



(11) **EP 3 183 245 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
26.09.2018 Bulletin 2018/39

(51) Int Cl.:
C07D 401/04 (2006.01) **A01N 43/50** (2006.01)
C07D 471/04 (2006.01) **C07F 5/02** (2006.01)
C07F 7/10 (2006.01) **C07D 213/79** (2006.01)

(21) Application number: **15753672.3**

(86) International application number:
PCT/EP2015/068928

(22) Date of filing: **18.08.2015**

(87) International publication number:
WO 2016/026848 (25.02.2016 Gazette 2016/08)

(54) **PESTICIDALLY ACTIVE HETEROCYCLIC DERIVATIVES WITH SULPHUR CONTAINING SUBSTITUENTS**

PESTIZIDWIRKSAME HETEROCYCLISCHE DERIVATE MIT SCHWEFELHALTIGEN SUBSTITUENTEN

DÉRIVÉS HÉTÉROCYCLIQUES ACTIFS SUR LE PLAN PESTICIDE AVEC DES SUBSTITUANTS CONTENANT DU SOUFRE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

- **MUEHLEBACH, Michel**
4332 Stein (CH)
- **RENOLD, Peter**
4332 Stein (CH)

(30) Priority: **21.08.2014 EP 14181715**

(74) Representative: **Syngenta International AG**
CHBS-B4.8
Schwarzwaldallee 215
4058 Basel (CH)

(43) Date of publication of application:
28.06.2017 Bulletin 2017/26

(73) Proprietor: **Syngenta Participations AG**
4058 Basel (CH)

(56) References cited:
EP-A1- 0 079 083 **WO-A1-2012/086848**
WO-A1-2013/018928

(72) Inventors:

- **STOLLER, André**
4332 Stein (CH)
- **JEANGUENAT, André**
4332 Stein (CH)
- **EDMUNDS, Andrew**
4332 Stein (CH)
- **JUNG, Pierre Joseph Marcel**
4332 Stein (CH)
- **EMERY, Daniel**
4332 Stein (CH)

- **ROBERTSON D W ET AL:**
"STRUCTURE-ACTIVITY RELATIONSHIPS OF ARYLIMIDAZOPYRIDINE CARDIOTONICS: DISCOVERY AND INOTROPIC ACTIVITY OF 2-Ú2-METHOXY-4- (METHYLSULFINYL)PHENYL 3/4 -1 H-IMIDAZOÚ4,5-C 3/4 PYRIDINE", **JOURNAL OF MEDICINAL CHEMISTRY, AMERICAN CHEMICAL SOCIETY, US, vol. 28, no. 6, 1985, pages 717-727, XP000577047, ISSN: 0022-2623, DOI: 10.1021/JM00383A006**

EP 3 183 245 B1

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

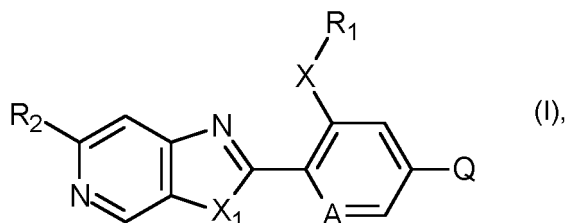
Description

[0001] The present invention relates to pesticidally active, in particular insecticidally active heterocyclic derivatives containing sulphur substituents, to intermediates for the preparation of those compounds, to compositions comprising those compounds, and to their use for controlling animal pests (including arthropods and in particular insects or representatives of the order *Acarina*).

[0002] Heterocyclic compounds with pesticidal action are known and described, for example, in WO 2012/086848 and WO 2013/018928.

[0003] There have now been found novel pesticidally active heterocyclic 6/5-bicyclic ring derivatives with sulphur containing phenyl and pyridyl substituents.

[0004] The present invention accordingly relates to compounds of formula I,



wherein

A represents CH or N;

Q is C₃-C₆cycloalkyl, or C₃-C₆cycloalkyl mono- or polysubstituted by substituents selected from the group consisting of halogen, cyano, C₁-C₄alkyl, C₁-C₄haloalkyl, C₃-C₆cycloalkyl and phenyl, or is phenyl which can be mono- or polysubstituted by substituents selected from the group consisting of halogen, cyano, C₁-C₄alkyl, C₁-C₄haloalkyl, C₁-C₄haloalkoxy, C₁-C₄alkoxy, C₁-C₄haloalkylsulfanyl, C₁-C₄halo-alkylsulfinyl, C₁-C₄haloalkylsulfonyl and -C(O)C₁-C₄haloalkyl; or

Q is C₂-C₆alkenyl, or C₂-C₆alkenyl mono- or polysubstituted by substituents selected from the group consisting of halogen, cyano, C₁-C₄alkyl, C₁-C₄haloalkyl, C₃-C₆cycloalkyl and phenyl, or is phenyl which can be mono- or polysubstituted by substituents selected from the group consisting of halogen, cyano, C₁-C₄alkyl, C₁-C₄haloalkyl, C₁-C₄haloalkoxy, C₁-C₄alkoxy, C₁-C₄haloalkylsulfanyl, C₁-C₄halo-alkylsulfinyl, C₁-C₄haloalkylsulfonyl and -C(O)C₁-C₄haloalkyl; or

Q is C₂-C₆alkynyl, or C₂-C₆alkynyl mono- or polysubstituted by substituents selected from the group consisting of halogen, cyano, C₁-C₄alkyl, C₁-C₄haloalkyl, C₃-C₆cycloalkyl, tri(C₁-C₄alkyl)silyl and phenyl, or is phenyl which can be mono- or polysubstituted by substituents selected from the group consisting of halogen, cyano, C₁-C₄alkyl, C₁-C₄haloalkyl, C₁-C₄haloalkoxy, C₁-C₄alkoxy, C₁-C₄halo-alkylsulfanyl, C₁-C₄haloalkylsulfinyl, C₁-C₄haloalkylsulfonyl and -C(O)C₁-C₄haloalkyl;

X is S, SO or SO₂;

R₁ is C₁-C₄alkyl, C₁-C₄haloalkyl, C₃-C₆cycloalkyl, C₃-C₆cycloalkyl-C₁-C₄alkyl or C₃-C₆cycloalkyl mono- or polysubstituted by substituents selected from the group consisting of halogen, cyano and C₁-C₄alkyl; or

R₁ is C₃-C₆cycloalkyl-C₁-C₄alkyl mono- or polysubstituted by substituents selected from the group consisting of halogen, cyano and C₁-C₄alkyl; or

R₁ is C₂-C₆alkenyl, C₂-C₆haloalkenyl or C₂-C₆alkynyl;

R₂ is halogen, cyano, C₁-C₆haloalkyl or C₁-C₆haloalkyl substituted by one or two substituents selected from the group consisting of hydroxyl, methoxy and cyano; or

R₂ is C₁-C₄haloalkylsulfanyl, C₁-C₄haloalkylsulfinyl, C₁-C₄haloalkylsulfonyl, O(C₁-C₄haloalkyl), or -C(O)C₁-C₄haloalkyl; or

R₂ is C₃-C₆cycloalkyl which can be mono- or polysubstituted by substituents selected from the group consisting of halogen, cyano and C₁-C₄alkyl;

X₁ is O, S or NR₃, wherein R₃ is hydrogen, C₁-C₄alkyl, C₂-C₆alkenyl, C₂-C₆alkynyl, C₁-C₄alkoxy-C₁-C₄alkyl or C₃-C₆cycloalkyl;

and agrochemically acceptable salts, stereoisomers, enantiomers, tautomers and N-oxides of those compounds.

[0005] Compounds of formula I which have at least one basic centre can form, for example, acid addition salts, for example with strong inorganic acids such as mineral acids, for example perchloric acid, sulfuric acid, nitric acid, nitrous acid, a phosphorus acid or a hydrohalic acid, with strong organic carboxylic acids, such as C₁-C₄alkanecarboxylic acids

which are unsubstituted or substituted, for example by halogen, for example acetic acid, such as saturated or unsaturated dicarboxylic acids, for example oxalic acid, malonic acid, succinic acid, maleic acid, fumaric acid or phthalic acid, such as hydroxycarboxylic acids, for example ascorbic acid, lactic acid, malic acid, tartaric acid or citric acid, or such as benzoic acid, or with organic sulfonic acids, such as C₁-C₄alkane- or arylsulfonic acids which are unsubstituted or substituted, for example by halogen, for example methane- or p-toluenesulfonic acid. Compounds of formula I which have at least one acidic group can form, for example, salts with bases, for example mineral salts such as alkali metal or alkaline earth metal salts, for example sodium, potassium or magnesium salts, or salts with ammonia or an organic amine, such as morpholine, piperidine, pyrrolidine, a mono-, di- or tri-lower-alkylamine, for example ethyl-, diethyl-, triethyl- or dimethylpropylamine, or a mono-, di- or trihydroxy-lower-alkylamine, for example mono-, di- or triethanolamine.

[0006] The alkyl groups occurring in the definitions of the substituents can be straight-chain or branched and are, for example, methyl, ethyl, n-propyl, isopropyl, n-butyl, sec-butyl, iso-butyl, tert-butyl, pentyl, hexyl, nonyl, decyl and their branched isomers. Alkylsulfanyl, alkylsulfinyl, alkylsulfonyl, alkoxy, alkenyl and alkynyl radicals are derived from the alkyl radicals mentioned. The alkenyl and alkynyl groups can be mono- or polyunsaturated.

[0007] Halogen is generally fluorine, chlorine, bromine or iodine. This also applies, correspondingly, to halogen in combination with other meanings, such as haloalkyl or halophenyl.

[0008] Haloalkyl groups preferably have a chain length of from 1 to 6 carbon atoms. Haloalkyl is, for example, fluoromethyl, difluoromethyl, trifluoromethyl, chloromethyl, dichloromethyl, trichloromethyl, 2,2,2-trifluoroethyl, 2-fluoroethyl, 2-chloroethyl, pentafluoroethyl, 1,1-difluoro-2,2,2-trichloroethyl, 2,2,3,3-tetrafluoroethyl and 2,2,2-trichloroethyl.

[0009] Alkoxy groups preferably have a preferred chain length of from 1 to 6 carbon atoms. Alkoxy is, for example, methoxy, ethoxy, propoxy, i-propoxy, n-butoxy, isobutoxy, sec-butoxy and tert-butoxy and also the isomeric pentyloxy and hexyloxy radicals.

[0010] Alkoxyalkyl groups preferably have a chain length of 1 to 6 carbon atoms.

Alkoxyalkyl is, for example, methoxymethyl, methoxyethyl, ethoxymethyl, ethoxyethyl, n-propoxymethyl, n-propoxyethyl, isopropoxymethyl or isopropoxyethyl.

[0011] Alkoxyalkyl is for example methoxycarbonyl (which is C₁alkoxycarbonyl), ethoxycarbonyl, propoxycarbonyl, isopropoxycarbonyl, n-butoxycarbonyl, tert-butoxycarbonyl, n-pentoxycarbonyl or hexoxycarbonyl.

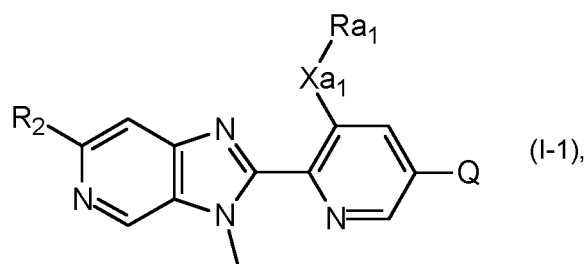
[0012] The cycloalkyl groups preferably have from 3 to 6 ring carbon atoms, for example cyclopropyl, cyclobutyl, cyclopentyl and cyclohexyl.

[0013] In the context of this invention "mono- to polysubstituted" in the definition of the substituents, means typically, depending on the chemical structure of the substituents, monosubstituted to seven-times substituted, preferably monosubstituted to five-times substituted, more preferably mono-, double- or triple-substituted.

[0014] Free radicals represent methyl groups.

[0015] The compounds of formula I according to the invention also include hydrates which may be formed during the salt formation.

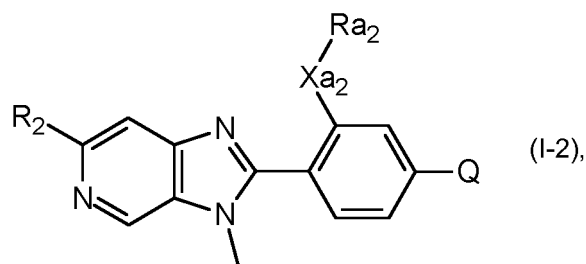
[0016] A preferred group of compounds of formula I is represented by the compounds of formula I-1



wherein R₂ and Q are as defined under formula I above; and wherein X_{a1} is S, SO or SO₂; Ra₁ is methyl, ethyl, n-propyl, i-propyl or cyclopropylmethyl; and agrochemically acceptable salts, stereoisomers, enantiomers, tautomers and N-oxides of those compounds. In this preferred group of compounds of formula 1-1, Q is preferably C₃-C₆cycloalkyl, or C₃-C₆cycloalkyl monosubstituted or disubstituted by substituents selected from the group consisting of cyano, C₁-C₄haloalkyl and halogen; in particular C₃-C₆cycloalkyl; R₂ is preferably C₁-C₄haloalkyl, X_{a1} is preferably SO₂ and Ra₁ is preferably ethyl.

[0017] A further preferred group of compounds of formula I is represented by the compounds of formula I-2

5



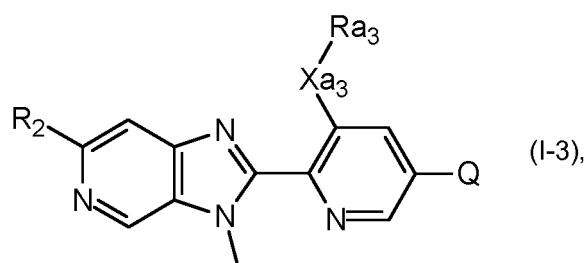
10

wherein R_2 and Q are as defined under formula I above; and wherein X_{a2} is S, SO or SO_2 ; R_{a2} is methyl, ethyl, n-propyl, i-propyl or cyclopropylmethyl; and agrochemically acceptable salts, stereoisomers, enantiomers, tautomers and N-oxides of those compounds. In this preferred group of compounds of formula I-2, Q is preferably C_3 - C_6 cycloalkyl, or is C_3 - C_6 cycloalkyl monosubstituted or disubstituted by substituents selected from the group consisting of cyano, C_1 - C_4 haloalkyl and halogen; in particular C_3 - C_6 cycloalkyl; R_2 is preferably C_1 - C_4 haloalkyl, X_{a1} is preferably SO_2 and R_{a1} is preferably ethyl.

15

[0018] A further preferred group of compounds of formula I is represented by the compounds of formula I-3

20



25

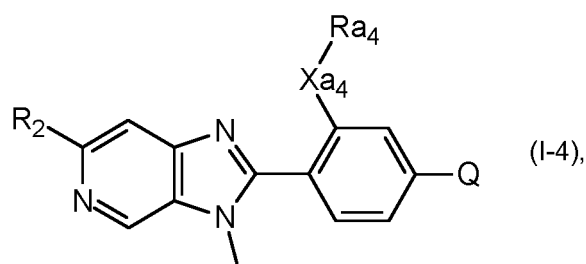
wherein R_2 and Q are as defined under formula I above; and wherein X_{a3} is S, SO or SO_2 ; R_{a3} is methyl, ethyl, n-propyl, i-propyl or cyclopropylmethyl; and agrochemically acceptable salts, stereoisomers, enantiomers, tautomers and N-oxides of those compounds. In this further preferred group of compounds of formula I-3, Q is preferably C_2 - C_6 alkenyl, or C_2 - C_6 alkenyl monosubstituted or disubstituted by substituents selected from the group consisting of C_1 - C_4 alkyl, C_3 - C_6 cycloalkyl, C_1 - C_4 haloalkyl, phenyl and phenyl monosubstituted by C_1 - C_4 haloalkyl; R_2 is preferably C_1 - C_4 haloalkyl, X_{a3} is preferably SO_2 and R_{a3} is preferably ethyl.

30

35

[0019] A further preferred group of compounds of formula I is represented by the compounds of formula I-4

40



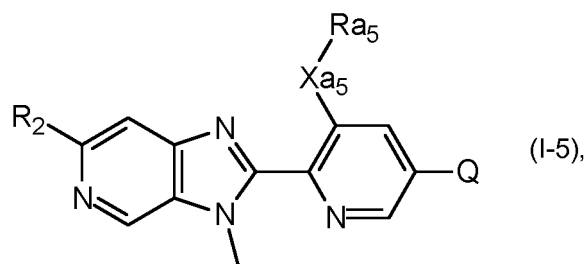
45

wherein R_2 and Q are as defined under formula I above; and wherein X_{a4} is S, SO or SO_2 ; R_{a4} is methyl, ethyl, n-propyl, i-propyl or cyclopropylmethyl; and agrochemically acceptable salts, stereoisomers, enantiomers, tautomers and N-oxides of those compounds. In this further preferred group of compounds of formula I-4, Q is preferably C_2 - C_6 alkenyl, or C_2 - C_6 alkenyl monosubstituted or disubstituted by substituents selected from the group consisting of C_1 - C_4 alkyl, C_3 - C_6 cycloalkyl, C_1 - C_4 haloalkyl, phenyl and phenyl monosubstituted by C_1 - C_4 haloalkyl; R_2 is preferably C_1 - C_4 haloalkyl, X_{a4} is preferably SO_2 and R_{a4} is preferably ethyl.

50

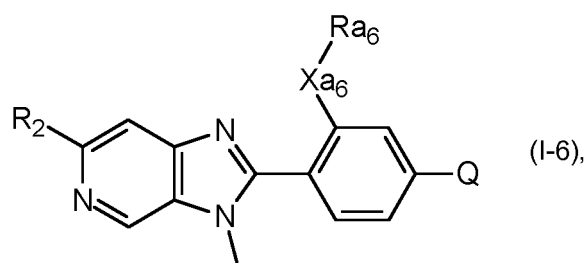
[0020] A further preferred group of compounds of formula I is represented by the compounds of formula I-5

55



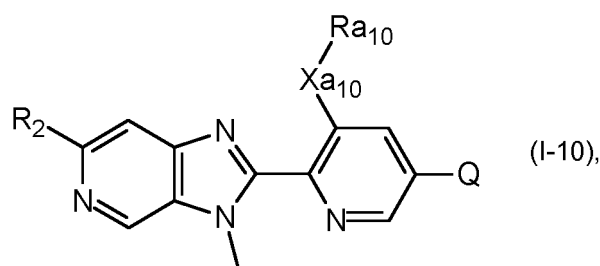
wherein R_2 and Q are as defined under formula I above; and wherein X_{a5} is S, SO or SO_2 ; R_{a5} is methyl, ethyl, n-propyl, i-propyl or cyclopropylmethyl; and agrochemically acceptable salts, stereoisomers, enantiomers, tautomers and N-oxides of those compounds. In this further preferred group of compounds of formula I-5, Q is preferably C_2 - C_6 alkynyl, or C_2 - C_6 alkynyl monosubstituted by substituents selected from the group consisting of tri(C_1 - C_4 alkyl)silyl, C_1 - C_4 haloalkyl and phenyl, or phenyl which can be monosubstituted by substituents selected from the group consisting of halogen, C_1 - C_4 alkyl and C_1 - C_4 haloalkyl; R_2 is preferably C_1 - C_4 haloalkyl, X_{a5} is preferably SO_2 and R_{a5} is preferably ethyl.

15 **[0021]** A further preferred group of compounds of formula I is represented by the compounds of formula I-6



wherein R_2 and Q are as defined under formula I above; and wherein X_{a6} is S, SO or SO_2 ; R_{a6} is methyl, ethyl, n-propyl, i-propyl or cyclopropylmethyl; and agrochemically acceptable salts, stereoisomers, enantiomers, tautomers and N-oxides of those compounds. In this further preferred group of compounds of formula I-6, Q is preferably C_2 - C_6 alkynyl, or C_2 - C_6 alkynyl monosubstituted by substituents selected from the group consisting of tri(C_1 - C_4 alkyl)silyl, C_1 - C_4 haloalkyl and phenyl, or phenyl which can be monosubstituted by substituents selected from the group consisting of halogen, C_1 - C_4 alkyl and C_1 - C_4 haloalkyl; R_2 is preferably C_1 - C_4 haloalkyl, X_{a6} is preferably SO_2 and R_{a6} is preferably ethyl.

30 **[0022]** A further preferred group of compounds of formula I is represented by the compounds of formula I-10



wherein

R_2 and Q are as defined under formula I in claim 1;

50 X_{a10} is S, SO or SO_2 ; and

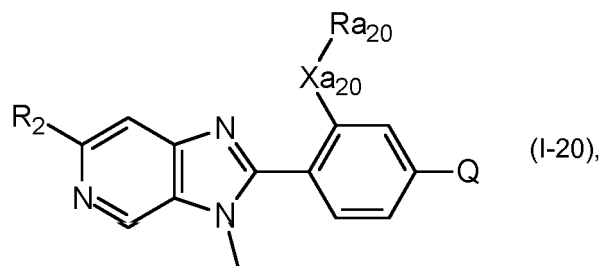
R_{a10} is methyl, ethyl, n-propyl, i-propyl or cyclopropylmethyl.

[0023] Preferred compounds of formula 1-10 are those, wherein

55 Q is C_3 - C_6 cycloalkyl, or C_3 - C_6 cycloalkyl mono- or disubstituted by substituents selected from the group consisting of cyano, C_1 - C_4 haloalkyl and halogen; or Q is C_2 - C_6 alkenyl, or C_2 - C_6 alkenyl mono- or disubstituted by substituents selected from the group consisting of C_1 - C_4 alkyl, C_3 - C_6 cycloalkyl, C_1 - C_4 haloalkyl, phenyl, or phenyl monosubstituted by C_1 - C_4 haloalkyl; or Q is C_2 - C_6 alkynyl, or C_2 - C_6 alkynyl monosubstituted by substituents selected from the group consisting of tri(C_1 - C_4 alkyl)silyl, C_1 - C_4 haloalkyl, phenyl, said phenyl can be monosubstituted by substituents selected from the

group consisting of halogen, C₁-C₄alkyl or C₁-C₄haloalkyl.

[0024] A further preferred group of compounds of formula I is represented by the compounds of formula I-20



wherein

15 R₂ and Q are as defined under formula I in claim 1;

X_{a20} is S, SO or SO₂; and

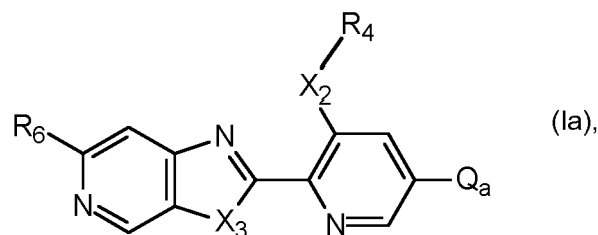
R_{a20} is methyl, ethyl, n-propyl, i-propyl or cyclopropylmethyl.

20 **[0025]** Preferred compounds of formula I-20 are those, wherein

Q is C₃-C₆cycloalkyl, or C₃-C₆cycloalkyl mono- or disubstituted by substituents selected from the group consisting of cyano, C₁-C₄haloalkyl and halogen; or Q is C₂-C₆alkenyl, or C₂-C₆alkenyl mono- or disubstituted by substituents selected from the group consisting of C₁-C₄alkyl or C₃-C₆cycloalkyl, C₁-C₄haloalkyl, phenyl, or phenyl monosubstituted by C₁-C₄haloalkyl; or Q is C₂-C₆alkynyl, or C₂-C₆alkynyl monosubstituted by substituents selected from the group consisting of

25 of tri(C₁-C₄alkyl)silyl, C₁-C₄haloalkyl, phenyl, said phenyl can be monosubstituted by substituents selected from the group consisting of halogen, C₁-C₄alkyl or C₁-C₄haloalkyl.

[0026] Especially preferred compounds are represented by the compounds of formula Ia



wherein

40 X₂ is SO₂;

X₃ is N-(C₁-C₄alkyl);

R₄ is C₁-C₄alkyl;

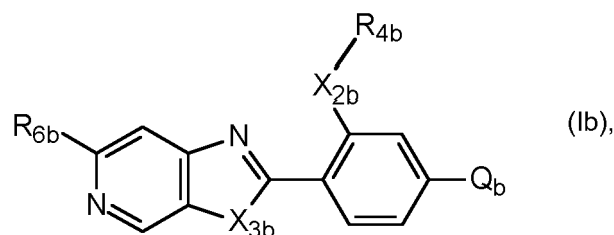
45 Q_a is C₃-C₆cycloalkyl, C₂-C₆alkenyl or C₂-C₆alkynyl, or is C₃-C₆cycloalkyl, C₂-C₆alkenyl or C₂-C₆alkynyl each mono- or disubstituted by substituents selected from the group consisting of halogen, C₁-C₄alkyl, C₁-C₄haloalkyl, cyano, C₃-C₆cycloalkyl, tri(C₁-C₄alkyl)silyl and phenyl, said phenyl can be monosubstituted by halogen or C₁-C₄haloalkyl;

or Q_a is C₃-C₆cycloalkenyl which itself can be mono- or di-substituted by C₁-C₄alkyl; and

R₆ is C₁-C₄haloalkyl.

50 **[0027]** In the compounds of formula Ia, Q_a is preferably C₃-C₆cycloalkyl which can be mono- or disubstituted by substituents selected from the group consisting of halogen, C₁-C₄haloalkyl and cyano; or Q_a is C₃-C₆cycloalkenyl which itself can be mono- or di-substituted by C₁-C₄alkyl.

[0028] Especially preferred compounds are represented by the compounds of formula Ib



10 wherein

X_{2b} is SO_2 ;

X_{3b} is N-(C_1 - C_4 alkyl);

R_{4b} is C_1 - C_4 alkyl;

15 Q_b is C_3 - C_6 cycloalkyl, C_2 - C_6 alkenyl or C_2 - C_6 alkynyl, or is C_3 - C_6 cycloalkyl, C_2 - C_6 alkenyl or C_2 - C_6 alkynyl each mono- or disubstituted by substituents selected from the group consisting of halogen, C_1 - C_4 alkyl, C_1 - C_4 haloalkyl, cyano, C_3 - C_6 cycloalkyl, tri(C_1 - C_4 alkyl)silyl and phenyl, said phenyl can be monosubstituted by halogen or C_1 - C_4 haloalkyl; and

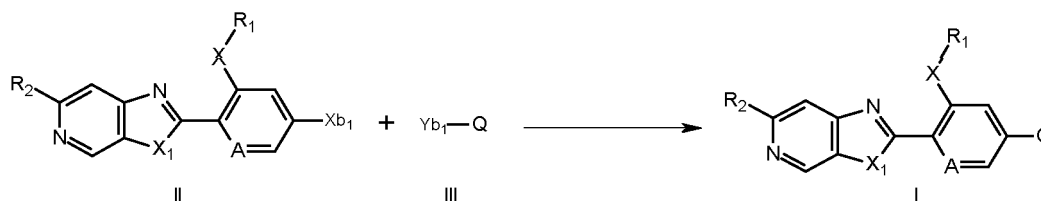
R_{6b} is C_1 - C_4 haloalkyl.

20 **[0029]** In the compounds of formula Ib, Q_b is preferably C_3 - C_6 cycloalkyl which can be mono- or disubstituted by substituents selected from the group consisting of halogen, C_1 - C_4 haloalkyl and cyano; or Q_b is C_3 - C_6 cycloalkenyl which itself can be mono- or di-substituted by C_1 - C_4 alkyl.

25 **[0030]** The process according to the invention for preparing compounds of formula I is carried out by methods known to those skilled in the art. More specifically, compounds of formula I can be prepared (as depicted in scheme 1) by reacting compounds of formula II with compounds of formula III, wherein X_{b1} can be a halogen, preferentially chlorine, bromine or iodine, or a sulfonate, like for example a trifluoromethanesulfonate and Y_{b1} can be a boron-derived functional group, as for example $B(OH)_2$ or $B(OR_{b1})_2$ wherein R_{b1} can be a C_1 - C_6 alkyl group or the two groups OR_{b1} can form together with the boron atom a five- or six-membered ring, as for example a pinacol boronic ester (such five- or six-membered boronic ester reagents of formula III are, for example, 4,4,5,5-tetramethyl-2-vinyl-1,3,2-dioxaborolane or 4,4,6-trimethyl-2-[1-(trifluoromethyl)vinyl]-1,3,2-dioxaborinane). In formula II and III, A, X_1 , R_1 , R_2 , X and Q are as described in formula I. The reaction can be catalyzed by a palladium based catalyst, for example tetrakis(triphenylphosphine)palladium(0), bis(triphenylphosphine) palladium(II) dichloride, chloro(2-dicyclohexylphosphino-2',4',6'-triisopropyl-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II) (XPhos palladacycle), or (1,1'-bis(diphenylphosphino)-ferrocene) dichloropalladium-dichloromethane (1:1 complex), in presence of a base, like sodium carbonate, tripotassium phosphate or cesium fluoride, in a solvent (such as toluene, 1,2-dimethoxy-ethane DME, tetrahydrofuran or dioxane) or a solvent mixture, like, for example a mixture of 1,2-dimethoxy-ethane and water, or of dioxane and water, preferably under inert atmosphere. The reaction temperature can preferentially range from room temperature to the boiling point of the reaction mixture, or alternatively heating may be performed under microwave irradiation.

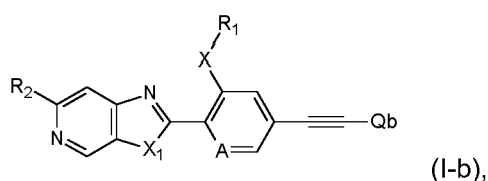
40

Scheme 1:



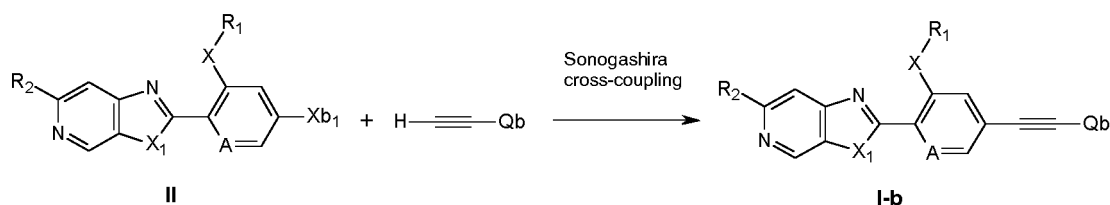
50 **[0031]** A particular case of compounds is represented by compounds of formula I-b, wherein A, R_1 , R_2 , X and X_1 are as described in formula I and Q is a 1-alkynyl group of the structure $C \equiv C-Q_b$:

55



wherein Qb is hydrogen, halogen, cyano, C₁-C₄alkyl, C₁-C₄haloalkyl, C₃-C₆cycloalkyl, tri(C₁-C₄alkyl)silyl or phenyl, or is phenyl which can be mono- or polysubstituted by substituents selected from the group consisting of halogen, cyano, C₁-C₄alkyl, C₁-C₄haloalkyl, C₁-C₄haloalkoxy, C₁-C₄alkoxy, C₁-C₄halo-alkylsulfanyl, C₁-C₄haloalkylsulfinyl, C₁-C₄haloalkylsulfonyl and -C(O)C₁-C₄haloalkyl. Compounds of the formula I-b can be prepared, for example, by reacting compounds of formula II with terminal alkynes of formula H-C≡C-Qb (scheme 1a), wherein X_{b1} can be a halogen, preferentially chlorine, bromine or iodine, or a sulfonate, like for example a trifluoromethanesulfonate. In formula II and H-C≡C-Qb, A, X, X₁, R₁, R₂ and Qb are as described above in formula I-b. This type of reaction is well known to a person skilled in the art and commonly described as the Sonogashira cross-coupling reaction. In this reaction, the substituted aromatic component of formula II is reacted with the terminal alkyne of formula H-C≡C-Qb in the presence of a copper(I) salt, like for example CuI, preferably in catalytic amount, and in the presence of a palladium based catalyst, for example bis(triphenylphosphine)-palladium dichloride or (1,1'-bis(diphenylphosphino)-ferrocene)dichloropalladium-dichloromethane (1:1 complex), preferably in catalytic amount, and in the presence of a base, such as a tertiary amine, for example triethylamine or Hünig's base (N,N-diisopropylethylamine), preferably in equivalent amount or in excess. The reaction can be performed in the amine as solvent or another compatible solvent can be used as dilutant, as for example an ether, like tetrahydrofuran. The reaction is best performed under inert atmosphere and can take place at temperatures in the range from below 0°C to the boiling point of the reaction mixture.

Scheme 1a:

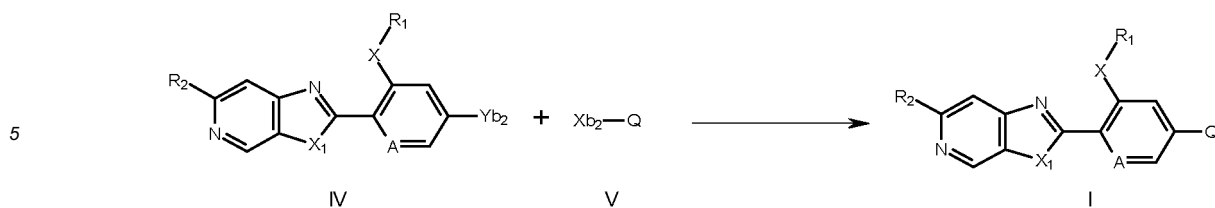


[0032] Compounds of formula I-b, wherein A, R₁, R₂, X and X₁ are as described in formula I, and in which Qb is tri(C₁-C₄alkyl)silyl may be transformed into compounds of formula I-b, wherein A, R₁, R₂, X and X₁ are as described in formula I, and in which Qb is hydrogen, by means of a deprotection step (e.g. trimethylsilyl cleavage, when C₁-C₄alkyl is methyl). Typically, the compound of formula I-b, wherein Qb is tri(C₁-C₄alkyl)silyl, is treated with a base, such as potassium carbonate, or sodium- or potassium hydroxide, in a protic solvent, such as an alcohol, preferably methanol or ethanol, at temperatures between 0°C and 50°C. Alternatively, compound of formula I-b, wherein Qb is tri(C₁-C₄alkyl)silyl, may also be treated with a fluoride source, such as for example, tetrabutyl ammonium fluoride or potassium fluoride, in solvents such as tetrahydrofuran or dioxane, at temperatures between 0°C and 50°C.

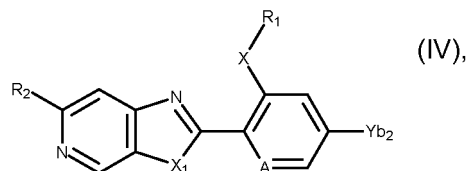
[0033] Compounds of formula II, wherein A, X₁, R₁, R₂ and X are as described in formula I, and wherein X_{b1} is a halogen, preferably chlorine, bromine or iodine, may be prepared in analogy to descriptions found in WO15/000715.

[0034] Compounds of formula I can also be made (as depicted in scheme 2) by reacting compounds of formula IV with compounds of formula V, wherein X_{b2} can be a halogen, preferentially chlorine, bromine or iodine, or a sulfonate, like for example a trifluoromethanesulfonate and Y_{b2} can be a boron-derived functional group, as for example B(OH)₂ or B(OR_{b2})₂ wherein R_{b2} can be a C₁-C₆alkyl group or the two groups OR_{b2} can form together with the boron atom a five- or six-membered ring, as for example a pinacol boronic ester. In formula IV and V, A, X₁, R₁, R₂, X and Q are as described in formula I. The reaction can be catalyzed by a palladium based catalyst, for example tetrakis(triphenylphosphine)-palladium, bis(triphenylphosphine) palladium(II) dichloride or (1,1'-bis(diphenylphosphino)-ferrocene)dichloropalladium-dichloromethane (1:1 complex), in presence of a base, like sodium carbonate, tripotassium phosphate or cesium fluoride, in a solvent (such as toluene, 1,2-dimethoxy-ethane DME, tetrahydrofuran or dioxane) or a solvent mixture, like, for example a mixture of 1,2-dimethoxyethane and water, or of dioxane and water, preferably under inert atmosphere. The reaction temperature can preferentially range from room temperature to the boiling point of the reaction mixture, or alternatively heating may be performed under microwave irradiation.

Scheme 2



10 **[0035]** The compounds of formula IV



20 wherein

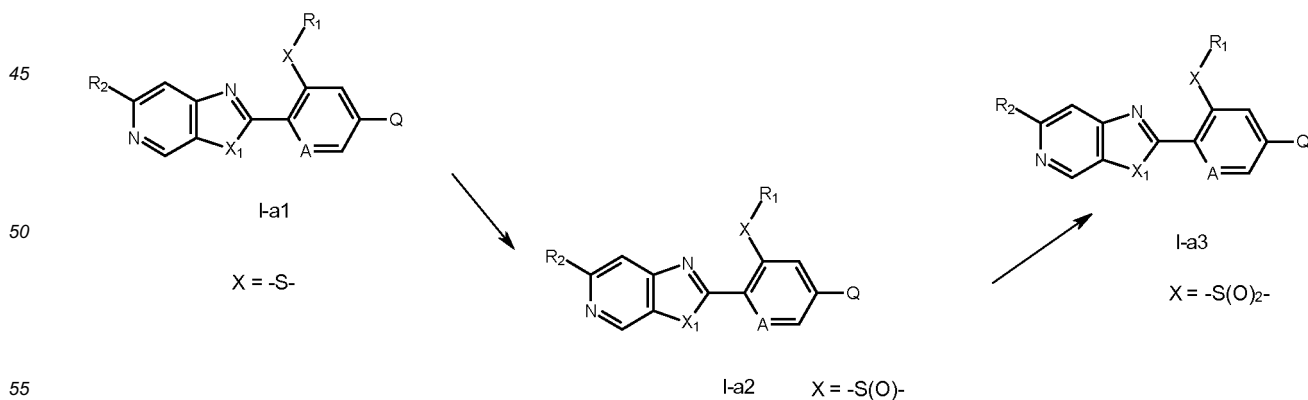
R₁, R₂, X, X₁ and A are as defined under formula I above, and Yb₂ is -B(OH)₂ or Yb₂ is



25 (a 4,4,4,5-tetramethyl-1,3,2-dioxaborolane group), are novel, especially developed for the preparation of the compounds of formula I according to the invention and therefore represent a further object of the invention. Preferred substituent meanings for the substituents R₁, R₂, X, X₁ and A mentioned under formula I, I-1, I-2, I-3, I-4, I-5, I-6, I-10, I-20 and Ia above are also valid for the compound of formula IV.

30 **[0036]** Compounds of formula I-a3, wherein A, R₁, R₂, X₁ and Q have the values defined in formula I, and X is -SO₂⁻, can be prepared by oxidation of compounds of formula I-a2, wherein A, R₁, R₂, X₁ and Q have the values defined in formula I, and X is -SO-. The reaction can be performed with reagents like, for example, a peracid as peracetic acid or m-chloroperbenzoic acid, or a hydroperoxide, as for example, hydrogen peroxide or tert-butylhydroperoxide, or an inorganic oxidant, like a monoperoxo-disulfate salt or potassium permanganate. In a similar way, compounds of formula I-a2, wherein A, R₁, R₂, X₁ and Q have the values defined in formula I, and X is -SO-, can be prepared by oxidation of compounds of formula I-a1, wherein A, R₁, R₂, X₁ and Q have the values defined in formula I, and X is -S-, under analogous conditions described above. These reactions can be performed in various organic or aqueous solvents compatible to these conditions, by temperatures from below 0°C up to the boiling point of the solvent system. The transformation of compounds of the formula I-a1 into compounds of the formula I-a2 and I-a3 is represented in scheme 3.

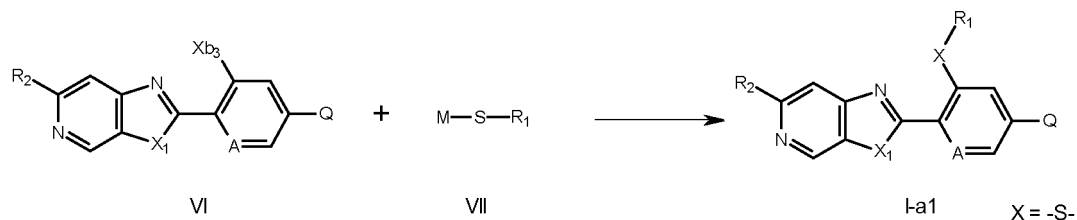
Scheme 3



[0037] Compounds of formula I-a1 may also be prepared (scheme 4) by reacting a compound of the formula VI with a compound of the formula VII, wherein A, R₁, R₂, X₁ and Q have the values defined in formula I and X is sulphur and

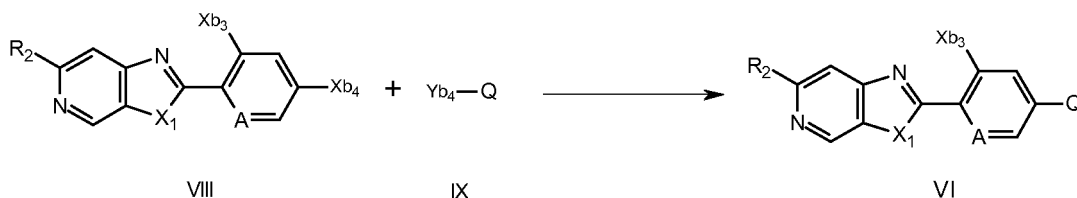
M is a metal or non-metal cation. In the scheme 4, the cation M is assumed to be monovalent, but polyvalent cations associated with more than one S-R₁ group can also be considered. Preferred cations are, for example lithium, sodium, potassium or cesium. For this transformation to work, Xb₃ is a leaving group like, for example, fluorine, chlorine, bromine or iodine, or an aryl- or alkylsulfonate, but many other leaving groups could be considered. The reaction can be performed

Scheme 4



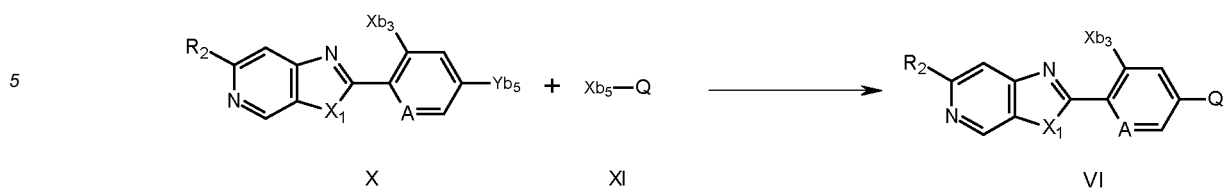
[0038] Compounds of formula VI, wherein Xb₃ is a leaving group like, for example, fluorine, chlorine, bromine or iodine, or an aryl- or alkylsulfonate such as trifluoromethanesulfonate, or any other similar leaving group, can be prepared (scheme 5) by reacting compounds of formula VIII with compounds of formula IX, wherein Xb₄ can be a halogen, preferentially chlorine, bromine or iodine, or a sulfonate, like for example a trifluoromethanesulfonate, most preferably bromine or iodine and Y_{b4} can be a boron-derived functional group, as for example B(OH)₂ or B(OR_{b4})₂ wherein R_{b4} can be a C₁-C₆alkyl group or the two groups OR_{b4} can form together with the boron atom a five- or six-membered ring, as for example a pinacol boronic ester. In formula VI, VIII and IX, A, X₁, R₂ and Q are as described in formula I. The reaction can be catalyzed by a palladium based catalyst, for example tetrakis(triphenylphosphine)palladium(0), bis(triphenylphosphine) palladium(II) dichloride or (1,1'-bis(diphenyl-phosphino)-ferrocene)dichloropalladium-dichloromethane (1:1 complex), in presence of a base, like sodium carbonate, tripotassium phosphate or cesium fluoride, in a solvent (such as toluene, 1,2-dimethoxy-ethane DME, tetrahydrofuran or dioxane) or a solvent mixture, like, for example a mixture of 1,2-dimethoxyethane and water, or of dioxane and water, preferably under inert atmosphere. The reaction temperature can preferentially range from ambient temperature to the boiling point of the reaction mixture, or alternatively heating may be performed under microwave irradiation.

Scheme 5



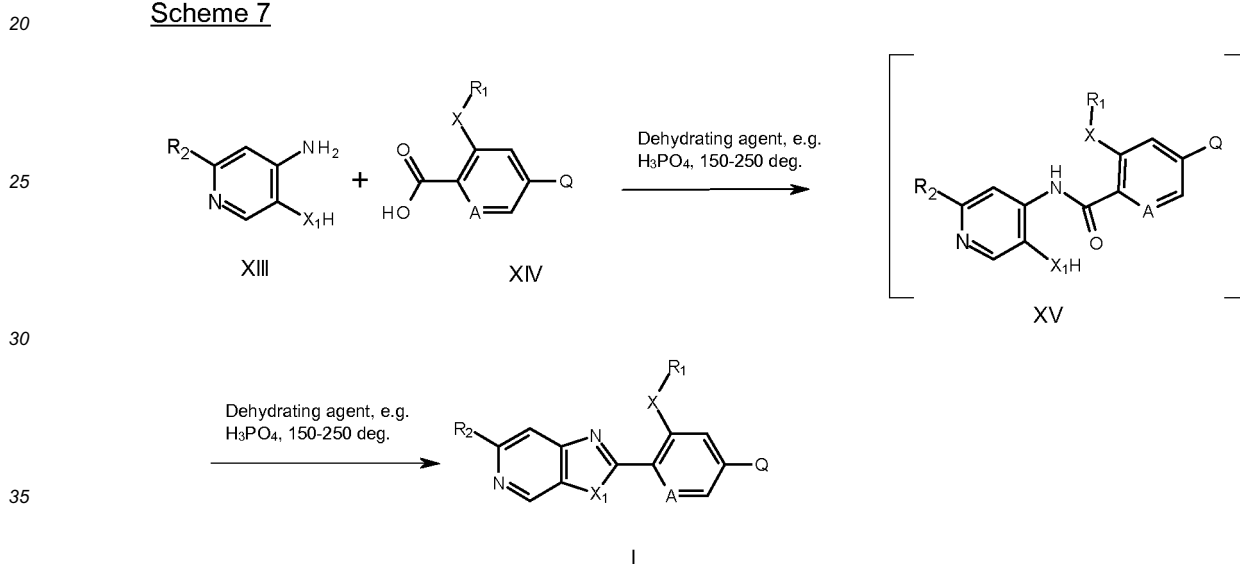
[0039] In an alternative way depicted in scheme 6, compounds of formula VI can also be prepared by reacting compounds of formula X, wherein Xb₃ is a leaving group like, for example, fluorine, chlorine, bromine or iodine, or an aryl- or alkylsulfonate such as trifluoromethanesulfonate, or any other similar leaving group, with compounds of formula XI, wherein Xb₅ can be a halogen, preferentially chlorine, bromine or iodine, or a sulfonate, like for example a trifluoromethanesulfonate, most preferably bromine or iodine, and Y_{b5} can be a boron-derived functional group, as for example B(OH)₂ or B(OR_{b5})₂ wherein R_{b5} can be a C₁-C₆alkyl group or the two groups OR_{b5} can form together with the boron atom a five- or six-membered ring, as for example a pinacol boronic ester. In formula VI, X and XI, A, X₁, R₂ and Q are as described in formula I. The reaction can be catalyzed by a palladium based catalyst, for example tetrakis(triphenylphosphine)palladium(0), bis(triphenylphosphine) palladium(II) dichloride or (1,1'-bis(diphenylphosphino)-ferrocene)dichloropalladium-dichloromethane (1:1 complex), in presence of a base, like sodium carbonate, tripotassium phosphate or cesium fluoride, in a solvent (such as toluene, 1,2-dimethoxy-ethane DME, tetrahydrofuran or dioxane) or a solvent mixture, like, for example a mixture of 1,2-dimethoxyethane and water, or of dioxane and water, preferably under inert atmosphere. The reaction temperature can preferentially range from ambient temperature to the boiling point of the reaction mixture, or alternatively heating may be performed under microwave irradiation.

