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(54) Titre : PROCÉDE D'INDUCTION DE RESISTANCE A DES CHAMPIGNONS NUISIBLES
(54) Title: METHOD OF INDUCING RESISTANCE TO HARMFUL FUNGI

(57) **Abrégé/Abstract:**

The present invention relates to a method of inducing plant tolerance to harmful fungi comprising the application to the plants, the soil, in which the plant grows or is to be grown and/or the seeds of the plant, of an effective amount of an active compound that inhibits the mitochondrial breathing chain at the level of the b/c_1 complex.



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(54) Title: METHOD OF INDUCING RESISTANCE TO HARMFUL FUNGI

(57) Abstract: The present invention relates to a method of inducing plant tolerance to harmful fungi comprising the application to the plants, the soil, in which the plant grows or is to be grown and/or the seeds of the plant, of an effective amount of an active compound that inhibits the mitochondrial breathing chain at the level of the b/c₁ complex.

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METHOD OF INDUCING RESISTANCE TO HARMFUL FUNGI

The present invention relates to a method of inducing plant tolerance to harmful fungi comprising a repeated treatment to the plants, the soil in which the plant grows or is to be grown and/or the seeds of the plant, with an effective amount of an active compound that inhibits the mitochondrial breathing chain at the level of the b/c₁ complex.

10 The active compounds used according to the present invention can be applied to the plants, the seeds and/or the soils before or after sowing the plants or before or after emergence of the plants.

20 Practical experience in agriculture has demonstrated that the repeated use of certain active substances in the control of harmful fungi leads, in many cases, to the rapid selection of those fungal strains, which have developed a natural or adapted increased resistance to the active substance in question. In such a case, an effective control of these fungi with the active substance in question is no longer possible. These fungal strains are usually also cross-resistant to other active substances with the same mode of action. Active substances with different modes of action are required for controlling these fungal strains. However, there is no unlimited supply of active substances with novel modes of action. Finding novel modes of action is an ongoing objective on which research in the agrochemical industry focuses. The development of novel active substances without cross-resistance with known active substances is expensive and time-consuming.

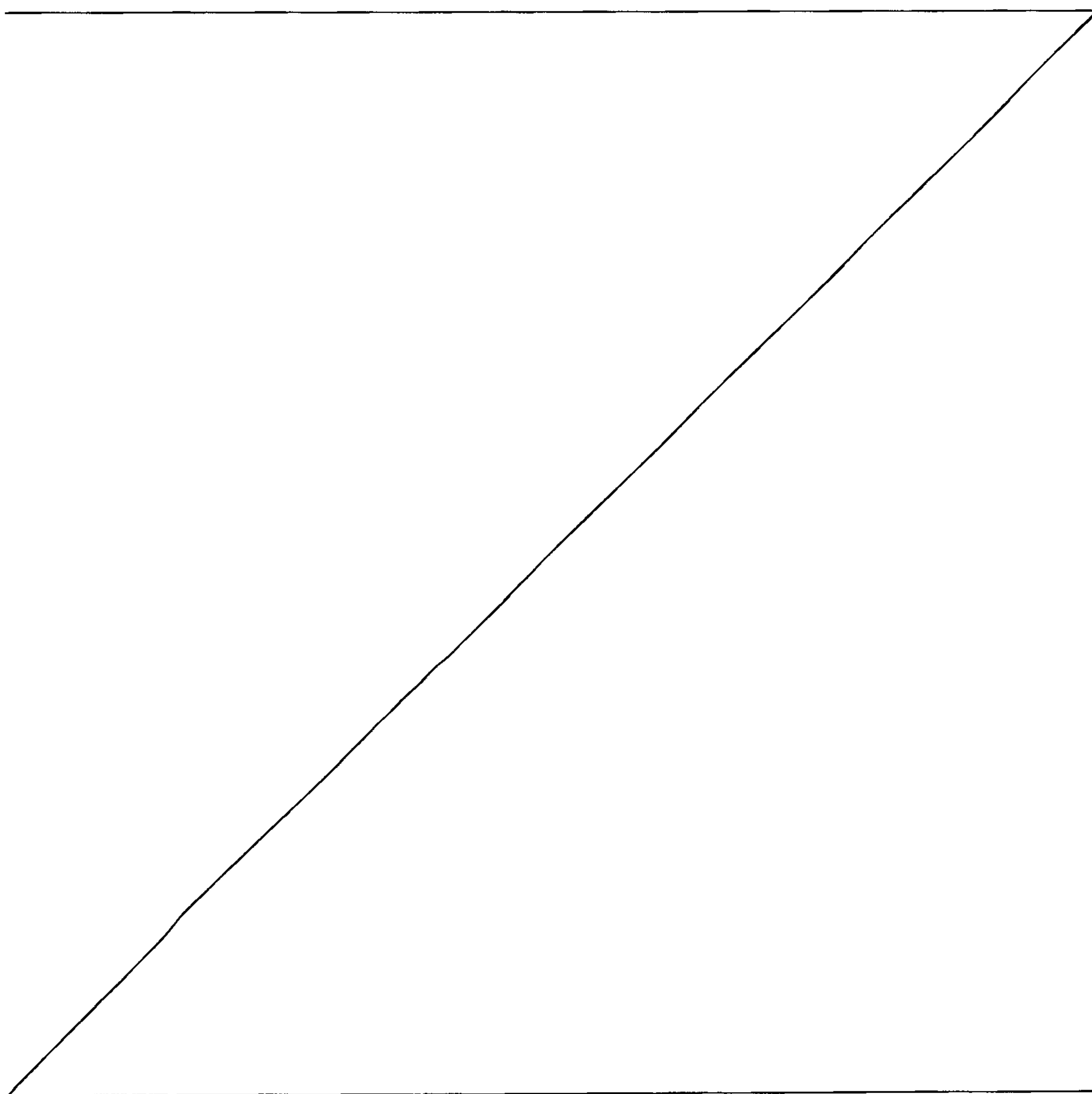
As regards the spread of harmful fungi, it was an object of the present invention to find an efficient, widely applicable method by means of which the plants develop an increased resistance/tolerance to harmful fungi. This makes it possible to counteract the increased use of fungicides in agriculture.

Surprisingly, it has now been found that plants, having been treated with an active substance that inhibits the mitochondrial breathing chain at the level of the b/c₁ complex have an increased tolerance to harmful fungi.

1a

"Induction of tolerance" in the sense of the present invention means that by application of the inventive method, a noticeably lower susceptibility of the treated plants to harmful fungi can be observed. Herein, this is also called "induction of resistance" in the plant to the respective harmful fungi.

Consequently, the plant that has been treated according to the present invention is less attacked by harmful fungi than a comparable plant that has not been subjected to the inventive method. In particular, the inventive method preferably results in at least 20 %, more preferably at least 30 %, even more preferably at least 40 %, still more preferred

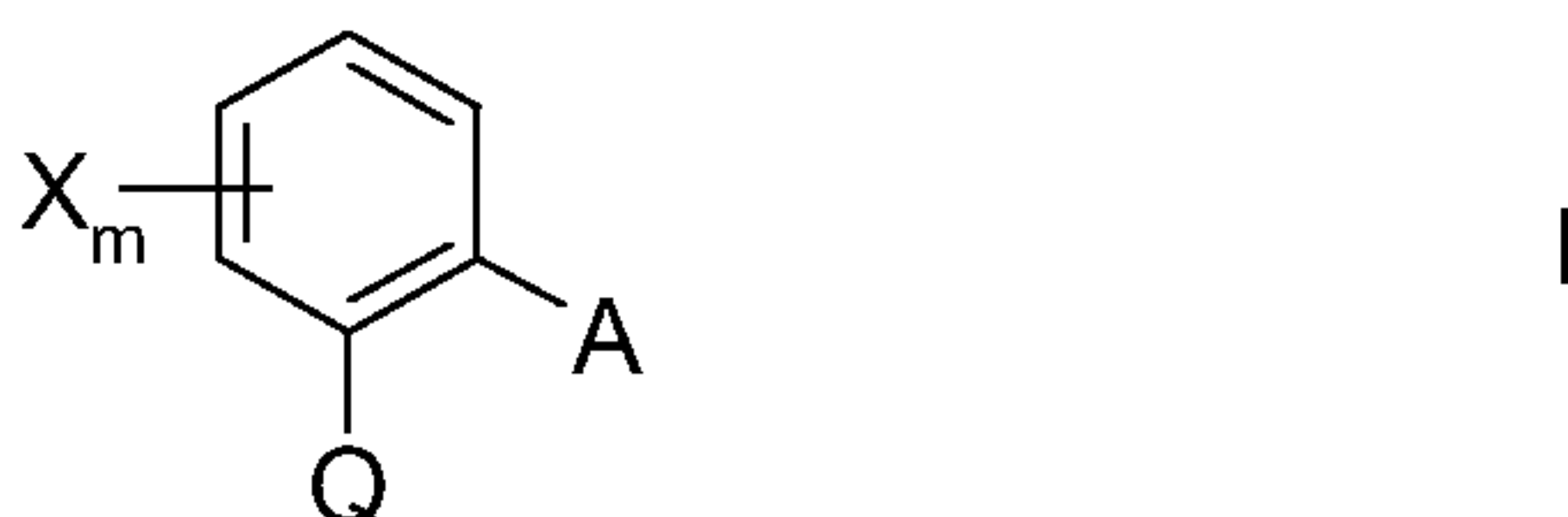


at least 50 %, still more preferred at least 60 %, still more preferred at least 70 %, most preferred at least 80 % less attack of harmful fungi than the respective control plant.

Active compounds that inhibit the mitochondrial breathing chain at the level of the b/c₁ complex are known as pesticides from the literature, wherein most of them are known as fungicides and/or insecticides [see for example Dechema-Monographien Bd. 129, 27-38, VCH Verlagsgemeinschaft Weinheim 1993; Natural Product Reports 1993, 565-574; Biochem. Soc. Trans. 22, 63S (1993)]. However, there has been no suggestion to date that such active compounds can effectively be used for inducing resistance in plants towards harmful fungi, which has only been found within the framework of the present invention.

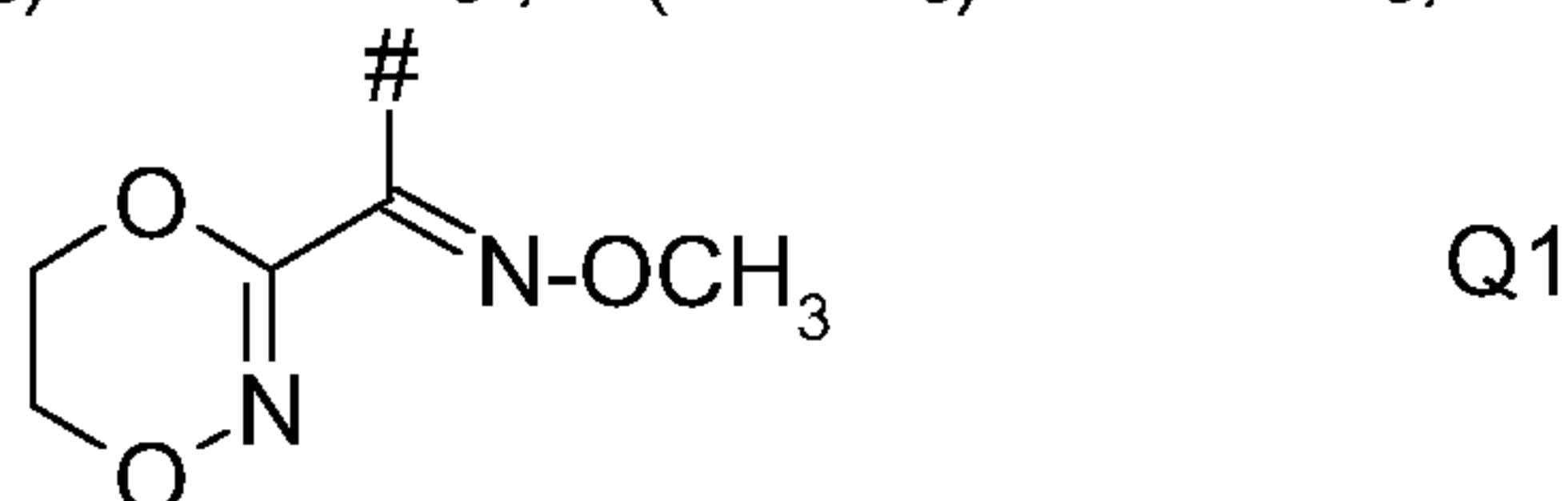
A particularly important class of active compounds that inhibit the mitochondrial breathing chain at the level of the b/c₁ complex useful according to the present invention are strobilurins. Strobilurins are generally known as pesticides since a long time and have particularly been described as fungicides and, in some cases, also as insecticides and are for example widely used for combating various fungal pathogens (EP-A 178 826; EP-A 253 213; WO 93/15046; WO 95/18789; WO 95/21153; WO 95/21154; WO 95/24396; WO 96/01256; WO 97/15552; WO 97/27189). A further example of an active compound that inhibits the mitochondrial breathing chain at the level of the b/c₁ complex is famoxadone (5-methyl-5-(4-phenoxyphenyl)-3-(phenylamino)-2,4-oxazolidinedione).

