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54 Titre: Protection of trees.

57 Abrégé:

A method for the protection of trees of the families Musaceae or Plantaginaceae from destructive pests whereby the trees to be protected share a common root system.

Protection of trees

This invention relates to a new method of protecting trees of the families Musaceae (banana) and Plantaginaceae (plantains) from harmful or destructive pests.

5 Global regulatory requirements are becoming more and more demanding with respect to the use of pesticides particularly with respect to unmanaged or unnecessary pesticide residues. Thus there exist mutually contradictory requirements of farmers in that the need to control destructive pests very thoroughly demands that more pesticides be used, while increasing pressures from regulatory agencies demand that less pesticides be used. These regulatory
10 demands are aimed to protect the safety and health of agricultural workers and the general public. It also well known that the general public would like less chemical residues on fruits and vegetables.

A particular consequence of this situation is that there is an increasing need to have more efficient methods of protection of banana trees and plantain trees. It is well known that such fruit-
15 producing trees attract a large number of pests, particularly destructive insects and nematodes.

A common technique for cultivating banana trees or plantain trees is by growing them on large blocks or plantations. The trees are disposed as mother plants having a series (for example 1 to 5, generally 1 to 3) of followers or peeps, that is daughter plants, growing from the corm (that is, the base of the pseudotrunk) of the mother plant. In this respect the mother and daughter
20 plants share a common root system. At an appropriate time before the harvest of the fruit of the mother plants or trees, all the daughter plants are removed except one per mother plant which are deemed by the grower to have the best chances of survival. Such a practice allows the next generation of banana or plantain plants to be readily produced. The removal of the daughter plants is possible after the harvest of the mother plants, but it is agronomically preferred to
25 remove them beforehand.

The fruits of the banana trees are harvested by cutting off the bunches of fruit. Afterwards, the mother trees are cut to remove the canopies. The pseudotrunks which are left are generally in a height range from 0.5 meters to 2.5 meters. Such a practice facilitates the growth of the daughter plants. The mother pseudotrunk is then left to decay or is cut down in stages until
30 only a daughter pseudotrunk remains.

Therefore there exists a need to provide an improved method of protection for daughter banana trees and plantain trees from pests which is efficient against destructive pests, especially

insects and nematodes and whereby the interval from the treatment of said trees by a pesticide to harvest is as long as possible and whereby the worker exposure is at a minimal level. It has now been found that these needs may be met in whole or in part by means of the instant invention.

According to the invention, a pesticide is found to be most advantageously applied onto or
5 into the pseudotrunk of the cut mother tree in order to protect the daughter tree. In another
embodiment, after the initial removal of the canopy of the mother tree the daughter plants may be
allowed to develop and the mother pseudotrunk gradually reduced in size by subsequent cuts. A
pesticide may be applied onto or into the mother pseudotrunk at any point during this time
including when the mother pseudotrunk has been effectively removed. However, it is most
10 advantageous to apply the pesticide early in the development of the daughter plant in order to
maximise the treatment-harvest time interval.

The instant invention is related to a method for the protection of two or more trees of the
families Musaceae or Plantaginaceae from destructive pests wherein the trees to be protected
share a common root system which method comprises:

- 15 (a) cutting one of the trees sharing the said root system to remove its fruit and
- (b) then introducing a pesticide into the said cut tree.

The pesticide may be introduced into any portion of the said cut tree. According to a
feature of the invention, the pesticide is introduced into the cut of the tree. According to another
feature of the invention, the tree is cut to remove its canopy after the removal of its fruit and
20 before introducing pesticide. The pesticide is, in a preferred feature of the invention, then
introduced into the cut of the tree formed by the removal of the canopy.

The pesticide is generally an insecticide, nematicide, fungicide or plant growth regulator,
preferably an insecticide or nematicide. The pesticide is generally translocatable and more
preferably water soluble at ambient temperature, the water solubility being generally higher than
25 0.5 g/l, preferably higher than 2 g/l at ambient temperature. The pesticide can be provided in a
formulation that is generally translocatable and more preferably water soluble at ambient
temperature.

Those species of banana or plantain trees to be preferably protected according to the
present invention are *Musa textilis*, *Musa sapientum*, or *Musa paradisiaca*.

30 The pesticide is generally introduced into the tree from zero to about thirty days after one
of the trees is cut, preferably from about one to about seven days and even more preferably from
about two to about three days.

