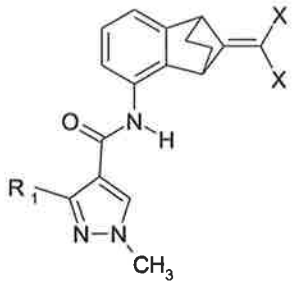
Fungicidal Compositions

The present invention relates to novel fungicidal compositions suitable for control of diseases caused by phytopathogens, especially phytopathogenic fungi and to a method of controlling diseases on useful plants, especially rust diseases on soybean plants.

It is known from WO 04/35589 and WO 06/37632 that certain tricyclic amine derivatives and mixtures comprising said amine derivatives have biological activity against phytopathogenic fungi. On the other hand various fungicidal compounds of different chemical classes are widely known as plant fungicides for application in various crops of cultivated plants. However, crop tolerance and activity against phytopathogenic plant fungi do not always satisfy the needs of agricultural practice in many incidents and aspects. For example, in the past in the most important regions for soybean cultures no economicly significant phytopathogens were known. However, recently there has been an increase in severe rust infections of soybean crops in South America by the harmful fungus Phakopsora pachyrhizi resulting in considerable yield losses. Most customary fungicides are unsuitable for controlling rust in soybeans or their action against Phakopsora pachyrhizi is unsatisafctory.

Out of the above-mentioned needs of agricultural practice for increased crop tolerance and/or increased activity against phytopathogenic fungi, such as Phakopsora pachyrhizi, there is therefore proposed in accordance with the present invention a novel composition suitable for control of diseases caused by phytopathogens comprising
a composition suitable for control of diseases caused by phytopathogens comprising
(A) a compound of formula I



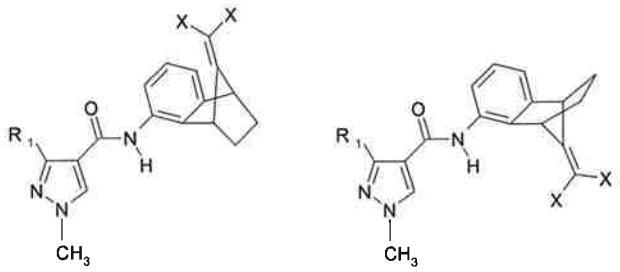
(I),

wherein R_1 is difluoromethyl or trifluoromethyl and X is chloro, fluoro or bromo; and
(B) fluopyram.

It has been found that the use of component (B) in combination with component (A) surprisingly and substantially enhance the effectiveness of the latter against fungi, and vice versa. Additionally, the method of the invention is effective against a wider spectrum of such fungi that can be combated with the active ingredients of this method, when used solely.

A further aspect of the present invention is a method of controlling diseases on useful plants or on propagation material thereof caused by phytopathogens, which comprises applying to the useful plants, the locus thereof or propagation material thereof a composition according to the invention. Preferred is a method, which comprises applying to the useful plants or to the locus thereof a composition according to the invention, more preferably to the useful plants. Further preferred is a method, which comprises applying to the propagation material of the useful plants a composition according to the invention.

The compounds of formula I occur in two different stereoisomers, which are described as the single enantiomers of formulae I_I and I_{II}:



I_I I_{II} .

The invention covers all such stereoisomers and mixtures thereof in any ratio. According to the invention "racemic compound of formula (I)" means a racemic mixture of compounds of formula I_I and I_{II}.

A preferred embodiment of the invention is represented by those compositions which comprise as component A) a compound of formula (I), wherein R_1 is difluoromethyl. Further preferred compounds of formula (I) are:

3-difluoromethyl-1-methyl-1H-pyrazole-4-carboxylic acid (9-dichloromethylidene-benzonorbornene-5-yl)amide (compound A-1.1);3-difluoromethyl-1-methyl-1H-pyrazole-4-carboxylic acid (9-difluoromethylidene-benzonorbornene-5-yl)amide (compound A-1.2); and 3-difluoromethyl-1-methyl-1H-pyrazole-4-carboxylic acid (9-dibromomethylidene-benzonorbornene-5-yl)amide (compound A-1.3).

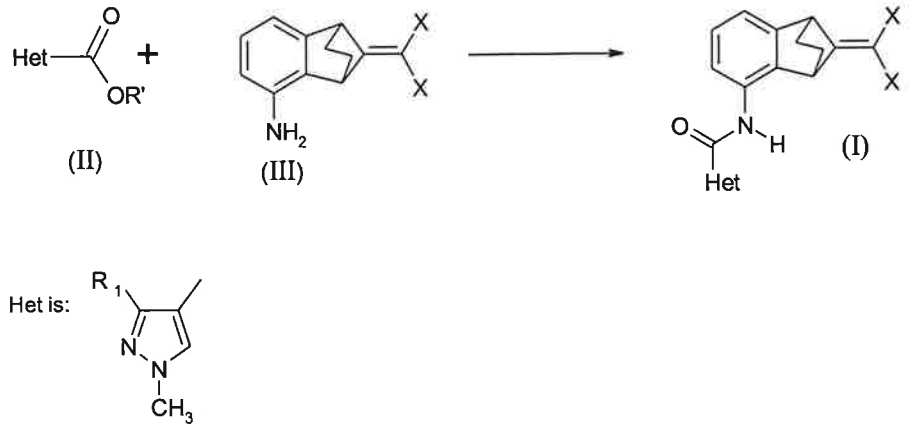
The designation of substituent X as chloro, fluoro or bromo means that both substituents X have the same meanings.

A preferred embodiment of the invention is represented by those compositions which comprise as component A) a compound of formula (I), wherein R_1 is trifluoromethyl. Further preferred compounds of formula (I) are:
1-methyl-3-trifluoromethyl-1H-pyrazole-4-carboxylic acid (9-dichloromethylidene-benzonorbornene-5-yl)amide (compound A-1.4);
1-methyl-3-trifluoromethyl-1H-pyrazole-4-carboxylic acid (9-difluoromethylidene-benzonorbornene-5-yl)amide (compound A-1.5); and
1-methyl-3-trifluoromethyl-1H-pyrazole-4-carboxylic acid (9-dibromomethylidene-benzonorbornene-5-yl)amide (compound A-1.6).

Especially preferred compositions according to the invention comprise as component (A) a compound selected from 3-difluoromethyl-1-methyl-1H-pyrazole-4-carboxylic acid (9-dichloromethylidene-benzonorbornene-5-yl)amide (compound A-1.1) and 3-difluoromethyl-1-methyl-1H-pyrazole-4-carboxylic acid (9-difluoromethylidene-benzonorbornene-5-yl)amide (compound A-1.2), and as component (B) fluopyram.
Further especially preferred compositions according to the invention comprise as component (A) the compound 3-difluoromethyl-1-methyl-1H-pyrazole-4-carboxylic acid (9-difluoromethylidene-benzonorbornene-5-yl)amide (compound A-1.2) and as component (B) fluopyram.