Specific examples for suitable strobilurins for use in the present invention are strobilurin compounds of the formula I



where the substituents and indices have the following meanings:

- 30 X denotes halogen, C₁-C₄-alkyl or trifluoromethyl;
 m denotes 0 or 1;
 Q denotes C(=CH-CH₃)-COOCH₃, C(=CH-OCH₃)-COOCH₃, C(=N-OCH₃)-CONHCH₃, C(=N-OCH₃)-COOCH₃, N(-OCH₃)-COOCH₃, or a group Q1



where # denotes the point of linkage to the phenyl ring;

A denotes -O-B, -CH₂O-B, -OCH₂-B, -CH₂S-B, -CH=CH-B, -C≡C-B, -CH₂O-N=C(R¹)-B, -CH₂S-N=C(R¹)-B, -CH₂O-N=C(R¹)-CH=CH-B, or -CH₂O-N=C(R¹)-C(R²)=N-OR³; where B has the following meanings:

5

B denotes phenyl, naphthyl, 5- or 6-membered heteroaryl or 5- or 6-membered heterocyclyl, comprising one, two or three N atoms and/or one O or S atom or one or two O and/or S atoms, the ring systems being unsubstituted or substituted by one, two or three identical or different groups R^a:

10

R^a denotes cyano, nitro, amino, aminocarbonyl, aminothiocarbonyl, halogen, C₁-C₆-alkyl, C₁-C₆-haloalkyl, C₁-C₆-alkylcarbonyl, C₁-C₆-alkylsulfonyl, C₁-C₆-alkylsulfinyl, C₃-C₆-cycloalkyl, C₁-C₆-alkoxy, C₁-C₆-haloalkoxy, C₁-C₆-alkyloxycarbonyl, C₁-C₆-alkylthio, C₁-C₆-alkylamino, di-C₁-C₆-alkylamino, C₁-C₆-alkylaminocarbonyl, di-C₁-C₆-alkylaminocarbonyl, C₁-C₆-alkylaminothiocarbonyl, di-C₁-C₆-alkylaminothiocarbonyl, C₂-C₆-alkenyl, C₂-C₆-alkenyloxy, phenyl, phenoxy, benzyl, benzyloxy, 5- or 6-membered heterocyclyl, 5- or 6-membered heteroaryl, 5- or 6-membered heteroaryloxy, C(=NOR^a)-R^b or OC(R^a)₂-C(R^b)=NOR^b,

15

20

the cyclic radicals, in turn, being unsubstituted or substituted by one, two or three identical or different groups R^b:

25

R^b denotes cyano, nitro, halogen, amino, aminocarbonyl, aminothiocarbonyl, C₁-C₆-alkyl, C₁-C₆-haloalkyl, C₁-C₆-alkylsulfonyl, C₁-C₆-alkylsulfinyl, C₃-C₆-cycloalkyl, C₁-C₆-alkoxy, C₁-C₆-haloalkoxy, C₁-C₆-alkyloxycarbonyl, C₁-C₆-alkylthio, C₁-C₆-alkylamino, di-C₁-C₆-alkylamino, C₁-C₆-alkylaminocarbonyl, di-C₁-C₆-alkylaminocarbonyl, C₁-C₆-alkylaminothiocarbonyl, di-C₁-C₆-alkylaminothiocarbonyl, C₂-C₆-alkenyl, C₂-C₆-alkenyloxy, C₃-C₆-cycloalkyl, C₃-C₆-cycloalkenyl, phenyl, phenoxy, phenylthio, benzyl, benzyloxy, 5- or 6-membered heterocyclyl, 5- or 6-membered heteroaryl, 5- or 6-membered heteroaryloxy or C(=NOR^A)-R^B; where

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R^A, R^B denote hydrogen or C₁-C₆-alkyl;

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R¹ denotes hydrogen, cyano, C₁-C₄-alkyl, C₁-C₄-haloalkyl, C₃-C₆-Cycloalkyl, C₁-C₄-alkoxy, or C₁-C₄-alkylthio;

R² denotes phenyl, phenylcarbonyl, phenylsulfonyl, 5- or 6-membered heteroaryl, 5- or 6-membered heteroarylcarbonyl or 5- or 6-membered heteroarylsulfonyl, the ring systems being unsubstituted or substituted by one, two or three identical or different radicals R^a,

5

C₁-C₁₀-alkyl, C₃-C₆-cycloalkyl, C₂-C₁₀-alkenyl, C₂-C₁₀-alkynyl, C₁-C₁₀-alkylcarbonyl, C₂-C₁₀-alkenylcarbonyl, C₃-C₁₀-alkynylcarbonyl, C₁-C₁₀-alkylsulfonyl, or C(=NOR^A)-R^B, the hydrocarbon radicals of these groups being unsubstituted or substituted by one, two or three identical or different radicals R^c:

10

R^c denotes cyano, nitro, amino, aminocarbonyl, aminothiocarbonyl, halogen, C₁-C₆-alkyl, C₁-C₆-haloalkyl, C₁-C₆-alkylsulfonyl, C₁-C₆-alkylsulfinyl, C₁-C₆-alkoxy, C₁-C₆-haloalkoxy, C₁-C₆-alkoxycarbonyl, C₁-C₆-alkylthio, C₁-C₆-alkylamino, di-C₁-C₆-alkylamino, C₁-C₆-alkylaminocarbonyl, di-C₁-C₆-alkylaminocarbonyl, C₁-C₆-alkylaminothiocarbonyl, di-C₁-C₆-alkylaminothiocarbonyl, C₂-C₆-alkenyl, C₂-C₆-alkenyloxy,

15

C₃-C₆-cycloalkyl, C₃-C₆-cycloalkyloxy, 5- or 6-membered heterocyclyl, 5- or 6-membered heterocyclyloxy, benzyl, benzyloxy, phenyl, phenoxy, phenylthio, 5- or 6-membered heteroaryl, 5- or 6-membered heteroaryloxy and heteroarylthio, it being possible for the cyclic groups, in turn, to be partially or fully halogenated and/or to have attached to them one, two or three identical or different radicals R^a; and

20
25

R³ denotes hydrogen, C₁-C₆-alkyl, C₂-C₆-alkenyl, C₂-C₆-alkynyl, the hydrocarbon radicals of these groups being unsubstituted or substituted by one, two or three identical or different radicals R^c; or an agriculturally acceptable salt thereof; and

30

the strobilurin compounds selected from the group consisting of methyl (2-chloro-5-[1-(3-methylbenzyloxyimino)ethyl]benzyl)carbamate and methyl (2-chloro-5-[1-(6-methylpyridin-2-ylmethoxyimino)ethyl]benzyl)carbamate and the agriculturally acceptable salts thereof.

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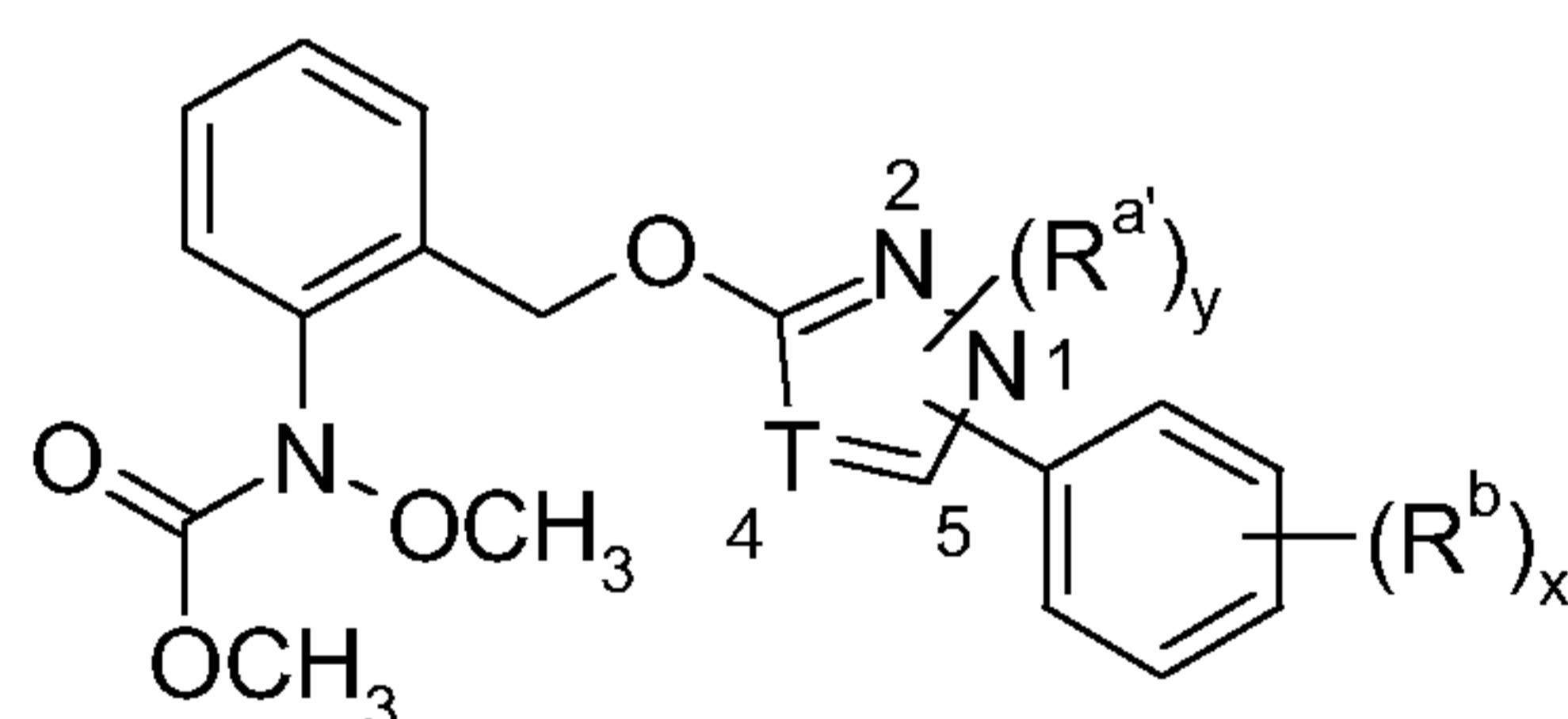
According to the present invention, agriculturally acceptable salts include in particular the salts of those cations or the acid addition salts of those acids whose cations and anions, respectively, have no adverse effect on the action of the compounds used according to the invention.

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- Thus, suitable cations are in particular the ions of the alkali metals, preferably sodium and potassium, of the alkaline earth metals, preferably calcium, magnesium and barium, and of the transition metals, preferably manganese, copper, zinc and iron, and also the ammonium ion which, if desired, may bear from one to four (C₁-C₄)-alkyl substituents and/or one phenyl or benzyl substituent, preferably diisopropylammonium, tetramethylammonium, tetrabutylammonium, trimethylbenzylammonium, and also phosphonium ions, sulfonium ions, preferably tri(C₁-C₄-alkyl)sulfonium, and sulfoxonium ions, preferably tri(C₁-C₄-alkyl)sulfoxonium.
- 10 Anions of acid addition salts which can be employed advantageously are, for example, chloride, bromide, fluoride, hydrogen sulfate, sulfate, dihydrogenphosphate, hydrogenphosphate, phosphate, nitrate, bicarbonate, carbonate, hexafluorosilicate, hexafluorophosphate, benzoate, and also the anions of (C₁-C₄)-alkanoic acids, preferably formate, acetate, propionate and butyrate. They can be formed by reaction of the compounds used according to the invention with an acid of the corresponding anion, preferably hydrochloric acid, hydrobromic acid, sulfuric acid, phosphoric acid or nitric acid. Particularly preferred according to the present invention are strobilurins selected from azoxystrobin, dimoxystrobin, enestroburin, fluoxastrobin, kresoxim-methyl, metominostrobin, picoxystrobin, pyraclostrobin, trifloxystrobin, oryastrobin, methyl (2-chloro-5-[1-(3-methylbenzyloxyimino)ethyl]benzyl)carbamate, methyl (2-chloro-5-[1-(6-methylpyridin-2-ylmethoxyimino)ethyl]benzyl)carbamate and methyl 2-(ortho(2,5-dimethylphenyl-oxymethylene)phenyl)-3-methoxyacrylate. Among these, it may be preferred according to the present invention to use a strobilurin selected from azoxystrobin, dimoxystrobin, enestroburin, fluoxastrobin, kresoxim-methyl, metominostrobin, picoxystrobin, pyraclostrobin, trifloxystrobin and oryastrobin.

Also particularly suitable for the use according to the invention are in particular the compounds listed in the tables below.