A preferred group of insecticides or nematocides according to the invention are carbamates. Carbamates are a well-known group of pesticides: those skilled in the art will recognise these in The Pesticide Manual 10th ed., edited by C. Tomlin, British Crop Protection Council, United Kingdom, 1994. A preferred group of carbamates are N-methyl carbamates, that
5 is those substances that possess the substituent -OC(O)NHMe. A particularly preferred carbamate that can be used according the instant invention is 2-methyl-2-(methylthio)propionaldehyde O-methylcarbamoyloxime (aldicarb). Other carbamates that can be used according to the invention are 2,3-dihydro-2,2-dimethylbenzofuran-7-yl methylcarbamate (carbofuran) and N,N-dimethyl-2-methylcarbamoyloxyimino-2-(methylthio)acetamide (oxamyl).

10 A carbamate can be used alone or in combination with other pesticides.

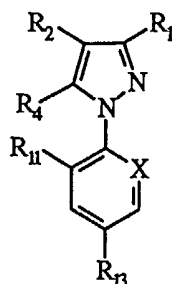
Other insecticides or nematocides that can be used according to the instant invention either alone or in combination with other pesticides include:

nitromethylenes or nitroimines including 1-(6-chloro-3-pyridylmethyl)-N-nitroimidazolidin-2-ylideneamine (imidacloprid);

15 cyanoimines including (E)-N¹-[(6-chloro-3-pyridyl)methyl]-N²-cyano-N¹-methylacetamidine (acetamiprid);and

organophosphates including S,S-di-*sec*-butyl O-ethyl phosphorodithioate (cadusafos); (RS)-S-*sec*-butyl O-ethyl 2-oxo-1,3-thiazolidin-3-ylphosphonothioate (fosthiazate); and O-ethyl S,S-dipropyl phosphorodithioate (ethoprophos).

20 Other insecticides or nematocides that can be used according to the instant invention either alone or in combination with other pesticides include compounds of formula (I):



(I)

in which:

25 R₁ is -CN or methyl;

R₂ is -S(O)_nR₃;

R₃ is alkyl or haloalkyl;

R₄ represents a hydrogen or halogen atom or a member of a group consisting of -NR₅R₆, -S(O)_mR₇, -C(O)O-R₇, alkyl, haloalkyl, -OR₈ and -N=C(R₉)(R₁₀);

R₅ and R₆ independently represent the hydrogen atom or an alkyl, haloalkyl, -C(O)alkyl, alkoxy carbonyl or -S(O)_rCF₃ radical; or R₅ and R₆ can together form a divalent alkylene radical
5 which can be interrupted by one or two divalent heteroatoms, such as oxygen or sulfur;

R₇ represents an alkyl or haloalkyl radical;

R₈ represents an alkyl or haloalkyl radical or a hydrogen atom;

R₉ represents an alkyl radical or hydrogen atom;

R₁₀ represents a phenyl or heteroaryl group which is unsubstituted or substituted by one
10 or more halogen atoms or a member of the group consisting of -OH, -O-alkyl, -S-alkyl, cyano, and alkyl;

X represents a trivalent nitrogen atom or a -C-R₁₂ radical, the other three valences of the carbon atom forming part of the aromatic ring;

R₁₁ and R₁₂ represent, independently of one another, a hydrogen or halogen atom;

15 R₁₃ represents a halogen atom or a haloalkyl, haloalkoxy, -S(O)_qCF₃ or SF₅ group;
m, n, q, and r represent, independently of one another, an integer equal to 0, 1, or 2;
provided that, when R₁ is methyl, then R₃ is haloalkyl, R₄ is -NH₂, R₁₁ is -Cl, R₁₃ is CF₃ and X is N.

By the term "alkyl" is meant carbon chains of from one to six carbon atom that are either
20 linear or branched chains. By the term "divalent alkylene" is meant a carbon chain that attaches at two points to the nitrogen atom of the radical R₄.

A preferred group of compounds of formula (I) is one in which:

R₁ is CN;

R₃ is a haloalkyl radical;

25 R₄ is NH₂;

X is C-R₁₂;

R₁₁ and R₁₂ represent, independently of one another, a halogen atom; and

R₁₃ is a haloalkyl radical.

A most highly preferred compound of formula (I) is 5-amino-1-(2,6-dichloro 4-
30 trifluoromethyl phenyl) 4-trifluoromethylsulfinyl-3-cyanopyrazole.

Compounds of formula (I) may be prepared according to known processes, for example as described in International Patent Publications No. WO 87/3781, 93/6089, and 94/21606 as well as

in European Patent Applications 295117, 403300, 385809 or 679650, German Patent Publication 19511269 and United States Patents 5232940 and 5236938 or other process according to the knowledge of a man skilled in the art of chemical synthesis.

