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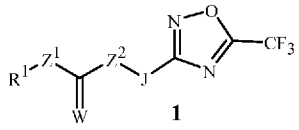
(54) Title: FUNGICIDAL OXADIAZOLES



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(57) Abstract: Disclosed are compounds of Formula 1, including all geometric and stereoisomers, tautomers, *N*-oxides, and salts thereof, wherein R^1, Z^1, W, Z^2 and J are as defined in the disclosure. Also disclosed are compositions containing the compounds of Formula 1 and methods for controlling plant disease caused by a fungal pathogen comprising applying an effective amount of a compound or a composition of the invention.

TITLE

FUNGICIDAL OXADIAZOLES

FIELD OF THE INVENTION

This invention relates to certain oxadiazoles, their *N*-oxides, salts and compositions, and methods of their use as fungicides.

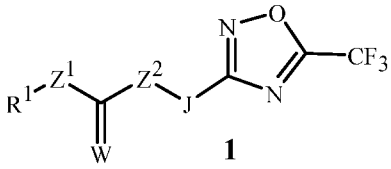
BACKGROUND OF THE INVENTION

The control of plant diseases caused by fungal plant pathogens is extremely important in achieving high crop efficiency. Plant disease damage to ornamental, vegetable, field, cereal, and fruit crops can cause significant reduction in productivity and thereby result in increased costs to the consumer. Many products are commercially available for these purposes, but the need continues for new compounds which are more effective, less costly, less toxic, environmentally safer or have different sites of action.

PCT Patent Publication WO 2017178549 discloses trifluoromethyl-oxadiazole derivatives and their use in agriculture.

SUMMARY OF THE INVENTION

This invention is directed to compounds of Formula **1** (including all stereoisomers), *N*-oxides, hydrates (and solvates thereof), and salts thereof, agricultural compositions containing them and their use as fungicides:



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wherein

R^1 is H; or C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_2-C_6 alkylcarbonyl or C_2-C_6 alkoxycarbonyl, each optionally substituted with up to 3 substituents independently selected from R^2; or phenyl optionally substituted with up to 3 substituents independently selected from R^{3a}; or a 3- to 7-membered nonaromatic carbocyclic ring, wherein up to 3 carbon atom ring members are independently selected from C(=O) and C(=S), each ring optionally substituted with up to 3 substituents independently selected from R^{3a}; or a 5- to 6-membered heterocyclic ring, each ring containing ring members selected from carbon atoms and 1 to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, wherein up to 3 carbon atom ring members are independently selected from C(=O) and C(=S), and the sulfur atom ring members are independently selected from $S(=O)_u(=NR^{12})_v$, each ring optionally substituted

with up to 5 substituents independently selected from R^{3a} on carbon atom ring members and R^{3b} on nitrogen atom ring members;

Z^1 is O, $-(CH_2)_nNR^{4a}-$, $-(CH_2)_nNR^{4a}NR^{4b}-$ or $-CH=NNR^{4b}-$, wherein the bond projecting to the left is attached to R^1, and the bond projecting to the right is attached to C=W;

W is O or S;

Z^2 is $-O(CH_2)_m-$, $-OCH_2CH_2O-$ or $-NR^5N=CH-$, wherein the bond projecting to the left is attached to C=W, and the bond projecting to the right is attached to J, each carbon atom optionally substituted with up to 2 substituents independently selected from R^6;

J is phenyl optionally substituted with up to 2 substituents independently selected from R^7; or a 5- to 6-membered heteroaromatic ring, each ring containing ring members selected from carbon atoms and 1 to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, wherein up to 2 ring members are independently selected from C(=O), C(=S), S(=O) and $S(=O)_2$, each ring optionally substituted with up to 2 substituents independently selected from R^7 on carbon atom ring members and R^8 on nitrogen atom ring members;

each R^2 is independently halogen, hydroxy, cyano, -S-C≡N, -SH, amino, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_3-C_6 cycloalkyl, C_3-C_6 halocycloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_1-C_4 alkylthio, C_1-C_4 alkylsulfinyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_1-C_4 alkylamino, C_2-C_4 dialkylamino, C_2-C_4 alkylcarbonyl, C_2-C_4 haloalkylcarbonyl, C_2-C_5 alkoxycarbonyl, C_2-C_5 haloalkoxycarbonyl, C_2-C_5 alkylaminocarbonyl or C_3-C_5 dialkylaminocarbonyl; or phenyl, pyridinyl, pyrazolyl, imidazolyl, triazolyl, thiazolyl, oxazolyl, isoxazolyl, oxetanyl, 1,3-dioxolanyl, tetrahydropyranyl, thienyl, furanyl, pyrrolidinyl, isoxazolinyl, tetrahydrofuranyl, piperidinyl, morpholinyl or piperazinyl, each optionally substituted with up to 3 substituents independently selected from R^{3c} on carbon atom ring members and R^{3d} on nitrogen atom ring members;

each R^{3a} and R^{3c} is independently halogen, hydroxy, cyano, amino, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_1-C_4 hydroxyalkyl, C_3-C_6 cycloalkyl, C_4-C_7 cycloalkylalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkenyloxy, C_2-C_4 alkynyloxy, C_2-C_4 alkoxyalkyl, C_2-C_6 alkylcarbonyloxy, C_1-C_4 alkylthio, C_1-C_4 haloalkylthio, C_2-C_6 alkylcarbonylthio, C_1-C_4 alkylsulfinyl, C_1-C_4 haloalkylsulfinyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_1-C_4 alkylsulfonyloxy, C_1-C_4 alkylamino, C_2-C_8 dialkylamino, C_3-C_6 cycloalkylamino, C_2-C_4 alkylcarbonyl, C_2-C_6 alkoxycarbonyl, C_2-C_6 alkylaminocarbonyl, C_3-C_8 dialkylaminocarbonyl or C_3-C_6 trialkylsilyl;

each R^{3b} and R^{3d} is independently C_1-C_3 alkyl, C_1-C_3 alkoxy, C_2-C_3 alkylcarbonyl or C_2-C_3 alkoxycarbonyl;

R^{4a} and R^{4b} are each independently H, hydroxy, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 haloalkenyl, C_2-C_4 alkynyl, C_2-C_4 haloalkynyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_2-C_4 alkylthioalkyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_2-C_4 alkylsulfinylalkyl, C_2-C_4 alkylsulfonylalkyl, C_2-C_4 alkylcarbonyl, C_2-C_4 haloalkylcarbonyl, C_2-C_5 alkoxycarbonyl, C_3-C_5 alkoxycarbonylalkyl, C_2-C_5 alkylaminocarbonyl, C_3-C_5 dialkylaminocarbonyl, C_3-C_7 alkylaminocarbonylalkyl or C_4-C_7 dialkylaminocarbonylalkyl; or

one pair of R^1 and R^{4a} substituents or one pair of R^1 and R^{4b} substituents are taken together with the atoms to which they are attached to form a 5- to 7-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, wherein up to 3 ring members are independently selected from C(=O), C(=S), S(=O) and $S(=O)_2$, each ring optionally substituted with up to 4 substituents independently selected from R^9; or

one pair of R^{3a} and R^{4a} substituents or one pair of R^{3a} and R^{4b} substituents are taken together with the atoms to which they are attached to form a 5- to 7-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, wherein up to 3 ring members are independently selected from C(=O), C(=S), S(=O) and $S(=O)_2$, each ring optionally substituted with up to 4 substituents independently selected from R^{10}; or

one pair of R^{3b} and R^{4a} substituents or one pair of R^{3b} and R^{4b} substituents are taken together with the nitrogen atoms to which they are attached to form a 5- to 7-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, wherein up to 3 ring members are independently selected from C(=O), C(=S), S(=O) and $S(=O)_2$, each ring optionally substituted with up to 4 substituents independently selected from R^{11};

R^5 is H, hydroxy, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 haloalkenyl, C_2-C_4 alkynyl, C_2-C_4 haloalkynyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_2-C_4 alkylthioalkyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_2-C_4 alkylsulfinylalkyl, C_2-C_4 alkylsulfonylalkyl, C_2-C_4 alkylcarbonyl, C_2-C_4 haloalkylcarbonyl, C_2-C_5 alkoxycarbonyl, C_3-C_5 alkoxycarbonylalkyl, C_2-C_5 alkylaminocarbonyl or C_3-C_5 dialkylaminocarbonyl;

each R^6 is independently halogen, hydroxy, cyano, nitro, C_1-C_2 alkyl, C_1-C_2 haloalkyl, C_1-C_2 alkoxy, C_1-C_2 haloalkoxy or C_2-C_4 alkoxyalkyl; or phenyl optionally substituted with up to 3 substituents independently selected from R^{13};

each R^7 is independently halogen, hydroxy, cyano, amino, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_1-C_4 hydroxyalkyl, C_3-C_6 cycloalkyl, C_4-C_7 cycloalkylalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkenyloxy, C_2-C_4 alkynyloxy, C_2-C_4 alkoxyalkyl, C_2-C_4 alkylcarbonyloxy, C_1-C_4 alkylthio, C_1-C_4 haloalkylthio, C_2-C_4 alkylcarbonylthio, C_1-C_4 alkylsulfinyl, C_1-C_4 haloalkylsulfinyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_1-C_4 alkylsulfonyloxy, C_1-C_4 alkylamino, C_2-C_6 dialkylamino, C_3-C_6 cycloalkylamino, C_2-C_4 alkylcarbonyl, C_2-C_6 alkoxycarbonyl, C_2-C_6 alkylaminocarbonyl, C_3-C_6 dialkylaminocarbonyl or C_3-C_6 trialkylsilyl;

each R^8 is independently C_1-C_3 alkyl;

each R^9, R^{10} and R^{11} is independently halogen, hydroxy, cyano, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 haloalkenyl, C_2-C_4 alkynyl, C_2-C_4 haloalkynyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_2-C_4 alkylthioalkyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_2-C_4 alkylsulfinylalkyl, C_2-C_4 alkylsulfonylalkyl, C_2-C_4 alkylcarbonyl, C_2-C_4 haloalkylcarbonyl, C_2-C_5 alkoxycarbonyl, C_3-C_5 alkoxycarbonylalkyl, C_2-C_5 alkylaminocarbonyl or C_3-C_5 dialkylaminocarbonyl;

each R^{12} is independently H, cyano, C_1-C_3 alkyl or C_1-C_3 haloalkyl;

each R^{13} is independently halogen, cyano, amino, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_1-C_4 hydroxyalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkenyloxy, C_2-C_4 alkynyloxy or C_2-C_4 alkoxyalkyl;

n is 0;

m is 1, 2 or 3; and

each u and v are independently 0, 1 or 2 in each instance of $S(=O)_u(=NR^{12})_v$, provided that the sum of u and v is 0, 1 or 2;

provided that:

(a) when J is phenyl or a 6-membered heteroaromatic ring, then J is attached to Z^2 and the oxadiazole ring in Formula **1** in a meta- or para-arrangement; and

(b) the compound of Formula **1** is not:

[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl](2-chlorophenyl)]methyl *N*-(phenylmethyl)carbamate;

[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl](4-chlorophenyl)]methyl *N*-(phenylmethyl)carbamate;

[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl] methyl ester 4-morpholinecarboxylic acid;

[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]benzyl acetyl(methyl)carbamate;

[4-[5-(trifluoromethyl)-1,2-3-oxadiazol-3-yl]phenyl]methyl *N*-methylcarbamate;

[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]methyl *N*-2-pyridinylcarbamate;

1-[4-[5-(trifluoromethyl)-1,2,3-oxadiazol-3-yl]phenyl]ethyl *N*,*N*-dimethylcarbamate;

[4-[5-(trifluoromethyl)-1,2-3-oxadiazol-3-yl]phenyl]methyl *N*-methoxy-*N*-methylcarbamate;

[4-[5-(trifluoromethyl)-1,2-3-oxadiazol-3-yl]phenyl]methyl *N*-(2,2,2-trifluoroethyl)carbamate;

[4-[5-(trifluoromethyl)-1,2-3-oxadiazol-3-yl]phenyl]methyl *N*-cyclopropylcarbamate; or

[4-[5-(trifluoromethyl)-1,2-3-oxadiazol-3-yl]phenyl]methyl *N*,*N*-dimethylcarbamate.

More particularly, this invention pertains to a compound of Formula **1** (including all geometric and stereoisomers), an *N*-oxide, a hydrate, or a salt thereof.

This invention also relates to a fungicidal composition comprising (a) a compound of Formula **1**; and (b) at least one additional component selected from the group consisting of surfactants, solid diluents and liquid diluents.

This invention also relates to a fungicidal composition comprising (a) a compound of Formula **1**; and (b) at least one other fungicide (e.g., at least one other fungicide having a different site of action).

This invention further relates to a method for controlling plant diseases caused by fungal plant pathogens comprising applying to the plant or portion thereof, or to the plant seed, a fungicidally effective amount of a compound of the invention (e.g., as a composition described herein).

This invention also relates to a composition comprising a compound of Formula **1**, an *N*-oxide, a hydrate, or a salt thereof, and at least one invertebrate pest control compound or agent.

DETAILS OF THE INVENTION

As used herein, the terms "comprises," "comprising," "includes," "including," "has," "having," "contains," "containing," "characterized by" or any other variation thereof, are intended to cover a non-exclusive inclusion, subject to any limitation explicitly indicated. For example, a composition, mixture, process or method that comprises a list of elements is not necessarily limited to only those elements but may include other elements not expressly listed or inherent to such composition, mixture, process or method.

The transitional phrase "consisting of" excludes any element, step, or ingredient not specified. If in the claim, such would close the claim to the inclusion of materials other than

those recited except for impurities ordinarily associated therewith. When the phrase "consisting of" appears in a clause of the body of a claim, rather than immediately following the preamble, it limits only the element set forth in that clause; other elements are not excluded from the claim as a whole.

The transitional phrase "consisting essentially of" is used to define a composition or method that includes materials, steps, features, components, or elements, in addition to those literally disclosed, provided that these additional materials, steps, features, components, or elements do not materially affect the basic and novel characteristic(s) of the claimed invention. The term "consisting essentially of" occupies a middle ground between "comprising" and "consisting of".

Where applicants have defined an invention or a portion thereof with an open-ended term such as "comprising," it should be readily understood that (unless otherwise stated) the description should be interpreted to also describe such an invention using the terms "consisting essentially of" or "consisting of."

Further, unless expressly stated to the contrary, "or" refers to an inclusive or and not to an exclusive or. For example, a condition A or B is satisfied by any one of the following: A is true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

Also, the indefinite articles "a" and "an" preceding an element or component of the invention are intended to be nonrestrictive regarding the number of instances (i.e. occurrences) of the element or component. Therefore "a" or "an" should be read to include one or at least one, and the singular word form of the element or component also includes the plural unless the number is obviously meant to be singular.

As referred to in the present disclosure and claims, "plant" includes members of Kingdom Plantae, particularly seed plants (Spermatopsida), at all life stages, including young plants (e.g., germinating seeds developing into seedlings) and mature, reproductive stages (e.g., plants producing flowers and seeds). Portions of plants include geotropic members typically growing beneath the surface of the growing medium (e.g., soil), such as roots, tubers, bulbs and corms, and also members growing above the growing medium, such as foliage (including stems and leaves), flowers, fruits and seeds.

As referred to herein, the term "seedling", used either alone or in a combination of words means a young plant developing from the embryo of a seed or bud of a vegetative propagation unit such as tuber, corm or rhizome.

As referred to herein, the term "broadleaf" used either alone or in words such as "broadleaf crop" means dicot or dicotyledon, a term used to describe a group of angiosperms characterized by embryos having two cotyledons.

As referred to in this disclosure, the terms "fungal pathogen" and "fungal plant pathogen" include pathogens in the Ascomycota, Basidiomycota and Zygomycota phyla, and the fungal-like Oomycota class that are the causal agents of a broad spectrum of plant

diseases of economic importance, affecting ornamental, turf, vegetable, field, cereal and fruit crops. In the context of this disclosure, "protecting a plant from disease" or "control of a plant disease" includes preventative action (interruption of the fungal cycle of infection, colonization, symptom development and spore production) and/or curative action (inhibition of colonization of plant host tissues).

