii* is treated in consecutive applications, such as three consecutive applications in intervals of 5 to 7 days for improved control.

Example 7. Application of formulations according to some embodiments of the invention on mite adults.

- 5 The present example aims to compare application of three formulations of the invention, with solo application of D-sorbitol and application of Abamectin for the control of *Tetranychus urticae*.

10 Abamectin is a mixture of avermectins containing more than 80 % avermectin B1a and less than 20 % avermectin B1b. These are insecticidal or anthelmintic compounds derived from the soil bacterium *Streptomyces avermitilis*. Abamectin works by affecting the nervous system of and paralyzing insects and mites, and has been widely used to control insect and mite pests on a range of agricultural crops.

15 Plants of French beans were cultivated in pots and maintained in greenhouse conditions, at least until the second and third leaf stage. Female mite adults were released 7 days before treatments. The crops were sprayed every seven days, three applications in total. For spraying, the formulations of the invention were first diluted to a start dilution of 1 (v/v)%, which was subsequently further diluted to a spray
20 dilution comprising 1 L of start dilution per 100 L of spray dilution. Said spray dilution being applied in an application rate of 1000 L/ha. An equivalent dilution was used for solo D-sorbitol. For abamectin a 1.8 EC dosage was used, i.e. an emulsifiable concentrate formulation of abamectin with a concentration of 1.8 (w/v)% active ingredient, which was further diluted to a spray dilution of 1 L per 1000 L of spray
25 dilution.

The number of insects on the French bean crops was counted. Results are shown in the graph of FIG. 7. The notations 2DA-A, 7DA-A, 2DA-B etc. respectively indicate 2
30 days after the first application, 7 days after the first application, 2 days after the second application etc.

It was concluded that the formulations of the invention are able to control the number of insects over the complete duration of the test, while solo application of D-sorbitol shows an initial decrease whereafter the insect count gradually increases
35 again.

Example 8. Application of formulations according to some embodiments of the invention on aphids.

The present example aims to compare application of three formulations of the invention, with solo application of D-sorbitol and application of Sulfoxaflor for the control of *Myzus persicae*.

5

Sulfoxaflor is a systemic insecticide that belongs to the class of chemicals known as sulfoximines. It was developed for the control of sap-feeding insects, particularly those that have developed resistance to older classes of insecticides. Sulfoxaflor targets pests like aphids, whiteflies, and certain types of plant hoppers. One point of contention regarding sulfoxaflor has been its potential impact on pollinators, especially honeybees. In the past, concerns about its effects on bee populations led to restrictions or modifications in its approved uses in some regions. The mode of action of sulfoxaflor involves the inhibition of the nicotinic acetylcholine receptor (nAChR) in the insect's nervous system.

10

Plants of Chinese cabbage were cultivated in pots and maintained in greenhouse conditions, at least until the second and third leaf stage. Aphid adults were released 3 days before treatments. For spraying, the formulations of the invention were first diluted to a start dilution of 1 (v/v)%, which was subsequently further diluted to a spray dilution comprising 1 L of start dilution per 100 L of spray dilution. Said spray dilution being applied in an application rate of 1000 L/ha. An equivalent dilution was used for solo D-sorbitol. For Sulfoxaflor a 0,1 (v/v)% start dilution was used, which was subsequently diluted to a spray dilution comprising 1 L of start dilution per 1000 L of spray dilution.

15

The number of aphids on the Chinese cabbage crops was counted and the mortality was calculated following the Henderson-Tilton formula (Henderson and Tilton, 1955). The Henderson-Tilton formula is used in the field of entomology, particularly in pest management. It's a formula for calculating the percentage of control or efficacy achieved in a given pest treatment when comparing treated and untreated groups. Results are shown in Table 4, the notation "DAT" meaning "days after treatment".

20

It was concluded that the formulations of the invention are able to control the number of aphids over the complete duration of the test, with a mortality ranging from 63 to 86 % at 2 days after treatment, and reducing at 7 days after treatment as the invention has only contact effect and the survival individuals kept on developing the population.

25

Table 4. Treatment of *Myzus persicae* with a formulation according to the invention, solo D-sorbitol and Sulfoxaflor.

Treatment	Dilution	Number of aphids			% Mortality.	
		0DAT	2DAT	7DAT	2DAT	7DAT
IN A	1 (v/v)%	88	25	210	86	34
IN B	1 (v/v)%	81	62	190	63	35
IN C	1 (v/v)%	53	39	130	64	32
D-sorbitol	1 (v/v)%	75	101	160	35	41
Sulfoxaflor (10 % SC)	0,1 (v/v)%	64	0	0	100	100
Control	-	69	143	250	0	0

5 Example 9. Application of formulations according to some embodiments of the invention on whitefly.

The present example aims to compare application of three formulations of the invention, with solo application of D-sorbitol for the control of *Bemisia tabaci*.

10 Cucumber leaf discs of 3 cm diameter were sprayed with 100 mL/m² of test solutions and fixed to 0,7 % agar in a glass tube. Test solutions comprised different dosages of AI (active ingredient), such as disclosed in Table 5. Twenty test insects were inoculated on the treated cucumber leaf discs. Three and fourteen days after treatment, the number of surviving insects was counted and mortality calculated

15 according to Henderson-Tilton formula (Henderson and Tilton, 1955). The Henderson-Tilton formula is used in the field of entomology, particularly in pest management. It's a formula for calculating the percentage of control or efficacy achieved in a given pest treatment when comparing treated and untreated groups.

20 Table 5. Treatment of *Bemisia tabaci* with a formulation according to the invention and solo D-sorbitol.

Treatment	Dosage (mg AI/L)	Mortality (%)
		3DAT
IN A	6	93
	3	100
	1,5	80
	0,75	73

	26	
IN B	6	98
	3	88
	1,5	90
	0,75	48
IN C	6	100
	3	95
	1,5	75
	0,75	43
Sorbitol	6	18
	3	35
	1,5	5
	0,75	8
Control	-	15

It was concluded that the formulations of the invention resulted in a significantly higher mortality of *Bemisia tabaci* in comparison to the application of solo D-sorbitol.

5 Example 10. Application of formulations according to some embodiments of the invention on whitefly.

The present example aims to compare application of three formulations of the invention, with solo application of D-sorbitol and Sulfoxaflor for the control of
10 *Bemisia tabaci*.

Cucumber plants were grown in pots until at least the fourth leaf stage. Test crops were sprayed at an application rate of 1000 L/ha by hand sprayer following the dosage schedule disclosed in Table 6. After the first treatment, 50 test insects were
15 released per pot. The number of survived insect was counted and mortality was calculated following the Henderson-Tilton formula (Henderson and Tilton, 1955). The Henderson-Tilton formula is used in the field of entomology, particularly in pest management. It's a formula for calculating the percentage of control or efficacy achieved in a given pest treatment when comparing treated and untreated groups.

20

Table 6. Treatment of *Bemisia tabaci* with a formulation according to the invention, solo D-sorbitol and Sulfoxaflor.

27

Treatment	Dilution rate	Dosage (mg/L)	Number of survived insect		Mortality (%)	
			Adults	Nymphs	Adults	Nymphs
			4 DA-A	2 DA-C	4 DA-A	2 DA-C
IN A	1 (v/v)%	8,643	9	4	82	99
IN B	1 (v/v)%	8,643	13	3	74	99
IN C	1 (v/v)%	8,643	15	9	70	98
Sulfoxaflor (10 % SC)	0,1 (v/v)%	100	0	0	100	100
Control	-	-	41	365	18	0

It can be concluded that the formulations of the invention provide good efficacy in controlling whitefly adults, as well as in controlling next generation nymphs.

- 5 Example 11. Application of formulations according to some embodiments of the invention on molds and/or fungi.