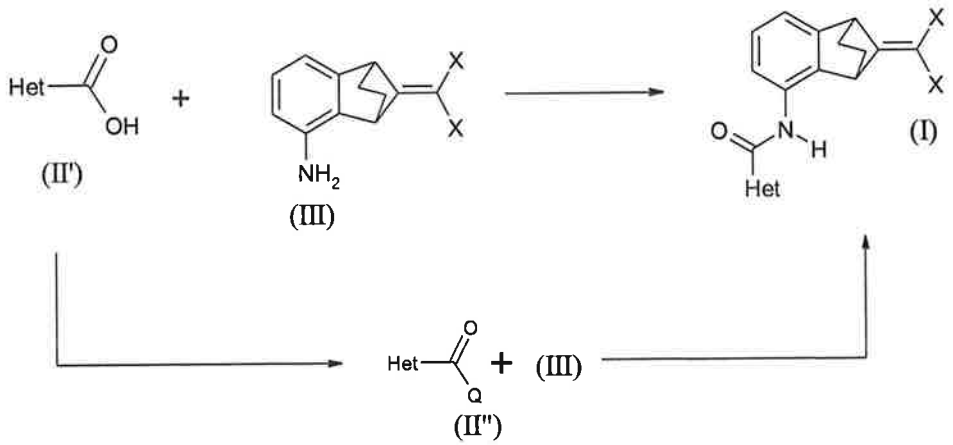
The compounds of formula (I) may be prepared as described below with reference to reaction Schemes 1 to 3.

Scheme 1



As shown in Scheme 1, a compound of formula (I), where R_1 and X are as defined above, may be synthesized by reacting a compound of formula (II), R_1 is as defined above and R' is C_{1-5} alkyl, with an aniline of formula (III), where X is as defined above, in the presence of $NaN(TMS)_2$ at -10°C to ambient temperature, preferably in dry THF, as described by *J.Wang et al. Synlett*, **2001**, 1485.

Scheme 2

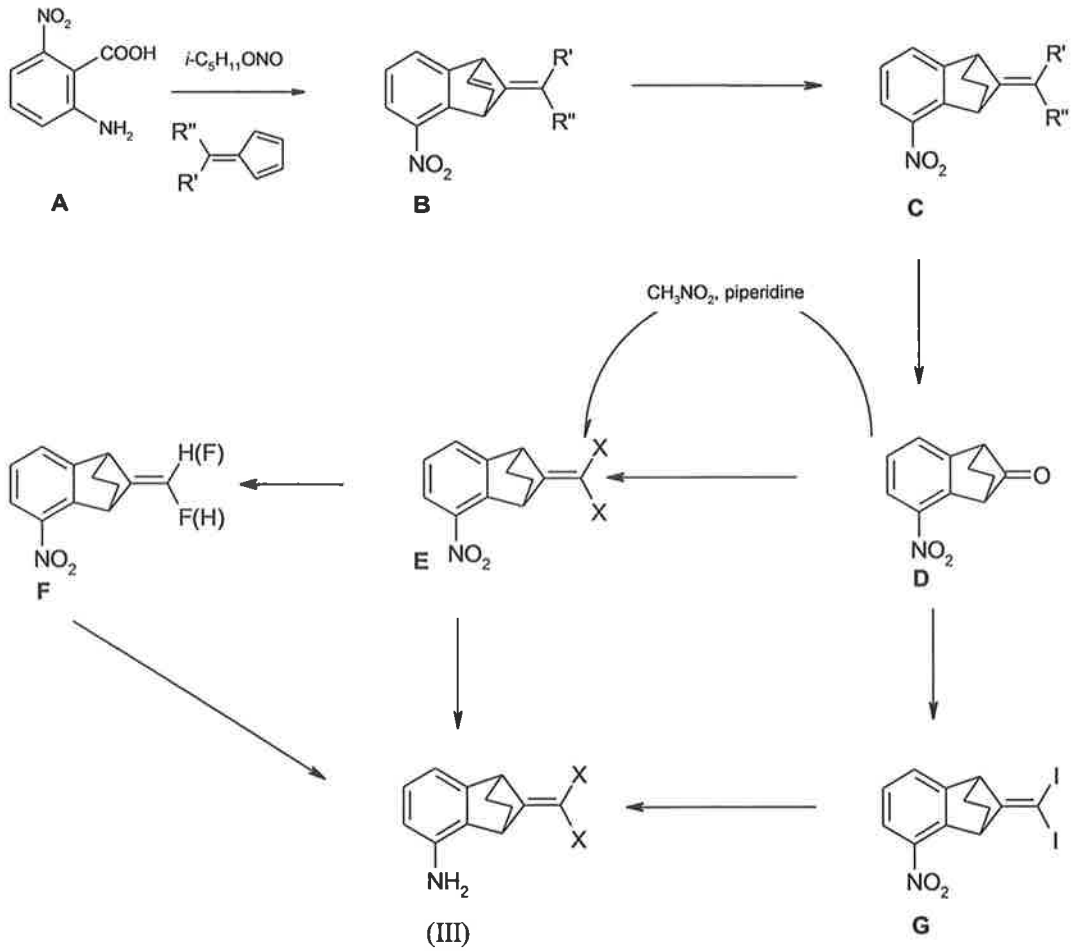


Alternatively, as shown in Scheme 2, a compound of formula (I), where Het is as defined in scheme 1, R_1 and X are as defined above, may be prepared by reacting a compound of formula (II'), where Het is as defined above, with an aniline of formula (III), where X is as defined above, in the presence of an activating agent, such as BOP-Cl (bis-(2-oxo-3-oxazolidinyl)-phosphinic acid), and two equivalents of a base, such as triethylamine, in a solvent, such as dichloromethane (as described, for example, by J. Cabré *et al,* Synthesis **1984**, 413) or by reacting a compound of formula (II"), where Het is as defined above and Q is chloro, fluoro or bromo, with an aniline of formula (III), where X is as defined above, in the presence of one equivalent of a base, such as triethylamine or sodium or potassium

carbonate or bicarbonate, in a solvent, such as dichloromethane, ethyl acetate or *N,N*-dimethylformamide, preferably at -10 to 30°C. The compound of formula (II") is obtained from a compound of formula (II') by treatment with a halogenating agent such as thionyl chloride, thionyl bromide, oxalyl chloride, phosgene, SF_4/HF, DAST ((diethylamino)sulphur trifluoride), or Deoxo-Fluor® ([bis(2-methoxyethyl)amino]sulphur trifluoride) in a solvent such as toluene, dichloromethane or acetonitrile.

The compounds (II) and (II') are generally known compounds and may be prepared as described in the chemical literature or obtained from commercial sources. The compound (III) is a novel compound and may be prepared as described with reference to Scheme 3.

