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(73) Patenthaver: **Stichting I-F Product Collaboration, Prins Bernhardplein 200, 1097 JB Amsterdam, Holland**

(72) Opfinder: **PELLACINI, Franco, Via Giacomo Balla 14, I-20151 Milano, Italien**
**VAZZOLA, Matteo Santino, Via P. Mascagni 11, I-20815 Cogliate (MB), Italien**
**SINANI, Entela, Via Monte San Michele 4, I-28100 Novara, Italien**
**RISERVATO, Manuela, Via Maestra T.Q. 130, I-28100 Novara, Italien**
**GUSMEROLI, Marilena, Viale Libertà, 114/B, I-20900 Monza (MB), Italien**

(74) Fuldmægtig i Danmark: **Plougmann Vingtoft A/S, Strandvejen 70, 2900 Hellerup, Danmark**

(54) Benævnelse: **SYNERGISTISKE SAMMENSÆTNINGER TIL BESKYTTELSEN AF LANDBRUGSAFGRØDER OG ANVENDELSEN DERAF**

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# DESCRIPTION

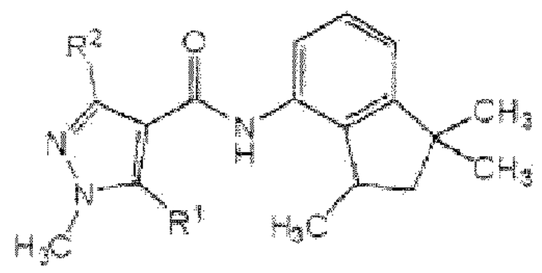
**[0001]** The present invention relates to synergistic compositions for the protection of agricultural crops and use thereof.

**[0002]** In particular, object of the present invention are compositions comprising one compound belonging to the N-indanyl-pyrazolecarboxamides chemical class and one or more fungicidal or insecticidal compounds.

**[0003]** In the application of antiparasitic products for agricultural use, it is widely known to combine two or more products having a different mechanism of action and/or a different biological target, in order to broaden the action range of the mixtures with respect to the product used individually and to prevent the occurrence of resistance phenomena from the harmful organisms, phenomena which with time tend to reduce the effectiveness of the antiparasitic products used.

**[0004]** Compositions of fungicidal N-indanyl-1-methyl-3-(halo)alkyl-4-pyrazolecarboxamides with fungicidal or insecticidal compounds such as azoles, strobilurins, acylalanines, phenylpyrroles, chlorothalonil, dithiocarbamates, abamectin, insecticidal diamides, neonicotinoids, sulfoxaflor, pyrethroids, carbamates, phenylpyrazoles, are describen in the patent applications WO 2011/135833, WO 2011/135835, WO 2011/135836, WO 2011/135837, WO 2011/135838, WO 2011/135839, WO 2011/135827, WO 2011/135828, WO 2011/135830, WO 2011/135831, WO 2011/135832, WO 2011/135834, WO 2011/135840.

**[0005]** WO 2011/135833 A1 discloses a composition comprising a carboxamide compound represented by following formula (I),




(I)

wherein R1 represents a hydrogen atom or a methyl group, and R2 represents a methyl group, a difluoromethyl group or a trifluoromethyl group, and one or more azole compounds selected from group (A) consisting of propiconazole, prothioconazole, triadimenol, prochloraz, penconazole, tebuconazole, flusilazole, diniconazole, bromuconazole, epoxiconazole, difenoconazole, cyproconazole, metconazole, triflumizole, tetraconazole, myclobutanil, fenbuconazole, hexaconazole, fluquinconazole, triticonazole, bitertanol, imazalil, ipconazole, simeconazole, hymexazol, etridiazole and flutriafol.

**[0006]** The applicant has now surprisingly found that combining one specific fungicidal compound belonging to the class of N-indanyl-pyrazolecarboxamides with one or more compounds selected from a series of compounds having fungicidal or insecticidal activity, compositions are obtained having biological activities which are:

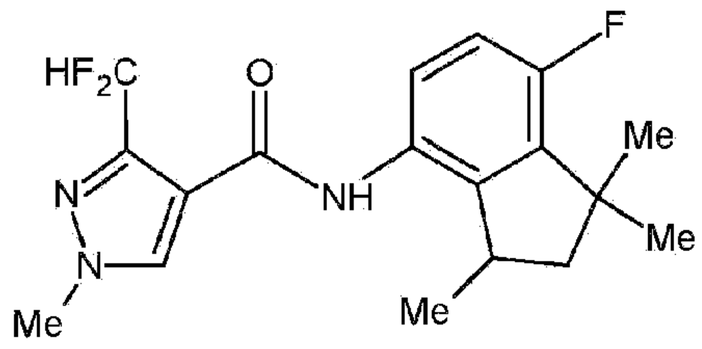
1. 1) improved with respect to those expected on the basis of the activities of the products

used alone;

2. 2) superior to those achievable with the compositions disclosed in said prior art documents.

**[0007]** A first object of the present invention therefore relates to synergistic compositions for the protection of agricultural crops according to claim 1 comprising:

- at least a component [A] consisting of the compound of formula (I) 3-difluoromethyl-N-(7-fluoro-1,1,3-trimethyl-4-indanyl)-1-methyl-4-pyrazolecarboxamide




(I)

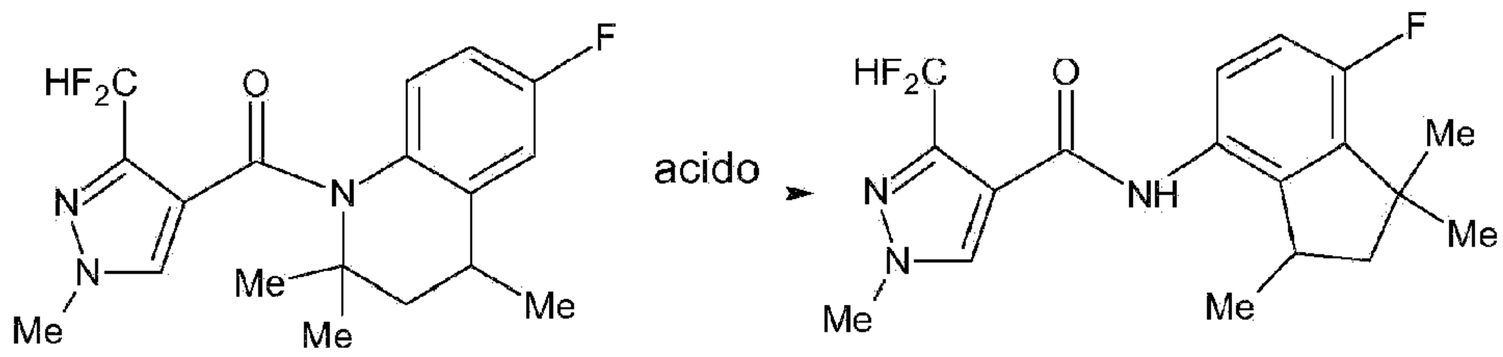
wherein Me represents a methyl group $CH_3$-,

- at least a component [B] selected from fungicidal or insecticidal compounds belonging to one or more of the following groups of fungicidal and insecticidal compounds of claim 1.