30 Table I

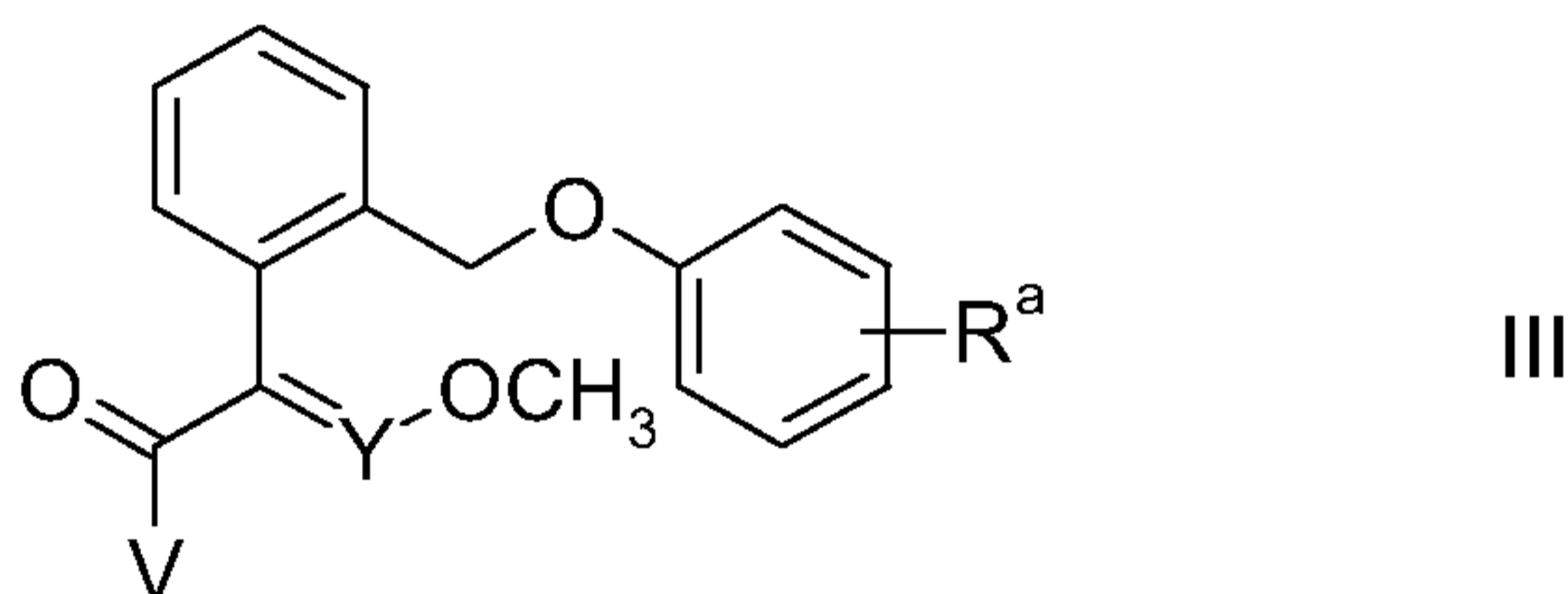


II

No.	T	(R ^a) _y	Position of the group phenyl-(R ^b) _x	(R ^b) _x	Reference
I-1	N	-	1	2,4-Cl ₂	WO 96/01256
I-2	N	-	1	4-Cl	WO 96/01256
I-3	CH	-	1	2-Cl	WO 96/01256
I-4	CH	-	1	3-Cl	WO 96/01256

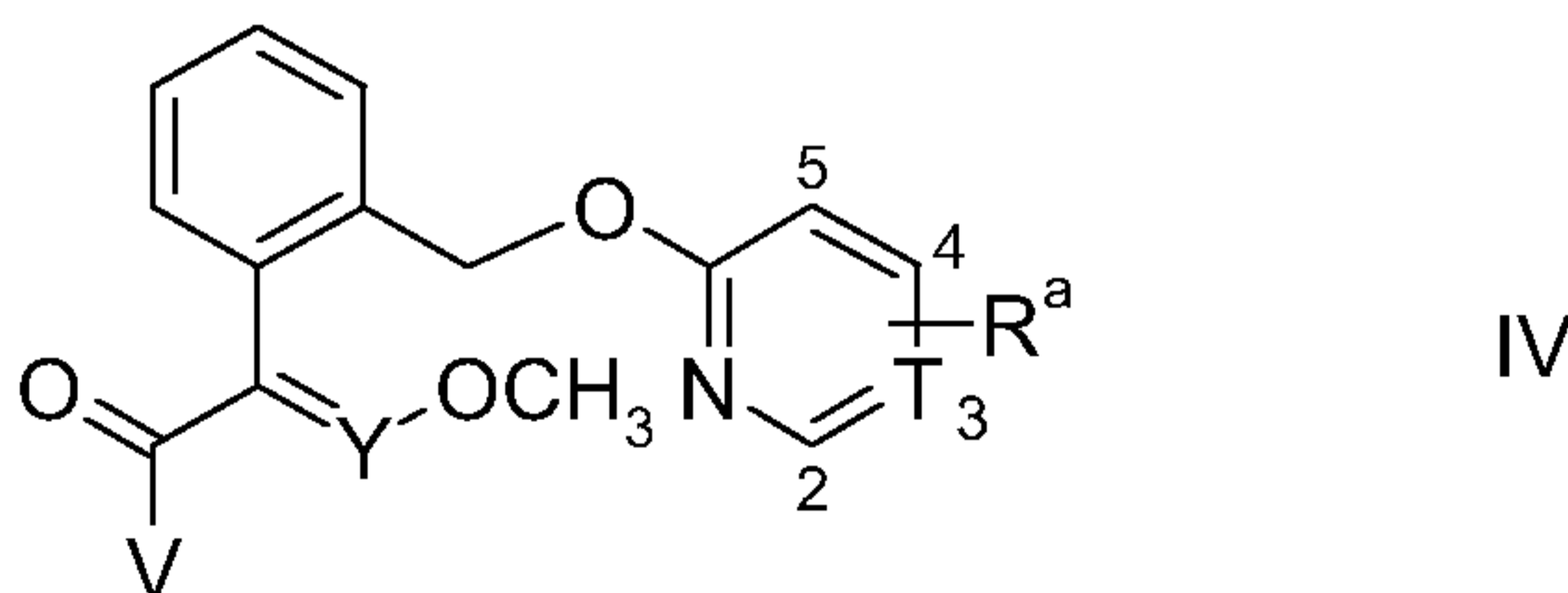
No.	T	(R ^a) _y	Position of the group phenyl-(R ^b) _x	(R ^b) _x	Reference
I-5	CH	-	1	4-Cl	WO 96/01256
I-6	CH	-	1	4-CH ₃	WO 96/01256
I-7	CH	-	1	H	WO 96/01256
I-8	CH	-	1	3-CH ₃	WO 96/01256
I-9	CH	5-CH ₃	1	3-CF ₃	WO 96/01256
I-10	CH	1-CH ₃	5	3-CF ₃	WO 99/33812
I-11	CH	1-CH ₃	5	4-Cl	WO 99/33812
I-12	CH	1-CH ₃	5	-	WO 99/33812

Table II



No.	V	Y	R ^a	Reference
II-1	OCH ₃	N	2-CH ₃	EP-A 253 213
II-2	OCH ₃	N	2,5-(CH ₃) ₂	EP-A 253 213
II-3	NHCH ₃	N	2,5-(CH ₃) ₂	EP-A 477 631
II-4	NHCH ₃	N	2-Cl	EP-A 398 692
II-5	NHCH ₃	N	2-CH ₃	EP-A 398 692
II-6	NHCH ₃	N	2-CH ₃ , 4-OCF ₃	EP-A 628 540
II-7	NHCH ₃	N	2-Cl, 4-OCF ₃	EP-A 628 540
II-8	NHCH ₃	N	2-CH ₃ , 4-OCH(CH ₃)-C(CH ₃)=NOCH ₃	EP-A 11 18 609
II-9	NHCH ₃	N	2-Cl, 4-OCH(CH ₃)-C(CH ₃)=NOCH ₃	EP-A 11 18 609
II-10	NHCH ₃	N	2-CH ₃ , 4-OCH(CH ₃)-C(CH ₂ CH ₃)=NOCH ₃	EP-A 11 18 609
II-11	OCH ₃	CH	2,5-(CH ₃) ₂	EP-A 226 917

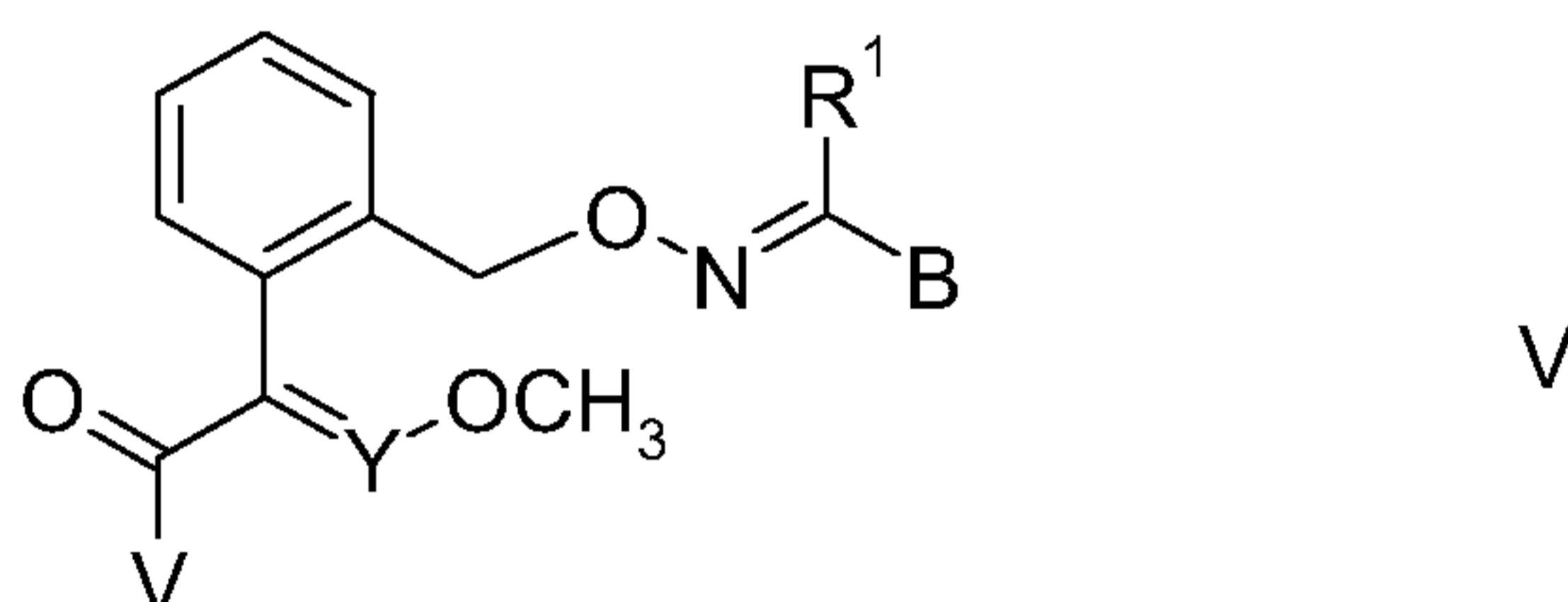
5 Table III



No.	V	Y	T	R ^a	Reference
III-1	OCH ₃	CH	N	2-OCH ₃ , 4-CF ₃	WO 96/16047

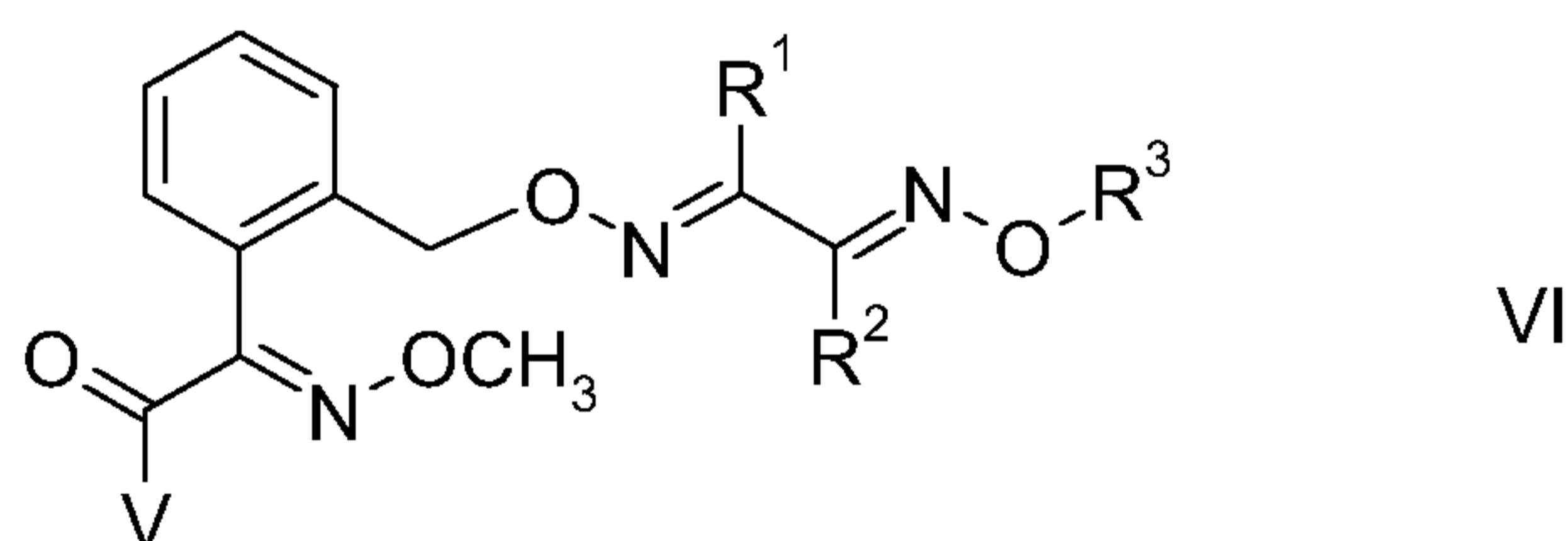
No.	V	Y	T	R ^a	Reference
III-2	OCH ₃	CH	N	2-OCH(CH ₃) ₂ , 4-CF ₃	WO 96/16047
III-3	OCH ₃	CH	CH	2-CF ₃	EP-A 278 595
III-4	OCH ₃	CH	CH	4-CF ₃	EP-A 278 595
III-5	NHCH ₃	N	CH	2-Cl	EP-A 398 692
III-6	NHCH ₃	N	CH	2-CF ₃	EP-A 398 692
III-7	NHCH ₃	N	CH	2-CF ₃ , 4-Cl	EP-A 398 692
III-8	NHCH ₃	N	CH	2-Cl, 4-CF ₃	EP-A 398 692