Scheme 3



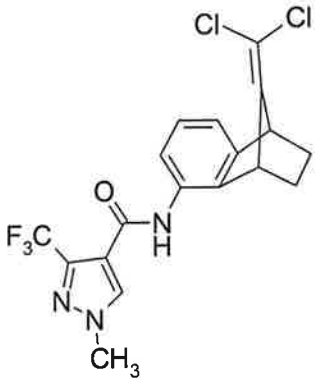
As shown in Scheme 3, the compound of formula (III) may be prepared by a *Bechamp* reduction or by other established methods, for example, by selective catalytic hydrogenation, of the nitro-compounds (E), (F) and (G).

The 9-dihalomethylidene-5-nitro-benzonorbornenes (E), where X is chloro, bromo or fluoro, may be obtained by the *Wittig* olefination of the ketones (D) with *in situ* generated dihalomethylidene phosphoranes $R'''_3P=C(R^4)R^5$, where R''' is triphenyl, tri C_{1-4} alkyl or tridimethylamine and X is halo, according to or by analogy with the procedures described by H-D. Martin *et al*, *Chem. Ber. 118*, 2514 (**1985**), S.Hayashi *et al*, *Chem. Lett.* **1979**, 983, or M. Suda, *Tetrahedron Letters, 22*, 1421 (**1981**).

Compounds of formula (I) may be obtained as described in examples H1 to H7.

EXAMPLE 1

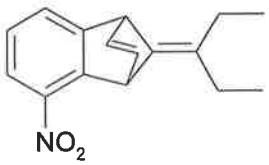
This Example illustrates the preparation of 1-methyl-3-trifluoromethyl-1H-pyrazole-4-carboxylic acid (9-dichloromethylidene-benzonorbornene-5-yl)amide (compound A-1.4):



9-Dichloromethylene-5-amino-benzonorbornene (175 mg, 0.729 mmol, prepared as described in Example 6) in dichloromethane (10ml) was reacted with 1-methyl-3-trifluoromethyl-1H-pyrazole-carboxylic acid (170mg, 0.874 mmol, 1.2 eq.) in the presence of bis-(2-oxo-3-oxazolidinyl)-phosphinic acid chloride (278 mg, 1.09 mmol, 1.5 eq.) and triethylamine (184 mg, 1.821 mmol, 2.5 eq.) at ambient temperature under stirring for 23 hours. The reaction mixture was extracted with saturated sodium bicarbonate solution and saturated brine, dried over Na_2SO_4 and purified on silica gel in ethyl acetate-hexane-(1:1). 210 mg (69% of theory) of 1-methyl-3-trifluoromethyl-1H-pyrazole-4-carboxylic acid (9-dichloromethylidene-benzonorbornene-5-yl)amide (compound A-1.4, m.p. 179-181 °C) was obtained.

EXAMPLE 2

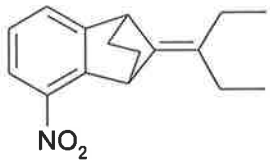
This Example illustrates the preparation of 9-(3-pentylidene)-5-nitro-benzonorbornadiene:



To a well stirred solution of isopentylnitrite (2.31 ml, 1.3 eq.) in dimethoxyethane (50 ml) at 58°C a mixture of 6-nitroanthranilic acid (2.76 g, 1 eq.) and 6,6-diethylfulvene (6.45 g of 79% purity, 2.5 eq.) dissolved in 25 ml dimethoxyethane was added dropwise within 8 minutes whilst the temperature rose to 67°C. After 30 minutes the dark reaction mixture was evaporated and purified on silica gel in hexane-ethyl acetate-(20:1) to give 3.02 g (78%) of the desired product as an oil that solidified at room temperature (m.p. 60-61°C).

EXAMPLE 3

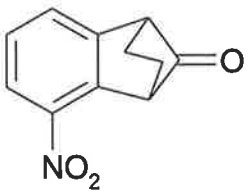
This Example illustrates the preparation of 9-(3-pentylidene)-5-nitro-benzonorbornene:



9-(3-pentylidene)-5-nitro-benzonorbornadiene (7.97 g prepared as described in Example 2) in THF (70ml) was hydrogenated at 20°C in the presence of $Rh(PPh_3)_3Cl$ (*Wilkinson's* catalyst; 0.8 g). The reaction ceased after uptake of one equivalent of hydrogen. Evaporation and filtration of the crude on silica gel in ethyl acetate-hexane-(100:2) gave the desired product as an oil (7.90 g) that solidified on standing at room temperature (m.p. 69-56 °C).

EXAMPLE 4

This Example illustrates the preparation of 9-Oxo-5-nitro-benzonorbornene

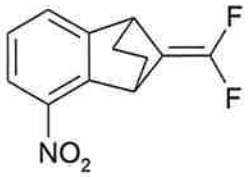


9-(3-pentylidene)-5-nitro-benzonorbornene (7.0 g, 27.2 mmol; prepared as described in Example 3) dissolved in dichloromethane (300 ml) and methanol (5ml) was ozonized (2.8 l O_2/min, 100 Watt, corresponding to 9.7 g O_3 / h) at –70°C until a persistent blue colour was observed (after approximately 15 minutes). The reaction mixture was flushed with nitrogen gas. Triphenylphosphine (8.4 g, 32.03 mmol, 1.18 eq.) was added and the temperature was

allowed to warm up to 20-25°C. After evaporation of the solvent the residue was purified on silica gel in hexane-EtOAc-3:1 to give 5.2 g of Compound 36.01 (m..p. 112-114 °C).

EXAMPLE 5

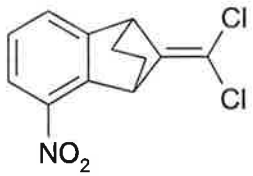
This Example illustrates the preparation of 9-difluoromethylidene-5-nitro-benzonorbornene



To a solution of dibromodifluoromethane (6.30 g, 30 mmol) at 0°C in THF (50 ml) was added tris-(dimethylamino)-phosphane (10.1 g at 97%, equivalent to 11.2 ml, 60 mmol) in THF (30 ml) within 20 minutes. To the resulting suspension, after stirring for 1 hour at room temperature, was added dropwise a solution of 9-oxo-5-nitro-benzonorbornene (6.10g, 30mmol; prepared as described in Example 4) in THF (20ml) within 25 minutes followed by stirring for 21 hours. The suspension was poured onto ice-water and extracted with ethyl acetate. Purification on silica gel in ethyl acetate-hexane-(1:4) yielded 4.675 g of 9-difluoromethylidene-5-nitro-benzonorbornene (m.p. 99-101°C).