As used herein, the term "mode of action" (MOA) is as define by the Fungicide Resistance Action Committee (FRAC), and is used to distinguish fungicides according to their biochemical mode of action in the biosynthetic pathways of plant pathogens. FRAC-defined modes of actions include (A) nucleic acid synthesis, (B) mitosis and cell division, (C) respiration, (D) amino acid and protein synthesis, (E) signal transduction, (F) lipid synthesis and membrane integrity, (G) sterol biosynthesis in membranes, (H) cell wall biosynthesis, (I) melanin synthesis in cell wall, (P) host plant defense induction, (U) unknown mode of action, (NC) not classified and (M) multi-site contact activity. Each mode of action (i.e. letters A through M) contain one or more subgroups (e.g., A includes subgroups A1, A2, A3 and A4) based either on individual validated target sites of action, or in cases where the precise target site is unknown, based on cross resistance profiles within a group or in relation to other groups. Each of these subgroups (e.g., A1, A2, A3 and A4) is assigned a FRAC code (a number and/or letter). For example, the FRAC code for subgroup A1 is 4. Additional information on target sites and FRAC codes can be obtained from publicly available databases maintained, for example, by FRAC.

As used herein, the term "cross resistance" refers to the phenomenon that occurs when a pathogen develops resistance to one fungicide and simultaneously becomes resistant to one or more other fungicides. These other fungicides are typically, but not always, in the same chemical class or have the same target site of action, or can be detoxified by the same mechanism.

Generally when a molecular fragment (i.e. radical) is denoted by a series of atom symbols (e.g., C, H, N, O and S) the implicit point or points of attachment will be easily recognized by those skilled in the art. In some instances herein, particularly when alternative points of attachment are possible, the point or points of attachment may be explicitly indicated by a hyphen ("-"). For example, "-SCN" indicates that the point of attachment is the sulfur atom (i.e. thiocyanato, not isothiocyanato).

As used herein, the term "alkylating agent" refers to a chemical compound in which a carbon-containing radical is bound through a carbon atom to a leaving group such as halide or sulfonate, which is displaceable by bonding of a nucleophile to said carbon atom. Unless otherwise indicated, the term "alkylating" does not limit the carbon-containing radical to alkyl; the carbon-containing radicals in alkylating agents include the variety of carbon-bound substituent radicals specified, for example, for R^2.

In the above recitations, the term "alkyl", used either alone or in compound words such as "alkylthio" or "haloalkyl" includes straight-chain and branched alkyl, such as, methyl,

ethyl, *n*-propyl, *i*-propyl, and the different butyl, pentyl and hexyl isomers. "Alkenyl" includes straight-chain and branched alkenes such as ethenyl, 1-propenyl, 2-propenyl, and the different butenyl, pentenyl and hexenyl isomers. "Alkenyl" also includes polyenes such as 1,2-propadienyl and 2,4-hexadienyl. "Alkynyl" includes straight-chain and branched alkynes such as ethynyl, 1-propynyl, 2-propynyl, and the different butynyl, pentynyl and hexynyl isomers. "Alkynyl" also includes moieties comprised of multiple triple bonds such as 2,5-hexadiynyl.

"Alkoxy" includes, for example, methoxy, ethoxy, *n*-propyloxy, *i*-propyloxy, and the different butoxy isomers. "Alkenyloxy" includes straight-chain and branched alkenyl attached to and linked through an oxygen atom. Examples of "alkenyloxy" include $H_2C{=}CHCH_2O$ and $CH_3CH{=}CHCH_2O$. "Alkynyloxy" includes straight-chain and branched alkynyloxy moieties. Examples of "alkynyloxy" include $HC{\equiv}CCH_2O$ and $CH_3C{\equiv}CCH_2O$.

The term "alkylthio" includes straight-chain and branched alkylthio moieties such as methylthio, ethylthio, and the different propylthio and butylthio isomers. "Alkylsulfinyl" includes both enantiomers of an alkylsulfinyl group. Examples of "alkylsulfinyl" include $CH_3S(=O)$, $CH_3CH_2S(=O)$, $CH_3CH_2CH_2S(=O)$, $(CH_3)_2CHS(=O)$, and the different butylsulfinyl isomers. Examples of "alkylsulfonyl" include $CH_3S(=O)_2$, $CH_3CH_2S(=O)_2$, $CH_3CH_2CH_2S(=O)_2$, $(CH_3)_2CHS(=O)_2$, and the different butylsulfonyl isomers.

"Alkylamino" includes an NH radical substituted with a straight-chain or branched alkyl group. Examples of "alkylamino" include CH_3CH_2NH, $CH_3CH_2CH_2NH$, and $(CH_3)_2CHCH_2NH$. Examples of "dialkylamino" include $(CH_3)_2N$, $(CH_3CH_2CH_2)_2N$ and $CH_3CH_2(CH_3)N$.

"Alkylcarbonyl" denotes a straight-chain or branched alkyl group bonded to a C(=O) moiety. Examples of "alkylcarbonyl" include $CH_3C(=O)$, $CH_3CH_2CH_2C(=O)$ and $(CH_3)_2CHC(=O)$. Examples of "alkoxycarbonyl" include $CH_3OC(=O)$, $CH_3CH_2OC(=O)$, $CH_3CH_2CH_2OC(=O)$, $(CH_3)_2CHOC(=O)$, and the different butoxy-, pentoxy- and hexyloxycarbonyl isomers. Examples of "alkylaminocarbonyl" include $CH_3NHC(=O)$, $CH_3CH_2NHC(=O)$, $CH_3CH_2CH_2NHC(=O)$, $(CH_3)_2CHNHC(=O)$, and the different butylamino-, pentylamino- and hexylaminocarbonyl isomers. Examples of "dialkylaminocarbonyl" include $(CH_3)_2NC(=O)$, $(CH_3CH_2)_2NC(=O)$, $CH_3CH_2(CH_3)NC(=O)$, $(CH_3)_2CH(CH_3)NC(=O)$ and $CH_3CH_2CH_2(CH_3)NC(=O)$.

"Alkoxyalkyl" denotes alkoxy substitution on alkyl. Examples of "alkoxyalkyl" include CH_3OCH_2, $CH_3OCH_2CH_2$, $CH_3CH_2OCH_2$, $CH_3CH_2CH_2OCH_2$ and $CH_3CH_2OCH_2CH_2$. "Alkylthioalkyl" denotes alkylthio substitution on alkyl. Examples of "alkylthioalkyl" include CH_3SCH_2, $CH_3SCH_2CH_2$, $CH_3CH_2SCH_2$, $CH_3CH_2CH_2SCH_2$ and $CH_3CH_2SCH_2CH_2$; "alkylsulfinylalkyl" and "alkylsulfonylalkyl" include the corresponding sulfoxides and sulfones, respectively.

"Alkylcarbonylthio" denotes a straight-chain or branched alkylcarbonyl attached to and linked through a sulfur atom. Examples of "alkylcarbonylthio" include $CH_3C(=O)S$,

$CH_3CH_2CH_2C(=O)S$ and $(CH_3)_2CHC(=O)S$. The term "alkylcarbonyloxy" denotes a straight-chain or branched alkyl bonded to a C(=O)O moiety. Examples of "alkylcarbonyloxy" include $CH_3CH_2C(=O)O$ and $(CH_3)_2CHC(=O)O$.

The term "alkylaminocarbonylalkyl" denotes a straight-chain or branched alkylaminocarbonyl attached to alkyl. Examples of "alkylaminocarbonylalkyl" include $(CH_3)_2CHCH_2NHC(=O)CH_2$ and $CH_3CH_2NHC(=O)CH_2$. Examples of "dialkylaminocarbonylalkyl" include $CH_3CH_2CH_2(CH_3)NC(=O)CH_2$ and $(CH_3)_2NC(=O)CH_2$.

"Cycloalkyl" includes, for example, cyclopropyl, cyclobutyl, cyclopentyl and cyclohexyl. The term "cycloalkylalkyl" denotes cycloalkyl substitution on an alkyl moiety. Examples of "cycloalkylalkyl" include cyclopropylmethyl, cyclopentylethyl, and other cycloalkyl moieties bonded to a straight-chain or branched alkyl group.

"Cycloalkylamino" denotes an NH radical substituted with cycloalkyl. Examples of "cycloalkylamino" include cyclopropylamino and cyclohexylamino.

The term "halogen", either alone or in compound words such as "haloalkyl", or when used in descriptions such as "alkyl substituted with halogen" includes fluorine, chlorine, bromine or iodine. Further, when used in compound words such as "haloalkyl", or when used in descriptions such as "alkyl substituted with halogen" said alkyl may be partially or fully substituted with halogen atoms which may be the same or different. Examples of "haloalkyl" or "alkyl substituted with halogen" include F_3C, $ClCH_2$, CF_3CH_2 and CF_3CCl_2. The terms "haloalkenyl", "haloalkynyl" "haloalkoxy", "haloalkylthio", "haloalkylsulfinyl", "haloalkylsulfonyl", "halocycloalkyl", and the like, are defined analogously to the term "haloalkyl". Examples of "haloalkenyl" include $Cl_2C=CHCH_2$ and $CF_3CH_2CH=CH$. Examples of "haloalkynyl" include $HC\equiv CCHCl$, $CF_3C\equiv C$, $CCl_3C\equiv C$ and $FCH_2C\equiv CCH_2$. Examples of "haloalkoxy" include CF_3O, CCl_3CH_2O, $F_2CHCH_2CH_2O$ and CF_3CH_2O. Examples of "haloalkylthio" include CCl_3S, CF_3S, CCl_3CH_2S and $ClCH_2CH_2CH_2S$. Examples of "haloalkylsulfinyl" include $CF_3S(=O)$, $CCl_3S(=O)$, $CF_3CH_2S(=O)$ and $CF_3CF_2S(=O)$. Examples of "haloalkylsulfonyl" include $CF_3S(=O)_2$, $CCl_3S(=O)_2$, $CF_3CH_2S(=O)_2$ and $CF_3CF_2S(=O)_2$. Examples of "halocycloalkyl" include 2-chlorocyclopropyl, 2-fluorocyclobutyl, 3-bromocyclopentyl and 4-chorocyclohexyl.

"Hydroxyalkyl" denotes an alkyl group substituted with one hydroxy group. Examples of "hydroxyalkyl" include $HOCH_2CH_2$, $CH_3CH_2(OH)CH$ and $HOCH_2CH_2CH_2CH_2$.

"Trialkylsilyl" includes 3 branched and/or straight-chain alkyl radicals attached to and linked through a silicon atom, such as trimethylsilyl, triethylsilyl and *tert*-butyldimethylsilyl.

The total number of carbon atoms in a substituent group is indicated by the "C_i-C_j" prefix where i and j are numbers from 1 to 8. For example, C_1-C_4 alkylsulfonyl designates methylsulfonyl through butylsulfonyl; C_2 alkoxyalkyl designates CH_3OCH_2; C_3 alkoxyalkyl designates, for example, $CH_3CH(OCH_3)$, $CH_3OCH_2CH_2$ or $CH_3CH_2OCH_2$; and C_4 alkoxyalkyl designates the various isomers of an alkyl group substituted with an alkoxy

group containing a total of four carbon atoms, examples including $CH_3CH_2CH_2OCH_2$ and $CH_3CH_2OCH_2CH_2$.

The term "unsubstituted" in connection with a group such as a ring or ring system means the group does not have any substituents other than its one or more attachments to the remainder of Formula **1**. The term "optionally substituted" means that the number of substituents can be zero. Unless otherwise indicated, optionally substituted groups may be substituted with as many optional substituents as can be accommodated by replacing a hydrogen atom with a non-hydrogen substituent on any available carbon or nitrogen atom. Commonly, the number of optional substituents (when present) ranges from 1 to 3. As used herein, the term "optionally substituted" is used interchangeably with the phrase "substituted or unsubstituted" or with the term "(un)substituted."

The number of optional substituents may be restricted by an expressed limitation. For example, the phrase "optionally substituted with up to 3 substituents independently selected from R^{3a}" means that 0, 1, 2 or 3 substituents can be present (if the number of potential connection points allows). Similarly, the phrase "optionally substituted with up to 5 substituents independently selected from R^{3a}" means that 0, 1, 2, 3, 4 or 5 substituents can be present if the number of available connection points allows. When a range specified for the number of substituents (e.g., k being an integer from 1 to 2 in Exhibit A) exceeds the number of positions available for substituents on a ring (e.g., 1 position available for $(R^3)_k$ on U-17 in Exhibit A), the actual higher end of the range is recognized to be the number of available positions.

When a compound is substituted with a substituent bearing a subscript that indicates the number of said substituents can vary (e.g., $(R^3)_k$ in Exhibit A wherein k is 1 to 2), then said substituents are independently selected from the group of defined substituents, unless otherwise indicated. When a variable group is shown to be optionally attached to a position, for example $(R^3)_k$ in Exhibit A wherein k may be 0, then hydrogen may be at the position even if not recited in the definition of the variable group.

Naming of substituents in the present disclosure uses recognized terminology providing conciseness in precisely conveying to those skilled in the art the chemical structure. For sake of conciseness, locant descriptors may be omitted.

Unless otherwise indicated, a "ring" or "ring system" as a component of Formula **1** (e.g., substituent R^1) is carbocyclic or heterocyclic. The term "ring system" denotes two or more connected rings. The term "bicyclic ring system" denotes a ring system consisting of two rings sharing two or more common atoms. In a "fused bicyclic ring system" the common atoms are adjacent, and therefore the rings share two adjacent atoms and bond connecting them.

A ring can be part of an extended ring system containing more than two rings wherein substituents on the ring, are taken together to form the additional rings, which may be in bicyclic a relationship with other rings in the extended ring system.

The term "ring member" refers to an atom (e.g., C, O, N or S) or other moiety (e.g., C(=O), C(=S) or $S(=O)_u(=NR^{12})_v$) forming the backbone of a ring or ring system. The term "aromatic" indicates that each ring atom is essentially in the same plane and has a *p*-orbital perpendicular to the ring plane, and that (4n + 2) π electrons, where n is a positive integer, are associated with the ring to comply with Hückel's rule.

The term "carbocyclic ring" denotes a ring wherein the atoms forming the ring backbone are selected only from carbon. Unless otherwise indicated, a carbocyclic ring can be a saturated, partially unsaturated, or fully unsaturated ring. When a fully unsaturated carbocyclic ring satisfies Hückel's rule, then said ring is also called an "aromatic ring". "Saturated carbocyclic" refers to a ring having a backbone consisting of carbon atoms linked to one another by single bonds; unless otherwise specified, the remaining carbon valences are occupied by hydrogen atoms.

As used herein, the term "partially unsaturated ring" or "partially unsaturated heterocycle" refers to a ring which contains unsaturated ring atoms and one or more double bonds but which is not aromatic.

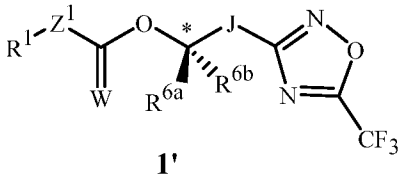
The terms "heterocyclic ring" or "heterocycle" denotes a ring wherein at least one of the atoms forming the ring backbone is other than carbon. Unless otherwise indicated, a heterocyclic ring can be a saturated, partially unsaturated, or fully unsaturated ring. When a fully unsaturated heterocyclic ring satisfies Hückel's rule, then said ring is also called a "heteroaromatic ring" or "aromatic heterocyclic ring". "Saturated heterocyclic ring" refers to a heterocyclic ring containing only single bonds between ring members.

Unless otherwise indicated, heterocyclic rings and ring systems are attached to the remainder of Formula **1** through any available carbon or nitrogen atom by replacement of a hydrogen on said carbon or nitrogen atom.

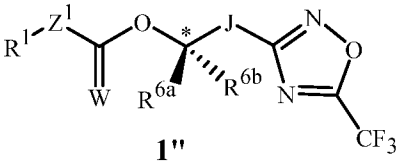
Compounds of this invention can exist as one or more stereoisomers. Stereoisomers are isomers of identical constitution but differing in the arrangement of their atoms in space and include enantiomers, diastereomers, *cis*- and *trans*-isomers (also known as geometric isomers) and atropisomers. Atropisomers result from restricted rotation about single bonds where the rotational barrier is high enough to permit isolation of the isomeric species. One skilled in the art will appreciate that one stereoisomer may be more active and/or may exhibit beneficial effects when enriched relative to the other stereoisomer(s) or when separated from the other stereoisomer(s). Additionally, the skilled artisan knows how to separate, enrich, and/or to selectively prepare said stereoisomers. For a comprehensive discussion of all aspects of stereoisomerism, see Ernest L. Eliel and Samuel H. Wilen, *Stereochemistry of Organic Compounds*, John Wiley & Sons, 1994.