Scheme 6



10 **[0040]** Compounds of formula I can also be prepared (scheme 7) by reacting compounds of formula XIII and compounds of formula XIV under various formal dehydration conditions, wherein A, R₁, R₂, X, X₁ and Q have the values defined in formula I. These methods are known to those skilled in the art or described for example in WO 2009/131237, WO 2011/043404, WO 2011/040629, WO 2010/125985, WO 2012/086848, WO 2013/018928, WO 2013/191113, WO 2013/180193 and WO 2013/180194. Such processes are well known and have been described for example in WO 15
 15 2011/040629 or WO 2009131237 (X₁ is oxygen), WO 2011088990 or Inorg. Chimica Acta, 358(9), 2701-2710; 2005 (X₁ is sulfur) and J. Am. Chem. Soc., 132(5), 1545-1557, 2010 or WO 2008128968 (X₁ is NR₃). The preparation of compounds of formula XIII, wherein X₁ and R₂ are as defined above, is detailed, for example, in WO15/000715.

Scheme 7



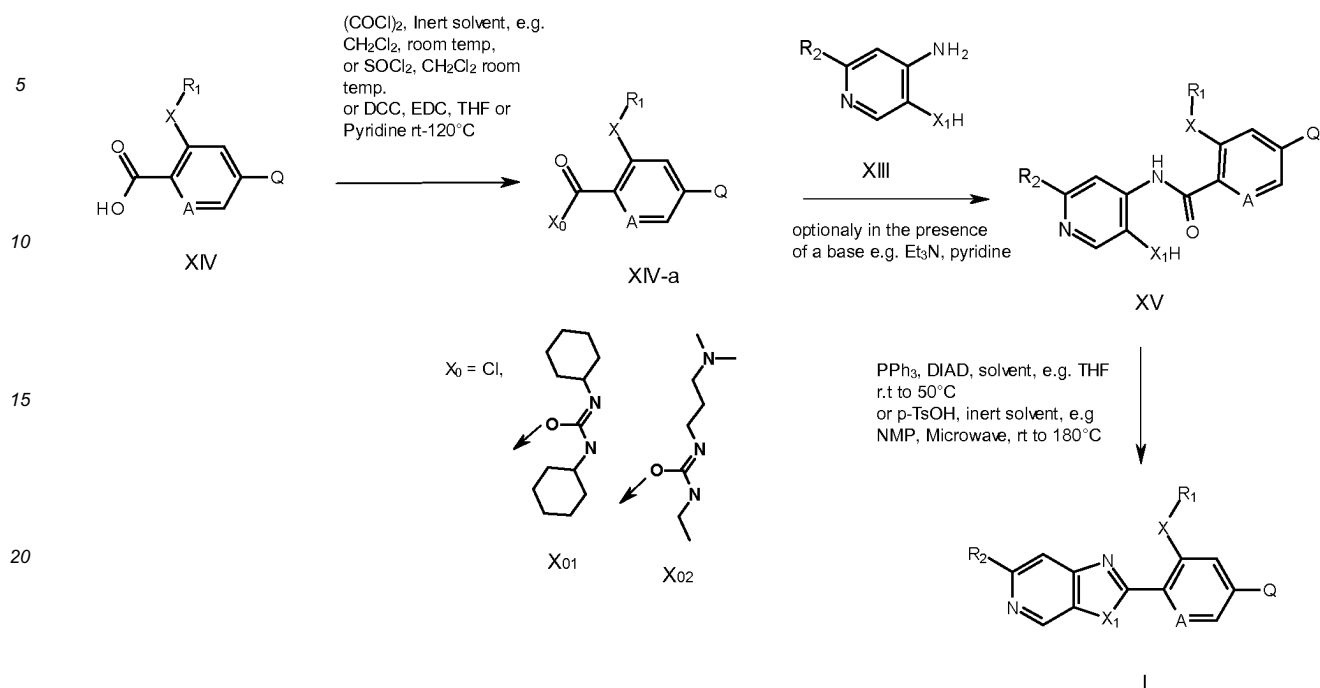
30
 35
 40 **[0041]** The process describing the reaction between compounds of formula XIII and compounds of formula XIV towards compounds of formula I is summarized in more details in scheme 8:

45

50

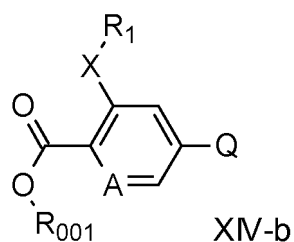
55

Scheme 8



[0042] Compounds of formula XIV, wherein A, R₁, X and Q are as previously described, are activated (scheme 8) to compounds of formula XIV-a by methods known to those skilled in the art and described in for example Tetrahedron, 61 (46), 10827-10852, 2005. For example compounds where X₀ is chlorine are formed by treatment with for example, oxalyl chloride or thionyl chloride in the presence of catalytic quantities of DMF in inert solvents such as methylene chloride or THF at temperatures between 20 °C to 100 °C, preferably 25 °C. Treatment of XIV-a with compounds of formula XIII, wherein R₂ and X₁ are as described in formula I, optionally in the presence of a base, e.g. triethylamine or pyridine, leads to compounds of formula XV. Alternatively, compounds of formula I can be prepared by treatment of compounds of formula XIV with dicyclohexyl carbodiimide (DCC) or 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide (EDC) to give the activated species XIV-a, wherein X₀ is X₀₁ and X₀₂ respectively, in an inert solvent, e.g. pyridine, or tetrahydrofuran (THF) optionally in the presence of a base, e.g. triethylamine, at temperatures between 50-180 °C.

[0043] Compounds of formula XIV-b



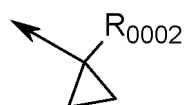
wherein X is SO₂;

R₁ is ethyl or methylene-cyclopropyl;

A is nitrogen or methine;

R₀₀₁ is hydrogen or C₁-C₄alkyl;

Q is a group:

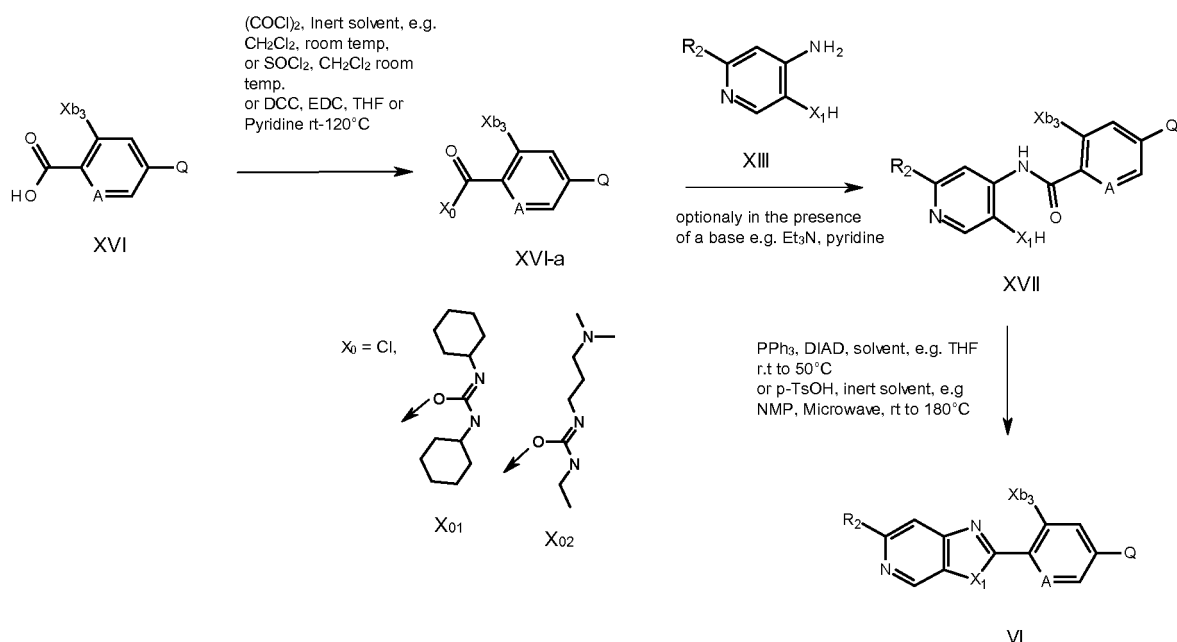


wherein R_{0002} is cyano; are novel and especially developed for the preparation of the compounds according to the present invention. The compounds of formula XVI-b therefore constitute a further object of the invention.

[0044] Compounds of formula XV so obtained can then be converted to compounds of formula I by dehydration, eg. by heating the compounds under microwave irradiation, in the presence of an acid catalyst, for example methanesulfonic acid, or *para*-toluenesulfonic acid, in an inert solvent such as N-methyl pyrrolidone at temperatures between 25-180 °C, preferably 130-170 °C. Such processes have been described previously in WO 2010/125985. Alternatively, compounds of formula XV can be converted to compounds of formula I (wherein X_1 is O) using triphenylphosphine, di-isopropyl azodicarboxylate in an inert solvent such as THF at temperatures between 25-50°C. Such Mitsunobu conditions have been previously described for such transformations (see WO 2009/131237).

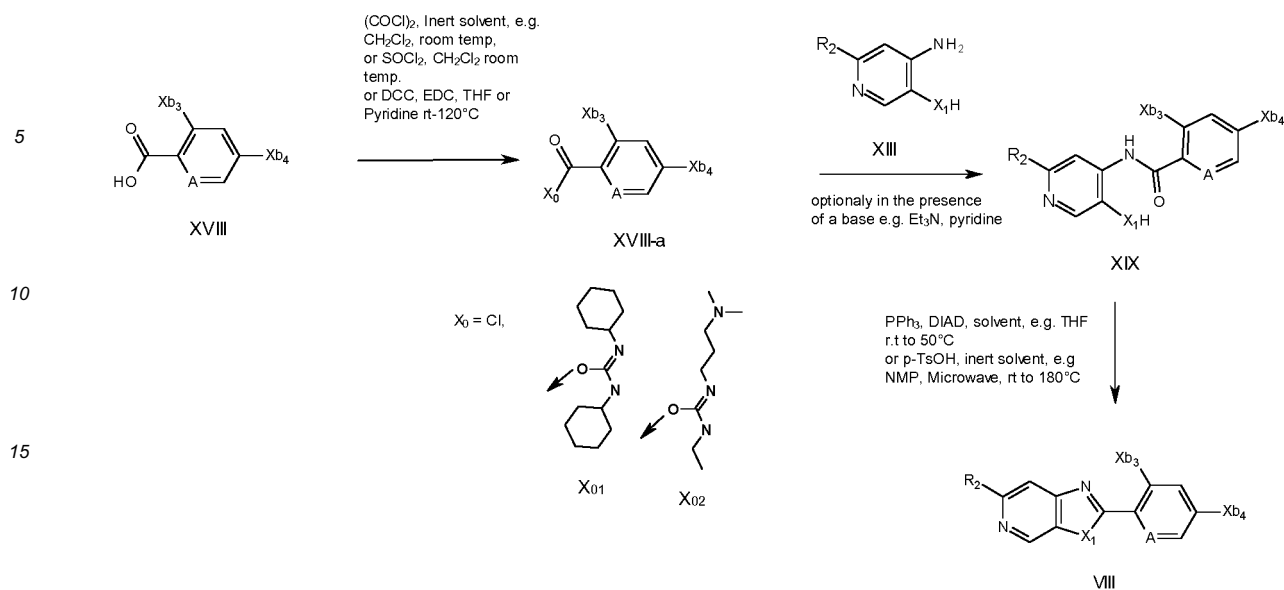
[0045] In an analogous way (scheme 9), compounds of formula VI, wherein X_{b3} is a leaving group like, for example, fluorine, chlorine, bromine or iodine, or an aryl- or alkylsulfonate such as trifluoromethanesulfonate, or any other similar leaving group, can be prepared by reacting compounds of formula XVI, wherein A and Q have the values defined for formula I, with an activating agent, like, for example oxalyl chloride or thionyl chloride or a carbodiimid reagent to generate the activated species XVI-a, followed by reaction with compounds of formula XIII, wherein R_2 and X_1 are as described in formula I. The intermediate compounds of formula XVII may be isolated, but are preferentially converted into the compounds of formula VI in a similar way as described above for the transformation of compounds XV into compounds of formula I.

Scheme 9



[0046] In a similar way as described above, compounds of formula VIII can be prepared as described in scheme 10, by reacting compounds of formula XVIII, respectively an activated form XVIII-a of compounds of formula XVIII, wherein A is carbon or nitrogen, and X_{b3} is a leaving group like, for example fluorine, chlorine, bromine or iodine, or an aryl- or alkylsulfonate such as trifluoromethanesulfonate, and X_{b4} can be a halogen, preferentially chlorine, bromine or iodine, or a sulfonate, like for example a trifluoromethanesulfonate, most preferably bromine or iodine, with compounds of the formula XIII, wherein X_1 and R_2 are as defined in formula I. The intermediate compounds of formula XIX may be isolated, but are preferentially converted into the compounds of formula VIII in a similar way as described above (transformation of compounds XV into compounds of formula I).

Scheme 10



25

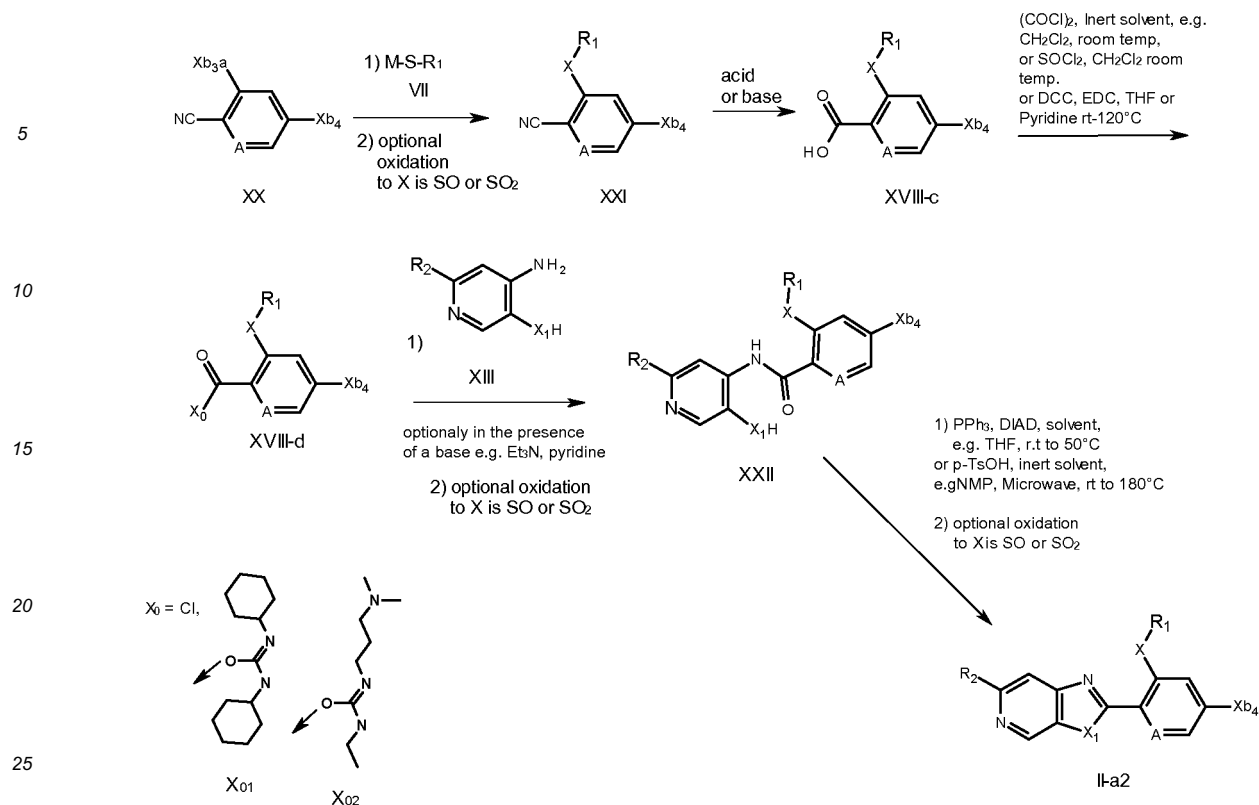
30

35

40

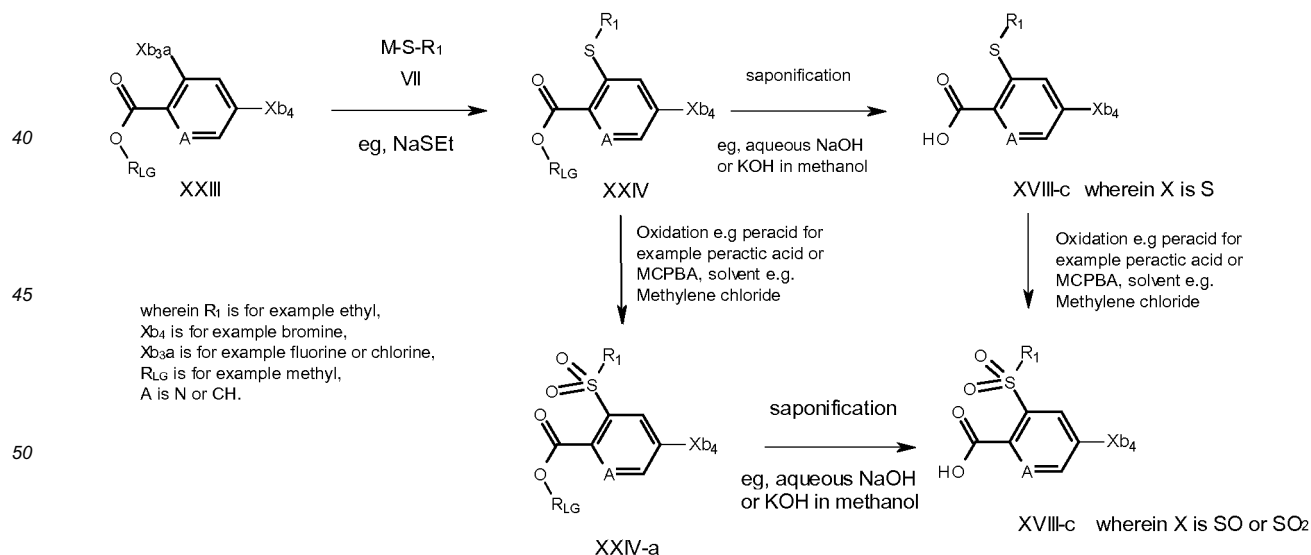
[0047] Compounds of formula XXI can be prepared as described in scheme 10a, by reacting compounds of formula XX, wherein A is CH or nitrogen, and X_{b3a} is a leaving group like, for example nitro, fluorine, chlorine, bromine or iodine, or an aryl- or alkylsulfonate such as trifluoromethanesulfonate, and X_{b4} can be a halogen, preferentially chlorine, bromine or iodine, or a sulfonate, like for example a trifluoromethanesulfonate, most preferably bromine or iodine, with a compound of formula VII, wherein R₁ is as defined in formula I, and M is a metal or non-metal cation. In scheme 10a, the cation M is assumed to be monovalent, but polyvalent cations associated with more than one S-R₁ group can also be considered. Preferred cations are, for example lithium, sodium, potassium or cesium. The reaction can be performed in a solvent, preferably polar aprotic, such as THF, N,N-dimethylformamide or MeCN, at temperatures between -78°C and the boiling temperature of the reaction mixture. Compounds of formula XVIII-c can be prepared by hydrolysis of compounds of formula XXI under acidic (e.g. HCl or H₂SO₄) or basic conditions (e.g. NaOH or KOH) as described in scheme 10a, under conditions known to a person skilled in the art. Compounds of formula II-a2 can be prepared, as described in scheme 10a, by reacting compounds of formula XVIII-c respectively an activated form XVIII-d of compounds of formula XVIII-c with compounds of formula XIII, wherein X₁ and R₂ are as defined in formula I. The intermediate compounds of formula XXII may be isolated, but are preferentially converted into the compounds of formula II-a2 in a similar way as described above (transformation of compounds XV into compounds of formula I). In compounds of formula XXI, XVIII-c, XVIII-d, XXII and II-a2, X can be S, SO or SO₂. The appropriate oxidation forms of the sulfur atom in compounds of formula XXI, XVIII-c, XVIII-d, XXII and II-a2 wherein X is SO or SO₂, can be prepared by oxidation of compounds of formula XXI, XVIII-c, XVIII-d, XXII and II-a2 wherein X is S. The reaction can be performed with reagents like, for example a peracid as peracetic acid or m-chloroperbenzoic acid, or a hydroperoxide as for example hydrogen peroxide or tert-butylhydroperoxide, or an inorganic oxidant, like a mono-peroxodisulfate salt or potassium permanganate, preferentially meta-chloroperbenzoic acid.

Scheme 10a



[0048] Compounds of formula XVIII-c, wherein X is S, SO or SO₂, can alternatively be prepared by analogous methods to those described in the literature (scheme 10b). For example, a compound of formula XVIII-c, wherein X is S, may be prepared by saponification of a compound of formula XXIV, wherein R_{LG} is C₁-C₄alkyl, under conditions known to a person skilled in the art (R₁ is as defined in formula I, A is N or CH, and X_{b4} can be a halogen, preferentially chlorine, bromine or iodine, or a sulfonate, like for example a trifluoromethanesulfonate, most preferably bromine or iodine).

Scheme 10b

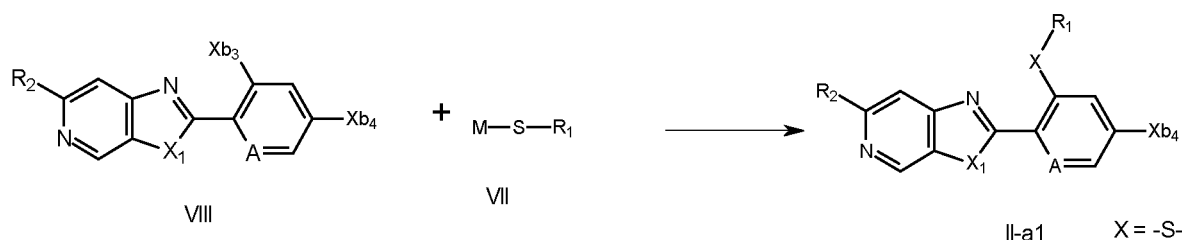


[0049] Compounds of formula XXIV, wherein R_{LG} is C₁-C₄alkyl, may be prepared by treatment of compounds of formula XXIII, wherein X_{b3a} is a leaving group like, for example nitro, fluorine, chlorine, bromine or iodine, or an aryl- or alkylsulfonate such as trifluoromethanesulfonate, and wherein R_{LG} is C₁-C₄alkyl, with a reagent M-S-R₁, wherein R₁ is as defined in formula I and M is a metal or non-metal cation, under conditions described above. Such processes involving

for example sodium methane- or ethanethiolate as reagents M-S-R₁ are well known and have been described previously in, for example, WO2014/152738. Compounds of formula XXIV can be oxidised to compounds of formula XXIV-a using methods known to those skilled in the art and described for example in Scheme 12, and then saponified to compounds of formula XVIII-c, wherein X is SO or SO₂. Alternatively compounds of formula XXIV can be first saponified to compounds of formula XVIII-c, wherein X is S, and then oxidised to compounds of formula XVIII-c, wherein X is SO or SO₂. Compounds of formula XXIII are either commercial or have been described in WO 2012/086848.

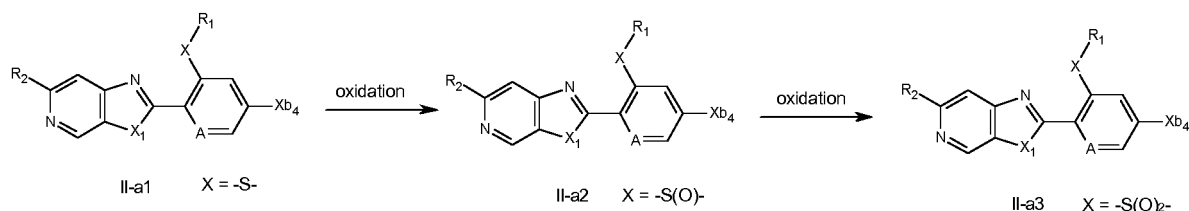
[0050] Compounds of formula II-a1, wherein X is sulfur, can be prepared (scheme 11) by reacting a compound of the formula VIII, wherein A, R₂ and X₁ are as defined in formula I, and wherein X_{b3} is a leaving group like, for example, fluorine, chlorine, bromine or iodine, or an aryl- or alkylsulfonate such as trifluoromethanesulfonate, preferentially fluorine or chlorine, and wherein X_{b4} is a halogen, preferentially chlorine, bromine or iodine, or a sulfonate, like for example a trifluoromethanesulfonate, most preferably bromine or iodine, with a compound of the formula VII, wherein R₁ is as defined in formula I, and M is a metal or non-metal cation. In scheme 11, the cation M is assumed to be monovalent, but polyvalent cations associated with more than one S-R₁ group can also be considered. Preferred cations are, for example lithium, sodium, potassium or cesium. The reaction can be performed in a solvent, preferably polar aprotic, at temperatures below 0°C or up to boiling temperature of the reaction mixture.

Scheme 11



[0051] Compounds of formula II-a3, wherein A, R₁, R₂ and X₁ have the values defined in formula I, and X is -SO₂⁻, and wherein X_{b4} is a halogen, preferentially chlorine, bromine or iodine, or a sulfonate, like for example a trifluoromethanesulfonate, can be prepared (scheme 12) by oxidation of compounds of formula II-a2, wherein A, R₁, R₂ and X₁ have the values defined in formula I, and X is -SO-, and wherein X_{b4} is a halogen, preferentially chlorine, bromine or iodine, or a sulfonate, like for example a trifluoromethanesulfonate. The reaction can be performed with reagents like, for example a peracid as peracetic acid or m-chloroperbenzoic acid, or a hydroperoxide as for example hydrogen peroxide or tert-butylhydroperoxide, or an inorganic oxidant, like a mono-peroxodisulfate salt or potassium permanganate, preferentially meta-chloroperbenzoic acid. In a similar way, compounds of formula II-a2, wherein A, R₁, R₂ and X₁ have the values defined in formula I, and X is -SO-, and wherein X_{b4} is a halogen, preferentially chlorine, bromine or iodine, or a sulfonate like for example a trifluoromethanesulfonate, can be prepared by oxidation of compounds of formula II-a1, wherein A, R₁, R₂ and X₁ have the values defined in formula I, and X is -S-, and wherein X_{b4} is a halogen, preferentially chlorine, bromine or iodine, or a sulfonate, like for example a trifluoromethanesulfonate. These reactions can be performed in various organic or aqueous solvents compatible to these conditions, by temperatures from below 0°C up to the boiling point of the solvent system.

Scheme 12



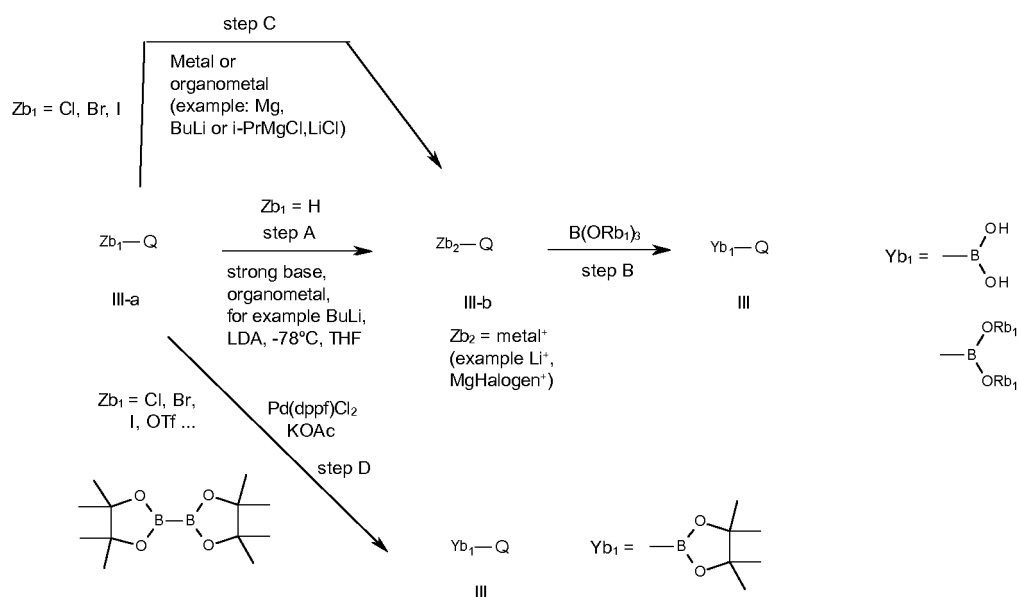
[0052] Many compounds of the formula V and XI, wherein Q has the values defined in formula I, and wherein X_{b2} and X_{b5} are as defined above, are commercially available or can be accessible to the person skilled in the art, by analogy to procedures described in the literature.

A large number of compounds of the formula III are commercially available or can be prepared by those skilled in the art. Many chemical transformations, well known by those skilled in the art, can be used to access boronic acid derivatives of formula III, starting from various and easily available starting materials, as for example, to cite only a few (scheme

13), hydrogen abstraction on a compound of the formula III-a wherein Zb_1 is hydrogen, with a strong base (step A), like butyllithium or lithium diisopropylamide or (i-PrMgCl, LiCl), followed by reaction of the metallated intermediate of the formula III-b, wherein Zb_2 is a metal such as Li^+ or $MgCl^+$ for example, with, for example, a trialkylborate (step B). Another way to access an organometal intermediate of the formula III-b is from a compound of the formula III-a wherein Zb_1 is chlorine, bromine or iodine, via metal-halogen exchange with an organometallic species (step C), like butyllithium or an organomagnesium compound, or direct metallation with a metal, like magnesium.

Introduction of a pinacolborate functional group via a palladium catalyzed reaction with bispinacol diborane on a compound of the formula III-a, wherein Zb_1 is chlorine, bromine, iodine or triflate, is another common strategy (scheme 13, step D). In the compounds of formula III-a, III-b and III within scheme 13, Q has the values defined for the formula I. A person skilled in the art will be able to select an adequate preparation method to access compounds of formula III from III-a depending on the values of Q.

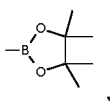
Scheme 13



[0053] The very same preparation methods described in scheme 13 may be applied for the synthesis of intermediates of the formula IX.

Compounds of formula IV, wherein A, X, X_1 , R_1 and R_2 are as described in formula I, can be prepared from compounds of formula II (scheme 14), wherein A, X, X_1 , R_1 and R_2 are as described in formula I. Indeed, compounds of formula II, wherein Xb_1 is chlorine, bromine or iodine, can be treated with an organometallic species like, for example, butyllithium or an organomagnesium compound, to generate an intermediate compound of the formula II-a, wherein Zb_3 is as defined in the scheme, via metal-halogen exchange. This reaction is preferentially performed in an anhydrous aprotic solvent, such as THF, at low temperature (between $-120^\circ C$ and $0^\circ C$), preferentially between $-110^\circ C$ and $-60^\circ C$). The intermediate organometal compound of formula II-a is preferably directly converted into compound of formula IV by reaction with a boronate compound $B(OR_{b2})_3$, wherein R_{b2} is a C_1 - C_6 alkyl group. Depending on the nature of the boronate, the reaction treatment conditions and the workup conditions, the boronic acid IV, wherein Yb_2 is $-B(OH)_2$, or a dialkylboronate IV, wherein Yb_2 is $-B(OR_{b2})_2$, can be formed.

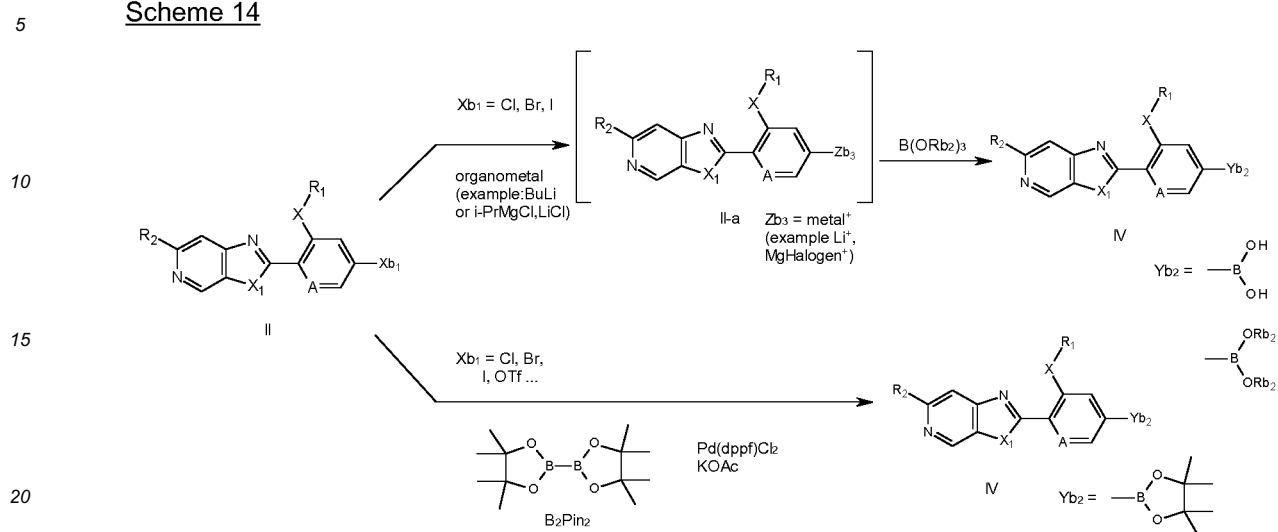
Introduction of a pinacolborate functional group via a palladium catalyzed reaction with bispinacol diborane B_2Pin_2 on a compound of the formula II, wherein A, X, X_1 , R_1 and R_2 are as described in formula I, and wherein Xb_1 is chlorine, bromine, iodine or triflate, is another common strategy. This reaction, generating a cyclic boronate IV, wherein Yb_2 is



can be performed in an aprotic solvent, in presence of a base, preferentially a weak base, such as potassium acetate KOAc. [1,1'-Bis(diphenylphosphino)ferrocene]dichloropalladium(II), also known as palladium dppf dichloride or

Pd(dppf)Cl₂ is a common catalyst for this type of reaction. The temperature of the reaction is preferably comprised between 0°C and the boiling point of the reaction mixture.

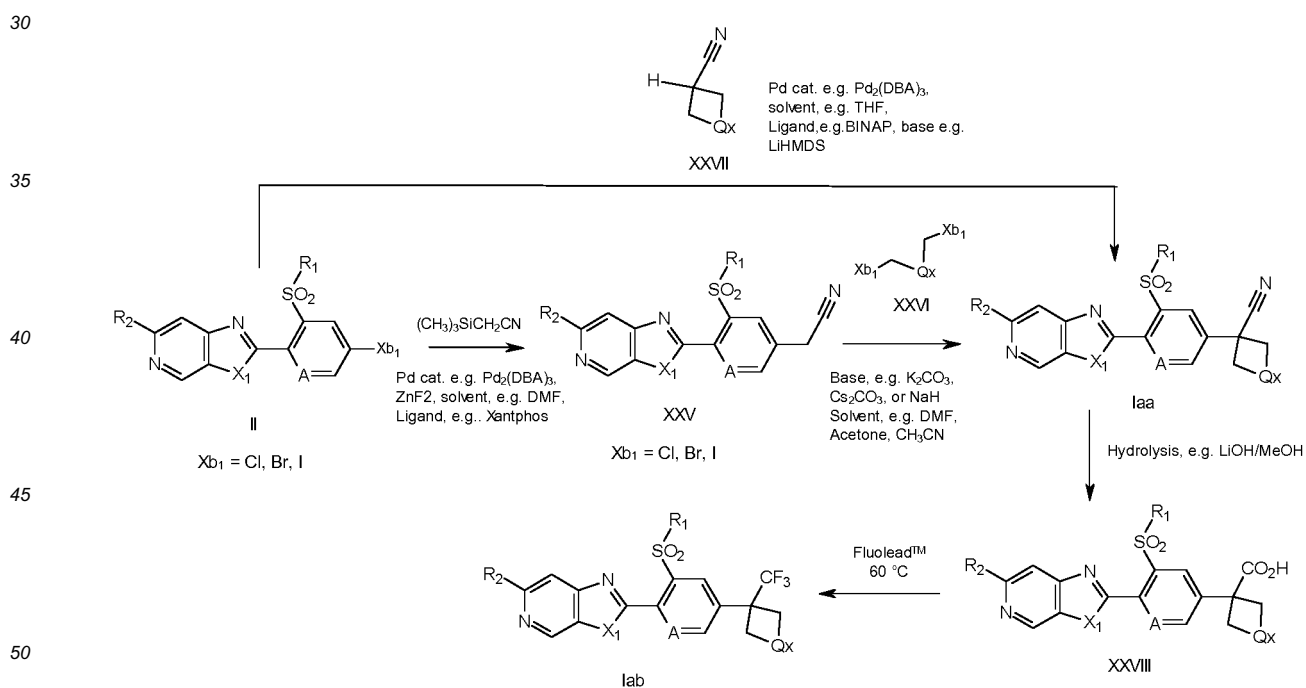
Scheme 14



25

[0054] Compounds of formula I wherein Q is C₃-C₆cycloalkyl, mono- or polysubstituted by substituents selected from the group consisting of halogen, cyano, C₁-C₄haloalkyl, and phenyl, may be prepared by methods described above. For the special case of compounds of formula I wherein Q is cycloalkyl substituted by cyano (e.g. compounds Iaa) and C₁-C₄haloalkyl (e.g. compounds Iab), the compounds can be prepared by the methods shown in scheme 15.

Scheme 15



55

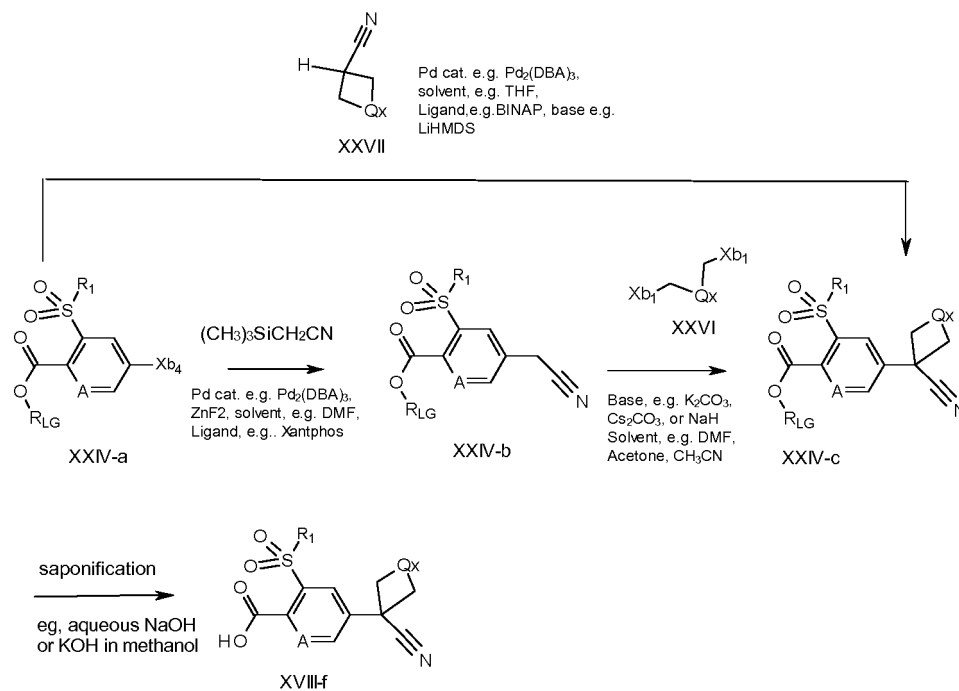
[0055] As shown in scheme 15, treatment of compounds of formula II, where X is SO₂, and wherein Xb₁ is preferably halogen (even more preferably chlorine, bromine or iodine), with trimethylsilyl-acetonitrile TMSCN, in the presence of zinc(II)fluoride, and a palladium(0)catalyst such as tris(dibenzylideneacetone)dipalladium(0)-chloroform adduct (Pd₂(dba)₃), a ligand, for example Xantphos, in an inert solvent, such as DMF at temperatures between 100-160 °C, optionally under microwave heating, leads to compounds of formula XXV. Such chemistry has been described in the literature, e.g. in Org. Lett., 16(24), 6314-6317; 2014. Compounds of formula XXV can be treated with compounds of

formula XXVI, wherein Qx is a direct bond or $(CH_2)_n$ and n is 1, 2 or 3, in the presence of a base such as sodium hydride, K_2CO_3 , or Cs_2CO_3 , in an inert solvent such as DMF, acetone, or acetonitrile, to give compounds of formula laa. Alternatively, compounds of formula laa can be prepared directly from compounds of formula II by treatment with compounds of formula XXVII, wherein Qx is as described in XXVI, with $Pd_2(dba)_3$, a ligand, such as BINAP, a strong base such as LiHMDS, in an inert solvent such as THF at temperatures between 40-70 °C. Such chemistry has been described in, for example, J. Am. Chem. Soc., 127(45), 15824-15832; 2005.

Compounds of the formula laa may further be utilized for the preparation of compounds of formula lab. Indeed, compounds of formula laa, wherein A, R_1 , X_1 and R_2 are as defined in formula I, and wherein Qx is a direct bond or $(CH_2)_n$ and n is 1, 2 or 3, may be hydrolyzed, under conditions known to a person skilled in the art (see scheme 10a), to compounds of formula XXVIII. Treatment of compounds of formula XXVIII with reagents such as SF_4 or Fluolead (4-tert-butyl-2, 6-dimethyl phenylsulfur trifluoride), optionally in the presence of HF, leads to compounds of formula lab.

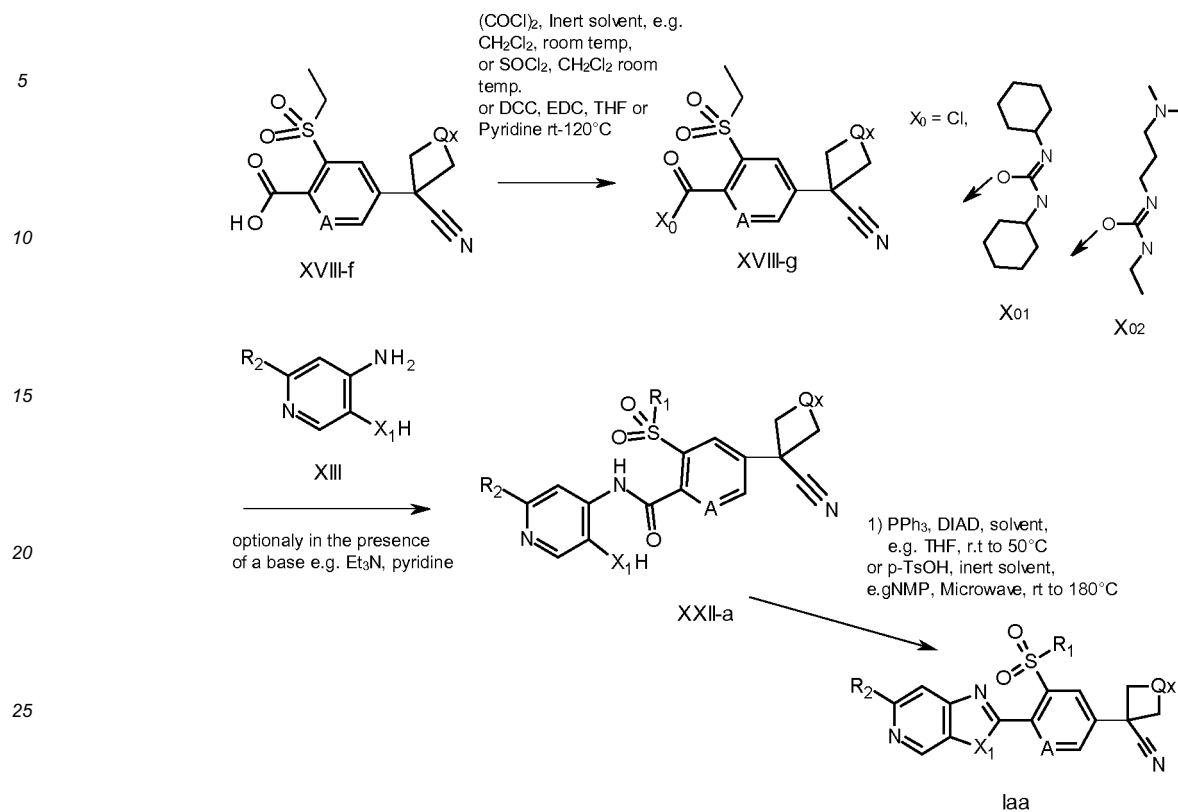
Alternatively compounds of formula laa can be prepared as shown in schemes 16 and 17. As shown in scheme 16, the chemistry used is identical to that described in scheme 15, it is just that the substrates for the reactions are different. Thus, reaction of the previously described compound XXIV-a with TMS-acetonitrile as described in scheme 15, leads to compounds of formula XXIV-b. These are converted in compounds of formula XXIV-c by reacting with compounds of formula XXVI as described in scheme 15. Similarly, compounds XXIV-c can be prepared directly from XXIV-a by the chemistry discussed in scheme 15. Compounds of formula XXIV-c are readily hydrolysed by methods known to those skilled in the art to give compounds of formula XVIII-f.

Scheme 16



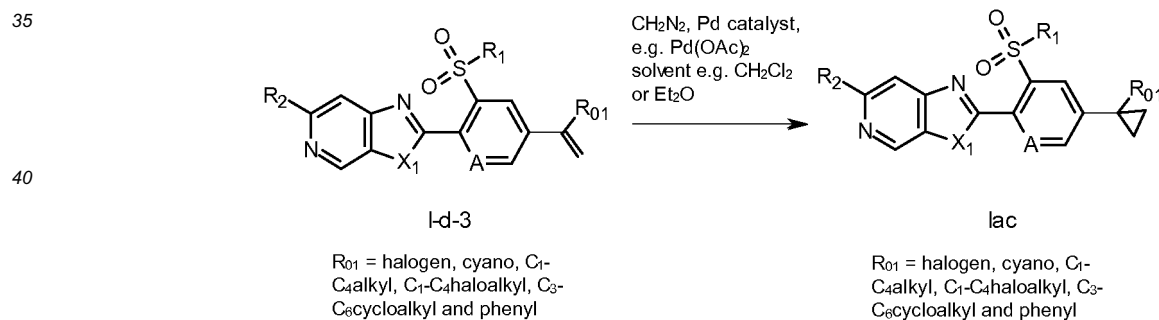
[0056] The chemistry shown in scheme 17 has previously been described in detail in, for example, scheme 10a. This chemistry involves forming an activated species XVIII-g, followed by amide coupling with a compound of formula XIII, to give the intermediate XXII-a. This intermediate can be cyclised to compounds of formula laa by the methods described under, for example, scheme 10a.