**[0008]** The compound of formula (I) can be prepared:

1. 1) by acid isomerization of N-(3-difluoromethyl-1-methyl-1H-4-pyrazolecarbonyl)-6-fluoro-2,2,4-trimethyl-1,2,3,4-tetrahydro-quinoline (II), according to reaction scheme 1, and as described in Example 1:

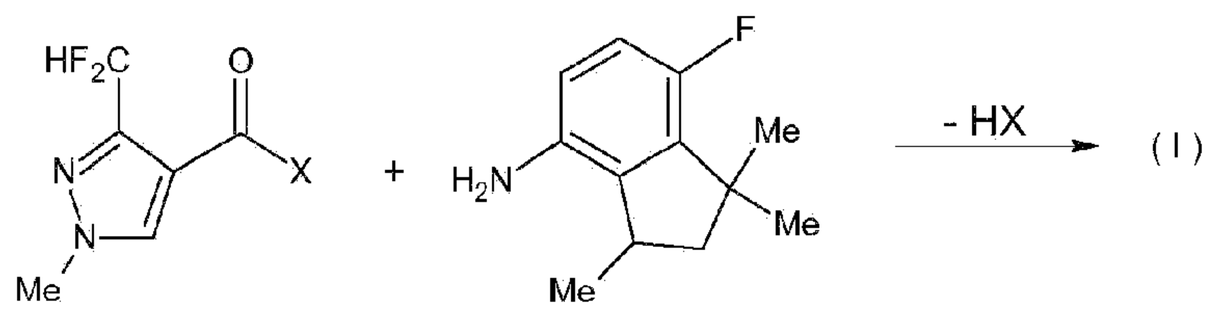
scheme 1




(II) (I)

2. 2) by condensation of 3-difluoromethyl-1-methyl-1H-pyrazole-4-carboxylic acid or its derivative, of general formula (III), with 7-fluoro-1,1,3-trimethyl-4-aminoindane (IV), utilizing methods well known in organic chemistry, according to scheme 2:

scheme 2

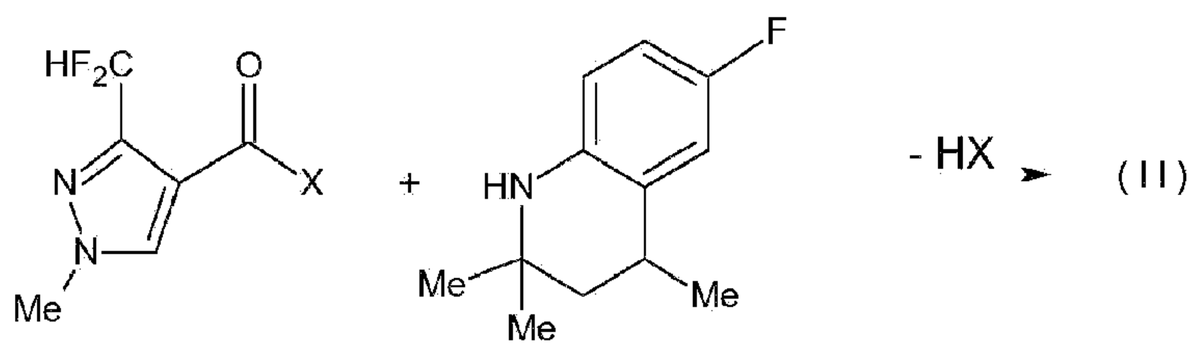


(III) (IV)

wherein X represents a group selected from OH, alkoxy $C_1$-$C_6$ or a halogen atom (preferably chlorine).

**[0009]** The intermediate of formula (II) is in turn obtained by condensation of a compound of general formula (III) with 6-fluoro-2,2,4-trimethyl-1,2,3,4-tetrahydroquinoline (V), according to scheme 3:

scheme 3



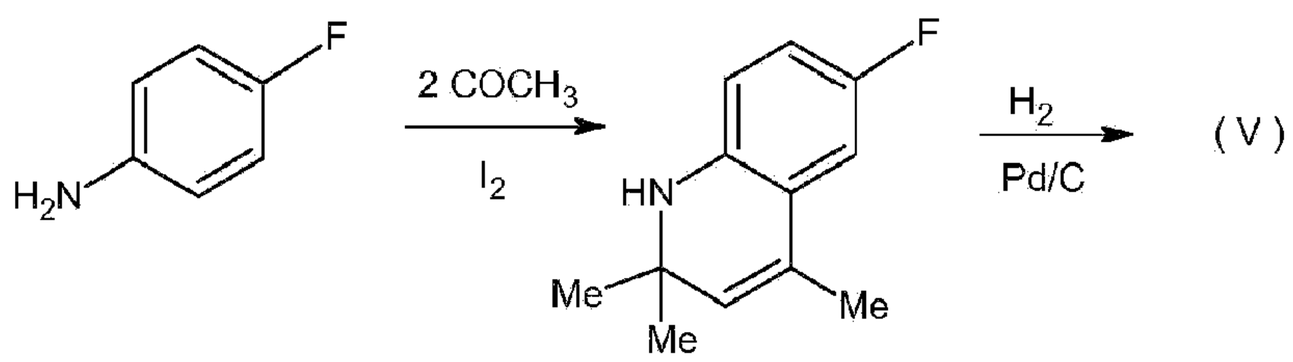

(III) (V)

wherein X represents a group selected from OH, alkoxy $C_1$-$C_6$ or a halogen atom (preferably chlorine).

**[0010]** The 3-difluoromethyl-1-methyl-1H-pyrazole-4-carboxylic acid and its derivatives of general formula (III) are known products, described for example in the patent N. US 5,093,347.

**[0011]** The intermediate of formula (V) can be prepared, according to reaction scheme 4, by hydrogenation of 6-fluoro-2,2,4-trimethyl-1,2-dihydroquinoline (VI), in turn obtained according to a method described in Organic Synthesis, Coll. Vol. III, pag. 329, starting from acetone and 4-fluoroaniline:

scheme 4




(VI)

in the aforesaid formulas (I)-(VI) Me represents a methyl group $CH_3$-.

**[0012]** The aminoindane of formula (IV) can be prepared, analogously to what described in the patent N. EP 0654464, by condensation of 6-fluoro-2,2,4-trimethyl-1,2-dihydroquinoline (VI) with a carboxylic acid or its derivative, hydrogenation on Pd/C, isomerization with sulfuric acid and hydrolysis of the amide bond with water in acetic acid.

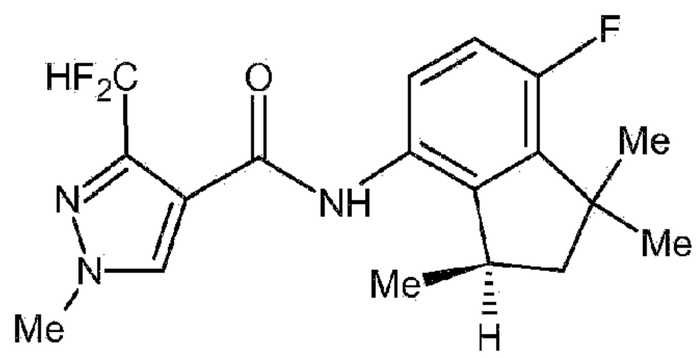
**[0013]** The compound of formula (I) contains an asymmetric carbon atom in position 3 of the indanyl group and it is usually obtained as racemic mixture of the two enantiomers having configurations R and S (molar ratio R:S equal to 1:1). However, it is possible to preparare

mixtures of the two enantiomers of the compound of formula (I) wherein the ratio R:S is different from 1:1 (enriched mixtures).

