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Method for immunizing plants against bacterioses

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(56) Related Art

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WO 2001/082701
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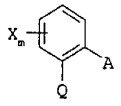
Immunization of plants against bacterioses

Abstract

A method of immunizing plants against bacterioses comprises treating the plants, the soil or seeds with an effective amount of a compound of the formula I



I

in which

X is halogen, C_1-C_4-alkyl or trifluoromethyl;

m is 0 or 1;

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

A is $-O-B$, $-CH_2O-B$, $-CH_2S-B$, $-OCH_2-B$, $-CH=CH-B$, $-C\equiv C-B$, $-CH_2O-N=C(R^1)-B$ or $-CH_2O-N=C(R^1)-C(R^2)=N-OR^3$, where

B is in each case unsubstituted or substituted phenyl, naphthyl, 5-membered or 6-membered hetaryl or 5-membered or 6-membered heterocyclyl comprising one to three N atoms and/or one O- or S atom or one or two O- and/or S atoms;

R^1 is hydrogen, cyano, alkyl, halogenalkyl, cycloalkyl, alkoxy;

R^2 is in each case unsubstituted or substituted phenyl, phenylcarbonyl, phenylsulfonyl, 5- or 6-membered hetaryl, 5- or 6-membered hetarylcarbonyl or 5- or 6-membered hetarylsulfonyl, or

alkyl, cycloalkyl, alkenyl, alkynyl, alkylcarbonyl, alkenylcarbonyl, alkynylcarbonyl, alkylsulfonyl, or $C(=NOR^{\alpha})-OR^{\beta}$; and

R^3 is hydrogen or in each case unsubstituted or substituted alkyl, alkenyl or alkynyl,

which is taken up by the plants or the seeds.

IN THE MATTER OF an Australian
Application corresponding to
PCT Application PCT/EP03/02420

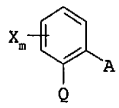
RWS Group Ltd, of Europa House, Marsham Way, Gerrards Cross, Buckinghamshire, England, hereby solemnly and sincerely declares that, to the best of its knowledge and belief, the following document, prepared by one of its translators competent in the art and conversant with the English and German languages, is a true and correct translation of the PCT Application filed under No. PCT/EP03/02420.

Date: 15 July 2004

S. ANTHONY
Director
For and on behalf of RWS Group Ltd

Immunization of plants against bacterioses

The present invention relates to a method for immunizing plants against bacterioses, which comprises treating the plants, the soil or the seeds with an effective amount of a compound of the formula I,



I

in which

X is halogen, C_1-C_4-alkyl or trifluoromethyl;

m is 0 or 1;

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

A is $-O-B$, $-CH_2O-B$, $-CH_2S-B$, $-OCH_2-B$, $-CH=CH-B$, $-C\equiv C-B$, $-CH_2O-N=C(R^1)-B$ or $-CH_2O-N=C(R^1)-C(R^2)=N-OR^3$, where

B is phenyl, naphthyl, 5-membered or 6-membered hetaryl or 5-membered or 6-membered heterocyclyl, comprising one to 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 to three radicals R^a:

R^a being cyano, nitro, amino, aminocarbonyl, aminothiocarbonyl, halogen, C_1-C_6-alkyl, C_1-C_6-halogenalkyl, C_1-C_6-alkylcarbonyl, C_1-C_6-alkylsulfonyl, C_1-C_6-alkylsulfoxyl, C_3-C_6-cycloalkyl, C_1-C_6-alkoxy, C_1-C_6-halogenalkoxy, 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 hetaryl, 5- or 6-membered hetaryloxy, $C(=NOR^\alpha)-OR^\beta$ or $OC(R^\alpha)_2-C(R^\beta)=NOR^\beta$

the cyclic radicals, in turn, being unsubstituted or substituted by one to three radicals R^b:

R^b being cyano, nitro, halogen, amino, aminocarbonyl, aminothiocarbonyl, C_1-C_6-alkyl, C_1-C_6-halogenalkyl, C_1-C_6-alkylsulfonyl, C_1-C_6-alkylsulfoxyl, C_3-C_6-cycloalkyl, C_1-C_6-alkoxy, C_1-C_6-halogenalkoxy, 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-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-cycloalkenyl, phenyl, phenoxy, phenylthio, benzyl, benzyloxy, 5- or 6-membered heterocyclyl, 5- or 6-membered hetaryl, 5- or 6-membered hetaryloxy or $C(=NOR^\alpha)$-OR^β;

R^α, R^β being hydrogen or C_1-C_6-alkyl;

R^1 is hydrogen, cyano, C_1-C_4-alkyl, C_1-C_4-halogenalkyl, C_3-C_6-cycloalkyl, C_1-C_4-alkoxy;