Compounds of Formula **1** may be present as a mixture of stereoisomers, individual stereoisomers, or as an optically active form. For example, when Z^2 is $-OC(R^{6a}R^{6b})-$, wherein R^{6a} and R^{6b} are selected from R^6 and are different, then Formula **1** possesses a chiral center at the carbon atom to which the R^{6a} and R^{6b} substituents are bonded. The two

enantiomers are depicted as Formula **1'** and Formula **1"** below and the chiral center is identified with an asterisk (*).



1'



1"

Compounds of Formula **1** comprise racemic mixtures, for example, equal amounts of the enantiomers of Formulae **1'** and **1"**. In addition, compounds of Formula **1** include compounds that are enriched compared to the racemic mixture in an enantiomer of Formula **1**. Also included are the essentially pure enantiomers of compounds of Formula **1**, for example, Formula **1'** and Formula **1"**.

Compounds of this invention can exist as one or more conformational isomers due to restricted rotation about an amide bond (e.g., C(=O)-N) in Formula **1**. This invention comprises mixtures of conformational isomers. In addition, this invention includes compounds that are enriched in one conformer relative to others.

This invention comprises all stereoisomers, conformational isomers and mixtures thereof in all proportions as well as isotopic forms such as deuterated compounds.

One skilled in the art will appreciate that not all nitrogen containing heterocycles can form *N*-oxides since the nitrogen requires an available lone pair for oxidation to the oxide; one skilled in the art will recognize those nitrogen-containing heterocycles which can form *N*-oxides. One skilled in the art will also recognize that tertiary amines can form *N*-oxides. Synthetic methods for the preparation of *N*-oxides of heterocycles and tertiary amines are very well known by one skilled in the art including the oxidation of heterocycles and tertiary amines with peroxy acids such as peracetic and *m*-chloroperbenzoic acid (MCPBA), hydrogen peroxide, alkyl hydroperoxides such as *t*-butyl hydroperoxide, sodium perborate, and dioxiranes such as dimethyldioxirane. These methods for the preparation of *N*-oxides have been extensively described and reviewed in the literature, see for example: T. L. Gilchrist in *Comprehensive Organic Synthesis*, vol. 7, pp 748-750, S. V. Ley, Ed., Pergamon Press; M. Tisler and B. Stanovnik in *Comprehensive Heterocyclic Chemistry*, vol. 3, pp 18-20, A. J. Boulton and A. McKillop, Eds., Pergamon Press; M. R. Grimmett and B. R. T. Keene in *Advances in Heterocyclic Chemistry*, vol. 43, pp 149-161, A. R. Katritzky, Ed., Academic Press; M. Tisler and B. Stanovnik in *Advances in Heterocyclic Chemistry*, vol. 9, pp 285-291, A. R. Katritzky and A. J. Boulton, Eds., Academic Press; and G. W. H. Cheeseman and E. S. G. Werstiuk in *Advances in Heterocyclic Chemistry*, vol. 22, pp 390–392, A. R. Katritzky and A. J. Boulton, Eds., Academic Press.

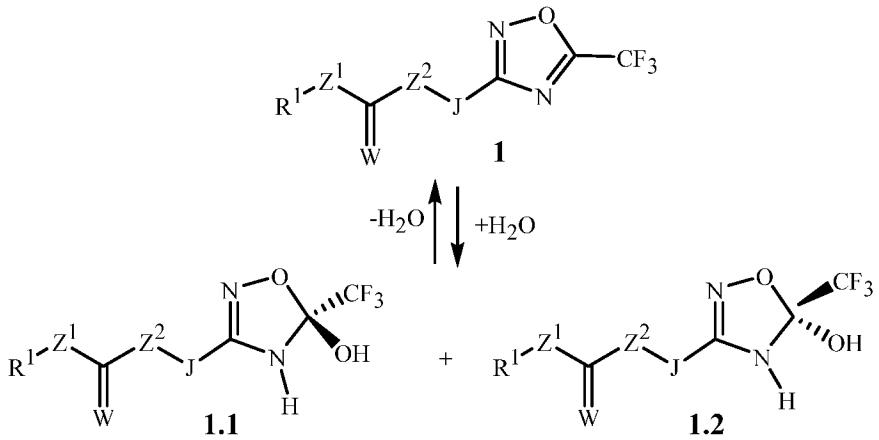
One skilled in the art recognizes that because in the environment and under physiological conditions salts of chemical compounds are in equilibrium with their

corresponding nonsalt forms, salts share the biological utility of the nonsalt forms. Thus a wide variety of salts of the compounds of Formula **1** are useful for control of plant diseases caused by fungal plant pathogens (i.e. are agriculturally suitable). The salts of the compounds of Formula **1** include acid-addition salts with inorganic or organic acids such as hydrobromic, hydrochloric, nitric, phosphoric, sulfuric, acetic, butyric, fumaric, lactic, maleic, malonic, oxalic, propionic, salicylic, tartaric, 4-toluenesulfonic or valeric acids. When a compound of Formula **1** contains an acidic moiety such as a carboxylic acid, salts also include those formed with organic or inorganic bases such as pyridine, triethylamine or ammonia, or amides, hydrides, hydroxides or carbonates of sodium, potassium, lithium, calcium, magnesium or barium. Accordingly, the present invention comprises compounds selected from Formula **1**, *N*-oxides and agriculturally suitable salts, solvates and hydrates thereof.

Compounds selected from Formula **1**, stereoisomers, tautomers, *N*-oxides, and salts thereof, typically exist in more than one form, and Formula **1** thus includes all crystalline and non-crystalline forms of the compounds that Formula **1** represents. Non-crystalline forms include embodiments which are solids such as waxes and gums as well as embodiments which are liquids such as solutions and melts. Crystalline forms include embodiments which represent essentially a single crystal type and embodiments which represent a mixture of polymorphs (i.e. different crystalline types). The term "polymorph" refers to a particular crystalline form of a chemical compound that can crystallize in different crystalline forms, these forms having different arrangements and/or conformations of the molecules in the crystal lattice. Although polymorphs can have the same chemical composition, they can also differ in composition due to the presence or absence of co-crystallized water or other molecules, which can be weakly or strongly bound in the lattice. Polymorphs can differ in such chemical, physical and biological properties as crystal shape, density, hardness, color, chemical stability, melting point, hygroscopicity, suspensibility, dissolution rate and biological availability. One skilled in the art will appreciate that a polymorph of a compound represented by Formula **1** can exhibit beneficial effects (e.g., suitability for preparation of useful formulations, improved biological performance) relative to another polymorph or a mixture of polymorphs of the same compound represented by Formula **1**. Preparation and isolation of a particular polymorph of a compound represented by Formula **1** can be achieved by methods known to those skilled in the art including, for example, crystallization using selected solvents and temperatures. For a comprehensive discussion of polymorphism see R. Hilfiker, Ed., *Polymorphism in the Pharmaceutical Industry*, Wiley-VCH, Weinheim, 2006.

The compounds herein, and the agriculturally acceptable salts thereof, may exist in a continuum of solid states ranging from fully amorphous to fully crystalline. They may also exist in unsolvated and solvated forms. The term "solvate" describes a molecular complex comprising the compound and one or more agriculturally acceptable solvent molecules (e.g.,

EtOH). The term "hydrate" is a solvate in which the solvent is water. Agriculturally acceptable solvates include those in which the solvent may be isotopically substituted (e.g., D_2O, d_6-acetone, d_6-DMSO). One skilled in the art will understand that when in an aqueous media, compounds of Formula **1** may be present in a reversible equilibrium with corresponding covalently hydrated forms at the trifluoromethyl-oxadiazole ring as depicted by Formula **1.1** and Formula **1.2** below.



A currently accepted classification system for solvates and hydrates of organic compounds is one that distinguishes between isolated site, channel, and metal-ion coordinated solvates and hydrates. See, e.g., K. R. Morris (H. G. Brittain ed.) *Polymorphism in Pharmaceutical Solids* (1995). Isolated site solvates and hydrates are ones in which the solvent (e.g., water) molecules are isolated from direct contact with each other by intervening molecules of the organic compound. In channel solvates, the solvent molecules lie in lattice channels where they are next to other solvent molecules. In metal-ion coordinated solvates, the solvent molecules are bonded to the metal ion.

Embodiments of the present invention as described in the Summary of the Invention include those described below. In the following Embodiments, Formula **1** includes stereoisomers, *N*-oxides, hydrates, and salts thereof, and reference to "a compound of Formula **1**" includes the definitions of substituents specified in the Summary of the Invention unless further defined in the Embodiments.

Embodiment 1. A compound of Formula **1** wherein when R^1 is separate (i.e. not taken together with R^{4a} or R^{4b} to form a ring), then R^1 is H; or C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_2-C_6 alkylcarbonyl or C_2-C_6 alkoxycarbonyl, each optionally substituted with up to 2 substituents independently selected from R^2; or phenyl optionally substituted with up to 3 substituents independently selected from R^{3a}; or a 3- to 7-membered nonaromatic carbocyclic ring, wherein up to 2 carbon atom ring members are independently selected from C(=O) and C(=S), each ring optionally substituted with up to 3 substituents independently selected from R^{3a}; or a 5- to 6-membered heterocyclic ring, each ring containing ring

members selected from carbon atoms and 1 to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, wherein up to 2 carbon atom ring members are independently selected from C(=O) and C(=S), each ring optionally substituted with up to 3 substituents independently selected from R^{3a} on carbon atom ring members and R^{3b} on nitrogen atom ring members.

Embodiment 2. A compound of Embodiment 1 wherein R^1 is H; or C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_2-C_6 alkylcarbonyl or C_2-C_6 alkoxycarbonyl, each optionally substituted with up to 2 substituents independently selected from R^2; or phenyl optionally substituted with up to 3 substituents independently selected from R^{3a}; or C_3-C_6 cycloalkyl optionally substituted with up to 2 substituents independently selected from R^{3a}; or a 5- to 6-membered heterocyclic ring, each ring containing ring members selected from carbon atoms and 1 to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, wherein up to 2 carbon atom ring members are independently selected from C(=O) and C(=S), each ring optionally substituted with up to 3 substituents independently selected from R^{3a} on carbon atom ring members and R^{3b} on nitrogen atom ring members.

Embodiment 3. A compound of Embodiment 2 wherein R^1 is H; or C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, each optionally substituted with up to 2 substituents independently selected from R^2; or phenyl optionally substituted with up to 3 substituents independently selected from R^{3a}; or C_3-C_6 cycloalkyl optionally substituted with up to 2 substituents independently selected from R^{3a}; or a 5- to 6-membered heterocyclic ring, each ring containing ring members selected from carbon atoms and 1 to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, wherein up to 2 carbon atom ring members are independently selected from C(=O) and C(=S), each ring optionally substituted with up to 3 substituents independently selected from R^{3a} on carbon atom ring members and R^{3b} on nitrogen atom ring members.

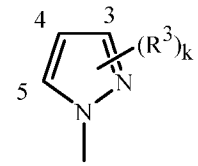
Embodiment 4. A compound of Embodiment 2 wherein R^1 is H; or C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_2-C_6 alkylcarbonyl or C_2-C_6 alkoxycarbonyl, each optionally substituted with up to 2 substituents independently selected from R^2; or C_3-C_6 cycloalkyl optionally substituted with up to 2 substituents independently selected from R^{3a}.

Embodiment 5. A compound of Embodiment 4 wherein R^1 is H; or C_1-C_4 alkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_2-C_4 alkylcarbonyl or C_2-C_4 alkoxycarbonyl, each optionally substituted with up to 1 substituent selected from R^2; or C_3-C_6 cycloalkyl optionally substituted with up to 2 substituents independently selected from R^{3a}.

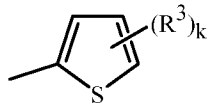
Embodiment 6. A compound of Embodiment 5 wherein R^1 is H; or C_1-C_4 alkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_2-C_4 alkylcarbonyl or C_2-C_4 alkoxycarbonyl, each optionally substituted with up to 1 substituent selected from R^2; or cycloproply optionally substituted with up to 2 substituents independently selected from R^{3a}.

Embodiment 7. A compound of Formula **1** or Embodiment 1 wherein when R^1 is separate (i.e. not taken together with R^{4a} or R^{4b} to form a ring), then R^1 is H; or C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_2-C_6 alkylcarbonyl or C_2-C_6 alkoxycarbonyl, each optionally substituted with up to 2 substituents independently selected from R^2; or R^1 is selected from U-1 through U-79 as shown in Exhibit A

Exhibit A



U-1 ,



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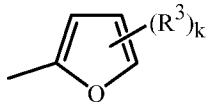

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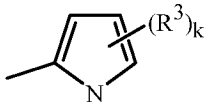

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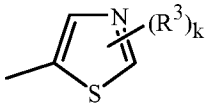

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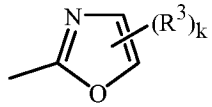

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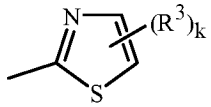

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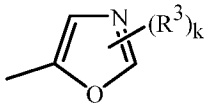

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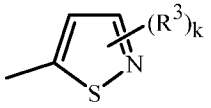

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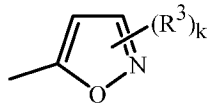

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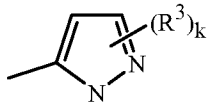

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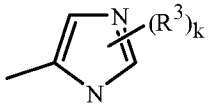

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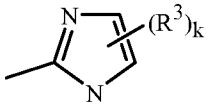

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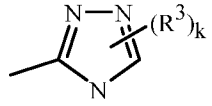

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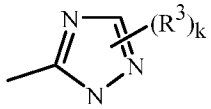

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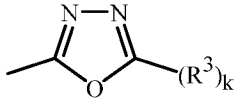

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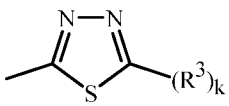

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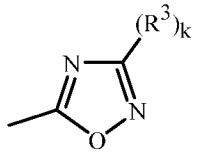

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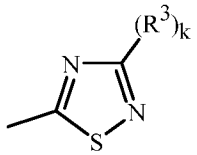

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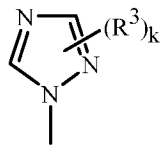

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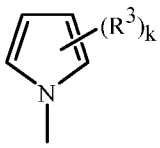

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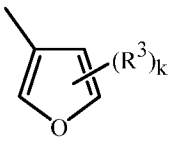

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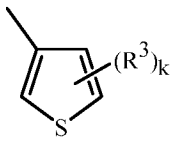

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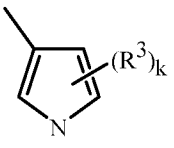

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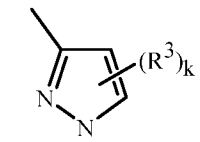
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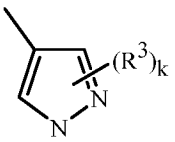
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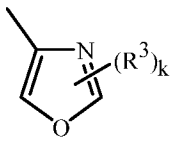
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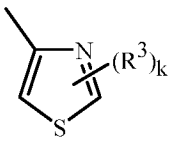
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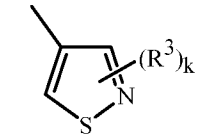
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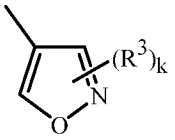
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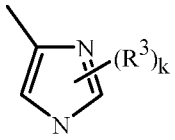
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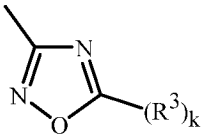
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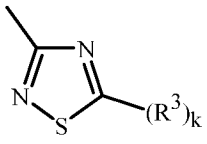
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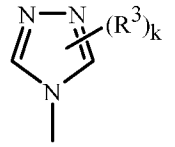
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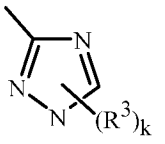
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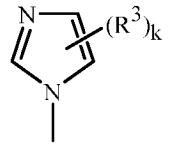
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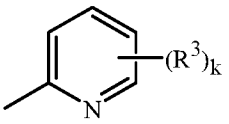
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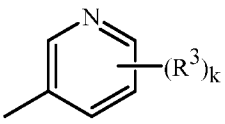
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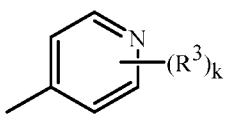
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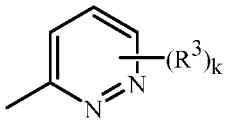
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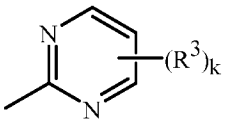
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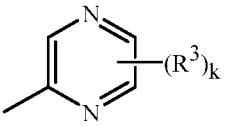
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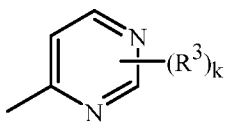
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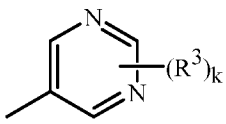
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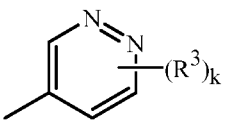
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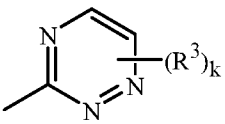
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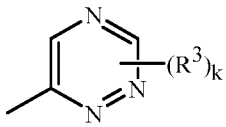
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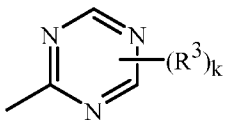
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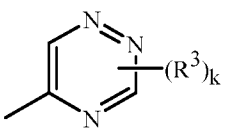
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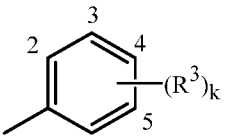