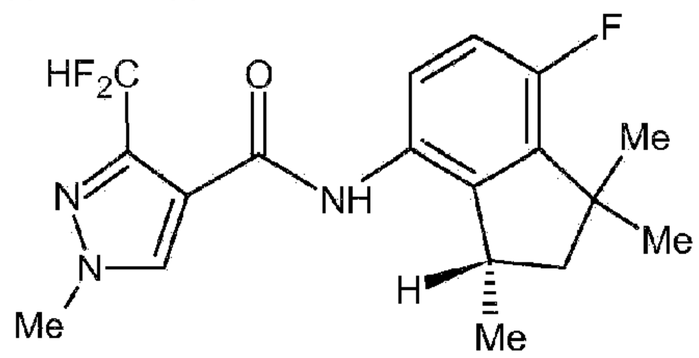
**[0014]** Moreover, it is possible to preparare the single enantiomers R and S of the compound of formula (I) in substantially pure form (> 99,99% by weight).

**[0015]** The aforesaid enantiomeric enriched mixtures and the substantially pure single enantiomers can be prepared, for example, by condensing the compounds of general formula (III) with enriched or enantiomerically pure forms (substantially pure single enantiomers) of the aminoindane of formula (IV), according to the reaction scheme 2; enriched or enantiomerically pure forms of the aminoindane of formula (IV) can be in turn obtained through enantioselective reactions and/or chemical and/or chromatographic separation of the enantiomers, according to methods described in literature for analogous products, for example as disclosed in the aforesaid EP 0654464.

**[0016]** In the synergistic compositions of the present invention the compound of formula (I) can be a racemic mixture, (I)-RS, or an enriched mixture of one of the two enantiomers, or even a substantially pure specific enantiomer (I)-R or (I)-S.




(I)-R




(I)-S

**[0017]** In the case of enriched mixtures of the compound of formula (I), those enriched in the enantiomer R are preferred, preferably with an R:S ratio of the two enantiomers ranging from 51:49 to 99.99:0.01 by weight.

**[0018]** Among the two enantiomeric forms of the compound of formula (I), the substantially pure isomer R is preferred.

**[0019]** The compounds among which to select the component [B] of the synergistic compositions are here indicated with their common international ISO name; their chemical structures and CAS and IUPAC chemical names are reported on the Alan Wood's Website (www.alanwood.net), Compendium of Pesticide Common Names; for most compounds, these features are also reported, togheter with chemical-physical data and biological features, in the "Pesticide Manual", C.D.S. Tomlin, 15th Edition, 2009, British Crop Production Council Editor.

**[0020]** Components [B] of the compositions object of the present invention are:

i) azoles: difenoconazole, flutriafol, prothioconazole, tetra-conazole;

ii) amino-derivatives: spiroxamine;

iii) strobilurins: azoxystrobin, fluoxa-strobin, kresoxim-methyl, pyraclostrobin;

vii) dicarboximides: iprodione;

viii) polyhalogenated fungicides: chlorothalonil;

ix) SAR inductors: acibenzolar;

xi) acylalanines: benalaxyl;

xii) anti-peronosporic compoundsvalifenalate;

xiii) dithiocarbamates: mancozeb;

xvi) copper-based cupric fungicides: copper (II) hydroxide, copper oxychloride;

xvii) fungicidal amides: boscalid, fluopyram, isopyrazam, penthiopyrad;

xix) neonicotinoids: imidacloprid;

xxi) pyrethroids: bifenthrin;

**[0021]** Among the aforesaid, components [B] particularly preferred are:

i) difenoconazole, prothioconazole, tetraconazole;

ii) spiroxamine;

iii) azoxystrobin, fluoxastrobin, kresoxim-methyl, pyraclostrobin;

vii) iprodione;

viii) chlorothalonil;

xi) benalaxyl;

xii) valifenalate;

xvi) copper oxychloride;

xix) imidacloprid.

**[0022]** The weight ratios of components [A] and [B] in the compositions object of the present invention can vary within a wide range, even depending on the parasites to be controlled and on the single component [B] used (or the plurality of components [B] used), and are usually

comprised between 1:20 and 20:1.

**[0023]** Preferred compositions are those comprising at least the following combinations of compounds:

C1: (I)-RS + tetraconazole;

C4: (I)-RS + difenoconazole;

C6: (I)-RS + flutriafol;

C8: (I)-RS + prothioconazole;

C11 (I)-RS + spiroxamine;

C12: (I)-RS + azoxystrobin;

C13: (I)-RS + fluoxastrobin;

C14: (I)-RS + kresoxim-methyl;

C16: (I)-RS + pyraclostrobin;

C22: (I)-RS + iprodione;

C26: (I)-RS + chlorothalonil;

C35: (I)-RS + valifenalate;

C39: (I)-RS + imidacloprid;

C49: (I)-RS + tetraconazole + azoxystrobin;

C50: (I)-RS + tebuconazole + azoxystrobin;

C51: (I)-RS + epoxyconazole + azoxystrobin;

C52: (I)-RS + cyproconazole + azoxystrobin;

C53: (I)-RS + propiconazole + azoxystrobin;

C54: (I)-RS + prothioconazole + azoxystrobin;

C55: (I)-RS + tetraconazole + picoxystrobin;

C60: (I)-RS + prothioconazole + picoxystrobin;

C61: (I)-RS + tetraconazole + kresoxim methyl;

C62: (I)-RS + tebuconazole + kresoxim methyl;

C64: (I)-RS + cyproconazole + kresoxim methyl;

C65: (I)-RS + propiconazole + kresoxim methyl;

C66: (I)-RS + prothioconazole + kresoxim methyl;

C67: (I)-RS + chlorothalonil + azoxystrobin;

C68: (I)-RS + chlorothalonil + picoxystrobin;

C69: (I)-RS + chlorothalonil + pyraclostrobin;

C70: (I)-RS + chlorothalonil + kresoxim methyl;

C71: (I)-RS + copper (II) hydroxide + copper oxychloride;

C72: (I)-RS + copper (II) hydroxide + copper oxychloride + copper salycilate $C_7H_4O_3 \cdot Cu$;

C73: (I)-$R_8S_2$ + tetraconazole;

C74: (I) -$R_8S_2$ + azoxystrobin;

C75: (I) -$R_8S_2$ + benalaxyl;

C76: (I) -$R_9S_1$ + tetraconazole;

C77: (I) -$R_9S_1$ + azoxystrobin;

C78: (I)-R + tetraconazole;

wherein:

- (I)-RS represents the compound of formula (I) in form of racemic mixture,
- (I)-$R_8S_2$ represents the compound having the enantiomers R and S in molar ratio R:S = 8:2,
- (I)-$R_9S_1$ represents the compound having the enantiomers R and S in molar ratio R:S = 9:1,
- (I)-R represents the enantiomer R in substantially pure form (>99,99 weight %).

**[0024]** Preferably, in said compositions C1, C4, C6, C8, C11-C14, C16, C22, C35, C39 and C73-C77 the weight ratio of components [A] e [B] ranges from 1:20 to 20:1.