R^2 is phenyl, phenylcarbonyl, phenylsulfonyl, 5- or 6-membered hetaryl, 5- or 6-membered hetarylcarbonyl or 5- or 6-membered hetarylsulfonyl, the ring systems being unsubstituted or substituted by one to three 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}-alkylcarbonyl, C_2-C_{10}-alkenylcarbonyl, C_3-C_{10}-alkynylcarbonyl, C_1-C_{10}-alkylsulfonyl, or $C(R^\alpha)=NOR^\beta$, the hydrocarbon radicals of these groups being unsubstituted or substituted by one to three radicals R^c:

R^c being cyano, nitro, amino, aminocarbonyl, aminothiocarbonyl, halogen, C_1-C_6-alkyl, C_1-C_6-halogenalkyl, C_1-C_6-alkylsulfonyl, C_1-C_6-alkylsulfoxyl, C_1-C_6-alkoxy, C_1-C_6-halogenalkoxy, 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-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 heterocyclyloxy, benzyl, benzyloxy, phenyl, phenoxy, phenylthio, 5- or 6-membered hetaryl, 5- or 6-membered hetaryloxy and hetarylthio, it being possible for the cyclic groups, in turn, to be partially or fully halogenated or to have attached to them one to three radicals R^a; and

R^3 is 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 to three radicals R^c;

which is taken up by the plants or seeds. In addition, the invention generally relates to the use of compounds of the formula I for immunizing plants against bacterioses.

Bacteria are predominantly found in moderate and humid-warm climatic regions as pathogens of diseases (bacterioses) in a large number of crop plants. Occasionally, these diseases cause substantial economic damage. Examples which are generally known are the death of entire fruit plantations caused by a variety of *Erwinia* species ("fireblight" in pears and apples), and bacterial soft rot in potatoes and many other plants, various plant tumors triggered by agrobacteria, and the necroses on a variety of vegetables, on rice, wheat and citrus fruit, caused by *Xanthomonas* species. The bacterioses caused by *Pseudomonas* species, in particular in vegetables, top fruit species and tobacco are especially dreaded.

As can be expected, conventional fungicides which engage in fungus-specific metabolic processes are not active against bacterioses. Thus, the only way of controlling them which has been possible to date was the use of antibiotics (for example Streptomycin, Blasticidin S or Kasugamicin), but this procedure is rarely practiced: the extensive use of antibiotics in agriculture is debated since, in principle, these antibiotics rely on the same mechanisms of action as are used against bacterial pathogens in human and veterinary medicine. They may

thus favor the build-up of resistances. Moreover, antibiotics are expensive, owing to their molecular structures (most of which are complicated) and can only be produced by biotechnological methods.

The exploitation or stimulation of the plants' intrinsic defenses would therefore constitute a sophisticated principle.

EP-A 420 803 describes the immunizing effect of benzo-1,2,3-thiazole derivatives against various phytopathogenic microorganisms. A similar effect of pyridylthiazoles is disclosed in WO-A 96/37493. However, the effect of these substances is frequently insufficient.

It is an aim of the present invention to provide a method which can be used widely, does not interfere with the tools available against bacterioses in humans and animals, is ecologically and toxicologically acceptable and does not damage the plants while bringing about effective immunization against phytobacterioses.

We have found that this object is achieved by the method defined at the outset. The active ingredients used are known as fungicides and, in some cases, also as insecticides (EP-A 178 826; EP-A 253 213; WO-A 93/15046; WO-A 95/18789; WO-A 95/21153; WO-A 95/21154; WO-A 95/24396; WO-A 96/01256; WO-A 97/15552). However, no results have been available as yet on a stimulation of the plant "Immunesystem", which leads to resistance to bacterioses.

The good tolerance, by plants, of the active ingredients of the formula I at the concentrations required for controlling plant diseases permits the treatment of aerial plant parts as well as the treatment of plant propagation material, seed and the soil.

In the method according to the invention, the active ingredient is taken up by the plant either via the leaf surface or via the roots and is distributed in all of the plants in the plant sap.

The protective action after applying the method according to the invention is therefore not only exerted to plant parts which have been sprayed directly, but the resistance of all of the plant to bacterioses is increased.

In a preferred embodiment of the method, the aerial plant parts are treated with a formulation of the active ingredient I.

The preparation of the active ingredients used in the method according to the invention is known from the documents cited at the outset.

Especially preferred active ingredients for the method according to the invention are those whose substituents, in each case alone or in combination, have the following meanings:

Especially preferred for the method according to the invention are active ingredients I in which Q is $C(=CH-OCH_3)-COOCH_3$, $C(=N-OCH_3)-COOCH_3$ or $N(-OCH_3)-COOCH_3$.