EXAMPLE 6

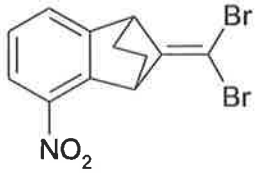
This Example illustrates the preparation of 9-Dichloromethylidene-5-nitro-benzonorbornene



Dry carbon tetrachloride (5.9 g, 33 mmol) was reacted with triphenylphosphine (14.46 g, 55.1 mmol) in dichloromethane (30 ml) at room temperature for 1 hour. 9-Oxo-5-nitro-benzonorbornene (5.60g, 27.56mmol; prepared as described in Example 4) in dichloromethane (10 ml) was added dropwise and stirred for 20 hours at room temperature. After aqueous work-up (ice-water) and extraction with dichloromethane, the crude product was purified on silica gel in ethyl acetate-hexane-(1:4) to obtain of the desired 9-Dichloromethylidene-5-nitro-benzonorbornene (1.83 g; m.p. 136-137 °C). Some starting material (4.06 g) was recovered.

EXAMPLE 7

This Example illustrates the preparation of 9-Dibromomethylidene-5-nitro-benzonorbornene



Carbon tetrabromide (4.66 g at 98%, 13.8 mmol) was reacted under stirring with triphenylphosphine (7.23 g, 27.6 mmol) in dichloromethane (50 ml) for 50 minutes at room temperature. 9-Oxo-5-nitro-benzonorbornene (2.8 g, 13.8 mmol; prepared as described in Example 4) in dichloromethane (10 ml) was added dropwise and stirred over night at room temperature. Aqueous work-up (ice-water) and extraction with dichloromethane followed by column chromatography (ethyl acetate-hexane-(1:9) of the crude product yielded the desired product 9-Dibromomethylidene-5-nitro-benzonorbornene (2.1 g; m.p. 153-155 °C).

Table 1

Table 1 shows melting point and NMR data, all with $CDCl_3$ as the solvent, unless otherwise stated, for compounds of formula (I). In the table, temperatures are given in degrees Celsius, "NMR" means nuclear magnetic resonance spectrum and the following abbreviations are used:

m.p. =	melting point	b.p. =	boiling point.
s =	singlet	br =	broad
d =	doublet	dd =	doublet of doublets
t =	triplet	q =	quartet
m =	multiplet	ppm =	parts per million
THF =	tetrahydrofuran		

Compund	m.p (°C)	^{1}H-NMR proton shifts δ (ppm) ($CDCl_3$)
A-1.1	179-181	8.06 (s,1H), 7.69 (d overlapped by brd signal, exchangeable with D_2O, 2H), 7.18 (t,1H), 7.06 (d,1H), 4.00 (s,3H), 3.96 (m, 2H), 2.12 (m, 2H), 1.51 (m,1H), 1.39 (m,1H).
A-1.2	137-143	8.06 (s,1H), 7.68 (brd, exchangeable with D_2O,1H), 7.67 (d,1H), 7.14 (d,1H), 4.00 (s,3H), 3.94 (m,2H), 2.06 (m,2H), 1.48 (m,1H), 1.36 (m.1H).
A-1.3	198-200	8.06 (s,1H), 7.71 (d,1H), 7.68 (brd, exchangeable with D_2O,1H), 7.18 (t,1H), 7.05 (d,1H), 4.00 (s,3H), 3.95 (m,1H), 3.93 (m,1H), 2.12 (m,2H), 1.50 (m,1H), 1.38 (m,1H).

A-1.4	183-188	7.78 (d,1H), 7.70 (brd, exchangeable with D_2O,1H), 7.39 (brd s,1H), 7.16 (t,1H), 7.01 (d overlapped from brd s, 2H), 4.00 (m,1H), 3.94 (m,1H), 3.72 (s,3H), 2.10 (m, 2H), 1.51 (m,1H), 1.38 (m,1H).
A-1.5	133-135	7.76 (d,1H), 7.70 (brd, exchangeable with D_2O,1H), 7.39 (brd s,1H), 7.13 (t,1H), 7.01 (brd s,1H), 7.00 (d,1H), 3.98 (m, 1H), 3.93 (m,1H), 3.72 (s,3H), 2.04 (m,2H), 1.49 (m,1H), 1.36 (m,1H).
A-1.6	155-158	7.79 (d,1H), 7.70 (brd, exchangeable with D_2O,1H), 7.39 (brd s,1H), 7.17 (t,1H), 7.02 (d,1H), 7.01 (brd s,1H), 3.98 (m,1H), 3.91 (m,1H), 3.72 (s,3H), 2.11 (m,2H), 1.50 (m,1H), 1.39 (m,1H).

The component (B) ("fluopyram") is known and registered under CAS-Reg. No: 658066-35-4 and described in WO 04/16088.

The compositions according to the invention are effective against harmful microorganisms, such as microorganisms, that cause phytopathogenic diseases, in particular against phytopathogenic fungi and bacteria.

The compositions according to the invention are effective especially against phytopathogenic fungi belonging to the following classes: Ascomycetes (e.g. Venturia, Podosphaera, Erysiphe, Monilinia, Mycosphaerella, Uncinula); Basidiomycetes (e.g. the genus Hemileia, Rhizoctonia, Phakopsora, Puccinia, Ustilago, Tilletia); Fungi imperfecti (also known as Deuteromycetes; e.g. Botrytis, Helminthosporium, Rhynchosporium, Fusarium, Septoria, Cercospora, Alternaria, Pyricularia and Pseudocercosporella); Oomycetes (e.g. Phytophthora, Peronospora, Pseudoperonospora, Albugo, Bremia, Pythium, Pseudosclerospora, Plasmopara).

According to the invention "useful plants" typically comprise the following species of plants: grape vines; cereals, such as wheat, barley, rye or oats; beet, such as sugar beet or fodder beet; fruits, such as pomes, stone fruits or soft fruits, for example apples, pears, plums, peaches, almonds, cherries, strawberries, raspberries or blackberries; leguminous plants, such as beans, lentils, peas or soybeans; oil plants, such as rape, mustard, poppy, olives, sunflowers, coconut, castor oil plants, cocoa beans or groundnuts; cucumber plants, such as marrows, cucumbers or melons; fibre plants, such as cotton, flax, hemp or jute; citrus fruit, such as oranges, lemons, grapefruit or mandarins; vegetables, such as spinach, lettuce,

asparagus, cabbages, carrots, onions, tomatoes, potatoes, cucurbits or paprika; lauraceae, such as avocados, cinnamon or camphor; maize; tobacco; nuts; coffee; sugar cane; tea; vines; hops; durian; bananas; natural rubber plants; turf or ornamentals, such as flowers, shrubs, broad-leaved trees or evergreens, for example conifers. This list does not represent any limitation.