The formulation A according to the invention was tested against *Sphaerotheca fuliginea*, causing powdery mildew. Formulation A was compared to products
 10 Armicarb (potassium bicarbonate 850 g/kg SP (soluble powder)) and Systhane Forte (Myclobutanil 240 g/l EC (emulsifiable concentrate)). The level of infection by *Sphaerotheca fuliginea* in the trial was very high.

Armicarb is a fungicide with potassium bicarbonate as its active ingredient.
 15 Potassium bicarbonate is used as a contact fungicide and disrupts the fungal cell membranes and also affects the pH of the environment, making it less conducive to fungal growth, especially effective against powdery mildew. Systhane Forte is a trade name for a fungicide with the active ingredient myclobutanil. Myclobutanil belongs to the group of sterol biosynthesis inhibitors, which means it interferes with the
 20 fungal cell's ability to produce essential sterols, leading to cell damage and ultimately death of the fungus.

In particular, the following treatments were compared:

1. untreated;

2. formulation A according to the invention in an application rate of 300 g AI/100 L;
3. formulation A according to the invention in an application rate of 450 g AI/100 L;
- 5 4. formulation A according to the invention in an application rate of 600 g AI/100 L;
5. Armicarb at an application rate of 425 g AI/100 L; and
6. Systhane Forte at an application rate of 9,6 g AI/100 L.

10 A randomized complete block design was done, with 4 replications per treatment. Elemental plots were 13 m² and 13 Cucumber plants per plot. Three foliar spray applications were conducted at seven days interval using a knapsack sprayer (Maruyama), at 600 kPa of pressure and 1000 L/ha of water volume. Six assessments were carried out at 0 DA-A, 7 DA-A, 2 DA-B, 7 DA-B, 7 DA-C and 17

15 DA-C evaluating the percentage of leaf affected (severity) and the percentage of leaves affected (incidence), based on 25 leaves from the central plants of the elemental plots, with the similar development stage and fully developed. Abbott efficacy was calculated.

20 Efficacy of the different treatments was calculated compared to untreated plants following Abbott's calculation method. In these adverse conditions, formulation A at 750 and 1000 mL/100 L (450 g AI/100 L and 600 g AI/100 L) reached around 80 % of control at 2 DA-B and 7 DA-B and around 70 % at 7 DA-A and 7 DA-C; statistically significant differences were observed between treated and untreated plots.

25 Results are summarized in Figures 8a and 8b, respectively showing graphs indicating the percentage of leaves affected (severity), and Abbott efficacy on percentage of leaves affected. Bars from left to right for each DAT-point indicate the several treatments 1 to 6 as described above.

30 Example 12. Application of formulations according to some embodiments of the invention on *Tetranychus urticae* adults.

35 To compare the effect of formulation A of the invention with solo concentrated sugar alcohols on *Tetranychus urticae* adults, formulation A (both active and blank), the respective sugar alcohols (SA 1-6), as well as a control and a chemical control comprising abamectin (CHEM) were sprayed on the adults and observed with a

magnifying glass one day after the application. The tested formulations and dilution rates were as follows in Table 7.

Table 7. Tested formulations.

<i>Treatment</i>	<i>Composition</i>	<i>Rate</i>
Control	Water	
IN A	IN A	1 L/hL
IN A (blank)	IN A - only water and co-formulants	1 L/hL
SA 1	sorbitol 71,2 wt.%	0,646 g/hL
SA 2	mannitol > 98 % wt.%	0,646 g/hL
SA 3	isomalt >97 % wt.%	0,646 g/hL
SA 4	maltitol >98 % wt.%	0,646 g/hL
SA 5	xylitol >98 % wt.%	0,646 g/hL
SA 6	erythritol 100 % wt.%	0,646 g/hL
CHEM	abamectin 1,8 % (w/v)	0,1 g/hL

5

For the test, 20 adults of *T. urticae* were inoculated on French bean leaf discs, placed in petri dishes of 10 cm diameter with wet paper and kept in the lab in proper conditions for their development. Two days after inoculation, alive adults in each petri dish were confirmed under a magnifying glass.

10

For the applications, the formulation A of the invention was diluted at 1 L/hL of water, the several sugar alcohols were diluted at 646,6 g of sugar alcohol per hL of water. The blank composition of the invention consisted in the formulation without sugar alcohol (only water and co-formulants), was diluted at 1 L/hL of water. All treatments were applied by hand sprayer on the leaf discs and mites, with a volume of 150 L/10a (= 10,5 mL / 700 cm² spray area). Four petri dishes (replications) were sprayed per treatment. After application the petri dishes were covered and kept in a growth chamber at room temperature, in light conditions of 16 light hours and 8 darkness hours, and at a relative humidity of 60 %. Assessment was done using a magnifying glass 24 hours after the application.

15

Consequently, 24 hours after the application, the number of alive adults were assessed (column 3 of Table 8), and mortality following the Henderson-Tilton formula was calculated (column 4 of Table 8).

20

25

Table 8. Treatment of *Tetranychus urticae* with a formulation according to the invention, sugar alcohols and abamectin.

<i>Treatment</i>	<i>Adults 0 DA-A</i>	<i>Adults 1-DA-A</i>	<i>Mortality (%) 1 DA-A</i>
Control	20,8	18,0	0,0
IN A	20,0	4,3	75,5
IN A (blank)	19,0	16,8	-1,6
SA 1	18,8	13,3	18,5
SA 2	17,5	14,5	4,5
SA 3	19,3	15,8	5,7
SA 4	19,5	17,5	-3,5
SA 5	18,8	17,8	-9,1
SA 6	18,3	17,5	-10,5
CHEM	20,0	0,0	100,0

- 5 It is clearly observed that the chemical control (abamectin, CHEM) behaves as expected, with a 100 % mortality at 1 DA-A. The formulation of the invention (IN A) showed a mortality of 75,5 % only after one application. On the other hand, the solo sugar alcohols (SA 1-6) and the blank formulation of the invention (IN A (blank)) had minimal to no effect whatsoever, showing no statistical difference from the water control.
- 10

It may be concluded that a proper formulation is required for the sugar alcohols to show a relevant effect towards *Tetranychus urticae*.

- 15 Example 13. Application of formulations according to some embodiments of the invention on *Tetranychus urticae* adults.

The effect was compared between formulation A of the invention and similar formulations wherein sorbitol has been replaced with other polyols. Therefore, formulation A (both active and blank), alternative formulations (IN 1-6), as well as a control and a chemical control comprising abamectin (CHEM) were sprayed on the adults of *Tetranychus urticae* and observed with a magnifying glass one day after the application. The tested formulations and dilution rates were as follows in Table 9.

20

Table 9. Tested formulations.

<i>Treatment</i>	<i>Composition</i>	<i>Rate</i>
Control	Water	
IN A	IN A	1 L/hL
IN A (blank)	IN A - only water and co-formulants	1 L/hL
IN 1	mannitol 17,60 wt.%	3,3 L/hL
IN 2	isomalt 17,60 wt.%	3,3 L/hL
IN 3	maltitol 52,60 wt.%	1 L/hL
IN 4	xylitol 52,90 wt.%	1 L/hL
IN 5	erythritol 17,60 wt. %	3,3 L/hL
IN 6	glycerol 52,90 wt.%	1 L/hL
CHEM	abamectin 1,8 % (w/v)	0,1 g/hL

The sugar-alcohols maltitol, xylitol and the vegetal origin polyol glycerol have good water solubility and replace the sorbitol in the IN A formulation at the same concentration (52,9 wt.%). On the other hand, mannitol, isomalt and erythritol have a lower solubility and the concentration in the final product was determined at 17,6 wt.%.

For the test, 10 adults of *T. urticae* were inoculated on French bean leaf discs, placed in petri dishes of 10 cm diameter with wet paper and kept in the lab in proper conditions for their development. Two days after inoculation, alive adults in each petri dish were confirmed under a magnifying glass.