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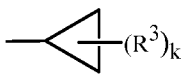
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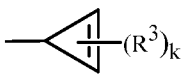
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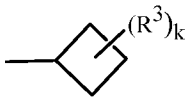
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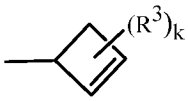
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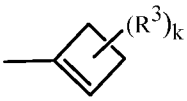
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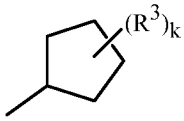
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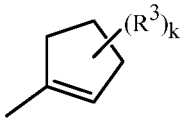
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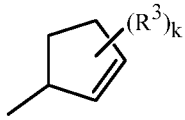
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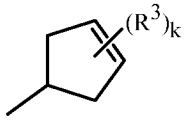
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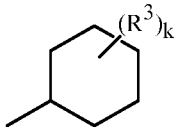
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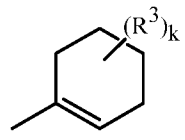
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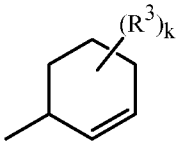
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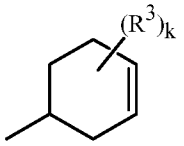
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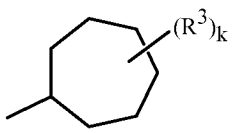
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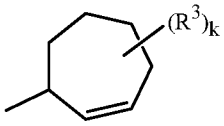
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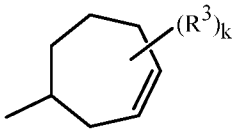
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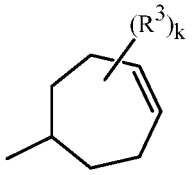
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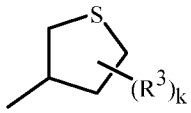
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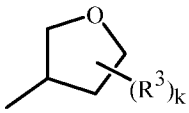
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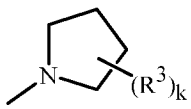
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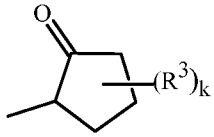
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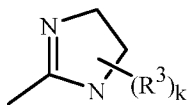
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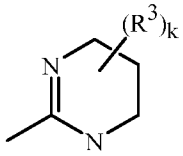
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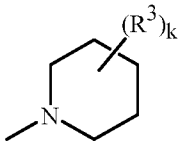
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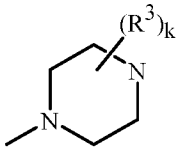
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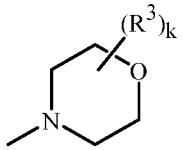
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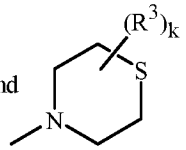
and 
U-79 ;

wherein when R^3 is attached to a carbon ring member, said R^3 is selected from R^{3a}, and when R^3 is attached to a nitrogen ring member (e.g., in U-4, U-11 through U-15, U-24 through U-26, U-31 or U-35), said R^3 is selected from R^{3b}; and k is 0, 1 or 2.

Embodiment 7a. A compound of Embodiment 7 wherein R^1 is selected from U-1 through U-79.

Embodiment 8. A compound of Embodiment 7 wherein R^1 is H; or C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_2-C_6 alkylcarbonyl or C_2-C_6 alkoxycarbonyl, each optionally substituted with up to 2 substituents independently selected from R^2; or U-1 through U-53, U-55, U-58, U-62, U-66 or U-74 through U-79.

Embodiment 8a. A compound of Embodiment 8 wherein R^1 is U-1 through U-53, U-55, U-58, U-62, U-66 or U-74 through U-79.

Embodiment 9. A compound of Embodiment 8 wherein R^1 is H; or C_1-C_4 alkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_2-C_4 alkylcarbonyl or C_2-C_4 alkoxycarbonyl, each optionally substituted with up to 2 substituents independently selected from R^2;

or U-1, U-2, U-3, U-5, U-20, U-21, U-28, U-36, U-37, U-38, U-39, U-41, U-43, U-50, U-53, U-55, U-58, U-62 or U-74 through U-78.

Embodiment 9a. A compound of Embodiment 9 wherein R^1 is U-1, U-2, U-3, U-5, U-20, U-21, U-28, U-36, U-37, U-38, U-39, U-41, U-43, U-50, U-53, U-55, U-58, U-62 or U-74 through U-78.

Embodiment 10. A compound of Embodiment 9 wherein R^1 is H; or C_1-C_4 alkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_2-C_4 alkylcarbonyl or C_2-C_4 alkoxycarbonyl, each optionally substituted with up to 1 substituent selected from R^2; or U-36, U-37, U-38, U-39, U-41, U-50, U-53, U-55 or U-58.

Embodiment 10a. A compound of Embodiment 10 wherein R^1 is U-36, U-37, U-38, U-39, U-41, U-50, U-53, U-55 or U-58.

Embodiment 11. A compound of Embodiment 10 wherein R^1 is H; or C_1-C_4 alkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_2-C_4 alkylcarbonyl or C_2-C_4 alkoxycarbonyl, each optionally substituted with up to 1 substituent selected from R^2; or U-36, U-37, U-39, U-50, U-53 or U-55.

Embodiment 11a. A compound of Embodiment 11 wherein R^1 is U-36, U-37, U-39, U-50, U-53 or U-55.

Embodiment 12. A compound of Embodiment 11 wherein R^1 is H; or C_1-C_4 alkyl, C_2-C_4 alkenyl or C_2-C_4 alkynyl, each optionally substituted with up to 1 substituent selected from R^2; or U-36, U-39, U-50, U-53 or U-55.

Embodiment 13. A compound of Embodiment 12 wherein R^1 is H, C_1-C_4 alkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, U-36, U-39, U-50, U-53 or U-55.

Embodiment 14. A compound of Embodiment 11 wherein R^1 is H, C_1-C_4 alkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_2-C_4 alkylcarbonyl, C_2-C_4 alkoxycarbonyl or U-50.

Embodiment 14a. A compound of Embodiment 14 wherein R^1 is H, C_1-C_4 alkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl or U-50.

Embodiment 15. A compound of Embodiments 14 or 14a wherein R^1 is U-50.

Embodiment 16. A compound of Formula **1** wherein when R^1 is separate (i.e. not taken together with R^{4a} or R^{4b} to form a ring), then R^1 is H; or C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_2-C_6 alkylcarbonyl or C_2-C_6 alkoxycarbonyl, each optionally substituted with up to 1 substituent selected from R^2; or U-38, U-50 or U-53.

Embodiment 17. A compound of Embodiment 16 wherein R^1 is H; or C_1-C_4 alkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_2-C_4 alkylcarbonyl or C_2-C_4 alkoxycarbonyl, each optionally substituted with up to 1 substituent selected from R^2; or U-38, U-50 or U-53.

Embodiment 18. A compound of Embodiment 17 wherein R^1 is H; or C_1-C_4 alkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_2-C_4 alkylcarbonyl or C_2-C_4 alkoxycarbonyl, each optionally substituted with up to 1 substituent selected from R^2; or U-50.

Embodiment 19. A compound of Embodiment 18 wherein R^1 is H; or C_1-C_4 alkyl, C_2-C_4 alkenyl or C_2-C_4 alkynyl, each optionally substituted with up to 1 substituent selected from R^2; or U-50.

Embodiment 20. A compound of Embodiment 19 wherein R^1 is H; or C_1-C_4 alkyl, C_2-C_4 alkenyl or C_2-C_4 alkynyl, each optionally substituted with up to 1 substituent selected from R^2.

Embodiment 21. A compound of Embodiment 20 wherein R^1 is H, C_1-C_4 alkyl, C_2-C_4 alkenyl or C_2-C_4 alkynyl.

Embodiment 22. A compound of Embodiment 21 wherein R^1 is H, C_1-C_2 alkyl, C_2-C_4 alkenyl or C_2-C_4 alkynyl.

Embodiment 23. A compound of Embodiment 22 wherein R^1 is H, C_1-C_2 alkyl or C_2-C_4 alkynyl.

Embodiment 24. A compound of Embodiment 23 wherein R^1 is H or C_1-C_2 alkyl.

Embodiment 25. A compound of Embodiment 24 wherein R^1 is H.

Embodiment 26. A compound of Formula **1** or any one of Embodiments 1 through 25 wherein Z^1 is -CH=NNR^{4b}-.

Embodiment 27. A compound of Formula **1** or any one of Embodiments 1 through 25 wherein Z^1 is O, -$(CH_2)_n$NR^{4a}- or -$(CH_2)_n$NR^{4a}NR^{4b}-.

Embodiment 27a. A compound of Formula **1** or any one of Embodiments 1 through 25 wherein Z^1 is O, -NR^{4a}- or -NR^{4a}NR^{4b}-.

Embodiment 28. A compound of Embodiment 27a wherein Z^1 is O or -NR^{4a}-.

Embodiment 29. A compound of Formula **1** or any one of Embodiments 1 through 25 wherein Z^1 is -$(CH_2)_n$NR^{4a}- or -$(CH_2)_n$NR^{4a}NR^{4b}-.

Embodiment 30. A compound of Embodiment 29 wherein Z^1 is -$(CH_2)_n$NR^{4a}-.

Embodiment 31. A compound of Embodiment 29 wherein Z^1 is -$(CH_2)_n$NR^{4a}NR^{4b}-.

Embodiment 32. A compound of Embodiment 29 wherein Z^1 is -NR^{4a}-.

Embodiment 33. A compound of Embodiment 29 wherein Z^1 is -NR^{4a}NR^{4b}-.

Embodiment 34. A compound of Formula **1** or any one of Embodiments 1 through 31 wherein n is 0.

Embodiment 35. A compound of Formula **1** or any one of Embodiments 1 through 34 wherein W is O.

Embodiment 36. A compound of Formula **1** or any one of Embodiments 1 through 34 wherein W is S.

Embodiment 37. A compound of Formula **1** or any one of Embodiments 1 through 36 wherein Z^2 is -O$(CH_2)_m$-, -OCH_2CH_2O- or -NR^{5}N=CH-, each carbon atom optionally substituted with up to 1 substituent selected from R^6.

Embodiment 38. A compound of Embodiment 37 wherein Z^2 is -O$(CH_2)_m$-.

Embodiment 39. A compound of Embodiment 37 wherein Z^2 is -OCH_2CH_2O-.

Embodiment 40. A compound of Embodiment 37 wherein Z^2 is -NR^{5}N=CH-.

Embodiment 41. A compound of Formula **1** or any one of Embodiments 1 through 36 wherein Z^2 is $-O(CH_2)_m-$ or $-OCH_2CH_2O-$, each carbon atom optionally substituted with up to 2 substituents independently selected from R^6.

Embodiment 42. A compound of Embodiment 41 wherein Z^2 is $-O(CH_2)_m-$, each carbon atom optionally substituted with up to 2 substituents independently selected from R^6.

Embodiment 43. A compound of Embodiment 42 wherein Z^2 is $-O(CH_2)_m-$, each carbon atom optionally substituted with up to 1 substituent selected from R^6.

Embodiment 44. A compound of Formula **1** or any one of Embodiments 1 through 36 wherein Z^2 is $-O(CH_2)_m-$ or $-NR^5N=CH-$, each carbon atom optionally substituted with up to 2 substituents independently selected from R^6.

Embodiment 44a. A compound of Embodiment 44 wherein Z^2 is $-O(CH_2)_m-$ or $-NR^5N=CH-$, each carbon atom optionally substituted with up to 1 substituent selected from R^6.

Embodiment 45. A compound of Embodiments 44 or 44a wherein Z^2 is $-O(CH_2)_m-$ or $-NR^5N=CH-$.

Embodiment 46. A compound of Formula **1** or any one of Embodiments 1 through 45 wherein m is 1 or 2.

Embodiment 47. A compound of Formula **1** or any one of Embodiments 1 through 45 wherein m is 3.

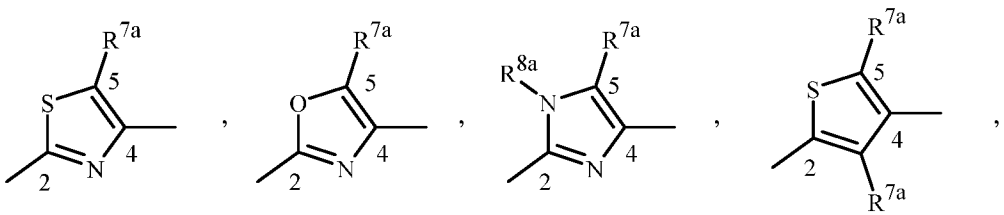
Embodiment 48. A compound of Embodiment 46 wherein m is 1.

Embodiment 49. A compound of Embodiment 46 wherein m is 2.

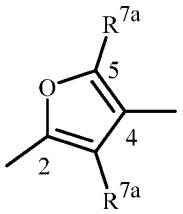
Embodiment 50. A compound of Formula **1** or any one of Embodiments 1 through 49 wherein J is phenyl optionally substituted with up to 2 substituents independently selected from R^7; or a 5- to 6-membered heteroaromatic ring, each ring containing ring members selected from carbon atoms and 1 to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, each ring optionally substituted with up to 2 substituents independently selected from R^7 on carbon atom ring members and R^8 on nitrogen atom ring members.