5 Pests that may be controlled according to the instant invention include *Cosmopolites sordidus* (banana weevil), *Radopholus similis* (burrowing nematode), *Helicotylenchus multicinctus* (Spiral nematode), *Meloidogyne incognita* (Rootknot nematode) and pests of the families Heteroderidae and Thripidae.

Fungicides that may be used according to the instant invention include:

10 methyl 1-(butylcarbamoyl)benzimidazol-2-ylcarbamate (benomyl);
triazoles including (\pm)-1-[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-ylmethyl]-1H-1,2,4-triazole (propiconazole); and
1-[(2RS,4RS:2RS,4SR)-4-bromo-2-(2,4dichlorophenyl)tetrahydrofurfuryl]-1H-1,2,4-triazole (bromuconazole).

15 Plant growth regulators that may be used according to the instant invention include:
a gibberellin such as gibberellic acid or
2-chloroethylphosphonic acid (ethephon).

20 The amount of pesticide which is used is an effective and agronomically acceptable amount per tree. In the case of 2-methyl-2-(methylthio)propionaldehyde O-methylcarbamoyloxime, quantities of from 0.01 to 5g per tree may be appropriate, preferably from 0.3 to 0.9g per tree.

The introduction of the pesticide in the pseudotrunk of the tree is made by insertion of a composition, which can be of liquid or solid formulation, preferably solid, in order to reduce worker exposure, especially with compounds having relatively high acute toxicity. A solid formulation is preferred for 2-methyl-2-(methylthio)propionaldehyde O-methylcarbamoyloxime.

25 Formulations are chosen so as to speed the transmission of the active ingredient into an aqueous phase such as the vascular tissue normally present in plants or trees. Formulations are also chosen in order to minimise the exposure of agricultural workers to the pesticide.

30 Still more preferable are those substantially dustless formulations, for example those whose particle size is greater than 0.1 mm, preferably from 0.4 to 0.8 mm. Acceptable formulations may be made by mixing the active ingredient with a polymer, especially a water soluble polymer. Gels may also be used.

The introduction of the pesticide into the pseudotrunk of the mother tree may be made by any suitable means. One possibility is the injection of the pesticide into the pseudotrunk. Another possibility is to make or drill holes in the tree and to put therein the formulation and then to plug or stop the holes. The holes may be made on the lateral part of the pseudotrunk, but it is
5 preferred to make the insertion where the pseudotrunk was cut to remove the canopy.

Another method of introduction of the pesticide is to cut a wedge out of the pseudotrunk, add the pesticidal formulation and replace the wedge back into the space from which it came. An especially preferred embodiment of this insertion is to cut the wedge out from the surface of the cut made by removing the canopy.

10 Another embodiment is the insertion into the pseudotrunk of a water-soluble capsule containing a dose of the desired pesticide.

The following non-limiting-example is given to illustrate the invention.

EXAMPLE

15 Banana trees are grown in a plantation. The trees are disposed as mother plants having a series (1 to 5) of daughter plants growing from the corm. Just before harvesting the mother plants, the daughter plants are removed except one daughter plant per mother plant.

The fruit of the banana trees are harvested by cutting the sets of fruits. Within one week after this harvest, the pseudotrunks of these plants are cut to remove the canopies. After two
20 days a wedge is cut from the surface resulting from the removal of the canopy of each pseudotrunk of each mother tree. A dose of 0.5 g per tree of 2-methyl-2-(methylthio)propionaldehyde O-methylcarbamoyloxime in the form of a 15 % w/w granular formulation is placed in the empty concave space from which each wedge was removed and the
wedges are replaced.

25 The daughter plants are protected against both nematodes and weevils up to harvest time of the daughter trees which is 35 weeks later thus to provide economically acceptable fruit. The risk of worker exposure is greatly reduced.