**[0025]** Preferably, in said composition C26 the weight ratio of components [A] e [B] ranges from 1:20 to a 20:10.

**[0026]** Preferably, in said compositions C49-C55, C60-C69 the weight ratio of component [A] with respect to the two components [B] ([A]:[$B_1$]:[$B_2$]) ranges from 1:20:20 to 20:1:1.

**[0027]** Preferably, in said composition C70 the weight ratio of component [A] with respect to the two components [B] ([A]:[$B_1$]:[$B_2$]) ranges from 1:20:20 to 20:10:1, whereas in C71 the ratio [A]:[$B_1$]:[$B_2$] ranges from 1:20:20 to 20:10:10.

**[0028]** Preferably, in said composition C72, the weight ratio of component [A] with respect to the three components [B] ([A]:[$B_1$]:[$B_2$]:[$B_3$]) ranges from 1:20: 20:20 to 20:10:10:10.

**[0029]** As said, the compositions object of the present invention exhibit a strong synergistic effect, which can be evaluated by applying the Colby's formula ("Weeds", 1967, 15, pag. 20-22):

$$E_t = E_A+E_B-(E_A x E_B/100)$$

wherein $E_t$ is the expected efficacy percentage for the composition containing the compounds A and B at the dosages $d_A+d_B$, $E_A$ is the efficacy percentage observed for the component A at the dosage dA, $E_B$ is the efficacy percentage observed for the component B at the dosage $d_B$.

**[0030]** When the efficacy observed for the composition A+B ($E_{A+B}$) is higher than the efficacy expected according to the Colby's formula ($E_{A+B}/E_t > 1$), there is the presence of a synergistic effect .

**[0031]** In case of ternary combinations, the Colby's formula becomes:

$$E_t = E_A+E_{B1}+E_{B2}-(E_A \cdot E_{B1}+E_A \cdot E_{B2}+E_{B1} \cdot E_{B2}/100)+(E_A \cdot E_{B1} \cdot E_{B2}/10000)$$

wherein $E_t$ is the expected efficacy percentage for the composition containing the compounds A, B1 e B2 at the dosages $d_A+d_{B1}+d_{B2}$, $E_A$ is the efficay percentag observed for the component A at the dosage $d_A$, $E_{B1}$ is the efficacy percentage observed for the component B1 at the dosage $d_{B1}$, $E_{B2}$ is the efficacy percentage observed for the component B2 at the dosage $d_{B2}$. When the efficacy observed for the composition A+B1+B2 ($E_{A+B1+B2}$) is higher than the efficacy expected according to the Colby's formula ($E_{A+B1+B2}/E_t > 1$), there is the presence of a synergistic effect.

**[0032]** Due to the high synergistic effects, the amplitude of the action range, the considerable reduction in resistance phenomena from the target microorganisms, the compositions object of the present invention are endowed with a very high fungicidal activity, which is exerted with respect to numerous phytopathogenic fungi attacking important agricultural crops.

**[0033]** Said compositions exert a fungicidal activity which can be curative, preventive or eradicant, and generally have a very low or null phytotoxicity on the treated crops.

**[0034]** It is therefore a further object of the present invention the use of the synergistic fungicidal compositions described above for the control of phytopathogenic fungi in agricultural crops.

**[0035]** Examples of phytopathogenic fungi that can be effectively treated and fought with the

compositions of the present invention, are those belonging to the groups of Basidiomycetes, Ascomycetes, Deuteromycetes or imperfect fungi, Oomycetes: *Puccinia* spp., *Ustilago* spp., *Tilletia* spp., *Uromyces* spp., *Phakopsora* spp., *Rhizoctonia* spp., *Erysiphe* spp., *Sphaerotheca* spp., *Podosphaera* spp., *Uncinula* spp., *Helminthosporium* spp., *Rhynchosporium* spp., *Pyrenophora* spp., *Monilinia* spp., *Sclerotinia* spp., *Septoria* spp. (*Mycosphaerella* spp.), *Venturia* spp., *Botrytis* spp., *Alternaria* spp., *Fusarium* spp., *Cercospora* spp., *Cercosporella herpotrichoides, Colletotrichum* spp., *Pyricularia oryzae, Sclerotium* spp., *Phytophtora* spp., *Pythium* spp., *Plasmopara viticola, Peronospora* spp., *Pseudoperonospora cubensis, Bremia lactucae.*

**[0036]** The main crops that can be protected with the compositions according to the present invention comprise cereals (wheat, barley, rye, oats, rice, maize, sorghum, etc.), fruit trees (apples, pears, plums, peaches, almonds, cherries, bananas, grapes, strawberries, raspberries, blackberries, etc.), citrus trees (oranges, lemons, mandarins, grapefruit, etc.), legumes (beans, peas, lentils, soybean, etc.), vegetables (spinach, lettuce, asparagus, cabbage, carrots, onions, tomatoes, potatoes, eggplants, peppers, etc.), cucurbitaceae (pumpkins, zucchini, cucumbers, melons, watermelons, etc.), oleaginous plants (sunflower, rape, peanut, castor, coconut, etc.), tobacco, coffee, tea, cocoa, sugar beet, sugar cane, cotton.

**[0037]** In particular, the compositions of the present invention have proved to be particularly effective in the control of *Plasmopara viticola* on vines, *Phytophtora infestans and Botrytis Cinerea* on tomatoes, *Puccinia recondita, Erysiphae graminis, Helminthosporium teres, Septoria nodorum and Fusarium* spp. on cereals, in the control of *Phakopsora pachyrhizi* on soybean, in the control of *Uromyces Appendiculatus* on beans, in the control of *Venturia inaequalis* on apple-trees, in the control of *Sphaerotheca fuliginea* on cucumbers.

**[0038]** In addition, the compositions of the present invention are also effective in the control of phytopathogenic bacteria and viruses, such as, for example, *Xanthomonas* spp., *Pseudomonas* spp., *Erwinia amylovora,* the tobacco mosaic virus.

**[0039]** The compositions comprising at least a compound of formula (I) and, as component [B], at least an insecticidal compound selected from one or more of the aforesaid groups of compounds xix and xxi, besides having an excellent fungicidal activity, also have an excellent insecticidal activity against numerous species of insects harmful to agricultural crops.

**[0040]** Examples of insects which can be controlled with the above said compositions, are those belonging to the order of Hemipthera, Lepidopthera, Tysanopthera, Dipthera, Coleopthera, Orthopthera, Hymenopthera: Aphis *gossypii, Myzus persicae, Macrosiphum euphorbiae, Brevicoryne brassicae, Toxoptera citricidus, Trialeurodes vaporariorum, Bemisia tabaci, Aonidiella aurantii, Comstockaspis perniciosa, Unaspis citri, Psylla piri, Laodelphax striatellus, Nilaparvata lugens, Nephotettix cincticeps, Nephotettix virescens, Chilo suppressalis, Ostrinia spp., Spodoptera spp., Mamestra brassicae, Agrotis spp., Thricoplusia spp., Heliothis spp., Helicoverpa spp., Pieris spp., Adoxophyes spp., Grapholita molesta, Cydia*

*spp., Phyllonorycter blancardella, Lymantria spp., Plutella xylostella, Pectinophora gossypiella, Hyphantria cunea, Thrips spp., Frankliniella spp., Dacus spp., Ceratitis capitata, Liriomyza trifolii, Anthonomus grandis, Callosobruchus chinensis, Diabrotica spp., Agriotes spp., Tribolium spp., Locusta migratoria, Oxya spp., Solenopsis spp., Blattella germanica, Periplaneta spp.*

**[0041]** Even if the components [A] and [B] can be mixed and applied as such on the crops to be protected, for the practical use in agriculture, it is usually preferable to use the fungicidal compositions, according to the present invention, in the form of suitable phytosanitary formulations.