Embodiment 51. A compound of Formula **1** or Embodiment 50 wherein J is selected from J-1 through J-71 as shown in Exhibit B

Exhibit B



J-1 J-2 J-3 J-4



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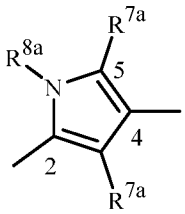

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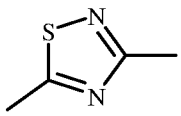

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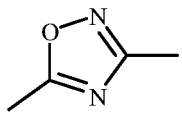

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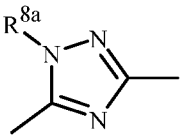

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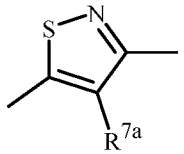

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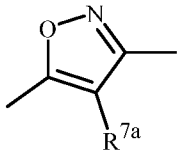

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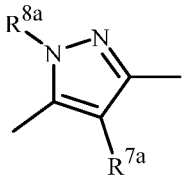

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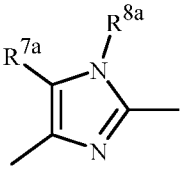

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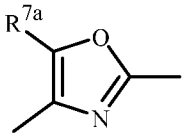

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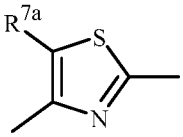

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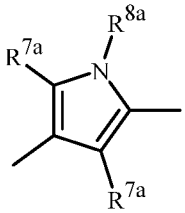

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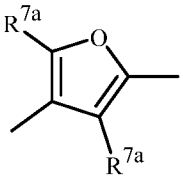

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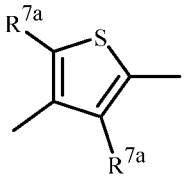

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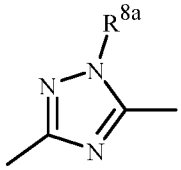

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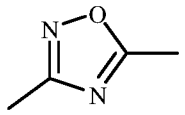

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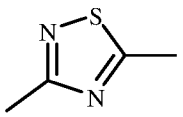

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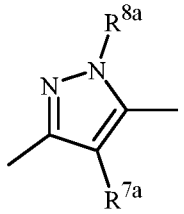

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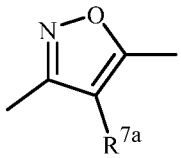

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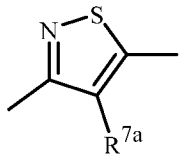

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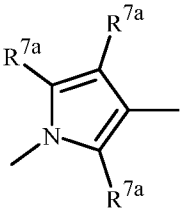

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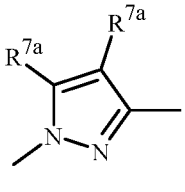

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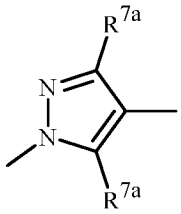

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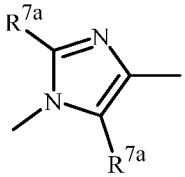

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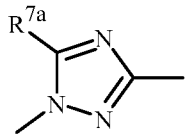

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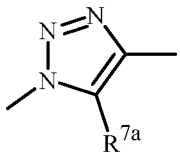

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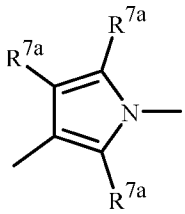

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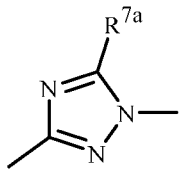

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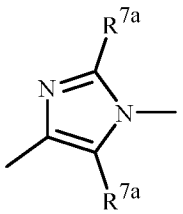

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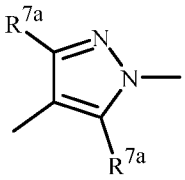

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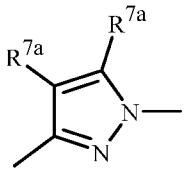

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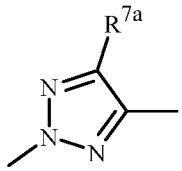

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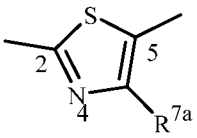

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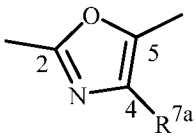

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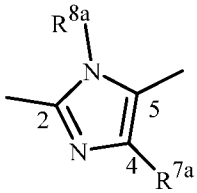

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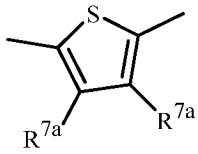

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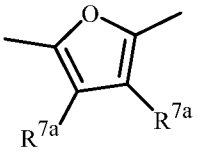

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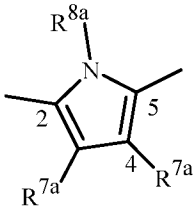

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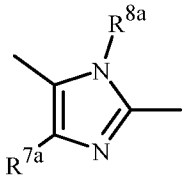

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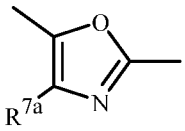

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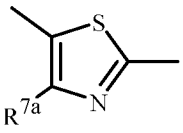

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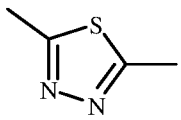

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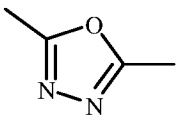

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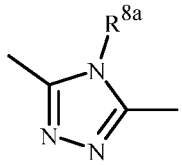

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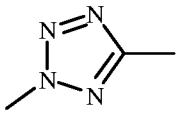

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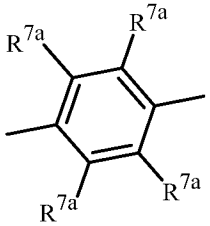

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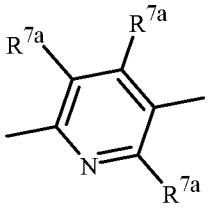

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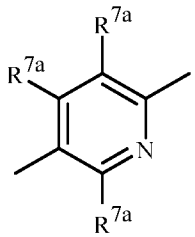

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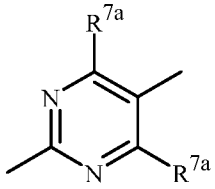
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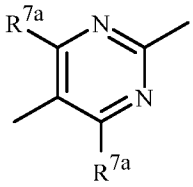
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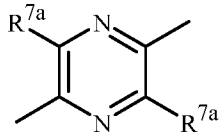
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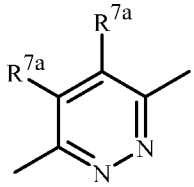
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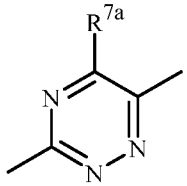
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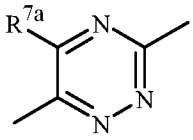
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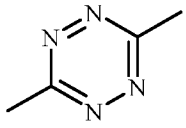
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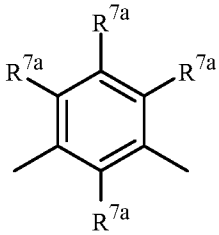
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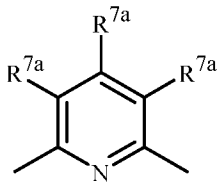
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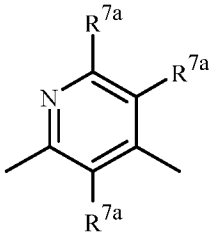
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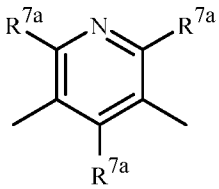
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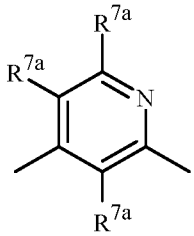
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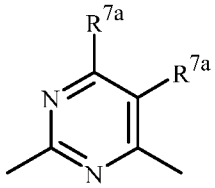
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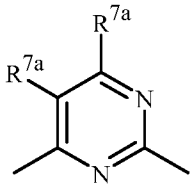
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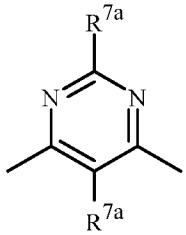
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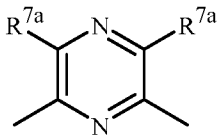
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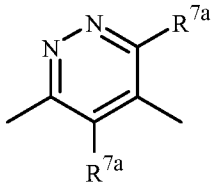
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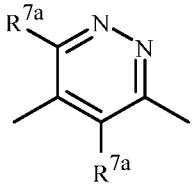
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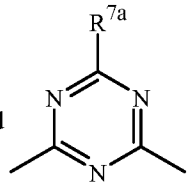

J-71 ;

wherein the bond projecting to the left is bonded to Z^2, and the bond projecting to the right is bonded to the oxadiazole ring in Formula **1**; each R^{7a} is independently H or R^7; and R^{8b} is H; provided that at most only two of R^{7a} are other than H.

Embodiment 51a. A compound of Embodiment 51 wherein each R^{7a} is H.

Embodiment 52. A compound of Embodiments 51 or 51a wherein J is J-1 through J-5, J-15, J-17, J-18, J-37 through J-41, J-45, J-50 through J-56 or J-60 through J-67.

Embodiment 53. A compound of Embodiment 52 wherein J is J-1, J-4, J-15, J-18, J-37, J-40, J-45, J-50, J-51, J-52, J-60, J-61, J-62, J-63 or J-64.

Embodiment 54. A compound of Embodiment 53 wherein J is J-4, J-18, J-40, J-50, J-51, J-52 or J-60.

Embodiment 55. A compound of Embodiment 54 wherein J is J-40, J-50, J-51 or J-52.

Embodiment 55a. A compound of Embodiment 55 wherein J is J-50, J-51 or J-52.

Embodiment 56. A compound of Embodiment 55 wherein J is J-40 or J-50.

Embodiment 57. A compound of Embodiment 56 wherein J is J-40.

Embodiment 58. A compound of Embodiment 56 wherein J is J-50.

Embodiment 59. A compound of Embodiment 55 wherein J is J-51.

Embodiment 60. A compound of Embodiment 55 wherein J is J-52.

Embodiment 61. A compound of Formula **1** or any one of Embodiments 1 through 60 wherein each R^2 is independently halogen, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_3-C_6 cycloalkyl, C_3-C_6 halocycloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkylcarbonyl, C_2-C_4 haloalkylcarbonyl or C_2-C_5 alkoxycarbonyl; or phenyl, pyridinyl, pyrazolyl, imidazolyl, triazolyl, oxazolyl, isoxazolyl, thienyl, furanyl, pyrrolidinyl, isoxazolinyl, tetrahydrofuranyl, piperidinyl, morpholinyl or piperazinyl, each optionally substituted with up to 3 substituents independently selected from R^{3c} on carbon atom ring members and R^{3d} on nitrogen atom ring members.

Embodiment 62. A compound of Embodiment 61 wherein each R^2 is independently halogen, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_3-C_6 cycloalkyl, C_3-C_6 halocycloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkylcarbonyl, C_2-C_4 haloalkylcarbonyl or C_2-C_5 alkoxycarbonyl; or phenyl, pyridinyl, pyrazolyl, imidazolyl, triazolyl, pyrrolidinyl, isoxazolinyl, tetrahydrofuranyl, piperidinyl, morpholinyl or piperazinyl, each optionally substituted with up to 2 substituents independently selected from R^{3c} on carbon atom ring members and R^{3d} on nitrogen atom ring members.

Embodiment 62a. A compound of Embodiment 62 wherein each R^2 is independently halogen, cyano, C_1-C_3 alkyl, C_1-C_3 haloalkyl, C_3-C_6 cycloalkyl, C_3-C_6 halocycloalkyl, C_1-C_3 alkoxy or C_1-C_3 haloalkoxy; or phenyl, pyridinyl, pyrazolyl, imidazolyl, triazolyl, pyrrolidinyl, isoxazolinyl, tetrahydrofuranyl, piperidinyl, morpholinyl or piperazinyl, each optionally substituted with up to 2 substituents independently selected from R^{3c} on carbon atom ring members and R^{3d} on nitrogen atom ring members.

Embodiment 63. A compound of Embodiment 62 wherein each R^2 is independently halogen, cyano, C_1-C_3 alkyl, C_1-C_3 haloalkyl, C_3-C_6 cycloalkyl, C_3-C_6 halocycloalkyl, C_1-C_3 alkoxy or C_1-C_3 haloalkoxy; or phenyl, pyridinyl, imidazolyl, triazolyl, pyrrolidinyl, piperidinyl, morpholinyl or piperazinyl, each optionally substituted with up to 2 substituents independently selected from R^{3c} on carbon atom ring members and R^{3d} on nitrogen atom ring members.

Embodiment 64. A compound of Embodiment 63 wherein each R^2 is independently halogen, cyano, C_1-C_3 alkyl, C_1-C_3 haloalkyl, C_3-C_6 halocycloalkyl or C_1-C_3 alkoxy; or phenyl, pyridinyl, imidazolyl, triazolyl, pyrrolidinyl, piperidinyl, morpholinyl or piperazinyl, each optionally substituted with up to 1 substituent selected from R^{3c} on carbon atom ring members and R^{3d} on nitrogen atom ring members.

Embodiment 65. A compound of Formula **1** or any one of Embodiments 1 through 61 wherein each R^2 is independently halogen, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_3-C_6 cycloalkyl, C_3-C_6 halocycloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkylcarbonyl, C_2-C_4 haloalkylcarbonyl or C_2-C_5 alkoxycarbonyl.

Embodiment 66. A compound of Embodiment 65 wherein each R^2 is independently halogen, cyano, C_1-C_3 alkyl, C_1-C_3 haloalkyl, C_3-C_6 cycloalkyl, C_3-C_6 halocycloalkyl, C_1-C_3 alkoxy or C_1-C_3 haloalkoxy.

Embodiment 67. A compound of Embodiment 66 wherein each R^2 is independently halogen, C_1-C_3 alkyl, C_1-C_3 haloalkyl, C_1-C_3 alkoxy or C_1-C_3 haloalkoxy.

Embodiment 68. A compound of Embodiment 67 wherein each R^2 is independently C_1-C_3 alkyl.

Embodiment 69. A compound of Embodiment 66 wherein each R^2 is independently halogen, cyano, C_1-C_3 alkyl or C_1-C_3 alkoxy.

Embodiment 70. A compound of Formula **1** or any one of Embodiments 1 through 61 wherein each R^2 is independently phenyl, pyridinyl, pyrazolyl, imidazolyl, triazolyl, oxazolyl, isoxazolyl, thienyl, furanyl, pyrrolidinyl, isoxazolinyl, tetrahydrofuranyl, piperidinyl, morpholinyl or piperazinyl, each optionally substituted with up to 3 substituents independently selected from R^{3c} on carbon atom ring members and R^{3d} on nitrogen atom ring members.

Embodiment 71. A compound of Embodiment 70 wherein each R^2 is independently phenyl, pyridinyl, imidazolyl, triazolyl, pyrrolidinyl, piperidinyl, morpholinyl or piperazinyl, each optionally substituted with up to 2 substituents independently selected from R^{3c} on carbon atom ring members and R^{3d} on nitrogen atom ring members.

Embodiment 72. A compound of Embodiment 71 wherein each R^2 is phenyl optionally substituted with up to 2 substituents independently selected from R^{3c}.

Embodiment 73. A compound of Formula **1** or any one of Embodiments 1 through 72 wherein each R^{3a} and R^{3c} when taken alone (i.e. not taken together with R^{4a} or R^{4b}) is independently halogen, cyano, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_3-C_6 cycloalkyl, C_4-C_7 cycloalkylalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkenyloxy, C_2-C_4 alkynyloxy, C_1-C_4 alkylthio, C_1-C_4 haloalkylthio, C_1-C_4 alkylsulfinyl, C_1-C_4 haloalkylsulfinyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_1-C_4 alkylsulfonyloxy, C_1-C_4 alkylamino, C_2-C_8

dialkylamino, C_3-C_6 cycloalkylamino, C_2-C_4 alkylcarbonyl, C_2-C_6 alkoxycarbonyl, C_2-C_6 alkylaminocarbonyl or C_3-C_8 dialkylaminocarbonyl.

Embodiment 74. A compound of Embodiment 73 wherein each R^{3a} and R^{3c} is independently halogen, cyano, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_3-C_6 cycloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkenyloxy, C_2-C_4 alkynyloxy, C_1-C_4 alkylthio, C_1-C_4 haloalkylthio, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_1-C_4 alkylsulfonyloxy, C_1-C_4 alkylamino, C_2-C_8 dialkylamino, C_3-C_6 cycloalkylamino, C_2-C_4 alkylcarbonyl, C_2-C_5 alkoxycarbonyl, C_2-C_5 alkylaminocarbonyl or C_3-C_7 dialkylaminocarbonyl.

Embodiment 75. A compound of Embodiment 74 wherein each R^{3a} and R^{3c} is independently halogen, cyano, nitro, C_1-C_3 alkyl, C_1-C_3 haloalkyl, C_2-C_3 alkenyl, C_2-C_3 alkynyl, C_3-C_6 cycloalkyl, C_1-C_3 alkoxy, C_1-C_3 haloalkoxy, C_2-C_3 alkenyloxy, C_2-C_3 alkynyloxy, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_1-C_4 alkylsulfonyloxy, C_2-C_4 alkylcarbonyl, C_2-C_5 alkoxycarbonyl, C_2-C_5 alkylaminocarbonyl or C_3-C_7 dialkylaminocarbonyl.

Embodiment 76. A compound of Embodiment 75 wherein each R^{3a} and R^{3c} is independently halogen, C_1-C_3 alkyl, C_1-C_3 haloalkyl, C_1-C_3 alkoxy or C_1-C_3 haloalkoxy.

Embodiment 77. A compound of Embodiment 76 wherein each R^{3a} and R^{3c} is independently halogen, methyl, ethyl, methoxy or C_1-C_2 haloalkoxy.

Embodiment 77a. A compound of Embodiment 77 wherein each R^{3a} and R^{3c} is independently halogen, methyl or methoxy.

Embodiment 78. A compound of Embodiment 75 wherein each R^{3a} and R^{3c} is independently halogen, cyano, C_1-C_2 alkyl, C_1-C_2 haloalkyl, C_2-C_3 alkenyl, C_2-C_3 alkynyl, C_1-C_2 alkoxy, C_2-C_3 alkenyloxy, C_2-C_3 alkynyloxy, C_2-C_4 alkylcarbonyl, C_2-C_5 alkoxycarbonyl, C_2-C_5 alkylaminocarbonyl or C_3-C_7 dialkylaminocarbonyl.

Embodiment 79. A compound of Embodiment 78 wherein each R^{3a} and R^{3c} is independently halogen, C_1-C_2 alkyl, C_1-C_2 haloalkyl, C_2-C_3 alkenyl, C_2-C_3 alkynyl, C_1-C_2 alkoxy, C_2-C_3 alkenyloxy, C_2-C_3 alkynyloxy, C_2-C_4 alkylcarbonyl or C_2-C_5 alkoxycarbonyl.