The term "useful plants" is to be understood as including also useful plants that have been rendered tolerant to herbicides like bromoxynil or classes of herbicides (such as, for example, HPPD inhibitors, ALS inhibitors, for example primisulfuron, prosulfuron and trifloxysulfuron, EPSPS (5-enol-pyrovyl-shikimate-3-phosphate-synthase) inhibitors, GS (glutamine synthetase) inhibitors or PPO (protoporphyrinogen-oxidase) inhibitors) as a result of conventional methods of breeding or genetic engineering. An example of a crop that has been rendered tolerant to imidazolinones, e.g. imazamox, by conventional methods of breeding (mutagenesis) is Clearfield® summer rape (Canola). Examples of crops that have been rendered tolerant to herbicides or classes of herbicides by genetic engineering methods include glyphosate- and glufosinate-resistant maize varieties commercially available under the trade names RoundupReady® , Herculex I® and LibertyLink®.

The term "useful plants" is to be understood as including also useful plants which have been so transformed by the use of recombinant DNA techniques that they are capable of synthesising one or more selectively acting toxins, such as are known, for example, from toxin-producing bacteria, especially those of the genus Bacillus.

The term "useful plants" is to be understood as including also useful plants which have been so transformed by the use of recombinant DNA techniques that they are capable of synthesising antipathogenic substances having a selective action, such as, for example, the so-called "pathogenesis-related proteins" (PRPs, see e.g. EP-A-0 392 225). Examples of such antipathogenic substances and transgenic plants capable of synthesising such antipathogenic substances are known, for example, from EP-A-0 392 225, WO 95/33818, and EP-A-0 353 191. The methods of producing such transgenic plants are generally known to the person skilled in the art and are described, for example, in the publications mentioned above.

The term "locus" of a useful plant as used herein is intended to embrace the place on which the useful plants are growing, where the plant propagation materials of the useful plants are sown or where the plant propagation materials of the useful plants will be placed into the soil. An example for such a locus is a field, on which crop plants are growing.

The term "plant propagation material" is understood to denote generative parts of the plant, such as seeds, which can be used for the multiplication of the latter, and vegetative material, such as cuttings or tubers, for example potatoes. There may be mentioned for example seeds (in the strict sense), roots, fruits, tubers, bulbs, rhizomes and parts of plants. Germinated plants and young plants which are to be transplanted after germination or after emergence from the soil, may also be mentioned. These young plants may be protected before transplantation by a total or partial treatment by immersion. Preferably "plant propagation material" is understood to denote seeds.

The compositions of the present invention may also be used in the field of protecting storage goods against attack of fungi. According to the present invention, the term "storage goods" is understood to denote natural substances of vegetable and/or animal origin and their processed forms, which have been taken from the natural life cycle and for which long-term protection is desired. Storage goods of vegetable origin, such as plants or parts thereof, for example stalks, leafs, tubers, seeds, fruits or grains, can be protected in the freshly harvested state or in processed form, such as pre-dried, moistened, comminuted, ground, pressed or roasted. Also falling under the definition of storage goods is timber, whether in the form of crude timber, such as construction timber, electricity pylons and barriers, or in the form of finished articles, such as furniture or objects made from wood. Storage goods of animal origin are hides, leather, furs, hairs and the like. The compositions according the present invention can prevent disadvantageous effects such as decay, discoloration or mold. Preferably "storage goods" is understood to denote natural substances of vegetable origin and/or their processed forms, more preferably fruits and their processed forms, such as pomes, stone fruits, soft fruits and citrus fruits and their processed forms. In another preferred embodiment of the invention "storage goods" is understood to denote wood.

Therefore a further aspect of the present invention is a method of protecting storage goods, which comprises applying to the storage goods a composition according to the invention.

The compositions of the present invention may also be used in the field of protecting technical material against attack of fungi. According to the present invention, the term "technical material" includes paper; carpets; constructions; cooling and heating systems; wall-boards; ventilation and air conditioning systems and the like; preferably "technical material" is understood to denote wall-boards. The compositions according the present invention can prevent disadvantageous effects such as decay, discoloration or mold.

The compositions according to the invention are particularly effective against powdery mildews; rusts; leafspot species; early blights and molds; especially against Septoria, Puccinia, Erysiphe, Pyrenophora and Tapesia in cereals; Phakopsora in soybeans; Hemileia in coffee; Phragmidium in roses; Alternaria in potatoes, tomatoes and cucurbits; Sclerotinia in turf, vegetables, sunflower and oil seed rape; black rot, red fire, powdery mildew, grey mold and dead arm disease in vine; Botrytis cinerea in fruits; Monilinia spp. in fruits and Penicillium spp. in fruits.
The compositions according to the invention are furthermore particularly effective against seedborne and soilborne diseases, such as Alternaria spp., Ascochyta spp., Botrytis cinerea, Cercospora spp., Claviceps purpurea, Cochliobolus sativus, Colletotrichum spp., Epicoccum spp., Fusarium graminearum, Fusarium moniliforme, Fusarium oxysporum, Fusarium proliferatum, Fusarium solani, Fusarium subglutinans, Gäumannomyces graminis , Helminthosporium spp., Microdochium nivale, Phoma spp., Pyrenophora graminea, Pyricularia oryzae, Rhizoctonia solani, Rhizoctonia cerealis, Sclerotinia spp., Septoria spp., Sphacelotheca reilliana, Tilletia spp., Typhula incarnata, Urocystis occulta, Ustilago spp. or Verticillium spp.; in particular against pathogens of cereals, such as wheat, barley, rye or oats; maize; rice; cotton; soybean; turf; sugarbeet; oil seed rape; potatoes; pulse crops, such as peas, lentils or chickpea; and sunflower.
The compositions according to the invention are furthermore particularly effective against post harvest diseasese such as Botrytis cinerea, Colletotrichum musae, Curvularia lunata, Fusarium semitecum, Geotrichum candidum, Monilinia fructicola, Monilinia fructigena, Monilinia laxa, Mucor piriformis, Penicilium italicum, Penicilium solitum, Penicillium digitatum or Penicillium expansum in particular against pathogens of fruits, such as pomefruits, for example apples and pears, stone fruits, for example peaches and plums, citrus, melons, papaya, kiwi, mango, berries, for example strawberries, avocados, pomegranates and bananas, and nuts.