**[0042]** The component [A] and the components [B] can be formulated separately and mixed in the preselected diluent (for example water) at the moment of the treatment of the agricultural crops to be protected, or combined together in single formulation ready to use before treatment.

**[0043]** Both in the case of components formulated separately, and in the case of components [A] and [B] combined together in formulations ready to use, the formulations can be in the form of dry powders, wettable powders, emulsifiable concentrates, emulsions, micro-emulsions, pastes, granules, water-dispersible granules, solutions, suspensions, etc.: the selection of the type of formulation depends both on the characteristics of components A and B, and on the specific use.

**[0044]** The compositions are prepared with known methods, for example by diluting the active ingredients with a solid or liquid diluent, possibly in the presence of surfactants, dispersers, suspending agents, stabilizers, adjuvants, etc..

**[0045]** The following can be used, for example, as solid diluent or carriers: silica, kaolin, bentonite, talc, diatomaceous earth, dolomite, calcium carbonate, magnesia, gypsum, clays, synthetic silicates, attapulgite, seppiolites.

**[0046]** The following can be used, for example, as solvents or liquid diluents, in addition to water, aromatic organic solvents (xyloles or alkylbenzole mixtures, chlorobenzene, etc.), paraffins (oil cuts), alcohols (methanol, propanol, butanol, octanol, glycerol, etc.), esters (ethyl acetate, isobutyl acetate, alkyl carbonates, alkyl esters of adipic acid, alkyl esters of glutaric acid, alkyl esters of succinic acid, alkyl esters of lactic acid, etc.), vegetable oils (rapeseed oil, sunflower oil, soybean oil, castor oil, corn oil, peanut oil, and their alkyl esters), ketones (cyclohexanone, acetone, acetophenone, isophorone, ethyl amyl ketone, etc.), amides (N, N-dimethylformamide, N-methylpyrrolidone, etc.), sulfoxides and sulfones (dimethylsulfoxide, dimethylsulfone, etc.) and mixtures thereof.

**[0047]** Surfactants that can be used are sodium salts, calcium salts, potassium salts, triethylamine or triethanolamine of alkylnaphthalensulfonates, polynaphthalenesulfonates, alkylsulfonates, arylsulfonates, alkylarylsulfonates, polycarboxylates, sulfosuccinates, alkylsulfosuccinates, lignin sulfonates, alkyl sulfates; and again polyethoxylated fatty alcohols,

polyethoxylated alkyl phenols, polyethoxylated esters of sorbitol, polyethoxylated polypropoxy (block copolymers), can be used.

**[0048]** The compositions can also contain special additives for particular purposes, for example antifreeze agents such as propylene glycol, or adhesives such as Arabic gum, polyvinyl alcohol, polyvinylpyrrolidone, etc..

**[0049]** If desired, other active ingredients compatible with [A] and [B] can be added to the compositions, such as, for example, furher fungicidal or insecticidal compounds different from components [B] described above, phytoregulators, antibiotics, herbicides, fertilizers and/or mixtures thereof.

**[0050]** Examples of fungicides, other than components [B], that can be included in the synergistic compositions object of the present invention are listed hereunder with their international ISO name: ampropylfos, anilazine, benodanil, blasticidin-S, bupirimate, buthiobate, chinomethionat, chloroneb, chlozolinate, debacarb, dichlone, diclobutrazol, diclomezine, dicloran, diclocymet, diethofencarb, diflumetorim, dimethirimol, dinocap, dipyrithione, ditalimfos, dithianon, edifenphos, ethirimol, ethoxyquin, etridiazole, fenaminosulf, fenapanil, fenarimol, fenfuram, fenoxanil, fentin, ferbam, ferimzone, fluoroimide, fluotrimazole, flusulfamide, hymexazol, hydroxy-quinoline sulfate, iprobenfos, isoprothiolane, kasugamycin, mancopper, mebenil, mepronil, meptyldinocap, methfuroxam, metiram, metsulfovax, natamycin, nitrothal-isopropyl, nuarimol, ofurace, oxadixyl, pefurazoate, pencycuron, pentachlorofenol and its salts, phthalide, piperalin, polyoxins, propamocarb, prothiocarb, pyracarbolid, pyrazophos, pyribencarb, pyrifenox, pyroquilon, pyroxyfur, quinacetol, quinazamid, quintozene, streptomycin, thiadifluor, thicyofen, thiram, tioxymid, tolclofos-methyl, triarimol, triazbutil, triazoxide, tricyclazole, triforine, validamycin, vinclozolin, ziram, sulfur.

**[0051]** The total concentration of components [A] and [B] in said compositions can vary within a wide range; it generally ranges from 1% to 99% by weight with respect to the total weight of the composition, preferably from 5% to 90% by weight with respect to the total weight of the composition.

**[0052]** In order to protect the agricultural crops, the compositions object of the present invention can be applied to any part of the plant, or on the seeds before sowing, or on the ground in which the plant grows.

**[0053]** A further object of the present invention therefore relates to a method for the control of phytopathogenic fungi in agricultural crops, which comprises applying an effective dose of at least one synergistic fungicidal composition of the type described above on one or more parts of the plant to be protected (for example, on seedlings, leaves, fruits, stems, branches, roots) and/or on the seeds of said plants before sowing, and/or on the ground in which the plant grows.

**[0054]** Preferred way of application for the compositions comprising the compound (I) and at

least an insecticidal compound selected from one or more groups of compounds xix and xxi is the seed-dressing.

**[0055]** The total amount of components [A] and [B] to be applied in order to obtain the desired effect can vary according to different factors such as, for example, the compounds used, the crop to be preserved, the type of pathogen or insect, the degree of infection, the climatic conditions, the application method, the formulation used.

**[0056]** Overall doses of components [A] and [B] ranging from 10 g to 5 kg per hectare of agricultural crop generally provide a sufficient control.

**[0057]** The following examples are provided for a better understanding of the invention, which should be considered as being illustrative and non-limiting of the same.

**EXAMPLE 1**

**Preparation of the 3-difluoromethyl-N-(7-fluoro-1,1,3-trimethyl-4-indanyl)-1-methyl-4-pyrazolecarboxamide (I)**

**[0058]** A solution of 40 g of 3-(difluoromethyl)-1-methyl-1H-pyrazole-4-carbonyl chloride [compound of formula (III); MW 194,5] in 40 ml of dichloroethane, is dropped at room temperature in a solution of 34 g of 6-fluoro-2,2,4-trimethyl-1,2,3,4-tetrahydroquinoline [compound of formula (V); MW 193] and 30 ml of triethylamine in 200 ml of dichloroethane.