Table IV



No.	V	Y	R ¹	B	Reference
IV-1	OCH ₃	CH	CH ₃	(3-CF ₃)C ₆ H ₄	EP-A 370 629
IV-2	OCH ₃	CH	CH ₃	(3,5-Cl ₂)C ₆ H ₃	EP-A 370 629
IV-3	NHCH ₃	N	CH ₃	(3-CF ₃)C ₆ H ₄	WO 92/13830
IV-4	NHCH ₃	N	CH ₃	(3-OCF ₃)C ₆ H ₄	WO 92/13830
IV-5	OCH ₃	N	CH ₃	(3-OCF ₃)C ₆ H ₄	EP-A 460 575
IV-6	OCH ₃	N	CH ₃	(3-CF ₃)C ₆ H ₄	EP-A 460 575
IV-7	OCH ₃	N	CH ₃	(3,4-Cl ₂)C ₆ H ₃	EP-A 460 575
IV-8	OCH ₃	N	CH ₃	(3,5-Cl ₂)C ₆ H ₃	EP-A 463 488
IV-9	OCH ₃	CH	CH ₃	CH=CH-(4-Cl)C ₆ H ₄	EP-A 936 213

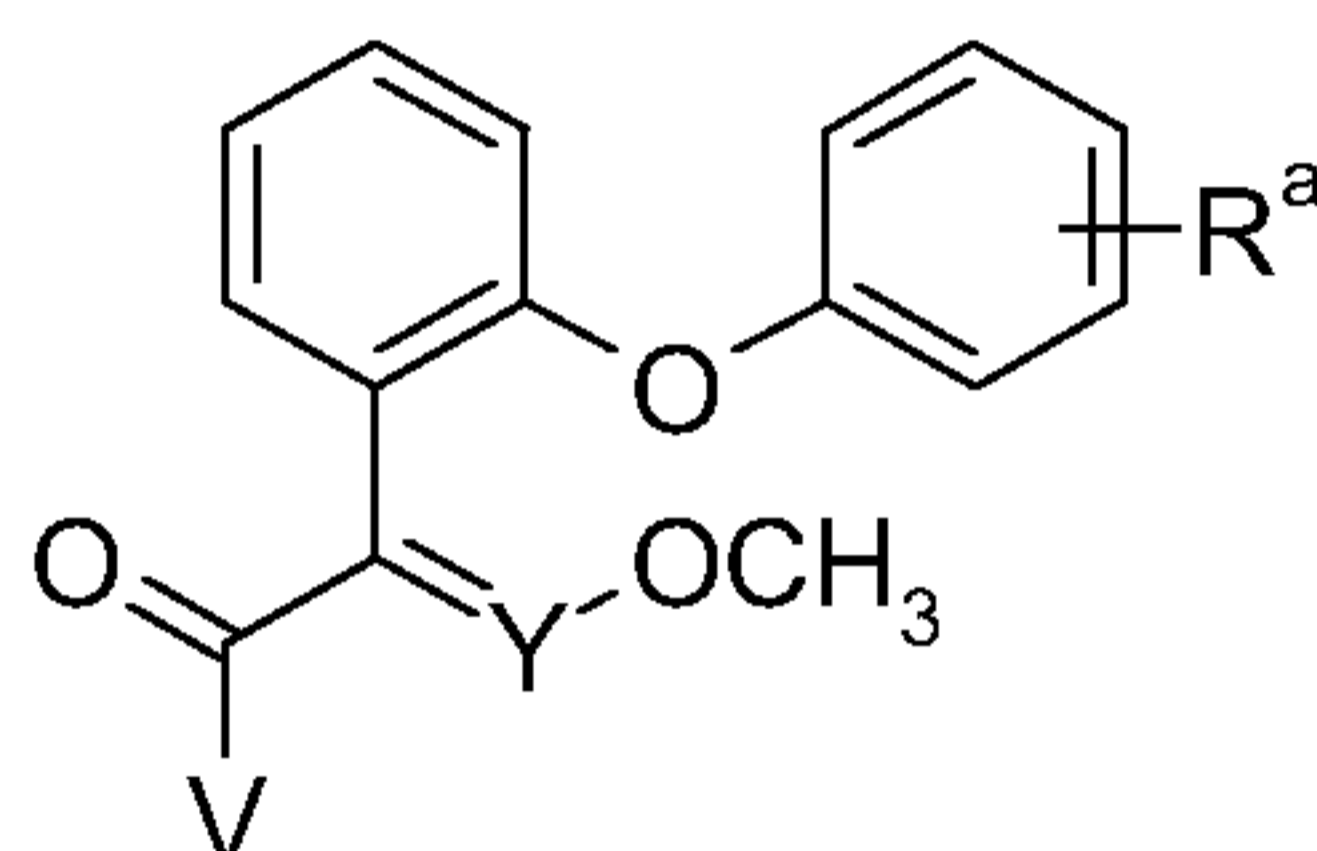
5 Table V



No.	V	R ¹	R ²	R ³	Reference
V-1	OCH ₃	CH ₃	CH ₃	CH ₃	WO 95/18789
V-2	OCH ₃	CH ₃	CH(CH ₃) ₂	CH ₃	WO 95/18789
V-3	OCH ₃	CH ₃	CH ₂ CH ₃	CH ₃	WO 95/18789
V-4	NHCH ₃	CH ₃	CH ₃	CH ₃	WO 95/18789
V-5	NHCH ₃	CH ₃	4-F-C ₆ H ₄	CH ₃	WO 95/18789

No.	V	R ¹	R ²	R ³	Reference
V-6	NHCH ₃	CH ₃	4-Cl-C ₆ H ₄	CH ₃	WO 95/18789
V-7	NHCH ₃	CH ₃	2,4-C ₆ H ₃	CH ₃	WO 95/18789
V-8	NHCH ₃	Cl	4-F-C ₆ H ₄	CH ₃	WO 98/38857
V-9	NHCH ₃	Cl	4-Cl-C ₆ H ₄	CH ₂ CH ₃	WO 98/38857
V-10	NHCH ₃	CH ₃	CH ₂ C(=CH ₂)CH ₃	CH ₃	WO 97/05103
V-11	NHCH ₃	CH ₃	CH=C(CH ₃) ₂	CH ₃	WO 97/05103
V-12	NHCH ₃	CH ₃	CH=C(CH ₃) ₂	CH ₂ CH ₃	WO 97/05103
V-13	NHCH ₃	CH ₃	CH=C(CH ₃)CH ₂ CH ₃	CH ₃	WO 97/05103
V-14	NHCH ₃	CH ₃	O-CH(CH ₃) ₂	CH ₃	WO 97/06133
V-15	NHCH ₃	CH ₃	O-CH ₂ CH(CH ₃) ₂	CH ₃	WO 97/06133
V-16	NHCH ₃	CH ₃	C(CH ₃)=NOCH ₃	CH ₃	WO 97/15552

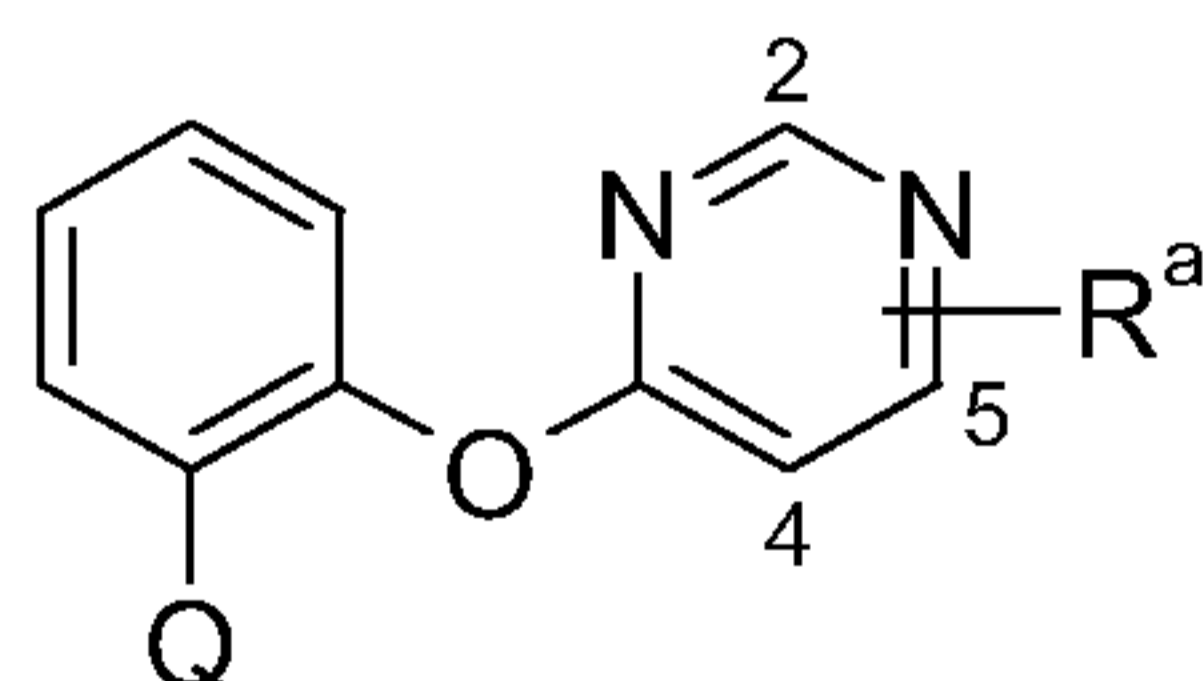
Table VI



VII

No.	V	Y	R ^a	Reference
VI-1	NHCH ₃	N	H	EP-A 398 692
VI-2	NHCH ₃	N	3-CH ₃	EP-A 398 692
VI-3	NHCH ₃	N	2-NO ₂	EP-A 398 692
VI-4	NHCH ₃	N	4-NO ₂	EP-A 398 692
VI-5	NHCH ₃	N	4-Cl	EP-A 398 692
VI-6	NHCH ₃	N	4-Br	EP-A 398 692

5 Table VII



VIII

No.	Q	R ^a	Reference
VII-1	C(=CH-OCH ₃)COOCH ₃	5-O-(2-CN-C ₆ H ₄)	EP-A 382 375
VII-2	C(=CH-OCH ₃)COOCH ₃	5-O-(2-Cl-C ₆ H ₄)	EP-A 382 375
VII-3	C(=CH-OCH ₃)COOCH ₃	5-O-(2-CH ₃ -C ₆ H ₄)	EP-A 382 375
VII-4	C(=N-OCH ₃)CONHCH ₃	5-O-(2-Cl-C ₆ H ₄)	GB-A 2253624
VII-5	C(=N-OCH ₃)CONHCH ₃	5-O-(2,4-Cl ₂ -C ₆ H ₃)	GB-A 2253624

No.	Q	R ^a	Reference
VII-6	C(=N-OCH ₃)CONHCH ₃	5-O-(2-CH ₃ -C ₆ H ₄)	GB-A 2253624
VII-7	C(=N-OCH ₃)CONHCH ₃	5-O-(2-CH ₃ ,3-Cl-C ₆ H ₃)	GB-A 2253624
VII-8	C(=N-OCH ₃)CONHCH ₃	4-F, 5-O-(2-CH ₃ -C ₆ H ₄)	WO 98/21189
VII-9	C(=N-OCH ₃)CONHCH ₃	4-F, 5-O-(2-Cl-C ₆ H ₄)	WO 98/21189
VII-10	C(=N-OCH ₃)CONHCH ₃	4-F, 5-O-(2-CH ₃ ,3-Cl-C ₆ H ₃)	WO 98/21189
VII-11	Q1	4-F, 5-O-(2-Cl-C ₆ H ₄)	WO 97/27189
VII-12	Q1	4-F, 5-O-(2-CH ₃ ,3-Cl-C ₆ H ₃)	WO 97/27189
VII-13	Q1	4-F, 5-O-(2,4-Cl ₂ -C ₆ H ₃)	WO 97/27189

Also particularly preferred for the use according to the invention are the commercially available active strobilurin compounds. Particular preference is given to the following active compounds of the tables above: compound I-5 (pyraclostrobin), II-1 (kresoxim-methyl), II-3 (dimoxystrobin), II-11 (ZJ 0712), III-3 (picoxystrobin), IV-6 (trifloxystrobin), IV-9 (enestroburin), V-16 (orysastrobin), VI-1 (metominostrobin), VII-1 (azoxystrobin) and VII-11 (fluoxastrobin). A further compound of formula I that is useful is fluacrypyrim (methyl (E)-2-{ α -[2-isopropoxy-6-(trifluoromethyl)pyrimidin-4-yloxy]-o-tolyl}-3-methoxyacrylate).