The compositions according to the invention are particularly useful for controlling the following diseases on the following crops:
Alternaria species in fruit and vegetables; Ascochyta species in pulse crops; Botrytis cinerea in strawberries, tomatoes, sunflower, pulse crops, vegetables and grapes, such as Botrytis cinerea on grape; Cercospora arachidicola in peanuts; Cochliobolus sativus in cereals; Colletotrichum species in pulse crops; Erysiphe species in cereals; such as Erysiphe graminis on wheat and Erysiphe graminis on barley; Erysiphe cichoracearum and Sphaerotheca fuliginea in cucurbits; Fusarium species in cereals and maize; Gäumannomyces graminis in cereals and lawns; Helminthosporium species in maize, rice and potatoes; Hemileia vastatrix on coffee; Microdochium species in wheat and rye; Mycosphaerella fijiensis in banana; Phakopsora species in soybeans, such as Phakopsora pachyrizi in soybeans; Puccinia species in cereals, broadleaf crops and perennial plants; such as Puccinia recondita on wheat, Puccinia striiformis on wheat and Puccinia recondita on barley; Pseudocercosporella species in cereals, such as Pseudocercosporella herpotrichoides in wheat; Phragmidium mucronatum in roses; Podosphaera species in fruits; Pyrenophora species in barley, such as Pyrenophora teres on barley; Pyricularia oryzae in rice; Ramularia collo-cygni in barley; Rhizoctonia species in cotton, soybean, cereals, maize, potatoes, rice and lawns, such as Rhizoctonia solani on potato, rice, turf and cotton; Rhynchosporium secalis on barley, Rhynchosporium secalis on rye; Sclerotinia species in lawns, lettuce, vegetables and oil seed rape, such as Sclerotinia sclerotiorum on oilseed rape and Sclerotinia homeocarpa on turf; Septoria species in cereals, soybean and vegetables, such as Septoria tritici on wheat, Septoria nodorum on wheat and Septoria glycines on soybean; Sphacelotheca reilliana in maize; Tilletia species in cereals; Uncinula necator, Guignardia bidwellii and Phomopsis viticola in vines; Urocystis occulta in rye; Uromyces species in beans; Ustilago species in cereals and maize; Venturia species in fruits, such as Venturia inequalis on apple; Monilinia species on fruits; Penicillium species on citrus and apples.

In general, the weight ratio of component (A) to component (B) is from 2000 : 1 to 1 : 1000. A non-limiting example for such weight ratios is compound of formula I : compound of formula B-2 is 10:1. The weight ratio of component (A) to component (B) is preferably from 100 : 1 to 1 : 100; more preferably from 20 : 1 to 1 : 50.

It has been found, surprisingly, that certain weight ratios of component (A) to component (B) are able to give rise to synergistic activity. Therefore, a further aspect of the invention are compositions, wherein component (A) and component (B) are present in the composition in amounts producing a synergistic effect. This synergistic activity is apparent from the fact that the fungicidal activity of the composition comprising component (A) and component (B) is greater than the sum of the fungicidal activities of component (A) and of component (B). This synergistic activity extends the range of action of component (A) and component (B) in two ways. Firstly, the rates of application of component (A) and component (B) are lowered whilst the action remains equally good, meaning that the active ingredient mixture still achieves a high degree of phytopathogen control even where the two individual components have become totally ineffective in such a low application rate range. Secondly, there is a substantial broadening of the spectrum of phytopathogens that can be controlled.

A synergistic effect exists whenever the action of an active ingredient combination is greater than the sum of the actions of the individual components. The action to be expected E for a given active ingredient combination obeys the so-called COLBY formula and can be calculated as follows (COLBY, S.R. "Calculating synergistic and antagonistic responses of herbicide combination". Weeds, Vol. 15, pages 20-22; 1967):
ppm = milligrams of active ingredient (= a.i.) per liter of spray mixture
X = % action by active ingredient A) using p ppm of active ingredient
Y = % action by active ingredient B) using q ppm of active ingredient.
According to COLBY, the expected (additive) action of active ingredients A)+B) using p+q ppm of active ingredient is $E = X + Y - \frac{X \cdot Y}{100}$

If the action actually observed (O) is greater than the expected action (E), then the action of the combination is super-additive, i.e. there is a synergistic effect. In mathematical terms, synergism corresponds to a positive value for the difference of (O-E). In the case of purely complementary addition of activities (expected activity), said difference (O-E) is zero. A negative value of said difference (O-E) signals a loss of activity compared to the expected activity.

However, besides the actual synergistic action with respect to fungicidal activity, the compositions according to the invention can also have further surprising advantageous properties. Examples of such advantageous properties that may be mentioned are: more advantageuos degradability; improved toxicological and/or ecotoxicological behaviour; or

improved characteristics of the useful plants including: emergence, crop yields, more developed root system, tillering increase, increase in plant height, bigger leaf blade, less dead basal leaves, stronger tillers, greener leaf colour, less fertilizers needed, less seeds needed, more productive tillers, earlier flowering, early grain maturity, less plant verse (lodging), increased shoot growth, improved plant vigor, and early germination.

Some compositions according to the invention have a systemic action and can be used as foliar, soil and seed treatment fungicides.

With the compositions according to the invention it is possible to inhibit or destroy the phytopathogenic microorganisms which occur in plants or in parts of plants (fruit, blossoms, leaves, stems, tubers, roots) in different useful plants, while at the same time the parts of plants which grow later are also protected from attack by phytopathogenic microorganisms.

The compositions according to the invention can be applied to the phytopathogenic microorganisms, the useful plants, the locus thereof, the propagation material thereof, storage goods or technical materials threatened by microorganism attack.

The compositions according to the invention may be applied before or after infection of the useful plants, the propagation material thereof, storage goods or technical materials by the microorganisms.

The amount of a composition according to the invention to be applied, will depend on various factors, such as the compounds employed; the subject of the treatment, such as, for example plants, soil or seeds; the type of treatment, such as, for example spraying, dusting or seed dressing; the purpose of the treatment, such as, for example prophylactic or therapeutic; the type of fungi to be controlled or the application time.

When applied to the useful plants component (A) is typically applied at a rate of 5 to 2000 g a.i./ha, particularly 10 to 1000 g a.i./ha, e.g. 50, 75, 100 or 200 g a.i./ha, typically in association with 1 to 5000 g a.i./ha, particularly 2 to 2000 g a.i./ha, e.g. 100, 250, 500, 800, 1000, 1500 g a.i./ha of component (B).

In agricultural practice the application rates of the compositions according to the invention depend on the type of effect desired, and typically range from 20 to 4000 g of total composition per hectare.

When the compositions according to the invention are used for treating seed, rates of 0.001 to 50 g of a compound of component (A) per kg of seed, preferably from 0.01 to 10g per kg of seed, and 0.001 to 50 g of a compound of component (B), per kg of seed, preferably from 0.01 to 10g per kg of seed, are generally sufficient.

The composition of the invention may be employed in any conventional form, for example in the form of a twin pack, a powder for dry seed treatment (DS), an emulsion for seed treatment (ES), a flowable concentrate for seed treatment (FS), a solution for seed treatment (LS), a water dispersible powder for seed treatment (WS), a capsule suspension for seed treatment (CF), a gel for seed treatment (GF), an emulsion concentrate (EC), a suspension concentrate (SC), a suspo-emulsion (SE), a capsule suspension (CS), a water dispersible granule (WG), an emulsifiable granule (EG), an emulsion, water in oil (EO), an emulsion, oil in water (EW), a micro-emulsion (ME), an oil dispersion (OD), an oil miscible flowable (OF), an oil miscible liquid (OL), a soluble concentrate (SL), an ultra-low volume suspension (SU), an ultra-low volume liquid (UL), a technical concentrate (TK), a dispersible concentrate (DC), a wettable powder (WP) or any technically feasible formulation in combination with agriculturally acceptable adjuvants.