B in formula I is preferably phenyl, pyridyl, pyrimidinyl, triazolyl and pyrazolyl.

Especially preferred for the method according to the invention are, in particular, the active ingredients of the formulae II to VIII, in which

V is OCH_3 and $NHCH_3$, in particular OCH_3,

Y is CH and N and

T and Z independently of one another are CH and N.

Preferred active ingredients of the formula I, in which Q is $N(-OCH_3)-COOCH_3$ are the compounds described in the publications WO-A 93/15046 and WO-A 96/01256.

Preferred active ingredients of the formula I, in which Q is $C(=CH-OCH_3)-COOCH_3$ are the compounds described in the publications EP-A 178 826 and EP-A 278 595.

Preferred active ingredients of the formula I, in which Q is $C(=N-OCH_3)-COOCH_3$ are the compounds described in the publications EP-A 253 213 and EP-A 254 426.

Preferred active ingredients of the formula I, in which Q is $C(=N-OCH_3)-CONHCH_3$ are the compounds described in the publications EP-A 398 692, EP-A 477 631 and EP-A 628 540.

Preferred active ingredients of the formula I, in which Q is $C(=CH-CH_3)-COOCH_3$ are the compounds described in the publications EP-A 280 185 and EP-A 350 691.

Preferred active ingredients of the formula I, in which A is $-CH_2O-N=C(R^1)-B$ are the compounds described in the publications EP-A 460 575 and EP-A 463 488.

Preferred active ingredients of the formula I, in which A is -O-B are the compounds described in the publications EP-A 382 375 and EP-A 398 692.

Preferred active ingredients of the formula I, in which A is $-CH_2O-N=C(R^1)-C(R^2)=N-OR^3$ are the compounds described in the publications WO-A 95/18789, WO-A 95/21153, WO-A 95/21154, WO-A 97/05103 and WO-A 97/06133.

Especially preferred active ingredients of the formula I are those in which

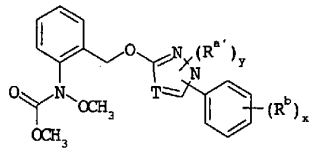
Q is $N(-OCH_3)-COOCH_3$,

A is CH_2-O- and

B is 3-pyrazolyl or 1,2,4-triazolyl, where B can have attached to it one or two substituents selected from the group consisting of

- halogen, methyl and trifluoromethyl and
- phenyl and pyridyl, in particular 2-pyridyl, these radicals being substituted by 1 to 3 radicals R^b.

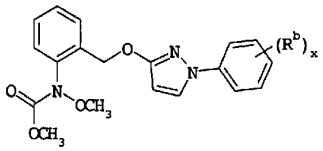
These active ingredients are described for the formula II



II

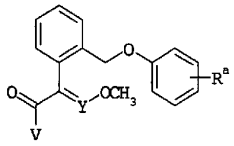
in which $R^{a'}$ is chlorine, methyl or trifluoromethyl, R^b has the meaning given for the formula I, x is 1 or 2 and y is 0 or 1.

Especially preferred active ingredients are also those of the formula II'.



II'

Furthermore, active ingredients of the formula III



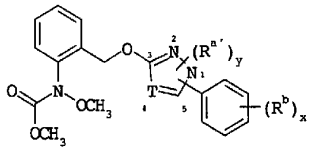
III

in which V is OCH_3 or $NHCH_3$ and Y is N and R^a is halogen, C_1-C_4-alkyl, C_1-C_4-halogenalkyl or C_1-C_4-halogenalkoxy, are preferred.

Active ingredients of the formula III, in which V is OCH_3 and R^a is halogen, methyl, dimethyl or trifluoromethyl, in particular methyl, are especially preferred.

With regard to their use, especially preferred compounds are those which are compiled in the tables which follow.

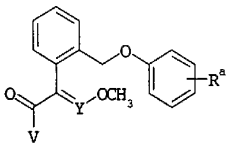
Table I



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-A 96/01256
I-2	N	-	1	4-Cl	WO-A 96/01256
I-3	CH	-	1	2-Cl	WO-A 96/01256
I-4	CH	-	1	3-Cl	WO-A 96/01256
I-5	CH	-	1	4-Cl	WO-A 96/01256
I-6	CH	-	1	4-CH_3	WO-A 96/01256
I-7	CH	-	1	H	WO-A 96/01256
I-8	CH	-	1	3-CH_3	WO-A 96/01256
I-9	CH	5-CH_3	1	3-CF_3	WO-A 96/01256
I-10	CH	1-CH_3	5	3-CF_3	WO-A 99/33812
I-11	CH	1-CH_3	5	4-Cl	WO-A 99/33812
I-12	CH	1-CH_3	5	-	WO-A 99/33812