Embodiment 80. A compound of Embodiment 79 wherein each R^{3a} and R^{3c} is independently halogen, C_1-C_2 alkyl, C_2-C_3 alkenyl, C_2-C_3 alkynyl, C_2-C_3 alkenyloxy, C_2-C_3 alkynyloxy, C_2-C_4 alkylcarbonyl or C_2-C_5 alkoxycarbonyl.

Embodiment 81. A compound of Embodiment 79 wherein each R^{3a} and R^{3c} is independently halogen, C_1-C_2 alkyl, C_2-C_4 alkylcarbonyl or C_2-C_5 alkoxycarbonyl.

Embodiment 81a. A compound of Embodiment 81 wherein each R^{3a} and R^{3c} is independently C_2-C_4 alkylcarbonyl or C_2-C_4 alkoxycarbonyl.

Embodiment 81b. A compound of Embodiment 81 wherein each R^{3a} and R^{3c} is independently Br, Cl, F, methyl, C_2-C_4 alkylcarbonyl or C_2-C_4 alkoxycarbonyl.

Embodiment 82. A compound of Formula **1** or any one of Embodiments 1 through 81b wherein each R^{3b} and R^{3d} when taken alone (i.e. not taken together with R^{4a} or R^{4b}) is independently C_1-C_2 alkyl, C_1-C_2 alkoxy, C_2-C_3 alkylcarbonyl or C_2-C_3 alkoxycarbonyl.

Embodiment 83. A compound of Embodiment 82 wherein each R^{3b} and R^{3d} is independently methyl, methylcarbonyl or methoxycarbonyl.

Embodiment 84. A compound of Embodiment 83 wherein each R^{3b} and R^{3d} is methyl.

Embodiment 85. A compound of Formula **1** or any one of Embodiments 1 through 84 wherein R^{4a} and R^{4b} when taken alone (i.e. not taken together with R^1, R^{3a} or R^{3b}) are each independently H, hydroxy, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_2-C_4 alkylcarbonyl, C_2-C_4 haloalkylcarbonyl, C_2-C_5 alkoxycarbonyl, C_2-C_5 alkylaminocarbonyl or C_3-C_5 dialkylaminocarbonyl.

Embodiment 86. A compound of Embodiment 85 wherein R^{4a} and R^{4b} are each independently H, C_1-C_3 alkyl, C_1-C_3 haloalkyl, C_2-C_3 alkenyl, C_2-C_3 alkynyl, C_2-C_3 alkoxyalkyl, C_1-C_3 alkylsulfonyl, C_1-C_3 haloalkylsulfonyl, C_2-C_3 alkylcarbonyl, C_2-C_3 haloalkylcarbonyl, C_2-C_3 alkoxycarbonyl, C_2-C_3 alkylaminocarbonyl or C_3-C_5 dialkylaminocarbonyl.

Embodiment 87. A compound of Embodiment 86 wherein R^{4a} and R^{4b} are each independently H, methyl, C_1-C_2 haloalkyl, methoxymethyl, methylsulfonyl, methylcarbonyl or methoxycarbonyl.

Embodiment 88. A compound of Embodiment 86 wherein R^{4a} and R^{4b} are each independently H, methyl or ethyl.

Embodiment 89. A compound of Embodiment 88 wherein R^{4a} and R^{4b} are each independently H or methyl.

Embodiment 89a. A compound of Embodiment 89 wherein R^{4a} and R^{4b} are each H.

Embodiment 90. A compound of Formula **1** or any one of Embodiments 1 through 89a wherein when one pair of R^1 and R^{4a} substituents or one pair of R^1 and R^{4b} substituents are taken together with the atoms to which they are attached to form a ring, said ring is a 5- to 7-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, each ring optionally substituted with up to 3 substituents independently selected from R^9.

Embodiment 91. A compound of Embodiment 90 wherein one pair of R^1 and R^{4a} substituents or one pair of R^1 and R^{4b} substituents are taken together with the atoms to which they are attached to form a 5- to 6-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, each ring optionally substituted with up to 3 substituents independently selected from R^9.

Embodiment 92. A compound of Embodiment 91 wherein one pair of R^1 and R^{4a} substituents or one pair of R^1 and R^{4b} substituents are taken together with the atoms to which they are attached to form a 5- to 6-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, each ring optionally substituted with up to 2 substituents independently selected from R^9.

Embodiment 92a. A compound of Embodiment 92 wherein one pair of R^1 and R^{4a} substituents or one pair of R^1 and R^{4b} substituents are taken together with the atoms to which they are attached to form a pyrazolyl, imidazolyl, pyrrolidinyl, isoxazolinyl, piperidinyl, morpholinyl or piperazinyl ring, each rine optionally substituted with up to 2 substituents independently selected from R^9.

Embodiment 92b. A compound of Embodiment 92a wherein one pair of R^1 and R^{4a} substituents are taken together with the atoms to which they are attached to form a pyrazolyl, imidazolyl, pyrrolidinyl, isoxazolinyl, piperidinyl, morpholinyl or piperazinyl ring, each ring optionally substituted with up to 2 substituents independently selected from R^9.

Embodiment 92c. A compound of Embodiment 92b wherein one pair of R^1 and R^{4a} substituents are taken together with the atoms to which they are attached to form a pyrazolyl or imidazolyl ring, each ring optionally substituted with up to 2 substituents independently selected from R^9.

Embodiment 92d. A compound of Embodiment 92c wherein one pair of R^1 and R^{4a} substituents are taken together with the atoms to which they are attached to form an imidazolyl ring, the ring optionally substituted with up to 2 substituents independently selected from R^9.

Embodiment 93. A compound of Formula **1** or any one of Embodiments 1 through 92d wherein when one pair of R^{3a} and R^{4a} substituents or one pair of R^{3a} and R^{4b} substituents are taken together with the atoms to which they are attached to form a ring, said ring is a 5- to 7-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, each ring optionally substituted with up to 3 substituents independently selected from R^{10}.

Embodiment 94. A compound of Embodiment 93 wherein one pair of R^{3a} and R^{4a} substituents or one pair of R^{3a} and R^{4b} substituents are taken together with the

atoms to which they are attached to form a 5- to 6-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, each ring optionally substituted with up to 3 substituents independently selected from R^{10}.

Embodiment 95. A compound of Embodiment 94 wherein one pair of R^{3a} and R^{4a} substituents or one pair of R^{3a} and R^{4b} substituents are taken together with the atoms to which they are attached to form a 5- to 6-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, each ring optionally substituted with up to 2 substituents independently selected from R^{10}.

Embodiment 96. A compound of Formula **1** or any one of Embodiments 1 through 95 wherein when one pair of R^{3b} and R^{4a} substituents or one pair of R^{3b} and R^{4b} substituents are taken together with the nitrogen atoms to which they are attached to form a ring, said ring is a 5- to 7-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, each ring optionally substituted with up to 3 substituents independently selected from R^{11}.

Embodiment 97. A compound of Embodiment 96 wherein one pair of R^{3b} and R^{4a} substituents or one pair of R^{3b} and R^{4b} substituents are taken together with the nitrogen atoms to which they are attached to form a 5- to 6-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, each ring optionally substituted with up to 3 substituents independently selected from R^{11}.

Embodiment 98. A compound of Embodiment 97 wherein one pair of R^{3b} and R^{4a} substituents or one pair of R^{3b} and R^{4b} substituents are taken together with the nitrogen atoms to which they are attached to form a 5- to 6-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, each ring optionally substituted with up to 2 substituents independently selected from R^{11}.

Embodiment 99. A compound of Formula **1** or any one of Embodiments 1 through 98 wherein R^5 is H, hydroxy, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_2-C_4 alkylcarbonyl, C_2-C_4 haloalkylcarbonyl, C_2-C_5 alkoxycarbonyl, C_3-C_5 alkoxycarbonylalkyl, C_2-C_5 alkylaminocarbonyl or C_3-C_5 dialkylaminocarbonyl.

Embodiment 100. A compound of Embodiment 99 wherein R^5 is H, hydroxy, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_1-C_4 alkoxy,

C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_2-C_4 alkylcarbonyl, C_2-C_4 haloalkylcarbonyl, C_2-C_5 alkoxycarbonyl, C_2-C_5 alkylaminocarbonyl or C_3-C_5 dialkylaminocarbonyl.

Embodiment 101. A compound of Embodiment 100 wherein R^5 is H, C_1-C_3 alkyl, C_1-C_3 haloalkyl, C_2-C_3 alkenyl, C_2-C_3 alkynyl, C_2-C_3 alkoxyalkyl, C_1-C_3 alkylsulfonyl, C_1-C_3 haloalkylsulfonyl, C_2-C_3 alkylcarbonyl, C_2-C_3 haloalkylcarbonyl, C_2-C_3 alkoxycarbonyl, C_2-C_5 alkylaminocarbonyl or C_3-C_5 dialkylaminocarbonyl.

Embodiment 102. A compound of Embodiment 101 wherein R^5 is H, methyl, methoxymethyl, methylcarbonyl or methoxycarbonyl.

Embodiment 103. A compound of Embodiment 102 wherein R^5 is H or methyl.

Embodiment 104. A compound of Embodiment 103 wherein R^5 is H.

Embodiment 105. A compound of Formula **1** or any one of Embodiments 1 through 104 wherein each R^6 is independently halogen, cyano, nitro, C_1-C_2 alkyl, C_1-C_2 haloalkyl, C_1-C_2 alkoxy or C_1-C_2 haloalkoxy.

Embodiment 106. A compound of Embodiment 105 wherein each R^6 is independently halogen, cyano, nitro, methyl, trifluoromethyl or methoxy.

Embodiment 107. A compound of Embodiment 106 wherein each R^6 is methyl or methoxy.

Embodiment 108. A compound of Formula **1** or any one of Embodiments 1 through 104 wherein each R^6 is independently halogen, C_1-C_2 alkyl, C_1-C_2 haloalkyl, C_1-C_2 alkoxy or C_2-C_4 alkoxyalkyl; or phenyl optionally substituted with up to 2 substituents independently selected from R^{13}.

Embodiment 109. A compound of Embodiment 108 wherein each R^6 is independently methyl, methoxy or C_2-C_4 alkoxyalkyl; or phenyl optionally substituted with up to 2 substituents independently selected from R^{13}.

Embodiment 110. A compound of Embodiment 109 wherein each R^6 is independently methyl or CH_3OCH_2; or phenyl optionally substituted with up to 1 substituent selected from R^{13}.

Embodiment 111. A compound of Embodiment 110 wherein each R^6 is independently methyl; or phenyl optionally substituted with up to 2 substituents independently selected from R^{13}.

Embodiment 112. A compound of Embodiment 111 wherein each R^6 is independently methyl; or phenyl optionally substituted with up to 1 substituent selected from R^{13}.

Embodiment 113. A compound of Embodiment 112 wherein each R^6 is independently methyl or phenyl.

Embodiment 114. A compound of Embodiment 113 wherein each R^6 is methyl.

Embodiment 115. A compound of Formula **1** or any one of Embodiments 1 through 114 wherein each R^7 is independently halogen, hydroxy, cyano, amino, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_1-C_4 hydroxyalkyl, C_3-C_6 cycloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkenyloxy, C_2-C_4 alkynyloxy, C_2-C_4 alkoxyalkyl, C_1-C_4 alkylthio, C_1-C_4 haloalkylthio, C_1-C_4 alkylsulfinyl, C_1-C_4 haloalkylsulfinyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_1-C_4 alkylsulfonyloxy, C_1-C_4 alkylamino, C_2-C_6 dialkylamino, C_3-C_6 cycloalkylamino, C_2-C_4 alkylcarbonyl, C_2-C_6 alkoxycarbonyl, C_2-C_6 alkylaminocarbonyl or C_3-C_6 dialkylaminocarbonyl.

Embodiment 116. A compound of Embodiment 115 wherein each R^7 is independently halogen, cyano, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_3-C_6 cycloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkenyloxy, C_2-C_4 alkynyloxy, C_1-C_4 alkylthio, C_1-C_4 haloalkylthio, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_1-C_4 alkylsulfonyloxy, C_1-C_4 alkylamino, C_2-C_6 dialkylamino, C_3-C_6 cycloalkylamino, C_2-C_4 alkylcarbonyl, C_2-C_6 alkoxycarbonyl, C_2-C_6 alkylaminocarbonyl or C_3-C_6 dialkylaminocarbonyl.

Embodiment 117. A compound of Embodiment 116 wherein each R^7 is independently halogen, cyano, nitro, C_1-C_3 alkyl, C_1-C_3 haloalkyl, C_2-C_3 alkenyl, C_2-C_3 alkynyl, C_3-C_6 cycloalkyl, C_1-C_3 alkoxy, C_1-C_3 haloalkoxy, C_2-C_3 alkenyloxy, C_2-C_3 alkynyloxy, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_1-C_4 alkylsulfonyloxy, C_2-C_4 alkylcarbonyl, C_2-C_6 alkoxycarbonyl, C_2-C_6 alkylaminocarbonyl or C_3-C_6 dialkylaminocarbonyl.

Embodiment 118. A compound of Embodiment 117 wherein each R^7 is independently halogen, C_1-C_3 alkyl, C_1-C_3 haloalkyl, C_2-C_3 alkenyl, C_1-C_3 alkoxy, C_1-C_3 haloalkoxy, C_2-C_4 alkylcarbonyl or C_2-C_6 alkoxycarbonyl.

Embodiment 119. A compound of Embodiment 118 wherein each R^7 is independently halogen, methyl, trifluoromethyl or methoxy.

Embodiment 120. A compound of Embodiment 119 wherein each R^7 is independently halogen or methyl.

Embodiment 121. A compound of Embodiment 120 wherein each R^7 is independently Cl, F or methyl.

Embodiment 122. A compound of Formula **1** or any one of Embodiments 1 through 121 wherein each R^8 is independently methyl or ethyl.

Embodiment 123. A compound of Embodiment 122 wherein R^8 is methyl.

Embodiment 124. A compound of Formula **1** or any one of Embodiments 1 through 123 wherein each R^9, R^{10} and R^{11} is independently halogen, hydroxy, cyano, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_2-C_4

alkylcarbonyl, C_2-C_4 haloalkylcarbonyl, C_2-C_5 alkoxycarbonyl, C_2-C_5 alkylaminocarbonyl or C_3-C_5 dialkylaminocarbonyl.

Embodiment 125. A compound of Embodiment 124 wherein each R^9, R^{10} and R^{11} is independently halogen, hydroxy, cyano, nitro, C_1-C_3 alkyl, C_1-C_3 haloalkyl, C_2-C_3 alkenyl, C_2-C_3 alkynyl, C_1-C_3 alkoxy, C_1-C_3 haloalkoxy, C_1-C_3 alkylsulfonyl, C_1-C_3 haloalkylsulfonyl, C_2-C_3 alkylcarbonyl, C_2-C_3 haloalkylcarbonyl, C_2-C_4 alkoxycarbonyl, C_2-C_4 alkylaminocarbonyl or C_3-C_5 dialkylaminocarbonyl.

Embodiment 126. A compound of Embodiment 125 wherein each R^9, R^{10} and R^{11} is independently halogen, hydroxy, cyano, nitro, C_1-C_3 alkyl, C_1-C_3 haloalkyl, C_1-C_3 alkoxy or C_1-C_3 haloalkoxy.

Embodiment 126a. A compound of Embodiment 126 wherein each R^9, R^{10} and R^{11} is independently halogen, hydroxy, C_1-C_2 alkyl, C_1-C_2 haloalkyl or C_1-C_2 alkoxy.

Embodiment 126b. A compound of Embodiment 126a wherein each R^9, R^{10} and R^{11} is independently F, Cl, methyl or methoxy.

Embodiment 127. A compound of Formula **1** or any one of Embodiments 1 through 126b wherein each R^{13} is independently halogen, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy or C_1-C_4 haloalkoxy.

Embodiment 128. A compound of Embodiment 127 wherein each R^{13} is independently halogen, C_1-C_2 alkyl, C_1-C_2 haloalkyl or C_1-C_2 alkoxy.

Embodiment 129. A compound of Embodiment 128 wherein each R^{13} is independently halogen or methyl.

Embodiment 130. A compound of Embodiment 129 wherein each R^{13} is independently Cl, F, methyl or methoxy.