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The method according to the present invention is particularly suitable for inducing tolerance to the below mentioned harmful fungi:

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- Alternaria species on vegetables, oilseed rape, sugar beet and fruit and rice, such as, for example, A. solani or A. alternata on potatoes and tomatoes;
- Aphanomyces species on sugar beet and vegetables;
- Ascochyta species on cereals and vegetables;
- Bipolaris and Drechslera species on corn, cereals, rice and lawns, such as, for example, D. maydis on corn;
- Blumeria graminis (powdery mildew) on cereals;
- Botrytis cinerea (gray mold) on strawberries, vegetables, flowers and grapevines;
- Bremia lactucae on lettuce;
- Cercospora species on corn, soybeans, rice and sugar beet;
- Cochliobolus species on corn, cereals, rice, such as, for example Cochliobolus sativus on cereals, Cochliobolus miyabeanus on rice;
- Colletotricum species on soybeans and cotton;
- Drechslera species, Pyrenophora species on corn, cereals, rice and lawns, such as, for example, D. teres on barley or D. tritici-repentis on wheat;
- Elsinoe ampelina on grapevines
- Esca on grapevines, caused by Phaeoacremonium chlamydosporium, Ph. Aleophilum and Formitipora punctata (syn. Phellinus punctatus);

30

- Exserohilum species on corn;
- Erysiphe cichoracearum and Sphaerotheca fuliginea on cucumbers;
- Fusarium and Verticillium species on various plants, such as, for example, F. graminearum or F. culmorum on cereals or F. oxysporum on a multitude of plants, such as, for example, tomatoes;
- 5 • Gaeumanomyces graminis on cereals;
- Gibberella species on cereals and rice (for example Gibberella fujikuroi on rice);
- Glomerella cingulata on grapevines;
- Grainstaining complex on rice;
- 10 • Helminthosporium species on corn and rice;
- Isariopsis clavispora on grapevines;
- Michrodochium nivale on cereals;
- Mycosphaerella species on cereals, bananas and groundnuts, such as, for example, M. graminicola on wheat or M.fijiensis on bananas;
- 15 • Peronospora species on cabbage and bulbous plants, such as, for example, P. brassicae on cabbage or P. destructor on onions;
- Phakopsara pachyrhizi and Phakopsara meibomiaie on soybeans;
- Phomopsis species on soybeans and sunflowers;
- Phomopsis viticola on grapevines;
- 20 • Phytophthora infestans on potatoes and tomatoes;
- Phytophthora species on various plants, such as, for example, P. capsici on bell pepper;
- Plasmopora viticola on grapevines;
- Podosphaera leucotricha on apples;
- 25 • Pseudocercospora herpotrichoides on cereals;
- Pseudoperonospora on various plants, such as, for example, P. cubensis on cucumber or P. humili on hops;
- Pseudopeziculla tracheiphila on grapevines;
- Puccinia species on various plants, such as, for example, P. triticina, P. striformis, P. hordei or P. graminis on cereals or P. asparagi on asparagus;
- 30 • Pyricularia oryzae, Corticium sasakii, Sarocladium oryzae, S.attenuatum, Entyloma oryzae on rice;
- Pyricularia grisea on lawns and cereals;
- Pythium spp. on lawns, rice, corn, cotton, oilseed rape, sunflowers, sugar beet, vegetables and other plants, such as, for example, P. ultimum on various plants, P. aphanidermatum on lawns;
- 35 • Guignardia bidwelli on grapevines;
- Rhizoctonia species on cotton, rice, potatoes, lawns, corn, oilseed rape, potatoes, sugar beet, vegetables and on various plants, such as, for example, R. solani on beet and various plants;
- 40 • Rhynchosporium secalis on barley, rye and triticale;
- Sclerotinia species on oilseed rape and sunflowers;

- Septoria tritici and Stagonospora nodorum on wheat;
- Erysiphe (syn. Uncinula) necator on grapevines;
- Setospaeria species on corn and lawns;
- Sphacelotheca reilinia on corn;
- 5 • Thievaliopsis species on soybeans and cotton;
- Tilletia species on cereals;
- Ustilago species on cereals, corn and sugar cane, such as, for example, U. maydis on corn;
- Venturia species (scab) on apples and pears, such as, for example,
- 10 V. inaequalis on apples.

The method according to the invention is also preferably suitable for controlling strains of harmful fungi, which have developed an increased tolerance to active substances of the strobilurin type, in particular for the control of Septoria species such as Septoria tritici.

The method is applied by treating the plants, the soil and/or the seeds of the plant with an effective amount of the active compound used according to the present invention, in particular of a compound of the formula I. The application can be effected both before (protective induction of tolerance to fungal attack) and after (induction of tolerance in order to restrict fungal growth and related plant damage against future fungal attack) the infection of the plants, of the soil and/or the seeds of the plant by the fungi.

In a preferred embodiment of the inventive method, the active substance used according to the present invention, in particular the compound of the formula I, is applied protectively, leading to an increased tolerance of the respective plant towards harmful fungi attack.

In a further preferred embodiment of the inventive method, the treatment of the plants with the active substance, particularly with a compound of the formula I, is carried out during the first six weeks, in particular during the first four weeks, of the vegetation period of the plants or after emergence of the plants, substantially before the first protective applications of fungicides are carried out. It can be particularly preferred that the first application is carried out during the first six, particularly during the first four weeks of the vegetation period of the plant to be rendered resistant against fungal attack.

It is usually preferred according to the present invention to treat the plants before the attack, in particular more than one week before the attack by harmful fungi. During this time, one to 10 treatments with the active substance, particularly with a compound of the formula I, are carried out. A noticeably lower susceptibility of the plants to harmful fungi can be observed.

In the case of vegetables and field crops, such as soybeans, cotton, tobacco, beans, peas and cereals, such as maize, wheat, barley, it can be preferred to apply the active substance shortly after emergence of the plant, preferably during the first four weeks
5 after emergence, or as a seed treatment. It is preferred to treat the plants twice to five times, in particular twice to three times.

In the case of fruit and other perennial plants, the treatment is preferably carried out during the first six, preferably the first four, weeks of the vegetation period. It is
10 preferred to carry out two to five treatments.

It can also be preferred according to the invention to carry out a repeated application of the active compound used according to the present invention, in particular of the compound of formula I. In general, the best effect can be observed when the treatment
15 is repeated every 10 to 20 days.

According to a further preferred embodiment of the invention, two to ten applications of the active compound used according to the present invention, particularly of a compound of the formula I, are carried out over one season.
20

According to the present invention, the first application is preferably carried out before the beginning of the vegetation period, which may be in particular useful if the inventive method is carried out on vegetables or field crops like, for example, winter wheat.

25 According to one embodiment of the present invention, the inventive method is preferably carried out as a foliar application. This can be particularly preferred in the case of field crops and vegetables, such as potatoes, tomatoes, cucumbers, onions and lettuce. It can be preferred to carry out up to 10 treatments.

30 According to one embodiment of the invention, the inventive method is carried out on vegetables or field crops. Particularly, in this embodiment, more than two and up to ten applications of the active compound used according to the present invention, particularly a compound of the formula I, are carried out.

35 According to still another embodiment of the invention, the inventive method is carried out on soybeans, maize (corn), cotton, tobacco, french beans, wheat, rye and peas.

According to still another embodiment of the invention, the inventive method is carried out on cereals, particularly on wheat.
40

According to another embodiment, by means of the inventive method tolerance to *Septoria* spp. is induced in the plants, particularly in wheat. More particularly, tolerance to *Septoria tritici* is induced thereby.

- 5 According to another embodiment of the invention, the method for inducing tolerance is carried out on perennial plants. One specific example therefor is the use of the inventive method on grapevines.

- 10 According to another embodiment, by means of the inventive method resistance to *Botrytis cinerea*, *Plasmopara viticola*, *Erysiphe necator* and/or Esca is induced in the plants, particularly in grapevines. More particularly, resistance to Esca is induced thereby.

- 15 Esca stands for a complex of fungi pathogens. The pathogens that can be associated with Esca symptoms according to the literature are *Fomitiporia punctata* (syn. *Phellinus punctatus*), *Fomitiporia mediterranea*, *Phaeroacremonium* spp.: *Phaeroacremonium aleophilum* and *Phaemoniella chlamydosporum*. The grapevine can be attacked by one, by several or even all of the pathogens that can be associated with Esca. One particular fungus, which was isolated from the wood of Esca attacked grapevines, is
- 20 *Phaemoniella chlamydosporum* (white rot fungi). There is known an acute form and a chronic form of the Esca disease and Esca can lead to different symptoms. The symptoms of the chronic form of the Esca disease are, for example, light green spots on the leaves and dark blotches on the berries. Further, the woody parts inside the grapevines often transform into a soft and spongy material, which is mostly observed in
- 25 older grapevines. A grapevine suffering from the acute form of Esca abruptly begins to wilt and ultimately withers and dies. Surprisingly, it has now been found that using the inventive method, grapevines can be rendered tolerant against Esca, providing an effective means for avoiding Esca attacks at the grapevine.

- 30 According to still another embodiment, by means of the inventive method resistance to *Plasmopora viticola*, *Uncinula necator*, *Guignardia bidwelli*, *Pseudopeziculla tracheiphila*, *Phomopsis viticola*, *Elsinoe ampelina*, *Glomerella cingulata*, *Isariopsis clavispora* and/or *Botrytis cinerea* is induced in the plants, particularly in grapevines.

- 35 Furthermore, according to another embodiment of the invention, the active compound, particularly a compound of the formula I, or the respective mixture or formulation containing the same, is taken up by the plants and/or the seeds of the plant during the first six weeks of the vegetation period of the plants or the germination of the seeds. Depending on the severity of the infection and the nature of the desired effect, the
- 40 application rates of the active substance are, upon application, between 1 and 1000 g, preferably 20 to 750 g, of active substance per ha.

The compositions, which comprise the active substance, particularly a compound of the formula I, generally comprise between 0.1 and 95, preferably between 0.5 and 90, % by weight of active substance.

- 5 Usually, the application rates are between 0.01 and 2.0 kg of active substance per ha, depending on the nature of the desired effect.

10 In the case of the treatment of seed, for example by dusting, coating or soaking seed, amounts of active substance of from 1 to 1000 g/100 kg, preferably 5 to 100 g/100 kg of seed, are generally required.

15 The active compounds used according to the present invention, particularly the compounds of formula I, can be converted into the customary formulations, for example solutions, emulsions, suspensions, dusts, powders, pastes and granules. The use form depends on the intended purpose; in any case, it should ensure a fine and uniform distribution of the compound used according to the invention.

The formulations are prepared in a known manner, for example by extending the active substance with solvents and/or carriers, if desired using emulsifiers and dispersants.

20 Suitable solvents/adjuvants are essentially:

- water, aromatic solvents (for example Solvesso products, xylene), paraffins (for example mineral oil fractions), alcohols (for example methanol, butanol, pentanol, benzyl alcohol), ketones (for example cyclohexanone, gamma-butyrolactone), pyrrolidones (NMP, NOP), acetates (glycol diacetate), glycols, 25 fatty acid dimethyl amides, fatty acids and fatty acid esters. In principle, solvent mixtures may also be used;
- carriers, such as ground natural minerals (for example kaolins, argillaceous earths, talc, chalk) and ground synthetic minerals (for example highly disperse silica, silicates); emulsifiers such as nonionic and anionic emulsifiers (for 30 example polyoxyethylene fatty alcohol ethers, alkylsulfonates and arylsulfonates) and dispersants such as lignin-sulfite waste liquors and methylcellulose.

35 Suitable surface-active substances are alkali metal, alkaline earth metal and ammonium salts of lignosulfonic acid, naphthalenesulfonic acid, phenolsulfonic acid, dibutyl-naphthalenesulfonic acid, alkylarylsulfonates, alkyl sulfates, alkylsulfonates, fatty alcohol sulfates, fatty acids and sulfated fatty alcohol glycol ethers, furthermore condensates of sulfonated naphthalene and naphthalene derivatives with formaldehyde, condensates of naphthalene or of naphthalenesulfonic acid with phenol 40 and formaldehyde, polyoxyethylene octylphenol ether, ethoxylated isooctylphenol, octylphenol, nonylphenol, alkylphenol polyglycol ethers, tributylphenyl polyglycol ether, tristyrylphenyl polyglycol ether, alkylaryl polyether alcohols, condensates of alcohol or

fatty alcohol with ethylene oxide, ethoxylated castor oil, polyoxyethylene alkyl ethers, ethoxylated polyoxypropylene, lauryl alcohol polyglycol ether acetal, sorbitol esters, lignin-sulfite waste liquors and methylcellulose.

- 5 Substances which are suitable for the preparation of directly sprayable solutions, emulsions, pastes or oil dispersions are mineral oil fractions of medium to high boiling point, such as kerosene or diesel oil, furthermore coal tar oils and oils of vegetable and animal origin, aliphatic, cycloaliphatic and aromatic hydrocarbons, for example toluene, xylene, paraffin, tetrahydronaphthalene, alkylated naphthalenes or their derivatives,
10 methanol, ethanol, propanol, butanol, cyclohexanol, cyclohexanone, isophorone, strongly polar solvents, for example dimethyl sulfoxide, N-methylpyrrolidone or water.