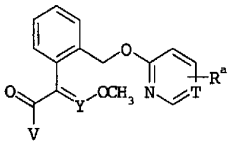
Table II



III

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 477 631
II-5	$NHCH_3$	N	$2-CH_3$	EP-A 477 631
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	$2-CH_3$,$4-OCH(CH_3)-C(CH_2CH_3)=NOCH_3$	EP-A 11 18 609
II-11	$NHCH_3$	N	$2-Cl$,$4-OCH(CH_3)-C(CH_3)=NOCH_2CH_3$	EP-A 11 18 609

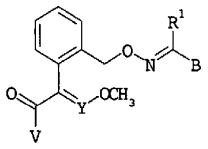
Table III



IV

No.	V	Y	T	R^a	Reference
III-1	OCH_3	CH	N	$2-OCH_3$, $4-CF_3$	WO-A 96/16047
III-2	OCH_3	CH	N	$2-OCH(CH_3)_2$, $4-CF_3$	WO-A 96/16047
III-3	OCH_3	CH	CH	$2-CF_3$	EP-A 278 595
III-4	OCH_3	CH	CH	$3-CF_3$	EP-A 278 595
III-5	$NHCH_3$	N	CH	3-Cl	EP-A 398 692
III-6	$NHCH_3$	N	CH	$3-CF_3$	EP-A 398 692
III-7	$NHCH_3$	N	CH	$3-CF_3$, 5-Cl	EP-A 398 692
III-8	$NHCH_3$	N	CH	3-Cl, $5-CF_3$	EP-A 398 692

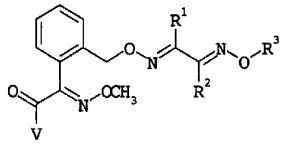
Table IV



V

No.	V	Y	R^1	B	Reference
IV-1	OCH_3	CH	CH_3	$(3\text{-}CF_3)C_6H_4$	EP-A 370 629
IV-2	OCH_3	CH	CH_3	$(3,5\text{-}Cl_2)C_6H_3$	EP-A 370 629
IV-3	$NHCH_3$	N	CH_3	$(3\text{-}CF_3)C_6H_4$	WO-A 92/13830
IV-4	$NHCH_3$	N	CH_3	$(3\text{-}OCF_3)C_6H_4$	WO-A 92/13830
IV-5	OCH_3	N	CH_3	$(3\text{-}OCF_3)C_6H_4$	EP-A 460 575
IV-6	OCH_3	N	CH_3	$(3\text{-}CF_3)C_6H_4$	EP-A 460 575
IV-7	OCH_3	N	CH_3	$(3,4\text{-}Cl_2)C_6H_3$	EP-A 460 575
IV-8	OCH_3	N	CH_3	$(3,5\text{-}Cl_2)C_6H_3$	EP-A 463 488

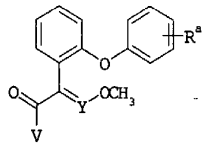
Table V



VI

No.	V	R^1	R^2	R^3	Reference
V-1	OCH_3	CH_3	CH_3	CH_3	WO-A 95/18789
V-2	OCH_3	CH_3	$CH(CH_3)_2$	CH_3	WO-A 95/18789
V-3	OCH_3	CH_3	CH_2CH_3	CH_3	WO-A 95/18789
V-4	$NHCH_3$	CH_3	CH_3	CH_3	WO-A 95/18789
V-5	$NHCH_3$	CH_3	$4\text{-}F\text{-}C_6H_4$	CH_3	WO-A 95/18789
V-6	$NHCH_3$	CH_3	$4\text{-}Cl\text{-}C_6H_4$	CH_3	WO-A 95/18789
V-7	$NHCH_3$	CH_3	$2,4\text{-}Cl_2\text{-}C_6H_3$	CH_3	WO-A 95/18789
V-8	$NHCH_3$	Cl	$4\text{-}F\text{-}C_6H_4$	CH_3	WO-A 98/38857
V-9	$NHCH_3$	Cl	$4\text{-}Cl\text{-}C_6H_4$	CH_2CH_3	WO-A 98/38857
V-10	$NHCH_3$	CH_3	$CH_2C(=CH_2)CH_3$	CH_3	WO-A 97/05103
V-11	$NHCH_3$	CH_3	$CH=C(CH_3)_2$	CH_3	WO-A 97/05103
V-12	$NHCH_3$	CH_3	$CH=C(CH_3)_2$	CH_2CH_3	WO-A 97/05103
V-13	$NHCH_3$	CH_3	$CH=C(CH_3)CH_2CH_3$	CH_3	WO-A 97/05103
V-14	$NHCH_3$	CH_3	$O\text{-}CH(CH_3)_2$	CH_3	WO-A 97/06133
V-15	$NHCH_3$	CH_3	$O\text{-}CH_2CH(CH_3)_2$	CH_3	WO-A 97/06133
V-16	$NHCH_3$	CH_3	$C(CH_3)=NOCH_3$	CH_3	WO-A 97/15552