Scheme 17



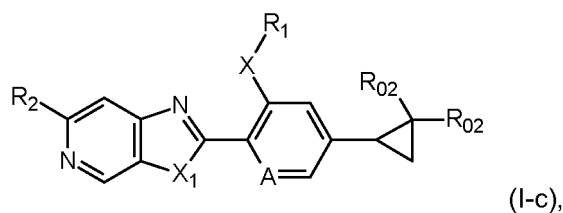
[0057] Compounds of formula I, where Q is substituted C₃-cycloalkyl, can be prepared from compounds of formula I wherein Q is C₂-C₆alkenyl by the chemistry illustrated in scheme 18.

Scheme 18



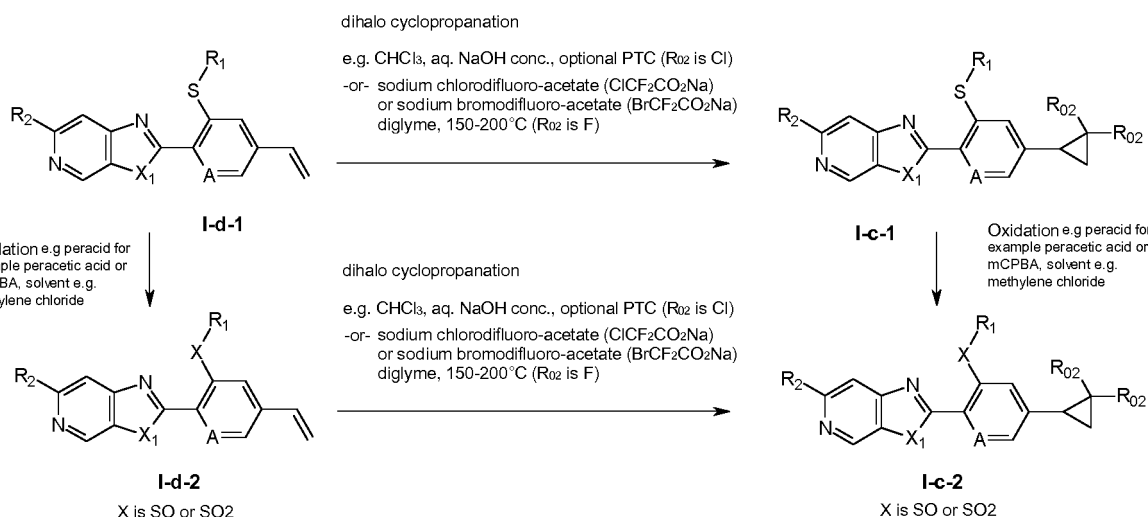
[0058] In scheme 18, compounds of formula I-d-3, wherein R₁, R₂, X₁ and A are as previously defined, and wherein R₀₁ is halogen, cyano, C₁-C₄alkyl, C₁-C₄haloalkyl, C₃-C₆cycloalkyl or phenyl, are treated with diazomethane CH₂N₂ in the presence a catalyst, such as Pd(OAc)₂ or bis(benzonitrile)palladium(II) dichloride, in an inert solvent such as methylene chloride or ether, at room temperature or below, to form compounds of formula I-a-c. Such chemistry has been described in the literature (see for example Org. Biomol. Chem. 2, 2471, 2004, WO03/064418, or Med. Chem. Letts., 4, 514-516, 2013). Compounds of formula I-d-3, wherein A, R₁, R₂ and X₁ are as described in formula I, constitute a particular subset of compounds of formula I, wherein Q is C₂-C₆alkenyl. Preparation of those compounds of formula I-d-3 was detailed above.

[0059] Another particular case of compounds of formula I is represented by compounds of formula I-c, wherein A, R₁, R₂, X and X₁ are as described in formula I and Q is a C₃-cycloalkyl disubstituted by halogen:



wherein R_{02} is halogen, preferably fluorine, chlorine or bromine.

10 Compounds of the formula I-c-1 (a particular subset of compounds I-c wherein X is S (sulfide)), wherein A, R_1 , R_2 and X_1 are as described in formula I and in which R_{02} is chlorine or bromine,



35 may be prepared, for example, by reacting compounds of formula I-d-1, wherein A, R_1 , R_2 and X_1 are as described in formula I, with chloroform CHCl_3 or bromoform CHBr_3 (possibly acting as reagent and solvent) in presence of concentrated aqueous sodium or potassium hydroxide, optionally in presence of a phase transfer catalyst PTC, such as for example tetrabutyl ammonium bromide or triethyl benzyl ammonium chloride, optionally in the presence of an additional solvent such as dichloromethane, preferably at temperatures around 0°C to 30°C. Such chemistry has been described in the literature (see for example Science of Synthesis, 34, 245-265, 2006). Alternatively, compounds of the formula I-c-1, wherein A, R_1 , R_2 and X_1 are as described in formula I and in which R_{02} is fluorine, may be prepared, for example, by reacting compounds of formula I-d-1, wherein A, R_1 , R_2 and X_1 are as described in formula I, with reagents such as sodium chlorodifluoro-acetate ($\text{ClCF}_2\text{CO}_2\text{Na}$), sodium bromodifluoro-acetate ($\text{BrCF}_2\text{CO}_2\text{Na}$) or sodium trifluoro-acetate ($\text{CF}_3\text{CO}_2\text{Na}$) in solvents such as diglyme, tetrahydrofuran, dioxane or dimethoxyethane, at temperatures between 100 and 200°C (preferably in the range 150-200°C). Such chemistry has been described in the literature (see for example Synthesis, 2080-2084, 2010).

Oxidation of compounds of formula I-c-1, wherein A, R_1 , R_2 and X_1 are as described in formula I, and wherein R_{02} is halogen, preferably fluorine, chlorine or bromine, with a suitable oxidizing agent, into compounds of formula I-c-2, wherein A, R_1 , R_2 and X_1 are as described in formula I, and wherein R_{02} is halogen, preferably fluorine, chlorine or bromine, and in which X is SO or SO_2 may be achieved under conditions already described above.

45 Alternatively, compounds of formula I-c-2, wherein X is SO or SO_2 , may be prepared from the sulfide compounds of formula I-d-1 by involving the same chemistry as described above, but by changing the order of the steps (i.e. by running the sequence I-d-1 to I-d-2 via oxidation, followed by a dihalo cyclopropanation step to form I-c-2, wherein X is SO or SO_2). Vinyl compounds of formula I-d-1 and I-d-2, wherein A, R_1 , R_2 , X and X_1 are as described in formula I, constitute a particular subset of compounds of formula I, wherein Q is $\text{C}_2\text{-C}_6$ alkenyl. Preparation of those compounds of formula I-d-1 and I-d-2 was detailed above.

50 **[0060]** The reactants can be reacted in the presence of a base. Examples of suitable bases are alkali metal or alkaline earth metal hydroxides, alkali metal or alkaline earth metal hydrides, alkali metal or alkaline earth metal amides, alkali metal or alkaline earth metal alkoxides, alkali metal or alkaline earth metal acetates, alkali metal or alkaline earth metal carbonates, alkali metal or alkaline earth metal dialkylamides or alkali metal or alkaline earth metal alkylsilylamides, alkylamines, alkylenediamines, free or N-alkylated saturated or unsaturated cycloalkylamines, basic heterocycles, ammonium hydroxides and carbocyclic amines. Examples which may be mentioned are sodium hydroxide, sodium hydride,

sodium amide, sodium methoxide, sodium acetate, sodium carbonate, potassium tert-butoxide, potassium hydroxide, potassium carbonate, potassium hydride, lithium diisopropylamide, potassium bis(trimethylsilyl)amide, calcium hydride, triethylamine, diisopropylethylamine, triethylenediamine, cyclohexylamine, N-cyclohexyl-N,N-dimethylamine, N,N-diethylaniline, pyridine, 4-(N,N-dimethylamino)pyridine, quinuclidine, N-methylmorpholine, benzyltrimethylammonium hydroxide and 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU).

[0061] The reactants can be reacted with each other as such, i.e. without adding a solvent or diluent. In most cases, however, it is advantageous to add an inert solvent or diluent or a mixture of these. If the reaction is carried out in the presence of a base, bases which are employed in excess, such as triethylamine, pyridine, N-methylmorpholine or N,N-diethylaniline, may also act as solvents or diluents.

[0062] The reaction is advantageously carried out in a temperature range from approximately -80°C to approximately +140°C, preferably from approximately -30°C to approximately +100°C, in many cases in the range between ambient temperature and approximately +80°C.

[0063] A compound of formula I can be converted in a manner known per se into another compound of formula I by replacing one or more substituents of the starting compound of formula I in the customary manner by (an)other substituent(s) according to the invention.

[0064] Depending on the choice of the reaction conditions and starting materials which are suitable in each case, it is possible, for example, in one reaction step only to replace one substituent by another substituent according to the invention, or a plurality of substituents can be replaced by other substituents according to the invention in the same reaction step.

[0065] Salts of compounds of formula I can be prepared in a manner known per se. Thus, for example, acid addition salts of compounds of formula I are obtained by treatment with a suitable acid or a suitable ion exchanger reagent and salts with bases are obtained by treatment with a suitable base or with a suitable ion exchanger reagent.

[0066] Salts of compounds of formula I can be converted in the customary manner into the free compounds I, acid addition salts, for example, by treatment with a suitable basic compound or with a suitable ion exchanger reagent and salts with bases, for example, by treatment with a suitable acid or with a suitable ion exchanger reagent.

[0067] Salts of compounds of formula I can be converted in a manner known per se into other salts of compounds of formula I, acid addition salts, for example, into other acid addition salts, for example by treatment of a salt of inorganic acid such as hydrochloride with a suitable metal salt such as a sodium, barium or silver salt, of an acid, for example with silver acetate, in a suitable solvent in which an inorganic salt which forms, for example silver chloride, is insoluble and thus precipitates from the reaction mixture.

[0068] Depending on the procedure or the reaction conditions, the compounds of formula I, which have salt-forming properties can be obtained in free form or in the form of salts.

[0069] The compounds of formula I and, where appropriate, the tautomers thereof, in each case in free form or in salt form, can be present in the form of one of the isomers which are possible or as a mixture of these, for example in the form of pure isomers, such as antipodes and/or diastereomers, or as isomer mixtures, such as enantiomer mixtures, for example racemates, diastereomer mixtures or racemate mixtures, depending on the number, absolute and relative configuration of asymmetric carbon atoms which occur in the molecule and/or depending on the configuration of non-aromatic double bonds which occur in the molecule; the invention relates to the pure isomers and also to all isomer mixtures which are possible and is to be understood in each case in this sense hereinabove and hereinbelow, even when stereochemical details are not mentioned specifically in each case.

[0070] Diastereomer mixtures or racemate mixtures of compounds of formula I, in free form or in salt form, which can be obtained depending on which starting materials and procedures have been chosen can be separated in a known manner into the pure diastereomers or racemates on the basis of the physicochemical differences of the components, for example by fractional crystallization, distillation and/or chromatography.

[0071] Enantiomer mixtures, such as racemates, which can be obtained in a similar manner can be resolved into the optical antipodes by known methods, for example by recrystallization from an optically active solvent, by chromatography on chiral adsorbents, for example high-performance liquid chromatography (HPLC) on acetyl cellulose, with the aid of suitable microorganisms, by cleavage with specific, immobilized enzymes, via the formation of inclusion compounds, for example using chiral crown ethers, where only one enantiomer is complexed, or by conversion into diastereomeric salts, for example by reacting a basic end-product racemate with an optically active acid, such as a carboxylic acid, for example camphor, tartaric or malic acid, or sulfonic acid, for example camphorsulfonic acid, and separating the diastereomer mixture which can be obtained in this manner, for example by fractional crystallization based on their differing solubilities, to give the diastereomers, from which the desired enantiomer can be set free by the action of suitable agents, for example basic agents.

[0072] Pure diastereomers or enantiomers can be obtained according to the invention not only by separating suitable isomer mixtures, but also by generally known methods of diastereoselective or enantioselective synthesis, for example by carrying out the process according to the invention with starting materials of a suitable stereochemistry.

N-oxides can be prepared by reacting a compound of the formula I with a suitable oxidizing agent, for example the

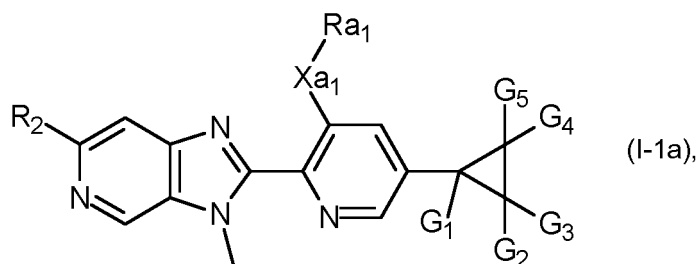
EP 3 183 245 B1

H₂O₂/urea adduct in the presence of an acid anhydride, e.g. trifluoroacetic anhydride. Such oxidations are known from the literature, for example from J. Med. Chem., 32 (12), 2561-73, 1989 or WO 00/15615.

It is advantageous to isolate or synthesize in each case the biologically more effective isomer, for example enantiomer or diastereomer, or isomer mixture, for example enantiomer mixture or diastereomer mixture, if the individual components have a different biological activity. The compounds of formula I and, where appropriate, the tautomers thereof, in each case in free form or in salt form, can, if appropriate, also be obtained in the form of hydrates and/or include other solvents, for example those which may have been used for the crystallization of compounds which are present in solid form.

[0073] The compounds according to the following Tables 1 to 18 below can be prepared according to the methods described above. The examples which follow are intended to illustrate the invention and show preferred compounds of formula I.

[0074] Table X: This table discloses 15 substituent definitions X.001 to X.015 of the formula I-1a:



wherein Ra₁, R₂, G₁, G₂, G₃, G₄ and G₅ are as defined below:

Table X:

Comp.No	R ₂	Ra ₁	G ₁	G ₂	G ₃	G ₄	G ₅
X.001	CF ₃	CH ₂ CH ₃	H	F	F	H	H
X.002	CF ₃	CH ₂ CH ₃	H	Cl	Cl	H	H
X.003	CF ₃	CH ₂ CH ₃	H	CH ₃	CH ₃	H	H
X.004	CF ₃	CH ₂ CH ₃	H	H	H	H	H
X.005	CF ₃	CH ₂ CH ₃	F	H	H	H	H
X.006	CF ₃	CH ₂ CH ₃	Cl	H	H	H	H
X.007	CF ₃	CH ₂ CH ₃	CH ₃	H	H	H	H
X.008	CF ₃	CH ₂ CH ₃	CF ₃	H	H	H	H
X.009	CF ₃	CH ₂ CH ₃	CN	H	H	H	H
X.010	CF ₃	CH ₂ CH ₃	4-Cl-Ph	H	H	H	H
X.011	CF ₃	CH ₂ CH ₃	H	CF ₃	H	H	H
X.012	CF ₃	CH ₂ CH ₃	H	CN	H	H	H
X.013	CF ₃	CH ₂ CH ₃	H	cyclo-C3	H	H	H
X.014	CF ₃	CH ₂ CH ₃	H	H	Ph	H	H
X.015	CF ₃	CH ₂ CH ₃	H	H	H	4-Cl-Ph	H

and the N-oxides of the compounds of Table X. Ph represents the phenyl group, cyclo-C3 is the cyclopropyl group.

Table 1: This table discloses the 15 compounds 1.001 to 1.015 of the formula I-1a, wherein Xa₁ is S, and Ra₁, R₂, G₁, G₂, G₃, G₄ and G₅ are as defined in Table X. For example, compound No. 1.001 has the following structure:

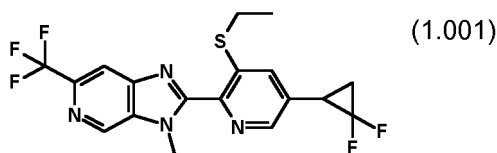
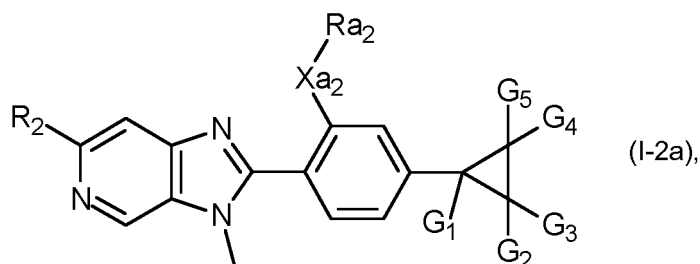


Table 2: This table discloses the 15 compounds 2.001 to 2.015 of the formula I-1a, wherein Xa_1 is SO, and Ra_1 , R_2 , G_1 , G_2 , G_3 , G_4 and G_5 are as defined in Table X.

Table 3: This table discloses the 15 compounds 3.001 to 3.015 of the formula I-1a, wherein Xa_1 is SO_2 , and Ra_1 , R_2 , G_1 , G_2 , G_3 , G_4 and G_5 are as defined in Table X.

Table Y: This table discloses 15 substituent definitions Y.001 to Y.015 of the formula I-2a:



wherein Ra_2 , R_2 , G_1 , G_2 , G_3 , G_4 and G_5 are as defined below:

Table Y:

Comp.No	R_2	Ra_2	G_1	G_2	G_3	G_4	G_5
Y.001	CF_3	CH_2CH_3	H	F	F	H	H
Y.002	CF_3	CH_2CH_3	H	Cl	Cl	H	H
Y.003	CF_3	CH_2CH_3	H	CH_3	CH_3	H	H
Y.004	CF_3	CH_2CH_3	H	H	H	H	H
Y.005	CF_3	CH_2CH_3	F	H	H	H	H
Y.006	CF_3	CH_2CH_3	Cl	H	H	H	H
Y.007	CF_3	CH_2CH_3	CH_3	H	H	H	H
Y.008	CF_3	CH_2CH_3	CF_3	H	H	H	H
Y.009	CF_3	CH_2CH_3	CN	H	H	H	H
Y.010	CF_3	CH_2CH_3	4-Cl-Ph	H	H	H	H
Y.011	CF_3	CH_2CH_3	H	CF_3	H	H	H
Y.012	CF_3	CH_2CH_3	H	CN	H	H	H
Y.013	CF_3	CH_2CH_3	H	cyclo-C3	H	H	H
Y.014	CF_3	CH_2CH_3	H	H	Ph	H	H
Y.015	CF_3	CH_2CH_3	H	H	H	4-Cl-Ph	H

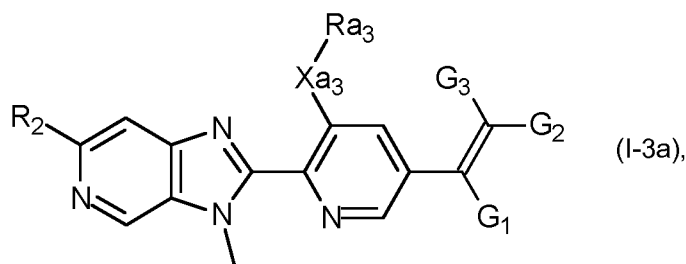
and the N-oxides of the compounds of Table Y. Ph represents the phenyl group, cyclo-C3 is the cyclopropyl group.

Table 4: This table discloses the 15 compounds 4.001 to 4.015 of the formula I-2a, wherein Xa_2 is S, and Ra_2 , R_2 , G_1 , G_2 , G_3 , G_4 and G_5 are as defined in Table Y.

Table 5: This table discloses the 15 compounds 5.001 to 5.015 of the formula I-2a, wherein Xa_2 is SO, and Ra_2 , R_2 , G_1 , G_2 , G_3 , G_4 and G_5 are as defined in Table Y.

Table 6: This table discloses the 15 compounds 6.001 to 6.015 of the formula I-2a, wherein Xa_2 is SO_2 , and Ra_2 , R_2 , G_1 , G_2 , G_3 , G_4 and G_5 are as defined in Table Y.

Table Z: This table discloses 18 substituent definitions Z.001 to Z.018 of the formula I-3a:



wherein Ra₃, R₂, G₁, G₂ and G₃ are as defined below:

Table Z:

15

Comp.No	R ₂	Ra ₃	G ₁	G ₂	G ₃
Z.001	CF ₃	CH ₂ CH ₃	H	F	F
Z.002	CF ₃	CH ₂ CH ₃	H	Cl	Cl
Z.003	CF ₃	CH ₂ CH ₃	H	CH ₃	CH ₃
Z.004	CF ₃	CH ₂ CH ₃	H	H	H
Z.005	CF ₃	CH ₂ CH ₃	H	H	CH ₃
Z.006	CF ₃	CH ₂ CH ₃	H	CH ₃	H
Z.007	CF ₃	CH ₂ CH ₃	H	H	Cl
Z.008	CF ₃	CH ₂ CH ₃	H	Cl	H
Z.009	CF ₃	CH ₂ CH ₃	H	Cyclo-C6	H
Z.010	CF ₃	CH ₂ CH ₃	H	4-Cl-Ph	H
Z.011	CF ₃	CH ₂ CH ₃	H	4-F-Ph	H
Z.012	CF ₃	CH ₂ CH ₃	H	4-CF ₃ -Ph	H
Z.013	CF ₃	CH ₂ CH ₃	H	CN	H
Z.014	CF ₃	CH ₂ CH ₃	CH ₃	H	H
Z.015	CF ₃	CH ₂ CH ₃	CF ₃	CH ₃	CH ₃
Z.016	CF ₃	CH ₂ CH ₃	CN	CH ₃	CH ₃
Z.017	CF ₃	CH ₂ CH ₃	H	Ph	H
Z.018	CF ₃	CH ₂ CH ₃	H	CF ₃	H

20

25

30

35

40

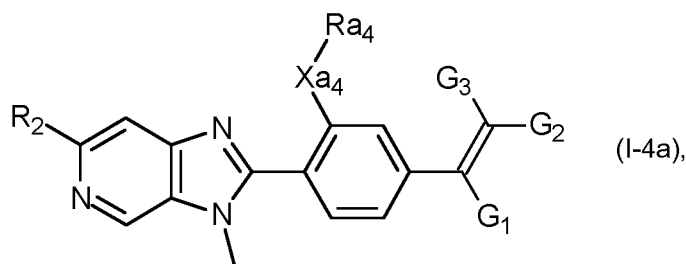
and the N-oxides of the compounds of Table Z. Ph represents the phenyl group, cyclo-C6 is the cyclohexyl group.

Table 7: This table discloses the 18 compounds 7.001 to 7.018 of the formula I-3a, wherein Xa₃ is S, and Ra₃, R₂, G₁, G₂ and G₃ are as defined in Table Z.

Table 8: This table discloses the 18 compounds 8.001 to 8.018 of the formula I-3a, wherein Xa₃ is SO, and Ra₃, R₂, G₁, G₂ and G₃ are as defined in Table Z.

Table 9: This table discloses the 18 compounds 9.001 to 9.018 of the formula I-3a, wherein Xa₃ is SO₂, and Ra₃, R₂, G₁, G₂ and G₃ are as defined in Table Z.

Table U: This table discloses 18 substituent definitions U.001 to U.018 of the formula I-4a:



wherein R_{a4} , R_2 , G_1 , G_2 and G_3 are as defined below:

Table U:

15

Comp.No	R_2	R_{a4}	G_1	G_2	G_3
U.001	CF_3	CH_2CH_3	H	F	F
U.002	CF_3	CH_2CH_3	H	Cl	Cl
U.003	CF_3	CH_2CH_3	H	CH_3	CH_3
U.004	CF_3	CH_2CH_3	H	H	H
U.005	CF_3	CH_2CH_3	H	H	CH_3
U.006	CF_3	CH_2CH_3	H	CH_3	H
U.007	CF_3	CH_2CH_3	H	H	Cl
U.008	CF_3	CH_2CH_3	H	Cl	H
U.009	CF_3	CH_2CH_3	H	Cyclo-C6	H
U.010	CF_3	CH_2CH_3	H	4-Cl-Ph	H
U.011	CF_3	CH_2CH_3	H	4-F-Ph	H
U.012	CF_3	CH_2CH_3	H	4- CF_3 -Ph	H
U.013	CF_3	CH_2CH_3	H	CN	H
U.014	CF_3	CH_2CH_3	CH_3	H	H
U.015	CF_3	CH_2CH_3	CF_3	CH_3	CH_3
U.016	CF_3	CH_2CH_3	CN	CH_3	CH_3
U.017	CF_3	CH_2CH_3	H	Ph	H
U.018	CF_3	CH_2CH_3	H	CF_3	H

20

25

30

35

40

and the N-oxides of the compounds of Table U. Ph represents the phenyl group, cyclo-C6 is the cyclohexyl group.

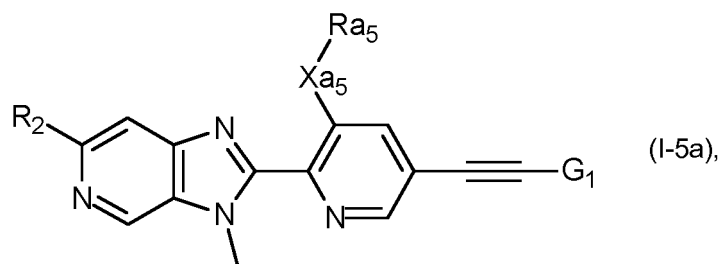
Table 10: This table discloses the 18 compounds 10.001 to 10.018 of the formula I-4a, wherein X_{a4} is S, and R_{a4} , R_2 , G_1 , G_2 and G_3 are as defined in Table U.

Table 11: This table discloses the 18 compounds 11.001 to 11.018 of the formula I-4a, wherein X_{a4} is SO, and R_{a4} , R_2 , G_1 , G_2 and G_3 are as defined in Table U.

Table 12: This table discloses the 18 compounds 12.001 to 12.018 of the formula I-4a, wherein X_{a4} is SO_2 , and R_{a4} , R_2 , G_1 , G_2 and G_3 are as defined in Table U.

Table V: This table discloses 8 substituent definitions V.001 to V.008 of the formula I-5a:

5



10

wherein R_{a5} , R_2 and G_1 are as defined below:

Table V:

15

Comp.No	R_2	R_{a5}	G_1
V.001	CF_3	CH_2CH_3	$-Si(CH_3)_3$
V.002	CF_3	CH_2CH_3	H
V.003	CF_3	CH_2CH_3	CF_3
V.004	CF_3	CH_2CH_3	Ph
V.005	CF_3	CH_2CH_3	4-Cl-Ph
V.006	CF_3	CH_2CH_3	4- CF_3 -Ph
V.007	CF_3	CH_2CH_3	4-F-Ph
V.008	CF_3	CH_2CH_3	CH_3

20

25

and the N-oxides of the compounds of Table V. Ph represents the phenyl group.

30

Table 13: This table discloses the 8 compounds 13.001 to 13.008 of the formula I-5a, wherein X_{a5} is S, and R_{a5} , R_2 and G_1 are as defined in Table V.

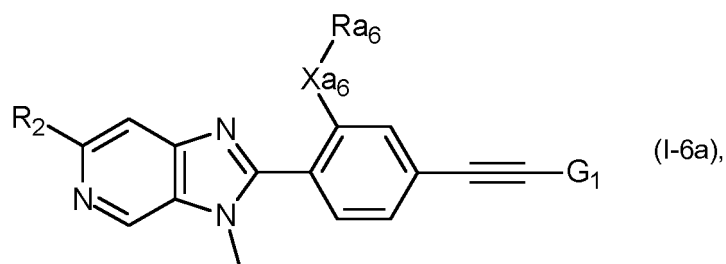
Table 14: This table discloses the 8 compounds 14.001 to 14.008 of the formula I-5a, wherein X_{a5} is SO, and R_{a5} , R_2 and G_1 are as defined in Table V.

Table 15: This table discloses the 8 compounds 15.001 to 15.008 of the formula I-5a, wherein X_{a5} is SO_2 , and R_{a5} , R_2 and G_1 are as defined in Table V.

35

Table W: This table discloses 8 substituent definitions W.001 to W.008 of the formula I-6a:

40



45

wherein R_{a6} , R_2 and G_1 are as defined below:

Table W:

50

Comp.No	R_2	R_{a6}	G_1
W.001	CF_3	CH_2CH_3	$-Si(CH_3)_3$
W.002	CF_3	CH_2CH_3	H
W.003	CF_3	CH_2CH_3	CF_3
W.004	CF_3	CH_2CH_3	Ph

55

(continued)

Comp.No	R ₂	Ra ₆	G ₁
W.005	CF ₃	CH ₂ CH ₃	4-Cl-Ph
W.006	CF ₃	CH ₂ CH ₃	4-CF ₃ -Ph
W.007	CF ₃	CH ₂ CH ₃	4-F-Ph
W.008	CF ₃	CH ₂ CH ₃	CH ₃

and the N-oxides of the compounds of Table W. Ph represents the phenyl group.

Table 16: This table discloses the 8 compounds 16.001 to 16.008 of the formula I-6a, wherein X_{a6} is S, and Ra₆, R₂ and G₁ are as defined in Table W.

Table 17: This table discloses the 8 compounds 17.001 to 17.008 of the formula I-6a, wherein X_{a6} is SO, and Ra₆, R₂ and G₁ are as defined in Table W.

Table 18: This table discloses the 8 compounds 18.001 to 18.008 of the formula I-6a, wherein X_{a6} is SO₂, and Ra₆, R₂ and G₁ are as defined in Table W.

[0075] The compounds of formula I according to the invention are preventively and/or curatively valuable active ingredients in the field of pest control, even at low rates of application, which have a very favorable biocidal spectrum and are well tolerated by warm-blooded species, fish and plants. The active ingredients according to the invention act against all or individual developmental stages of normally sensitive, but also resistant, animal pests, such as insects or representatives of the order Acarina. The insecticidal or acaricidal activity of the active ingredients according to the invention can manifest itself directly, i. e. in destruction of the pests, which takes place either immediately or only after some time has elapsed, for example during ecdysis, or indirectly, for example in a reduced oviposition and/or hatching rate.

[0076] Examples of the abovementioned animal pests are:

from the order *Acarina*, for example,

Acalitus spp, Aculus spp, Acaricalus spp, Aceria spp, Acarus siro, Amblyomma spp., Argas spp., Boophilus spp., Brevipalpus spp., Bryobia spp, Calipitrimerus spp., Chorioptes spp., Dermanyssus gallinae, Dermatophagoides spp, Eotetranychus spp, Eriophyes spp., Hemitarsonemus spp, Hyalomma spp., Ixodes spp., Olygonychus spp, Ornithodoros spp., Polyphagotarsonema latus, Panonychus spp., Phyllocoptura oleivora, Phytoneumus spp, Polyphagotarsonemus spp, Psoroptes spp., Rhipicephalus spp., Rhizoglyphus spp., Sarcoptes spp., Steneotarsonemus spp, Tarsonemus spp. and Tetranychus spp.;

from the order *Anoplura*, for example,

Haematopinus spp., Linognathus spp., Pediculus spp., Pemphigus spp. and Phylloxera spp.;

from the order *Coleoptera*, for example,

Agriotes spp., Amphimallon majale, Anomala orientalis, Anthonomus spp., Aphodius spp, Astylus atromaculatus, Ataenius spp, Atomaria linearis, Chaetocnema tibialis, Cerotoma spp, Conoderus spp, Cosmopolites spp., Cotinis nitida, Curculio spp., Cyclocephala spp, Dermestes spp., Diabrotica spp., Diloboderus abderus, Epilachna spp., Eremnus spp., Heteronychus arator, Hypothenemus hampei, Lagria vilosa, Leptinotarsa decemlineata, Lissorhoptrus spp., Liogenys spp, Maecolaspis spp, Maladera castanea, Megascelis spp, Meligethes aeneus, Melolontha spp., Myochrous armatus, Oryzaephilus spp., Otiorhynchus spp., Phyllophaga spp, Phlyctinus spp., Popillia spp., Psylliodes spp., Rhyssomatus aubtilis, Rhizopertha spp., Scarabeidae, Sitophilus spp., Sitotroga spp., Somaticus spp, Sphenophorus spp, Sternechus subsignatus, Tenebrio spp., Tribolium spp. and Trogoderma spp.;

from the order *Diptera*, for example,

Aedes spp., Anopheles spp, Antherigona soccata, Bactrocea oleae, Bibio hortulanus, Bradysia spp, Calliphora erythrocephala, Ceratitis spp., Chrysomyia spp., Culex spp., Cuterebra spp., Dacus spp., Delia spp, Drosophila melanogaster, Fannia spp., Gastrophilus spp., Geomyza tripunctata, Glossina spp., Hypoderma spp., Hyppobosca spp., Liriomyza spp., Lucilia spp., Melanagromyza spp., Musca spp., Oestrus spp., Orseolia spp., Oscinella frit, Pegomyia hyoscyami, Phorbia spp., Rhagoletis spp, Rivelia quadrifasciata, Scatella spp, Sciara spp., Stomoxys spp., Tabanus spp., Tannia spp. and Tipula spp.;

from the order *Hemiptera*, for example,

Acanthocoris scabrator, Acrosternum spp, Adelphocoris lineolatus, Amblypelta nitida, Bathycoelia thalassina, Blisus spp, Cimex spp., Clavigralla tomentosicollis, Creontiades spp, Distantiella theobroma, Dichelops furcatus, Dysdercus spp., Edessa spp, Euschistus spp., Eurydema pulchrum, Eurygaster spp., Halyomorpha halys, Horcias nobilillus, Leptocoris spp., Lygus spp, Margarodes spp, Murgantia histrionica, Neomegalotomus spp, Nesidiocoris tenuis, Nezara spp., Nysius simulans, Oebalus insularis, Piesma spp., Piezodorus spp, Rhodnius spp., Sahlbergella singularis, Scaptocoris castanea, Scotinophara spp., Thyanta spp., Triatoma spp., Vatica illudens;

EP 3 183 245 B1

Acyrtosium pisum, Adalges spp, Agalliana ensigera, Agonoscena targionii, Aleurodicus spp, Aleurocanthus spp, Aleurolobus barodensis, Aleurothrixus floccosus, Aleyrodes brassicae, Amarasca biguttula, Amritodus atkinsoni, Aonidiella spp., Aphididae, Aphis spp., Aspidiotus spp., Aulacorthum solani, Bactericera cockerelli, Bemisia spp, Brachycaudus spp, Brevicoryne brassicae, Cacopsylla spp, Cavariella aegopodii Scop., Ceroplaster spp., Chrysomphalus aonidium, Chrysomphalus dictyospermi, Cicadella spp, Cofana spectra, Cryptomyzus spp, Cicadulina spp, Coccus hesperidum, Dalbulus maidis, Dialeurodes spp, Diaphorina citri, Diuraphis noxia, Dysaphis spp, Empoasca spp., Eriosoma larigerum, Erythroneura spp., Gascardia spp., Glycaspis brimblecombei, Hyadaphis pseudobrassicae, Hyalopterus spp, Hyperomyzus pallidus, Idioscopus clypealis, Jacobiasca lybica, Laodelphax spp., Lecanium corni, Lepidosaphes spp., Lopaphis erysimi, Lyogenys maidis, Macrosiphum spp., Mahanarva spp, Metcalfa pruinosa, Metopolophium dirhodum, Myndus crudus, Myzus spp., Neotoxoptera sp, Nephrotettix spp., Nilaparvata spp., Nippolachnus piri Mats, Odonaspis ruthae, Oregma lanigera Zehnter, Parabemisia myricae, Paratrioza cockerelli, Parlatoria spp., Pemphigus spp., Peregrinus maidis, Perkinsiella spp, Phorodon humuli, Phylloxera spp, Planococcus spp., Pseudaulacaspis spp., Pseudococcus spp., Pseudatomoscelis seriatus, Psylla spp., Pulvinaria aethiopica, Quadraspidiotus spp., Quesada gigas, Recilia dorsalis, Rhopalosiphum spp., Saissetia spp., Scaphoideus spp., Schizaphis spp., Sitobion spp., Sogatella furcifera, Spissistilus festinus, Tarophagus Proserpina, Toxoptera spp, Trialeurodes spp, Tridiscus sporoboli, Trionymus spp, Trioza erytrae , Unaspis citri, Zyginia flammigera, Zyginidia scutellaris, ;

from the order *Hymenoptera*, for example,

Acromyrmex, Arge spp, Atta spp., Cephus spp., Diprion spp., Diprionidae, Gilpinia polytoma, Hoplo-campa spp., Lasius spp., Monomorium pharaonis, Neodiprion spp., Pogonomyrmex spp, Slenopsis invicta, Solenopsis spp. and Vespa spp.;

from the order *Isoptera*, for example,

Coptotermes spp, Cornitermes cumulans, Incisitermes spp, Macrotermes spp, Mastotermes spp, Microtermes spp, Reticulitermes spp.; Solenopsis geminate

from the order *Lepidoptera*, for example,

Acleris spp., Adoxophyes spp., Aegeria spp., Agrotis spp., Alabama argillaceae, Amylois spp., Anticarsia gemmatalis, Archips spp., Argyresthia spp, Argyrotaenia spp., Autographa spp., Bucculatrix thurberiella, Busseola fusca, Cadra cautella, Carposina nipponensis, Chilo spp., Choristoneura spp., Chrysoteuchia topiaria, Clysia ambiguella, Cnaphalocrocis spp., Cnephasia spp., Cochylis spp., Coleophora spp., Colias lesbia, Cosmophila flava, Crambus spp, Crocidolomia binotalis, Cryptophlebia leucotreta, Cydalima perspectalis, Cydia spp., Diaphania perspectalis, Diatraea spp., Diparopsis castanea, Earias spp., Eldana saccharina, Ephestia spp., Epinotia spp, Estigmene acrea, Etiella zinckenella, Eucosma spp., Eupoecilia ambiguella, Euproctis spp., Euxoa spp., Feltia jaculiferia, Grapholita spp., Hedyia nubiferana, Heliothis spp., Hellula undalis, Herpetogramma spp, Hyphantria cunea, Keiferia lycopersicella, Lasmopalpus lignosellus, Leucoptera scitella, Lithocolletis spp., Lobesia botrana, Loxostege bifidalis, Lymantria spp., Lyonetia spp., Malacosoma spp., Mamestra brassicae, Manduca sexta, Mythimna spp, Noctua spp, Operophtera spp., Orniodes indica, Ostrinia nubilalis, Pammene spp., Pandemis spp., Panolis flammea, Papaipema nebris, Pectinophora gossypiella, Perileucoptera coffeella, Pseudaletia unipuncta, Phthorimaea operculella, Pieris rapae, Pieris spp., Plutella xylostella, Prays spp., Pseudoplusia spp, Rachiplusia nu, Richia albicosta, Scirpophaga spp., Sesamia spp., Sparganothis spp., Spodoptera spp., Sylepta derogate, Synanthedon spp., Thaumetopoea spp., Tortrix spp., Trichoplusia ni, Tuta absoluta, and Yponomeuta spp.;

from the order *Mallophaga*, for example,

Damalinea spp. and Trichodectes spp.;

from the order *Orthoptera*, for example,

Blatta spp., Blattella spp., Gryllotalpa spp., Leucophaea maderae, Locusta spp., Neocurtilla hexadactyla, Periplaneta spp. , Scapteriscus spp, and Schistocerca spp.;

from the order *Psocoptera*, for example,

Liposcelis spp.;

from the order *Siphonaptera*, for example,

Ceratophyllus spp., Ctenocephalides spp. and Xenopsylla cheopis;

from the order *Thysanoptera*, for example,

Calliothrips phaseoli, Frankliniella spp., Heliothrips spp, Hercinothrips spp., Parthenothrips spp, Scirtothrips aurantii, Sericothrips variabilis, Taeniothrips spp., Thrips spp;

from the order *Thysanura*, for example, Lepisma saccharina.

[0077] The active ingredients according to the invention can be used for controlling, i. e. containing or destroying, pests of the abovementioned type which occur in particular on plants, especially on useful plants and ornamentals in agriculture, in horticulture and in forests, or on organs, such as fruits, flowers, foliage, stalks, tubers or roots, of such plants, and in some cases even plant organs which are formed at a later point in time remain protected against these pests.

[0078] Suitable target crops are, in particular, cereals, such as wheat, barley, rye, oats, rice, maize or sorghum; beet, such as sugar or fodder beet; fruit, for example pomaceous fruit, stone fruit or soft fruit, such as apples, pears, plums, peaches, almonds, cherries or berries, for example strawberries, raspberries or blackberries; leguminous crops, such as beans, lentils, peas or soya; oil crops, such as oilseed rape, mustard, poppies, olives, sunflowers, coconut, castor, cocoa or ground nuts; cucurbits, such as pumpkins, cucumbers or melons; fibre plants, such as cotton, flax, hemp or jute; citrus fruit, such as oranges, lemons, grapefruit or tangerines; vegetables, such as spinach, lettuce, asparagus, cabbages, carrots, onions, tomatoes, potatoes or bell peppers; Lauraceae, such as avocado, Cinnamomum or camphor; and also tobacco, nuts, coffee, eggplants, sugarcane, tea, pepper, grapevines, hops, the plantain family and latex plants.

[0079] The compositions and/or methods of the present invention may be also used on any ornamental and/or vegetable crops, including flowers, shrubs, broad-leaved trees and evergreens.

For example the invention may be used on any of the following ornamental species: *Ageratum* spp., *Alonsoa* spp., *Anemone* spp., *Anisodonteia capensis*, *Anthemis* spp., *Antirrhinum* spp., *Aster* spp., *Begonia* spp. (e.g. *B. elatior*, *B. semperflorens*, *B. tubéreux*), *Bougainvillea* spp., *Brachycome* spp., *Brassica* spp. (ornamental), *Calceolaria* spp., *Cap-sicum annuum*, *Catharanthus roseus*, *Canna* spp., *Centaurea* spp., *Chrysanthemum* spp., *Cineraria* spp. (*C. maritime*), *Coreopsis* spp., *Crassula coccinea*, *Cuphea ignea*, *Dahlia* spp., *Delphinium* spp., *Dicentra spectabilis*, *Dorotheantus* spp., *Eustoma grandiflorum*, *Forsythia* spp., *Fuchsia* spp., *Geranium gnaphalium*, *Gerbera* spp., *Gomphrena globosa*, *Heliotropium* spp., *Helianthus* spp., *Hibiscus* spp., *Hortensia* spp., *Hydrangea* spp., *Hypoestes phyllostachya*, *Impatiens* spp. (*I. Walleriana*), *Iresines* spp., *Kalanchoe* spp., *Lantana camara*, *Lavatera trimestris*, *Leonotis leonurus*, *Lilium* spp., *Mesembryanthemum* spp., *Mimulus* spp., *Monarda* spp., *Nemesia* spp., *Tagetes* spp., *Dianthus* spp. (carnation), *Canna* spp., *Oxalis* spp., *Bellis* spp., *Pelargonium* spp. (*P. peltatum*, *P. Zonale*), *Viola* spp. (pansy), *Petunia* spp., *Phlox* spp., *Plecthranthus* spp., *Poinsettia* spp., *Parthenocissus* spp. (*P. quinquefolia*, *P. tricuspidata*), *Primula* spp., *Ranunculus* spp., *Rhododendron* spp., *Rosa* spp. (rose), *Rudbeckia* spp., *Saintpaulia* spp., *Salvia* spp., *Scaevola aemola*, *Schizanthus wisetonensis*, *Sedum* spp., *Solanum* spp., *Surfinia* spp., *Tagetes* spp., *Nicotinia* spp., *Verbena* spp., *Zinnia* spp. and other bedding plants.

For example the invention may be used on any of the following vegetable species: *Allium* spp. (*A. sativum*, *A. cepa*, *A. oschaninii*, *A. Porrum*, *A. ascalonicum*, *A. fistulosum*), *Anthriscus cerefolium*, *Apium graveolus*, *Asparagus officinalis*, *Beta vulgaris*, *Brassica* spp. (*B. Oleracea*, *B. Pekinensis*, *B. rapa*), *Capsicum annuum*, *Cicer arietinum*, *Cichorium endivia*, *Cichorium* spp. (*C. intybus*, *C. endivia*), *Citrullus lanatus*, *Cucumis* spp. (*C. sativus*, *C. melo*), *Cucurbita* spp. (*C. pepo*, *C. maxima*), *Cyanara* spp. (*C. scolymus*, *C. cardunculus*), *Daucus carota*, *Foeniculum vulgare*, *Hypericum* spp., *Lactuca sativa*, *Lycopersicon* spp. (*L. esculentum*, *L. lycopersicum*), *Mentha* spp., *Ocimum basilicum*, *Petroselinum crispum*, *Phaseolus* spp. (*P. vulgaris*, *P. coccineus*), *Pisum sativum*, *Raphanus sativus*, *Rheum rhaponticum*, *Rosemarinus* spp., *Salvia* spp., *Scorzonera hispanica*, *Solanum melongena*, *Spinacea oleracea*, *Valerianella* spp. (*V. locusta*, *V. eriocarpa*) and *Vicia faba*.

Preferred ornamental species include African violet, *Begonia*, *Dahlia*, *Gerbera*, *Hydrangea*, *Verbena*, *Rosa*, *Kalanchoe*, *Poinsettia*, *Aster*, *Centaurea*, *Coreopsis*, *Delphinium*, *Monarda*, *Phlox*, *Rudbeckia*, *Sedum*, *Petunia*, *Viola*, *Impatiens*, *Geranium*, *Chrysanthemum*, *Ranunculus*, *Fuchsia*, *Salvia*, *Hortensia*, rosemary, sage, St. Johnswort, mint, sweet pepper, tomato and cucumber.

The active ingredients according to the invention are especially suitable for controlling *Aphis craccivora*, *Diabrotica balteata*, *Heliothis virescens*, *Myzus persicae*, *Plutella xylostella* and *Spodoptera littoralis* in cotton, vegetable, maize, rice and soya crops. The active ingredients according to the invention are further especially suitable for controlling *Mamestra* (preferably in vegetables), *Cydia pomonella* (preferably in apples), *Empoasca* (preferably in vegetables, vineyards), *Leptinotarsa* (preferably in potatoes) and *Chilo suppressalis* (preferably in rice).

[0080] The active ingredients according to the invention are especially suitable for controlling *Aphis craccivora*, *Diabrotica balteata*, *Heliothis virescens*, *Myzus persicae*, *Plutella xylostella* and *Spodoptera littoralis* in cotton, vegetable, maize, rice and soya crops. The active ingredients according to the invention are further especially suitable for controlling *Mamestra* (preferably in vegetables),

[0081] *Cydia pomonella* (preferably in apples), *Empoasca* (preferably in vegetables, vineyards), *Leptinotarsa* (preferably in potatoes) and *Chilo suppressalis* (preferably in rice).