Embodiments of this invention, including Embodiments 1-130 above as well as any other embodiments described herein, can be combined in any manner, and the descriptions of variables in the embodiments pertain not only to the compounds of Formula **1** but also to the starting compounds and intermediate compounds useful for preparing the compounds of Formula **1**. In addition, embodiments of this invention, including Embodiments 1-130 above as well as any other embodiments described herein, and any combination thereof, pertain to the compositions and methods of the present invention.

Combinations of Embodiments 1-130 are illustrated by:

Embodiment A. A compound of Formula **1** wherein

R^1 is H; or C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_2-C_6 alkylcarbonyl or C_2-C_6 alkoxycarbonyl, each optionally substituted with up to 2 substituents independently selected from R^2; or phenyl optionally substituted with up to 3 substituents independently selected from R^{3a}; or a 3- to 7-membered nonaromatic carbocyclic ring, wherein up to 2

carbon atom ring members are independently selected from C(=O) and C(=S), each ring optionally substituted with up to 3 substituents independently selected from R^{3a}; or a 5- to 6-membered heterocyclic ring, each ring containing ring members selected from carbon atoms and 1 to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, wherein up to 2 carbon atom ring members are independently selected from C(=O) and C(=S), each ring optionally substituted with up to 3 substituents independently selected from R^{3a} on carbon atom ring members and R^{3b} on nitrogen atom ring members;

Z^1 is O, $-NR^{4a}-$ or $-NR^{4a}NR^{4b}-$;

W is O;

Z^2 is $-O(CH_2)_m-$ or $-NR^5N=CH-$, each carbon atom optionally substituted with up to 2 substituents independently selected from R^6;

J is phenyl optionally substituted with up to 2 substituents independently selected from R^7; or a 5- to 6-membered heteroaromatic ring, each ring containing ring members selected from carbon atoms and 1 to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, each ring optionally substituted with up to 2 substituents independently selected from R^7 on carbon atom ring members and R^8 on nitrogen atom ring members;

each R^2 is independently halogen, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_3-C_6 cycloalkyl, C_3-C_6 halocycloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkylcarbonyl, C_2-C_4 haloalkylcarbonyl or C_2-C_5 alkoxycarbonyl; or phenyl, pyridinyl, pyrazolyl, imidazolyl, triazolyl, pyrrolidinyl, isoxazolinyl, tetrahydrofuranyl, piperidinyl, morpholinyl or piperazinyl, each optionally substituted with up to 2 substituents independently selected from R^{3c} on carbon atom ring members and R^{3d} on nitrogen atom ring members;

each R^{3a} and R^{3c} is independently halogen, cyano, C_1-C_2 alkyl, C_1-C_2 haloalkyl, C_2-C_3 alkenyl, C_2-C_3 alkynyl, C_1-C_2 alkoxy, C_2-C_3 alkenyloxy, C_2-C_3 alkynyloxy, C_2-C_4 alkylcarbonyl, C_2-C_5 alkoxycarbonyl, C_2-C_5 alkylaminocarbonyl or C_3-C_7 dialkylaminocarbonyl;

each R^{3b} and R^{3d} is independently C_1-C_2 alkyl, C_1-C_2 alkoxy, C_2-C_3 alkylcarbonyl or C_2-C_3 alkoxycarbonyl;

R^{4a} and R^{4b} are each independently H, methyl, C_1-C_2 haloalkyl, methoxymethyl, methylsulfonyl, methylcarbonyl or methoxycarbonyl; or

one pair of R^1 and R^{4a} substituents or one pair of R^1 and R^{4b} substituents are taken together with the atoms to which they are attached to form a 5- to 6-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, each ring optionally substituted with up to 2 substituents independently selected from R^9; or

one pair of R^{3a} and R^{4a} substituents or one pair of R^{3a} and R^{4b} substituents are taken together with the atoms to which they are attached to form a 5- to 6-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, each ring optionally substituted with up to 2 substituents independently selected from R^{10}; or

one pair of R^{3b} and R^{4a} substituents or one pair of R^{3b} and R^{4b} substituents are taken together with the nitrogen atoms to which they are attached to form a 5- to 6-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, each ring optionally substituted with up to 2 substituents independently selected from R^{11};

R^5 is H or methyl;

each R^6 is independently halogen, C_1-C_2 alkyl, C_1-C_2 haloalkyl, C_1-C_2 alkoxy or C_2-C_4 alkoxyalkyl; or phenyl optionally substituted with up to 2 substituents independently selected from R^{13};

each R^7 is independently halogen, methyl, trifluoromethyl or methoxy;

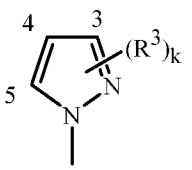
each R^8 is independently methyl or ethyl;

each R^9, R^{10} and R^{11} is independently halogen, hydroxy, cyano, nitro, C_1-C_3 alkyl, C_1-C_3 haloalkyl, C_1-C_3 alkoxy or C_1-C_3 haloalkoxy; and

each R^{13} is independently halogen, C_1-C_2 alkyl, C_1-C_2 haloalkyl or C_1-C_2 alkoxy.

Embodiment B. A compound of Embodiment A wherein

R^1 is H; or C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_2-C_6 alkylcarbonyl or C_2-C_6 alkoxycarbonyl, each optionally substituted with up to 2 substituents independently selected from R^2; or R^1 is selected from U-1 through U-79



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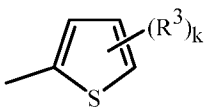

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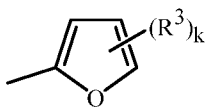

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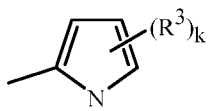

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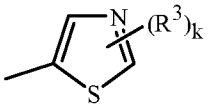
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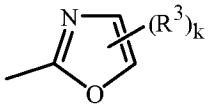
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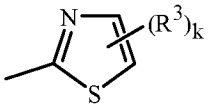
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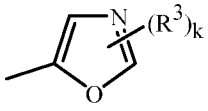
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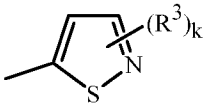
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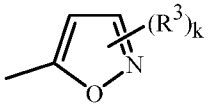
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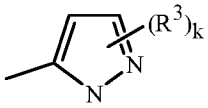
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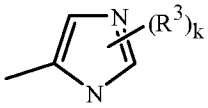
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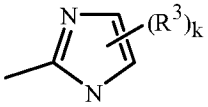
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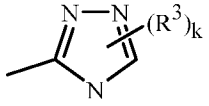
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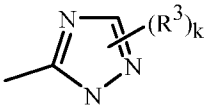
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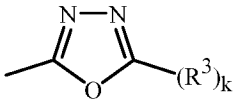
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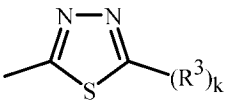
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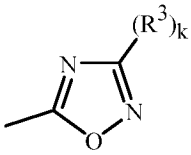
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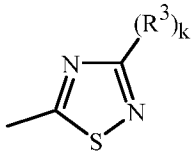
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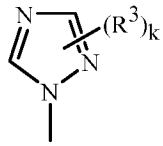
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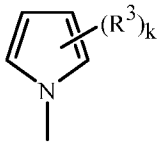
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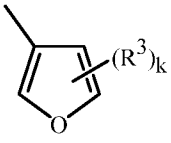
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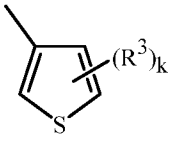
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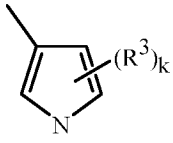
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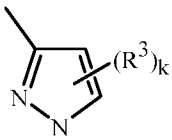
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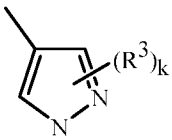
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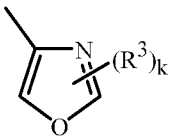
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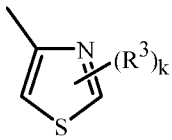
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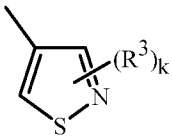
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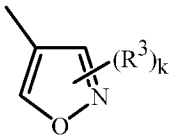
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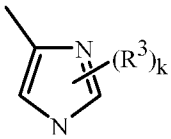
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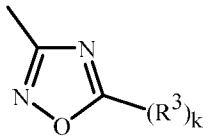
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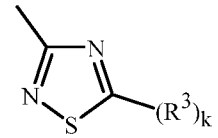
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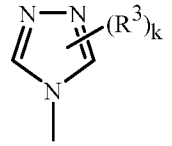
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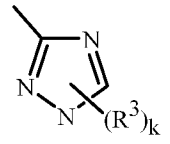
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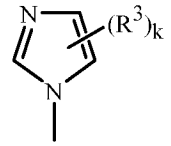
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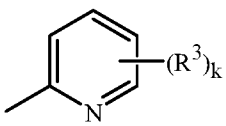
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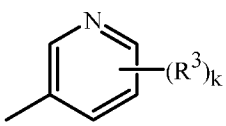
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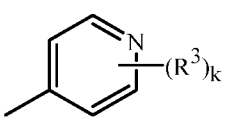
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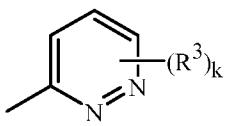
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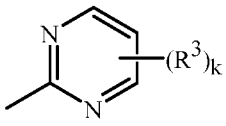
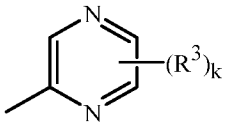
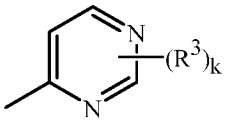
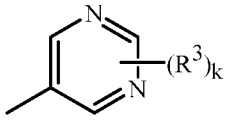
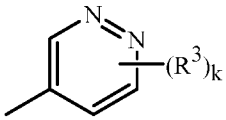
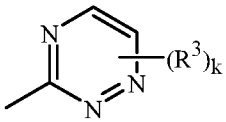
U-37 

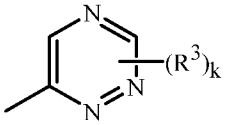
U-38 

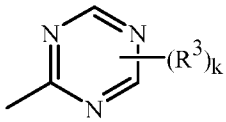
U-39 

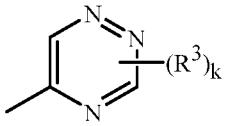
U-40 

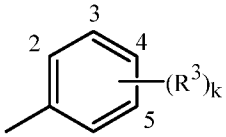
U-41 

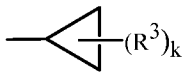
U-42 

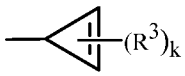
U-43 

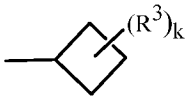
U-44 

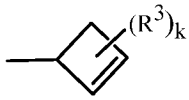
U-45 

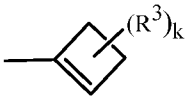
U-46 

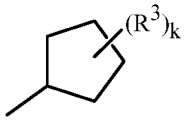
U-47 

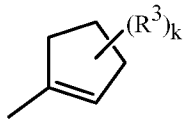
U-48 

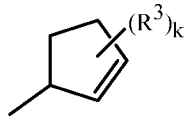
U-49 

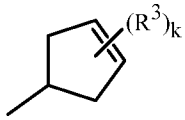
U-50 

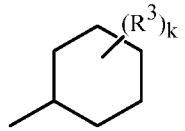
U-53 

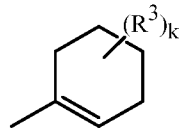
U-54 

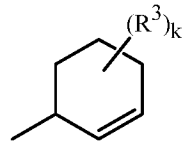
U-55 

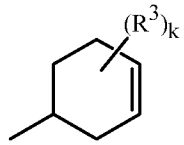
U-56 

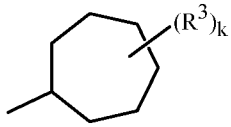
U-57 

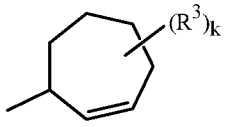
U-58 

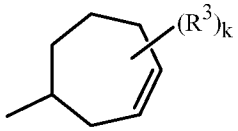
U-59 

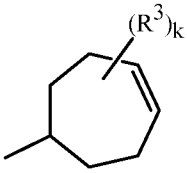
U-60 

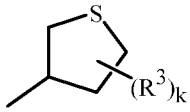
U-61 

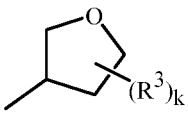
U-62 

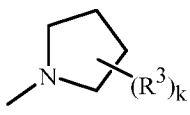
U-63 

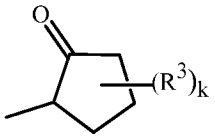
U-64 

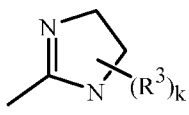
U-65 

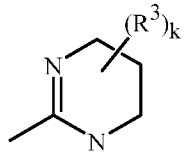
U-66 

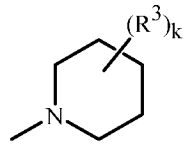
U-67 

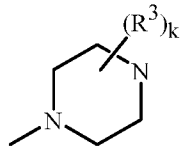
U-68 

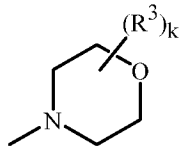
U-69 

U-70 

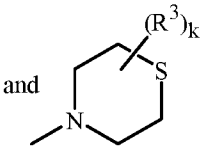
U-71 

U-72 

U-73 

U-74 

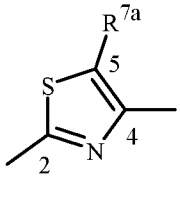
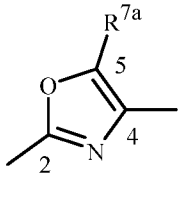
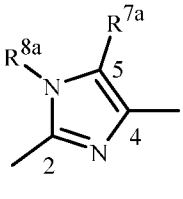
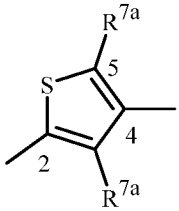
U-75 U-76 U-77 U-78

and  ;

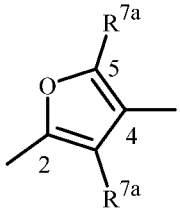
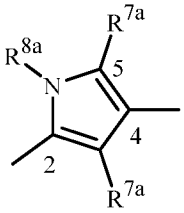
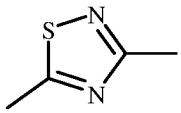
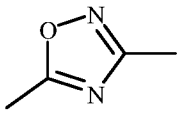
U-79

wherein when R^3 is attached to a carbon ring member, said R^3 is selected from R^{3a}, and when R^3 is attached to a nitrogen ring member said R^3 is selected from R^{3b}; and k is 0, 1 or 2;

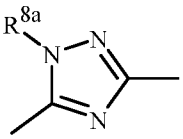
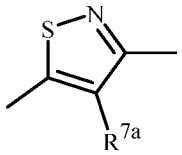
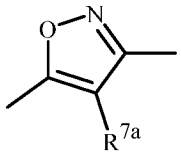
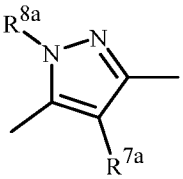
J is selected from J-1 through J-71

 ,  ,  ,  ,

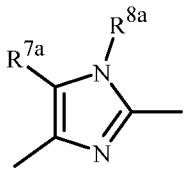
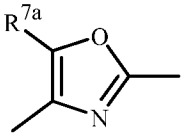
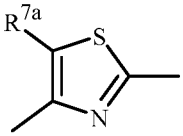
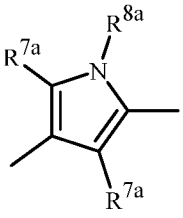
J-1 J-2 J-3 J-4

 ,  ,  ,  ,

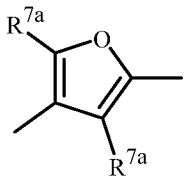
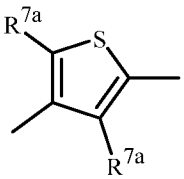
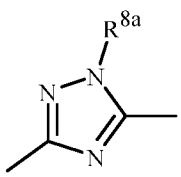
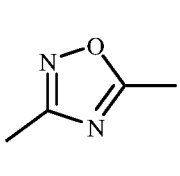
J-5 J-6 J-7 J-8