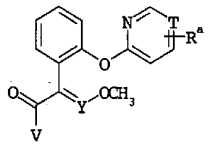
Table VI



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

Table VII



VIII

No.	V	Y	T	R^a	Reference
VII-1	OCH_3	CH	N	4-O-(2-CN-C_6H_4)	EP-A 382 375
VII-2	OCH_3	CH	N	4-O-(2-Cl-C_6H_4)	EP-A 382 375
VII-3	OCH_3	CH	N	4-O-(2-CH_3-C_6H_4)	EP-A 382 375
VII-4	$NHCH_3$	N	N	4-O-(2-Cl-C_6H_4)	GB-A 22 53 624
VII-5	$NHCH_3$	N	N	4-O-(2,4-Cl_2-C_6H_3)	GB-A 22 53 624
VII-6	$NHCH_3$	N	N	4-O-(2-CH_3-C_6H_4)	GB-A 22 53 624
VII-7	$NHCH_3$	N	N	4-O-(2-CH_3,3-Cl-C_6H_3)	GB-A 22 53 624
VII-8	$NHCH_3$	N	N	4-O-(2-CH_3-C_6H_4), 5-F	WO-A 98/21189
VII-9	$NHCH_3$	N	N	4-O-(2-Cl-C_6H_4), 5-F	WO-A 98/21189
VII-10	$NHCH_3$	N	N	4-O-(2-CH_3,3-Cl-C_6H_3), 5-F	WO-A 98/21189
VII-11	$NHCH_3$	N	N	4-O-(2-Cl,3-CH_3-C_6H_3), 5-F	WO-A 98/21189

The compounds I increase the resistance of plants to bacterioses. They are especially important for controlling bacteria on a variety of crop plants such as vegetables, top fruit species and tobacco, and all the seeds of these plants.

Specifically, they are suitable for controlling the following plant diseases:
Pseudomonas species on tobacco, potatoes, tomatoes and pulses, and, in particular,
Erwinia species on fruit, vegetables and potatoes.

Compounds of the formula III in particular compound II-1, are especially suitable for controlling Erwinia species.

The compounds I are applied by treating the plants, seeds or the soil to be protected from bacterial infection with an effective amount of the active ingredients. Application takes place before the bacteria infect the plants or seeds. A markedly reduced susceptibility of the plant to bacterioses can thereby be observed.

For use in crop protection, the application rates are between 0.01 and 2.0 kg of active ingredient per ha, depending on the pathogen species and the plant species.

In the treatment of seed, amounts of active ingredient of from 0.001 to 0.1 g, preferably from 0.01 to 0.05 g, are generally required per kilogram of seed.

The compounds I can be converted into the formulations which are customary for fungicides, for example solutions, emulsions, suspensions, dusts, powders, pastes and granules. The use form depends on the particular purpose; it is intended to ensure in each case a fine and uniform distribution of the compound according to the invention.

The formulations are prepared in a known manner, eg. by extending the active ingredient with solvents and/or carriers, if desired using emulsifiers and dispersants, it also being possible to use other organic solvents as auxiliary solvents if water is used as the diluent. Auxiliaries which are suitable are essentially those conventionally used as fungicides.
In general, the formulations comprise from 0.01 to 95% by weight, preferably from 0.1 to 90% by weight, of the active ingredient. The active ingredients are employed in a purity of from 90% to 100%, preferably 95% to 100% (according to NMR spectrum).

The following are examples of formulations:

I. 5 parts by weight of a compound according to the invention are mixed intimately with 95 parts by weight of finely divided kaolin. This gives a dust which comprises 5% by

weight of the active ingredient.

II. 30 parts by weight of a compound according to the invention are mixed intimately with a mixture of 92 parts by weight of pulverulent silica gel and 8 parts by weight of paraffin oil which had been sprayed onto the surface of this silica gel. This gives a formulation of the active ingredient with good adhesion properties (active ingredient content 23% by weight).

III. 10 parts by weight of a compound according to the invention are dissolved in a mixture composed of 90 parts by weight of xylene, 6 parts by weight of the adduct of 8 to 10 mol of ethylene oxide and 1 mol of oleic acid N-monoethanolamide, 2 parts by weight of calcium dodecylbenzenesulfonate and 2 parts by weight of the adduct of 40 mol of ethylene oxide and 1 mol of castor oil (active ingredient content 9% by weight).