[0082] In a further aspect, the invention may also relate to a method of controlling damage to plant and parts thereof by plant parasitic nematodes (Endoparasitic-, Semiendoparasitic- and Ectoparasitic nematodes), especially plant parasitic nematodes such as root knot nematodes, *Meloidogyne hapla*, *Meloidogyne incognita*, *Meloidogyne javanica*, *Meloidogyne arenaria* and other *Meloidogyne* species; cyst-forming nematodes, *Globodera rostochiensis* and other *Globodera* species; *Heterodera avenae*, *Heterodera glycines*, *Heterodera schachtii*, *Heterodera trifolii*, and other *Heterodera* species; Seed gall nematodes, *Anguina* species; Stem and foliar nematodes, *Aphelenchoides* species; Sting nematodes, *Belonolaimus longicaudatus* and other *Belonolaimus* species; Pine nematodes, *Bursaphelenchus xylophilus* and other *Bursaphelenchus* species; Ring nematodes, *Criconema* species, *Criconemella* species, *Criconemoides* species, *Mesocriconema* species; Stem and bulb nematodes, *Ditylenchus destructor*, *Ditylenchus dipsaci* and other *Ditylenchus* species; Awl nematodes, *Dolichodorus* species; Spiral nematodes, *Helicotylenchus multicinctus* and other

Helicotylenchus species; Sheath and sheathoid nematodes, Hemicycliophora species and Hemicriconemoides species; Hirshmanniella species; Lance nematodes, Hoploaimus species; false rootknot nematodes, Nacobbus species; Needle nematodes, Longidorus elongatus and other Longidorus species; Pin nematodes, Pratylenchus species; Lesion nematodes, Pratylenchus neglectus, Pratylenchus penetrans, Pratylenchus curvatus, Pratylenchus goodeyi and other Pratylenchus species; Burrowing nematodes, Radopholus similis and other Radopholus species; Reniform nematodes, Rotylenchus robustus, Rotylenchus reniformis and other Rotylenchus species; Scutellonema species; Stubby root nematodes, Trichodorus primitivus and other Trichodorus species, Paratrichodorus species; Stunt nematodes, Tylenchorhynchus claytoni, Tylenchorhynchus dubius and other Tylenchorhynchus species; Citrus nematodes, Tylenchulus species; Dagger nematodes, Xiphinema species; and other plant parasitic nematode species, such as Subanguina spp., Hypsoperine spp., Macroposthonia spp., Melinius spp., Punctodera spp., and Quinisulcius spp..

[0083] The compounds of the invention may also have activity against the molluscs. Examples of which include, for example, Ampullariidae; Arion (*A. ater*, *A. circumscriptus*, *A. hortensis*, *A. rufus*); Bradybaenidae (*Bradybaena fruticum*); Cepaea (*C. hortensis*, *C. Nemoralis*); ochlodina; Deroceras (*D. agrestis*, *D. empiricorum*, *D. laeve*, *D. reticulatum*); Discus (*D. rotundatus*); Euomphalia; Galba (*G. trunculata*); Helicelia (*H. itala*, *H. obvia*); Helicidae *Helicigona arbustorum*); Helicodiscus; Helix (*H. aperta*); Limax (*L. cinereoniger*, *L. flavus*, *L. marginatus*, *L. maximus*, *L. tenellus*); Lymnaea; Milax (*M. gagates*, *M. marginatus*, *M. sowerbyi*); Opeas; Pomacea (*P. canaticulata*); Vallonia and Zanitoides.

[0084] The term "crops" is to be understood as including also crop plants which have been so transformed by the use of recombinant DNA techniques that they are capable of synthesising one or more selectively acting toxins, such as are known, for example, from toxin-producing bacteria, especially those of the genus *Bacillus*.

[0085] Toxins that can be expressed by such transgenic plants include, for example, insecticidal proteins, for example insecticidal proteins from *Bacillus cereus* or *Bacillus popilliae*; or insecticidal proteins from *Bacillus thuringiensis*, such as δ -endotoxins, e.g. Cry1Ab, Cry1Ac, Cry1F, Cry1Fa2, Cry2Ab, Cry3A, Cry3Bb1 or Cry9C, or vegetative insecticidal proteins (Vip), e.g. Vip1, Vip2, Vip3 or Vip3A; or insecticidal proteins of bacteria colonising nematodes, for example *Photorhabdus* spp. or *Xenorhabdus* spp., such as *Photorhabdus luminescens*, *Xenorhabdus nematophilus*; toxins produced by animals, such as scorpion toxins, arachnid toxins, wasp toxins and other insect-specific neurotoxins; toxins produced by fungi, such as *Streptomyces* toxins, plant lectins, such as pea lectins, barley lectins or snowdrop lectins; agglutinins; proteinase inhibitors, such as trypsin inhibitors, serine protease inhibitors, patatin, cystatin, papain inhibitors; ribosome-inactivating proteins (RIP), such as ricin, maize-RIP, abrin, luffin, saporin or bryodin; steroid metabolism enzymes, such as 3-hydroxysteroidoxidase, ecdysteroid-UDP-glycosyl-transferase, cholesterol oxidases, ecdysone inhibitors, HMG-COA-reductase, ion channel blockers, such as blockers of sodium or calcium channels, juvenile hormone esterase, diuretic hormone receptors, stilbene synthase, bibenzyl synthase, chitinases and glucanases.

In the context of the present invention there are to be understood by δ -endotoxins, for example Cry1Ab, Cry1Ac, Cry1F, Cry1Fa2, Cry2Ab, Cry3A, Cry3Bb1 or Cry9C, or vegetative insecticidal proteins (Vip), for example Vip1, Vip2, Vip3 or Vip3A, expressly also hybrid toxins, truncated toxins and modified toxins. Hybrid toxins are produced recombinantly by a new combination of different domains of those proteins (see, for example, WO 02/15701). Truncated toxins, for example a truncated Cry1Ab, are known. In the case of modified toxins, one or more amino acids of the naturally occurring toxin are replaced. In such amino acid replacements, preferably non-naturally present protease recognition sequences are inserted into the toxin, such as, for example, in the case of Cry3A055, a cathepsin-G-recognition sequence is inserted into a Cry3A toxin (see WO 03/018810). Examples of such toxins or transgenic plants capable of synthesising such toxins are disclosed, for example, in EP-A-0 374 753, WO 93/07278, WO 95/34656, EP-A-0 427 529, EP-A-451 878 and WO 03/052073.

The processes for the preparation of such transgenic plants are generally known to the person skilled in the art and are described, for example, in the publications mentioned above. CryI-type deoxyribonucleic acids and their preparation are known, for example, from WO 95/34656, EP-A-0 367 474, EP-A-0 401 979 and WO 90/13651.

The toxin contained in the transgenic plants imparts to the plants tolerance to harmful insects. Such insects can occur in any taxonomic group of insects, but are especially commonly found in the beetles (Coleoptera), two-winged insects (Diptera) and moths (Lepidoptera).

Transgenic plants containing one or more genes that code for an insecticidal resistance and express one or more toxins are known and some of them are commercially available. Examples of such plants are: YieldGard® (maize variety that expresses a Cry1Ab toxin); YieldGard Rootworm® (maize variety that expresses a Cry3Bb1 toxin); YieldGard Plus® (maize variety that expresses a Cry1Ab and a Cry3Bb1 toxin); Starlink® (maize variety that expresses a Cry9C toxin); Herculex I® (maize variety that expresses a Cry1Fa2 toxin and the enzyme phosphinothricine N-acetyltransferase (PAT) to achieve tolerance to the herbicide glufosinate ammonium); NuCOTN 33B® (cotton variety that expresses a Cry1Ac toxin); Bollgard I® (cotton variety that expresses a Cry1Ac toxin); Bollgard II® (cotton variety that expresses a Cry1Ac and a Cry2Ab toxin); VipCot® (cotton variety that expresses a Vip3A and a Cry1Ab toxin); NewLeaf® (potato variety that expresses a Cry3A toxin); NatureGard®, Agrisure® GT Advantage (GA21 glyphosate-tolerant trait), Agrisure® CB Advantage (Bt11 corn borer (CB) trait) and Protecta®.

Further examples of such transgenic crops are:

EP 3 183 245 B1

1. **Bt11 Maize** from Syngenta Seeds SAS, Chemin de l'Hobit 27, F-31 790 St. Sauveur, France, registration number C/FR/96/05/10. Genetically modified *Zea mays* which has been rendered resistant to attack by the European corn borer (*Ostrinia nubilalis* and *Sesamia nonagrioides*) by transgenic expression of a truncated Cry1Ab toxin. Bt11 maize also transgenically expresses the enzyme PAT to achieve tolerance to the herbicide glufosinate ammonium.
2. **Bt176 Maize** from Syngenta Seeds SAS, Chemin de l'Hobit 27, F-31 790 St. Sauveur, France, registration number C/FR/96/05/10. Genetically modified *Zea mays* which has been rendered resistant to attack by the European corn borer (*Ostrinia nubilalis* and *Sesamia nonagrioides*) by transgenic expression of a Cry1Ab toxin. Bt176 maize also transgenically expresses the enzyme PAT to achieve tolerance to the herbicide glufosinate ammonium.
3. **MIR604 Maize** from Syngenta Seeds SAS, Chemin de l'Hobit 27, F-31 790 St. Sauveur, France, registration number C/FR/96/05/10. Maize which has been rendered insect-resistant by transgenic expression of a modified Cry3A toxin. This toxin is Cry3A055 modified by insertion of a cathepsin-G-protease recognition sequence. The preparation of such transgenic maize plants is described in WO 03/018810.
4. **MON 863 Maize** from Monsanto Europe S.A. 270-272 Avenue de Tervuren, B-1150 Brussels, Belgium, registration number C/DE/02/9. MON 863 expresses a Cry3Bb1 toxin and has resistance to certain Coleoptera insects.
5. **IPC 531 Cotton** from Monsanto Europe S.A. 270-272 Avenue de Tervuren, B-1150 Brussels, Belgium, registration number C/ES/96/02.
6. **1507 Maize** from Pioneer Overseas Corporation, Avenue Tedesco, 7 B-1160 Brussels, Belgium, registration number C/NL/00/10. Genetically modified maize for the expression of the protein Cry1F for achieving resistance to certain Lepidoptera insects and of the PAT protein for achieving tolerance to the herbicide glufosinate ammonium.
7. **NK603 × MON 810 Maize** from Monsanto Europe S.A. 270-272 Avenue de Tervuren, B-1150 Brussels, Belgium, registration number C/GB/02/M3/03. Consists of conventionally bred hybrid maize varieties by crossing the genetically modified varieties NK603 and MON 810. NK603 × MON 810 Maize transgenically expresses the protein CP4 EPSPS, obtained from *Agrobacterium sp.* strain CP4, which imparts tolerance to the herbicide Roundup® (contains glyphosate), and also a Cry1Ab toxin obtained from *Bacillus thuringiensis subsp. kurstaki* which brings about tolerance to certain Lepidoptera, include the European corn borer.

Transgenic crops of insect-resistant plants are also described in BATS (Zentrum für Biosicherheit und Nachhaltigkeit, Zentrum BATS, Clarastrasse 13, 4058 Basel, Switzerland) Report 2003, (<http://bats.ch>).

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

[0086] Crops may also be modified for enhanced resistance to fungal (for example Fusarium, Anthracnose, or Phytophthora), bacterial (for example Pseudomonas) or viral (for example potato leafroll virus, tomato spotted wilt virus, cucumber mosaic virus) pathogens.

[0087] Crops also include those that have enhanced resistance to nematodes, such as the soybean cyst nematode. Crops that are tolerance to abiotic stress include those that have enhanced tolerance to drought, high salt, high temperature, chill, frost, or light radiation, for example through expression of NF-YB or other proteins known in the art.

[0088] Antipathogenic substances which can be expressed by such transgenic plants include, for example, ion channel blockers, such as blockers for sodium and calcium channels, for example the viral KP1, KP4 or KP6 toxins; stilbene synthases; bibenzyl synthases; chitinases; glucanases; the so-called "pathogenesis-related proteins" (PRPs; see e.g. EP-A-0 392 225); antipathogenic substances produced by microorganisms, for example peptide antibiotics or heterocyclic antibiotics (see e.g. WO 95/33818) or protein or polypeptide factors involved in plant pathogen defence (so-called "plant disease resistance genes", as described in WO 03/000906).

[0089] Further areas of use of the compositions according to the invention are the protection of stored goods and store rooms and the protection of raw materials, such as wood, textiles, floor coverings or buildings, and also in the hygiene sector, especially the protection of humans, domestic animals and productive livestock against pests of the mentioned type.

[0090] The present invention also provides a method for controlling pests (such as mosquitoes and other disease vectors; see also http://www.who.int/malaria/vector_control/irs/en/). In one embodiment, the method for controlling pests comprises applying the compositions of the invention to the target pests, to their locus or to a surface or substrate by brushing, rolling, spraying, spreading or dipping. By way of example, an IRS (indoor residual spraying) application of a surface such as a wall, ceiling or floor surface is contemplated by the method of the invention. In another embodiment, it is contemplated to apply such compositions to a substrate such as non-woven or a fabric material in the form of (or which can be used in the manufacture of) netting, clothing, bedding, curtains and tents.

EP 3 183 245 B1

[0091] In one embodiment, the method for controlling such pests comprises applying a pesticidally effective amount of the compositions of the invention to the target pests, to their locus, or to a surface or substrate so as to provide effective residual pesticidal activity on the surface or substrate. Such application may be made by brushing, rolling, spraying, spreading or dipping the pesticidal composition of the invention. By way of example, an IRS application of a surface such as a wall, ceiling or floor surface is contemplated by the method of the invention so as to provide effective residual pesticidal activity on the surface. In another embodiment, it is contemplated to apply such compositions for residual control of pests on a substrate such as a fabric material in the form of (or which can be used in the manufacture of) netting, clothing, bedding, curtains and tents.

[0092] Substrates including non-woven, fabrics or netting to be treated may be made of natural fibres such as cotton, raffia, jute, flax, sisal, hessian, or wool, or synthetic fibres such as polyamide, polyester, polypropylene, polyacrylonitrile or the like. The polyesters are particularly suitable. The methods of textile treatment are known, e.g. WO 2008/151984, WO 2003/034823, US 5631072, WO 2005/64072, WO2006/128870, EP 1724392, WO 2005113886 or WO 2007/090739.

[0093] Further areas of use of the compositions according to the invention are the field of tree injection/trunk treatment for all ornamental trees as well all sort of fruit and nut trees.

[0094] In the field of tree injection/trunk treatment, the compounds according to the present invention are especially suitable against wood-boring insects from the order *Lepidoptera* as mentioned above and from the order *Coleoptera*, especially against woodborers listed in the following tables A and B:

Table A. Examples of exotic woodborers of economic importance.

Family	Species	Host or Crop Infested
Buprestidae	<i>Agilus planipennis</i>	Ash
Cerambycidae	<i>Anoplura glabripennis</i>	Hardwoods
Scolytidae	<i>Xylosandrus crassiusculus</i>	Hardwoods
	<i>X. mutilatus</i>	Hardwoods
	<i>Tomicus piniperda</i>	Conifers

Table B. Examples of native woodborers of economic importance.

Family	Species	Host or Crop Infested
Buprestidae	<i>Agilus anxius</i>	Birch
	<i>Agilus politus</i>	Willow, Maple
	<i>Agilus sayi</i>	Bayberry, Sweetfern
	<i>Agilus vittaticollis</i>	Apple, Pear, Cranberry, Serviceberry, Hawthorn
	<i>Chrysobothris femorata</i>	Apple, Apricot, Beech, Boxelder, Cherry, Chestnut, Currant, Elm, Hawthorn, Hackberry, Hickory, Horsechestnut, Linden, Maple, Mountain-ash, Oak, Pecan, Pear, Peach, Persimmon, Plum, Poplar, Quince, Redbud, Serviceberry, Sycamore, Walnut, Willow
	<i>Texania campestris</i>	Basswood, Beech, Maple, Oak, Sycamore, Willow, Yellow-poplar
Cerambycidae	<i>Goes pulverulentus</i>	Beech, Elm, Nuttall, Willow, Black oak, Cherrybark oak, Water oak, Sycamore
	<i>Goes tigrinus</i>	Oak
	<i>Neoclytus acuminatus</i>	Ash, Hickory, Oak, Walnut, Birch, Beech, Maple, Eastern hophornbeam, Dogwood, Persimmon, Redbud, Holly, Hackberry, Black locust, Honeylocust, Yellow-poplar, Chestnut, Osage-orange, Sassafras, Lilac, Mountain-mahogany, Pear, Cherry, Plum, Peach, Apple, Elm, Basswood, Sweetgum

EP 3 183 245 B1

(continued)

Family	Species	Host or Crop Infested
	<i>Neoptychodes trilineatus</i>	Fig, Alder, Mulberry, Willow, Nettleleaf hackberry
	<i>Oberea ocellata</i>	Sumac, Apple, Peach, Plum, Pear, Currant, Blackberry
	<i>Oberea tripunctata</i>	Dogwood, Viburnum, Elm, Sourwood, Blueberry, Rhododendron, Azalea, Laurel, Poplar, Willow, Mulberry
	<i>Oncideres cingulata</i>	Hickory, Pecan, Persimmon, Elm, Sourwood, Basswood, Honeylocust, Dogwood, Eucalyptus, Oak, Hackberry, Maple, Fruit trees
	<i>Saperda Calcarata</i>	Poplar
	<i>Strophiona nitens</i>	Chestnut, Oak, Hickory, Walnut, Beech, Maple
Scolytidae	<i>Corthylus columbianus</i>	Maple, Oak, Yellow-poplar, Beech, Boxelder, Sycamore, Birch, Basswood, Chestnut, Elm
	<i>Dendroctonus frontalis</i>	Pine
	<i>Dryocoetes betulae</i>	Birch, Sweetgum, Wild cherry, Beech, Pear
	<i>Monarthrum fasciatum</i>	Oak, Maple, Birch, Chestnut, Sweetgum, Blackgum, Poplar, Hickory, Mimosa, Apple, Peach, Pine
	<i>Phloeotribus liminaris</i>	Peach, Cherry, Plum, Black cherry, Elm, Mulberry, Mountain-ash
	<i>Pseudopityophthorus pruinus</i>	Oak, American beech, Black cherry, Chickasaw plum, Chestnut, Maple, Hickory, Hornbeam, Hophornbeam
Sesiidae	<i>Paranthrene simulans</i>	Oak, American chestnut
	<i>Sannina uroceriformis</i>	Persimmon
	<i>Synanthedon exitiosa</i>	Peach, Plum, Nectarine, Cherry, Apricot, Almond, Black cherry
	<i>Synanthedon pictipes</i>	Peach, Plum, Cherry, Beach, Black Cherry
	<i>Synanthedon rubrofascia</i>	Tupelo
	<i>Synanthedon scitula</i>	Dogwood, Pecan, Hickory, Oak, Chestnut, Beech, Birch, Black cherry, Elm, Mountain-ash, Viburnum, Willow, Apple, Loquat, Ninebark, Bayberry
	<i>Vitacea polistiformis</i>	Grape

[0095] The present invention may be also used to control any insect pests that may be present in turfgrass, including for example beetles, caterpillars, fire ants, ground pearls, millipedes, sow bugs, mites, mole crickets, scales, mealybugs ticks, spittlebugs, southern chinch bugs and white grubs. The present invention may be used to control insect pests at various stages of their life cycle, including eggs, larvae, nymphs and adults.

In particular, the present invention may be used to control insect pests that feed on the roots of turfgrass including white grubs (such as *Cyclocephala* spp. (e.g. masked chafer, *C. lurida*), *Rhizotrogus* spp. (e.g. European chafer, *R. majalis*), *Cotinus* spp. (e.g. Green June beetle, *C. nitida*), *Popillia* spp. (e.g. Japanese beetle, *P. japonica*), *Phyllophaga* spp. (e.g. May/June beetle), *Ataenius* spp. (e.g. Black turfgrass ataenius, *A. spretulus*), *Maladera* spp. (e.g. Asiatic garden beetle, *M. castanea*) and *Tomarus* spp.), ground pearls (*Margarodes* spp.), mole crickets (tawny, southern, and short-winged; *Scapteriscus* spp., *Gryllotalpa africana*) and leatherjackets (European crane fly, *Tipula* spp.).

The present invention may also be used to control insect pests of turfgrass that are thatch dwelling, including armyworms (such as fall armyworm *Spodoptera frugiperda*, and common armyworm *Pseudaletia unipuncta*), cutworms, billbugs (*Sphenophorus* spp., such as *S. venatus* *verstitus* and *S. parvulus*), and sod webworms (such as *Crambus* spp. and the tropical sod webworm, *Herpetogramma phaeopteralis*).

The present invention may also be used to control insect pests of turfgrass that live above the ground and feed on the turfgrass leaves, including chinch bugs (such as southern chinch bugs, *Blissus insularis*), Bermudagrass mite (*Eriophyes cynodoniensis*), rhodesgrass mealybug (*Antonina graminis*), two-lined spittlebug (*Prospapia bicincta*), leafhoppers, cut-

worms (*Noctuidae* family), and greenbugs. The present invention may also be used to control other pests of turfgrass such as red imported fire ants (*Solenopsis invicta*) that create ant mounds in turf.

[0096] In the hygiene sector, the compositions according to the invention are active against ectoparasites such as hard ticks, soft ticks, mange mites, harvest mites, flies (biting and licking), parasitic fly larvae, lice, hair lice, bird lice and fleas.

Examples of such parasites are:

Of the order Anoplurida: *Haematopinus* spp., *Linognathus* spp., *Pediculus* spp. and *Phtirus* spp., *Solenopotes* spp..

[0097] Of the order Mallophagida: *Trimenopon* spp., *Menopon* spp., *Trinoton* spp., *Bovicola* spp., *Werneckiella* spp., *Lepikentron* spp., *Damalina* spp., *Trichodectes* spp. and *Felicola* spp..

[0098] Of the order Diptera and the suborders Nematocera and Brachycera, for example *Aedes* spp., *Anopheles* spp., *Culex* spp., *Simulium* spp., *Eusimulium* spp., *Phlebotomus* spp., *Lutzomyia* spp., *Culicoides* spp., *Chrysops* spp., *Hybomitra* spp., *Atylotus* spp., *Tabanus* spp., *Haematopota* spp., *Philipomyia* spp., *Braula* spp., *Musca* spp., *Hydrotaea* spp., *Stomoxys* spp., *Haematobia* spp., *Morellia* spp., *Fannia* spp., *Glossina* spp., *Calliphora* spp., *Lucilia* spp., *Chrysomyia* spp., *Wohlfahrtia* spp., *Sarcophaga* spp., *Oestrus* spp., *Hypoderma* spp., *Gasterophilus* spp., *Hippobosca* spp., *Lipoptena* spp. and *Melophagus* spp..

[0099] Of the order Siphonaptera, for example *Pulex* spp., *Ctenocephalides* spp., *Xenopsylla* spp., *Ceratophyllus* spp..

[0100] Of the order Heteroptera, for example *Cimex* spp., *Triatoma* spp., *Rhodnius* spp., *Panstrongylus* spp..

[0101] Of the order Blattaria, for example *Blatta orientalis*, *Periplaneta americana*, *Blattella germanica* and *Supella* spp..

[0102] Of the subclass Acaria (Acarida) and the orders Meta- and Meso-stigmata, for example *Argas* spp., *Ornithodoros* spp., *Otobius* spp., *Ixodes* spp., *Amblyomma* spp., *Boophilus* spp., *Dermacentor* spp., *Haemophysalis* spp., *Hyalomma* spp., *Rhipicephalus* spp., *Dermanyssus* spp., *Raillietia* spp., *Pneumonyssus* spp., *Sternostoma* spp. and *Varroa* spp..

[0103] Of the orders Actiniedida (Prostigmata) and Acaridida (Astigmata), for example *Acarapis* spp., *Cheyletiella* spp., *Ornithocheyletia* spp., *Myobia* spp., *Psorergatesspp.*, *Demodex* spp., *Trombicula* spp., *Listrophorus* spp., *Acarus* spp., *Tyrophagus* spp., *Caloglyphus* spp., *Hypodectes* spp., *Pterolichus* spp., *Psoroptes* spp., *Chorioptes* spp., *Otodectes* spp., *Sarcoptes* spp., *Notoedres* spp., *Knemidocoptes* spp., *Cytodites* spp. and *Laminosioptes* spp..

[0104] The compositions according to the invention are also suitable for protecting against insect infestation in the case of materials such as wood, textiles, plastics, adhesives, glues, paints, paper and card, leather, floor coverings and buildings.

[0105] The compositions according to the invention can be used, for example, against the following pests: beetles such as *Hylotrupes bajulus*, *Chlorophorus pilosis*, *Anobium punctatum*, *Xestobium rufovillosum*, *Ptilinuspecticornis*, *Dendrobium pertinex*, *Ernobius mollis*, *Priobium carpini*, *Lyctus brunneus*, *Lyctus africanus*, *Lyctus planicollis*, *Lyctus linearis*, *Lyctus pubescens*, *Trogoxylon aequale*, *Minthesrugicollis*, *Xyleborus spec.*, *Tryptodendron spec.*, *Apate monachus*, *Bostrychus capucins*, *Heterobostrychus brunneus*, *Sinoxylon spec.* and *Dinoderus minutus*, and also hymenoptera such as *Sirex juvencus*, *Urocerus gigas*, *Urocerus gigas taignus* and *Urocerus augur*, and termites such as *Kaloterms flavicollis*, *Cryptotermes brevis*, *Heterotermes indicola*, *Reticulitermes flavipes*, *Reticulitermes santonensis*, *Reticulitermes lucifugus*, *Mastotermes darwiniensis*, *Zootermopsis nevadensis* and *Coptotermes formosanus*, and bristletails such as *Lepisma saccharina*.

[0106] The compounds according to the invention can be used as pesticidal agents in unmodified form, but they are generally formulated into compositions in various ways using formulation adjuvants, such as carriers, solvents and surface-active substances. The formulations can be in various physical forms, e.g. in the form of dusting powders, gels, wettable powders, water-dispersible granules, water-dispersible tablets, effervescent pellets, emulsifiable concentrates, microemulsifiable concentrates, oil-in-water emulsions, oil-flowables, aqueous dispersions, oily dispersions, suspo-emulsions, capsule suspensions, emulsifiable granules, soluble liquids, water-soluble concentrates (with water or a water-miscible organic solvent as carrier), impregnated polymer films or in other forms known e.g. from the Manual on Development and Use of FAO and WHO Specifications for Pesticides, United Nations, First Edition, Second Revision (2010). Such formulations can either be used directly or diluted prior to use. The dilutions can be made, for example, with water, liquid fertilisers, micronutrients, biological organisms, oil or solvents.

The formulations can be prepared e.g. by mixing the active ingredient with the formulation adjuvants in order to obtain compositions in the form of finely divided solids, granules, solutions, dispersions or emulsions. The active ingredients can also be formulated with other adjuvants, such as finely divided solids, mineral oils, oils of vegetable or animal origin, modified oils of vegetable or animal origin, organic solvents, water, surface-active substances or combinations thereof. The active ingredients can also be contained in very fine microcapsules. Microcapsules contain the active ingredients in a porous carrier. This enables the active ingredients to be released into the environment in controlled amounts (e.g. slow-release). Microcapsules usually have a diameter of from 0.1 to 500 microns. They contain active ingredients in an amount of about from 25 to 95 % by weight of the capsule weight. The active ingredients can be in the form of a monolithic solid, in the form of fine particles in solid or liquid dispersion or in the form of a suitable solution. The encapsulating

membranes can comprise, for example, natural or synthetic rubbers, cellulose, styrene/butadiene copolymers, polyacrylonitrile, polyacrylate, polyesters, polyamides, polyureas, polyurethane or chemically modified polymers and starch xanthates or other polymers that are known to the person skilled in the art. Alternatively, very fine microcapsules can be formed in which the active ingredient is contained in the form of finely divided particles in a solid matrix of base substance, but the microcapsules are not themselves encapsulated.

The formulation adjuvants that are suitable for the preparation of the compositions according to the invention are known *per se*. As liquid carriers there may be used: water, toluene, xylene, petroleum ether, vegetable oils, acetone, methyl ethyl ketone, cyclohexanone, acid anhydrides, acetonitrile, acetophenone, amyl acetate, 2-butanone, butylene carbonate, chlorobenzene, cyclohexane, cyclohexanol, alkyl esters of acetic acid, diacetone alcohol, 1,2-dichloropropane, diethanolamine, p-diethylbenzene, diethylene glycol, diethylene glycol abietate, diethylene glycol butyl ether, diethylene glycol ethyl ether, diethylene glycol methyl ether, *N,N*-dimethylformamide, dimethyl sulfoxide, 1,4-dioxane, dipropylene glycol, dipropylene glycol methyl ether, dipropylene glycol dibenzoate, diproxitol, alkylpyrrolidone, ethyl acetate, 2-ethylhexanol, ethylene carbonate, 1,1,1-trichloroethane, 2-heptanone, alpha-pinene, d-limonene, ethyl lactate, ethylene glycol, ethylene glycol butyl ether, ethylene glycol methyl ether, gamma-butyrolactone, glycerol, glycerol acetate, glycerol diacetate, glycerol triacetate, hexadecane, hexylene glycol, isoamyl acetate, isobornyl acetate, isooctane, isophorone, isopropylbenzene, isopropyl myristate, lactic acid, laurylamine, mesityl oxide, methoxypropanol, methyl isoamyl ketone, methyl isobutyl ketone, methyl laurate, methyl octanoate, methyl oleate, methylene chloride, m-xylene, n-hexane, n-octylamine, octadecanoic acid, octylamine acetate, oleic acid, oleylamine, o-xylene, phenol, polyethylene glycol, propionic acid, propyl lactate, propylene carbonate, propylene glycol, propylene glycol methyl ether, p-xylene, toluene, triethyl phosphate, triethylene glycol, xylenesulfonic acid, paraffin, mineral oil, trichloroethylene, perchloroethylene, ethyl acetate, amyl acetate, butyl acetate, propylene glycol methyl ether, diethylene glycol methyl ether, methanol, ethanol, isopropanol, and alcohols of higher molecular weight, such as amyl alcohol, tetrahydrofurfuryl alcohol, hexanol, octanol, ethylene glycol, propylene glycol, glycerol, *N*-methyl-2-pyrrolidone and the like.

Suitable solid carriers are, for example, talc, titanium dioxide, pyrophyllite clay, silica, attapulgite clay, kieselguhr, limestone, calcium carbonate, bentonite, calcium montmorillonite, cottonseed husks, wheat flour, soybean flour, pumice, wood flour, ground walnut shells, lignin and similar substances.

[0107] A large number of surface-active substances can advantageously be used in both solid and liquid formulations, especially in those formulations which can be diluted with a carrier prior to use. Surface-active substances may be anionic, cationic, non-ionic or polymeric and they can be used as emulsifiers, wetting agents or suspending agents or for other purposes. Typical surface-active substances include, for example, salts of alkyl sulfates, such as diethanolammonium lauryl sulfate; salts of alkylarylsulfonates, such as calcium dodecylbenzenesulfonate; alkylphenol/alkylene oxide addition products, such as nonylphenol ethoxylate; alcohol/alkylene oxide addition products, such as tridecylalcohol ethoxylate; soaps, such as sodium stearate; salts of alkylnaphthalenesulfonates, such as sodium dibutylnaphthalenesulfonate; dialkyl esters of sulfosuccinate salts, such as sodium di(2-ethylhexyl)sulfosuccinate; sorbitol esters, such as sorbitol oleate; quaternary amines, such as lauryltrimethylammonium chloride, polyethylene glycol esters of fatty acids, such as polyethylene glycol stearate; block copolymers of ethylene oxide and propylene oxide; and salts of mono- and dialkylphosphate esters; and also further substances described e.g. in McCutcheon's Detergents and Emulsifiers Annual, MC Publishing Corp., Ridgewood New Jersey (1981).

Further adjuvants that can be used in pesticidal formulations include crystallisation inhibitors, viscosity modifiers, suspending agents, dyes, anti-oxidants, foaming agents, light absorbers, mixing auxiliaries, antifoams, complexing agents, neutralising or pH-modifying substances and buffers, corrosion inhibitors, fragrances, wetting agents, take-up enhancers, micronutrients, plasticisers, glidants, lubricants, dispersants, thickeners, antifreezes, microbicides, and liquid and solid fertilisers.

The compositions according to the invention can include an additive comprising an oil of vegetable or animal origin, a mineral oil, alkyl esters of such oils or mixtures of such oils and oil derivatives. The amount of oil additive in the composition according to the invention is generally from 0.01 to 10 %, based on the mixture to be applied. For example, the oil additive can be added to a spray tank in the desired concentration after a spray mixture has been prepared. Preferred oil additives comprise mineral oils or an oil of vegetable origin, for example rapeseed oil, olive oil or sunflower oil, emulsified vegetable oil, alkyl esters of oils of vegetable origin, for example the methyl derivatives, or an oil of animal origin, such as fish oil or beef tallow. Preferred oil additives comprise alkyl esters of C₈-C₂₂ fatty acids, especially the methyl derivatives of C₁₂-C₁₈ fatty acids, for example the methyl esters of lauric acid, palmitic acid and oleic acid (methyl laurate, methyl palmitate and methyl oleate, respectively). Many oil derivatives are known from the Compendium of Herbicide Adjuvants, 10th Edition, Southern Illinois University, 2010.

The inventive compositions generally comprise from 0.1 to 99 % by weight, especially from 0.1 to 95 % by weight, of compounds of the present invention and from 1 to 99.9 % by weight of a formulation adjuvant which preferably includes from 0 to 25 % by weight of a surface-active substance. Whereas commercial products may preferably be formulated as concentrates, the end user will normally employ dilute formulations.

The rates of application vary within wide limits and depend on the nature of the soil, the method of application, the crop

EP 3 183 245 B1

plant, the pest to be controlled, the prevailing climatic conditions, and other factors governed by the method of application, the time of application and the target crop. As a general guideline compounds may be applied at a rate of from 1 to 2000 l/ha, especially from 10 to 1000 l/ha.

[0108] Preferred formulations can have the following compositions (weight %):

5

Emulsifiable concentrates:

[0109]

10

active ingredient: 1 to 95 %, preferably 60 to 90 %

surface-active agent: 1 to 30 %, preferably 5 to 20 %

liquid carrier: 1 to 80 %, preferably 1 to 35 %

15

Dusts:

[0110]

20

active ingredient: 0.1 to 10 %, preferably 0.1 to 5 %

solid carrier: 99.9 to 90 %, preferably 99.9 to 99 %

Suspension concentrates:

25

[0111]

active ingredient: 5 to 75 %, preferably 10 to 50 %

water: 94 to 24 %, preferably 88 to 30 %

surface-active agent: 1 to 40 %, preferably 2 to 30 %

30

Wettable powders:

[0112]

35

active ingredient: 0.5 to 90 %, preferably 1 to 80 %

surface-active agent: 0.5 to 20 %, preferably 1 to 15 %

solid carrier: 5 to 95 %, preferably 15 to 90 %

40

Granules:

[0113]

45

active ingredient: 0.1 to 30 %, preferably 0.1 to 15 %

solid carrier: 99.5 to 70 %, preferably 97 to 85 %

[0114] The following Examples further illustrate, but do not limit, the invention.

50

<u>Wettable powders</u>	a)	b)	c)
active ingredients	25 %	50 %	75 %
sodium lignosulfonate	5 %	5 %	-
sodium lauryl sulfate	3 %	-	5 %
sodium diisobutyl-naphthalenesulfonate	-	6 %	10 %
phenol polyethylene glycol ether (7-8 mol of ethylene oxide)	-	2 %	-

55

EP 3 183 245 B1

(continued)

<u>Wettable powders</u>	a)	b)	c)
highly dispersed silicic acid	5 %	10 %	10 %
Kaolin	62 %	27 %	-

[0115] The combination is thoroughly mixed with the adjuvants and the mixture is thoroughly ground in a suitable mill, affording wettable powders that can be diluted with water to give suspensions of the desired concentration.

<u>Powders for dry seed treatment</u>	a)	b)	c)
active ingredients	25 %	50 %	75 %
light mineral oil	5 %	5 %	5 %
highly dispersed silicic acid	5 %	5 %	-
Kaolin	65 %	40 %	-
Talcum	-		20

[0116] The combination is thoroughly mixed with the adjuvants and the mixture is thoroughly ground in a suitable mill, affording powders that can be used directly for seed treatment.

<u>Emulsifiable concentrate</u>	
active ingredients	10 %
octylphenol polyethylene glycol ether (4-5 mol of ethylene oxide)	3 %
calcium dodecylbenzenesulfonate	3 %
castor oil polyglycol ether (35 mol of ethylene oxide)	4 %
Cyclohexanone	30 %
xylene mixture	50 %

[0117] Emulsions of any required dilution, which can be used in plant protection, can be obtained from this concentrate by dilution with water.

<u>Dusts</u>	a)	b)	c)
Active ingredients	5 %	6 %	4 %
Talcum	95 %	-	-
Kaolin	-	94 %	-
mineral filler	-	-	96 %

[0118] Ready-for-use dusts are obtained by mixing the combination with the carrier and grinding the mixture in a suitable mill. Such powders can also be used for dry dressings for seed.

<u>Extruder granules</u>	
Active ingredients	15 %
sodium lignosulfonate	2 %
carboxymethylcellulose	1 %
Kaolin	82 %

EP 3 183 245 B1

[0119] The combination is mixed and ground with the adjuvants, and the mixture is moistened with water. The mixture is extruded and then dried in a stream of air.

Coated granules	
Active ingredients	8 %
polyethylene glycol (mol. wt. 200)	3 %
Kaolin	89 %

[0120] The finely ground combination is uniformly applied, in a mixer, to the kaolin moistened with polyethylene glycol. Non-dusty coated granules are obtained in this manner.

Suspension concentrate

[0121]

active ingredients	40 %
propylene glycol	10 %
nonylphenol polyethylene glycol ether (15 mol of ethylene oxide)	6 %
Sodium lignosulfonate	10 %
carboxymethylcellulose	1 %
silicone oil (in the form of a 75 % emulsion in water)	1 %
Water	32 %

[0122] The finely ground combination is intimately mixed with the adjuvants, giving a suspension concentrate from which suspensions of any desired dilution can be obtained by dilution with water. Using such dilutions, living plants as well as plant propagation material can be treated and protected against infestation by microorganisms, by spraying, pouring or immersion.

Flowable concentrate for seed treatment

[0123]

active ingredients	40 %
propylene glycol	5 %
copolymer butanol PO/EO	2 %
Tristyrenephenole with 10-20 moles EO	2 %
1,2-benzisothiazolin-3-one (in the form of a 20% solution in water)	0.5 %
monoazo-pigment calcium salt	5 %
Silicone oil (in the form of a 75 % emulsion in water)	0.2 %
Water	45.3 %

[0124] The finely ground combination is intimately mixed with the adjuvants, giving a suspension concentrate from which suspensions of any desired dilution can be obtained by dilution with water. Using such dilutions, living plants as well as plant propagation material can be treated and protected against infestation by microorganisms, by spraying, pouring or immersion.

Slow Release Capsule Suspension

[0125] 28 parts of the combination are mixed with 2 parts of an aromatic solvent and 7 parts of toluene diisocyanate/polymethylene-polyphenylisocyanate-mixture (8:1). This mixture is emulsified in a mixture of 1.2 parts of polyvinylalcohol, 0.05 parts of a defoamer and 51.6 parts of water until the desired particle size is achieved. To this emulsion a mixture of 2.8 parts 1,6-diaminohexane in 5.3 parts of water is added. The mixture is agitated until the polymerization reaction is completed. The obtained capsule suspension is stabilized by adding 0.25 parts of a thickener and 3 parts of a dispersing agent. The capsule suspension formulation contains 28% of the active ingredients. The medium capsule diameter is 8-15 microns. The resulting formulation is applied to seeds as an aqueous suspension in an apparatus suitable for that purpose.

[0126] Formulation types include an emulsion concentrate (EC), a suspension concentrate (SC), a suspo-emulsion (SE), a capsule suspension (CS), a water dispersible granule (WG), an emulsifiable granule (EG), an emulsion, water in oil (EO), an emulsion, oil in water (EW), a micro-emulsion (ME), an oil dispersion (OD), an oil miscible flowable (OF), an oil miscible liquid (OL), a soluble concentrate (SL), an ultra-low volume suspension (SU), an ultra-low volume liquid (UL), a technical concentrate (TK), a dispersible concentrate (DC), a wettable powder (WP), a soluble granule (SG) or any technically feasible formulation in combination with agriculturally acceptable adjuvants.

Preparatory Examples:

[0127] "Mp" means melting point in °C. Free radicals represent methyl groups. ¹H NMR measurements were recorded on a Bruker 400MHz spectrometer, chemical shifts are given in ppm relevant to a TMS standard. Spectra measured in deuterated solvents as indicated. Either one of the LCMS methods below was used to characterize the compounds. The characteristic LCMS values obtained for each compound were the retention time ("Rt", recorded in minutes) and the measured molecular ion (M+H)⁺ or (M-H)⁻.

LCMS Methods:Method 1:

[0128] Spectra were recorded on a Mass Spectrometer from Waters (ZQ Single quadrupole mass spectrometer) equipped with an electrospray source (Polarity: positive or negative ions, Capillary: 3.00 kV, Cone range: 30-60 V, Extractor: 2.00 V, Source Temperature: 150°C, Desolvation Temperature: 350°C, Cone Gas Flow: 0 L/Hr, Desolvation Gas Flow: 650 L/Hr, Mass range: 100 to 900 Da) and an Acquity UPLC from Waters: Binary pump, heated column compartment and diode-array detector. Solvent degasser, binary pump, heated column compartment and diode-array detector. Column: Waters UPLC HSS T3, 1.8 μm, 30 x 2.1 mm, Temp: 60 °C, DAD Wavelength range (nm): 210 to 500, Solvent Gradient: A = water + 5% MeOH + 0.05 % HCOOH, B= Acetonitrile + 0.05 % HCOOH; gradient: 0 min 0% B, 100% A; 2.7-3.0 min 100% B; Flow (ml/min) 0.85.

Method 2:

[0129] Spectra were recorded on an ACQUITY SQD Mass Spectrometer from Waters (Single quadrupole mass spectrometer), Ionisation method: Electrospray, Polarity: positive ions, Capillary (kV) 3.00, Cone (V) 20.00, Extractor (V) 3.00, Source Temperature (°C) 150, Desolvation Temperature (°C) 400, Cone Gas Flow (L/Hr) 60, Desolvation Gas Flow (L/Hr) 700, Mass range: 100 to 800 Da, DAD Wavelength range (nm): 210 to 400. Method Waters ACQUITY UPLC with the following HPLC gradient conditions (Solvent A: Water/Methanol 9:1, 0.1% formic acid and Solvent B: Acetonitrile, 0.1% formic acid)

Time (minutes)	A (%)	B (%)	Flow rate (ml/min)
0	100	0	0.75
2.5	0	100	0.75
2.8	0	100	0.75
3.0	100	0	0.75

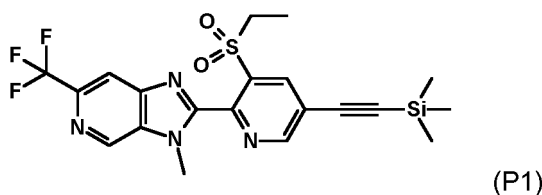
Type of column: Waters ACQUITY UPLC HSS T3; Column length: 30 mm; Internal diameter of column: 2.1 mm; Particle Size: 1.8 micron; Temperature: 60°C.

EXAMPLE P1: Preparation of 2-[5-ethylsulfonyl-6-[3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridin-2-yl]-3-pyridyl]ethynyl-trimethyl-silane (compound P1)

[0130]

5

10



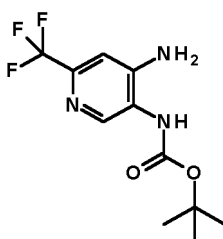
Step A-1: Preparation of tert-butyl N-[4-amino-6-(trifluoromethyl)-3-pyridyl]carbamate

15

[0131]

20

25



[0132] To a solution of 6-(trifluoromethyl)pyridine-3,4-diamine (3.140 g, 17.73 mmol)(commercially available) in tetrahydrofuran (50 ml), was added tert-butoxycarbonyl tert-butyl carbonate (4.643 g, 1.2 equiv.). The reaction mixture was stirred at 50°C for 20 hours, after which time, more tert-butoxycarbonyl tert-butyl carbonate (1.1 g, 0.3 equiv.) was added. After 20 more hours stirring, the reaction mixture was evaporated under reduced pressure to leave a solid residue which was taken-up in dichloromethane, cooled to 0°C and the resulting suspension filtered. The crystalline residue was tert-butyl N-[4-amino-6-(trifluoromethyl)-3-pyridyl]carbamate. LCMS (method 1): 278 (M+H)⁺; retention time: 0.79 min. ¹H NMR (400 MHz, CD₃CN) δ ppm: 8.28 (s, 1 H); 7.09 (s, 1 H); 6.94 (br. s, 1 H); 5.24 (br. s, 2 H); 1.50 (s, 9H).

30

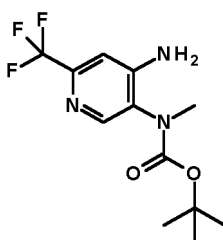
35

Step A-2: Preparation of tert-butyl N-[4-amino-6-(trifluoromethyl)-3-pyridyl]-N-methyl-carbamate

[0133]

40

45



A solution of tert-butyl N-[4-amino-6-(trifluoromethyl)-3-pyridyl]carbamate (synthesis described here above) (3.920 g, 14.14 mmol) in N,N-dimethylformamide (20 ml) was added to a stirred suspension of sodium hydride (0.648 g, 1.05 equiv.) in N,N-dimethylformamide (30 ml) over 20 minutes at 20-25°C. Fifteen minutes after the gas evolution ceased, iodomethane (2.21 g, 1.1 equiv.) was added. The temperature rose to 30°C and was kept at this level for 30 minutes. The reaction mixture was then poured cautiously onto water (200 ml) and the product was extracted twice with ethyl acetate. The organic phase was washed with brine, dried over sodium sulfate and evaporated under reduced pressure. The obtained pale brown solid was purified by column chromatography over silica gel, eluting with a mixture of ethyl acetate and heptanes. After recrystallization from ethyl acetate-heptanes, the tert-butyl N-[4-amino-6-(trifluoromethyl)-3-pyridyl]-N-methyl-carbamate was isolated as colorless crystals. LCMS (method 1): 292 (M+H)⁺; retention time: 0.85 min. ¹H NMR (400 MHz, CDCl₃) δ ppm: 8.21 (s, 1 H); 7.00 (s, 1 H); 5.58 (br. s, 2 H); 3.18 (s, 3H); 1.43 (s, 9H).

50

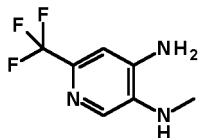
55

EP 3 183 245 B1

Step A-3: Preparation of N3-methyl-6-(trifluoromethyl)pyridine-3,4-diamine

[0134]

5



10

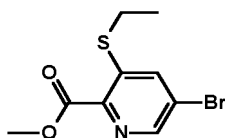
[0135] A solution of tert-butyl N-[4-amino-6-(trifluoromethyl)-3-pyridyl]-N-methyl-carbamate (3.530 g, 12.12 mmol) (preparation described here above) in 1,4-dioxane (50 ml) was treated with 2N aqueous HCl solution (18.18 ml, 3 equiv.) and the resulting mixture was heated. Gas evolution started at around 70°C until the reaction mixture had boiled for 20 minutes. Most of the dioxane was then removed under reduced pressure and the residual solution was treated with sodium bicarbonate (3.1 g, 36.9 mmol) after cooling down to 20°C. There was formation of a thick slurry that was extracted with ethyl acetate. The organic phase was washed with brine, dried over sodium sulfate and concentrated under reduced pressure. The title compound was obtained as colorless crystals. LCMS (method 1): 192 (M+H)⁺; retention time: 0.25 min. ¹H NMR (400 MHz, CDCl₃) δ ppm: 7.90 (s, 1 H); 6.93 (s, 1 H); 4.09 (br s, 2 H); 3.40 (br s, 1H); 2.95 (s, 3 H).