Such compositions may be produced in conventional manner, e.g. by mixing the active ingredients with at least one appropriate inert formulation adjuvant (for example, diluents, solvents, fillers and optionally other formulating ingredients such as surfactants, biocides, anti-freeze, stickers, thickeners and compounds that provide adjuvancy effects). Also conventional slow release formulations may be employed where long lasting efficacy is intended. Particularly formulations to be applied in spraying forms, such as water dispersible concentrates (e.g. EC, SC, DC, OD, SE, EW, EO and the like), wettable powders and granules, may contain surfactants such as wetting and dispersing agents and other compounds that provide adjuvancy effects, e.g. the condensation product of formaldehyde with naphthalene sulphonate, an alkylarylsulphonate, a lignin sulphonate, a fatty alkyl sulphate, and ethoxylated alkylphenol and an ethoxylated fatty alcohol.

The compositions according to the invention may also comprise further pesticides, such as, for example, fungicides, insecticides or herbicides.

A seed dressing formulation is applied in a manner known per se to the seeds employing the compositions according to the invention and a diluent in suitable seed dressing formulation form, e.g. as an aqueous suspension or in a dry powder form having good adherence to the seeds. Such seed dressing formulations are known in the art. Seed dressing formulations may contain the single active ingredients or the combination of active ingredients in encapsulated form, e.g. as slow release capsules or microcapsules.

In general, the formulations include from 0.01 to 90% by weight of active agent, from 0 to 20% agriculturally acceptable surfactant and 10 to 99.99% solid or liquid formulation inerts and adjuvant(s), the active agent consisting of at least a compound of component (A) together with a compound of component (B), and optionally other active agents, particularly microbiocides or conservatives or the like. Concentrated forms of compositions generally contain in between about 2 and 80%, preferably between about 5 and 70% by weight of active agent. Application forms of formulation may for example contain from 0.01 to 20% by weight, preferably from 0.01 to 5% by weight of active agent. Whereas commercial products will preferably be formulated as concentrates, the end user will normally employ diluted formulations.

The methods according to the invention, also allows good control of other harmful fungi frequently encountered in soybean plants. The most important fungal diseases in soybeans being Phakopsora pachyrhizi, Microsphaera diffusa, Cercospora kikuchi, Cercospora sojina, Septoria glycines and Colletotrichum truncatum, some of which comprise the so-called “late season disease complex”, and furthermore Rhizoctonia solani, Corynespora cassiicola, Sclerotinia sclerotiorum and Sclerosium rolfsii.

As described above for the term “useful plant”, the term “soybean plant” includes all soybean plants and all varieties, including transgenic plants. The term “soybean plant” includes especially glyphosate tolerant soybean plants.

By "glyphosate tolerant" is meant that the plants for use in the methods are resistant to glyphosate application or tolerant of glyphosate. Glyphosate tolerant plants are made tolerant to glyphosate by conventional breeding or having a transgenic event that provides

glyphosate resistance. Some examples of such preferred transgenic plants having transgenic events that confer glyphosate resistance are described in U.S. Pat. Nos. 5,914,451; 5,866,775; 5,804,425; 5,776,760; 5,633,435; 5,627,061; 5,463,175; 5,312,910; 5,310,667; 5,188,642; 5,145,783; 4,971,908 and 4,940,835. The use of "stacked" transgenic events in the plant is also contemplated.
Stacked transgenic events including additional herbicide-resistant traits such as resistance to HPPD-inhibitors, sulfonyl-ureas, glufosinate and bromoxynil are widely used and described in readily available resources. The stacked transgenic events may also be directed to other pesticide resistant traits, such as insecticide, nematicide, fungicide, etc resistance, which may be made by conventional breeding or introducing a transgenic event.
Lines of transgenic glyphosate tolerant crop plants contemplated for use in the methods of the present invention include, for example, Roundup Ready® Soybean 40-3-2.

A "transgenic plant" refers to a plant that contains genetic material not found (i.e. "exogenous") in a wild-type plant of the same species, variety or cultivar. The genetic material may include a transgene, an insertional mutagenesis event (such as by transposon or T-DNA insertional mutagenesis), an activation tagging sequence, a mutated sequence, a homologous recombination event or a sequence modified by chimeraplasty. Typically, the foreign genetic material has been introduced into the plant by human manipulation, but any method can be used as one of skill in the art recognizes. A transgenic plant may contain an expression vector or cassette. The expression cassette typically comprises a polypeptide-encoding sequence operably linked (i. e., under regulatory control of) to appropriate inducible or constitutive regulatory sequences that allow for the expression of the polypeptide. The expression cassette can be introduced into a plant by transformation or by breeding after transformation of a parent plant. As previously described a plant refers to a whole plant, including seedlings and mature plants, as well as to a plant part, such as seed, fruit, leaf, or root, plant tissue, plant cells or any other plant material, e. g., a plant explant, as well as to progeny thereof, and to in vitro systems that mimic biochemical or cellular components or processes in a cell.

The Examples which follow serve to illustrate the invention, "active ingredient" denotes a mixture of component (A) and component (B) in a specific mixing ratio.

Formulation Examples

Wettable powders	a)	b)
active ingredient [A): B) = 1:3(a), 1:1(b)]	25 %	75 %
sodium lignosulfonate	5 %	-
sodium lauryl sulfate	3 %	5 %
sodium diisobutylnaphthalenesulfonate	-	10 %
(7-8 mol of ethylene oxide)		
highly dispersed silicic acid	5 %	10 %
kaolin	62 %	-

The active ingredient is thoroughly mixed with the other formulation components and the mixture is thoroughly ground in a suitable mill, affording wettable powders that can be diluted with water to give suspensions of the desired concentration.

Powders for dry seed treatment	a)	b)
active ingredient [A) : B) = 1:3(a), 1:1(b)]	25 %	75 %
light mineral oil	5 %	5 %
highly dispersed silicic acid	5 %	-
kaolin	65 %	-
talc	-	20

The active ingredient is thoroughly mixed with the other formulation components and the mixture is thoroughly ground in a suitable mill, affording powders that can be used directly for seed treatment.

Emulsifiable concentrate	
active ingredient (A): B) = 1:6)	10 %
octylphenol polyethylene glycol ether	3 %
(4-5 mol of ethylene oxide)	
calcium dodecylbenzenesulfonate	3 %
castor oil polyglycol ether (35 mol of ethylene oxide)	4 %
cyclohexanone	30 %
xylene mixture	50 %

Emulsions of any required dilution, which can be used in plant protection, can be obtained from this concentrate by dilution with water.