IV. 20 parts by weight of a compound according to the invention are dissolved in a mixture composed of 60 parts by weight of cyclohexanone, 30 parts by weight of isobutanol, 5 parts by weight of the adduct of 7 mol of ethylene oxide and 1 mol of isooctylphenol and 5 parts by weight of the adduct of 40 mol of ethylene oxide and 1 mol of castor oil (active ingredient content 16% by weight).

V. 80 parts by weight of a compound according to the invention are mixed thoroughly with 3 parts by weight of sodium diisobutylnaphthalene-alpha-sulfonate, 10 parts by weight of the sodium salt of a lignosulfonic acid from a sulfite waste liquor and 7 parts by weight of pulverulent silica gel, and the mixture is ground in a hammer mill (active ingredient content 80% by weight).

VI. 90 parts by weight of a compound according to the invention are mixed with 10 parts by weight of N-methyl-α-pyrrolidone, which gives a solution which is suitable for use in the form of microdrops (active ingredient content 90% by weight).

VII. 20 parts by weight of a compound according to the invention are dissolved in a mixture composed of 40 parts by weight of cyclohexanone, 30 parts by weight of isobutanol, 20 parts by weight of the adduct of 7 mol of ethylene oxide and 1 mol of isooctylphenol and 10 parts by weight of the adduct of 40 mol of ethylene oxide and 1 mol of castor oil. Pouring the solution into 100,000 parts by weight of water and

finely distributing it therein gives an aqueous dispersion which comprises 0.02% by weight of the active ingredient.

VIII. 20 parts by weight of a compound according to the invention are mixed thoroughly with 3 parts by weight of sodium diisobutylnaphthalene-α-sulfonate, 17 parts by weight of the sodium salt of a lignosulfonic acid from a sulfite waste liquor and 60 parts by weight of pulverulent silica gel, and the mixture is ground in a hammer mill. Finely distributing the mixture in 20,000 parts by weight of water gives a spray mixture which comprises 0.1% by weight of the active ingredient.

Aqueous use forms can usually 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 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.

The active ingredient concentrations in the ready-to-use products can be varied within relatively wide ranges. In general, they are from 0.0001 to 10%, preferably from 0.01 to 1%.

The active ingredients may also be used successfully in the ultra-low-volume process (ULV), it being possible to apply formulations comprising over 95% by weight of active ingredient, or even to apply the active ingredient without additives.

Various types of oils, herbicides, other fungicides, other pesticides, or bactericides may be added to the active ingredients, 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 1:10 to 10:1.

The resistance-inducing effect of the active ingredients I against bacteria can be mentioned as a printed note on the packaging or in product data sheets. Preparations which can be applied in combination together with the active ingredients I may also be provided with this note.

The induction of resistance can also constitute an indication which may be the subject matter of approval of the active ingredients I by the authorities.

The effect of the compounds of the formula I was demonstrated by the following experiments:

Use examples for the induction of resistance to bacteria

Plant material

For the experiments, tobacco plants (Nicotinia tabacum cv. Xanthi-nc) were grown for 6 to 8 weeks in seed compost (standard soil type ED 73) at 25°C, 59% atmospheric humidity and a daily photoperiod of 16 hours (150-200 µM quanta/s^{-1}/m^{-2}). Some of the plants were fed once per week by adding a commercial fertilizer for flowers (total nitrogen 10%, phosphate 9%, potash 7%) to the irrigation of water and the recommended dosage rate.

Application of the active ingredient

The active ingredient was sprayed onto the plant in the form of a 0.1 mM aqueous solution (dilutions prepared with 1% v/v dimethyl sulfoxide [DMSO]) or infiltrated directly into the leaf tissue with the aid of a very fine canula. The control plants were treated analogously with solutions without active ingredient. To minimize the effect of biological variations, some experiments involved treating in each case one half of a leaf (left or right of the central vein) with active ingredient solution and the other half of the same leaf with control solutions.

Following the application and also following subsequent inoculation with *Pseudomonas syringae*, the plants remained in the growth cabinet.

Inoculation/infection, and determination of the resistance

The tobacco plants or leaves to which active ingredient had been applied as described hereinabove were infected with *Pseudomonas syringae* pv. *tomato* (strain DC3000; origin: Brian Staskawicz, University of California, Berkeley, CA) or *Pseudomonas syringae* pv. *tabaci* (Deutsche Sammlung von Mikroorganismen und Zellkulturen [German Collection of Microorganisms and Cell Cultures], Brunswick, Germany). To this end, the bacteria were grown on King's B Medium for 1 day at 30°C, centrifuged, washed and brought to a density of 10^5 cfu ml^{-1} in a 10mM $MgCl_2$ solution. Approximately 200 µl ($2x10^4$ cfu ml^{-1}) of this inoculum were

infiltrated directly into the leaf tissue via small leaf scarifications made with a cannula.