For the applications, the formulation A of the invention and the formulations with maltitol, xylitol and glycerol were diluted at 1 L/hL of water. The formulations with mannitol, isomalt and erythritol were diluted at 3,3 L/hL of water in order to obtain 646,6 g of sugar alcohol per hL of water. The blank composition of the invention consisted in the formulation without sugar alcohol (only water and co-formulants), was diluted at 1 L/hL of water. All treatments were applied by hand sprayer on the leaf discs and mites, with a volume of 150 L/10a (= 10,5 mL / 700 cm² spray area). Four petri dishes (replications) were sprayed per treatment. After application the petri dishes were covered and kept in a growth chamber at room temperature, in light conditions of 16 light hours and 8 darkness hours, and at a relative humidity of 60 %. Assessment was done using a magnifying glass 24 hours after the application.

25

This test was done five times on different dates to confirm the results.

Consequently, 24 hours after the application, the number of alive adults were assessed (column 3 of Table 10), and efficacy following the Abbot formula was calculated (column 4 of Table 10).

5

Table 10. Treatment of *Tetranychus urticae* with a formulation according to the invention, sugar alcohols and abamectin, averages of 5 tests.

<i>Treatment</i>	<i>Adults 0 DA-A</i>	<i>Adults 1-DA-A</i>	<i>Efficacy (%) 1 DA-A</i>
Control	10	10	0
IN A	10	3	68
IN A (blank)	10	9	10
IN 1	10	4	56
IN 2	10	3	66
IN 3	10	4	64
IN 4	10	4	62
IN 5	10	4	62
IN 6	10	5	54
CHEM	10	0	100

- 10 Although results over the five tests were similar for the sugar alcohols (IN 1-5), glycerol showed inconsistent results as several replications were underperforming. In particular 1 DA-A efficacies for the formulation comprising glycerol varied between 20 and 70 %, making it less reliable.
- 15 It can be concluded that different sugar alcohols have a similar performance on *Tetranychus urticae* control when formulated according to the invention. Polyols which are not sugar alcohols, like glycerol, may be less reliable and inconsistent in their performance.
- 20 The present invention is in no way limited to the embodiments described in the examples and/or shown in the figures. On the contrary, formulations and methods according to the present invention may be realized in many different ways without departing from the scope of the invention.

CLAIMS

1. A formulation for use as a pesticide, said formulation comprising:
 - a. between 30 and 85 wt.% of a polyol or a mixture of polyols obtained
5 by hydrogenation of a natural sugar;
 - b. between 1 and 10 wt.% of one or more alkyl polyglucosides; and
 - c. between 5 and 69 wt.% of water;characterized in that, said polyol or mixture of polyols consists of more than
10 90 wt.% of monomeric polyols, based on the total weight of polyols in the
formulation.
2. The formulation according to claim 1, characterized in that, said polyol or
mixture of polyols is a sugar alcohol or mixture of sugar alcohol, wherein said
15 sugar alcohol or mixture of sugar alcohols consists of more than 90 wt.% of
monomeric sugar alcohols, based on the total weight of sugar alcohols in the
formulation, and wherein said monomeric sugar alcohols are chosen from the
group consisting of monomeric erythritol, monomeric xylitol, monomeric
mannitol, monomeric maltitol, monomeric lactitol, monomeric isomalt, or
20 combinations thereof.
3. The formulation according to claim 1 or 2, characterized in that, said polyol
or mixture of polyols consists of more than 95 wt.% of monomeric polyols,
based on the total weight of polyols in the formulation.
- 25 4. The formulation according to any one of preceding claims 1 to 3,
characterized in that, said monomeric polyols consist of monomeric D-
sorbitol.
5. The formulation according to any one of preceding claims 1 to 4,
30 characterized in that, said formulation comprises between 50 and 56 wt.% of
said polyol or mixture of polyols.
6. The formulation according to any one of preceding claims 1 to 5,
35 characterized in that, said alkyl polyglucosides are chosen from the group
consisting of C8 alkyl polyglucoside, C9 alkyl polyglucoside, C10 alkyl
polyglucoside, or combinations thereof.

7. The formulation according to any one of preceding claims 1 to 6, characterized in that, said formulation comprises between 3 and 4,5 wt.% of said alkyl polyglucosides.
- 5 8. The formulation according to any one of preceding claims 1 to 7, characterized in that, said formulation comprise 40,5 to 47 wt.% of water.
9. The formulation according to any one of preceding claims 1 to 8, characterized in that, said formulation comprises:
- 10 a. between 50 and 56 wt.% of said polyol or mixture of polyols;
b. between 3 and 4,5 wt.% of C8 alkyl polyglucoside, C9 alkyl polyglucoside, C10 alkyl polyglucoside, or combinations thereof;
c. between 0,1 and 1 wt.% of one or more co-formulants, and
d. between 38,5 and 46,9 wt.% of water;
- 15 wherein said polyol or mixture of polyols consists of more than 90 wt.% of monomeric D-sorbitol, based on the total weight of polyols in the formulation.
10. A method of controlling pests, said method comprising:
- 20 providing a formulation comprising
- a. between 30 and 85 wt.% of a polyol or a mixture of polyols obtained by hydrogenation of a natural sugar;
b. between 1 and 10 wt.% of one or more alkyl polyglucosides; and
c. between 5 and 69 wt.% of water;
- 25 applying said formulation to a crop plant susceptible to said pests, a habitat of a crop plant susceptible to said pests, or a combination thereof, characterized in that, said polyol or mixture of polyols consists of more than 90 wt.% of monomeric polyols, based on the total weight of polyols in the formulation.
- 30
11. The method according to claim 10, characterized in that, said formulation is a formulation according to any one of claims 1 to 9.
12. The method according to claim 10 or 11, characterized in that, applying said
- 35 formulation comprises diluting said formulation to a start dilution, said start dilution comprising between 0,5 (v/v)% and 5 (v/v)% of said formulation.

35

13. The method according to claim 12, characterized in that, applying said formulation comprises applying a spray or application dilution, said spray or application dilution comprising 1 L of start dilution per 100 L of application or spray dilution, said application or spray dilution being applied at an application rate of between 800 and 1200 L/ha.

5

14. The method according to any one of preceding claims 10 to 13, characterized in that, said pest is chosen from the group consisting of consisting of whiteflies, aphids, mites, or combinations thereof.

10

15. The method according to any one of preceding claims 10 to 14, characterized in that, said crop is chosen from the group consisting of fruit crops, vegetable crops, cereal crops, vine crops, ornamental crops, or combinations thereof.