**[0059]** After stirring for 3 hours at reflux, the reaction mixture is poured in water (1,2 1) and extracted with dichloroethane. The organic layer is washed with 10% aqueous hydrochloric acid, anhydrified with sodium sulfate, concentrated under vacuum to afford 58 g of a crude solid product corresponding to N-(3-difluoromethyl-1-methyl-1H-4-pyrazolecarbonyl)-6-fluoro-2,2,4-trimethyl-1,2,3,4-tetrahydroquinoline [compound of formula (II); GC-mass: $M^+$ = 351].

**[0060]** To this crude product, 165 ml of 85% aqueous sulfuric acid are added and the mixture is then heated under stirring at 60°C for 30 minutes. After cooling the mixture is poured into water and ice, and extracted with dichloromethane. The organic layer is then washed with water, with a saturated solution of sodium bicarbonate in water, and with a saturated solution of sodium chloride in water. The organic layer is anhydrified with sodium sulfate and concentrated under vacuum: the residue is purified by chromatography on silica gel (eluent heptane/EtOAc 6:4) to give 48 g of a white solid with melting point 147°C, corresponding to the desired product in racemic form, (I)-RS. GC-mass: $M^+$ = 351.

$^1$H NMR (200 Mhz, $CDCl_3$) δ at: 1,43 (3H,d), 1,38 (3H,s), 1,44 (3H,s), 1,66 (1H,dd), 2,21 (1H,dd), 3,38 (1H m), 3,98(3H,s),6,81 (1H, bs), 6,95 (1H,t), 6,70.(1H, m), 7,81 (1H,bs), 8,03 (1H,bs)

EXAMPLE 2

**Preparation of separated enantiomers of compound (I).**

**[0061]** 36.8 g (1 eq) of racemic 7-fluoro-1,1,3-trimethyl-4-aminoindane [compound (IV)] and 14.3 g (0.5 eq) of D-(2*S*,3*S*)-(-)-tartaric acid in methanol (30 ml) were mixed and heated at 70 °C for 1 hour.

**[0062]** The mixture was left to cool to room temperature; a precipitate was formed and the mixture kept for one night at 4 °C. The formed solid was filtered off, washed with a small amount of methanol and recrystallized from methanol for six times to afford 14.8 g of an off white solid, corresponding to the 7-fluoro-1,1,3-trimethyl-4-aminoindane D-tartarate.

**[0063]** To the salt, a 5 % sodium hydroxide aqueous solution was added until pH > 10, and the mixture extracted three times with diethyl ether. The reunited organic layers were washed with water and brine. Then, dried over $Na_2SO_4$ and concentrated under reduced pressure to obtain 6.38 g of (-)-4-amino-7-fluoro-1,1,3-trimethylindane as a white powder (yield 17%); e.e. > 99% (HPLC).

**[0064]** To a solution of 600 mg of 3-difluoromethyl-1-methyl-1H-pyrazole-4-carboxylic acid [compound (III)] and a catalytic amount of N,N-dimethylformamide in dichloromethane (7 mL), 450 mg of thionyl chloride were added dropwise. The mixture was refluxed for 2h. The reaction was monitored by GC/MS. The solvent was evaporated in vacuo. The crude acid chloride obtained was used in the following step.

**[0065]** A solution of the crude 3-difluoromethyl-1-methyl-1H-pyrazole-4-carbonyl chloride in dichloroethane (6 mL) was added dropwise over a period of 10 minutes, under nitrogen atmosphere, to a solution of 660 mg of (-)-4-amino-7-fluoro-1,1,3-trimethylindane, a catalytic amount of 4-dimethylaminopyridine and 420 mg of triethylamine in dichloroethane (5 mL).

**[0066]** The mixture was stirred at room temperature overnight. At completion of the reaction (monitored through GC-MS) the mixture was diluted with dichloromethane (20 mL) and cooled at 0°C; a solution (20 mL) of 5% HCl was added.

**[0067]** The layers were separated and the organic phase washed with 5% HCl solution (2 x 20 mL), water (2 x 20 mL) and brine, then dried over $Na_2SO_4$. The solvent was evaporated under reduced pressure to give 1.3 g of a pale yellow solid.

**[0068]** The crude product was purified by column chromatograpy (eluent: heptane/EtOAc 6:4) to give 1.1 g (yield 92%) of 99.5 % pure enantiomer (-) (e.e. > 99% determined by HPLC with

chiral column) as a white solid with m.p. = 129-130°C.

GC-MS: $M^+$ = 351; $[\alpha]_D^{20}$ = - 59.5°($CHCl_3$, 1g/100 ml).

**[0069]** In analogous manner, starting from racemic 7-fluoro-1,1,3-trimethyl-4-aminoindane [compound (IV)] and L-(2*R*,3*R*)-(+)-tartaric acid, the 99.3 %pure enantiomer (+) was prepared (e.e. > 99% determined by HPLC with chiral column): white solid with m.p. = 131-132°C.

GC-MS: $M^+$ = 351; $[\alpha]_D^{20}$ = + 60.1°($CHCl_3$, 1g/100 ml).

**EXAMPLE 3**

**Determination of "in vitro" activities of racemic (I) and enantiomers against phytopathogenic microorganisms.**

**[0070]** Under sterile conditions, the technical racemic (I), the (-) and (+) enantiomers (prepared in Example 2) under testing, were dissolved in dimethylsulfoxide and serially diluted 3-fold to obtain a growth inhibition curve. Aqueous treatment solutions were prepared by adding DMSO stocks to water and mixing by pipet resulting in 2x final treatment concentration and 2x final DMSO concentration of 1.6%.

**[0071]** Sporulating plates of phytopathogenic microorganisms were harvested under sterile conditions in ½ strength Potato Dextrose Broth. Spores were filtered with cheesecloth and diluted to about 40000 spores per ml. Spores were aliquotted into 96 well microtiter plates at 150 microliters of spore suspension per well. Pathogenic spore suspensions were then treated with the 2x aqueous treatment solution or 1.6% DMSO for controls to give 1x final concentration or 0.8% DMSO. Plates were then held for 43 hours at room temperature.

**[0072]** After 43 hours at room temperature, plates were visually assessed microscopically for spore germination and growth inhibition. Plates were also quantitatively measured for growth inhibition by measuring optical density on a spectrophotometric plate reader at 405 nanometer wavelength. Optical density was corrected for absorbance of the media and active ingredient by subtracting the 405 nm readings for the 2x aqueous treatment solution or DMSO solution diluted with 1/2 strength POTATO DEXTROSE BROTH and no spores.

**[0073]** The % growth inhibition of the pathogen obtained for the technical racemic (I), (-) and (+) enantiomers was calculated according to the formula:

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Percent Inhibition = ((1 - (OD trt - OD trt blank) /(OD
untreated - OD untreated blank)) x 100)
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wherein OD trt is the optical density at 405 nm for the spore suspension plus aqueous treatment solution and OD trt blank is the optical density at 405 nm for the 2x aqueous treatment solution plus ½ strength POTATO DEXTROSE BROTH and no spores and OD untreated is the optical density at 405 nm for the spores plus 1.6% DMSO and OD untreated

blank is the optical density at 405nm for the 1.6% DMSO plus ½ strength POTATO DEXTROSE BROTH and no spores. Values are the average of three replicates. Concentrations of the racemic, (-) and (+) enantiomers giving 50% growth inhibition (pI50) were calculated using GraphPad Prism software Percent inhibition values were calculated using GraphPad Prism software Version 4.