In the subsequent week, the degree of foliar necroses as the consequence of the infection was determined. The absence of necrotic symptoms characterizes the induced resistance of the leaf tissue.

Determination of the bacterial growth

To quantity the bacterial population, the groups of two leaf segments (Ø 1 cm) were punched from infected leaf areas and were homogenized in 500 µL sterile water. A dilution series of this was plated into King's B Agar, and the concentration of the starting population (cfu) per leaf disk was calculated after incubation for 2 days at 30°C on the basis of numbers of colonies formed.

Use example

Increased resistance to *Pseudomonas syringae* pv. *tomato DC3000* (incompatible interaction) and reduced production of disease symptoms caused by *Pseudomonas syringae* pv. *tabaci* (compatible interaction) on tobacco leaves after treatment with active ingredient I-5.

Example 1: Immunization against *Pseudomonas syringae* pv. *tabaci* (compatible interaction)

In the case of compatible host-pathogen combination, the application (24 to 48 hours prior to inoculation) with a ≤ 0.01 % strength preparation of the active ingredient I-5 suppresses the bacterial growth and reduces the manifestation of disease symptoms.

The course of the growth kinetic of *Pseudomonas syringae* pv. *tabaci* following inoculation of King's B medium with a colony in the presence or absence of the active ingredient I-5 demonstrates that the active ingredient itself has no effect on the bacterial growth in vitro.

The observed effect is therefore based on a stimulation of the plants' intrinsic defence or resistance to the pathogen.

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Table A: Growth of *Pseudomonas syringae* pv. *tabaci* in inoculated tobacco leaves

Time[hrs]	Bacteria ($x10^6$ cells/ml (leaf $disk^{-1}$))	
	Active ingredient I-5	Control
0	0	0
16	0.3	0.3
24	1.2	3.3
48	1.4	3.7

Example 2: Immunization against *Pseudomonas syringae* pv. *tomato DC3000* (incompatible interaction)

The manifestation of symptoms is greatly reduced even in the case of incompatible interaction (i.e. the plant per se responds rapidly to pathogens which have penetrated by developing ("defense") necroses, which, however, involve the death of the infected tissue regions).

Table B: Course of the infection in tobacco leaves following inoculation of an intercostal region with *Pseudomonas syringae* pv. *tomato DC3000*

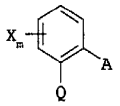
Time [hrs]	Changes on the leaf (area % of the intercostal region)			
	Active ingredient I-5		Control	
	Wilting symptoms	Necroses	Wilting symptoms	Necroses
0	0	0	0	0
24	0	0	100	0
48	0	5	-	100
72	0	8	-	100
144	0	15	-	100
168	0	20	-	100

Following application of the preparation of the active ingredient I-5, the few regions showing necroses were limited directly to the inoculation sites where the leaves were scarified. The leaves of the control plant had wilted after 24 hours and died completely after 48 hours.

Comprises/comprising and grammatical variations thereof when used in this specification are to be taken to specify the presence of stated features, integers, steps or components or groups thereof, but do not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

We claim:

1. Method for immunizing plants against bacterioses, which comprises treating the plants, the soil or the seeds with an effective amount of a compound of the formula I,



I

in which

X is halogen, C_1-C_4-alkyl or trifluoromethyl;

m is 0 or 1;

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

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

B is phenyl, naphthyl, 5-membered or 6-membered hetaryl or 5-membered or 6-membered heterocyclyl, comprising one to 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 to three radicals R^a:

R^a being cyano, nitro, amino, aminocarbonyl, aminothiocarbonyl, halogen, C_1-C_6-alkyl, C_1-C_6-halogenalkyl, C_1-C_6-alkylcarbonyl, C_1-C_6-alkylsulfonyl, C_1-C_6-alkylsulfoxyl, C_3-C_6-cycloalkyl, C_1-C_6-alkoxy, C_1-C_6-halogenalkoxy, 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 hetaryl, 5- or 6-membered hetaryloxy, $C(=NOR^\alpha)-OR^\beta$ or $OC(R^\alpha)_2-C(R^\beta)=NOR^\beta$,

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the cyclic radicals, in turn, being unsubstituted or substituted by one to three radicals R^b:

R^b being cyano, nitro, halogen, amino, aminocarbonyl, aminothiocarbonyl, C_1-C_6-alkyl, C_1-C_6-halogenalkyl, C_1-C_6-alkylsulfonyl, C_1-C_6-alkylsulfoxyl, C_3-C_6-cycloalkyl, C_1-C_6-alkoxy, C_1-C_6-halogenalkoxy, 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-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-cycloalkenyl, phenyl, phenoxy, phenylthio, benzyl, benzyloxy, 5- or 6-membered heterocyclyl, 5- or 6-membered hetaryl, 5- or 6-membered hetaryloxy or $C(=NOR^\alpha)$-OR^β;

R^α, R^β being hydrogen or C_1-C_6-alkyl;

R^1 is hydrogen, cyano, C_1-C_4-alkyl, C_1-C_4-halogenalkyl, C_3-C_6-cycloalkyl, C_1-C_4-alkoxy;

R^2 is phenyl, phenylcarbonyl, phenylsulfonyl, 5- or 6-membered hetaryl, 5- or 6-membered hetarylcarbonyl or 5- or 6-membered hetarylsulfonyl, the ring systems being unsubstituted or substituted by one to three 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}-alkylcarbonyl, C_2-C_{10}-alkenylcarbonyl, C_3-C_{10}-alkynylcarbonyl, C_1-C_{10}-alkylsulfonyl, or $C(R^\alpha)=NOR^\beta$, the hydrocarbon radicals of these groups being unsubstituted or substituted by one to three radicals R^c:

R^c being cyano, nitro, amino, aminocarbonyl, aminothiocarbonyl, halogen, C_1-C_6-alkyl, C_1-C_6-halogenalkyl, C_1-C_6-alkylsulfonyl, C_1-C_6-alkylsulfoxyl, C_1-C_6-alkoxy, C_1-C_6-halogenalkoxy, C_1-C_6-alkoxycarbonyl, C_1-C_6-alkylthio, C_1-C_6-alkylamino,

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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,

C_3-C_6-cycloalkyl, C_3-C_6-cycloalkyloxy, 5- or 6-membered heterocyclyl, 5- or 6-membered heterocyclyloxy, benzyl, benzyloxy, phenyl, phenoxy, phenylthio, 5- or 6-membered hetaryl, 5- or 6-membered hetaryloxy and hetarylthio, it being possible for the cyclic groups, in turn, to be partially or fully halogenated or to have attached to them one to three radicals R^a; and

R^3 is 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 to three radicals R^c;

which is taken up by the plants or seeds.

2. A method as claimed in claim 1, wherein an active ingredient of the formula I, in which Q is $C(=CH-OCH_3)-COOCH_3$, $C(=N-OCH_3)-COOCH_3$ or $N(-OCH_3)-COOCH_3$, is used.

3. A method as claimed in claim 1 or 2, wherein the index m is zero and the substituents in formula I have the following meanings:

A is $-O-B$, $-CH_2O-B$, $-CH_2O-N=C(R^1)-B$ or $CH_2-O-N=C(R^1)-C(R^2)=N-OR^3$;

B is phenyl, pyridyl, pyrimidinyl, pyrazolyl, triazolyl, these ring systems being substituted by one or two radicals R^a;

R^2 is 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 radicals $R^{b'}$;

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

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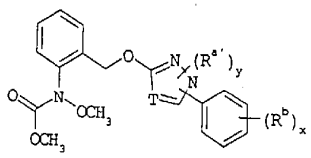
or phenyl, which is unsubstituted or substituted by one or two radicals R^a; and

R^3 is C_1-C_6-alkyl, C_2-C_{10}-alkenyl or C_2-C_{10}-alkynyl.

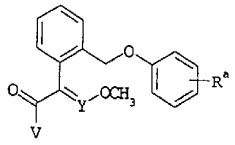
4. A method as claimed in any one of claims 1 to 3, wherein an active ingredient of the formula II



II

in which T is a carbon atom or a nitrogen atom, $R^{a'}$ is chlorine, methyl or trifluoromethyl, R^b has the meaning given for formula I and x is 1 or 2 and y is zero or 1, is used.

5. A method according to any one of claims 1 to 3, wherein an active ingredient of the formula III



III

in which V is OCH_3, Y is N and R^a is methyl, dimethyl or halogen, is used.

6. A method as claimed in any one of claims 1 to 5 for immunizing against Erwinia species.

7. A method as claimed in any one of claims 1 to 6, wherein the plants are treated.

8. A method as claimed in any one of claims 1 to 6, wherein the seeds are treated.

9. The use of a compound of the formula I, II, or III as defined in any one of claims 1 to 5 for immunizing plants against bacterioses.

10. A method according to any one of claims 1 to 8, substantially as hereinbefore described with reference to the examples.

11. The use of a compound according to claim 9 substantially as hereinbefore described with reference to the examples.