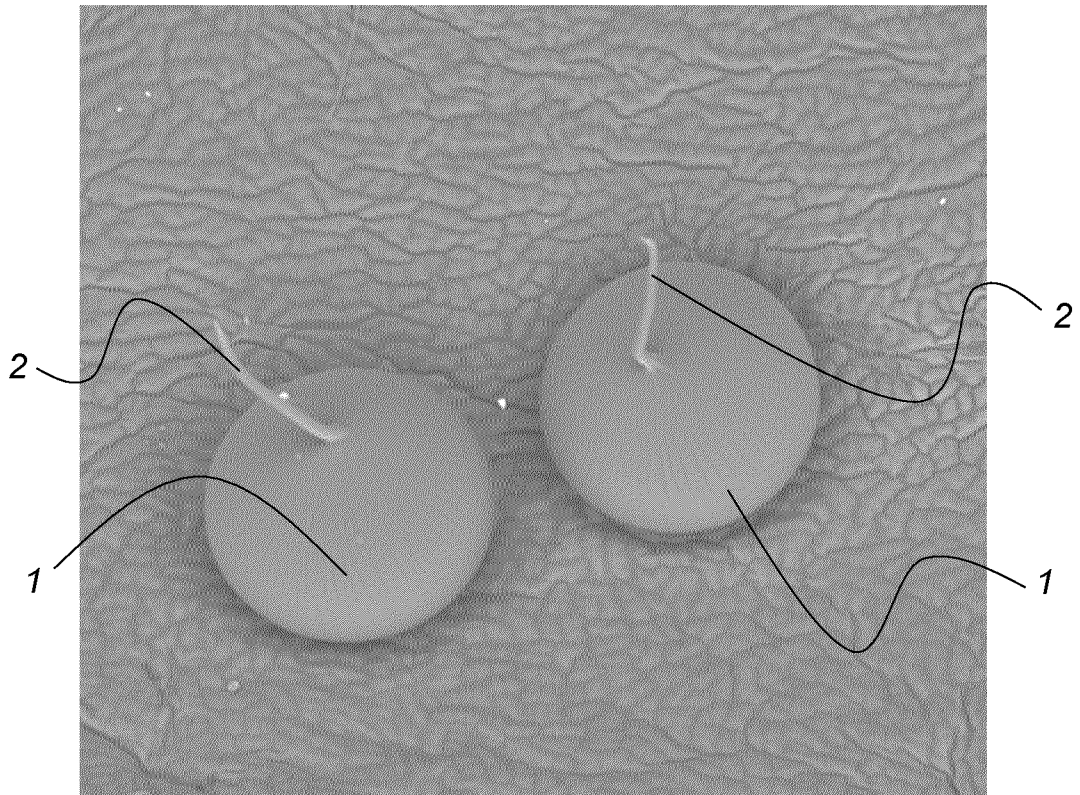


Fig. 1

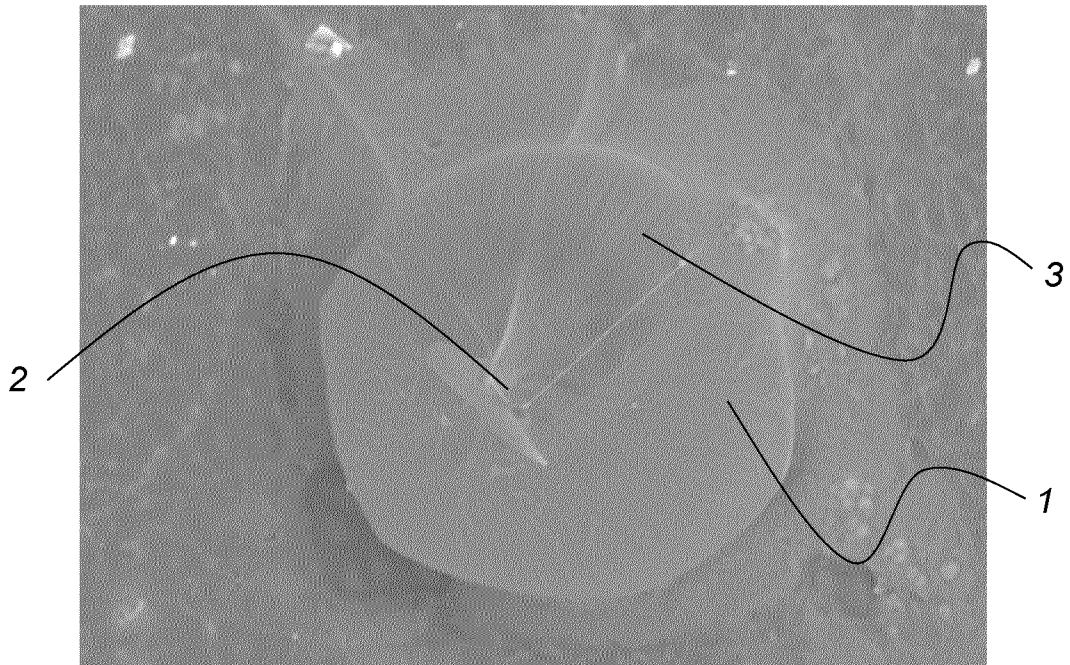


Fig. 2

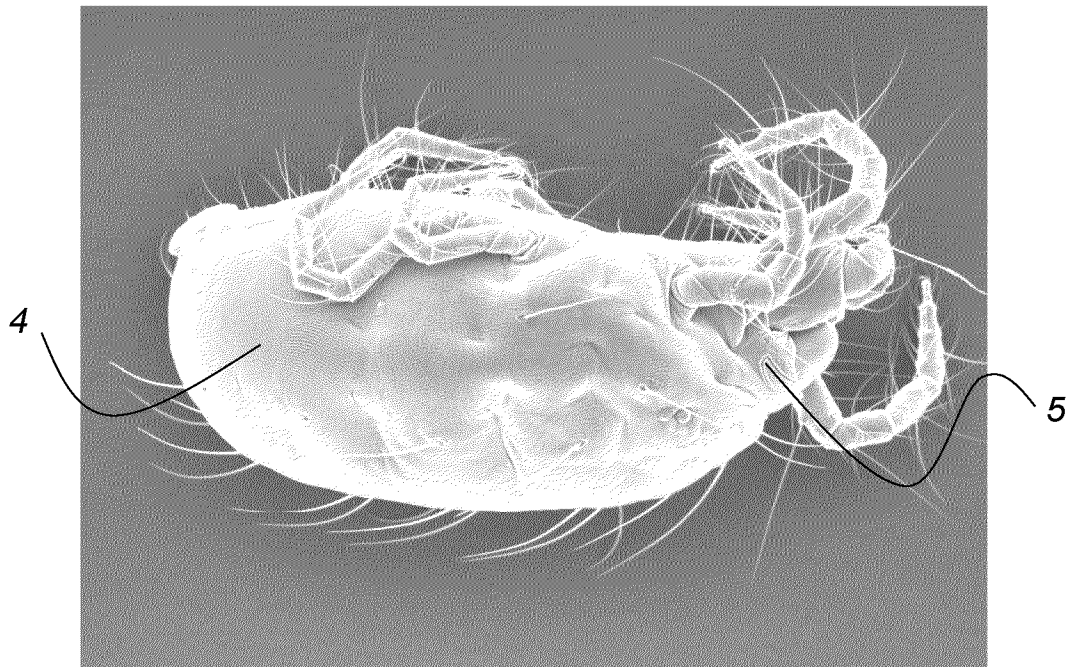


Fig. 3a

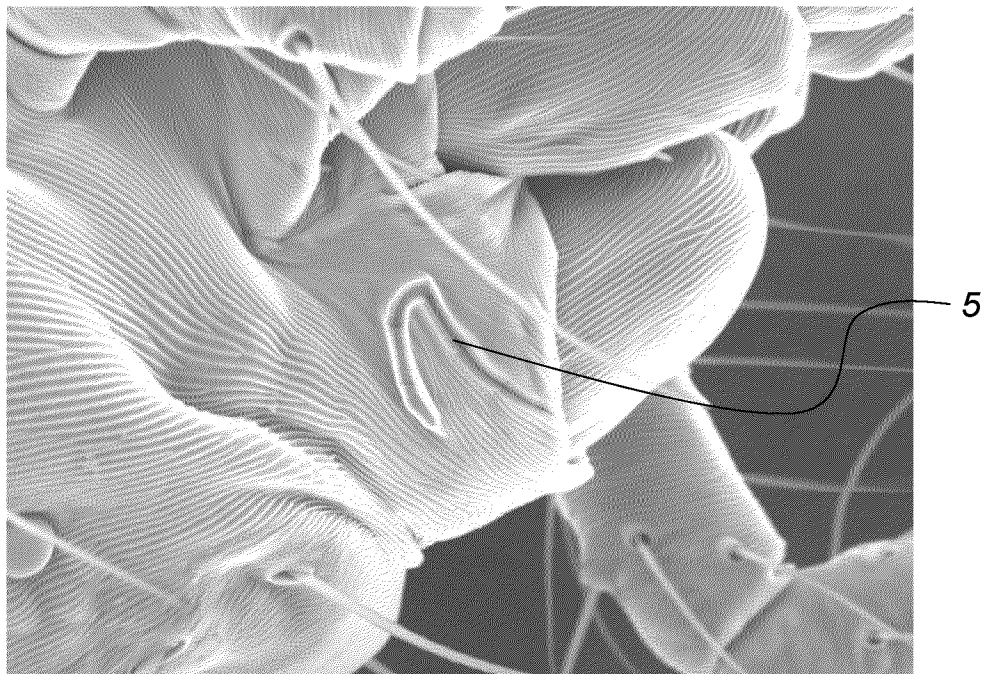


Fig. 3b

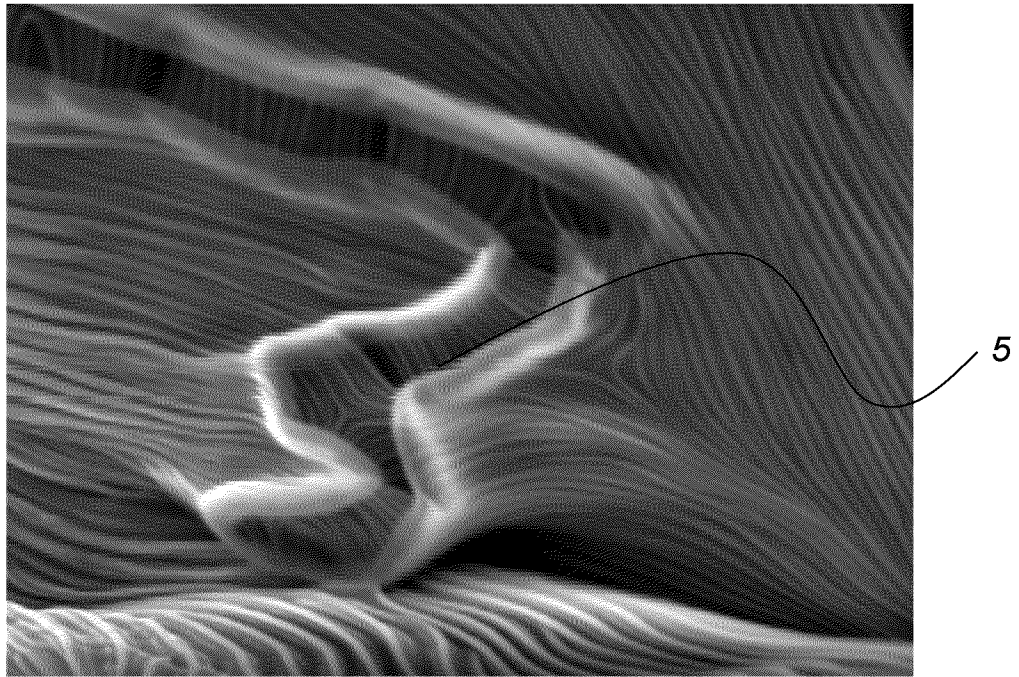


Fig. 3c

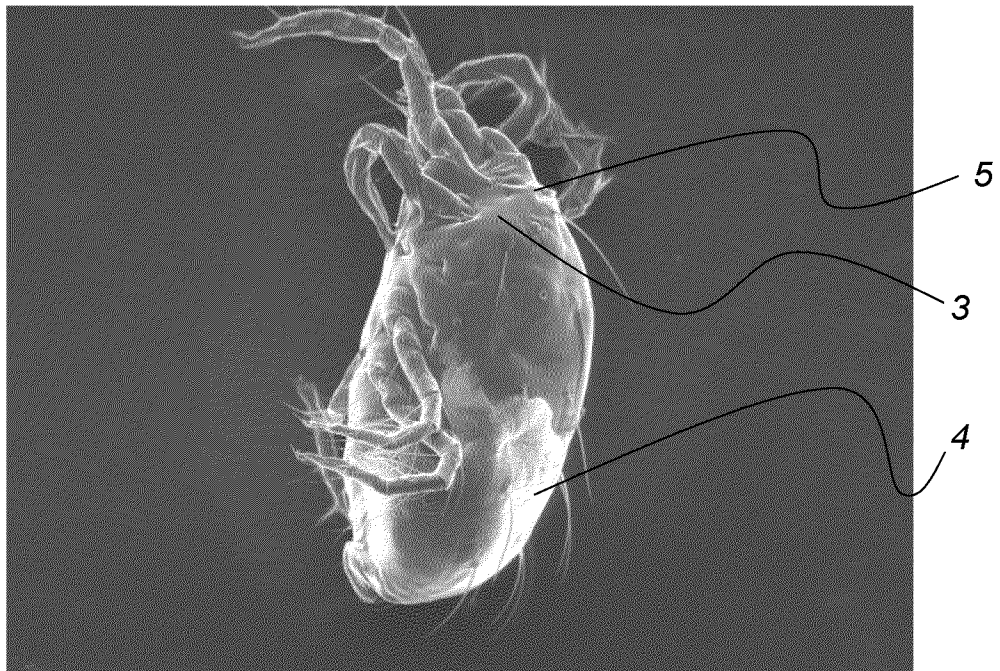


Fig. 4a

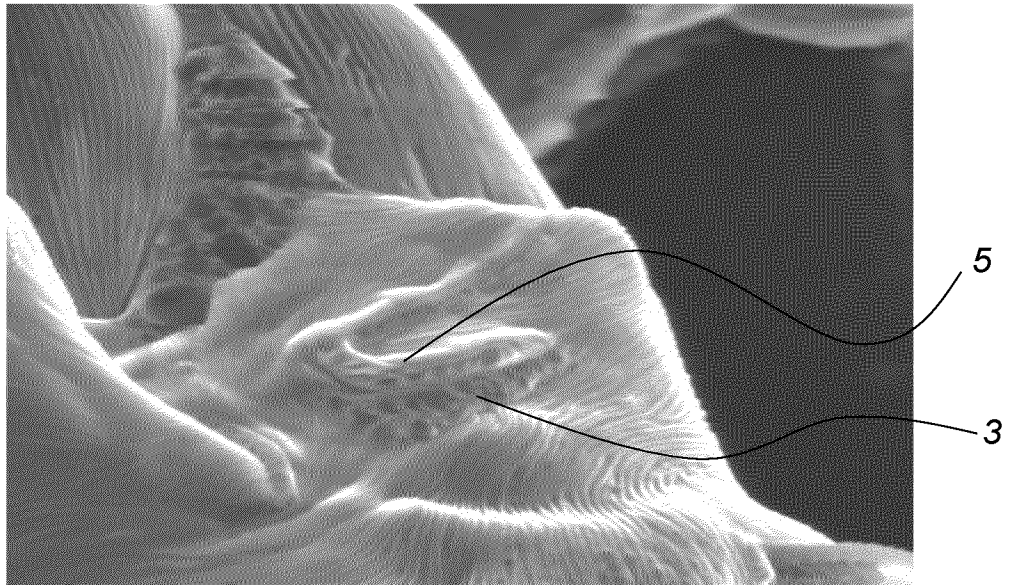


Fig. 4b

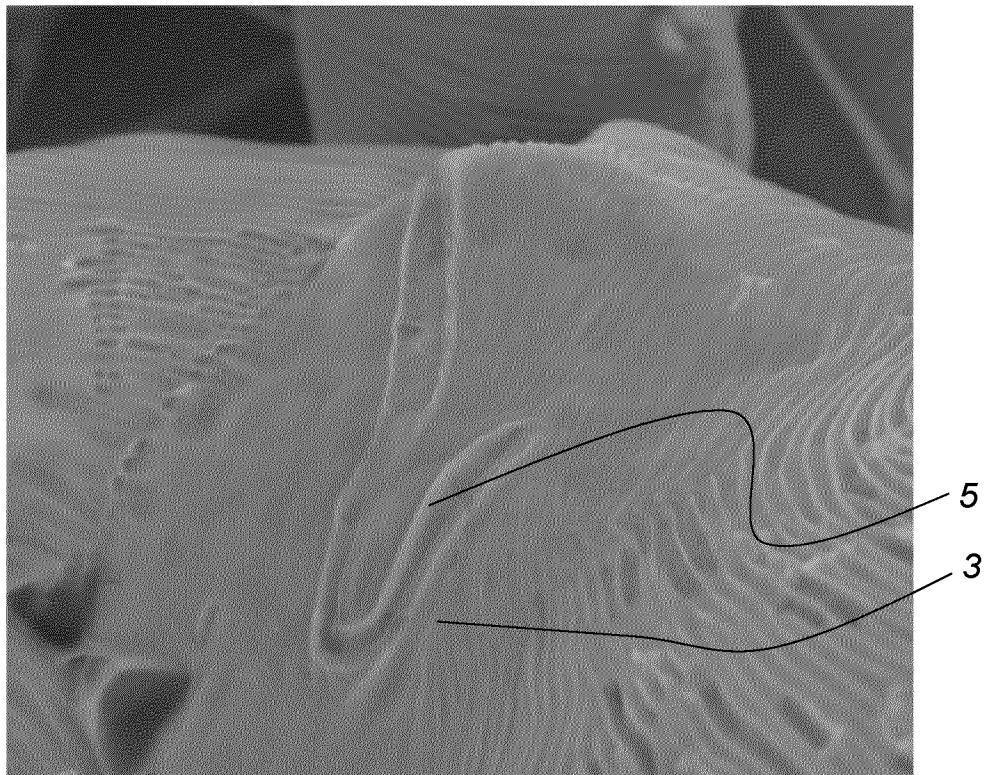


Fig. 4c

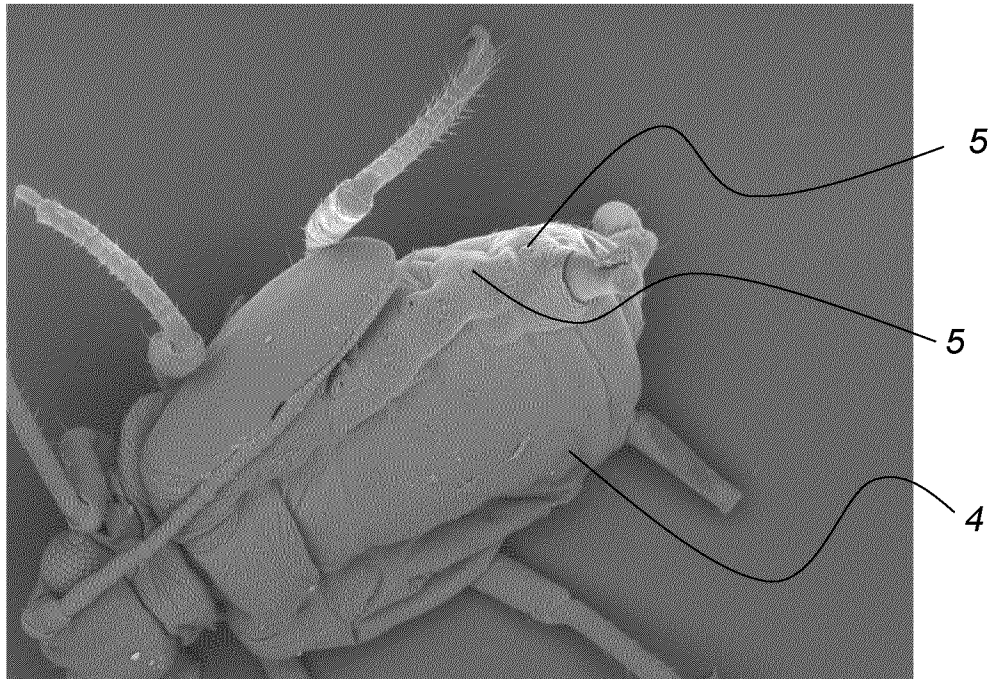


Fig. 5a

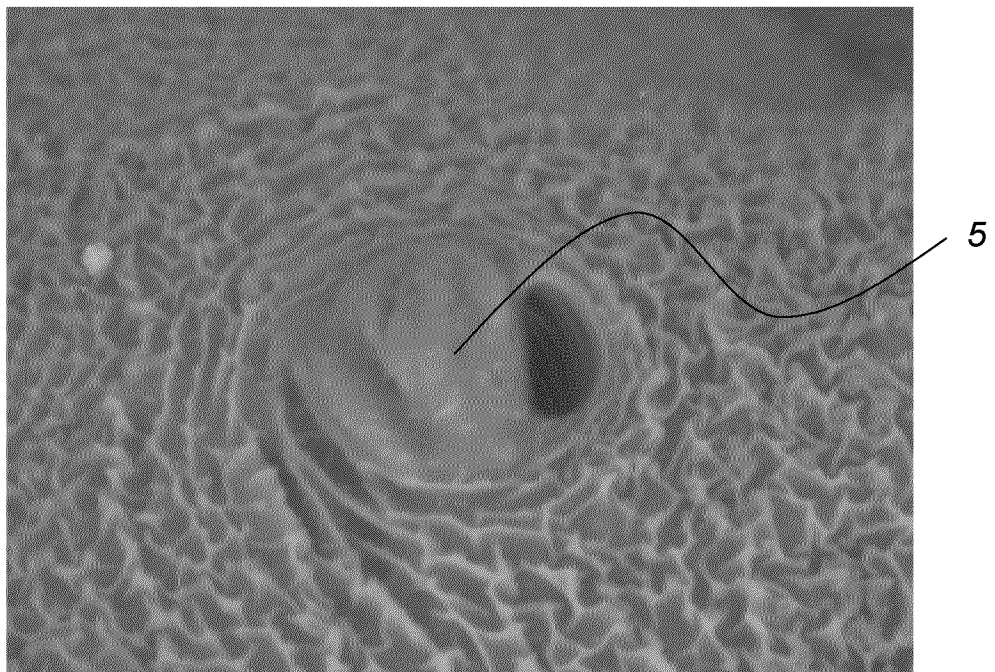


Fig. 5b

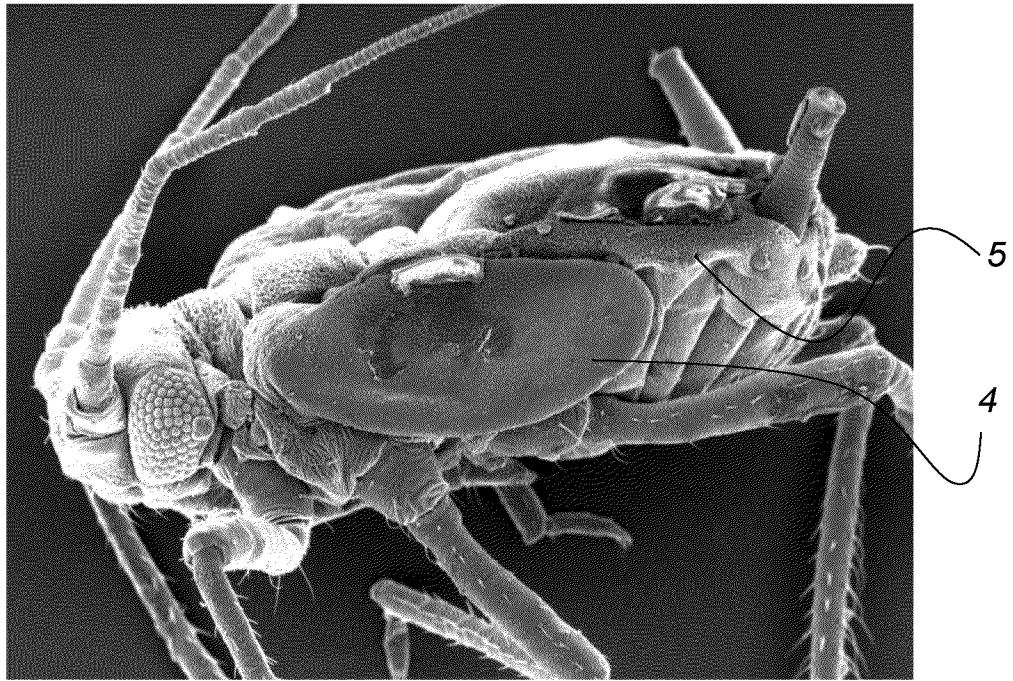


Fig. 6a

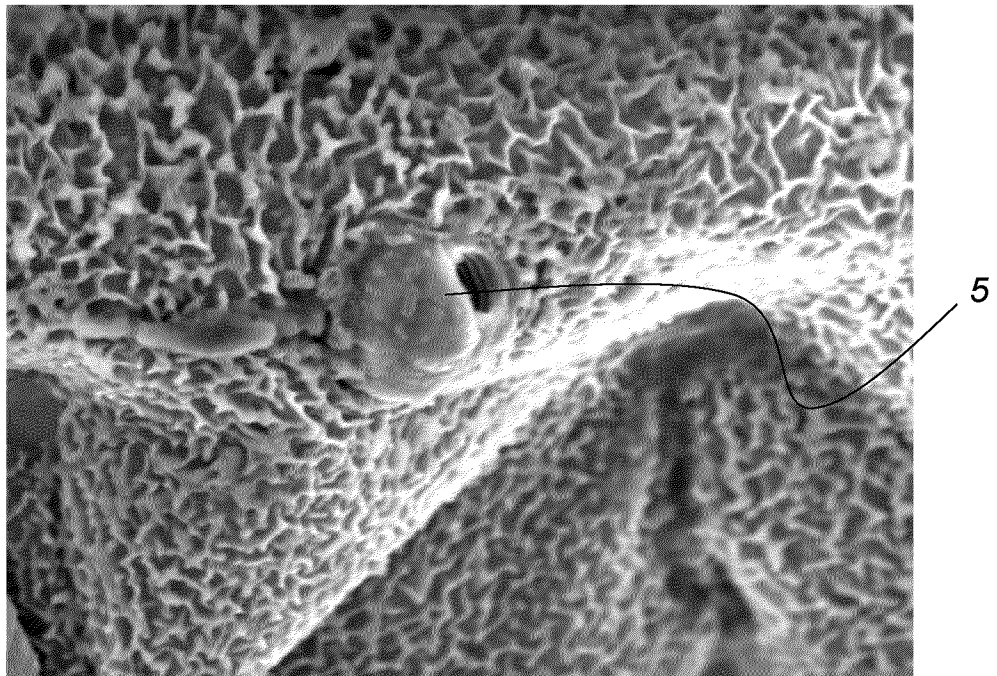


Fig. 6b

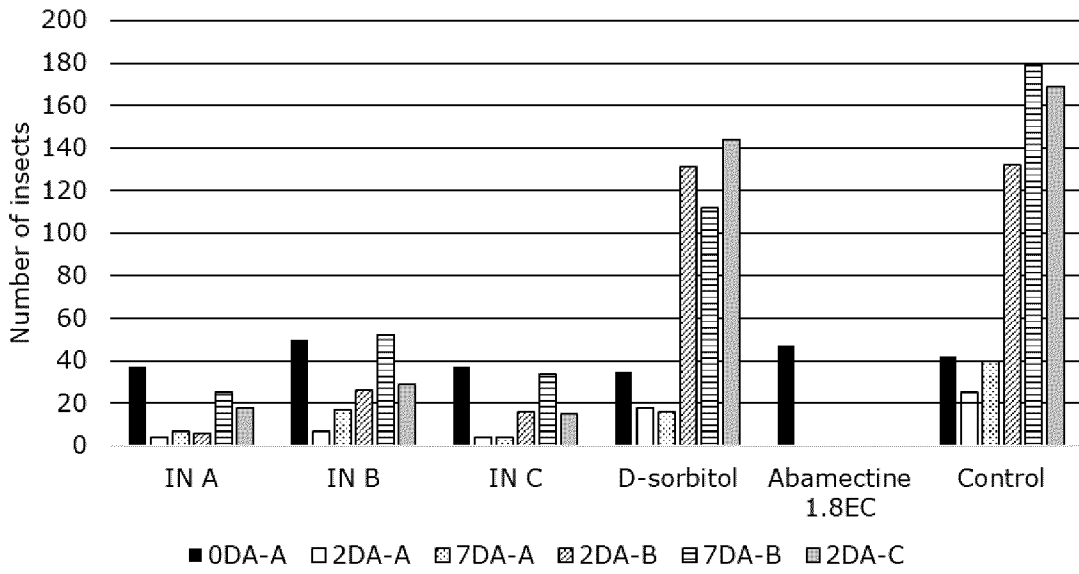


Fig. 7

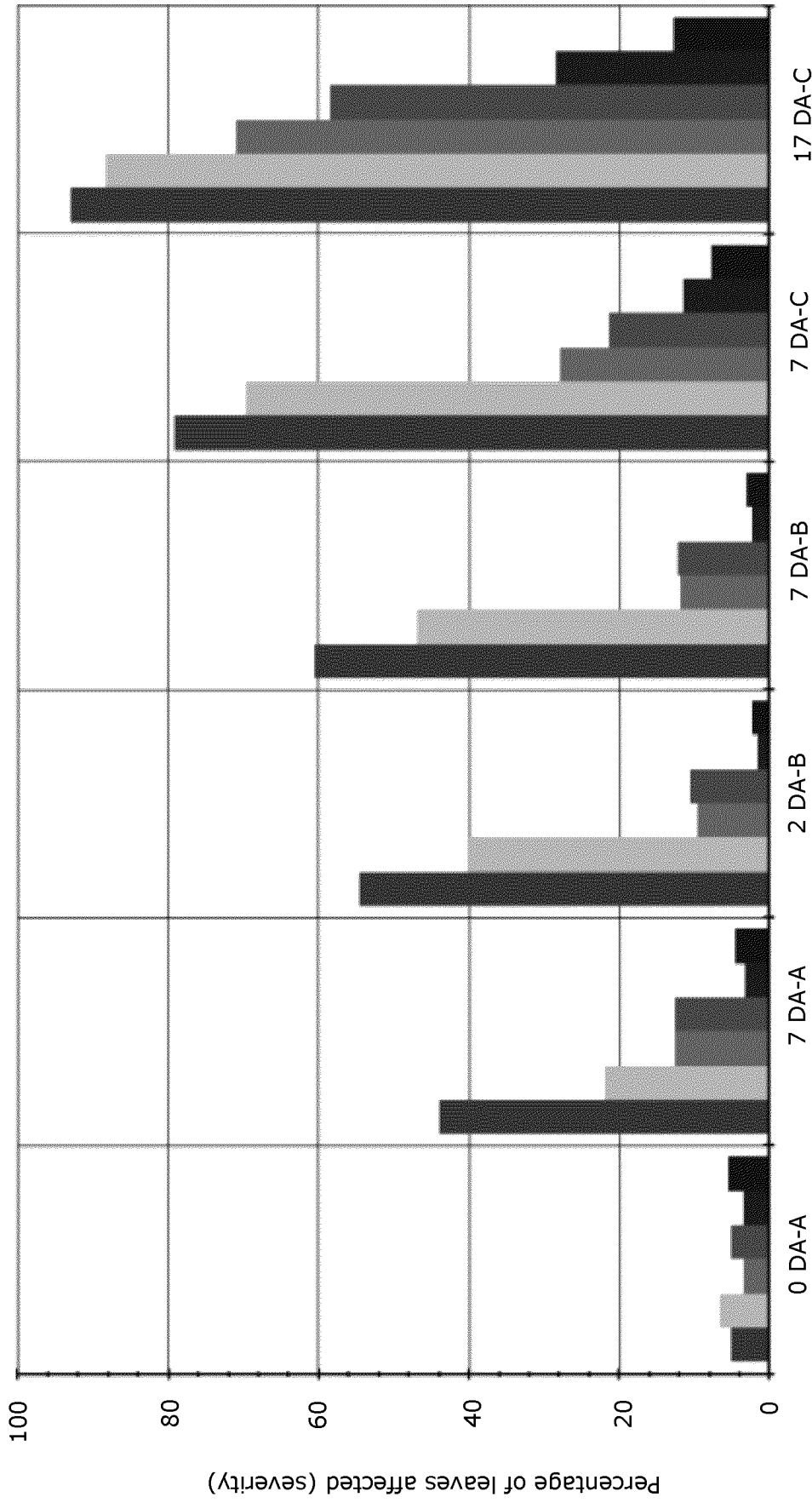


Fig. 8a

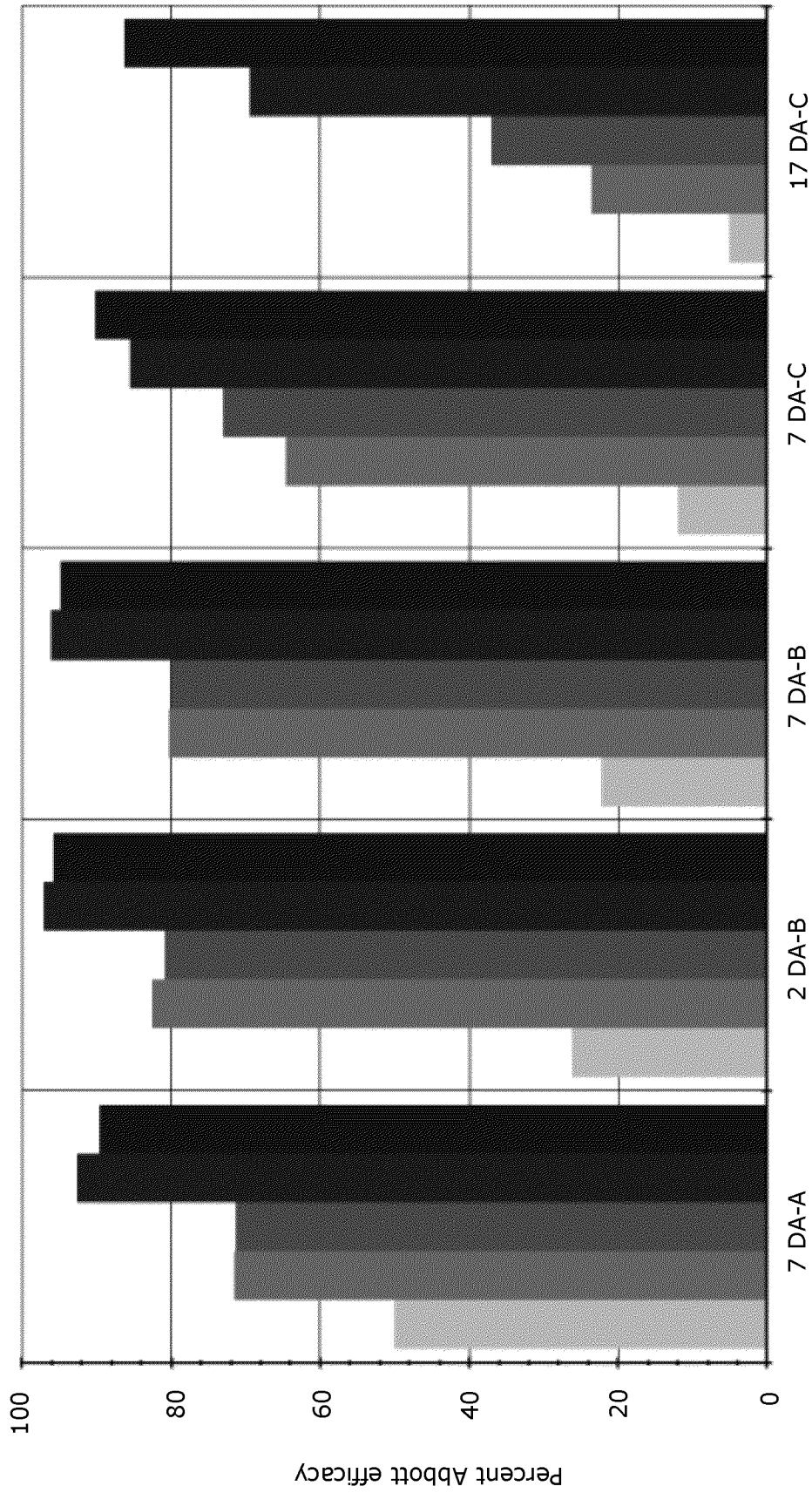