15

20 Step B-1: Preparation of methyl 5-bromo-3-ethylsulfanyl-pyridine-2-carboxylate

[0136]

25



[0137] To a solution of methyl 5-bromo-3-chloro-pyridine-2-carboxylate (0.100 g, 0.399 mmol) (commercial product) in tetrahydrofuran, stirred at 0°C, was added ethylsulfanylsodium (0.034 g, 1 equiv.). After 1 hour at that temperature, the ice bath was removed and stirring was continued for 20 hours. The reaction mixture was then poured onto water (15 ml) and extracted twice with ethyl acetate. The organic phases were dried over sodium sulfate and the solvent was removed. The residue was submitted to flash chromatography over silica gel and the selected fractions evaporated to yield methyl 5-bromo-3-ethylsulfanyl-pyridine-2-carboxylate as a colorless solid. LCMS (method 1): 276, 278 (M+H)⁺; retention time: 0.92 min. ¹H NMR (400 MHz, CDCl₃) δ ppm: 8.46 (s, 1 H); 7.79 (s, 1 H); 4.00 (s, 3 H); 2.94 (q, J = 7.4 Hz, 2H); 1.42 (t, J = 7.4 Hz, 3H).

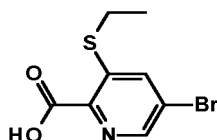
35

40 Step B-2: Preparation of 5-bromo-3-ethylsulfanyl-pyridine-2-carboxylic acid

40

[0138]

45

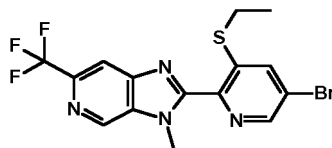


[0139] A solution of methyl 5-bromo-3-ethylsulfanyl-pyridine-2-carboxylate (3.900 g, 14.12 mmol) (preparation described here above) in a mixture of methyl alcohol (75 ml) and water (20 ml) stirred at 20°C was treated with 2N aqueous sodium hydroxide solution (7.04 ml, 1.05 equiv.). The mixture was stirred for two hours, then most of the alcohol was eliminated under reduced pressure. The residue was then treated with 2N aqueous HCl solution and the resulting precipitate was filtered off, washed with water and dried under vacuum. The title compound was obtained as a colorless solid. LCMS (method 1): 260, 262 (M-H)⁻; retention time: 0.77 min. ¹H NMR (400 MHz, d6-DMSO) δ ppm: 13.4 (br s, 1 H); 8.50 (s, 1 H); 8.07 (s, 1 H); 3.04 (q, J=7.53 Hz, 2 H); 1.27 (t, J=7.53 Hz, 3 H).

55

Step C-1: Preparation of 2-(5-bromo-3-ethylsulfanyl-2-pyridyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine:

[0140]

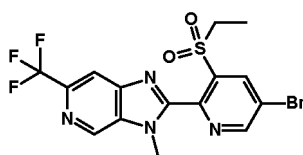


[0141] To a suspension of 5-bromo-3-ethylsulfanyl-pyridine-2-carboxylic acid (2.800 g, 10.68 mmol) in dichloromethane (10 ml) was added one drop of N,N-dimethylformamide, followed by oxalyl chloride (2.034 g, 1.400 ml, 1.5 equiv.). After the end of gas evolution, the reaction mixture was a pale red solution. The latter was evaporated under reduced pressure at a bath temperature of 60°C. The residue formed dark red crystals of 5-bromo-3-ethylsulfanyl-pyridine-2-carbonyl chloride. To a clear solution of N3-methyl-6-(trifluoromethyl)pyridine-3,4-diamine (2.042 g, 10.68 mmol) in tetrahydrofuran (30 ml) was added a solution of the 5-bromo-3-ethylsulfanyl-pyridine-2-carbonyl chloride (described here above) dissolved in tetrahydrofuran (20 ml). The resulting mixture was heated to reflux temperature. A bulky white precipitate formed. After cooling to 20°C, the mixture was filtered and the filtrate evaporated under reduced pressure. The residue and the filter cake were combined and dissolved into water. The solution was neutralized by addition of a saturated aqueous solution of sodium bicarbonate and the product was extracted twice with ethyl acetate. The organic solution was dried over sodium sulfate and evaporated under reduced pressure to yield the crude product as a dark brown gum. This gum was taken-up into *meta*-xylene (10 ml), *para*-toluenesulfonic acid (mono hydrate) (2.032 g, 1 equiv.) was added and the mixture was heated up to 150°C for 8 hours. The reaction mixture was then poured onto water (300 ml) and extracted twice with ethyl acetate. The crude dark brown product, after evaporation of the solvent under reduced pressure, was purified by column chromatography over silica gel, eluting with ethyl acetate in heptanes. The selected fractions were evaporated to yield the title compound as a colorless solid. LCMS (method 1): 417, 419 (M+H)⁺; retention time: 1.04 min. ¹H NMR (400 MHz, CDCl₃) δ ppm: 8.96 (s, 1 H); 8.56 (s, 1 H); 8.20 (s, 1 H); 7.88 (s, 1 H); 4.07 (s, 3 H); 2.98 (q, J= 7.44 Hz, 2 H); 1.38 (t, J= 7.44 Hz, 3H).

[0142] Similarly, 2-(4-bromo-2-ethylsulfanyl-phenyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (solid, mp 113-114°C) may be obtained from 4-bromo-2-ethylsulfanyl-benzoic acid and N3-methyl-6-(trifluoromethyl)pyridine-3,4-diamine. LCMS (method 1): 417, 419 (M+H)⁺; retention time: 1.04 min. ¹H NMR (400 MHz, CDCl₃) δ ppm: 8.96 (s, 1 H); 8.56 (s, 1 H); 8.20 (s, 1 H); 7.88 (s, 1 H); 4.07 (s, 3 H); 2.98 (q, J= 7.44 Hz, 2 H); 1.38 (t, J= 7.44 Hz, 3H).

Step C-2: Preparation of 2-(5-bromo-3-ethylsulfonyl-2-pyridyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine

[0143]



[0144] A solution of 2-(5-bromo-3-ethylsulfanyl-2-pyridyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (2.000 g, 4.79 mmol) in dichloromethane (50 ml) was stirred in an ice bath and *meta*-chloroperbenzoic acid (2.54 g, 70% purity, 2.5 equiv.) was added in portions, in such a way that the temperature of the reaction mixture was kept below 10°C. The bath was then removed and the mixture was stirred 4 further hours at 20°C. After completion of the reaction, the mixture was stirred with saturated aqueous sodium bicarbonate solution. The phases were separated and the aqueous phase was extracted with dichloromethane. The organic layers were combined, dried over sodium sulfate and evaporated. The residue was subjected to column chromatography over silica gel, eluting with ethyl acetate in heptanes. The selected fractions were evaporated and the residue was triturated with heptanes to yield the title compound as colorless solid. LCMS (method 1): 449, 451 (M+H)⁺; retention time: 0.95 min. ¹H NMR (400 MHz, CDCl₃) δ ppm: 9.06 (s, 1 H); 9.00 (s, 1 H); 8.68 (s, 1 H); 8.11 (s, 1 H); 3.90 (s, 3 H); 3.82 (q, 2 H); 1.38 (t, 3H).

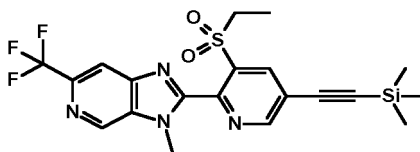
[0145] Similarly, 2-(4-bromo-2-ethylsulfonyl-phenyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (solid, mp 180-181 °C) may be obtained from 2-(4-bromo-2-ethylsulfanyl-phenyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine. LCMS (method 1): 448/450 (M+H)⁺; retention time: 0.95 min. ¹H NMR (400 MHz, CDCl₃) δ ppm: 1.27 (t, 3H), 3.38 (q, 2H), 3.74 (s, 3H), 7.43 (d, 1H), 7.98 (dd, 1H), 8.09 (d, 1H), 8.37 (d, 1H), 8.95 (s, 1H).

EP 3 183 245 B1

Step C-3: Preparation of 2-[5-ethylsulfonyl-6-[3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridin-2-yl]-3-pyridyl]ethynyl-trimethyl-silane (compound P1):

[0146]

5



10

[0147] A mixture of 2-(5-bromo-3-ethylsulfonyl-2-pyridyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (0.100 g, 0.223 mmol), N-ethyl-N-isopropyl-propan-2-amine (0.116 g, 4.0 equiv.), trimethylsilyl-acetylene (0.066 g, 3.0 equiv.) and copper(I) iodide (0.004 g, 0.1 equiv.) in tetrahydrofuran (4.0 ml) was charged in a vial equipped with a magnetic stirring bar. Argon was bubbled through it for a few minutes, then bis triphenylphosphine palladium dichloride (0.016 g, 0.1 equiv.) was added. The reaction mixture turned from light yellow to light brown within a few minutes. The reaction mixture was stirred at 20°C under inert atmosphere for 22 hours. The reaction was followed by TLC analysis on silica gel, until the consumption of the starting bromide. The reaction mixture was then diluted with ethyl acetate and washed with 1N aqueous HCl, then dried over sodium sulfate. After evaporation of the solvent under reduced pressure, the residue was submitted to flash chromatography over silica gel, eluting with a mixture of ethyl acetate and heptanes. Evaporation of the selected fractions yielded the title compound P1 as a solid. LCMS (method 1): 468 (M+H)⁺; retention time: 1.17 min. ¹H NMR (400 MHz, CDCl₃) δ ppm: 8.92 (s, 2 H); 8.54 (s, 1 H); 8.10 (s, 1 H); 3.79 (s, 3 H); 3.80 (q, J = 7.66 Hz, 2 H); 1.38 (t, J = 7.66 Hz, 3H); 0.34 (s, 9H).

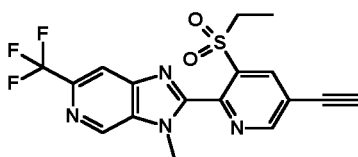
15

20

25 EXAMPLE P2: Preparation of 2-(3-ethylsulfonyl-5-ethynyl-2-pyridyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (compound P2):

[0148]

30



35

(P2)

[0149] A solution of 2-[5-ethylsulfonyl-6-[3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridin-2-yl]-3-pyridyl]ethynyl-trimethyl-silane (compound P1 described above) (0.064 g, 0.137 mmol) in methyl alcohol (2.0 ml) was treated with potassium carbonate (0.048 g, 2.5 equiv.). The reaction mixture turned brown within a few minutes and was stirred at 20°C until disappearance of the starting material (LC-MS analysis). The reaction mixture was then poured onto a 1N aqueous solution of HCl (20 ml) and the resulting mixture was extracted twice with ethyl acetate. The combined organic phases were successively washed with water, brine and dried over sodium sulfate. After removal of the solvent under reduced pressure, the residue was subjected to flash chromatography over silica gel, eluting with a mixture of ethyl acetate and heptanes. Evaporation of the selected fractions yielded the title compound P2 as a colorless solid. LCMS (method 1): 395 (M+H)⁺; retention time: 0.91 min. ¹H NMR (400 MHz, CDCl₃) δ ppm: 9.04 (s, 1H); 8.99 (s, 1 H); 8.58 (s, 1 H); 8.11 (s, 1 H); 3.91 (s, 3 H); 3.82 (q, J = 7.66 Hz, 2 H); 3.54 (s, 1H); 1.38 (t, J = 7.66 Hz, 3H).

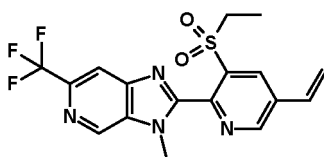
40

45

50 EXAMPLE P3: Preparation of 2-(3-ethylsulfonyl-5-vinyl-2-pyridyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (compound P3):

[0150]

55



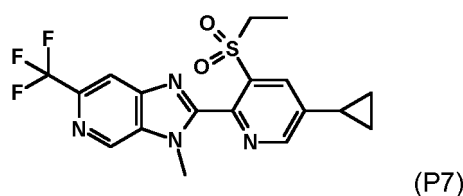
(P3)

EP 3 183 245 B1

[0151] To a solution of 2-(5-bromo-3-ethylsulfonyl-2-pyridyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (preparation described above) (0.051 g, 0.113 mmol) in a mixture of 1,4-dioxane (2.0 ml) and water (0.6 ml), in a vial equipped with a magnetic stirring bar, was added cesium fluoride (0.035 g, 2.0 equiv.). The mixture was flushed with argon, then 4,4,5,5-tetramethyl-2-vinyl-1,3,2-dioxaborolane (0.026 g, 1.5 equiv.) was added, followed by (1,1'-bis(diphenylphosphino)ferrocene)dichloropalladium-dichloromethane (1:1 complex) (0.005 g, 0.05 equiv.). After stirring for 20 hours at 90°C under argon atmosphere, the reaction mixture was cooled down to room temperature and poured on water (20 ml). The resulting mixture was extracted twice with ethyl acetate and the combined organic phases were successively washed with brine and dried over sodium sulfate. After removal of the solvent under reduced pressure, the residue was subjected to flash chromatography over silica gel, eluting with a mixture of ethyl acetate and heptanes. Evaporation of the selected fractions yielded the title compound P3 as a colorless gum. LCMS (method 1): 397 (M+H)⁺; retention time: 0.92 min. ¹H NMR (400 MHz, CDCl₃) δ ppm: 8.98 (s, 1H); 8.96 (s, 1H); 8.50 (s, 1H); 8.10 (s, 1H); 6.87 (dd, J₁ = 17.6 Hz, J₂ = 10.8 Hz, 1H); 6.14 (d, J = 17.6 Hz, 1H); 5.72 (d, J = 10.8 Hz, 1H); 3.89 (s, 3H); 3.70 (q, J = 7.66 Hz, 2H); 1.37 (t, J = 7.66 Hz, 3H).

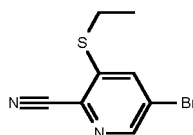
EXAMPLE P4: Preparation of 2-(5-cyclopropyl-3-ethylsulfonyl-2-pyridyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (compound P7):

[0152]



Step 1: Preparation of 5-bromo-3-ethylsulfonyl-pyridine-2-carbonitrile

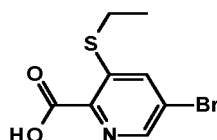
[0153]



[0154] To a solution of 5-bromo-2-cyano-3-nitropyridine (58.0g, 242mmol, 1.0 eq.) in 1000ml N,N-dimethylformamide under argon, sodium ethanethiolate (23.7g, 254 mmol, 1.05 eq.) was slowly added at temperature between -40 and -50°C. The dark mixture was allowed to stir at rt overnight. After dilution with *tert*-butylmethylether, the mixture was quenched with water. The organic layer was washed with water and brine, dried over sodium sulfate, filtrated and evaporated. The crude brown oil was purified by column chromatography, eluting with ethyl acetate/cyclohexane to give a light orange solid. ¹H NMR (400 MHz, CDCl₃) δ ppm: 8.50 (s, 1H); 7.81 (s, 1H); 3.06 (q, 2H); 1.40 (t, 3H).

Step 2: Preparation of 5-bromo-3-ethylsulfonyl-pyridine-2-carboxylic acid

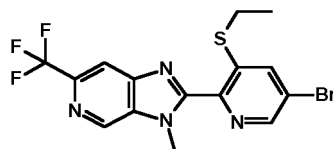
[0155]



[0156] A solution of 5-bromo-3-ethylsulfonyl-pyridine-2-carbonitrile (43g, 170 mmol, 1.0 eq.) in 800ml aqueous hydrogen chloride HCl 32% was heated to 60°C overnight. Dioxane (100ml) was added and the mixture was further stirred at 60°C for 48h. The reaction mixture was cooled to 0-5°C, treated with an aqueous sodium hydroxide solution (NaOH 30%) until pH11 and washed with 2x200ml *tert*-butylmethylether. The water phase was acidified with HCl 10% back to pH4, the resulting solid was filtrated, washed with water and dried in vacuo. LCMS (method 1): 262, 264 (M+H)⁺; retention

EP 3 183 245 B1

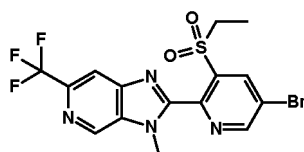
time: 0.77 min. ^1H NMR (400 MHz, CDCl_3) δ ppm: 8.50 (s, 1 H); 8.06 (s, 1 H); 3.03 (q, 2 H); 1.24 (t, 3H). Step 3: Preparation of 2-(5-bromo-3-ethylsulfanyl-2-pyridyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine



Preparation according to EXAMPLE P1, step C-1 above.

Step 4: Preparation of 2-(5-bromo-3-ethylsulfonyl-2-pyridyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine

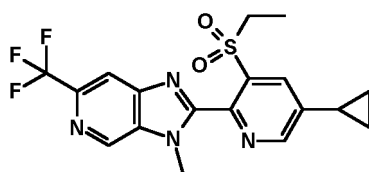
[0157]



Preparation according to EXAMPLE P1, step C-2 above.

Step 5: Preparation of 2-(5-cyclopropyl-3-ethylsulfonyl-2-pyridyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (compound P7)

[0158]



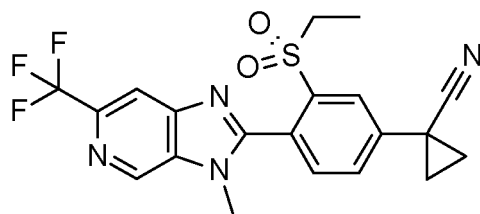
(P7)

[0159] A solution of 2-(5-bromo-3-ethylsulfonyl-2-pyridyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (preparation described above) (100 mg, 0.211 mmol), 2M aqueous sodium carbonate (0.317 ml, 0.634 mmol) and cyclopropylboronic acid (47.8 mg, 0.529 mmol) in toluene (2 ml) was purged with argon for 10 minutes. X-Phos aminobiphenyl palladium chloride precatalyst (17 mg, 0.1 eq.) was added and the mixture heated at 90°C overnight. The mixture was diluted with water, extracted with tert-butyl methyl (3x), the combined organic phase washed with brine, dried over sodium sulfate, filtrated and evaporated. The residue was purified by column chromatography over silica gel (0-70% gradient of ethyl acetate in cyclohexane) to afford the title compound P7 as a solid, mp $185\text{-}186^\circ\text{C}$. LCMS (method 2): 411 ($\text{M}+\text{H}$) $^+$; retention time: 1.44 min. ^1H NMR (400 MHz, CDCl_3) δ ppm: 0.97 (m, 2H), 1.30 (m, 2H), 1.34 (t, 3H), 2.13 (m, 1H), 3.74 (q, 2H), 3.86 (s, 3H), 8.07 (d, 1H), 8.10 (s, 1H), 8.75 (d, 1H), 8.96 (s, 1H).

Example P5: Preparation of 1-[3-ethylsulfonyl-4-[3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridin-2-yl]phenyl]cyclopropanecarbonitrile (compound P15):

[0160]

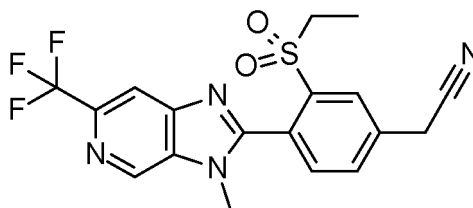
EP 3 183 245 B1



(compound P15)

Step1: Preparation of 2-[3-ethylsulfonyl-4-[3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridin-2-yl]phenyl]acetonitrile

[0161]

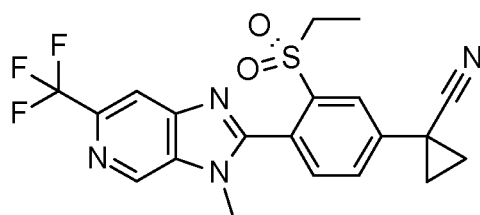


[0162] A solution of 2-(4-bromo-2-ethylsulfonyl-phenyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (0.50 g, 1.1 mmol, prepared as described in WO 2015/000715) in DMF (2 mL) was placed in a 5 mL microwave vial. Under argon, trimethylsilyl acetonitrile (0.19 g, 0.23 mL, 1.7 mmol), difluorozinc (0.069 g, 0.67 mmol), XANTPHOS (0.013 g, 0.022 mmol) and Pd₂(dba)₃ (0.011 g, 0.011 mmol) were added, the vial was capped, and heated at 140 °C for 30 min in the microwave. LC/MS after this time showed reaction completion. The reaction mixture was diluted with tert-butyl methyl ether, and then washed with water (3X) and once with brine. The organic layer was dried over Na₂SO₄, filtered and concentrated *in vacuo* to give the crude product. Purification over a silica gel cartridge (Rf200), eluting with Cyclohexane / EtOAc gave the title compound as a beige solid, mp. 253-254°C.

LCMS (method 1): 409 (M+H)⁺; retention time: 0.8 min. ¹H NMR (400 MHz, CDCl₃) δ ppm: 1.26 (t, *J*=7.3 Hz, 3 H), 3.39 (br. q, *J*=7.3 Hz, 2 H), 3.74 (s, 3 H), 4.01 (s, 2 H), 7.63 (d, *J*=7.7 Hz, 1 H), 7.90 (dd, *J*=7.70, 1.83 Hz, 1 H), 8.10 (s, 1 H), 8.17 (d, *J*=1.83 Hz, 1 H), 8.96 (s, 1 H).

Step 2: Preparation of 1-[3-ethylsulfonyl-4-[3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridin-2-yl]phenyl]cyclopropane-carbonitrile (compound P15)

[0163]



(compound P15)

[0164] A solution of 2-[3-ethylsulfonyl-4-[3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridin-2-yl]phenyl]acetonitrile (0.27 g, 0.66 mmol) in acetonitrile (10 mL) and treated with cesium carbonate (0.65 g, 2.0 mmol) and then 1,2-dibromoethane (0.25 g, 0.12 mL, 1.3 mmol). The brown solution was stirred at 80°C. LC/MS after 50min showed consumption of starting material and mainly desired product at Rt=0.92min. The reaction mixture was concentrated *in vacuo*, and the residue was dissolved in EtOAc and diluted with water. The organic layer was decanted, washed with water and brine, dried over Na₂SO₄, filtered and concentrated *in vacuo*. The crude product was purified over a silica gel cartridge (Rf200), eluting with CH₂Cl₂/EtOAc, to give the title product as a white solid, mp. 220-221°C.

LCMS (method 1): 435 (M+H)⁺; retention time: 0.92 min. ¹H NMR (400 MHz, CDCl₃) δ ppm: 1.24 (t, *J*=7.5 Hz, 3 H), 1.60 - 1.66 (m, 2 H), 1.94 - 2.01 (m, 2 H), 3.39 (q, *J*=7.5 Hz, 2 H), 3.74 (s, 3 H), 7.59 (d, *J*=7.7 Hz, 1 H), 7.88 - 7.97 (m, 2 H), 8.09 (s, 1 H), 8.94 (s, 1 H).

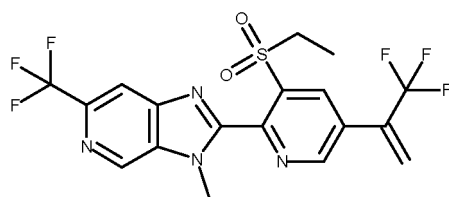
EP 3 183 245 B1

Example P6: Preparation of 2-[3-ethylsulfonyl-5-[1-(trifluoromethyl)viny]-2-pyridyl]-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (compound P17):

[0165]

5

10



(compound P17)

[0166] A mixture of (2-(5-bromo-3-ethylsulfonyl-2-pyridyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (0.60 g, 1.3 mmol, prepared according to Example P1, step C-2 above), 4,4,6-trimethyl-2-[1-(trifluoromethyl)viny]-1,3,2-dioxaborinane (0.61 g, 2.7 mmol), Na₂CO₃ (2.0 mL, 4.0 mmol) and PdCl₂(PPh₃)₂ (0.16 g, 0.23 mmol) were dissolved in DME (12 mL, 110 mmol) in a microwave vial. The vial was sealed and the reaction mixture was stirred at 110°C for 30min in a microwave. LC/MS detected desired mass at Rt=1.07 min. The reaction mixture was diluted with EtOAc, washed successively with NaOH 1M, water, and the organic phase was dried over Na₂SO₄, filtered and concentrated *in vacuo*. The crude product was dissolved in DCM and adsorbed onto TEFLON BULK SORBENTS. Purification over a silica gel cartridge (Rf200), eluting with Cyclohexane /EtOAc, gave the title compound as a beige solid with mp. 142-143°C.

LCMS (method 1): 465(M+H)⁺; retention time: 1.04 min. ¹H NMR (400 MHz, CDCl₃) δ ppm: 1.39 (t, J=7.3 Hz, 3 H), 3.84 (q, J=7.3Hz, 2 H), 3.94 (s, 3 H), 6.14 (s, 1 H), 6.35 (s, 1 H), 8.12 (s, 1 H), 8.58 (d, J=2.20 Hz, 1 H), 9.01 (s, 1 H), 9.06 (d, J=2.20 Hz, 1 H).

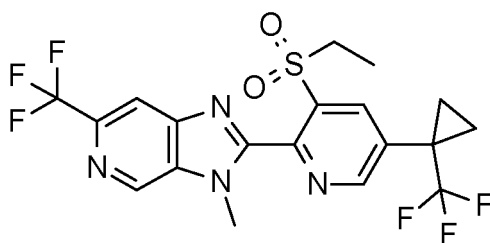
Example P7: Preparation of 2-[3-ethylsulfonyl-5-[1-(trifluoromethyl)cyclopropyl]-2-pyridyl]-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (compound P18):

30

[0167]

35

40



(compound 18)

[0168] A solution of 2-[3-ethylsulfonyl-5-[1-(trifluoromethyl)viny]-2-pyridyl]-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (100mg, 0.215 mmol) in CH₂Cl₂ (2 mL) containing bis(benzonitrile)palladium(II)dichloride (4.3 mg, 0.0011mmol) was treated dropwise with freshly prepared ethanol containing ethereal solution of diazomethane (WARNING! diazomethane is toxic and potentially explosive!). The diazomethane was prepared from DIAZALD® as described Sigma-Aldrich in a mini Diazald® Apparatus. The reaction mixture was allowed to stir over night, treated with a few drops of acetic acid and concentrated *in vacuo*. LCMS analysis showed the title product.

LCMS (method 1): 479 (M+H)⁺; retention time: 1.07 min.

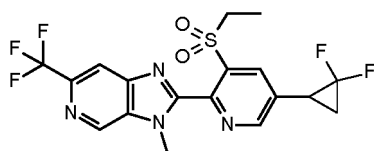
50

EXAMPLE P8: Preparation of 2-[5-(2,2-difluorocyclopropyl)-3-ethylsulfonyl-2-pyridyl]-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (compound P21):

[0169]

55

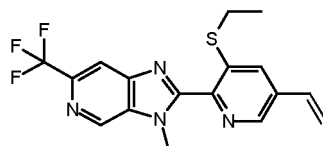
EP 3 183 245 B1



(P21)

Step 1: Preparation of 2-(3-ethylsulfanyl-5-vinyl-2-pyridyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (compound P19)

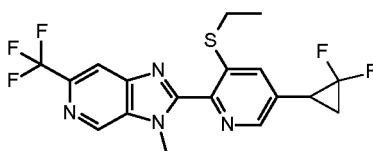
[0170]



[0171] A solution of 2-(5-bromo-3-ethylsulfanyl-2-pyridyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (preparation described above) (500 mg, 1.198 mmol) and cesium fluoride (364 mg, 2.397 mmol) in a mixture of 1,4-dioxane (9 ml) and water (3 ml) was flushed with argon. Then, 4,4,5,5-tetramethyl-2-vinyl-1,3,2-dioxaborolane (369 mg, 2.397 mmol) was added, followed by (1,1'-bis(diphenylphosphino)ferrocene)dichloropalladium-dichloromethane (1:1 complex) (48.9 mg, 0.060 mmol) and the reaction mixture was heated at 85°C in the microwave for 2 hours. The mixture was diluted with water and extracted with tert-butyl methyl ether (5x). The combined organic layers were washed with water and brine, dried over sodium sulfate, filtered and concentrated *in vacuo* to afford the title compound P19 as a solid. This material was used without further purification. LCMS (method 1): 365 (M+H)⁺; retention time: 1.05 min. ¹H NMR (400 MHz, CDCl₃) δ ppm: 1.36 (t, *J*=7.34 Hz, 3 H), 2.99 (q, *J*=7.34 Hz, 2 H), 4.06 (s, 3H), 5.57 (d, *J*=11.00 Hz, 1 H), 5.99 (d, *J*=17.61 Hz, 1 H), 6.78 (dd, *J*=17.61 Hz, *J*=11.00 Hz, 1 H), 7.76 (d, *J*=1.8 Hz, 1 H), 8.20 (s, 1 H), 8.55 (d, *J*=1.8 Hz, 1 H), 8.95 (s, 1 H).

Step 2: Preparation of 2-[5-(2,2-difluorocyclopropyl)-3-ethylsulfanyl-2-pyridyl]-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (compound P20)

[0172]

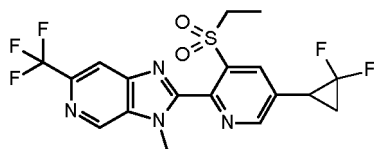


[0173] To a solution of 2-(3-ethylsulfanyl-5-vinyl-2-pyridyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (100 mg, 0.274 mmol) in diglyme (2 ml) was added a diglyme solution (6 ml) of sodium chlorodifluoroacetate (ClCF₂CO₂Na; 2.09 g, 13.72 mmol) dropwise for 30 minutes at 180°C. Then, the reaction mixture was stirred at 180°C overnight. Another portion of sodium chlorodifluoroacetate (420 mg) was added and the mixture stirred at 180°C for a total of 40 hours. After cooling, the reaction mixture was concentrated *in vacuo* and the residue treated with diethyl ether (20 ml) under stirring. The suspension was filtered (salts removal) and the filtrate dried over sodium sulfate, filtered and concentrated under reduced pressure to afford the title compound P20 as a gum. This material was used without further purification. LCMS (method 1): 415 (M+H)⁺; retention time: 1.06 min.

Step 3: Preparation of 2-[5-(2,2-difluorocyclopropyl)-3-ethylsulfanyl-2-pyridyl]-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (compound P21)

[0174]

EP 3 183 245 B1



(P21)

[0175] Obtained from crude 2-[5-(2,2-difluorocyclopropyl)-3-ethylsulfanyl-2-pyridyl]-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (preparation described above) (40 mg, 0.097 mmol) and *meta*-chloroperbenzoic acid (45.5 mg, 0.198 mmol, 75%) in dichloromethane (1.5 ml) according to procedure EXAMPLE P1, step C-2. The mixture was stirred at 5°C for one hour. After dilution with tert-butyl methyl ether, the reaction mixture was successively washed with a sat. aqueous sodium bisulfite solution, a sat. aqueous NaHCO₃ solution and brine. The organic layer was dried over sodium sulfate and concentrated under reduced pressure. LCMS analysis of the residue indicated the title product P21. LCMS (method 1): 447 (M+H)⁺; retention time: 1.01 min.

Table P1: Examples of compounds of formula (I)

Compound No.	Structures	Melting Point	MS/NMR
P1		175-178°C	LCMS (method 1): 468 (M+H) ⁺ R _t = 1.17 min
P2		193-195°C	LCMS (method 1): 395 (M+H) ⁺ R _t = 0.91 min
P3			LCMS (method 1): 397 (M+H) ⁺ R _t = 0.92 min ¹ H NMR (400 MHz, CDCl ₃) δ ppm: 8.98 (s, 1H); 8.96 (s, 1H); 8.50 (s, 1H); 8.10 (s, 1H); 6.87 (dd, J ₁ = 17.6 Hz, J ₂ = 10.8 Hz, 1H); 6.14 (d, J = 17.6 Hz, 1H); 5.72 (d, J = 10.8 Hz, 1H); 3.89 (s, 3H); 3.70 (q, J = 7.66 Hz, 2H); 1.37 (t, J = 7.66 Hz, 3H).
P4		182-184°C	LCMS (method 1): 505, 507 (M+H) ⁺ R _t = 1.17 min
P5			LCMS (method 2): 479 (M+H) ⁺ R _t = 2.03 min
P6			LCMS (method 2): 411 (M+H) ⁺ R _t = 1.53 min

EP 3 183 245 B1

(continued)

Compound No.	Structures	Melting Point	MS/NMR
P7		185-186°C	LCMS (method 2): 411 (M+H) ⁺ R _t = 1.44 min

Table P1 (continued): Examples of compounds of formula (I)

Compound No.	Structures	LCMS Rt (min)	LCMS [M+H] ⁺	Method	Mp °C
P8		1.16	504/506	1	190 - 191
P9		1.05	462	1	209 - 210
P10		1.15	540	1	223-225
P11		1.63	425	2	
P12		1.97	479	2	
P13		0.95	396	1	80-81
P14		1.01	464	1	171 - 172

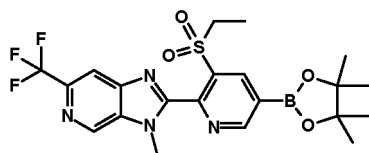
EP 3 183 245 B1

(continued)

Compound No.	Structures	LCMS Rt (min)	LCMS [M+H] ⁺	Method	Mp °C
P15		0.92	435	1	220 - 221
P16		0.93	436	1	254 - 255
P17		1.04	465	1	142 - 143
P18		1.07	479	1	-
P19		1.05	365	1	
P20		1.06	415	1	
P21		1.01	447	1	

EXAMPLE 11: Preparation of intermediate 2-[3-ethylsulfonyl-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-2-pyridyl]-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (compound 11):

[0176]



(11)

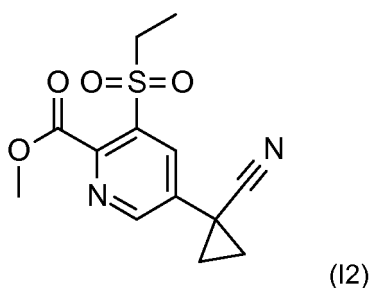
[0177] A mixture of 2-(5-bromo-3-ethylsulfonyl-2-pyridyl)-3-methyl-6-(trifluoromethyl)imidazo[4,5-c]pyridine (preparation described above) (0.050 g, 0.111 mmol), potassium acetate (0.027 g, 2.5 equiv.) and 4,4,5,5-tetramethyl-2-(4,4,5,5-

EP 3 183 245 B1

tetramethyl-1,3,2-dioxaborolan-2-yl)-1,3,2-dioxaborolane (0.042 g, 1.5 equiv.) in 1,2-dimethoxyethane (3 ml) was gently flushed with argon, then 1,1'-bis(diphenylphosphino)-ferrocene)dichloropalladium-dichloromethane (1:1) complex (0.005 g, 0.05 equiv.) was added and the pale yellow mixture was stirred under inert atmosphere, while heated to 90°C. After consumption of the starting bromide, the dark reaction mixture was diluted with water (20 ml) and extracted twice with ethyl acetate. The combined organic phases were dried over sodium sulfate and concentrated under reduced pressure. The dark brown gum was taken up in diethyl ether and filtered through a pad of celite®. The filtrate was extracted with a mixture of water (5 ml) and 1N aqueous sodium hydroxide (0.2 ml), and then the aqueous phase was treated with 1N-aqueous hydrochloric acid (0.3 ml). The precipitated solid was extracted twice with diethyl ether. The organic phase was washed with brine, dried over sodium sulfate and evaporated under reduced pressure to yield the title compound as a colorless solid. ¹H NMR (400 MHz, CDCl₃) δ ppm: 9.28 (s, 1 H); 8.99 (s, 1 H); 8.87 (s, 1 H); 8.11 (s, 1 H); 3.88 (s, 3 H); 3.76 (q, J = 7.4 Hz, 2 H); 1.41 (s, 12 H); 1.38 (t, J = 7.4 Hz, 3 H). LCMS (method 1): 413 (M-H)⁻; 827 (2M-H)⁻; 415 (M+H)⁺ for the corresponding boronic acid; retention time: 0.77 min (in this case, M corresponds to the corresponding boronic acid and not the pinacol ester, but the NMR shows the pinacol part).

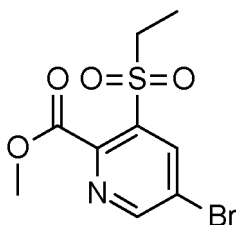
Example I2: Preparation of methyl 5-(1-cyanocyclopropyl)-3-ethylsulfonyl-pyridine-2-carboxylate (compound I2):

[0178]



Step 1: Preparation of methyl 5-bromo-3-ethylsulfonyl-pyridine-2-carboxylate

[0179]



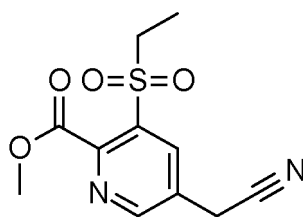
[0180] Methyl 5-bromo-3-ethylsulfonyl-pyridine-2-carboxylate (24.4 g, 88.4 mmol, step B1 from Example P1) was suspended in dichloromethane (250 mL), cooled to 0°C, and treated portion wise with *m*CPBA (37.6 g, 185.7 mmol). The mixture was stirred at ambient temperature for 18 hours. The mixture was diluted with water and dichloromethane, the aqueous phase was back extracted with dichloromethane (2X), and the combined organic phases washed with Na₂S₂O₄, dried over Na₂SO₄. Partial concentration of the solvent, led to a solid (the desired title compound) that was filtered. The filtrate was evaporated to dryness, which was purified by chromatography on silica to give further pure title compound as white solid.

LCMS (method 1): 308/310 (M+H)⁺; retention time: 0.76 min. ¹H NMR (d⁶-DMSO, 400 MHz): 9.08 (d, J=2.4Hz, 1H), 8.58 (d, J=2.4Hz, 1H), 3.87 (s, 3H), 3.52 (q, J=7.8Hz, 2H), 1.18 (t, J=7.8Hz, 3H).

Step 2: Preparation of methyl 5-(cyanomethyl)-3-ethylsulfonyl-pyridine-2-carboxylate

[0181]

EP 3 183 245 B1

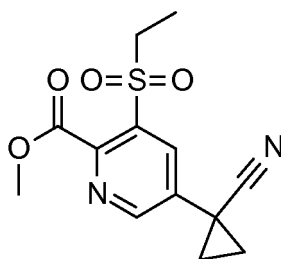


10 **[0182]** A solution of methyl 5-bromo-3-ethylsulfonyl-pyridine-2-carboxylate, (2.00 g, 6.49 mmol) in DMF (13.0 mL) was treated with TMS-acetonitrile (2.25 g, 2.71 mL, 19.5 mmol), difluorozinc (0.403 g, 3.89 mmol), XANTPHOS (0.153 g, 0.260 mmol) and Pd₂(dba)₃ (0.119 g, 0.130 mmol) under argon. The resulting mixture was stirred for 5 hours at 100°C. LCMS after this time showed no further reaction progression. The mixture was cooled, diluted with EtOAc, and filtered over hyflo. The filtrate was washed with water/NH₄Cl, brine, dried over Na₂SO₄, filtered and concentrated *in vacuo*. The crude product was purified by combi flash chromatography with a column of 40 g and a gradient cyclohexane + 0-50 % ethylacetate. This gave the title compound as yellow oil.

15 LCMS (method 1): 269 (M+H)⁺; retention time: 0.58 min. ¹H NMR (400 MHz, CDCl₃) δ ppm: 1.38 (t, J=7.5 Hz, 3 H), 3.58 (q, J=7.5 Hz, 2 H), 3.95 (s, 2 H), 4.06 (s, 3 H), 8.37 (d, J=2.20 Hz, 1 H), 8.86 (d, J=2.20 Hz, 1 H).

20 Step 3: Preparation of methyl 5-(1-cyanocyclopropyl)-3-ethylsulfonyl-pyridine-2-carboxylate

[0183]



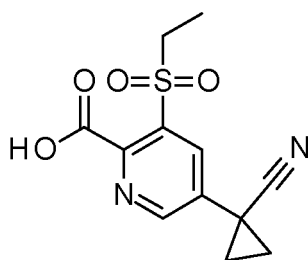
(12)

35 **[0184]** Methyl 5-(cyanomethyl)-3-ethylsulfonyl-pyridine-2-carboxylate (0.63 g, 2.3 mmol) was dissolved in acetonitrile (19 mL) and cesium carbonate (2.3 g, 7.0 mmol) was added to the colourless solution (solution darkened), followed by addition of 1,2-dibromoethane (0.90 g, 0.41 mL, 4.7 mmol) The brown solution was stirred at 80°C bath temperature. LC/MS detected desired mass at Rt=0.73 min after 1.5h. The reaction mixture was concentrated *in vacuo* and diluted with EtOAc and water. The organic layer was separated, washed successively with water and brine, dried over Na₂SO₄, filtered and concentrated *in vacuo*. The crude product was dissolved in dichloromethane and adsorbed onto TEFLON BULK SORBENTS. Purification over a silica gel cartridge (Rf200) eluting with Cyclohexane /EtOAc, gave the title compound as a beige resin.

40 LCMS (method 1): 295 (M+H)⁺; retention time: 0.72 min. ¹H NMR (400 MHz, CDCl₃) δ ppm: 1.36 (t, J=7.5 Hz, 3 H), 1.57 - 1.62 (m, 2 H), 1.95 - 2.00 (m, 2 H), 2.05 (s, 2 H), 4.04 (s, 4 H), 8.13 (d, J=2.20 Hz, 1 H), 8.87 (d, J=2.20 Hz, 1 H).

45 Example I3: Preparation of 5-(1-cyanocyclopropyl)-3-ethylsulfonyl-pyridine-2-carboxylic acid (compound I3):

[0185]



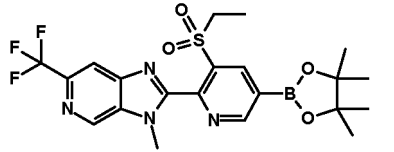
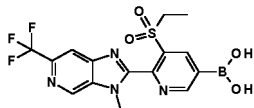
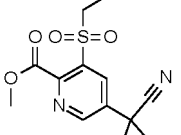
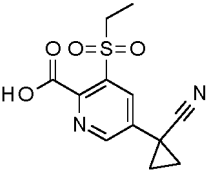
(I3)

EP 3 183 245 B1

[0186] A solution of methyl 5-(1-cyanocyclopropyl)-3-ethylsulfonyl-pyridine-2-carboxylate (0.27 g, 0.92 mmol) was dissolved in THF (4mL) and water (1.5 mL) (red solution), and then treated with LiOH•H₂O (0.058 g, 1.4 mmol). The mixture was stirred at ambient temperature for 2 hours by which time LCMS analysis showed reaction completion (only desired product at Rt=0.32 min, method 1). The THF was evaporated *in vacuo* and the residue was acidified with 1M HCl and extracted with EtOAc. The organic layer was washed with brine, dried over Na₂SO₄ filtrated and concentrated *in vacuo* to give pure title product as a beige solid.

LCMS (method 1): 281 (M+H)⁺; retention time: 0.30 min. ¹H NMR (400 MHz, methanol-d₄) δ ppm: 1.31 (t, J=7.3 Hz, 3H), 1.71 - 1.78 (m, 2 H), 1.92 - 1.98 (m, 2 H), 3.60 (q, J=7.3 Hz, 2 H), 8.28 (d, J=2.20 Hz, 1 H), 8.83 (d, J=2.20 Hz, 1 H).

Table I1: Examples of intermediate compounds of formula (IV), (XXIV-c) and (XVIII-f):

Compound No.	Structures	Melting Point	MS/NMR
11			LCMS (method 1): 415 (M+H) ⁺ R _t = 0.77 min M consistent with the corresponding boronic acid: 
12			LCMS (method 1): 295 (M+H) ⁺ ; retention time: 0.72 min.
13			LCMS (method 1): 281 (M+H) ⁺ ; retention time: 0.30 min.