**[0074]** Microorganisms tested were *Botrytis cinerea* (BC), *Stagonospora nodorum* (SN) and *Magnaporthe griseae* (MG).

**[0075]** The results are reported in Table 1.

Table 1.

| Compound | BC pI50 (ppm) | SN pI50 (ppm) | MG pI50 (ppm) |
|---|---|---|---|
| Racemic (I) | 0.32 | 1.1 | 0.72 |
| (-)-(I) | 0.17 | 0.42 | 0.46 |
| (+)-(I) | n.i. | 72 | 4.6 |
| n.i. = no inhibition | | | |

**EXAMPLE 4**

**Determination of the fungicidal activity in preventive application (5 days) against *Puccinia recondita* on wheat.**

**[0076]** Leaves of wheat plants of the Salgemma variety, grown in pots in a conditioned environment kept at 20°C and 70% of relative humidity (R.H.), were treated by spraying both sides of the leaves with the compounds and the compositions under testing, dispersed in hydroacetonic solutions at 20% by volume of acetone.

**[0077]** After remaining 5 days in a conditioned environment, the plants were sprayed on both sides of the leaves with an aqueous suspension of conidia of *Puccinia recondita* (2 mg of inoculum per 1 ml of solution for infection).

**[0078]** After being sprayed, the plants were kept in a humidity-saturated environment at a temperature ranging from 18 to 24°C for the incubation period of the fungus (1 day).

**[0079]** After this period, the plants were put in a greenhouse with R.H. of 70% and at a temperature of 18-24 °C for 14 days.

**[0080]** At the end of this period the external symptoms of the pathogen appeared and it was therefore possible to proceed with the visual assessment of the intensity of the infection. The

fungicidal activity was expressed as percentage of reduction of affected leaves areas with respect to those of untreated plants used as control: the scale comprised, as extremes, the value 100 (full activity; healthy plant) and the value 0 (no activity; completely infected plant).

**[0081]** At the same time, the phytotoxicity (percentage of leaf necrosis) induced on the wheat plants by the application of the products and compositions was evaluated: in this case, the scale ranged from 0 (no phytotoxicity) to 100 (completely necrotized plant).

**[0082]** In Table 2, the activities of racemic (I) and pure enantiomers of compound (I), prepared in Example 2, are reported.

Table 2.

| Compound | Rate (ppm) | % Activity | % Phytotoxicity |
|---|---|---|---|
| Racemic (I) | 125 | 98 | 0 |
| | 62.5 | 96 | 0 |
| (-)-(I) | 125 | 100 | 0 |
| | 62.5 | 96 | 0 |
| (+)-(I) | 125 | 45 | 0 |
| | 62.5 | 20 | 0 |

**[0083]** The synergism of the compositions (A+B) under testing was evaluated according to the Colby's formula:

$E_t = E_A+E_B-(E_A x E_B/100)$

wherein $E_t$ is the expected efficacy percentage for the composition containing the compounds A and B at the dosages $d_A+d_B$, $E_A$ is the efficacy percentage observed for the component A at the dosage dA, $E_B$ is the efficacy percentage observed for the component B at the dosage $d_B$.

**[0084]** When the efficacy observed for the composition A+B ($E_{A+B}$) is higher than the efficacy expected according to the Colby's formula ($E_{A+B}/E_t > 1$), a synergistic effect is confirmed.

**<u>EXAMPLE 5</u>**

**Determination of synergistic effects "in vitro" against phytopathogenic microorganisms.**

**[0085]** Under sterile conditions, the products and the compositions under testing were dissolved in dimethylsulfoxide, diluted with water and added under vigorous stirring to POTATO DEXTROSE AGAR, kept in a thermostatic bath at 55°C. The AGAR preparations, containing the compounds and the compositions under testing at the desired rates, were poured into 60

mm diameter Petri dishes (three for each product and composition) and left to cool to ambient temperature.

**[0086]** After solidification of the agarized medium, AGAR disks having 6 mm of diameter and supporting the micelyum of the microorganism, were placed in the centre of the Petri dishes; Petri dishes containing untreated POTATO DEXTROSE AGAR were also inoculated with the microorganism and used as control.

**[0087]** After incubation at 28°C, when control colonies had grown over 30 mm in diameter, but without reaching the edge of the dishes, the diameters of the developed colonies in treated and untreated dishes were measured; the percentage growth inhibition of the microorganism obtained with products and compositions was calculated according to the formula:

$$I = (1 - z_1/z_0) \times 100$$

wherein $z_1$ is the diameter (average of three replicates) of the colonies treated with compounds and mixtures and $z_0$ is the diameter (average of three replicates) of untreated colonies.

**[0088]** Microorganisms tested were *Botrytis cinerea, Fusarium culmorum, Helminthosporium teres, Pyricularia oryzae, Septoria nodorum, Venturia inaequalis.*

**[0089]** The synergism of a binary mixture (A + B) at the dose ($d_A$+$d_B$) was evaluated according to the Colby's formula:

$$I_t = I_A + I_B - (I_A \times I_B/100)$$

wherein:

$I_t$ is the % growth inhibition expected for the mixture; $I_A$ is the % growth inhibition observed for compound A at the dose $d_A$; $I_B$ is the % growth inhibition observed for compound B at the dose $d_B$.

**[0090]** When the % growth inhibition observed for the composition (A+B) is higher than that calculated by the Colby's formula ($I_{A+B} > I_t$; $I_{A+B}/I_t > 1$), a synergistic effect is confirmed.

# REFERENCES CITED IN THE DESCRIPTION

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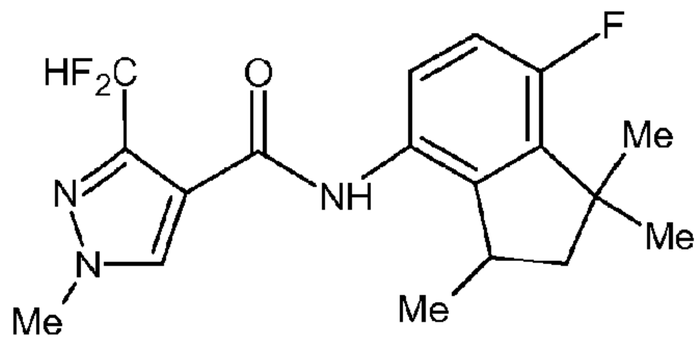
**Patentkrav**

**1.** Synergistiske sammensætninger til beskyttelsen af landbrugsafgrøder omfattende:

- mindst en komponent (A), bestående af forbindelsen med formel (I) 3-difluormethyl-N-(7-fluor-1,1,3-trimethyl-4-indanyl)-1-methyl-4-pyrazolcarboxamid




(I)

hvor Me repræsenterer en $CH_3$- methylgruppe,

- mindst en komponent [B] valgt fra forbindelser med en svampedræbende eller insektdræbende aktivitet tilhørende en eller flere af de følgende grupper af svampedræbende og insektdræbende forbindelser:

svampedræbende forbindelser:

i) azoler: difenoconazol, flutriafol, prothioconazol, tetraconazol;

ii) aminoderivater: spiroxamin;

iii) strobiluriner: azoxystrobin, fluoxa-strobin, kresoxim-methyl, pyraclostrobin;

vii) dicarboxyimider: iprodion;

viii) polyhalogenerede svampedræbende midler: chlorthalonil;

ix) inducere af erhvervt systemisk resistens (SAR): acibenzolar;

xi) acylalaniner: benalaxyl;

xii) antiperonosporiske forbindelser: valifenalat;

xiii) dithiocarbamater: mancozeb;

xvi) kobberbaserede kobbersvampedræbende midler: kobberoxychlorid;

xvii) svampedræbende amider: boscalid, fluopyram, fluxapyroxad, isopyrazam, penthiopyrad;

insektdræbende forbindelser:

xix) neonicotinoider: imidacloprid;

xxi) pyrethroider: bifenthrin.