CLAIMS

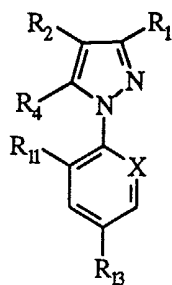
1. A method for the protection of two or more trees of the families Musaceae or Plantaginaceae from destructive pests wherein the trees to be protected share a common root system which method comprises:
 - 5 (a) cutting one of the trees sharing the said root system to remove its fruit and
 - (b) then introducing a pesticide into the said cut tree.
2. A method according to claim 1 wherein the cut tree is cut to remove its canopy after the removal of its fruit and before introducing the pesticide.
3. A method according to claim 1 or claim 2 wherein the pesticide is introduced into the
10 cut of the tree.
4. A method according to anyone of the foregoing claims wherein the pesticide is introduced into the cut of the tree formed by the removal of the canopy.
5. A method according to claim 1 or claim 2 wherein the pesticide is introduced into the lateral portion of the tree.
- 15 6. A method according to any one of the foregoing claims wherein the pesticide is introduced from zero to about thirty days after the tree is cut.
7. A method according to any one of the foregoing claims wherein the pesticide is an insecticide or nematicide.
8. A method according to any one of the foregoing claims wherein the pesticide is
20 generally translocatable at ambient temperature.
9. A method according to any one of the foregoing claims wherein the pesticide is provided in a formulation which is water soluble at ambient temperature.
10. A method according to any one of the foregoing claims wherein the trees are either *Musa textilis*, *Musa sapientum*, or *Musa paradisiaca*.
- 25 11. A method according to any one of the foregoing claims wherein the insecticide or nematicide is a carbamate, preferably an N-methyl carbamate.
12. A method according to claim 10 wherein the insecticide or nematicide is 2-methyl-2-(methylthio)propionaldehyde O-methylcarbamoyloxime or 2,3-dihydro-2,2-dimethylbenzofuran-7-yl methylcarbamate.

13. A method according to claim 12 wherein the amount of 2-methyl-2-(methylthio)propionaldehyde O-methylcarbamoyloxime used per tree is from 0.01g and 5g per tree, preferably from 0.3g to 0.9g per tree.

14. A method according to any one of claims 1 to 10 wherein the insecticide or
5 nematicide is:

- 1-(6-chloro-3-pyridylmethyl)-N-nitroimidazolidin-2-ylideneamine (imidacloprid);
- (E)-N¹-[(6-chloro-3-pyridyl)methyl]-N²-cyano-N¹-methylacetamidine (acetamiprid);
- N,N-dimethyl-2-methylcarbamoyloxyimino-2-(methylthio)acetamide (oxamyl);
- S,S-di-*sec*-butyl O-ethyl phosphorodithioate (cadusafos);
- 10 (RS)-S- *sec*-butyl O-ethyl 2-oxo-1,3-thiazolidin-3-ylphosphonothioate (fosthiazate);or
- O-ethyl S,S-dipropyl phosphorodithioate (ethoprophos).

15. A method according to any one of claims 1 to 10 wherein the pesticide is a compound of formula:



(I)

in which:

R₁ is CN or methyl;

R₂ is S(O)_nR₃;

R₃ is alkyl or haloalkyl;

16 R₄ represents a hydrogen or halogen atom or a member of a group consisting of NR₅R₆,
17 S(O)_mR₇, C(O)O-R₇, alkyl, haloalkyl, OR₈ and -N=C(R₉)(R₁₀);

18 R₅ and R₆ independently represent the hydrogen atom or an alkyl, haloalkyl, C(O)alkyl,
19 alkoxy carbonyl or S(O)_rCF₃ radical; or R₅ and R₆ can together form a divalent alkylene radical
20 which can be interrupted by one or two divalent heteroatoms, such as oxygen or sulfur;

21 R₇ represents an alkyl or haloalkyl radical;

22 R₈ represents an alkyl or haloalkyl radical or a hydrogen atom;

R₉ represents an alkyl radical or hydrogen atom;

R₁₀ represents a phenyl or heteroaryl group which is unsubstituted or substituted by one or more halogen atoms or a member of the group consisting of OH, -O-alkyl, -S-alkyl, cyano, and alkyl;

5 X represents a trivalent nitrogen atom or a C-R₁₂ radical, the other three valences of the carbon atom forming part of the aromatic ring;

R₁₁ and R₁₂ represent, independently of one another, a hydrogen or halogen atom;

R₁₃ represents a halogen atom or a haloalkyl, haloalkoxy, S(O)_qCF₃ or SF₅ group;

m, n, q, and r represent, independently of one another, an integer equal to 0, 1, or 2;

10 provided that, when R₁ is methyl, then R₃ is haloalkyl, R₄ is NH₂, R₁₁ is Cl, R₁₃ is CF₃ and X is N.

16. A method according to any one of claims 1 to 10, and 15 wherein the compound of formula (I) is 5-amino-3-cyano-1-(2,6-dichloro 4-trifluoromethylphenyl)-4-trifluoromethylsulfinylpyrazole.

15 17 A method according to any one of the foregoing claims wherein the pesticide used is in a solid or liquid formulation, preferably a solid formulation.

18 A method according to claim 17 wherein the formulation is substantially dustless.

19 A method according to claim 17 or claim 18 wherein the formulation has a particle size greater than 0.1 mm, preferably from 0.4 to 0.8 mm.