[0187] The following mixtures of the compounds of formula I with active ingredients are preferred (the abbreviation "TX" means "one compound selected from the group consisting of the compounds described in Tables 1 to 18 and P1 of the present invention"):

an adjuvant selected from the group of substances consisting of petroleum oils (alternative name) (628) + TX, an acaricide selected from the group of substances consisting of 1,1-bis(4-chlorophenyl)-2-ethoxyethanol (IUPAC name) (910) + TX, 2,4-dichlorophenyl benzenesulfonate (IUPAC/Chemical Abstracts name) (1059) + TX, 2-fluoro-N-methyl-N-1-naphthylacetamide (IUPAC name) (1295) + TX, 4-chlorophenyl phenyl sulfone (IUPAC name) (981) + TX, abamectin (1) + TX, acequinocyl (3) + TX, acetoprole [CCN] + TX, acrinathrin (9) + TX, aldicarb (16) + TX, aldoxycarb (863) + TX, alpha-cypermethrin (202) + TX, amidithion (870) + TX, amidoflumet [CCN] + TX, amidothioate (872) + TX, amiton (875) + TX, amiton hydrogen oxalate (875) + TX, amitraz (24) + TX, aramite (881) + TX, arsenous oxide (882) + TX, AVI 382 (compound code) + TX, AZ 60541 (compound code) + TX, azinphos-ethyl (44) + TX, azinphos-methyl (45) + TX, azobenzene (IUPAC name) (888) + TX, azocyclotin (46) + TX, azothoate (889) + TX, benomyl (62) + TX, benoxafos (alternative name) [CCN] + TX, benzoximate (71) + TX, benzyl benzoate (IUPAC name) [CCN] + TX, bifenazate (74) + TX, bifenthrin (76) + TX, binapacryl (907) + TX, brofenvalerate (alternative name) + TX, bromo-cyden (918) + TX, bromophos (920) + TX, bromophos-ethyl (921) + TX, bromopropylate (94) + TX, buprofezin (99) + TX, butocarboxim (103) + TX, butoxycarboxim (104) + TX, butylpyridaben (alternative name) + TX, calcium polysulfide (IUPAC name) (111) + TX, camphechlor (941) + TX, carbanolate (943) + TX, carbaryl (115) + TX, carbofuran (118) + TX, carbophenothion (947) + TX, CGA 50'439 (development code) (125) + TX, chinomethionat (126) + TX, chlorbenside (959) + TX, chlordimeform (964) + TX, chlordimeform hydrochloride (964) + TX, chlorfenapyr (130) + TX, chlorfenethol (968) + TX, chlorfenson (970) + TX, chlorfensulfide (971) + TX, chlorfenvinphos (131) + TX, chlorobenzilate (975) + TX, chloromebuform (977) + TX, chloromethiuron (978) + TX, chloropropylate (983) + TX, chlorpyrifos (145) + TX, chlorpyrifos-methyl (146) + TX, chlorthiophos (994) + TX, cinerin I (696) + TX, cinerin II (696) + TX, cinerins (696) + TX, clofentezine (158) + TX, closantel (alternative name) [CCN]

EP 3 183 245 B1

+ TX, coumaphos (174) + TX, crotamiton (alternative name) [CCN] + TX, crotoxyphos (1010) + TX, cufraneb (1013) + TX, cyanthoate (1020) + TX, cyflumetofen (CAS Reg. No.: 400882-07-7) + TX, cyhalothrin (196) + TX, cyhexatin (199) + TX, cypermethrin (201) + TX, DCPM (1032) + TX, DDT (219) + TX, demephion (1037) + TX, demephion-O (1037) + TX, demephion-S (1037) + TX, demeton (1038) + TX, demeton-methyl (224) + TX, demeton-O (1038) + TX, demeton-O-methyl (224) + TX, demeton-S (1038) + TX, demeton-S-methyl (224) + TX, demeton-S-methyl-sulfon (1039) + TX, diafenthiuron (226) + TX, dialifos (1042) + TX, diazinon (227) + TX, dichlofluanid (230) + TX, dichlorvos (236) + TX, dicliphos (alternative name) + TX, dicofol (242) + TX, dicrotophos (243) + TX, dienochlor (1071) + TX, dimefox (1081) + TX, dimethoate (262) + TX, dinactin (alternative name) (653) + TX, dinex (1089) + TX, dinex-diclexine (1089) + TX, dinobuton (269) + TX, dinocap (270) + TX, dinocap-4 [CCN] + TX, dinocap-6 [CCN] + TX, dinocton (1090) + TX, dinopenton (1092) + TX, dinosulfon (1097) + TX, dinoterbon (1098) + TX, dioxathion (1102) + TX, diphenyl sulfone (IUPAC name) (1103) + TX, disulfiram (alternative name) [CCN] + TX, disulfoton (278) + TX, DNOC (282) + TX, dofenapyn (1113) + TX, doramectin (alternative name) [CCN] + TX, endosulfan (294) + TX, endothion (1121) + TX, EPN (297) + TX, eprinomectin (alternative name) [CCN] + TX, ethion (309) + TX, ethoate-methyl (1134) + TX, etoxazole (320) + TX, etrimfos (1142) + TX, fenazaflor (1147) + TX, fenazaquin (328) + TX, fenbutatin oxide (330) + TX, fenothiocarb (337) + TX, fenpropathrin (342) + TX, fenpyrad (alternative name) + TX, fenpyroximate (345) + TX, fenson (1157) + TX, fentrifanil (1161) + TX, fenvalerate (349) + TX, fipronil (354) + TX, fluacrypyrim (360) + TX, fluzazuron (1166) + TX, flubenzimine (1167) + TX, flucycloxuron (366) + TX, flucythrinate (367) + TX, fluenetil (1169) + TX, flufenoxuron (370) + TX, flumethrin (372) + TX, fluorbenside (1174) + TX, fluvalinate (1184) + TX, FMC 1137 (development code) (1185) + TX, formetanate (405) + TX, formetanate hydrochloride (405) + TX, formothion (1192) + TX, formparanate (1193) + TX, gamma-HCH (430) + TX, glyodin (1205) + TX, halfenprox (424) + TX, heptenophos (432) + TX, hexadecyl cyclopropanecarboxylate (IUPAC/Chemical Abstracts name) (1216) + TX, hexythiazox (441) + TX, iodomethane (IUPAC name) (542) + TX, isocarbophos (alternative name) (473) + TX, isopropyl O-(methoxyaminothiophosphoryl)salicylate (IUPAC name) (473) + TX, ivermectin (alternative name) [CCN] + TX, jasmolin I (696) + TX, jasmolin II (696) + TX, jodfenphos (1248) + TX, lindane (430) + TX, lufenuron (490) + TX, malathion (492) + TX, malonoben (1254) + TX, mecarbam (502) + TX, mephosfolan (1261) + TX, mesulfen (alternative name) [CCN] + TX, methacrifos (1266) + TX, methamidophos (527) + TX, methidathion (529) + TX, methiocarb (530) + TX, methomyl (531) + TX, methyl bromide (537) + TX, metolcarb (550) + TX, mevinphos (556) + TX, mexacarbate (1290) + TX, milbemectin (557) + TX, milbemycin oxime (alternative name) [CCN] + TX, mipafox (1293) + TX, monocrotophos (561) + TX, morphothion (1300) + TX, moxidectin (alternative name) [CCN] + TX, naled (567) + TX, NC-184 (compound code) + TX, NC-512 (compound code) + TX, nifluridide (1309) + TX, nikkomyctins (alternative name) [CCN] + TX, nitrilacarb (1313) + TX, nitrilacarb 1:1 zinc chloride complex (1313) + TX, NNI-0101 (compound code) + TX, NNI-0250 (compound code) + TX, omethoate (594) + TX, oxamyl (602) + TX, oxydeprofos (1324) + TX, oxydisulfoton (1325) + TX, pp'-DDT (219) + TX, parathion (615) + TX, permethrin (626) + TX, petroleum oils (alternative name) (628) + TX, phenkapton (1330) + TX, phenthoate (631) + TX, phorate (636) + TX, phosalone (637) + TX, phosfolan (1338) + TX, phosmet (638) + TX, phosphamidon (639) + TX, phoxim (642) + TX, pirimiphos-methyl (652) + TX, polychloroterpenes (traditional name) (1347) + TX, polynactins (alternative name) (653) + TX, proclonol (1350) + TX, profenofos (662) + TX, promacyl (1354) + TX, propargite (671) + TX, propetamphos (673) + TX, propoxur (678) + TX, prothidathion (1360) + TX, prothoate (1362) + TX, pyrethrin I (696) + TX, pyrethrin II (696) + TX, pyrethrins (696) + TX, pyridaben (699) + TX, pyridaphenthion (701) + TX, pyrimidifen (706) + TX, pyrimitate (1370) + TX, quinalphos (711) + TX, quintiofos (1381) + TX, R-1492 (development code) (1382) + TX, RA-17 (development code) (1383) + TX, rotenone (722) + TX, schradan (1389) + TX, sebufos (alternative name) + TX, selamectin (alternative name) [CCN] + TX, SI-0009 (compound code) + TX, sophamide (1402) + TX, spirodiclofen (738) + TX, spiromesifen (739) + TX, SSI-121 (development code) (1404) + TX, sulfiram (alternative name) [CCN] + TX, sulfluramid (750) + TX, sulfotep (753) + TX, sulfur (754) + TX, SZI-121 (development code) (757) + TX, tau-fluvalinate (398) + TX, tebufenpyrad (763) + TX, TEPP (1417) + TX, terbam (alternative name) + TX, tetrachlorvinphos (777) + TX, tetradifon (786) + TX, tetranactin (alternative name) (653) + TX, tetrasul (1425) + TX, thiafenox (alternative name) + TX, thiocarboxime (1431) + TX, thiofanox (800) + TX, thiometon (801) + TX, thioquinox (1436) + TX, thuringiensin (alternative name) [CCN] + TX, triamiphos (1441) + TX, triarathene (1443) + TX, triazophos (820) + TX, triazuron (alternative name) + TX, trichlorfon (824) + TX, trifenofos (1455) + TX, trinactin (alternative name) (653) + TX, vamidothion (847) + TX, vaniliprole [CCN] and YI-5302 (compound code) + TX, an algicide selected from the group of substances consisting of bethoxazin [CCN] + TX, copper dioctanoate (IUPAC name) (170) + TX, copper sulfate (172) + TX, cybutryne [CCN] + TX, dichlone (1052) + TX, dichlorophen (232) + TX, endothal (295) + TX, fentin (347) + TX, hydrated lime [CCN] + TX, nabam (566) + TX, quinoclamine (714) + TX, quinonamid (1379) + TX, simazine (730) + TX, triphenyltin acetate (IUPAC name) (347) and triphenyltin hydroxide (IUPAC name) (347) + TX, an anthelmintic selected from the group of substances consisting of abamectin (1) + TX, crufomate (1011) + TX, doramectin (alternative name) [CCN] + TX, emamectin (291) + TX, emamectin benzoate (291) + TX, eprinomectin (alternative name) [CCN] + TX, ivermectin (alternative name) [CCN] + TX, milbemycin oxime (alternative name)

EP 3 183 245 B1

[CCN] + TX, moxidectin (alternative name) [CCN] + TX, piperazine [CCN] + TX, selamectin (alternative name) [CCN] + TX, spinosad (737) and thiophanate (1435) + TX,

an avicide selected from the group of substances consisting of chloralose (127) + TX, endrin (1122) + TX, fenthion (346) + TX, pyridin-4-amine (IUPAC name) (23) and strychnine (745) + TX,

a bactericide selected from the group of substances consisting of 1-hydroxy-1*H*-pyridine-2-thione (IUPAC name) (1222) + TX, 4-(quinoxalin-2-ylamino)benzenesulfonamide (IUPAC name) (748) + TX, 8-hydroxyquinoline sulfate (446) + TX, bronopol (97) + TX, copper dioctanoate (IUPAC name) (170) + TX, copper hydroxide (IUPAC name) (169) + TX, cresol [CCN] + TX, dichlorophen (232) + TX, dipyrithione (1105) + TX, dodicin (1112) + TX, fenaminosulf (1144) + TX, formaldehyde (404) + TX, hydrargaphen (alternative name) [CCN] + TX, kasugamycin (483) + TX, kasugamycin hydrochloride hydrate (483) + TX, nickel bis(dimethyldithiocarbamate) (IUPAC name) (1308) + TX, nitrapyrin (580) + TX, octhilonone (590) + TX, oxolinic acid (606) + TX, oxytetracycline (611) + TX, potassium hydroxyquinoline sulfate (446) + TX, probenazole (658) + TX, streptomycin (744) + TX, streptomycin sesquisulfate (744) + TX, tecloftalam (766) + TX, and thiomersal (alternative name) [CCN] + TX,

a biological agent selected from the group of substances consisting of *Adoxophyes orana* GV (alternative name) (12) + TX, *Agrobacterium radiobacter* (alternative name) (13) + TX, *Amblyseius* spp. (alternative name) (19) + TX, *Anagrapha falcifera* NPV (alternative name) (28) + TX, *Anagrus atomus* (alternative name) (29) + TX, *Aphelinus abdominalis* (alternative name) (33) + TX, *Aphidius colemani* (alternative name) (34) + TX, *Aphidoletes aphidimyza* (alternative name) (35) + TX, *Autographa californica* NPV (alternative name) (38) + TX, *Bacillus firmus* (alternative name) (48) + TX, *Bacillus sphaericus* Neide (scientific name) (49) + TX, *Bacillus thuringiensis* Berliner (scientific name) (51) + TX, *Bacillus thuringiensis* subsp. *aizawai* (scientific name) (51) + TX, *Bacillus thuringiensis* subsp. *israelensis* (scientific name) (51) + TX, *Bacillus thuringiensis* subsp. *japonensis* (scientific name) (51) + TX, *Bacillus thuringiensis* subsp. *kurstaki* (scientific name) (51) + TX, *Bacillus thuringiensis* subsp. *tenebrionis* (scientific name) (51) + TX, *Beauveria bassiana* (alternative name) (53) + TX, *Beauveria brongniartii* (alternative name) (54) + TX, *Chrysoperla carnea* (alternative name) (151) + TX, *Cryptolaemus montrouzieri* (alternative name) (178) + TX, *Cydia pomonella* GV (alternative name) (191) + TX, *Dacnusa sibirica* (alternative name) (212) + TX, *Diglyphus isaea* (alternative name) (254) + TX, *Encarsia formosa* (scientific name) (293) + TX, *Eretmocerus eremicus* (alternative name) (300) + TX, *Helicoverpa zea* NPV (alternative name) (431) + TX, *Heterorhabditis bacteriophora* and *H. megidis* (alternative name) (433) + TX, *Hippodamia convergens* (alternative name) (442) + TX, *Leptomastix dactylopii* (alternative name) (488) + TX, *Macrolophus caliginosus* (alternative name) (491) + TX, *Mamestra brassicae* NPV (alternative name) (494) + TX, *Metaphycus helvolus* (alternative name) (522) + TX, *Metarhizium anisopliae* var. *acridum* (scientific name) (523) + TX, *Metarhizium anisopliae* var. *anisopliae* (scientific name) (523) + TX, *Neodiprion sertifer* NPV and *N. lecontei* NPV (alternative name) (575) + TX, *Orius* spp. (alternative name) (596) + TX, *Paecilomyces fumosoroseus* (alternative name) (613) + TX, *Phytoseiulus persimilis* (alternative name) (644) + TX, *Spodoptera exigua* multicapsid nuclear polyhedrosis virus (scientific name) (741) + TX, *Steinernema bibionis* (alternative name) (742) + TX, *Steinernema carpocapsae* (alternative name) (742) + TX, *Steinernema feltiae* (alternative name) (742) + TX, *Steinernema glaseri* (alternative name) (742) + TX, *Steinernema riobrave* (alternative name) (742) + TX, *Steinernema riobrave* (alternative name) (742) + TX, *Steinernema scapterisci* (alternative name) (742) + TX, *Steinernema* spp. (alternative name) (742) + TX, *Trichogramma* spp. (alternative name) (826) + TX, *Typhlodromus occidentalis* (alternative name) (844) and *Verticillium lecanii* (alternative name) (848) + TX,

a soil sterilant selected from the group of substances consisting of iodomethane (IUPAC name) (542) and methyl bromide (537) + TX,

a chemosterilant selected from the group of substances consisting of apholate [CCN] + TX, bisazir (alternative name) [CCN] + TX, busulfan (alternative name) [CCN] + TX, diflubenzuron (250) + TX, dimatif (alternative name) [CCN] + TX, hemel [CCN] + TX, hempa [CCN] + TX, metepa [CCN] + TX, methiotepa [CCN] + TX, methyl apholate [CCN] + TX, morzid [CCN] + TX, penfluron (alternative name) [CCN] + TX, tepa [CCN] + TX, thiohempa (alternative name) [CCN] + TX, thiotepa (alternative name) [CCN] + TX, tretamine (alternative name) [CCN] and uredepa (alternative name) [CCN] + TX,

an insect pheromone selected from the group of substances consisting of (*E*)-dec-5-en-1-yl acetate with (*E*)-dec-5-en-1-ol (IUPAC name) (222) + TX, (*E*)-tridec-4-en-1-yl acetate (IUPAC name) (829) + TX, (*E*)-6-methylhept-2-en-4-ol (IUPAC name) (541) + TX, (*E,Z*)-tetradeca-4,10-dien-1-yl acetate (IUPAC name) (779) + TX, (*Z*)-dodec-7-en-1-yl acetate (IUPAC name) (285) + TX, (*Z*)-hexadec-11-enal (IUPAC name) (436) + TX, (*Z*)-hexadec-11-en-1-yl acetate (IUPAC name) (437) + TX, (*Z*)-hexadec-13-en-11-yn-1-yl acetate (IUPAC name) (438) + TX, (*Z*)-icos-13-en-10-one (IUPAC name) (448) + TX, (*Z*)-tetradec-7-en-1-yl acetate (IUPAC name) (782) + TX, (*Z*)-tetradec-9-en-1-yl acetate (IUPAC name) (783) + TX, (*Z*)-tetradec-9-en-1-yl acetate (IUPAC name) (784) + TX, (7*E*,9*Z*)-dodeca-7,9-dien-1-yl acetate (IUPAC name) (283) + TX, (9*Z*,11*E*)-tetradeca-9,11-dien-1-yl acetate (IUPAC name) (780) + TX, (9*Z*,12*E*)-tetradeca-9,12-dien-1-yl acetate (IUPAC name) (781) + TX, 14-methyloctadec-1-ene (IUPAC name) (545) + TX, 4-methylnonan-5-ol with 4-methylnonan-5-one (IUPAC name) (544) + TX, alpha-multistriatin (alternative name) [CCN] + TX, brevicomin (alternative name) [CCN] + TX, codlure (alternative name) [CCN] + TX, codlemone

(alternative name) (167) + TX, cuelure (alternative name) (179) + TX, disparlure (277) + TX, dodec-8-en-1-yl acetate (IUPAC name) (286) + TX, dodec-9-en-1-yl acetate (IUPAC name) (287) + TX, dodeca-8 + TX, 10-dien-1-yl acetate (IUPAC name) (284) + TX, dominicalure (alternative name) [CCN] + TX, ethyl 4-methyloctanoate (IUPAC name) (317) + TX, eugenol (alternative name) [CCN] + TX, frontalinal (alternative name) [CCN] + TX, gossypolure (alternative name) (420) + TX, grandlure (421) + TX, grandlure I (alternative name) (421) + TX, grandlure II (alternative name) (421) + TX, grandlure III (alternative name) (421) + TX, grandlure IV (alternative name) (421) + TX, hexalure [CCN] + TX, ipsdienol (alternative name) [CCN] + TX, ipsenol (alternative name) [CCN] + TX, japonilure (alternative name) (481) + TX, lineatin (alternative name) [CCN] + TX, litlure (alternative name) [CCN] + TX, looplure (alternative name) [CCN] + TX, medlure [CCN] + TX, megatomoic acid (alternative name) [CCN] + TX, methyl eugenol (alternative name) (540) + TX, muscalure (563) + TX, octadeca-2,13-dien-1-yl acetate (IUPAC name) (588) + TX, octadeca-3,13-dien-1-yl acetate (IUPAC name) (589) + TX, orfralure (alternative name) [CCN] + TX, oryctalure (alternative name) (317) + TX, ostramone (alternative name) [CCN] + TX, siglure [CCN] + TX, sordidin (alternative name) (736) + TX, sulcatol (alternative name) [CCN] + TX, tetradec-11-en-1-yl acetate (IUPAC name) (785) + TX, trimedlure (839) + TX, trimedlure A (alternative name) (839) + TX, trimedlure B₁ (alternative name) (839) + TX, trimedlure B₂ (alternative name) (839) + TX, trimedlure C (alternative name) (839) and trunc-call (alternative name) [CCN] + TX, an insect repellent selected from the group of substances consisting of 2-(octylthio)ethanol (IUPAC name) (591) + TX, butopyronoxyl (933) + TX, butoxy(polypropylene glycol) (936) + TX, dibutyl adipate (IUPAC name) (1046) + TX, dibutyl phthalate (1047) + TX, dibutyl succinate (IUPAC name) (1048) + TX, diethyltoluamide [CCN] + TX, dimethyl carbate [CCN] + TX, dimethyl phthalate [CCN] + TX, ethyl hexanediol (1137) + TX, hexamide [CCN] + TX, methoquin-butyl (1276) + TX, methylneodecanamide [CCN] + TX, oxamate [CCN] and picaridin [CCN] + TX, an insecticide selected from the group of substances consisting of 1-dichloro-1-nitroethane (IUPAC/Chemical Abstracts name) (1058) + TX, 1,1-dichloro-2,2-bis(4-ethylphenyl)ethane (IUPAC name) (1056), + TX, 1,2-dichloropropane (IUPAC/Chemical Abstracts name) (1062) + TX, 1,2-dichloropropane with 1,3-dichloropropene (IUPAC name) (1063) + TX, 1-bromo-2-chloroethane (IUPAC/Chemical Abstracts name) (916) + TX, 2,2,2-trichloro-1-(3,4-dichlorophenyl)ethyl acetate (IUPAC name) (1451) + TX, 2,2-dichlorovinyl 2-ethylsulfinyethyl methyl phosphate (IUPAC name) (1066) + TX, 2-(1,3-dithiolan-2-yl)phenyl dimethylcarbamate (IUPAC/ Chemical Abstracts name) (1109) + TX, 2-(2-butoxyethoxy)ethyl thiocyanate (IUPAC/Chemical Abstracts name) (935) + TX, 2-(4,5-dimethyl-1,3-dioxolan-2-yl)phenyl methylcarbamate (IUPAC/ Chemical Abstracts name) (1084) + TX, 2-(4-chloro-3,5-xylyloxy)ethanol (IUPAC name) (986) + TX, 2-chlorovinyl diethyl phosphate (IUPAC name) (984) + TX, 2-imidazolidone (IUPAC name) (1225) + TX, 2-isovalerylindan-1,3-dione (IUPAC name) (1246) + TX, 2-methyl(prop-2-ynyl)aminophenyl methylcarbamate (IUPAC name) (1284) + TX, 2-thiocyanatoethyl laurate (IUPAC name) (1433) + TX, 3-bromo-1-chloroprop-1-ene (IUPAC name) (917) + TX, 3-methyl-1-phenylpyrazol-5-yl dimethylcarbamate (IUPAC name) (1283) + TX, 4-methyl(prop-2-ynyl)amino-3,5-xylyl methylcarbamate (IUPAC name) (1285) + TX, 5,5-dimethyl-3-oxocyclohex-1-enyl dimethylcarbamate (IUPAC name) (1085) + TX, abamectin (1) + TX, acephate (2) + TX, acetamiprid (4) + TX, acethion (alternative name) [CCN] + TX, acetoprole [CCN] + TX, acrinathrin (9) + TX, acrylonitrile (IUPAC name) (861) + TX, alanycarb (15) + TX, aldicarb (16) + TX, aldoxycarb (863) + TX, aldrin (864) + TX, allethrin (17) + TX, allosamidin (alternative name) [CCN] + TX, allyxcarb (866) + TX, alpha-cypermethrin (202) + TX, alpha-ecdysone (alternative name) [CCN] + TX, aluminium phosphide (640) + TX, amidithion (870) + TX, amidothioate (872) + TX, aminocarb (873) + TX, amiton (875) + TX, amiton hydrogen oxalate (875) + TX, amitraz (24) + TX, anabasine (877) + TX, athidathion (883) + TX, AVI 382 (compound code) + TX, AZ 60541 (compound code) + TX, azadirachtin (alternative name) (41) + TX, azamethiphos (42) + TX, azinphos-ethyl (44) + TX, azinphos-methyl (45) + TX, azothoate (889) + TX, *Bacillus thuringiensis* delta endotoxins (alternative name) (52) + TX, barium hexafluoro-silicate (alternative name) [CCN] + TX, barium polysulfide (IUPAC/Chemical Abstracts name) (892) + TX, barthrin [CCN] + TX, Bayer 22/190 (development code) (893) + TX, Bayer 22408 (development code) (894) + TX, bendiocarb (58) + TX, benfuracarb (60) + TX, bensultap (66) + TX, beta-cyfluthrin (194) + TX, beta-cypermethrin (203) + TX, bifenthrin (76) + TX, bioallethrin (78) + TX, bioallethrin S-cyclopentenyl isomer (alternative name) (79) + TX, bioethanomethrin [CCN] + TX, biopermethrin (908) + TX, bioresmethrin (80) + TX, bis(2-chloroethyl) ether (IUPAC name) (909) + TX, bistrifluron (83) + TX, borax (86) + TX, brofenvalerate (alternative name) + TX, bromfenvinfos (914) + TX, bromocyclen (918) + TX, bromo-DDT (alternative name) [CCN] + TX, bromophos (920) + TX, bromophos-ethyl (921) + TX, bufencarb (924) + TX, buprofezin (99) + TX, butacarb (926) + TX, butathiofos (927) + TX, butocarboxim (103) + TX, butonate (932) + TX, butoxycarboxim (104) + TX, butylpyridaben (alternative name) + TX, cadusafos (109) + TX, calcium arsenate [CCN] + TX, calcium cyanide (444) + TX, calcium polysulfide (IUPAC name) (111) + TX, camphechlor (941) + TX, carbanolate (943) + TX, carbaryl (115) + TX, carbofuran (118) + TX, carbon disulfide (IUPAC/Chemical Abstracts name) (945) + TX, carbon tetrachloride (IUPAC name) (946) + TX, carbophenothion (947) + TX, carbosulfan (119) + TX, cartap (123) + TX, cartap hydrochloride (123) + TX, cevadine (alternative name) (725) + TX, chlorbicyclen (960) + TX, chlordan (128) + TX, chlordecone (963) + TX, chlordimeform (964) + TX, chlordimeform hydrochloride (964) + TX, chlorethoxyfos (129) + TX, chlorfenapyr (130) + TX, chlorfenvinphos (131) + TX, chlorfluazuron (132) + TX, chlormephos (136) + TX, chloroform [CCN] + TX, chloropicrin (141) + TX, chlo-

EP 3 183 245 B1

rphoxim (989) + TX, chlorprazophos (990) + TX, chlorpyrifos (145) + TX, chlorpyrifos-methyl (146) + TX, chlorthiophos (994) + TX, chromafenozide (150) + TX, cinerin I (696) + TX, cinerin II (696) + TX, cinerins (696) + TX, cis-resmethrin (alternative name) + TX, cismethrin (80) + TX, clocythrin (alternative name) + TX, cloethocarb (999) + TX, closantel (alternative name) [CCN] + TX, clothianidin (165) + TX, copper acetoarsenite [CCN] + TX, copper arsenate [CCN] + TX, copper oleate [CCN] + TX, coumaphos (174) + TX, coumithoate (1006) + TX, crotamiton (alternative name) [CCN] + TX, crotoxyphos (1010) + TX, crufomate (1011) + TX, cryolite (alternative name) (177) + TX, CS 708 (development code) (1012) + TX, cyanofenphos (1019) + TX, cyanophos (184) + TX, cyanthoate (1020) + TX, cyclethrin [CCN] + TX, cycloprothrin (188) + TX, cyfluthrin (193) + TX, cyhalothrin (196) + TX, cypermethrin (201) + TX, cyphenothrin (206) + TX, cyromazine (209) + TX, cythioate (alternative name) [CCN] + TX, d-limonene (alternative name) [CCN] + TX, d-tetramethrin (alternative name) (788) + TX, DAEP (1031) + TX, dazomet (216) + TX, DDT (219) + TX, decarbofuran (1034) + TX, deltamethrin (223) + TX, demephion (1037) + TX, demephion-O (1037) + TX, demephion-S (1037) + TX, demeton (1038) + TX, demeton-methyl (224) + TX, demeton-O (1038) + TX, demeton-O-methyl (224) + TX, demeton-S (1038) + TX, demeton-S-methyl (224) + TX, demeton-S-methylsulphon (1039) + TX, diafenthiuron (226) + TX, dialifos (1042) + TX, diamidafos (1044) + TX, diazinon (227) + TX, dicapthion (1050) + TX, dichlofenthion (1051) + TX, dichlorvos (236) + TX, dicliphos (alternative name) + TX, dicresyl (alternative name) [CCN] + TX, dicrotophos (243) + TX, dicyclanil (244) + TX, dieldrin (1070) + TX, diethyl 5-methylpyrazol-3-yl phosphate (IUPAC name) (1076) + TX, diflufenzuron (250) + TX, dilor (alternative name) [CCN] + TX, dimefluthrin [CCN] + TX, dimefox (1081) + TX, dimetan (1085) + TX, dimethoate (262) + TX, dimethrin (1083) + TX, dimethylvinphos (265) + TX, dimetilan (1086) + TX, dinex (1089) + TX, dinex-diclexine (1089) + TX, dinoprop (1093) + TX, dinosam (1094) + TX, dinoseb (1095) + TX, dinotefuran (271) + TX, diofenolan (1099) + TX, dioxabenzofos (1100) + TX, dioxacarb (1101) + TX, dioxathion (1102) + TX, disulfoton (278) + TX, dithicrofos (1108) + TX, DNOC (282) + TX, doramectin (alternative name) [CCN] + TX, DSP (1115) + TX, ecdysterone (alternative name) [CCN] + TX, EI 1642 (development code) (1118) + TX, emamectin (291) + TX, emamectin benzoate (291) + TX, EMPC (1120) + TX, empenthrin (292) + TX, endosulfan (294) + TX, endothion (1121) + TX, endrin (1122) + TX, EPBP (1123) + TX, EPN (297) + TX, epofenonane (1124) + TX, eprinomectin (alternative name) [CCN] + TX, esfenvalerate (302) + TX, etaphos (alternative name) [CCN] + TX, ethiofencarb (308) + TX, ethion (309) + TX, ethiprole (310) + TX, ethoate-methyl (1134) + TX, ethoprophos (312) + TX, ethyl formate (IUPAC name) [CCN] + TX, ethyl-DDD (alternative name) (1056) + TX, ethylene dibromide (316) + TX, ethylene dichloride (chemical name) (1136) + TX, ethylene oxide [CCN] + TX, etofenprox (319) + TX, etrimfos (1142) + TX, EXD (1143) + TX, famphur (323) + TX, fenamiphos (326) + TX, fenazaflor (1147) + TX, fenchlorphos (1148) + TX, fenethacarb (1149) + TX, fenfluthrin (1150) + TX, fenitrothion (335) + TX, fenobucarb (336) + TX, fenoxacrim (1153) + TX, fenoxycarb (340) + TX, fenpirithrin (1155) + TX, fenpropathrin (342) + TX, fenpyrad (alternative name) + TX, fensulfthion (1158) + TX, fenthion (346) + TX, fenthion-ethyl [CCN] + TX, fenvalerate (349) + TX, fipronil (354) + TX, flonicamid (358) + TX, flubendiamide (CAS. Reg. No.: 272451-65-7) + TX, flucofuron (1168) + TX, flucycloخورon (366) + TX, flucythrinate (367) + TX, fluenetil (1169) + TX, flufenerim [CCN] + TX, flufenoxuron (370) + TX, flufenprox (1171) + TX, flumethrin (372) + TX, fluvalinate (1184) + TX, FMC 1137 (development code) (1185) + TX, fonofos (1191) + TX, formetanate (405) + TX, formetanate hydrochloride (405) + TX, formothion (1192) + TX, formparanate (1193) + TX, fosmethilan (1194) + TX, fospirate (1195) + TX, fosthiazate (408) + TX, fosthietan (1196) + TX, furathiocarb (412) + TX, furethrin (1200) + TX, gamma-cyhalothrin (197) + TX, gamma-HCH (430) + TX, guazatine (422) + TX, guazatine acetates (422) + TX, GY-81 (development code) (423) + TX, halfenprox (424) + TX, halofenozide (425) + TX, HCH (430) + TX, HEOD (1070) + TX, heptachlor (1211) + TX, heptenophos (432) + TX, heterophos [CCN] + TX, hexaflumuron (439) + TX, HHDN (864) + TX, hydramethylnon (443) + TX, hydrogen cyanide (444) + TX, hydroprene (445) + TX, hyquincarb (1223) + TX, imidacloprid (458) + TX, imiprothrin (460) + TX, indoxacarb (465) + TX, iodomethane (IUPAC name) (542) + TX, IPSP (1229) + TX, isazofos (1231) + TX, isobenzan (1232) + TX, isocarbophos (alternative name) (473) + TX, isodrin (1235) + TX, isofenphos (1236) + TX, isolane (1237) + TX, isoprocarb (472) + TX, isopropyl O-(methoxy-aminothiophosphoryl)salicylate (IUPAC name) (473) + TX, isoprothiolane (474) + TX, isothioate (1244) + TX, isoxathion (480) + TX, ivermectin (alternative name) [CCN] + TX, jasmolin I (696) + TX, jasmolin II (696) + TX, jodfenphos (1248) + TX, juvenile hormone I (alternative name) [CCN] + TX, juvenile hormone II (alternative name) [CCN] + TX, juvenile hormone III (alternative name) [CCN] + TX, kelevan (1249) + TX, kinoprene (484) + TX, lambda-cyhalothrin (198) + TX, lead arsenate [CCN] + TX, lepimectin (CCN) + TX, leptophos (1250) + TX, lindane (430) + TX, lirimfos (1251) + TX, lufenuron (490) + TX, lythidathion (1253) + TX, m-cumenyl methylcarbamate (IUPAC name) (1014) + TX, magnesium phosphide (IUPAC name) (640) + TX, malathion (492) + TX, malonoben (1254) + TX, mazidox (1255) + TX, mecarbarn (502) + TX, mecarphon (1258) + TX, menazon (1260) + TX, mephosfolan (1261) + TX, mercurous chloride (513) + TX, mesulfenfos (1263) + TX, metaflumizone (CCN) + TX, metam (519) + TX, metam-potassium (alternative name) (519) + TX, metam-sodium (519) + TX, methacrifos (1266) + TX, methamidophos (527) + TX, methanesulfonyl fluoride (IUPAC/Chemical Abstracts name) (1268) + TX, methidathion (529) + TX, methiocarb (530) + TX, methocrotophos (1273) + TX, methomyl (531) + TX, methoprene (532) + TX, methoquin-butyl (1276) + TX, methothrin (alternative name) (533) + TX, methoxychlor (534) + TX, methoxyfenozide

EP 3 183 245 B1

(535) + TX, methyl bromide (537) + TX, methyl isothiocyanate (543) + TX, methylchloroform (alternative name) [CCN] + TX, methylene chloride [CCN] + TX, metofluthrin [CCN] + TX, metolcarb (550) + TX, metoxadiazone (1288) + TX, mevinphos (556) + TX, mexacarbate (1290) + TX, milbemectin (557) + TX, milbemycin oxime (alternative name) [CCN] + TX, mipafox (1293) + TX, mirex (1294) + TX, monocrotophos (561) + TX, morphothion (1300) + TX, moxidectin (alternative name) [CCN] + TX, naftalofos (alternative name) [CCN] + TX, naled (567) + TX, naphthalene (IUPAC/Chemical Abstracts name) (1303) + TX, NC-170 (development code) (1306) + TX, NC-184 (compound code) + TX, nicotine (578) + TX, nicotine sulfate (578) + TX, nifluridide (1309) + TX, nitenpyram (579) + TX, nithiazine (1311) + TX, nitrilacarb (1313) + TX, nitrilacarb 1:1 zinc chloride complex (1313) + TX, NNI-0101 (compound code) + TX, NNI-0250 (compound code) + TX, norm nicotine (traditional name) (1319) + TX, novaluron (585) + TX, noviflururon (586) + TX, O-5-dichloro-4-iodophenyl O-ethyl ethylphosphonothioate (IUPAC name) (1057) + TX, O,O-diethyl O-4-methyl-2-oxo-2H-chromen-7-yl phosphorothioate (IUPAC name) (1074) + TX, O,O-diethyl O-6-methyl-2-propylpyrimidin-4-yl phosphorothioate (IUPAC name) (1075) + TX, O,O,O',O'-tetrapropyl dithiopyrophosphate (IUPAC name) (1424) + TX, oleic acid (IUPAC name) (593) + TX, omethoate (594) + TX, oxamyl (602) + TX, oxydemeton-methyl (609) + TX, oxydeprofos (1324) + TX, oxydisulfoton (1325) + TX, pp'-DDT (219) + TX, para-dichlorobenzene [CCN] + TX, parathion (615) + TX, parathion-methyl (616) + TX, penfluron (alternative name) [CCN] + TX, pentachlorophenol (623) + TX, pentachlorophenyl laurate (IUPAC name) (623) + TX, permethrin (626) + TX, petroleum oils (alternative name) (628) + TX, PH 60-38 (development code) (1328) + TX, phenkapton (1330) + TX, phenothrin (630) + TX, phenthoate (631) + TX, phorate (636) + TX, phosalone (637) + TX, phosfolan (1338) + TX, phosmet (638) + TX, phosnichlor (1339) + TX, phosphamidon (639) + TX, phosphine (IUPAC name) (640) + TX, phoxim (642) + TX, phoxim-methyl (1340) + TX, pirimetaphos (1344) + TX, pirimicarb (651) + TX, pirimiphos-ethyl (1345) + TX, pirimiphos-methyl (652) + TX, polychlorodicyclopentadiene isomers (IUPAC name) (1346) + TX, polychloroterpenes (traditional name) (1347) + TX, potassium arsenite [CCN] + TX, potassium thiocyanate [CCN] + TX, prallethrin (655) + TX, precocene I (alternative name) [CCN] + TX, precocene II (alternative name) [CCN] + TX, precocene III (alternative name) [CCN] + TX, primidophos (1349) + TX, profenofos (662) + TX, profluthrin [CCN] + TX, promacyl (1354) + TX, promecarb (1355) + TX, propaphos (1356) + TX, propetamphos (673) + TX, propoxur (678) + TX, prothidathion (1360) + TX, prothiofos (686) + TX, prothoate (1362) + TX, protrifenbutate [CCN] + TX, pymetrozine (688) + TX, pyraclofos (689) + TX, pyrazophos (693) + TX, pyresmethrin (1367) + TX, pyrethrin I (696) + TX, pyrethrin II (696) + TX, pyrethrins (696) + TX, pyridaben (699) + TX, pyridalyl (700) + TX, pyridaphenthion (701) + TX, pyrimidifen (706) + TX, pyrimitate (1370) + TX, pyriproxyfen (708) + TX, quassia (alternative name) [CCN] + TX, quinalphos (711) + TX, quinalphos-methyl (1376) + TX, quinothion (1380) + TX, quintiofos (1381) + TX, R-1492 (development code) (1382) + TX, rafoxanide (alternative name) [CCN] + TX, resmethrin (719) + TX, rotenone (722) + TX, RU 15525 (development code) (723) + TX, RU 25475 (development code) (1386) + TX, ryania (alternative name) (1387) + TX, ryanodine (traditional name) (1387) + TX, sabadilla (alternative name) (725) + TX, schradan (1389) + TX, sebufos (alternative name) + TX, selamectin (alternative name) [CCN] + TX, SI-0009 (compound code) + TX, SI-0205 (compound code) + TX, SI-0404 (compound code) + TX, SI-0405 (compound code) + TX, silafluofen (728) + TX, SN 72129 (development code) (1397) + TX, sodium arsenite [CCN] + TX, sodium cyanide (444) + TX, sodium fluoride (IUPAC/Chemical Abstracts name) (1399) + TX, sodium hexafluorosilicate (1400) + TX, sodium pentachlorophenoxide (623) + TX, sodium selenate (IUPAC name) (1401) + TX, sodium thiocyanate [CCN] + TX, sophamide (1402) + TX, spinosad (737) + TX, spiromesifen (739) + TX, spirotetramat (CCN) + TX, sulcofuron (746) + TX, sulcofuron-sodium (746) + TX, sulfluramid (750) + TX, sulfotep (753) + TX, sulfuryl fluoride (756) + TX, sulprofos (1408) + TX, tar oils (alternative name) (758) + TX, tau-fluvalinate (398) + TX, tazimcarb (1412) + TX, TDE (1414) + TX, tebufenozide (762) + TX, tebufenpyrad (763) + TX, tebupirimfos (764) + TX, teflubenzuron (768) + TX, tefluthrin (769) + TX, temephos (770) + TX, TEPP (1417) + TX, terallethrin (1418) + TX, terbam (alternative name) + TX, terbufos (773) + TX, tetrachloroethane [CCN] + TX, tetrachlorvinphos (777) + TX, tetramethrin (787) + TX, theta-cypermethrin (204) + TX, thiacloprid (791) + TX, thiafenox (alternative name) + TX, thiamethoxam (792) + TX, thiofos (1428) + TX, thiocarboxime (1431) + TX, thiocyclam (798) + TX, thiocyclam hydrogen oxalate (798) + TX, thiodicarb (799) + TX, thiofanox (800) + TX, thiometon (801) + TX, thionazin (1434) + TX, thiosultap (803) + TX, thiosultap-sodium (803) + TX, thuringiensin (alternative name) [CCN] + TX, tolfenpyrad (809) + TX, tralomethrin (812) + TX, transfluthrin (813) + TX, transpermethrin (1440) + TX, triamiphos (1441) + TX, triazamate (818) + TX, triazophos (820) + TX, triazuron (alternative name) + TX, trichlorfon (824) + TX, trichlormetaphos-3 (alternative name) [CCN] + TX, trichloronat (1452) + TX, trifenofos (1455) + TX, triflumuron (835) + TX, trimethacarb (840) + TX, triprene (1459) + TX, vamidothion (847) + TX, vaniliprole [CCN] + TX, veratridine (alternative name) (725) + TX, veratrine (alternative name) (725) + TX, XMC (853) + TX, xylylcarb (854) + TX, YI-5302 (compound code) + TX, zeta-cypermethrin (205) + TX, zetamethrin (alternative name) + TX, zinc phosphide (640) + TX, zolapofos (1469) and ZXI 8901 (development code) (858) + TX, cyantraniliprole [736994-63-19 + TX, chlorantraniliprole [500008-45-7] + TX, cyenopyrafen [560121-52-0] + TX, cyflumetofen [400882-07-7] + TX, pyrifluquinazon [337458-27-2] + TX, spinetoram [187166-40-1 + 187166-15-0] + TX, spirotetramat [203313-25-1] + TX, sulfoxaflor [946578-00-3] + TX, flufiprole [704886-18-0] + TX, meperfluthrin [915288-13-0] + TX, tetramethylfluthrin [84937-88-2]

EP 3 183 245 B1

+ TX, triflumezopyrim (disclosed in WO 2012/092115) + TX, fluxametamide (WO 2007/026965) + TX, epsilon-metofluthrin [240494-71-7] + TX, epsilon-momfluorothrin [1065124-65-3] + TX, fluazaindolizine [1254304-22-7] + TX, chloroprallethrin [399572-87-3] + TX, fluxametamide [928783-29-3] + TX, cyhalodiamide [1262605-53-7] + TX, tioxazafen [330459-31-9] + TX, broflanilide [1207727-04-5] + TX, flufiprole [704886-18-0] + TX, cyclaniliprole [1031756-98-5] + TX, tetraniliprole [1229654-66-3] + TX, guadiopyr (described in WO2010/060231) + TX, cycloxaprid (described in WO2005/077934) + TX,

5 a molluscicide selected from the group of substances consisting of bis(tributyltin) oxide (IUPAC name) (913) + TX, bromoacetamide [CCN] + TX, calcium arsenate [CCN] + TX, cloethocarb (999) + TX, copper acetoarsenite [CCN] + TX, copper sulfate (172) + TX, fentin (347) + TX, ferric phosphate (IUPAC name) (352) + TX, metaldehyde (518) + TX, methiocarb (530) + TX, niclosamide (576) + TX, niclosamide-olamine (576) + TX, pentachlorophenol (623) + TX, sodium pentachlorophenoxide (623) + TX, tazimcarb (1412) + TX, thiodicarb (799) + TX, tributyltin oxide (913) + TX, trifenmorph (1454) + TX, trimethacarb (840) + TX, triphenyltin acetate (IUPAC name) (347) and triphenyltin hydroxide (IUPAC name) (347) + TX, pyriprole [394730-71-3] + TX,

10 a nematocide selected from the group of substances consisting of AKD-3088 (compound code) + TX, 1,2-dibromo-3-chloropropane (IUPAC/Chemical Abstracts name) (1045) + TX, 1,2-dichloropropane (IUPAC/ Chemical Abstracts name) (1062) + TX, 1,2-dichloropropane with 1,3-dichloropropene (IUPAC name) (1063) + TX, 1,3-dichloropropene (233) + TX, 3,4-dichlorotetrahydrothiophene 1,1-dioxide (IUPAC/Chemical Abstracts name) (1065) + TX, 3-(4-chlorophenyl)-5-methylrhodanine (IUPAC name) (980) + TX, 5-methyl-6-thioxo-1,3,5-thiadiazinan-3-ylacetic acid (IUPAC name) (1286) + TX, 6-isopentenylaminopurine (alternative name) (210) + TX, abamectin (1) + TX, acetoprole [CCN] + TX, alanycarb (15) + TX, aldicarb (16) + TX, aldoxycarb (863) + TX, AZ 60541 (compound code) + TX, benclotiaz [CCN] + TX, benomyl (62) + TX, butylpyridaben (alternative name) + TX, cadusafos (109) + TX, carbosulfan (118) + TX, carbon disulfide (945) + TX, carbosulfan (119) + TX, chloropicrin (141) + TX, chlorpyrifos (145) + TX, cloethocarb (999) + TX, cytokinins (alternative name) (210) + TX, dazomet (216) + TX, DBCP (1045) + TX, DCIP (218) + TX, diamidafos (1044) + TX, dichlofenthion (1051) + TX, dicliphos (alternative name) + TX, dimethoate (262) + TX, doramectin (alternative name) [CCN] + TX, emamectin (291) + TX, emamectin benzoate (291) + TX, eprinomectin (alternative name) [CCN] + TX, ethoprophos (312) + TX, ethylene dibromide (316) + TX, fenamiphos (326) + TX, fenpyrad (alternative name) + TX, fensulfothion (1158) + TX, fosthiazate (408) + TX, fosthietan (1196) + TX, furfural (alternative name) [CCN] + TX, GY-81 (development code) (423) + TX, heterophos [CCN] + TX, iodomethane (IUPAC name) (542) + TX, isamidofos (1230) + TX, isazofos (1231) + TX, ivermectin (alternative name) [CCN] + TX, kinetin (alternative name) (210) + TX, mecarphon (1258) + TX, metam (519) + TX, metam-potassium (alternative name) (519) + TX, metam-sodium (519) + TX, methyl bromide (537) + TX, methyl isothiocyanate (543) + TX, milbemycin oxime (alternative name) [CCN] + TX, moxidectin (alternative name) [CCN] + TX, *Myrothecium verrucaria* composition (alternative name) (565) + TX, NC-184 (compound code) + TX, oxamyl (602) + TX, phorate (636) + TX, phosphamidon (639) + TX, phosphocarb [CCN] + TX, sebufos (alternative name) + TX, selamectin (alternative name) [CCN] + TX, spinosad (737) + TX, terbam (alternative name) + TX, terbufos (773) + TX, tetrachlorothiophene (IUPAC/ Chemical Abstracts name) (1422) + TX, thiafenox (alternative name) + TX, thionazin (1434) + TX, triazophos (820) + TX, triazuron (alternative name) + TX, xylenols [CCN] + TX, YI-5302 (compound code) and zeatin (alternative name) (210) + TX, fluensulfone [318290-98-1] + TX,

20 a nitrification inhibitor selected from the group of substances consisting of potassium ethylxanthate [CCN] and nitrapyrin (580) + TX,

25 a plant activator selected from the group of substances consisting of acibenzolar (6) + TX, acibenzolar-S-methyl (6) + TX, probenazole (658) and *Reynoutria sachalinensis* extract (alternative name) (720) + TX,

30 a rodenticide selected from the group of substances consisting of 2-isovalerylindan-1,3-dione (IUPAC name) (1246) + TX, 4-(quinoxalin-2-ylamino)benzenesulfonamide (IUPAC name) (748) + TX, alpha-chlorohydrin [CCN] + TX, aluminium phosphide (640) + TX, antu (880) + TX, arsenous oxide (882) + TX, barium carbonate (891) + TX, bithiosemi (912) + TX, brodifacoum (89) + TX, bromadiolone (91) + TX, bromethalin (92) + TX, calcium cyanide (444) + TX, chloralose (127) + TX, chlorophacinone (140) + TX, cholecalciferol (alternative name) (850) + TX, coumachlor (1004) + TX, coumafuryl (1005) + TX, coumatetralyl (175) + TX, crimidine (1009) + TX, difenacoum (246) + TX, difethialone (249) + TX, diphacinone (273) + TX, ergocalciferol (301) + TX, flocoumafen (357) + TX, fluoroacetamide (379) + TX, flupropradine (1183) + TX, flupropradine hydrochloride (1183) + TX, gamma-HCH (430) + TX, HCH (430) + TX, hydrogen cyanide (444) + TX, iodomethane (IUPAC name) (542) + TX, lindane (430) + TX, magnesium phosphide (IUPAC name) (640) + TX, methyl bromide (537) + TX, norbormide (1318) + TX, phosacetim (1336) + TX, phosphine (IUPAC name) (640) + TX, phosphorus [CCN] + TX, pindone (1341) + TX, potassium arsenite [CCN] + TX, pyrinuron (1371) + TX, scilliroside (1390) + TX, sodium arsenite [CCN] + TX, sodium cyanide (444) + TX, sodium fluoroacetate (735) + TX, strychnine (745) + TX, thallium sulfate [CCN] + TX, warfarin (851) and zinc phosphide (640) + TX,