Fig. 8b

INTERNATIONAL SEARCH REPORT

International application No PCT/EP2024/080267

A. CLASSIFICATION OF SUBJECT MATTER					
INV.	A01N25/02	A01N25/30	A01N43/16	A01P7/00	A01P17/00
	A01N31/02	A01N37/02	A01N43/56	A01N43/90	A01N47/06
	A01N53/00	A01N59/02	A01N63/30	A01P7/02	A01P7/04
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 A01P

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, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/318774 A1 (PATEL SMITA [DE] ET AL) 25 December 2008 (2008-12-25)	1, 3, 6, 10, 11, 15
Y	claims 1-5 page 18, paragraph 365 - page 19; examples 1-2; table 1	2, 4, 5, 7-9, 12-14

Y	US 11 771 938 B2 (TYCO FIRE PRODUCTS LP [US]) 3 October 2023 (2023-10-03) claims 1, 9, 11, 16-17, 25 page 10, column 16; table 2 page 13, column 22 - page 14, column 23; example 1; table 4	1-15

-/-		

<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C.	<input checked="" type="checkbox"/> See patent family annex.
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* Special categories of cited documents :

<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"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</p> <p>"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</p> <p>"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</p> <p>"&" document member of the same patent family</p>
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Date of the actual completion of the international search 9 January 2025	Date of mailing of the international search report 17/01/2025