**2.** Sammensætningerne ifølge krav 1, hvor nævnte forbindelse med formel (I) er en racemisk blanding ((I)-RS) .

**3.** Sammensætningerne ifølge krav 1, hvor nævnte forbindelse med formel (I) er valgt fra:

- en blanding beriget i en af enantiomererne, fortrinsvis en blanding beriget i enantiomeren R,
- et af de to enantiomerer R ((I)-R) eller S ((I)-S) i en i alt væsentligt ren form (>99,99 vægtprocent), fortrinsvis enantiomeren R.

**4.** Sammensætningerne ifølge et eller flere af de foregående krav, hvor vægtforholdet mellem nævnte mindst ene komponent [A] og nævnte mindst ene komponent [B] er i området fra 1:20 til 20:1.

**5.** Sammensætningerne ifølge et eller flere af de foregående krav, valgt fra:

C1: (I)-RS + tetraconazol;

C4: (I)-RS + difenoconazol;

C6: (I)-RS + flutriafol;

C8: (I)-RS + prothioconazol;

C11: (I)-RS + spiroxamin;

C12: (I)-RS + azoxystrobin;

C13: (I)-RS + fluoxastrobin;

C14: (I)-RS + kresoxim-methyl;

C16: (I)-RS + pyraclostrobin;

C22: (I)-RS + iprodion;

C26: (I)-RS + chlorthalonil;

C35: (I)-RS + valifenalat;

C39: (I)-RS + imidacloprid;

C49: (I)-RS + tetraconazol + azoxystrobin;

C50: (I)-RS + tebuconazol + azoxystrobin;

C51: (I)-RS + epoxyconazol + azoxystrobin;

C52: (I)-RS + cyproconazol + azoxystrobin;

C53: (I)-RS + propiconazol + azoxystrobin;

C54: (I)-RS + prothioconazol + azoxystrobin;

C55: (I)-RS + tetraconazol + picoxystrobin;

C60: (I)-RS + prothioconazol + picoxystrobin;

C61: (I)-RS + tetraconazol + kresoxim methyl;

C62: (I)-RS + tebuconazol + kresoxim methyl;

C64: (I)-RS + cyproconazol + kresoxim methyl;

C65: (I)-RS + propiconazol + kresoxim methyl;

C66: (I)-RS + prothioconazol + kresoxim methyl;

C67: (I)-RS + chlorthalonil + azoxystrobin;

C68: (I)-RS + chlorthalonil + picoxystrobin;

C69: (I)-RS + chlorthalonil + pyraclostrobin;

C70: (I)-RS + chlorthalonil + kresoxim methyl;

C71: (I)-RS + kobber (II) hydroxid + kobberoxychlorid;

C72: (I)-RS + kobber (II) hydroxid + kobberoxychlorid + kobbersalicylat $C_7H_4O_3 \cdot Cu$;

C73: (I) -$R_8S_2$ + tetraconazol;

C74: (I) -$R_8S_2$ + azoxystrobin;

C75: (I) -$R_8S_2$ + benalaxyl;

C76: (I) -$R_9S_1$ + tetraconazol;

C77: (I) -$R_9S_1$ + azoxystrobin;

C78: (I)-R + tetraconazol;

hvor:

- (I)-RS indikerer forbindelsen med formel (I) i formen af en racemisk blanding,

- (I) -$R_8S_2$ indikerer forbindelsen indeholdende enantiomererne R og S i et molforhold R:S = 8:2,

- (I)-$R_9S_1$ indikerer forbindelsen indeholdende enantiomererne R og S i et molforhold R:S = 9:1,

- (I)-R indikerer enantiomeren R i i alt væsentligt ren form (>99,99 vægtprocent).

**6.** Sammensætningerne ifølge et eller flere af de foregående krav, hvor nævnte mindst ene komponent [A] og nævnte mindst ene komponent [B], sammen eller separat, fortyndes med et eller flere faste eller flydende fortyndingsmidler, eventuelt med tilsætningen af et eller flere overfladeaktive stoffer, dispergeringsmidler, opslæmningsmidler, stabiliseringsmidler, hjælpestoffer, antifrysemidler, klæbestoffer.

**7.** Sammensætningerne ifølge krav 6, omfattende mindst en yderligere aktiv bestanddel, kompatible med nævnte komponenter [A] og [B], valgt fra svampedræbende forbindelser eller insektdræbende forbindelser forskellige fra nævnte forbindelser [B], phytoregulatorer, antibiotika, ukrudtsbekæmpelsesmidler, gødningsmidler og blandinger deraf.

**8.** Anvendelse af de synergistiske sammensætninger ifølge et eller flere af de foregående krav til kontrol af phytopathogene svampe i landbrugsafgrøder.

**9.** Anvendelse af de synergistiske sammensætninger ifølge krav 8, til bekæmpelsen af phytopathogene svampe valgt fra de følgende grupper: Basidiomycetter, Ascomycetter, Deuteromycetter eller ufuldkommen svampe, Oomycetter: *Puccinia* spp., *Ustilago* spp., *Tilletia* spp., *Uromyces* spp., *Phakopsora* spp., *Rhizoctonia* spp., *Erysiphe* spp., *Sphaerotheca* spp., *Podosphaera* spp., *Uncinula* spp., *Helminthosporium* spp., *Rhynchosporium* spp., *Pyrenophora* spp., *Monilinia* spp., *Sclerotinia* spp., *Septoria* spp. (*Mycosphaerella* spp.), *Venturia* spp., *Botrytis* spp., *Alternaria* spp., *Fusarium* spp., *Cercospora* spp., *Cercosporella herpotrichoides, Colletotrichum* spp., *Pyricularia oryzae, Sclerotium* spp., *Phytophtora* spp., *Pythium* spp., *Plasmopara viticola, Peronospora* spp., *Pseudoperonospora cubensis, Bremia lactucae.*

**10.** Anvendelse af de synergistiske sammensætninger ifølge krav 8 eller 9, hvor landbrugsafgrøderne er valgt fra: korn, frugttræer, citrusfrugter, bælgfrugter, havebrugsafgrøder, græskarfamilien, olieholdige planter, tobak, kaffe, te, kakao, sukkerroe, sukkerrør, bomuld.

**11.** Fremgangsmåde til bekæmpelsen af phytopathogene svampe i landbrugsafgrøder, hvilken omfatter anvendelsen af en effektiv dosis af mindst en synergistisk sammensætning ifølge et hvilket som helst af kravene fra 1 til 7, på en eller flere dele af planterne, som skal beskyttes, og/eller på frøene af nævnte planter før såning og/eller på jorden i hvilken nævnte planter gror.