35 a synergist selected from the group of substances consisting of 2-(2-butoxyethoxy)ethyl piperonylate (IUPAC name) (934) + TX, 5-(1,3-benzodioxol-5-yl)-3-hexylcyclohex-2-enone (IUPAC name) (903) + TX, farnesol with nerolidol

EP 3 183 245 B1

(alternative name) (324) + TX, MB-599 (development code) (498) + TX, MGK 264 (development code) (296) + TX, piperonyl butoxide (649) + TX, piprotal (1343) + TX, propyl isomer (1358) + TX, S421 (development code) (724) + TX, sesamex (1393) + TX, sesasmolin (1394) and sulfoxide (1406) + TX,
5 an animal repellent selected from the group of substances consisting of anthraquinone (32) + TX, chloralose (127) + TX, copper naphthenate [CCN] + TX, copper oxychloride (171) + TX, diazinon (227) + TX, dicyclopentadiene (chemical name) (1069) + TX, guazatine (422) + TX, guazatine acetates (422) + TX, methiocarb (530) + TX, pyridin-4-amine (IUPAC name) (23) + TX, thiram (804) + TX, trimethacarb (840) + TX, zinc naphthenate [CCN] and ziram (856) + TX,
10 a virucide selected from the group of substances consisting of imanin (alternative name) [CCN] and ribavirin (alternative name) [CCN] + TX,
a wound protectant selected from the group of substances consisting of mercuric oxide (512) + TX, octhilinone (590) and thiophanate-methyl (802) + TX,
and biologically active compounds selected from the group consisting of azaconazole (60207-31-0) + TX, bitertanol [70585-36-3] + TX, bromuconazole [116255-48-2] + TX, cyproconazole [94361-06-5] + TX, difenoconazole [119446-68-3] + TX, diniconazole [83657-24-3] + TX, epoxiconazole [106325-08-0] + TX, fenbuconazole [114369-43-6] + TX, fluquinconazole [136426-54-5] + TX, flusilazole [85509-19-9] + TX, flutriafol [76674-21-0] + TX, hexaconazole [79983-71-4] + TX, imazalil [35554-44-0] + TX, imibenconazole [86598-92-7] + TX, ipconazole [125225-28-7] + TX, metconazole [125116-23-6] + TX, myclobutanil [88671-89-0] + TX, pefurazoate [101903-30-4] + TX, penconazole [66246-88-6] + TX, prothioconazole [178928-70-6] + TX, pyrifenoxy [88283-41-4] + TX, prochloraz [67747-09-5] + TX, propiconazole [60207-90-1] + TX, simeconazole [149508-90-7] + TX, tebuconazole [107534-96-3] + TX, tetraconazole [112281-77-3] + TX, triadimefon [43121-43-3] + TX, triadimenol [55219-65-3] + TX, triflumizole [99387-89-0] + TX, triticonazole [131983-72-7] + TX, ancymidol [12771-68-5] + TX, fenarimol [60168-88-9] + TX, nuarimol [63284-71-9] + TX, bupirimate [41483-43-6] + TX, dimethirimol [5221-53-4] + TX, ethirimol [23947-60-6] + TX, dodemorph [1593-77-7] + TX, fenpropidine [67306-00-7] + TX, fenpropimorph [67564-91-4] + TX, spiroxamine [118134-30-8] + TX, tridemorph [81412-43-3] + TX, cyprodinil [121552-61-2] + TX, mepanipyrim [110235-47-7] + TX, pyrimethanil [53112-28-0] + TX, fempiclonil [74738-17-3] + TX, fludioxonil [131341-86-1] + TX, benalaxyl [71626-11-4] + TX, furalaxyl [57646-30-7] + TX, metalaxyl [57837-19-1] + TX, R-metalaxyl [70630-17-0] + TX, ofurace [58810-48-3] + TX, oxadixyl [77732-09-3] + TX, benomyl [17804-35-2] + TX, carbendazim [10605-21-7] + TX, debacarb [62732-91-6] + TX, fuberidazole [3878-19-1] + TX, thiabendazole [148-79-8] + TX, chlozolate [84332-86-5] + TX, dichlozoline [24201-58-9] + TX, iprodione [36734-19-7] + TX, myclobutyl [54864-61-8] + TX, procymidone [32809-16-8] + TX, vinclozoline [50471-44-8] + TX, boscalid [188425-85-6] + TX, carboxin [5234-68-4] + TX, fenfuram [24691-80-3] + TX, flutolanil [66332-96-5] + TX, mepronil [55814-41-0] + TX, oxycarboxin [5259-88-1] + TX, penthiopyrad [183675-82-3] + TX, thifluzamide [130000-40-7] + TX, guazatine [108173-90-6] + TX, dodine [2439-10-3] [112-65-2] (free base) + TX, iminoctadine [13516-27-3] + TX, azoxystrobin [131860-33-8] + TX, dimoxystrobin [149961-52-4] + TX, enestroburin {Proc. BCPC, Int. Congr., Glasgow, 2003, 1, 93} + TX, fluoxystrobin [361377-29-9] + TX, kresoxim-methyl [143390-89-0] + TX, metominostrobin [133408-50-1] + TX, trifloxystrobin [141517-21-7] + TX, orysastrobin [248593-16-0] + TX, picoxystrobin [117428-22-5] + TX, pyraclostrobin [175013-18-0] + TX, ferbam [14484-64-1] + TX, mancozeb [8018-01-7] + TX, maneb [12427-38-2] + TX, metiram [9006-42-2] + TX, propineb [12071-83-9] + TX, thiram [137-26-8] + TX, zineb [12122-67-7] + TX, ziram [137-30-4] + TX, captan [2425-06-1] + TX, captan [133-06-2] + TX, dichlofluanid [1085-98-9] + TX, fluoroimide [41205-21-4] + TX, folpet [133-07-3] + TX, tolylfluanid [731-27-1] + TX, bordeaux mixture [8011-63-0] + TX, copperhydroxid [20427-59-2] + TX, copperoxychlorid [1332-40-7] + TX, coppersulfat [7758-98-7] + TX, copperoxid [1317-39-1] + TX, mancopper [53988-93-5] + TX, oxine-copper [10380-28-6] + TX, dinocap [131-72-6] + TX, nitrothal-isopropyl [10552-74-6] + TX, edifenphos [17109-49-8] + TX, iprobenphos [26087-47-8] + TX, isoprothiolane [50512-35-1] + TX, phosdiphen [36519-00-3] + TX, pyrazophos [13457-18-6] + TX, tolclofos-methyl [57018-04-9] + TX, acibenzolar-S-methyl [135158-54-2] + TX, anilazine [101-05-3] + TX, benthiavalicarb [413615-35-7] + TX, blastidicid-S [2079-00-7] + TX, chinomethionat [2439-01-2] + TX, chloroneb [2675-77-6] + TX, chlorothalonil [1897-45-6] + TX, cyflufenamid [180409-60-3] + TX, cymoxanil [57966-95-7] + TX, dichlone [117-80-6] + TX, diclocymet [139920-32-4] + TX, diclomezine [62865-36-5] + TX, dicloran [99-30-9] + TX, diethofencarb [87130-20-9] + TX, dimethomorph [110488-70-5] + TX, SYP-L190 (Flumorph) [211867-47-9] + TX, dithianon [3347-22-6] + TX, ethaboxam [162650-77-3] + TX, etridiazole [2593-15-9] + TX, famoxadone [131807-57-3] + TX, fenamidone [161326-34-7] + TX, fenoxanil [115852-48-7] + TX, fentin [668-34-8] + TX, ferimzone [89269-64-7] + TX, fluazinam [79622-59-6] + TX, fluopicolide [239110-15-7] + TX, flusulfamide [106917-52-6] + TX, fenhexamid [126833-17-8] + TX, fosetyl-aluminium [39148-24-8] + TX, hymexazol [10004-44-1] + TX, iprovalicarb [140923-17-7] + TX, IKF-916 (Cyazofamid) [120116-88-3] + TX, kasugamycin [6980-18-3] + TX, methasulfocarb [66952-49-6] + TX, metrafenone [220899-03-6] + TX, pencycuron [66063-05-6] + TX, phthalide [27355-22-2] + TX, polyoxins [11113-80-7] + TX, probenazole [27605-76-1] + TX, propamocarb [25606-41-1] + TX, proquinazid [189278-12-4] + TX, pyroquilon [57369-32-1] + TX, quinoxifen [124495-18-7] + TX, quintozone [82-68-8] + TX, sulfur [7704-34-9] +

TX, tiadinil [223580-51-6] + TX, triazoxide [72459-58-6] + TX, tricyclazole [41814-78-2] + TX, triforine [26644-46-2] + TX, validamycin [37248-47-8] + TX, zoxamide (RH7281) [156052-68-5] + TX, mandipropamid [374726-62-2] + TX, isopyrazam [881685-58-1] + TX, sedaxane [874967-67-6] + TX, 3-difluoromethyl-1-methyl-1H-pyrazole-4-carboxylic acid (9-dichloromethylene-1,2,3,4-tetrahydro-1,4-methano-naphthalen-5-yl)-amide (disclosed in WO 2007/048556) + TX, 3-difluoromethyl-1-methyl-1H-pyrazole-4-carboxylic acid (3',4',5'-trifluoro-biphenyl-2-yl)-amide (disclosed in WO 2006/087343) + TX, [(3S,4R,4aR,6S,6aS,12R,12aS,12bS)-3-[(cyclopropylcarbonyl)oxy]-1,3,4,4a,5,6,6a,12,12a,12b-decahydro-6,12-dihydroxy-4,6a,12b-trimethyl-11-oxo-9-(3-pyridinyl)-2H,11Hnaphtho[2,1-b]pyrano[3,4-e]pyran-4-yl)methyl-cyclopropanecarboxylate [915972-17-7] + TX and 1,3,5-trimethyl-N-(2-methyl-1-oxopropyl)-N-[3-(2-methylpropyl)-4-[2,2,2-trifluoro-1-methoxy-1-(trifluoromethyl)ethyl]phenyl]-1H-pyrazole-4-carboxamide [926914-55-8] + TX; and

microbials including: *Acinetobacter lwoffii* + TX, *Acremonium alternatum* + TX + TX, *Acremonium cephalosporium* + TX + TX, *Acremonium diospyri* + TX, *Acremonium obclavatum* + TX, *Adoxophyes orana granulovirus* (AdoxGV) (Capex®) + TX, *Agrobacterium radiobacter* strain K84 (Galltrol-A®) + TX, *Alternaria alternate* + TX, *Alternaria cassia* + TX, *Alternaria destruens* (Smolder®) + TX, *Ampelomyces quisqualis* (AQ10®) + TX, *Aspergillus flavus* AF36 (AF36®) + TX, *Aspergillus flavus* NRRL 21882 (Aflaguard®) + TX, *Aspergillus* spp. + TX, *Aureobasidium pullulans* + TX, *Azospirillum* + TX, (MicroAZ®) + TX, TAZO B®) + TX, *Azotobacter* + TX, *Azotobacter chroococcum* (Azotomeal®) + TX, *Azotobacter* cysts (Bionatural Blooming Blossoms®) + TX, *Bacillus amyloliquefaciens* + TX, *Bacillus cereus* + TX, *Bacillus chitinosporus* strain CM-1 + TX, *Bacillus chitinosporus* strain AQ746 + TX, *Bacillus licheniformis* strain HB-2 (Biostart™ Rhizoboost®) + TX, *Bacillus licheniformis* strain 3086 (EcoGuard® + TX, Green Releaf®) + TX, *Bacillus circulans* + TX, *Bacillus firmus* (BioSafe® + TX, BioNem-WP® + TX, VOTIVO®) + TX, *Bacillus firmus* strain I-1582 + TX, *Bacillus macerans* + TX, *Bacillus marismortui* + TX, *Bacillus megaterium* + TX, *Bacillus mycoides* strain AQ726 + TX, *Bacillus papillae* (Milky Spore Powder®) + TX, *Bacillus pumilus* spp. + TX, *Bacillus pumilus* strain GB34 (Yield Shield®) + TX, *Bacillus pumilus* strain AQ717 + TX, *Bacillus pumilus* strain QST 2808 (Sonata® + TX, Ballad Plus®) + TX, *Bacillus spahericus* (VectoLex®) + TX, *Bacillus* spp. + TX, *Bacillus* spp. strain AQ175 + TX, *Bacillus* spp. strain AQ177 + TX, *Bacillus* spp. strain AQ178 + TX, *Bacillus subtilis* strain QST 713 (CEASE® + TX, Serenade® + TX, Rhapsody®) + TX, *Bacillus subtilis* strain QST 714 (JAZZ®) + TX, *Bacillus subtilis* strain AQ153 + TX, *Bacillus subtilis* strain AQ743 + TX, *Bacillus subtilis* strain QST3002 + TX, *Bacillus subtilis* strain QST3004 + TX, *Bacillus subtilis* var. *amyloliquefaciens* strain FZB24 (Taegro® + TX, Rhizopro®) + TX, *Bacillus thuringiensis* Cry 2Ae + TX, *Bacillus thuringiensis* Cry1Ab + TX, *Bacillus thuringiensis aizawai* GC 91 (Agree®) + TX, *Bacillus thuringiensis israelensis* (BMP123® + TX, Aquabac® + TX, VectoBac®) + TX, *Bacillus thuringiensis kurstaki* (Javelin® + TX, Deliver® + TX, CryMax® + TX, Bonide® + TX, Scutella WP® + TX, Turilav WP® + TX, Astuto® + TX, Dipel WP® + TX, Biobit® + TX, Foray®) + TX, *Bacillus thuringiensis kurstaki* BMP 123 (Baritone®) + TX, *Bacillus thuringiensis kurstaki* HD-1 (Bioprotec-CAF / 3P®) + TX, *Bacillus thuringiensis* strain BD#32 + TX, *Bacillus thuringiensis* strain AQ52 + TX, *Bacillus thuringiensis* var. *aizawai* (XenTari® + TX, DiPel®) + TX, bacteria spp. (GROWMEND® + TX, GROWSWEET® + TX, Shootup®) + TX, bacteriophage of *Clavipacter michiganensis* (AgriPhage®) + TX, Bakflor® + TX, *Beauveria bassiana* (Beaugenic® + TX, Brocaril WP®) + TX, *Beauveria bassiana* GHA (Mycotrol ES® + TX, Mycotrol O® + TX, BotaniGuard®) + TX, *Beauveria brongniartii* (Engerlingspilz® + TX, Schweizer Beauveria® + TX, Melocont®) + TX, *Beauveria* spp. + TX, *Botrytis cineria* + TX, *Bradyrhizobium japonicum* (TerraMax®) + TX, *Brevibacillus brevis* + TX, *Bacillus thuringiensis tenebrionis* (Novodor®) + TX, BtBooster + TX, *Burkholderia cepacia* (Deny® + TX, Intercept® + TX, Blue Circle®) + TX, *Burkholderia gladii* + TX, *Burkholderia gladioli* + TX, *Burkholderia* spp. + TX, Canadian thistle fungus (CBH Canadian Bioherbicide®) + TX, *Candida butyri* + TX, *Candida famata* + TX, *Candida fructus* + TX, *Candida glabrata* + TX, *Candida guilliermondii* + TX, *Candida melibiosica* + TX, *Candida oleophila* strain O + TX, *Candida parapsilosis* + TX, *Candida pelliculosa* + TX, *Candida pulcherrima* + TX, *Candida reukaufii* + TX, *Candida saitoana* (Bio-Coat® + TX, Biocure®) + TX, *Candida sake* + TX, *Candida* spp. + TX, *Candida tenuis* + TX, *Cedecea dravisae* + TX, *Cellulomonas flavigena* + TX, *Chaetomium cochliodes* (Nova-Cide®) + TX, *Chaetomium globosum* (Nova-Cide®) + TX, *Chromobacterium subtsugae* strain PRAA4-1T (Grandevo®) + TX, *Cladosporium cladosporioides* + TX, *Cladosporium oxysporum* + TX, *Cladosporium chlorocephalum* + TX, *Cladosporium* spp. + TX, *Cladosporium tenuissimum* + TX, *Clonostachys rosea* (EndoFine®) + TX, *Colletotrichum acutatum* + TX, *Coniothyrium minitans* (Cotans WG®) + TX, *Coniothyrium* spp. + TX, *Cryptococcus albidus* (YIELDPLUS®) + TX, *Cryptococcus humicola* + TX, *Cryptococcus infirmo-miniatus* + TX, *Cryptococcus laurentii* + TX, *Cryptophlebia leucotreta granulovirus* (Cryptex®) + TX, *Cupriavidus campinensis* + TX, *Cydia pomonella granulovirus* (CYD-X®) + TX, *Cydia pomonella granulovirus* (Madex® + TX, Madex Plus® + TX, Madex Max/ Carpovirusine®) + TX, *Cylindrobasidium laeve* (Stumpout®) + TX, *Cylindrocladium* + TX, *Debaryomyces hansenii* + TX, *Drechslera hawaiiensis* + TX, *Enterobacter cloacae* + TX, *Enterobacteriaceae* + TX, *Entomophthora virulenta* (Vektor®) + TX, *Epicoccum nigrum* + TX, *Epicoccum purpurascens* + TX, *Epicoccum* spp. + TX, *Filobasidium floriforme* + TX, *Fusarium acuminatum* + TX, *Fusarium chlamydosporum* + TX, *Fusarium oxysporum* (Fusaclean® / Biofox C®) + TX, *Fusarium proliferatum* + TX, *Fusarium* spp. + TX, *Galactomyces geotrichum* + TX, *Gliocladium catenulatum* (Primastop® + TX, Prestop®) + TX, *Gliocladium roseum* + TX, *Gliocladium* spp. (SoilGard®) + TX,

EP 3 183 245 B1

Gliocladium virens (Soilgard®) + TX, *Granulovirus* (Granupom®) + TX, *Halobacillus halophilus* + TX, *Halobacillus litoralis* + TX, *Halobacillus trueperi* + TX, *Halomonas* spp. + TX, *Halomonas subglaciescola* + TX, *Halovibrio variabilis* + TX, *Hanseniaspora uvarum* + TX, *Helicoverpa armigera nucleopolyhedrovirus* (Helicovex®) + TX, *Helicoverpa zea nuclear polyhedrosis virus* (Gemstar®) + TX, Isoflavone - formononetin (Myconate®) + TX, *Kloeckera apiculata* + TX, *Kloeckera* spp. + TX, *Lagenidium giganteum* (Laginex®) + TX, *Lecanicillium longisporum* (Vertiblast®) + TX, *Lecanicillium muscarium* (Vertikil®) + TX, *Lymantria Dispar nucleopolyhedrosis virus* (Disparvirus®) + TX, *Marinococcus halophilus* + TX, *Meira geulakonigii* + TX, *Metarhizium anisopliae* (Met52®) + TX, *Metarhizium anisopliae* (Destruxin WP®) + TX, *Metschnikowia fruticola* (Shemer®) + TX, *Metschnikowia pulcherrima* + TX, *Microdochium dimerum* (Antibot®) + TX, *Micromonospora coerulea* + TX, *Microsphaeropsis ochracea* + TX, *Muscodor albus* 620 (Muscudor®) + TX, *Muscodor roseus* strain A3-5 + TX, *Mycorrhizae* spp. (AMYkor® + TX, Root Maximizer®) + TX, *Myrothecium verrucaria* strain AARC-0255 (DiTera®) + TX, BROS PLUS® + TX, *Ophiostoma piliferum* strain D97 (Sylvanex®) + TX, *Paecilomyces farinosus* + TX, *Paecilomyces fumosoroseus* (PFR-97® + TX, PreFeRal®) + TX, *Paecilomyces linacinus* (Biostat WP®) + TX, *Paecilomyces lilacinus* strain 251 (MeloCon WG®) + TX, *Paenibacillus polymyxa* + TX, *Pantoea agglomerans* (BlightBan C9-1®) + TX, *Pantoea* spp. + TX, *Pasteuria* spp. (Econem®) + TX, *Pasteuria nishizawae* + TX, *Penicillium aurantiogriseum* + TX, *Penicillium billai* (Jumpstart® + TX, TagTeam®) + TX, *Penicillium brevicompactum* + TX, *Penicillium frequentans* + TX, *Penicillium griseofulvum* + TX, *Penicillium purpurogenum* + TX, *Penicillium* spp. + TX, *Penicillium viridicatum* + TX, *Phlebiopsis gigantea* (Rotstop®) + TX, phosphate solubilizing bacteria (Phosphomeal®) + TX, *Phytophthora cryptogea* + TX, *Phytophthora palmivora* (Devine®) + TX, *Pichia anomala* + TX, *Pichia guillemontii* + TX, *Pichia membranaefaciens* + TX, *Pichia onychis* + TX, *Pichia stipites* + TX, *Pseudomonas aeruginosa* + TX, *Pseudomonas aureofasciens* (Spot-Less Biofungicide®) + TX, *Pseudomonas cepacia* + TX, *Pseudomonas chlororaphis* (AtEze®) + TX, *Pseudomonas corrugate* + TX, *Pseudomonas fluorescens* strain A506 (BlightBan A506®) + TX, *Pseudomonas putida* + TX, *Pseudomonas reactans* + TX, *Pseudomonas* spp. + TX, *Pseudomonas syringae* (Bio-Save®) + TX, *Pseudomonas viridiflava* + TX, *Pseudomonas fluorescens* (Zequanox®) + TX, *Pseudozyma flocculosa* strain PF-A22 UL (Sporodex L®) + TX, *Puccinia canaliculata* + TX, *Puccinia thlaspeos* (Wood Warrior®) + TX, *Pythium paroecandrum* + TX, *Pythium oligandrum* (Polygandron® + TX, Polyversum®) + TX, *Pythium periplocum* + TX, *Rhanella aquatilis* + TX, *Rhanella* spp. + TX, *Rhizobia* (Dormal® + TX, Vault®) + TX, *Rhizoctonia* + TX, *Rhodococcus globerulus* strain AQ719 + TX, *Rhodosporidium diobovatum* + TX, *Rhodosporidium toruloides* + TX, *Rhodotorula* spp. + TX, *Rhodotorula glutinis* + TX, *Rhodotorula graminis* + TX, *Rhodotorula mucilagnosa* + TX, *Rhodotorula rubra* + TX, *Saccharomyces cerevisiae* + TX, *Salinococcus roseus* + TX, *Sclerotinia minor* + TX, *Sclerotinia minor* (SARRITOR®) + TX, *Scytalidium* spp. + TX, *Scytalidium uredinicola* + TX, *Spodoptera exigua nuclear polyhedrosis virus* (Spod-X® + TX, Spexit®) + TX, *Serratia marcescens* + TX, *Serratia plymuthica* + TX, *Serratia* spp. + TX, *Sordaria fimicola* + TX, *Spodoptera littoralis nucleopolyhedrovirus* (Littovir®) + TX, *Sporobolomyces roseus* + TX, *Stenotrophomonas maltophilia* + TX, *Streptomyces ahngroscopicus* + TX, *Streptomyces albaduncus* + TX, *Streptomyces exfoliates* + TX, *Streptomyces galbus* + TX, *Streptomyces griseoplanus* + TX, *Streptomyces griseoviridis* (Mycostop®) + TX, *Streptomyces lydicus* (Actinovate®) + TX, *Streptomyces lydicus* WYEC-108 (ActinoGrow®) + TX, *Streptomyces violaceus* + TX, *Tilletiopsis minor* + TX, *Tilletiopsis* spp. + TX, *Trichoderma asperellum* (T34 Biocontrol®) + TX, *Trichoderma gamsii* (Tenet®) + TX, *Trichoderma atroviride* (Plantmate®) + TX, *Trichoderma hamatum* TH 382 + TX, *Trichoderma harzianum rifai* (Mycostar®) + TX, *Trichoderma harzianum* T-22 (Trianum-P® + TX, PlantShield HC® + TX, RootShield® + TX, Trianum-G®) + TX, *Trichoderma harzianum* T-39 (Trichodex®) + TX, *Trichoderma inhamatum* + TX, *Trichoderma koningii* + TX, *Trichoderma* spp. LC 52 (Sentinel®) + TX, *Trichoderma lignorum* + TX, *Trichoderma longibrachiatum* + TX, *Trichoderma polysporum* (Binab T®) + TX, *Trichoderma taxi* + TX, *Trichoderma virens* + TX, *Trichoderma virens* (formerly *Gliocladium virens* GL-21) (SoilGuard®) + TX, *Trichoderma viride* + TX, *Trichoderma viride* strain ICC 080 (Remedier®) + TX, *Trichosporon pullulans* + TX, *Trichosporon* spp. + TX, *Trichothecium* spp. + TX, *Trichothecium roseum* + TX, *Typhula phacorrhiza* strain 94670 + TX, *Typhula phacorrhiza* strain 94671 + TX, *Ulocladium atrum* + TX, *Ulocladium oudemansii* (Botry-Zen®) + TX, *Ustilago maydis* + TX, various bacteria and supplementary micronutrients (Natural II®) + TX, various fungi (Millennium Microbes®) + TX, *Verticillium chlamydosporium* + TX, *Verticillium lecanii* (Mycotal® + TX, Vertalec®) + TX, Vip3Aa20 (VIPTera®) + TX, *Virgibacillus marismortui* + TX, *Xanthomonas campestris* pv. *Poae* (Camperico®) + TX, *Xenorhabdus bovienii* + TX, *Xenorhabdus nematophilus*; and

Plant extracts including: pine oil (Retenol®) + TX, azadirachtin (Plasma Neem Oil® + TX, AzaGuard® + TX, MeemA-zal® + TX, Molt-X® + TX, Botanical IGR (Neemazad® + TX, Neemix®) + TX, canola oil (Lilly Miller Vegol®) + TX, *Chenopodium ambrosioides near ambrosioides* (Requiem®) + TX, *Chrysanthemum* extract (Crisant®) + TX, extract of neem oil (Trilogy®) + TX, essentials oils of *Labiatae* (Botania®) + TX, extracts of clove rosemary peppermint and thyme oil (Garden insect killer®) + TX, Glycinebetaine (Greenstim®) + TX, garlic + TX, lemongrass oil (GreenMatch®) + TX, neem oil + TX, *Nepeta cataria* (Catnip oil) + TX, *Nepeta catarina* + TX, nicotine + TX, oregano oil (MossBuster®) + TX, *Pedaliaceae* oil (Nematon®) + TX, pyrethrum + TX, *Quillaja saponaria* (NemaQ®) + TX, *Reynoutria sachalinensis* (Regalia® + TX, Sakalia®) + TX, rotenone (Eco Roten®) + TX, *Rutaceae* plant extract (Soleo®) + TX,

EP 3 183 245 B1

soybean oil (Ortho ecosense®) + TX, tea tree oil (Timorex Gold®) + TX, thymus oil + TX, AGNIQUE® MMF + TX, BugOil® + TX, mixture of rosemary sesame peppermint thyme and cinnamon extracts (EF 300®) + TX, mixture of clove rosemary and peppermint extract (EF 400®) + TX, mixture of clove peppermint garlic oil and mint (Soil Shot®) + TX, kaolin (Screen®) + TX, storage glucan of brown algae (Laminarin®); and

5 pheromones including: blackheaded fireworm pheromone (3M Sprayable Blackheaded Fireworm Pheromone®) + TX, Codling Moth Pheromone (Paramount dispenser-(CM)/ Isomate C-Plus®) + TX, Grape Berry Moth Pheromone (3M MEC-GBM Sprayable Pheromone®) + TX, Leafroller pheromone (3M MEC - LR Sprayable Pheromone®) + TX, Muscamone (Snip7 Fly Bait® + TX, Starbar Premium Fly Bait®) + TX, Oriental Fruit Moth Pheromone (3M oriental fruit moth sprayable pheromone®) + TX, Peachtree Borer Pheromone (Isomate-P®) + TX, Tomato Pinworm Pheromone (3M Sprayable pheromone®) + TX, Entostat powder (extract from palm tree) (Exosex CM®) + TX, (E + TX,Z + TX,Z)-3 + TX,8 + TX,11 Tetradecatrienyl acetate + TX, (Z + TX,Z + TX,E)-7 + TX,11 + TX,13-Hexadecatrienal + TX, (E + TX,Z)-7 + TX,9-Dodecadien-1-yl acetate + TX, 2-Methyl-1-butanol + TX, Calcium acetate + TX, Scenturion® + TX, Biolure® + TX, Check-Mate® + TX, Lavandulyl senecioate; and

15 Macrobials including: *Aphelinus abdominalis* + TX, *Aphidius ervi* (Aphelinus-System®) + TX, *Acerophagus papaya* + TX, *Adalia bipunctata* (Adalia-System®) + TX, *Adalia bipunctata* (Adaline®) + TX, *Adalia bipunctata* (Aphidalia®) + TX, *Ageniaspis citricola* + TX, *Ageniaspis fuscicollis* + TX, *Amblyseius andersoni* (Anderline®) + TX, *Anderoni-System*® + TX, *Amblyseius californicus* (Amblyline® + TX, Spical®) + TX, *Amblyseius cucumeris* (Thripex® + TX, Bugline cucumeris®) + TX, *Amblyseius fallacis* (Fallacis®) + TX, *Amblyseius swirskii* (Bugline swirskii® + TX, Swirskii-Mite®) + TX, *Amblyseius womersleyi* (WomerMite®) + TX, *Amitus hesperidum* + TX, *Anagrus atomus* + TX, *Anagrus fusciventris* + TX, *Anagrus kamali* + TX, *Anagrus loeckii* + TX, *Anagrus pseudococci* (Citripar®) + TX, *Anicetus benefices* + TX, *Anisopteromalus calandrae* + TX, *Anthocoris nemoralis* (Anthocoris-System®) + TX, *Aphelinus abdominalis* (Apheline® + TX, Aphiline®) + TX, *Aphelinus asychis* + TX, *Aphidius colemani* (Aphipar®) + TX, *Aphidius ervi* (Ervipar®) + TX, *Aphidius gifuensis* + TX, *Aphidius matricariae* (Aphipar-M®) + TX, *Aphidoletes aphidimyza* (Aphidend®) + TX, *Aphidoletes aphidimyza* (Aphidoline®) + TX, *Aphytis lingnanensis* + TX, *Aphytis melinus* + TX,

25 *Aprostocetus hagenowii* + TX, *Atheta coriaria* (Staphyline®) + TX, *Bombus* spp. + TX, *Bombus terrestris* (Natupol Beehive®) + TX, *Bombus terrestris* (Beeline® + TX, Tripol®) + TX, *Cephalonomia stephanoderis* + TX, *Chilocorus nigritus* + TX, *Chrysoperla carnea* (Chrysoline®) + TX, *Chrysoperla carnea* (Chrysopa®) + TX, *Chrysoperla rufilabris* + TX, *Cirrospilus ingenuus* + TX, *Cirrospilus quadristriatus* + TX, *Citrostichus phyllocnistoides* + TX, *Closterocerus chamaeleon* + TX, *Closterocerus* spp. + TX, *Coccidoxenoides perminutus* (Planopar®) + TX, *Coccophagus cowperi* + TX, *Coccophagus lycimnia* + TX, *Cotesia flavipes* + TX, *Cotesia plutellae* + TX, *Cryptolaemus montrouzieri* (Cryptobug® + TX, Cryptoline®) + TX, *Cybocephalus nipponicus* + TX, *Dacnusa sibirica* + TX, *Dacnusa sibirica* (Minusa®) + TX, *Diglyphus isaea* (Diminex®) + TX, *Delphastus catalinae* (Delphastus®) + TX, *Delphastus pusillus* + TX, *Diachasmimorpha krausii* + TX, *Diachasmimorpha longicaudata* + TX, *Diaparsis jucunda* + TX, *Diaphorencyrtus aligarhensis* + TX, *Diglyphus isaea* + TX, *Diglyphus isaea* (Miglyphus® + TX, Digline®) + TX, *Dacnusa sibirica* (DacDigline® + TX, Minex®) + TX, *Diversinervus* spp. + TX, *Encarsia citrina* + TX, *Encarsia formosa* (Encarsia max® + TX, Encarline® + TX, En-Strip®) + TX, *Eretmoceris eremicus* (Enermix®) + TX, *Encarsia guadeloupae* + TX, *Encarsia haitiensis* + TX, *Episyrrhus balteatus* (Syrphidend®) + TX, *Eretmoceris siphonini* + TX, *Eretmoceris californicus* + TX, *Eretmoceris eremicus* (Ercal® + TX, Eretline e®) + TX, *Eretmoceris eremicus* (Bemimix®) + TX, *Eretmoceris hayati* + TX, *Eretmoceris mundus* (Bemipar® + TX, Eretline m®) + TX, *Eretmoceris siphonini* + TX,

40 *Exochomus quadripustulatus* + TX, *Feltiella acarisuga* (Spidend®) + TX, *Feltiella acarisuga* (Feltiline®) + TX, *Fopius arisanus* + TX, *Fopius ceratitivorus* + TX, Formononetin (Wirless Beehome®) + TX, *Franklinothrips vespiformis* (Vespop®) + TX, *Galendromus occidentalis* + TX, *Goniozus legneri* + TX, *Habrobracon hebetor* + TX, *Harmonia axyridis* (HarmoBeetle®) + TX, *Heterorhabditis* spp. (Lawn Patrol®) + TX, *Heterorhabditis bacteriophora* (NemaShield HB® + TX, Nemaseek® + TX, Terranem-Nam® + TX, Terranem® + TX, Larvanem® + TX, B-Green® + TX, NemAttack® + TX, Nematop®) + TX, *Heterorhabditis megidis* (Nemasys H® + TX, BioNem H® + TX, Exhibitline hm® + TX, Larvanem-M®) + TX, *Hippodamia convergens* + TX, *Hypoaspis aculeifer* (Aculeifer-System® + TX, Entomite-A®) + TX, *Hypoaspis miles* (Hypoline m® + TX, Entomite-M®) + TX, *Lbalia leucospoides* + TX, *Lecanoides floccissimus* + TX, *Lemophagus errabundus* + TX, *Leptomastidea abnormis* + TX, *Leptomastix dactylopii* (Leptopar®) + TX, *Leptomastix epona* + TX, *Lindorus lophanthae* + TX, *Lipolexis oregmae* + TX, *Lucilia caesar* (Natufly®) + TX, *Lysiphlebus testaceipes* + TX, *Macrolophus caliginosus* (Mirical-N® + TX, Macroline c® + TX, Mirical®) + TX, *Mesoseiulus longipes* + TX, *Metaphycus flavus* + TX, *Metaphycus lounsburyi* + TX, *Micromus angulatus* (Milacewing®) + TX, *Microterys flavus* + TX, *Muscidifurax raptorellus* and *Spalangia cameroni* (Biopar®) + TX, *Neodryinus typhlocybae* + TX, *Neoseiulus californicus* + TX, *Neoseiulus cucumeris* (THRYPEX®) + TX, *Neoseiulus fallacis* + TX, *Nesideocoris tenuis* (NesidioBug® + TX, Nesibug®) + TX, *Ophyra aenescens* (Biofly®) + TX, *Orius insidiosus* (Thripor-I® + TX, Oriline i®) + TX, *Orius laevigatus* (Thripor-L® + TX, Oriline l®) + TX, *Orius majusculus* (Oriline m®) + TX, *Orius strigicollis* (Thripor-S®) + TX, *Pauesia juniperorum* + TX, *Pediobius foveolatus* + TX, *Phasmarhabditis hermaphrodita* (Nemaslug®) + TX, *Phymastichus coffea* + TX, *Phytoseiulus macropilus* + TX, *Phytoseiulus persimilis* (Spidex® + TX, Phytoline p®) + TX, *Podisus maculiventris* (Podisus®) + TX, *Pseudacteon curvatus* + TX,

Pseudacteon obtusus + TX, *Pseudacteon tricuspis* + TX, *Pseudaphycus maculipennis* + TX, *Pseudleptomastix mexicana* + TX, *Psyllaephagus pilosus* + TX, *Psytalia concolor* (complex) + TX, *Quadrastichus* spp. + TX, *Rhyzobius lophanthae* + TX, *Rodolia cardinalis* + TX, *Rumina decollate* + TX, *Semielaecher petiolatus* + TX, *Sitobion avenae* (Ervibank®) + TX, *Steinernema carpocapsae* (Nematac C® + TX, Millenium® + TX, BioNem C® + TX, NemAttack® + TX, Nemastar® + TX, Capsanem®) + TX, *Steinernema feltiae* (NemaShield® + TX, Nemasys F® + TX, BioNem F® + TX, Steinernema-System® + TX, NemAttack® + TX, Nemaplus® + TX, Exhibitline sf® + TX, Scia-rid® + TX, Entonem®) + TX, *Steinernema kraussei* (Nemasys L® + TX, BioNem L® + TX, Exhibitline srb®) + TX, *Steinernema riobrave* (BioVector® + TX, BioVektor®) + TX, *Steinernema scapterisci* (Nematac S®) + TX, *Steinernema* spp. + TX, *Steinernematid* spp. (Guardian Nematodes®) + TX, *Stethorus punctillum* (Stethorus®) + TX, *Tamarixia radiate* + TX, *Tetrastichus setifer* + TX, *Thripobius semiluteus* + TX, *Torymus sinensis* + TX, *Trichogramma brassicae* (Tricholine b®) + TX, *Trichogramma brassicae* (Tricho-Strip®) + TX, *Trichogramma evanescens* + TX, *Trichogramma minutum* + TX, *Trichogramma ostrinae* + TX, *Trichogramma platneri* + TX, *Trichogramma pretiosum* + TX, *Xanthopimpla stemmator*; and
 other biologicals including: abscisic acid + TX, bioSea® + TX, *Chondrostereum purpureum* (Chontrol Paste®) + TX, *Colletotrichum gloeosporioides* (Collego®) + TX, Copper Octanoate (Cueva®) + TX, Delta traps (Trapline d®) + TX, Erwinia amylovora (Harpin) (ProAct® + TX, Ni-HIBIT Gold CST®) + TX, Ferri-phosphate (Ferramol®) + TX, Funnel traps (Trapline y®) + TX, Gallex® + TX, Grower's Secret® + TX, Homo-brassonolide + TX, Iron Phosphate (Lilly Miller Worry Free Ferramol Slug & Snail Bait®) + TX, MCP hail trap (Trapline f®) + TX, *Microctonus hyperodae* + TX, *Mycoleptodiscus terrestris* (Des-X®) + TX, BioGain® + TX, Aminomite® + TX, Zenox® + TX, Pheromone trap (Thripline ams®) + TX, potassium bicarbonate (MilStop®) + TX, potassium salts of fatty acids (Sanova®) + TX, potassium silicate solution (Sil-Matrix®) + TX, potassium iodide + potassiumthiocyanate (Enzicur®) + TX, SuffOil-X® + TX, Spider venom + TX, *Nosema locustae* (Semaspore Organic Grasshopper Control®) + TX, Sticky traps (Trapline YF® + TX, Rebell Amarillo®) + TX and Traps (Takitrapline y + b®) + TX.

[0188] The references in brackets behind the active ingredients, e.g. [3878-19-1] refer to the Chemical Abstracts Registry number. The above described mixing partners are known. Where the active ingredients are included in "The Pesticide Manual" [The Pesticide Manual - A World Compendium; Thirteenth Edition; Editor: C. D. S. Tomlin; The British Crop Protection Council], they are described therein under the entry number given in round brackets hereinabove for the particular compound; for example, the compound "abamectin" is described under entry number (1). Where "[CCN]" is added hereinabove to the particular compound, the compound in question is included in the "Compendium of Pesticide Common Names", which is accessible on the internet [A. Wood; Compendium of Pesticide Common Names, Copyright © 1995-2004]; for example, the compound "acetoprole" is described under the internet address <http://www.alan-wood.net/pesticides/acetoprole.html>.

[0189] Most of the active ingredients described above are referred to hereinabove by a so-called "common name", the relevant "ISO common name" or another "common name" being used in individual cases. If the designation is not a "common name", the nature of the designation used instead is given in round brackets for the particular compound; in that case, the IUPAC name, the IUPAC/Chemical Abstracts name, a "chemical name", a "traditional name", a "compound name" or a "development code" is used or, if neither one of those designations nor a "common name" is used, an "alternative name" is employed. "CAS Reg. No" means the Chemical Abstracts Registry Number.

[0190] The active ingredient mixture of the compounds of formula I selected from Tables 1 to 18 and P1 with active ingredients described above comprises a compound selected from Tables 1 to 18 and P1 and an active ingredient as described above preferably in a mixing ratio of from 100:1 to 1:6000, especially from 50:1 to 1:50, more especially in a ratio of from 20:1 to 1:20, even more especially from 10:1 to 1:10, very especially from 5:1 and 1:5, special preference being given to a ratio of from 2:1 to 1:2, and a ratio of from 4:1 to 2:1 being likewise preferred, above all in a ratio of 1:1, or 5:1, or 5:2, or 5:3, or 5:4, or 4:1, or 4:2, or 4:3, or 3:1, or 3:2, or 2:1, or 1:5, or 2:5, or 3:5, or 4:5, or 1:4, or 2:4, or 3:4, or 1:3, or 2:3, or 1:2, or 1:600, or 1:300, or 1:150, or 1:35, or 2:35, or 4:35, or 1:75, or 2:75, or 4:75, or 1:6000, or 1:3000, or 1:1500, or 1:350, or 2:350, or 4:350, or 1:750, or 2:750, or 4:750. Those mixing ratios are by weight.

[0191] The mixtures as described above can be used in a method for controlling pests, which comprises applying a composition comprising a mixture as described above to the pests or their environment, with the exception of a method for treatment of the human or animal body by surgery or therapy and diagnostic methods practised on the human or animal body.

[0192] The mixtures comprising a compound of formula I selected from Tables 1 to 18 and P1 and one or more active ingredients as described above can be applied, for example, in a single "ready-mix" form, in a combined spray mixture composed from separate formulations of the single active ingredient components, such as a "tank-mix", and in a combined use of the single active ingredients when applied in a sequential manner, i.e. one after the other with a reasonably short period, such as a few hours or days. The order of applying the compounds of formula I selected from Tables 1 to 18 and P1 and the active ingredients as described above is not essential for working the present invention.

[0193] The compositions according to the invention can also comprise further solid or liquid auxiliaries, such as sta-

bilizers, for example unepoxidized or epoxidized vegetable oils (for example epoxidized coconut oil, rapeseed oil or soya oil), antifoams, for example silicone oil, preservatives, viscosity regulators, binders and/or tackifiers, fertilizers or other active ingredients for achieving specific effects, for example bactericides, fungicides, nematocides, plant activators, molluscicides or herbicides.

[0194] The compositions according to the invention are prepared in a manner known per se, in the absence of auxiliaries for example by grinding, screening and/or compressing a solid active ingredient and in the presence of at least one auxiliary for example by intimately mixing and/or grinding the active ingredient with the auxiliary (auxiliaries). These processes for the preparation of the compositions and the use of the compounds I for the preparation of these compositions are also a subject of the invention.

[0195] The application methods for the compositions, that is the methods of controlling pests of the abovementioned type, such as spraying, atomizing, dusting, brushing on, dressing, scattering or pouring - which are to be selected to suit the intended aims of the prevailing circumstances - and the use of the compositions for controlling pests of the abovementioned type are other subjects of the invention. Typical rates of concentration are between 0.1 and 1000 ppm, preferably between 0.1 and 500 ppm, of active ingredient. The rate of application per hectare is generally 1 to 2000 g of active ingredient per hectare, in particular 10 to 1000 g/ha, preferably 10 to 600 g/ha.

[0196] A preferred method of application in the field of crop protection is application to the foliage of the plants (foliar application), it being possible to select frequency and rate of application to match the danger of infestation with the pest in question. Alternatively, the active ingredient can reach the plants via the root system (systemic action), by drenching the locus of the plants with a liquid composition or by incorporating the active ingredient in solid form into the locus of the plants, for example into the soil, for example in the form of granules (soil application). In the case of paddy rice crops, such granules can be metered into the flooded paddy-field.

[0197] The compounds of the invention and compositions thereof are also be suitable for the protection of plant propagation material, for example seeds, such as fruit, tubers or kernels, or nursery plants, against pests of the abovementioned type. The propagation material can be treated with the compound prior to planting, for example seed can be treated prior to sowing. Alternatively, the compound can be applied to seed kernels (coating), either by soaking the kernels in a liquid composition or by applying a layer of a solid composition. It is also possible to apply the compositions when the propagation material is planted to the site of application, for example into the seed furrow during drilling. These treatment methods for plant propagation material and the plant propagation material thus treated are further subjects of the invention. Typical treatment rates would depend on the plant and pest/fungi to be controlled and are generally between 1 to 200 grams per 100 kg of seeds, preferably between 5 to 150 grams per 100 kg of seeds, such as between 10 to 100 grams per 100 kg of seeds.

[0198] The term seed embraces seeds and plant propagules of all kinds including but not limited to true seeds, seed pieces, suckers, corns, bulbs, fruit, tubers, grains, rhizomes, cuttings, cut shoots and the like and means in a preferred embodiment true seeds.

[0199] The present invention also comprises seeds coated or treated with or containing a compound of formula I. The term "coated or treated with and/or containing" generally signifies that the active ingredient is for the most part on the surface of the seed at the time of application, although a greater or lesser part of the ingredient may penetrate into the seed material, depending on the method of application. When the said seed product is (re)planted, it may absorb the active ingredient. In an embodiment, the present invention makes available a plant propagation material adhered thereto with a compound of formula (I). Further, it is hereby made available, a composition comprising a plant propagation material treated with a compound of formula (I).

[0200] Seed treatment comprises all suitable seed treatment techniques known in the art, such as seed dressing, seed coating, seed dusting, seed soaking and seed pelleting. The seed treatment application of the compound formula (I) can be carried out by any known methods, such as spraying or by dusting the seeds before sowing or during the sowing/planting of the seeds.

Biological Examples:

Example B1: *Spodoptera littoralis* (Egyptian cotton leaf worm)

[0201] Cotton leaf discs were placed on agar in 24-well microtiter plates and sprayed with aqueous test solutions prepared from 10'000 ppm DMSO stock solutions. After drying, the leaf discs were infested with five L1 larvae. The samples were assessed for mortality, anti-feedant effect, and growth inhibition in comparison to untreated samples 3 days after infestation. Control of *Spodoptera littoralis* by a test sample is when at least one of mortality, anti-feedant effect, and growth inhibition is higher than the untreated sample.

The following compounds resulted in at least 80% control at an application rate of 200 ppm: P1, P2, P3, P4, P6, P7, P8, P10, P11, P13, P14, P15 and P16.

EP 3 183 245 B1

Example B2: *Spodoptera littoralis* (Egyptian cotton leaf worm)

5 [0202] Test compounds were applied by pipette from 10'000 ppm DMSO stock solutions into 24-well plates and mixed with agar. Lettuce seeds were placed on the agar and the multi well plate was closed by another plate which contains also agar. After 7 days the roots have absorbed the compound and the lettuce has grown into the lid plate. The lettuce leaves were now cut off into the lid plate. Spodoptera eggs were pipetted through a plastic stencil on a humid gel blotting paper and the plate closed with it. The samples were assessed for mortality, anti-feedant effect and growth inhibition in comparison to untreated samples 6 days after infestation.

10 The following compounds gave an effect of at least 80% in at least one of the three categories (mortality, anti-feedancy, or growth inhibition) at a test rate of 12.5 ppm: P6, P7, P8, P13, P15 and P16.

Example B3: *Plutella xylostella* (Diamond back moth)

15 [0203] 24-well microtiter plates with artificial diet were treated with aqueous test solutions prepared from 10'000 ppm DMSO stock solutions by pipetting. After drying, the plates were infested with L2 larvae (10 to 15 per well). The samples were assessed for mortality and growth inhibition in comparison to untreated samples 5 days after infestation.