Powders, materials for broadcasting and dusts can be prepared by mixing or concomitantly grinding the active substances together with a solid carrier.

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- Granules, for example coated granules, impregnated granules and homogeneous granules, can be prepared by binding the active substances to solid carriers. Examples of solid carriers are mineral earths such as silica gels, silicates, talc, kaolin, attaclay, limestone, lime, chalk, bole, loess, clay, dolomite, diatomaceous earth, calcium sulfate,
20 magnesium sulfate, magnesium oxide, ground synthetic materials, fertilizers such as, for example, ammonium sulfate, ammonium phosphate, ammonium nitrate, ureas, and products of vegetable origin, such as cereal meal, tree bark meal, wood meal and nutshell meal, cellulose powders and other solid carriers.

- 25 Formulations for the treatment of seed may additionally comprise binders and/or gellants and, if appropriate, colorants.

- Binders can be added in order to increase the adherence of the active substances on the seed after the treatment. Examples of suitable binders are EO/PO block copolymer
30 surfactants, but also polyvinyl alcohols, polyvinylpyrrolidones, polyacrylates, polymethacrylates, polybutenes, polyisobutylenes, polystyrenes, polyethylenamines, polyethylenamides, polyethylenimines (Lupasol®, Polymin®), polyethers, polyurethanes, polyvinyl acetates, tylose, and copolymers of these polymers. A suitable gellant is, for example, carrageenan (Satiagel®).

35

In general, the formulations comprise between 0.01 and 95% by weight, preferably between 0.1 and 90% by weight, of the active substance. In this context, the active substances are employed in a purity of from 90% to 100%, preferably 95% to 100% (according to NMR spectrum).

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The active substance concentrations in the ready-to-use preparations can be varied within substantial ranges. In general, they are between 0.0001 and 10%, preferably

between 0.01 and 1%.

The active substances can also be used successfully in the ultra-low-volume (ULV) method, it being possible to apply formulations with more than 95% by weight of active substance, or indeed the active substance without additions.

For the treatment of seed, the formulations in question are diluted twice to ten-fold and then give active substance concentrations of from 0.01 to 60% by weight, preferably 0.1 to 40% by weight, in the ready-to-use preparations.

The following are examples of formulations according to the invention:

1. Products for dilution with water

A Water-soluble concentrates (SL, LS)

10 parts by weight of a compound used according to the invention are dissolved using 90 parts by weight of water or a water-soluble solvent. As an alternative, wetters or other auxiliaries are added. The active ingredient dissolves upon dilution with water. This gives a formulation with an active substance content of 10%.

B Dispersible concentrates (DC)

20 parts by weight of a compound used according to the invention are dissolved in 70 parts by weight of cyclohexanone with addition of 10 parts by weight of a dispersant, for example polyvinylpyrrolidone. Dilution with water gives a dispersion. The active substance content is 20% by weight.

C Emulsifiable concentrates (EC)

15 parts by weight of a compound used according to the invention are dissolved in 75 parts by weight of xylene with addition of calcium dodecylbenzenesulfonate and castor oil ethoxylate (in each case 5 parts by weight). Dilution with water gives an emulsion. The formulation has an active substance content of 15%.

D Emulsions (EW, EO, ES)

25 parts by weight of a compound used according to the invention are dissolved in 35 parts by weight of xylene with addition of calcium dodecylbenzenesulfonate and castor oil ethoxylate (in each case 5 parts by weight). This mixture is introduced into 30 parts by weight of water by means of an emulsifier machine (Ultraturrax, for example) and made into a homogeneous emulsion. Dilution with water gives an emulsion. The formulation has an active substance content of 25%.

E Suspensions (SC, OD, FS)

In an agitated ball mill, 20 parts by weight of a compound used according to the invention are comminuted with addition of 10 parts by weight of dispersants and

wetters and 70 parts by weight of water or an organic solvent to give a fine active ingredient suspension. Dilution with water gives a stable suspension of the active ingredient. The active substance content in the formulation is 20% by weight.

5 F Water-dispersible granules and water-soluble granules (WG, SG)
50 parts by weight of a compound used according to the invention are ground finely with addition of 50 parts by weight of dispersants and wetters and made into water-dispersible or water-soluble granules by means of technical appliances (for example
10 extrusion, spray tower, fluidized bed). Dilution with water gives a stable dispersion or solution of the active ingredient. The formulation has an active substance content of 50% by weight.

G Water-dispersible powders and water-soluble powders (WP, SP, SS, WS)
75 parts by weight of a compound used according to the invention are ground in a
15 rotor-stator mill with addition of 25 parts by weight of dispersants and wetters and also silica gel. Dilution with water gives a stable dispersion or solution of the active ingredient. The active substance content in the formulation is 75% by weight.

H Gel formulations
20 In a ball mill, 20 parts by weight of a compound used according to the invention, 10 parts by weight of dispersant, 1 part by weight of gellant and 70 parts by weight of water or of an organic solvent are ground to give a fine suspension. Dilution with water gives a stable suspension with an active substance content of 20% by weight.

25 2. Products to be applied undiluted

I Dusts (DP, DS)
5 parts by weight of a compound used according to the invention are ground finely and mixed intimately with 95 parts by weight of finely divided kaolin. This gives a dustable
30 product with an active substance content of 5% by weight.

J Granules (GR, FG, GG, MG)
0.5 part by weight of a compound used according to the invention is ground finely and associated with 99.5 parts by weight of carriers. Current methods are extrusion, spray-
35 drying or the fluidized bed. This gives granules to be applied undiluted with an active substance content of 0.5% by weight.

K ULV solutions (UL)
10 parts by weight of a compound used according to the invention are dissolved in 90
40 parts by weight of an organic solvent, for example xylene. This gives a product to be applied undiluted with an active substance content of 10% by weight.

Formulations which are used for the treatment of seed are usually water-soluble concentrates (LS), suspensions (FS), dusts (DS), water-dispersible and water-soluble powders (WS, SS), emulsions (ES), emulsifiable concentrates (EC) and gel formulations (GF). These formulations can be applied to the seed in undiluted or, preferably, diluted form. Application can be effected prior to sowing.

It is preferred to use FS formulations for the treatment of seed. Usually, such formulations comprise 1 to 800 g/l active substance, 1 to 200 g/l surfactants, 0 to 200 g/l antifreeze agents, 0 to 400 g/l binders, 0 to 200 g/l colorants and solvents, preferably water.

The active substances can be used as such, in the form of their formulations or the use forms prepared therefrom, e.g. in the form of directly sprayable solutions, powders, suspensions or dispersions, emulsions, oil dispersions, pastes, dustable products, materials for spreading, or granules, by means of spraying, atomizing, dusting, spreading or pouring. The use forms depend entirely on the intended purposes; it is intended to ensure in each case the finest possible distribution of the active substances according to the invention.

Aqueous use forms can be prepared from emulsion concentrates, pastes or wettable powders (sprayable powders, oil dispersions) by adding water. To prepare emulsions, pastes or oil dispersions, the substances, as such or dissolved in an oil or solvent, can be homogenized in water by means of a wetter, tackifier, dispersant or emulsifier. Alternatively, it is possible to prepare concentrates composed of active substance, wetter, tackifier, dispersant or emulsifier and, if appropriate, solvent or oil, and such concentrates are suitable for dilution with water.

Various types of oils, wetters, adjuvants, herbicides, fungicides, other pesticides, or bactericides may be added to the active substances, if appropriate just immediately prior to use (tank mix). These agents can be admixed with the agents according to the invention in a weight ratio of 1:100 to 100:1, preferably 1:10 to 10:1.

The active compounds used according to the invention can also be present together with other active substances, for example with herbicides, insecticides, growth regulators, fungicides or else with fertilizers. Mixing the respective active compounds, particularly the compounds of formula I, or the compositions comprising them with one or more further active substances, in particular fungicides, can frequently widen the spectrum of action or prevent the development of resistance. In many cases, synergistic effects result.

The following list of fungicides together with which the compounds that are suitable for being used in the inventive method can be used is intended to illustrate the possible

combinations, but not to impose any limitation:

Carboxamides

- carboxanilides: benalaxyl, benodanil, boscalid, carboxin, mepronil, fenfuram, fenhexamid, flutolanil, furametpyr, metalaxyl, ofurace, oxadixyl, oxycarboxin, penthiopyrad, thifluzamide, tiadinil, N-(4'-bromobiphenyl-2-yl)-4-difluoromethyl-2-methylthiazole-5-carboxamide, N-(4'-trifluoromethylbiphenyl-2-yl)-4-difluoromethyl-2-methylthiazole-5-carboxamide, N-(4'-chloro-3'-fluorobiphenyl-2-yl)-4-difluoromethyl-2-methylthiazole-5-carboxamide, N-(3',4'-dichloro-4-fluorobiphenyl-2-yl)-3-difluoromethyl-1-methylpyrazole-4-carboxamide, N'-(3',4'-dichloro-5-fluorobiphenyl-2-yl)-3-difluoromethyl-1-methylpyrazole-4-carboxamide, N-(2-cyanophenyl)-3,4-dichloro-5-isothiazole-5-carboxamide;
- carboxylic acid morpholides: dimethomorph, flumorph;
- benzamides: flumetover, fluopicolide (picobenzamid), zoxamide;
- other carboxamides: carpropamid, diclocymet, mandipropamid, N-(2-(4-[3-(4-chlorophenyl)prop-2-ynyloxy]-3-methoxyphenyl)ethyl)-2-methanesulfonylamino-3-methylbutyramide, N-(2-(4-[3-(4-chlorophenyl)prop-2-ynyloxy]-3-methoxyphenyl)-ethyl)-2-ethanesulfonylamino-3-methylbutyramide;

20 Azoles

- triazoles: bitertanol, bromuconazole, cyproconazole, difenoconazole, diniconazole, enilconazole, epoxiconazole, fenbuconazole, flusilazole, fluquinconazole, flutriafol, hexaconazole, imibenconazole, ipconazole, metconazole, myclobutanil, penconazole, propiconazole, prothioconazole, simeconazole, tebuconazole, tetraconazole, triadimenol, triadimefon, triticonazole;
- imidazoles: cyazofamid, imazalil, pefurazoate, prochloraz, trflumizole;
- benzimidazoles: benomyl, carbendazim, fuberidazole, thiabendazole;
- others: ethaboxam, etridiazole, hymexazole;

30

Nitrogenous heterocyclyl compounds

- pyridines: fluazinam, pyrifenox, 3-[5-(4-chlorophenyl)-2,3-dimethylisoxazolidin-3-yl]pyridine;
- pyrimidines: bupirimate, cyprodinil, ferimzone, fenarimol, mepanipyrim, nuarimol, pyrimethanil;
- piperazines: triforine;
- pyrroles: fludioxonil, fempiclonil;
- morpholines: aldimorph, dodemorph, fenpropimorph, tridemorph;
- dicarboximides: iprodione, procymidone, vinclozolin;
- others: acibenzolar-S-methyl, anilazine, captan, captafol, dazomet, diclomezine, fenoxanil, folpet, fenpropidin, famoxadone, fenamidone, octhilinone, probenazole, proquinazid, pyroquilon, quinoxifen, tricyclazole, 5-chloro-7-(4-methylpiperidin-1-

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yl)-6-(2,4,6-trifluorophenyl)-[1,2,4]triazolo[1,5-a]pyrimidine, 2-butoxy-6-iodo-3-propylchromen-4-one, N,N-dimethyl-3-(3-bromo-6-fluoro-2-methylindole-1-sulfonyl)-[1,2,4]triazole-1-sulfonamide;

5 Carbamates and dithiocarbamates

- dithiocarbamates: ferbam, mancozeb, maneb, metiram, metam, propineb, thiram, zineb, ziram;
- carbamates: diethofencarb, flubenthiavalicarb, iprovalicarb, propamocarb, methyl 3-(4-chlorophenyl)-3-(2-isopropoxycarbonylamino-3-methylbutyrylamino)propionate, 4-fluorophenyl N-(1-(1-(4-cyanophenyl)ethanesulfonyl)but-2-yl)carbamate;

Other fungicides

- guanidines: dodine, iminoctadine, guazatine;
- 15 - antibiotics: kasugamycin, polyoxins, streptomycin, validamycin A;
- organometal compounds: fentin salts;
- sulfur-containing heterocyclyl compounds: isoprothiolane, dithianon;
- organophosphorus compounds: edifenphos, fosetyl, fosetyl-aluminum, iprobenfos, pyrazophos, tolclofos-methyl, phosphorous acid and its salts;
- 20 - organochlorine compounds: thiophanate methyl, chlorothalonil, dichlofluanid, tolylfluanid, flusulfamide, phthalide, hexachlorobenzene, pencycuron, quintozene;
- nitrophenyl derivatives: binapacryl, dinocap, dinobuton;
- inorganic active compounds: Bordeaux mixture, copper acetate, copper hydroxide, copper oxychloride, basic copper sulfate, sulfur;
- 25 -others: spiroxamine, cyflufenamid, cymoxanil, metrafenone.