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Größl, Sylvester
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INTERNATIONAL SEARCH REPORT

International application No
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Y	DÍAZ-FLEISCHER FRANCISCO ET AL: "Sickly Sweet: Insecticidal Polyols Induce Lethal Regurgitation in Dipteran Pests", INSECTS , vol. 10, no. 2 12 February 2019 (2019-02-12), page 53, XP093145680, CH ISSN: 2075-4450, DOI: 10.3390/insects10020053 Retrieved from the Internet: URL:https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6410098/pdf/insects-10-00053.pdf title abstract chapters 1, 2.2 and 2.4; page 2 ch. 3.1; page 5 ch. 3.3; page 7 - page 8 ch. 3.5; page 9 - page 10 ch. 4; page 10 - page 11 -----	1-15
Y	AU 2021 245 085 A1 (BIONOME TECH LIMITED [GB]) 1 December 2022 (2022-12-01) claims 4,6-8,14,18,21-23 page 3, line 27 - page 4, line 11 -----	1-15
X	WO 2019/104025 A1 (VALENT USA LLC [US]) 31 May 2019 (2019-05-31)	1,3,6, 10,11,15
Y	claims 1-2,5,7,11-13,17-18,21 page 12 - page 13; examples 1-3,5; table 1 -----	2,4,5, 7-9, 12-14
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International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	claims 3-4, 6-8 page 12, line 31 - page 13, line 3 -----	4,5,8,9, 12-14

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Information on patent family members

International application No

PCT/EP2024/080267

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