The following compounds gave an effect of at least 80% in at least one of the two categories (mortality or growth inhibition) at an application rate of 200 ppm: P1, P2, P3, P4, P5, P6, P7, P8, P10, P11, P12, P13, P14, P15 and P16.

Example B4: *Diabrotica balteata* (Corn root worm)

20 [0204] Maize sprouts, placed on an agar layer in 24-well microtiter plates were treated with aqueous test solutions prepared from 10'000 ppm DMSO stock solutions by spraying. After drying, the plates were infested with L2 larvae (6 to 10 per well). The samples were assessed for mortality and growth inhibition in comparison to untreated samples 4 days after infestation.

25 The following compounds gave an effect of at least 80% in at least one of the two categories (mortality or growth inhibition) at an application rate of 200 ppm: P3, P4, P5, P6, P7, P8, P9, P10, P11, P13, P14, P15, P16 and P17.

Example B5: *Myzus persicae* (Green peach aphid)

30 [0205] Sunflower leaf discs were placed on agar in a 24-well microtiter plate and sprayed with aqueous test solutions prepared from 10'000 ppm DMSO stock solutions. After drying, the leaf discs were infested with an aphid population of mixed ages. The samples were assessed for mortality 6 days after infestation.

35 The following compounds resulted in at least 80% mortality at an application rate of 200 ppm: P3, P4, P6, P7, P11, P12, P15 and P16.

Example B6: *Myzus persicae* (Green peach aphid)

40 [0206] Roots of pea seedlings infested with an aphid population of mixed ages were placed directly in the aqueous test solutions prepared from 10'000 DMSO stock solutions. The samples were assessed for mortality 6 days after placing seedlings in test solutions.

The following compounds resulted in at least 80% mortality at a test rate of 24 ppm: P3, P7, P15 and P16.

Example B7: *Bemisia tabaci* (Cotton white fly)

45 [0207] Cotton leaf discs were placed on agar in 24-well microtiter plates and sprayed with aqueous test solutions prepared from 10'000 ppm DMSO stock solutions. After drying the leaf discs were infested with adult white flies. The samples were checked for mortality 6 days after incubation.

50 The following compounds resulted in at least 80% mortality at an application rate of 200 ppm: P5, P8, P12, P15 and P16.

Example B8: *Euschistus heros* (Neotropical Brown Stink Bug)

55 [0208] Soybean leaf on agar in 24-well microtiter plates were sprayed with aqueous test solutions prepared from 10'000 ppm DMSO stock solutions. After drying the leaf were infested with N-2 nymphs. The samples were assessed for mortality 5 days after infestation.

The following compounds resulted in at least 80% mortality at an application rate of 200 ppm: P6, P7, P8, P10, P11, P12, P15 and P16.

Example B9: *Aedes aegypti* (Yellow fever mosquito)

[0209] Test solutions, at an application rate of 200ppm in ethanol, were applied to 12 well tissue culture plates. Once the deposits were dry, five, two to five day old adult female *Aedes aegypti* were added to each well, and sustained with a 10% sucrose solution in a cotton wool plug. Assessment of knockdown was made one hour after introduction, and mortality was assessed at 24 and 48 hours after introduction.

The following compounds gave at least 80% control of *Aedes aegypti* after 48h: P1, P7, P8, P10, P15 and P16.

Example B10: *Tetranychus urticae* (Two-spotted spider mite)

[0210] Bean leaf discs on agar in 24-well microtiter plates were sprayed with aqueous test solutions prepared from 10'000 ppm DMSO stock solutions. After drying the leaf discs were infested with a mite population of mixed ages. The samples were assessed for mortality on mixed population (mobile stages) 8 days after infestation.

The following compounds resulted in at least 80% mortality at an application rate of 200 ppm: P9 and P15.

Example B11: *Thrips tabaci* (Onion thrips)

[0211] Sunflower leaf discs were placed on agar in 24-well microtiter plates and sprayed with aqueous test solutions prepared from 10'000 ppm DMSO stock solutions. After drying the leaf discs were infested with a thrips population of mixed ages. The samples were assessed for mortality 6 days after infestation.

The following compound resulted in at least 80% mortality at an application rate of 200 ppm: P16.

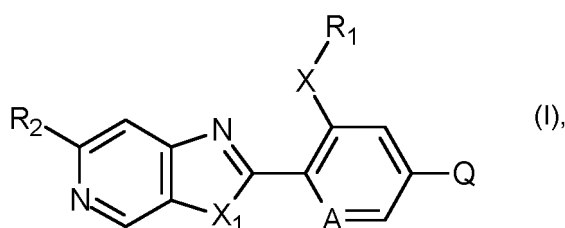
Example B12: *Frankliniella occidentalis* (Western flower thrips)

[0212] Sunflower leaf discs were placed on agar in 24-well microtiter plates and sprayed with aqueous test solutions prepared from 10'000 DMSO stock solutions. After drying the leaf discs were infested with a *Frankliniella* population of mixed ages. The samples were assessed for mortality 7 days after infestation.

The following compounds resulted in at least 80% mortality at an application rate of 200 ppm: P15 and P16.

Claims

1. A compound of formula I,



wherein

A represents CH or N;

Q is C₃-C₆cycloalkyl, or C₃-C₆cycloalkyl mono - or polysubstituted by substituents selected from the group consisting of halogen, cyano, C₁-C₄alkyl, C₁-C₄haloalkyl, C₃-C₆cycloalkyl and phenyl, or is phenyl which can be mono- or polysubstituted by substituents selected from the group consisting of halogen, cyano, C₁-C₄alkyl, C₁-C₄haloalkyl, C₁-C₄haloalkoxy, C₁-C₄alkoxy, C₁-C₄haloalkylsulfanyl, C₁-C₄halo-alkylsulfanyl, C₁-C₄haloalkylsulfonyl and -C(O)C₁-C₄haloalkyl; or

Q is C₂-C₆alkenyl, or C₂-C₆alkenyl mono - or polysubstituted by substituents selected from the group consisting of halogen, cyano, C₁-C₄alkyl, C₁-C₄haloalkyl, C₃-C₆cycloalkyl and phenyl, or is phenyl which can be mono- or polysubstituted by substituents selected from the group consisting of halogen, cyano, C₁-C₄alkyl, C₁-C₄haloalkyl, C₁-C₄haloalkoxy, C₁-C₄alkoxy, C₁-C₄haloalkylsulfanyl, C₁-C₄haloalkylsulfanyl, C₁-C₄haloalkylsulfonyl and -C(O)C₁-C₄haloalkyl; or

Q is C₂-C₆alkynyl, or C₂-C₆alkynyl mono - or polysubstituted by substituents selected from the group consisting of halogen, cyano, C₁-C₄alkyl, C₁-C₄haloalkyl, C₃-C₆cycloalkyl, tri(C₁-C₄alkyl)silyl and phenyl, or is phenyl

which can be mono- or polysubstituted by substituents selected from the group consisting of halogen, cyano, C₁-C₄alkyl, C₁-C₄haloalkyl, C₁-C₄haloalkoxy, C₁-C₄alkoxy, C₁-C₄haloalkylsulfanyl, C₁-C₄haloalkylsulfinyl, C₁-C₄haloalkylsulfonyl and -C(O)C₁-C₄haloalkyl;

X is S, SO or SO₂;

R₁ is C₁-C₄alkyl, C₁-C₄haloalkyl, C₃-C₆cycloalkyl, C₃-C₆cycloalkyl-C₁-C₄alkyl or C₃-C₆cycloalkyl mono- or polysubstituted by substituents selected from the group consisting of halogen, cyano and C₁-C₄alkyl; or R₁ is C₃-C₆cycloalkyl-C₁-C₄alkyl mono- or polysubstituted by substituents selected from the group consisting of halogen, cyano and C₁-C₄alkyl; or

R₁ is C₂-C₆alkenyl, C₂-C₆haloalkenyl or C₂-C₆alkynyl;

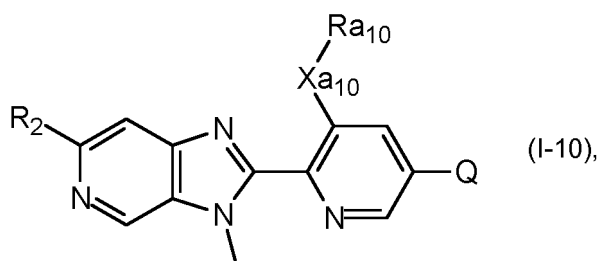
R₂ is halogen, cyano, C₁-C₆haloalkyl or C₁-C₆haloalkyl substituted by one or two substituents selected from the group consisting of hydroxyl, methoxy and cyano; or

R₂ is C₁-C₄haloalkylsulfanyl, C₁-C₄haloalkylsulfinyl, C₁-C₄haloalkylsulfonyl, O(C₁-C₄haloalkyl), or -C(O)C₁-C₄haloalkyl; or

R₂ is C₃-C₆cycloalkyl which can be mono- or polysubstituted by substituents selected from the group consisting of halogen, cyano and C₁-C₄alkyl;

X₁ is O, S or NR₃, wherein R₃ is hydrogen, C₁-C₄alkyl, C₂-C₆alkenyl, C₂-C₆alkynyl, C₁-C₄alkoxy-C₁-C₄alkyl or C₃-C₆cycloalkyl; and agrochemically acceptable salts, stereoisomers, enantiomers, tautomers and N-oxides of those compounds.

2. A compound of formula I according to claim 1, represented by the compounds of formula I-10



wherein

R₂ and Q are as defined under formula I in claim 1;

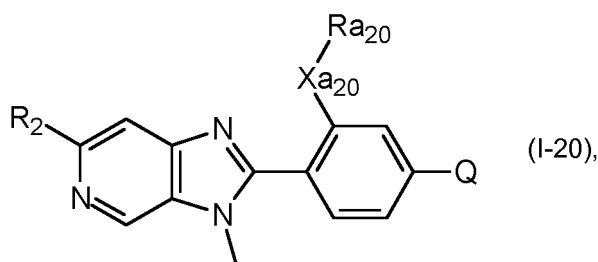
X_{a10} is S, SO or SO₂; and

Ra₁₀ is methyl, ethyl, n-propyl, i-propyl or cyclopropylmethyl.

3. A compound of formula I-10 according to claim 2, wherein

Q is C₃-C₆cycloalkyl, or C₃-C₆cycloalkyl mono- or disubstituted by substituents selected from the group consisting of cyano, C₁-C₄haloalkyl and halogen; or Q is C₂-C₆alkenyl, or C₂-C₆alkenyl monosubstituted by substituents selected from the group consisting of C₁-C₄alkyl and C₃-C₆cycloalkyl; or Q is C₂-C₆alkynyl, or C₂-C₆alkynyl monosubstituted by substituents selected from the group consisting of tri(C₁-C₄alkyl)silyl, phenyl and phenyl which itself can be monosubstituted by substituents selected from the group consisting of halogen, C₁-C₄alkyl or C₁-C₄haloalkyl.

4. A compound of formula I according to claim 1, represented by the compounds of formula I-20

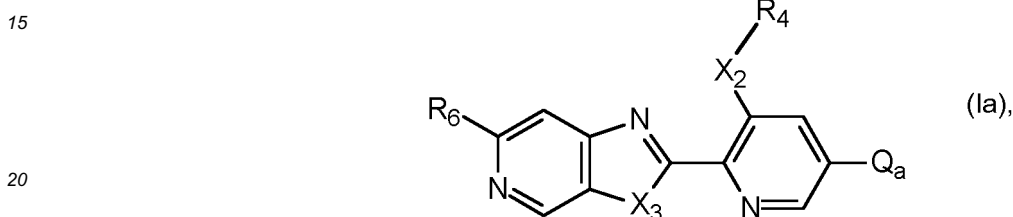


wherein

R₂ and Q are as defined under formula I in claim 1;
 X_{a20} is S, SO or SO₂; and
 Ra₂₀ is methyl, ethyl, n-propyl, i-propyl or cyclopropylmethyl.

5 5. A compound of formula I-20 according to claim 4, wherein Q is C₃-C₆cycloalkyl, or C₃-C₆cycloalkyl mono- or dis-
 substituted by substituents selected from the group consisting of cyano, C₁-C₄haloalkyl and halogen; or Q is
 C₂-C₆alkenyl, or C₂-C₆alkenyl monosubstituted by substituents selected from the group consisting of C₁-C₄alkyl
 and C₃-C₆cycloalkyl; or Q is C₂-C₆alkynyl, or C₂-C₆alkynyl monosubstituted by substituents selected from the group
 10 consisting of tri(C₁-C₄alkyl)silyl and phenyl, said phenyl can be monosubstituted by substituents selected from the
 group consisting of halogen, C₁-C₄alkyl or C₁-C₄haloalkyl.

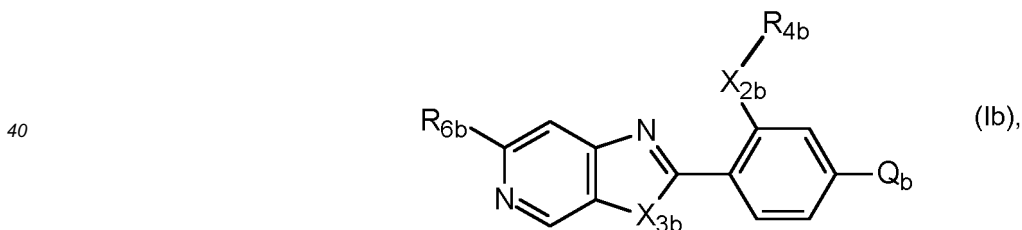
6. A compound of formula Ia



wherein

25 X₂ is SO₂;
 X₃ is N-(C₁-C₄alkyl);
 R₄ is C₁-C₄alkyl;
 Q_a is C₃-C₆cycloalkyl, C₂-C₆alkenyl or C₂-C₆alkynyl, or is C₃-C₆cycloalkyl, C₂-C₆alkenyl or C₂-C₆alkynyl each
 mono- or disubstituted by substituents selected from the group consisting of halogen, C₁-C₄alkyl, C₁-C₄haloalkyl,
 30 cyano, C₃-C₆cycloalkyl, tri(C₁-C₄alkyl)silyl and phenyl, said phenyl can be monosubstituted by halogen or
 C₁-C₄haloalkyl; or Q_a is C₃-C₆cycloalkenyl which itself can be mono- or disubstituted by C₁-C₄alkyl; and
 R₆ is C₁-C₄haloalkyl.

7. A compound of formula Ib



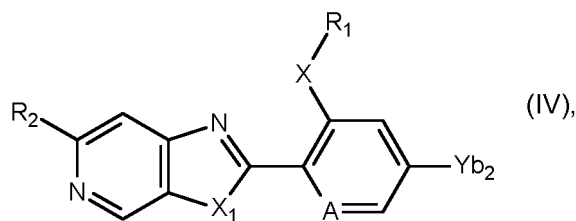
wherein

45 X_{2b} is SO₂;
 X_{3b} is N-(C₁-C₄alkyl);
 R_{4b} is C₁-C₄alkyl;
 Q_b is C₃-C₆cycloalkyl, C₂-C₆alkenyl or C₂-C₆alkynyl, or is C₃-C₆cycloalkyl, C₂-C₆alkenyl or C₂-C₆alkynyl each
 mono- or disubstituted by substituents selected from the group consisting of halogen, C₁-C₄alkyl, C₁-C₄haloalkyl,
 50 cyano, C₃-C₆cycloalkyl, tri(C₁-C₄alkyl)silyl and phenyl, said phenyl can be monosubstituted by halogen or
 C₁-C₄haloalkyl; and
 R_{6b} is C₁-C₄haloalkyl.

8. A compound of formula IV

55

5



10

wherein

R₁, R₂, X, X₁ and A are as defined under formula I in claim 1, and Yb₂ is -B(OH)₂ or
or Yb₂ is the group

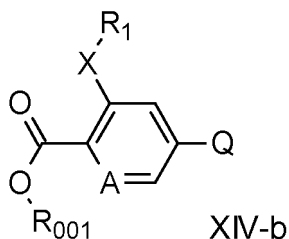
15



20

9. A compound of formula XIV-b

25



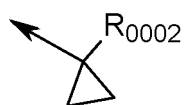
30

wherein X is SO₂;

R₁ is ethyl or methylene-cyclopropyl;
A is nitrogen or methine;
R₀₀₁ is hydrogen or C₁-C₄alkyl;
Q is a group

35

40



wherein R₀₀₀₂ is cyano.

45

10. A pesticidal composition, which comprises at least one compound of formula I according to claim 1 or, where appropriate, a tautomer thereof, in each case in free form or in agrochemically utilizable salt form, as active ingredient and at least one auxiliary.

50

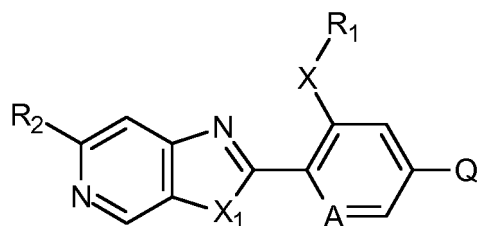
11. A method for controlling pests, which comprises applying a composition according to claim 10 to the pests or their environment with the exception of a method for treatment of the human or animal body by surgery or therapy and diagnostic methods practised on the human or animal body.

55

12. A method for the protection of plant propagation material from the attack by pests, which comprises treating the propagation material or the site, where the propagation material is planted, with a composition according to claim 10.

Patentansprüche

1. Verbindung der Formel I,



(I),

wobei

A für CH oder N steht;

Q für C₃-C₆-Cycloalkyl oder C₃-C₆-Cycloalkyl, das ein- oder mehrfach durch Substituenten, die aus der Gruppe bestehend aus Halogen, Cyano, C₁-C₄-Alkyl, C₁-C₄-Halogenalkyl, C₃-C₆-Cycloalkyl und Phenyl ausgewählt sind, substituiert ist, oder für Phenyl, das ein- oder mehrfach durch Substituenten, die aus der Gruppe bestehend aus Halogen, Cyano, C₁-C₄-Alkyl, C₁-C₄-Halogenalkyl, C₁-C₄-Halogenalkoxy, C₁-C₄-Alkoxy, C₁-C₄-Halogenalkylsulfanyl,

C₁-C₄-Halogenalkylsulfanyl, C₁-C₄-Halogenalkylsulfonyl und -C(O)C₁-C₄-Halogenalkyl ausgewählt sind, substituiert sein kann, steht; oder

Q für C₂-C₆-Alkenyl oder C₂-C₆-Alkenyl, das ein- oder mehrfach durch Substituenten, die aus der Gruppe bestehend aus Halogen, Cyano, C₁-C₄-Alkyl, C₁-C₄-Halogenalkyl, C₃-C₆-Cycloalkyl und Phenyl ausgewählt sind, substituiert ist, oder für Phenyl, das ein- oder mehrfach durch Substituenten, die aus der Gruppe bestehend aus Halogen, Cyano, C₁-C₄-Alkyl, C₁-C₄-Halogenalkyl, C₁-C₄-Halogenalkoxy, C₁-C₄-Alkoxy, C₁-C₄-Halogenalkylsulfanyl, C₁-C₄-Halogenalkylsulfanyl, C₁-C₄-Halogenalkylsulfonyl und -C(O)C₁-C₄-Halogenalkyl ausgewählt sind, substituiert sein kann, steht; oder

Q für C₂-C₆-Alkynyl oder C₂-C₆-Alkynyl, das ein- oder mehrfach durch Substituenten, die aus der Gruppe bestehend aus Halogen, Cyano, C₁-C₄-Alkyl, C₁-C₄-Halogenalkyl, C₃-C₆-Cycloalkyl, Tri (C₁-C₄alkyl) silyl und Phenyl ausgewählt sind, substituiert ist, oder für Phenyl, das ein- oder mehrfach durch Substituenten, die aus der Gruppe bestehend aus Halogen, Cyano, C₁-C₄-Alkyl, C₁-C₄-Halogenalkyl, C₁-C₄-Halogenalkoxy, C₁-C₄-Alkoxy, C₁-C₄-Halogenalkylsulfanyl, C₁-C₄-Halogenalkylsulfanyl, C₁-C₄-Halogenalkylsulfonyl und -C(O)C₁-C₄-Halogenalkyl ausgewählt sind, substituiert sein kann, steht;

X für S, SO oder SO₂ steht;

R₁ für C₁-C₄-Alkyl, C₁-C₄-Halogenalkyl, C₃-C₆-Cycloalkyl, C₃-C₆-Cycloalkyl-C₁-C₄-alkyl oder C₃-C₆-Cycloalkyl, das ein- oder mehrfach durch Substituenten, die aus der Gruppe bestehend aus Halogen, Cyano und C₁-C₄-Alkyl ausgewählt sind, substituiert ist, steht; oder

R₁ für C₃-C₆-Cycloalkyl-C₁-C₄-Alkyl, das ein- oder mehrfach durch Substituenten, die aus der Gruppe bestehend aus Halogen, Cyano und C₁-C₄-Alkyl ausgewählt sind, substituiert ist, steht; oder

R₁ für C₂-C₆-Alkenyl, C₂-C₆-Halogenalkenyl oder C₂-C₆-Alkynyl steht;

R₂ für Halogen, Cyano, C₁-C₆-Halogenalkyl oder C₁-C₆-Halogenalkyl steht, das mit einem oder zwei Substituenten substituiert ist, die aus der Gruppe ausgewählt sind, die aus Hydroxyl, Methoxy und Cyano besteht; oder R₂ für C₁-C₄-Halogenalkylsulfanyl, C₁-C₄-Halogenalkylsulfanyl, C₁-C₄-Halogenalkylsulfonyl, O(C₁-C₄-Halogenalkyl) oder

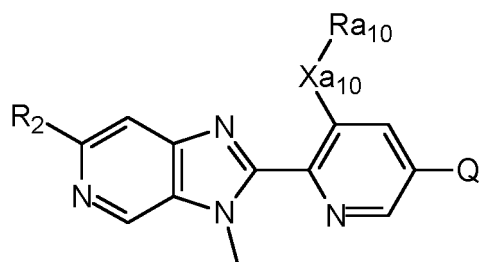
-C(O)C₁-C₄-Halogenalkyl steht; oder

R₂ für C₃-C₆-Cycloalkyl, das ein- oder mehrfach durch Substituenten, die aus der Gruppe bestehend aus Halogen, Cyano und C₁-C₄-Alkyl ausgewählt sind, substituiert sein kann, steht;

X₁ für O, S oder NR₃ steht, wobei R₃ für Wasserstoff, C₁-C₄-Alkyl, C₂-C₆-Alkenyl, C₂-C₆-Alkynyl, C₁-C₄-Alkoxy-C₁-C₄-alkyl oder C₃-C₆-Cycloalkyl steht; und agrochemisch unbedenkliche Salze, Stereoisomere, Enantiomere, Tautomere und N-Oxide dieser Verbindungen.

2. Verbindung der Formel I nach Anspruch 1, die wiedergegeben wird durch die Verbindungen der Formel I-10

5



10

(I-10),

wobei

15

R₂ und Q wie unter Formel I in Anspruch 1 definiert sind;
 Xa₁₀ für S, SO oder SO₂ steht; und
 Ra₁₀ für Methyl, Ethyl, n-Propyl, i-Propyl oder Cyclopropylmethyl steht.

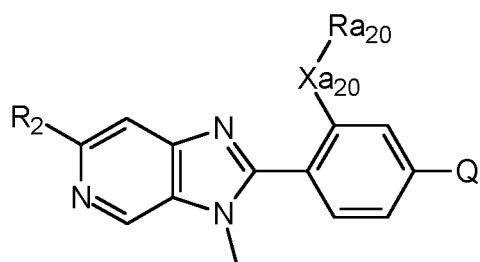
20

25

3. Verbindung der Formel I-10 nach Anspruch 2, wobei Q für C₃-C₆-Cycloalkyl oder C₃-C₆-Cycloalkyl, das ein- oder zweifach durch Substituenten, die aus der Gruppe bestehend aus Cyano, C₁-C₄-Halogenalkyl und Halogen ausgewählt sind, substituiert ist, steht; oder Q für C₂-C₆-Alkenyl oder C₂-C₆-Alkenyl, das einfach durch Substituenten, die aus der Gruppe bestehend aus C₁-C₄-Alkyl und C₃-C₆-Cycloalkyl ausgewählt sind, substituiert ist, steht; oder Q für C₂-C₆-Alkynyl oder C₂-C₆-Alkynyl, das einfach durch Substituenten, die aus der Gruppe bestehend aus Tri(C₁-C₄alkyl)silyl, Phenyl und Phenyl, das selbst einfach durch Substituenten, die aus der Gruppe bestehend aus Halogen, C₁-C₄-Alkyl oder C₁-C₄-Halogenalkyl ausgewählt sind, substituiert sein kann, ausgewählt sind, substituiert ist, steht.

4. Verbindung der Formel I nach Anspruch 1, die wiedergegeben wird durch die Verbindungen der Formel I-20

30



35

(I-20),

40

wobei

45

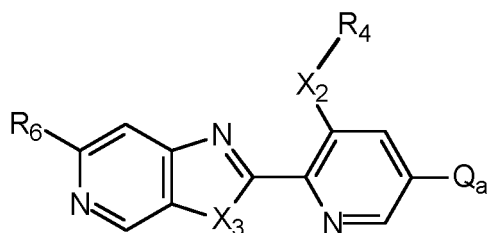
R₂ und Q wie unter Formel I in Anspruch 1 definiert sind;
 Xa₂₀ für S, SO oder SO₂ steht; und
 Ra₂₀ für Methyl, Ethyl, n-Propyl, i-Propyl oder Cyclopropylmethyl steht.

50

5. Verbindung der Formel I-20 nach Anspruch 4, wobei Q für C₃-C₆-Cycloalkyl oder C₃-C₆-Cycloalkyl, das ein- oder zweifach durch Substituenten, die aus der Gruppe bestehend aus Cyano, C₁-C₄-Halogenalkyl und Halogen ausgewählt sind, substituiert ist, steht; oder Q für C₂-C₆-Alkenyl oder C₂-C₆-Alkenyl, das einfach durch Substituenten, die aus der Gruppe bestehend aus C₁-C₄-Alkyl und C₃-C₆-Cycloalkyl ausgewählt sind, substituiert ist, steht; oder Q für C₂-C₆-Alkynyl oder C₂-C₆-Alkynyl, das einfach durch Substituenten, die aus der Gruppe bestehend aus Tri(C₁-C₄alkyl)silyl und Phenyl, wobei das Phenyl einfach durch Substituenten, die aus der Gruppe bestehend aus Halogen, C₁-C₄-Alkyl oder C₁-C₄-Halogenalkyl ausgewählt sind, substituiert sein kann, ausgewählt sind, substituiert ist, steht.

55

6. Verbindung der Formel Ia



(Ia),

wobei

X_2 für SO_2 steht;

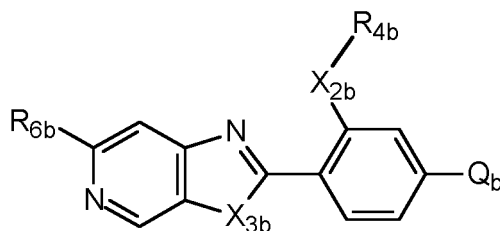
X_3 für N-(C_1 - C_4 -Alkyl) oder S steht;

R_4 für C_1 - C_4 -Alkyl steht;

Q_a für C_3 - C_6 -Cycloalkyl, C_2 - C_6 -Alkenyl oder C_2 - C_6 -Alkynyl oder für C_3 - C_6 -Cycloalkyl, C_2 - C_6 -Alkenyl oder C_2 - C_6 -Alkynyl, das jeweils ein- oder zweifach durch Substituenten, die aus der Gruppe bestehend aus Halogen, C_1 - C_4 -Alkyl,

C_1 - C_4 -Halogenalkyl, Cyano, C_3 - C_6 -Cycloalkyl, Tri(C_1 - C_4 alkyl)silyl und Phenyl ausgewählt sind, substituiert sind, wobei das Phenyl einfach durch Halogen oder C_1 - C_4 -Halogenalkyl substituiert sein kann, steht; oder Q_a für C_3 - C_6 -Cycloalkenyl, das selbst ein- oder zweifach durch C_1 - C_4 -Alkyl substituiert sein kann, steht; und R_6 für C_1 - C_4 -Halogenalkyl steht.

7. Verbindung der Formel Ib



(Ib),

wobei

X_{2b} für SO_2 steht;

X_{3b} für N-(C_1 - C_4 -Alkyl) steht;

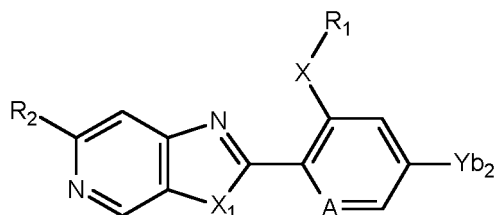
R_{4b} für C_1 - C_4 -Alkyl steht;

Q_b für C_3 - C_6 -Cycloalkyl, C_2 - C_6 -Alkenyl oder C_2 - C_6 -Alkynyl oder für C_3 - C_6 -Cycloalkyl, C_2 - C_6 -Alkenyl oder C_2 - C_6 -Alkynyl, das jeweils ein- oder zweifach durch Substituenten, die aus der Gruppe bestehend aus Halogen, C_1 - C_4 -Alkyl, C_1 - C_4 -Halogenalkyl, Cyano, C_3 - C_6 -Cycloalkyl, Tri(C_1 - C_4 alkyl) silyl und Phenyl ausgewählt sind, substituiert ist, wobei das Phenyl einfach durch Halogen oder C_1 - C_4 -Halogenalkyl substituiert sein kann, steht;

und

R_{6b} für C_1 - C_4 -Halogenalkyl steht.

8. Verbindung der Formel IV



(IV),

wobei

R₁, R₂, X, X₁ und A wie unter Formel I in Anspruch 1 definiert sind und Yb₂ für -B(OH)₂ steht oder
 oder Yb₂ für die Gruppe

5

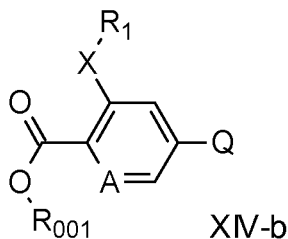


10

steht.

9. Verbindung der Formel XIV-b

15



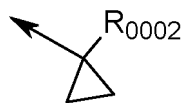
20

wobei X für SO₂ steht;

25

R₁ für Ethyl oder Methylencyclopropyl steht,
 A für Stickstoff oder Methin steht;
 R₀₀₁ für Wasserstoff oder C₁-C₄-Alkyl steht;
 Q für eine Gruppe

30



35

steht, wobei R₀₀₀₂ für Cyano steht.

10. Pestizide Zusammensetzung, die mindestens eine Verbindung der Formel I nach Anspruch 1 oder gegebenenfalls ein Tautomer davon, in jedem Fall in freier Form oder in Form eines agrochemisch brauchbaren Salzes, als Wirkstoff und mindestens einen Hilfsstoff umfasst.

40

11. Verfahren zum Bekämpfen von Schädlingen, bei dem man eine Zusammensetzung nach Anspruch 10 auf die Schädlinge oder ihre Umgebung aufbringt, mit der Ausnahme von einem Verfahren zur Behandlung des menschlichen oder tierischen Körpers durch Chirurgie oder Therapie und Diagnoseverfahren, die am menschlichen oder tierischen Körper durchgeführt werden.

45

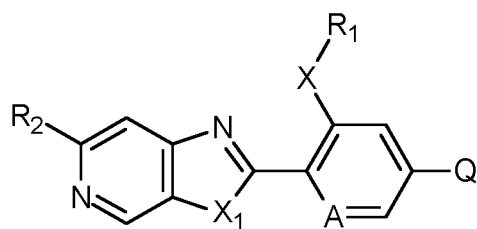
12. Verfahren zum Schutz von Pflanzenfortpflanzungsmaterial gegen Befall durch Schädlinge, bei dem man das Fortpflanzungsmaterial oder die Stelle, an der das Fortpflanzungsmaterial angepflanzt ist, mit einer Zusammensetzung nach Anspruch 10 behandelt.

50

Revendications

1. Composé de formule I,

55



(I),

dans lequel

A représente CH ou N ;

Q est C₃-C₆cycloalkyle, ou C₃-C₆cycloalkyle mono- ou polysubstitué par des substituants choisis dans le groupe constitué par halogène, cyano, C₁-C₄alkyle, C₁-C₄halogénoalkyle, C₃-C₆cycloalkyle et phényle, ou est phényle qui peut être mono- ou polysubstitué par des substituants choisis dans le groupe constitué par halogène, cyano, C₁-C₄alkyle, C₁-C₄halogénoalkyle, C₁-C₄halogénoalcoxy, C₁-C₄alcoxy, C₁-C₄halogénoalkylsulfanyle, C₁-C₄halogénoalkylsulfinyle, C₁-C₄halogénoalkylsulfonyle et -C(O)C₁-C₄halogénoalkyle ; ou

Q est C₂-C₆alcényle, ou C₂-C₆alcényle mono- ou polysubstitué par des substituants choisis dans le groupe constitué par halogène, cyano, C₁-C₄alkyle, C₁-C₄halogénoalkyle, C₃-C₆cycloalkyle et phényle, ou est phényle qui peut être mono- ou polysubstitué par des substituants choisis dans le groupe constitué par halogène, cyano, C₁-C₄alkyle, C₁-C₄halogénoalkyle, C₁-C₄halogénoalcoxy, C₁-C₄alcoxy, C₁-C₄halogénoalkylsulfanyle, C₁-C₄halogénoalkylsulfinyle, C₁-C₄halogénoalkylsulfonyle et -C(O)C₁-C₄halogénoalkyle ; ou

Q est C₂-C₆alcynyle, ou C₂-C₆alcynyle mono- ou polysubstitué par des substituants choisis dans le groupe constitué par halogène, cyano, C₁-C₄alkyle, C₁-C₄halogénoalkyle, C₃-C₆cycloalkyle, tri(C₁-C₄alkyl) silyle et phényle, ou est phényle qui peut être mono- ou polysubstitué par des substituants choisis dans le groupe constitué par halogène, cyano, C₁-C₄alkyle, C₁-C₄halogénoalkyle, C₁-C₄halogénoalcoxy, C₁-C₄alcoxy, C₁-C₄halogénoalkylsulfanyle, C₁-C₄halogénoalkylsulfinyle, C₁-C₄halogénoalkylsulfonyle et -C(O)C₁-C₄halogénoalkyle ; X est S, SO ou SO₂ ;

R₁ est C₁-C₄alkyle, C₁-C₄halogénoalkyle, C₃-C₆cycloalkyle, C₃-C₆cycloalkyl-C₁-C₄alkyle ou C₃-C₆cycloalkyle mono- ou polysubstitué par des substituants choisis dans le groupe constitué par halogène, cyano et C₁-C₄alkyle ; ou

R₁ est C₃-C₆cycloalkyl-C₁-C₄alkyle mono- ou polysubstitué par des substituants choisis dans le groupe constitué par halogène, cyano et C₁-C₄alkyle ; ou

R₁ est C₂-C₆alcényle, C₂-C₆halogénoalcényle ou C₂-C₆alcynyle ;

R₂ est halogène, cyano, C₁-C₆halogénoalkyle ou C₁-C₆halogénoalkyle substitué par un ou deux substituants choisis dans le groupe constitué par hydroxyle, méthoxy et cyano ; ou

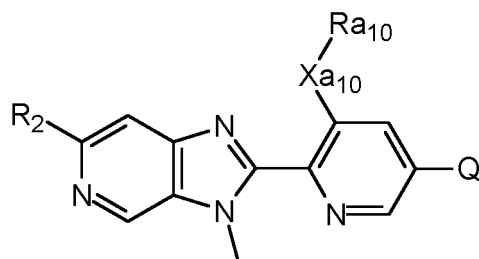
R₂ est C₁-C₄halogénoalkylsulfanyle, C₁-C₄halogénoalkylsulfinyle, C₁-C₄halogénoalkylsulfonyle, O(C₁-C₄halogénoalkyl), ou

-C(O)C₁-C₄halogénoalkyle ; ou

R₂ est C₃-C₆cycloalkyle qui peut être mono- or polysubstitué par des substituants choisis dans le groupe constitué par halogène, cyano et C₁-C₄alkyle ;

X₁ est O, S ou NR₃, où R₃ est hydrogène, C₁-C₄alkyle, C₂-C₆alcényle, C₂-C₆alcynyle, C₁-C₄alcoxy-C₁-C₄alkyle ou C₃-C₆cycloalkyle ; ainsi que les sels, stéréoisomères, énantiomères, tautomères et N-oxydes acceptables sur le plan agrochimique de ces composés.

2. Composé de formule I selon la revendication 1, représenté par les composés de formule I-10



(I-10),

dans lesquels

R_2 et Q sont tels que définis sous la formule I selon la revendication 1 ;

X_{a10} est S, SO ou SO_2 ; et

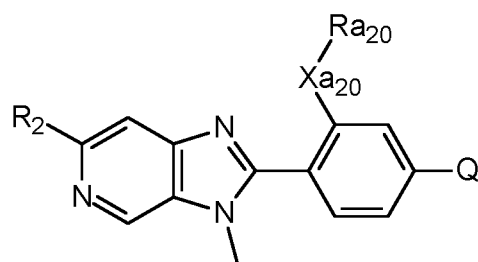
R_{a10} est méthyle, éthyle, n-propyle, i-propyle ou cyclopropylméthyle.

3. Composé de formule I-10 selon la revendication 2, dans lequel

Q est C_3 - C_6 cycloalkyle, ou C_3 - C_6 cycloalkyle mono- ou disubstitué par des substituants choisis dans le groupe constitué par cyano, C_1 - C_4 halogénoalkyle et halogène ; ou

Q est C_2 - C_6 alcényle, ou C_2 - C_6 alcényle monosubstitué par des substituants choisis dans le groupe constitué par C_1 - C_4 alkyle et C_3 - C_6 cycloalkyle ; ou Q est C_2 - C_6 alcynyle, ou C_2 - C_6 alcynyle monosubstitué par des substituants choisis dans le groupe constitué par tri(C_1 - C_4 alkyl)silyle, phényle et phényle pouvant lui-même être monosubstitué par des substituants choisis dans le groupe constitué par halogène, C_1 - C_4 alkyle ou C_1 - C_4 halogénoalkyle.

4. Composé de formule I selon la revendication 1, représenté par les composés de formule I-20



(I-20),

dans lesquels

R_2 et Q sont tels que définis sous la formule I selon la revendication 1 ;

X_{a20} est S, SO ou SO_2 ; et

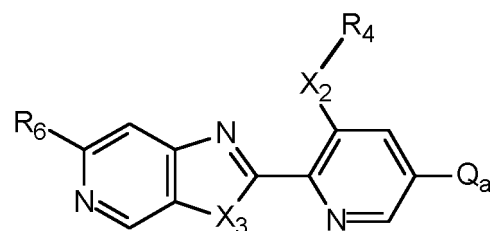
R_{a20} est méthyle, éthyle, n-propyle, i-propyle ou cyclopropylméthyle.

5. Composé de formule I-20 selon la revendication 4, dans lequel

Q est C_3 - C_6 cycloalkyle, ou C_3 - C_6 cycloalkyle mono- ou disubstitué par des substituants choisis dans le groupe constitué par cyano, C_1 - C_4 halogénoalkyle et halogène ; ou

Q est C_2 - C_6 alcényle, ou C_2 - C_6 alcényle monosubstitué par des substituants choisis dans le groupe constitué par C_1 - C_4 alkyle et C_3 - C_6 cycloalkyle ; ou Q est C_2 - C_6 alcynyle, ou C_2 - C_6 alcynyle monosubstitué par des substituants choisis dans le groupe constitué par tri(C_1 - C_4 alkyl) silyle et phényle, ledit phényle pouvant être monosubstitué par des substituants choisis dans le groupe constitué par halogène, C_1 - C_4 alkyle ou C_1 - C_4 halogénoalkyle.

6. Composé de formule la



(Ia),

dans lequel

X_2 est SO_2 ;

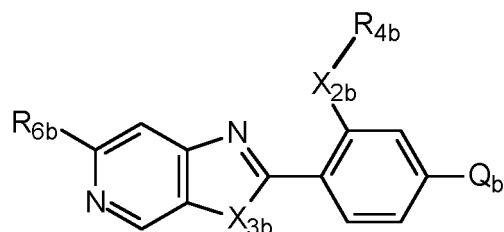
X_3 est N-(C_1 - C_4 alkyl) ;

R_4 est C_1 - C_4 alkyle ;

EP 3 183 245 B1

Q_a est C₃-C₆cycloalkyle, C₂-C₆alcényle ou C₂-C₆alcynyle, ou est C₃-C₆cycloalkyle, C₂-C₆alcényle ou C₂-C₆alcynyle, chacun mono- ou disubstitué par des substituants choisis dans le groupe constitué par halogène, C₁-C₄alkyle, C₁-C₄halogénoalkyle, cyano, C₃-C₆cycloalkyle, tri(C₁-C₄alkyl)silyle et phényle, ledit phényle pouvant être mono-substitué par halogène ou C₁-C₄halogénoalkyle ; ou Q_a est C₃-C₆cycloalcényle pouvant lui-même être mono- ou disubstitué par C₁-C₄alkyle ; et R₆ est C₁-C₄halogénoalkyle.

7. Composé de formule Ib



(Ib),

dans lequel

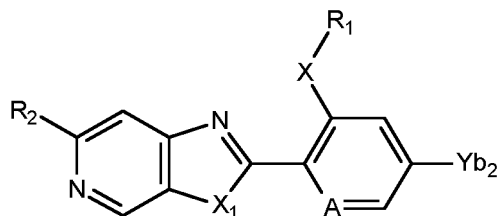
X_{2b} est SO₂ ;

X_{3b} est N-(C₁-C₄alkyl) ;

R_{4b} est C₁-C₄alkyle ;

Q_b est C₃-C₆cycloalkyle, C₂-C₆alcényle ou C₂-C₆alcynyle, ou est C₃-C₆cycloalkyle, C₂-C₆alcényle ou C₂-C₆alcynyle, chacun mono- ou disubstitué par des substituants choisis dans le groupe constitué par halogène, C₁-C₄alkyle, C₁-C₄halogénoalkyle, cyano, C₃-C₆cycloalkyle, tri(C₁-C₄alkyl)silyle et phényle, ledit phényle pouvant être monosubstitué par halogène ou C₁-C₄halogénoalkyle ; et R_{6b} est C₁-C₄halogénoalkyle.

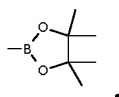
8. Composé de formule IV



(IV),

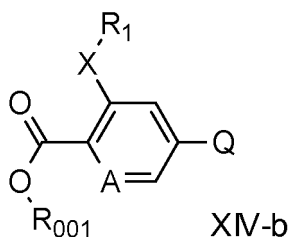
dans lequel

R₁, R₂, X, X₁ et A sont tels que définis pour la formule I selon la revendication 1, et Yb₂ est -B(OH)₂ ou Yb₂ est le groupement



9. Composé de formule XIV-b

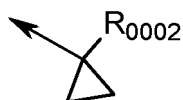
5



10

dans lequel X est SO₂ ;
 R₁ est éthyle ou méthylène-cyclopropyle ;
 A est azote ou méthine ;
 R₀₀₁ est hydrogène ou C₁-C₄alkyle ;
 Q est un groupement

15



20

où R₀₀₀₂ est cyano.

25

10. Composition pesticide, comprenant au moins un composé de formule I selon la revendication 1 ou, le cas échéant, un tautomère de celui-ci, dans chaque cas sous forme libre ou sous forme de sel utilisable sur le plan agrochimique, comme ingrédient actif, et au moins un auxiliaire.

30

11. Méthode destinée au contrôle de nuisibles, comprenant l'application d'une composition selon la revendication 10 aux nuisibles ou à leur environnement, à l'exception d'une méthode de traitement du corps humain ou animal par chirurgie ou thérapie et de méthodes de diagnostic pratiquées sur le corps humain ou animal.

35

12. Méthode destinée à la protection de matériel de propagation végétal contre une attaque par des nuisibles, comprenant le traitement du matériel de propagation ou du site où le matériel de propagation est planté, par une composition selon la revendication 10.

40

45

50

55

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2012086848 A [0002] [0040] [0049]
- WO 2013018928 A [0002] [0040]
- WO 15000715 A [0033] [0040]
- WO 2009131237 A [0040] [0044]
- WO 2011043404 A [0040]
- WO 2011040629 A [0040]
- WO 2010125985 A [0040] [0044]
- WO 2013191113 A [0040]
- WO 2013180193 A [0040]
- WO 2013180194 A [0040]
- WO 2011088990 A [0040]
- WO 2008128968 A [0040]
- WO 2014152738 A [0049]
- WO 03064418 A [0058]
- WO 0015615 A [0072]
- WO 0215701 A [0085]
- WO 03018810 A [0085]
- EP 0374753 A [0085]
- WO 9307278 A [0085]
- WO 9534656 A [0085]
- EP 0427529 A [0085]
- EP 451878 A [0085]
- WO 03052073 A [0085]
- EP 0367474 A [0085]
- EP 0401979 A [0085]
- WO 9013651 A [0085]
- EP 0392225 A [0085] [0088]
- WO 9533818 A [0085] [0088]
- EP 0353191 A [0085]
- WO 03000906 A [0088]
- WO 2008151984 A [0092]
- WO 2003034823 A [0092]
- US 5631072 A [0092]
- WO 200564072 A [0092]
- WO 2006128870 A [0092]
- EP 1724392 A [0092]
- WO 2005113886 A [0092]
- WO 2007090739 A [0092]
- WO 2015000715 A [0162]
- WO 2012092115 A [0187]
- WO 2007026965 A [0187]
- WO 2010060231 A [0187]
- WO 2005077934 A [0187]
- WO 2007048556 A [0187]
- WO 2006087343 A [0187]

Non-patent literature cited in the description

- *Inorg. Chimica Acta*, 2005, vol. 358 (9), 2701-2710 [0040]
- *J. Am. Chem. Soc.*, 2010, vol. 132 (5), 1545-1557 [0040]
- *Tetrahedron*, 2005, vol. 61 (46), 10827-10852 [0042]
- *Org. Lett.*, 2014, vol. 16 (24), 6314-6317 [0055]
- *J. Am. Chem. Soc.*, 2005, vol. 127 (45), 15824-15832 [0055]
- *Org. Biomol. Chem.*, 2004, vol. 2, 2471 [0058]
- *Med. Chem. Letts.*, 2013, vol. 4, 514-516 [0058]
- *Science of Synthesis*, 2006, vol. 34, 245-265 [0059]
- *Synthesis*, 2010, 2080-2084 [0059]
- *J. Med. Chem.*, 1989, vol. 32 (12), 2561-73 [0072]
- Manual on Development and Use of FAO and WHO Specifications for Pesticides, United Nations. 2010 [0106]
- McCutcheon's Detergents and Emulsifiers Annual. MC Publishing Corp, 1981 [0107]
- Compendium of Herbicide Adjuvants. Illinois University, 2010 [0107]
- *CHEMICAL ABSTRACTS*, 400882-07-7 [0187]
- *Proc. BCPC, Int. Congr.*, 2003, vol. 1, 93 [0187]
- The Pesticide Manual - A World Compendium. The British Crop Protection Council [0188]
- **A. WOOD.** *Compendium of Pesticide Common Names*, 1995-2004 [0188]