Thus, in a further embodiment of the invention, the active compound that inhibits the mitochondrial breathing chain at the level of the b/c₁ complex, in particular the compound of formula I, is used together with a further fungicidal compound, preferably one of the above-mentioned fungicides.

The present invention also provides a method of generating a plant, which is tolerant to harmful fungi, comprising the treatment of the plants, of the soil in which the plant is present, and/or of the seeds of the plant with an effective amount of a compound that inhibits the mitochondrial breathing chain at the level of the b/c₁ complex as defined herein. According to this method, the same preferred embodiments apply as detailed above.

Particularly preferably, in this method, the active compound is selected from pyraclostrobin, kresoxim methyl, dimoxystrobin, methyl 2-(ortho-((2,5-dimethylphenyloxymethylene)phenyl)-3-methoxyacrylate, picoxystrobin, trifloxystrobin, enestroburin, oryastrobin, metominostrobin, azoxystrobin and fluoxastrobin.

Furthermore, according to one embodiment, the plant is preferably a field crop. More preferred, the plant is cereal, in particular wheat.

5 According to another embodiment, the harmful fungus is *Septoria* spp., in particular *Septoria tritici*.

According to still another embodiment, the plant is a perennial plant, particularly a grapevine.

10 According to still another embodiment, the harmful fungi are *Botrytis cinerea*, *Plasmopara viticola*, *Erysiphe necator* and/or *Esca*.

15 According to another embodiment, the active compound, particularly the compound of formula I, is used together with a further fungicidal compound in order to generate a plant, which is tolerant to harmful fungi.

It has been also surprisingly found within the framework of the present invention, that 5-chloro-7-(4-methylpiperidin-1-yl)-6-(2,4,6-trifluorophenyl)-[1,2,4]triazolo[1,5-a]pyrimidine is effective for the induction of resistance of plants to harmful fungi. Thus, 20 a further embodiment of the present invention is a method of inducing the resistance of plants to harmful fungi, comprising the treatment of the plants, of the soil, in which the plant is present or will be present and/or the seeds of the plant with an effective amount of 5-chloro-7-(4-methylpiperidin-1-yl)-6-(2,4,6-trifluorophenyl)-[1,2,4]triazolo[1,5-a]pyrimidine or a salt thereof.

25 The examples which follow are intended to illustrate the invention, but without imposing any limitation.

Example 1

30 1.1 Experiment

Wheat seedlings at the 2 leaf stage were used in the study. Plants were grown singly in pots and were split into two batches. First leaves were sprayed with pyraclostrobin at 35 the recommended rate (first leaves of controls were sprayed with distilled water) and the plants to be used for disease assessment were inoculated with *S. tritici* once leaves had dried. Both first and second leaves were inoculated by spraying with a spore suspension of 1×10^5 spores / ml of distilled water containing a drop of Tween 20. Immediately after inoculation, pots were placed in water-saturated trays and covered 40 with clear polyethene bags for 48 h. Thereafter plants were grown at 18 °C with 12 h /12 h light / dark alternation. Infection intensity was assessed 18 days after inoculation by estimating the % leaf area covered by symptoms.

1.2 Results

Pyraclostrobin applied to first leaves reduced *S. tritici* infection on both first and second leaves significantly compared to non treated controls (Table 1). Thus, after 18 days, the fungicide had reduced infection on first and second leaves by 65 % and 61 %, respectively (Table 1).

These data show that pyraclostrobin reduces *S. tritici* infection of first and second leaves of wheat seedlings by > 60 %. This is surprising since the isolate of *S. tritici* used in this study is resistant to pyraclostrobin.

Table 1

Effect of treating first leaves of wheat seedlings with pyraclostrobin on *S. tritici* infection on first and second leaves

Treatment	Infection (% leaf area showing symptoms)	
	First leaf	Second leaf
Untreated	48 \pm 5.3	41 \pm 5.2
Pyraclostrobin	17 \pm 2.3	16 \pm 1.4

Values represent the means \pm SE of 10 replicates. Both treatments significant at $P \leq 0.01$ (Students t-test).

Consequently, these data suggest that pyraclostrobin induces resistance in wheat to the pathogen *Septoria tritici*.

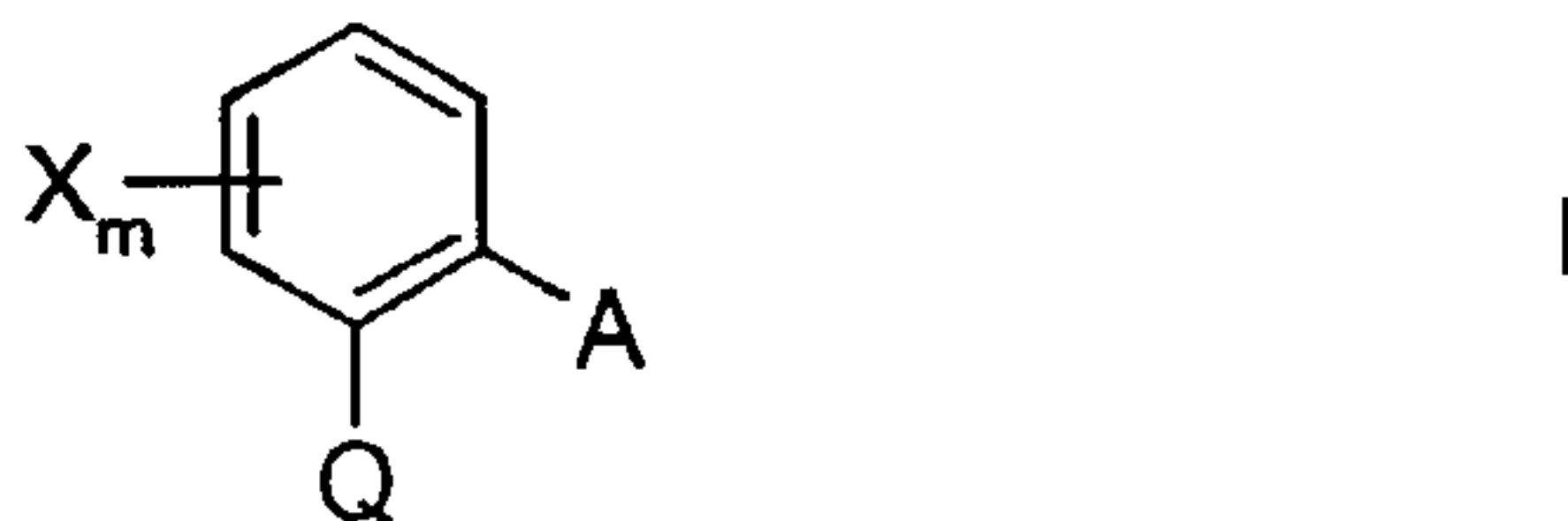
WHAT IS CLAIMED IS:

1. A method of inducing the resistance of plants to harmful fungi, comprising a repeated treatment of the plants, of the soil in which the plant is present or is to be present and/or the seeds of the plant, with an effective amount of an active compound that inhibits the mitochondrial breathing chain at the level of the b/c, complex.

2. The method of claim 1, wherein the active compound is a strobilurin or an agriculturally acceptable salt thereof.

3. The method of claim 1 or 2, wherein the active compound is a compound of the formula I:

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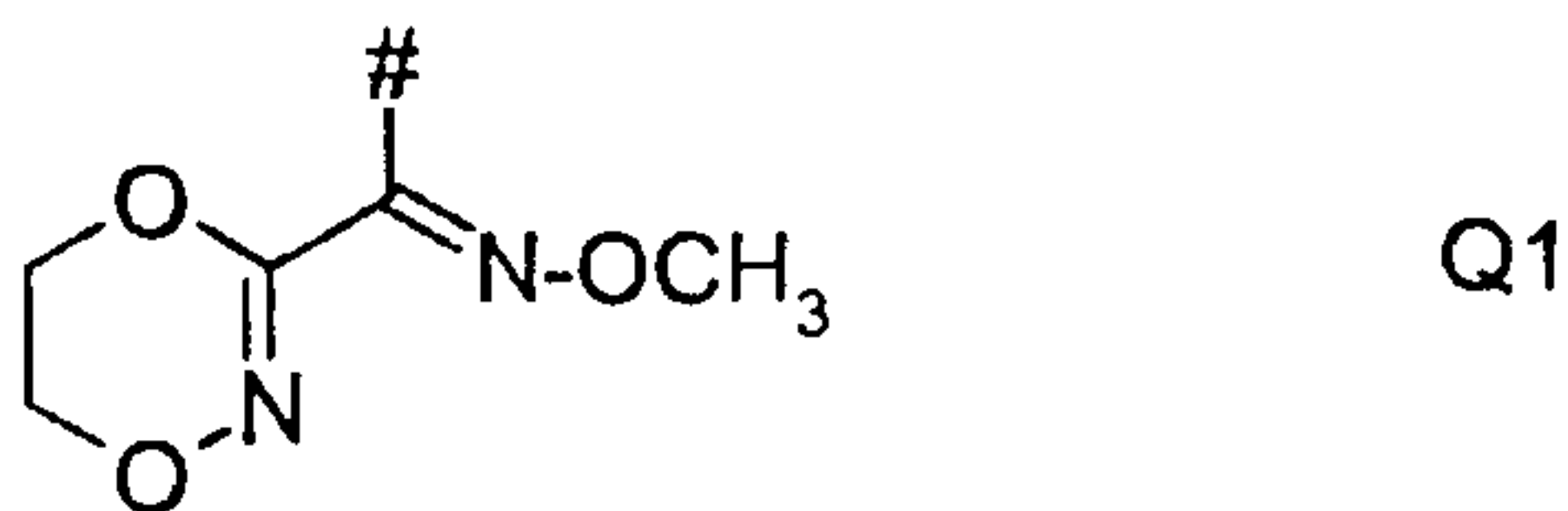


wherein the substituents and indices have the following meanings:

X denotes halogen, C₁-C₄-alkyl or trifluoromethyl;

m denotes 0 or 1;

Q denotes C(=CH-CH₃)-COOCH₃, C(=CH-OCH₃)-COOCH₃, C(=N-OCH₃)-CONHCH₃, C(=N-OCH₃)-COOCH₃, N(-OCH₃)-COOCH₃, or a group Q1



where # denotes the point of linkage to the phenyl ring;

A denotes -O-B, -CH₂O-B, -OCH₂-B, -CH₂S-B, -CH=CH-B, -C≡C-B,

20 -CH₂O-N=C(R¹)-B, -CH₂S-N=C(R¹)-B, -CH₂O-N=C(R¹)-CH=CH-B,
or -CH₂O-N=C(R¹)-C(R²)=N-OR³; where B has the following meanings:

B denotes phenyl, naphthyl, 5- or 6-membered heteroaryl or 5- or 6-membered heterocyclyl, comprising one, two or three N atoms and/or one O or S atom or one or two O and/or S atoms, the ring systems being unsubstituted or substituted by one, two or three identical or different groups R^a :

R^a denotes cyano, nitro, amino, aminocarbonyl, aminothiocarbonyl, halogen, C_1 - C_6 -alkyl, C_1 - C_6 -haloalkyl, C_1 - C_6 -alkylcarbonyl, C_1 - C_6 -alkylsulfonyl, C_1 - C_6 -alkylsulfinyl, C_3 - C_6 -cycloalkyl, C_1 - C_6 -alkoxy, C_1 - C_6 -haloalkoxy, C_1 - C_6 -alkyloxycarbonyl, C_1 - C_6 -alkylthio, C_1 - C_6 -alkylamino, di- C_1 - C_6 -alkylamino, C_1 - C_6 -alkylaminocarbonyl, di- C_1 - C_6 -alkylaminocarbonyl, C_1 - C_6 -alkylaminothiocarbonyl, di- C_1 - C_6 -alkylaminothiocarbonyl, C_2 - C_6 -alkenyl, C_2 - C_6 -alkenyloxy, phenyl, phenoxy, benzyl, benzyloxy, 5- or 6-membered heterocyclyl, 5- or 6-membered heteroaryl, 5- or 6-membered heteroaryloxy, $C(=NOR^a)-R^b$ or $OC(R^a)_2-C(R^b)=NOR^b$,

the cyclic radicals, in turn, being unsubstituted or substituted by one, two or three identical or different groups R^b :

R^b denotes cyano, nitro, halogen, amino, aminocarbonyl, amino-thiocarbonyl, C_1 - C_6 -alkyl, C_1 - C_6 -haloalkyl, C_1 - C_6 -alkylsulfonyl, C_1 - C_6 -alkylsulfinyl, C_3 - C_6 -cycloalkyl, C_1 - C_6 -alkoxy, C_1 - C_6 -halo-alkoxy, C_1 - C_6 -alkoxycarbonyl, C_1 - C_6 -alkylthio, C_1 - C_6 -alkylamino, di- C_1 - C_6 -alkylamino, C_1 - C_6 -alkylaminocarbonyl, di- C_1 - C_6 -alkyl-aminocarbonyl, C_1 - C_6 -alkylaminothiocarbonyl, di- C_1 - C_6 -alkyl-aminothiocarbonyl, C_2 - C_6 -alkenyl, C_2 - C_6 -alkenyloxy, C_3 - C_6 -cycloalkyl, C_3 - C_6 -cycloalkenyl, phenyl, phenoxy, phenylthio, benzyl, benzyloxy, 5- or 6-membered heterocyclyl, 5- or 6-membered heteroaryl, 5- or 6-membered heteroaryloxy or $C(=NOR^A)-R^B$; where