Dustable powders	a)	b)
active ingredient [A) : B) = 1:6(a), 1:10(b)]	5 %	6 %
talcum	95 %	-
kaolin	-	94 %

Ready-for-use dusts are obtained by mixing the active ingredient with the carriers and grinding the mixture in a suitable mill. Such powders can also be used for dry dressings for seed.

Extruded granules	% w/w
active ingredient (A) : B) = 2:1)	15 %
sodium lignosulfonate	2 %
sodium alkyl naphthalene sulfonate	1 %
kaolin	82 %

The active ingredient is mixed and ground with the other formulation components, and the mixture is moistened with water. The mixture is extruded and then dried in a stream of air.

Suspension concentrate	
active ingredient (A) : B) = 1:8)	40 %
propylene glycol	10 %
nonylphenol polyethylene glycol ether (15 mol of ethylene oxide)	6 %
sodium lignosulfonate	10 %
carboxymethylcellulose	1 %
silicone oil (in the form of a 75 % emulsion in water)	1 %
water	32 %

The finely ground active ingredient is intimately mixed with the other formulation components, giving a suspension concentrate which can be diluted in water at any desired rate. Using such dilutions, living plants as well as plant propagation material can be treated and protected against infestation by microorganisms, by spraying, pouring or immersion.

Flowable concentrate for seed treatment	
active ingredient (A) : B) = 1:8)	40 %
propylene glycol	5 %
copolymer butanol PO/EO	2 %
tristyrenephenole ethoxylate (with 10-20 moles EO)	2 %

1,2-benzisothiazolin-3-one	0.5 %
monoazo-pigment calcium salt	5 %
silicone oil (in the form of a 75 % emulsion in water)	0.2 %
water	45.3 %

The finely ground active ingredient is intimately mixed with the other formulation components, giving a suspension concentrate which can be diluted further in water to be applied to seeds. Using such dilutions, propagation material can be treated and protected against infestation by microorganisms, by spraying, pouring or immersion.

Biological Examples

Example B1: fungicidal action against *Gaeumannomyces graminis* (Take-all of cereals):
Mycelial fragments of the fungus from cryogenic storage are directly mixed into nutrient broth (PDB potato dextrose broth). After placing a (DMSO) solution of the test compounds into a microtiter plate (96-well format) the nutrient broth containing the fungal spores is added. The test plates are incubated at 24 °C and the inhibition of growth is evaluated after 4 days. The results are given in Tables B1:

Tables B1: Fungicidal action against *Gaeumannomyces graminis*:

Table B1.1:

Compound A-1.2	Fluopyram		
ppm	ppm	% activity	
0.5000		90	
0.2500		0	
	2.0000	0	
	1.0000	0	
	0.5000	0	
	0.2500	0	
	0.1250	0	expected action (Colby)
0.5000	2.0000	100	90
0.5000	1.0000	100	90
0.5000	0.5000	100	90
0.5000	0.1250	100	90
0.2500	0.5000	50	0
0.2500	0.2500	90	0

Table B1.2:

Compound A-1.1	Fluopyram		
ppm	ppm	% activity	
0.0156		70	
	0.0313	0	
	0.0156	0	
	0.0078	0	
	0.0039	0	expected action (Colby)
0.0156	0.0313	90	70
0.0156	0.0156	100	70
0.0156	0.0078	90	70
0.0156	0.0039	90	70

Example B2: fungicidal action against *Cercospora arachidicola* (syn.Mycosphaerella arachidis), Brown leaf spot of groundnut (peanut):

Conidia of the fungus from cryogenic storage are directly mixed into nutrient broth (PDB potato dextrose broth). After placing a (DMSO) solution of the test compounds into a microtiter plate (96-well format) the nutrient broth containing the fungal spores is added. The test plates are incubated at 24 C and the inhibition of growth is evaluated after 7 days. The results are given in Table B2:

Table B2: Fungicidal action against *Cercospora arachidicola*:

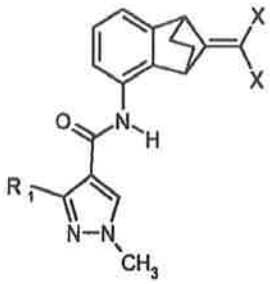
Table B2.1:

Compound A-1.2	Fluopyram		
ppm	ppm	% activity	
0.2500		50	
0.1250		20	
	0.2500	20	
	0.1250	20	
	0.0625	0	
	0.0313	0	expected action (Colby)
0.2500	0.2500	90	60
0.2500	0.1250	90	60
0.2500	0.0625	90	50
0.1250	0.2500	70	36
0.1250	0.1250	50	36
0.1250	0.0625	50	20
0.1250	0.0313	70	20

Claims

1. A composition suitable for control of diseases caused by phytopathogens comprising

   (A) a compound of formula I



(I),

   wherein R_1 is difluoromethyl or trifluoromethyl and X is chloro, fluoro or bromo; and
   (B) the compound fluopyram.

2. A composition according to claim 1, wherein component (A) is a compound of formula (I), wherein R_1 is difluoromethyl.

3. A composition according to claim 1, wherein component (A) is a compound of formula (I), wherein R_1 is difluoromethyl and X is chloro.

4. A composition according to claim 1, wherein component (A) is a compound of formula (I), wherein R_1 is difluoromethyl and X is fluoro.

5. A composition according to claim 1, wherein component (A) is a compound of formula (I), wherein R_1 is difluoromethyl and X is bromo.

6. A composition according to claim 1, which comprises as component (A) a compound selected from 3-difluoromethyl-1-methyl-1H-pyrazole-4-carboxylic acid (9-dichloromethylidene-benzonorbornene-5-yl)amide and 3-difluoromethyl-1-methyl-1 H-pyrazole-4-carboxylic acid (9-difluoromethylidene-benzonorbornene-5-yl)amide, and as component (B) fluopyram.

7. A composition according to claim 1, which comprises as component (A) the compound 3-difluoromethyl-1-methyl-1 H-pyrazole-4-carboxylic acid (9-dichloromethylidene-benzonorbornene-5-yl)amide and as component (B) fluopyram.

8. A composition according to claim 1, which comprises as component (A) the compound 3-difluoromethyl-1-methyl-1H-pyrazole-4-carboxylic acid (9-difluoromethylidene-benzonorbornene-5-yl)amide and as component (B) fluopyram.

9. A composition according to claim 1, wherein the weight ratio of (A) to (B) is from 2000 : 1 to 1 : 1000.

10. A method of controlling diseases on useful plants or on propagation material thereof caused by phytopathogens, which comprises applying to the useful plants, the locus thereof or propagation material thereof a composition according to claim 1.

11. A method of controlling diseases on soybean plants caused by phytopathogens, which comprises applying to the soybean plants or to the locus thereof a composition according to claim 1.

12. A method according to claim 11, wherein the phytopathogen is Phakopsora pachyrhizi.