R^A, R^B denote hydrogen or C_1-C_6 -alkyl;

R^1 denotes hydrogen, cyano, C_1-C_4 -alkyl, C_1-C_4 -haloalkyl, C_3-C_6 -cycloalkyl, C_1-C_4 -alkoxy, or C_1-C_4 -alkylthio;

R^2 denotes phenyl, phenylcarbonyl, phenylsulfonyl, 5- or 6-membered heteroaryl, 5- or 6-membered heteroarylcarbonyl or 5- or 6-membered heteroarylsulfonyl, the ring systems being unsubstituted or substituted by one, two or three identical or different radicals R^a ,

C_1-C_{10} -alkyl, C_3-C_6 -cycloalkyl, C_2-C_{10} -alkenyl, C_2-C_{10} -alkynyl, C_1-C_{10} -alkyl-carbonyl, C_2-C_{10} -alkenylcarbonyl, C_3-C_{10} -alkynylcarbonyl, C_1-C_{10} -

10 alkyl-sulfonyl, or $C(=NOR^A)-R^B$, the hydrocarbon radicals of these groups being unsubstituted or substituted by one, two or three identical or different radicals R^C :

R^C denotes cyano, nitro, amino, aminocarbonyl, aminothiocarbonyl, halogen, C_1-C_6 -alkyl, C_1-C_6 -haloalkyl, C_1-C_6 -alkylsulfonyl, C_1-C_6 -alkyl-sulfinyl, C_1-C_6 -alkoxy, C_1-C_6 -haloalkoxy, C_1-C_6 -alkoxycarbonyl, C_1-C_6 -alkylthio, C_1-C_6 -alkylamino, di- C_1-C_6 -alkylamino, C_1-C_6 -alkylamino-carbonyl, di- C_1-C_6 -alkylaminocarbonyl, C_1-C_6 -alkylaminothiocarbonyl, di- C_1-C_6 -alkylaminothiocarbonyl, C_2-C_6 -alkenyl, C_2-C_6 -alkenyloxy, C_3-C_6 -cycloalkyl, C_3-C_6 -cycloalkyloxy, 5- or 6-membered heterocyclyl, 5- or 6-membered

20 heterocyclyloxy, benzyl, benzyloxy, phenyl, phenoxy, phenylthio, 5- or 6-membered heteroaryl, 5- or 6-membered heteroaryloxy and heteroarylthio, it being possible for the cyclic groups, in turn, to be partially or fully halogenated and/or to have attached to them one, two or three identical or different radicals R^a ;

and

R^3 denotes hydrogen, C_1-C_6 -alkyl, C_2-C_6 -alkenyl, C_2-C_6 -alkynyl, the hydrocarbon radicals of these groups being unsubstituted or substituted by one, two or three identical or different radicals R^C

or an agriculturally acceptable salt thereof; or

a strobilurin compound selected from the group consisting of methyl (2-chloro-5-[1-(3-methylbenzyloxyimino)ethyl]benzyl)carbamate and methyl (2-chloro-5-[1-(6-methylpyridin-2-ylmethoxyimino)ethyl]benzyl)carbamate or agriculturally acceptable salts of these strobilurin compounds.

10 4. The method according to claim 3, wherein the index m in formula I denotes zero and the substituents have the following meanings:

Q denotes $C(=CH-CH_3)-COOCH_3$, $C(=CH-OCH_3)-COOCH_3$,
 $C(=N-OCH_3)-CONHCH_3$, $C(=N-OCH_3)-COOCH_3$ or $N(-OCH_3)-COOCH_3$;

A denotes $-O-B$, $-CH_2O-B$, $-OCH_2-B$, $-CH_2O-N=C(R^1)-B$ or
 $-CH_2O-N=C(R^1)-C(R^2)=N-OR^3$, where

B denotes phenyl, pyridyl, pyrimidyl, pyrazolyl, triazolyl, these rings being unsubstituted or substituted by one, two or three identical or different radicals R^a ;

R^1 denotes hydrogen, cyano, C_1-C_4 -alkyl, C_1-C_4 -haloalkyl, C_3-C_6 -cycloalkyl or C_1-C_4 -alkoxy;

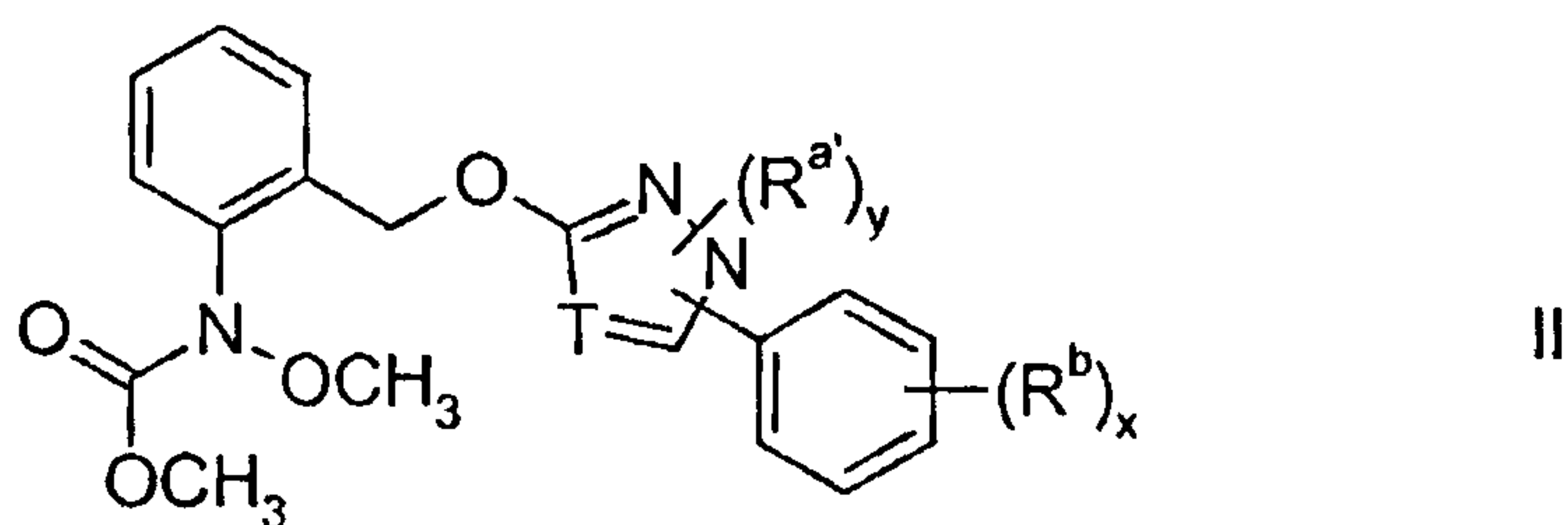
20 R^2 denotes C_1-C_6 -alkyl, C_2-C_{10} -alkenyl, C_3-C_6 -cycloalkyl, these groups being unsubstituted or substituted by one or two identical or different radicals $R^{b'}$;

$R^{b'}$ denotes C_1-C_6 -alkyl, C_3-C_6 -cycloalkyl, C_1-C_6 -alkoxy, C_1-C_6 -haloalkoxy, benzyl, phenyl or phenoxy;

phenyl which is unsubstituted or substituted by one or two identical or different R^a ; and

R^3 denotes C_1 - C_6 -alkyl, C_2 - C_6 -alkenyl, or C_2 - C_6 -alkynyl.

5. The method according to claim 3, wherein an active substance of the formula II,



in which

T denotes a carbon or nitrogen atom,

$R^{a'}$ is selected from the series consisting of halogen, methyl and trifluoromethyl,

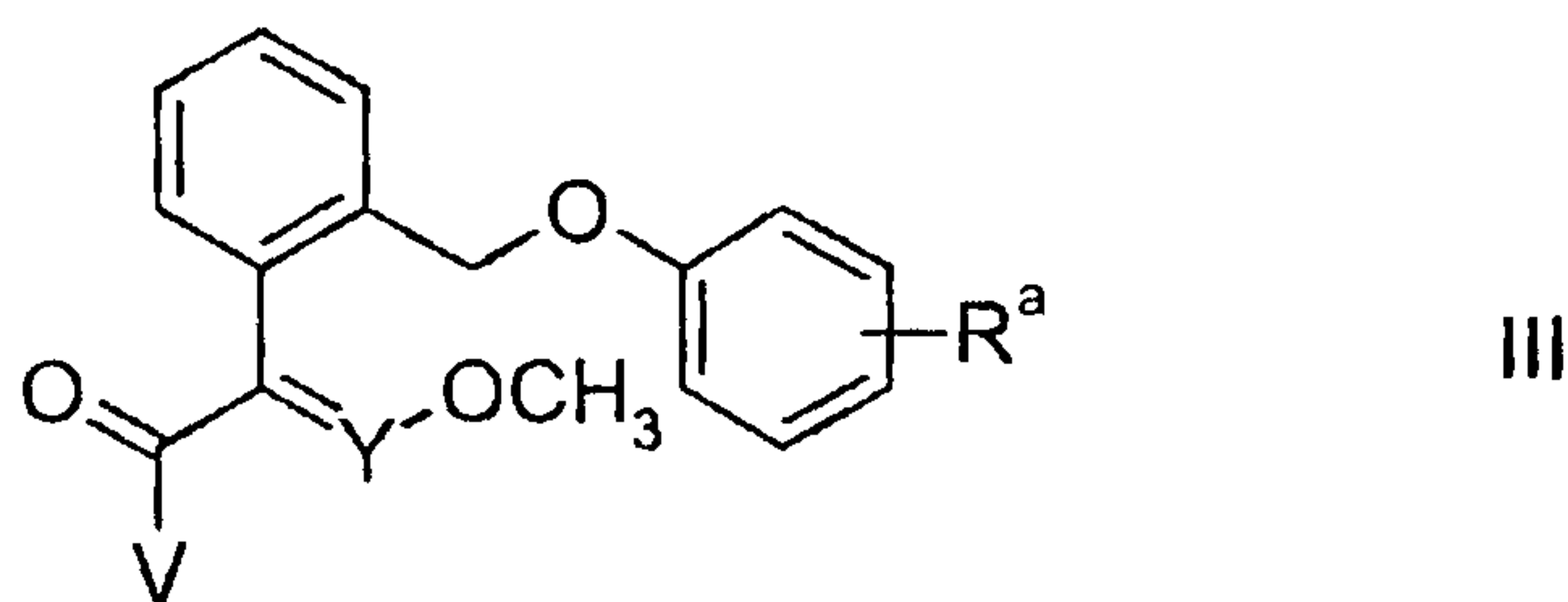
10 y represents zero, 1 or 2,

R^b is as defined for formula I in claim 1; and

x represents zero, 1, 2, 3 or 4

is used.

6. The method according to claim 3, wherein an active substance of the formula III,



in which:

R^a denotes one or two identical or different groups selected from the series consisting of halogen, C_1 - C_6 -alkyl, C_1 - C_6 -alkoxy, halomethyl, halomethoxy, methyl and trifluoromethyl, the groups R^a being unsubstituted or substituted by a C_1 - C_6 -alkoxyimino group;

V denotes OCH_3 , or $NHCH_3$; and

Y denotes CH or N

is used.

10 7. The method according to claim 3, wherein the compound of the formula I is selected from the group consisting of pyraclostrobin, kresoxim methyl, dimoxystrobin, methyl 2-(ortho-((2,5-dimethylphenyloxymethylene)phenyl)-3-methoxyacrylate, picoxystrobin, trifloxystrobin, enestroburin, oryastrobin, metominostrobin, azoxystrobin and fluoxastrobin.

8. The method according to claim 3, wherein the compound of the formula I is selected from the group consisting of azoxystrobin, pyraclostrobin and picoxystrobin.

9. The method according to claim 3, wherein the compound of the formula I is pyraclostrobin.

20 10. The method according to any one of claims 1 to 9, wherein the application of the active compound is carried out during the first six weeks of the vegetation period of the plants or after emergence of the plants.

11. The method according to any one of claims 1 to 10, wherein a repeated application of the active compound is carried out every 10 to 20 days.

12. The method according to any one of claims 1 to 11, wherein two to ten applications of the active compound are carried out over one season.

13. The method according to any one of claims 1 to 12, which is carried out as a foliar application.

14. The method according to any one of claims 1 to 13, which is carried out on vegetables or field crops.

15. The method according to any one of claims 1 to 14, which is carried out on soybeans, maize, cotton, tobacco, french beans, wheat, rye and peas.

10 16. The method according to any one of claims 1 to 14, which is carried out on cereals.

17. The method according to claim 16, which is carried out on wheat.

18. The method according to claim 17, wherein a tolerance to *Septoria spp.* is induced in the plants.

19. The method according to claim 18, wherein a tolerance to *Septoria tritici* is induced in the plants.

20. The method according to any one of claims 1 to 13, which is carried out on perennial plants.

21. The method according to claim 20, which is carried out on grapevines.

20 22. The method according claim 21, wherein a resistance to *Botrytis cinerea*, *Plasmopara viticola*, *Erysiphe necator* and/or *Esca* is induced in the plants.

23. The method according to any one of claims 1 to 22, wherein the active compound is used together with a further fungicidal compound.