 ,  ,  ,  ,

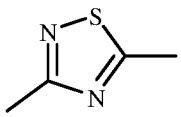
J-9 J-10 J-11 J-12

 ,  ,  ,  ,

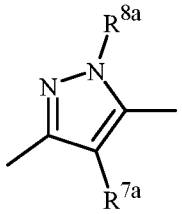
J-13 J-14 J-15 J-16

 ,  ,  ,  ,

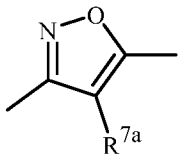
J-17 J-18 J-19 J-20



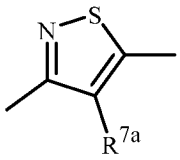
J-21



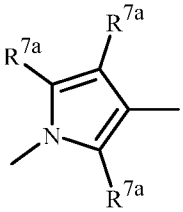
J-22



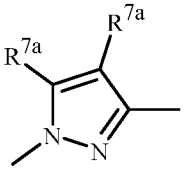
J-23



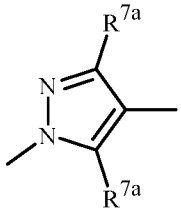
J-24



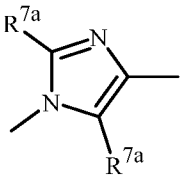
J-25



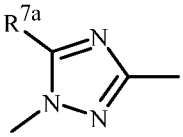
J-26



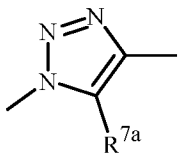
J-27



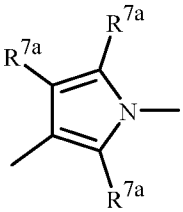
J-28



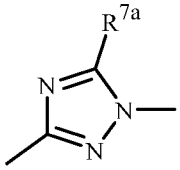
J-29



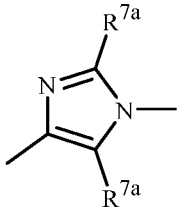
J-30



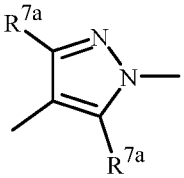
J-31



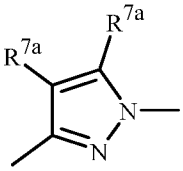
J-32



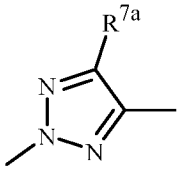
J-33



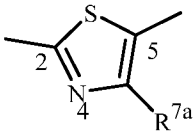
J-34



J-35



J-36



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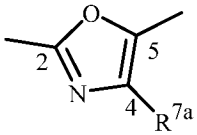

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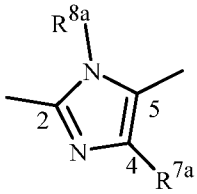

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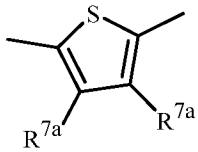

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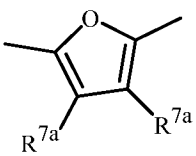

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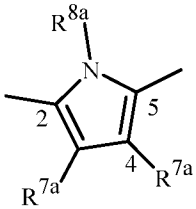

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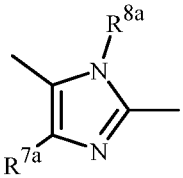

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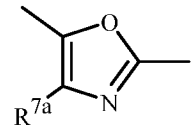

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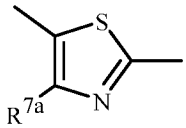
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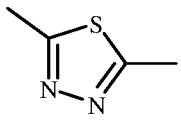
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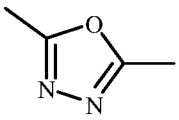
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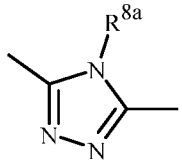
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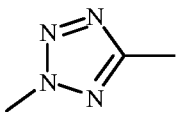
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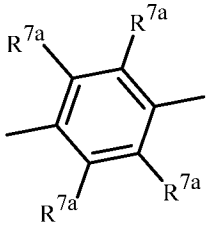
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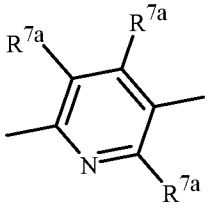
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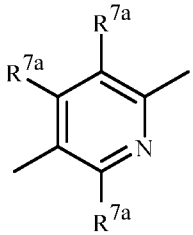
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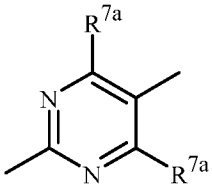
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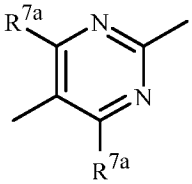
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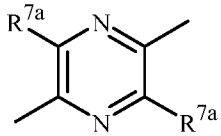
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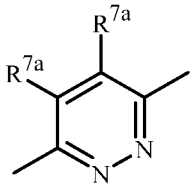
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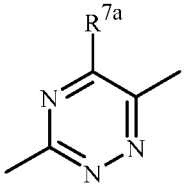
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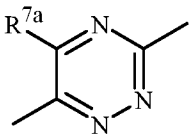
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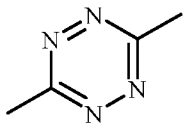
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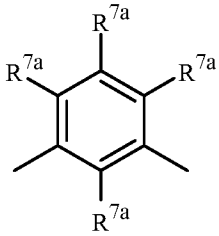
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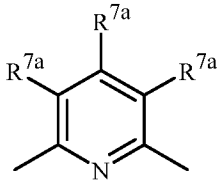
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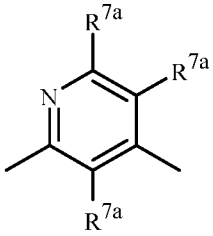
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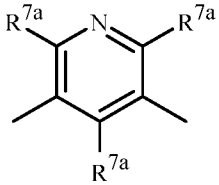
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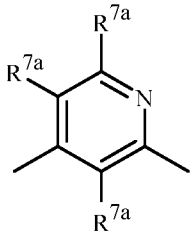
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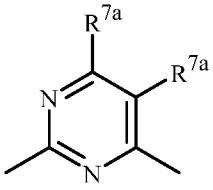
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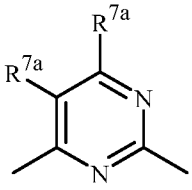
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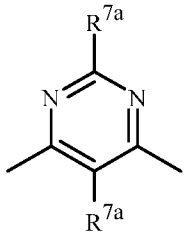
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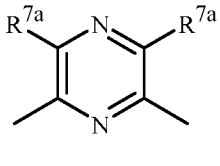
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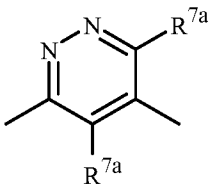

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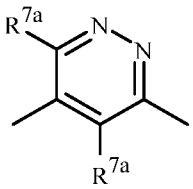

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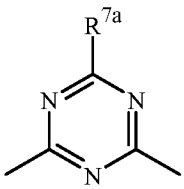


;

J-69 J-70 J-71

wherein the bond projecting to the left is bonded to Z^2, and the bond projecting to the right is bonded to the oxadiazole ring in Formula **1**; each R^{7a} is independently H or R^7; and R^{8b} is H; provided that at most only two of R^{7a} are other than H;

each R^2 is independently halogen, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_3-C_6 cycloalkyl, C_3-C_6 halocycloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkylcarbonyl, C_2-C_4 haloalkylcarbonyl or C_2-C_5 alkoxycarbonyl;

each R^{3a} is independently halogen, C_1-C_2 alkyl, C_2-C_3 alkenyl, C_2-C_3 alkynyl, C_2-C_3 alkenyloxy, C_2-C_3 alkynyloxy, C_2-C_4 alkylcarbonyl or C_2-C_5 alkoxycarbonyl;

each R^{3b} is methyl;

R^{4a} and R^{4b} are each independently H or methyl; or

one pair of R^1 and R^{4a} substituents are taken together with the atoms to which they are attached to form a pyrazolyl or imidazolyl ring, each ring optionally substituted with up to 2 substituents independently selected from R^9;

R^5 is H;

each R^6 is independently methyl, methoxy or C_2-C_4 alkoxyalkyl; or phenyl optionally substituted with up to 2 substituents independently selected from R^{13};

each R^7 is independently halogen or methyl;

each R^9 is independently halogen, hydroxy, C_1-C_2 alkyl, C_1-C_2 haloalkyl or C_1-C_2 alkoxy; and

R^{13} is halogen or methyl.

Embodiment C. A compound of Embodiment B wherein

R^1 is H; or C_1-C_4 alkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_2-C_4 alkylcarbonyl or C_2-C_4 alkoxycarbonyl, each optionally substituted with up to 1 substituent selected from R^2; or U-36, U-37, U-38, U-39, U-41, U-50, U-53, U-55 or U-58;

Z^1 is -NR^{4a}-;

J is J-40, J-50, J-51 or J-52;

R^2 is halogen, cyano, C_1-C_3 alkyl, C_1-C_3 haloalkyl, C_3-C_6 cycloalkyl, C_3-C_6 halocycloalkyl, C_1-C_3 alkoxy or C_1-C_3 haloalkoxy;

each R^{3a} is independently halogen, C_1-C_2 alkyl, C_2-C_4 alkylcarbonyl or C_2-C_5 alkoxycarbonyl;

R^{4a} is H; or

one pair of R^1 and R^{4a} substituents are taken together with the atoms to which they are attached to form an imidazolyl ring, the ring optionally substituted with up to 2 substituents independently selected from R^9;

each R^6 is independently methyl or CH_3OCH_2; or phenyl optionally substituted with up to 1 substituent selected from R^{13};

each R^7 is independently Cl, F or methyl; and

each R^9 is independently F, Cl, methyl or methoxy.

Embodiment D. A compound of Embodiment C wherein

R^1 is H; or C_1-C_4 alkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_2-C_4 alkylcarbonyl or C_2-C_4 alkoxycarbonyl, each optionally substituted with up to 1 substituent selected from R^2; or U-50;

Z^2 is $-O(CH_2)_m-$;

J is J-50;

R^2 is halogen, cyano, C_1-C_3 alkyl or C_1-C_3 alkoxy;

each R^{3a} is independently Br, Cl, F, methyl, C_2-C_4 alkylcarbonyl or C_2-C_4 alkoxycarbonyl;

R^{4a} is H;

each R^{7a} is H; and

m is 1 or 2.

Embodiment E. A compound of Embodiment D wherein

R^1 is H, C_1-C_2 alkyl, C_2-C_4 alkenyl or C_2-C_4 alkynyl; and

m is 1.

Embodiment F. A compound of any one of Embodiments A through C wherein

m is 3.

Specific embodiments include compounds of Formula **1** selected from the group consisting of:

[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]methyl carbamate (Compound 17);
[6-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]-3-pyridinyl]methyl] carbamate;
[5-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]-2-pyridinyl]methyl] carbamate;
[5-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]-2-thienyl]methyl] carbamate;
1-[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]ethyl *N*-3-pyridinyl-carbamate (Compound 23);

2-[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]ethyl *N*-ethylcarbamate (Compound 43); and
methyl 2-[[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]methylene]-hydrazinecarboxylate (Compound 105).

This invention provides a fungicidal composition comprising a compound of Formula **1** (including all stereoisomers, *N*-oxides, and salts thereof), and at least one other fungicide. Of note as embodiments of such compositions are compositions comprising a compound corresponding to any of the compound embodiments described above.

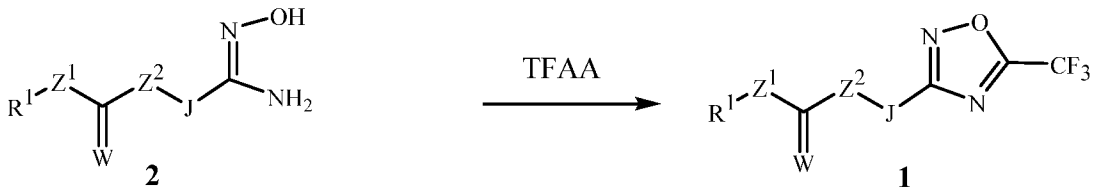
This invention provides a fungicidal composition comprising a compound of Formula **1** (including all stereoisomers, *N*-oxides, and salts thereof) (i.e. in a fungicidally effective amount), and at least one additional component selected from the group consisting of surfactants, solid diluents and liquid diluents. Of note as embodiments of such compositions are compositions comprising a compound corresponding to any of the compound embodiments described above.

This invention provides a method for controlling plant diseases caused by fungal plant pathogens comprising applying to the plant or portion thereof, or to the plant seed, a fungicidally effective amount of a compound of Formula **1** (including all stereoisomers, *N*-oxides, and salts thereof). Of note as embodiments of such methods are methods comprising applying a fungicidally effective amount of a compound corresponding to any of the compound embodiments describe above. Of particular note are embodiments where the compounds are applied as compositions of this invention.

One or more of the following methods and variations as described in Schemes 1-8 can be used to prepare the compounds of Formula **1**. The definitions of R^1, Z^1, W, Z^2 and J in the compounds of Formulae **1**-**12** below are as defined above in the Summary of the Invention unless otherwise noted.

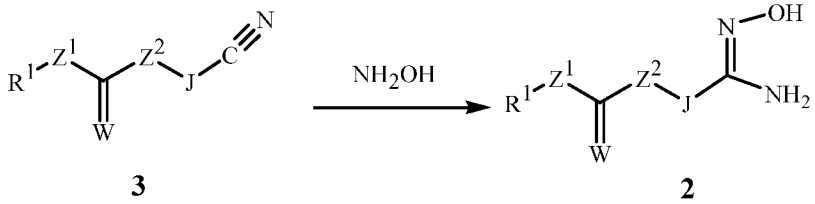
As shown in Scheme 1, compounds of Formula **1** can be prepared by reacting amide oximes of Formula **2** with trifluoroacetic anhydride (TFAA) or an equivalent. The reaction of Scheme 1 can be carried out without solvent other than the compounds of Formula **2** and TFAA. Typically the reaction is conducted in a liquid phase with a solvent such as acetonitrile, tetrahydrofuran or toluene at a temperature between about 0 and 100 °C, optionally in the presence of a base such as pyridine or trimethylamine. Preparation of oxadiazole rings by this method and others are known in the art; see, for example, *Comprehensive Heterocyclic Chemistry*, Vol. 6, Part 4B, pages 365-391, Kevin T. Potts editor, Pergamon Press, New York, **1984**.

Scheme 1



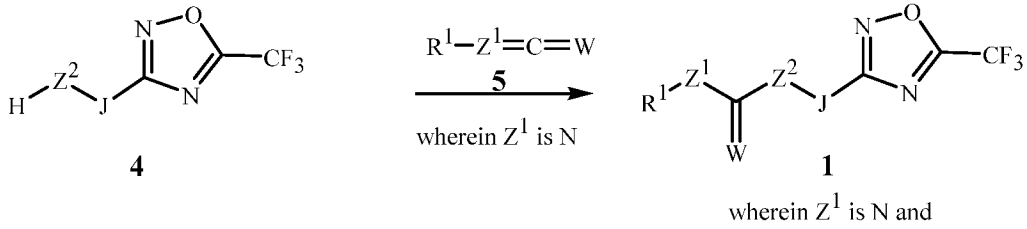
As shown in Scheme 2, oximes of Formula **2** can be prepared from corresponding nitriles of Formula **3** and hydroxylamine or a hydroxylamine salt (e.g., hydroxylamine hydrochloride) in a solvent such as ethanol or methanol at temperatures generally ranging from about 0 to 80 °C. A base is needed to liberate the hydroxylamine from its salt. Suitable bases for this reaction include, but are not limited to, sodium hydroxide, sodium bicarbonate or sodium carbonate.

Scheme 2



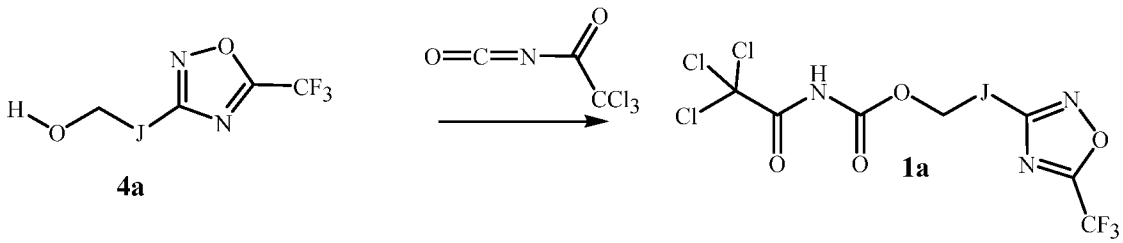
As shown in Scheme 3, compounds of Formula **1** wherein Z^1 is N can also be prepared by reacting a compound of Formula **4** with an isocyanate or isothiocyanate of Formula **5** as depicted in Scheme 3. These reactions are typically run at 0-100 °C in a solvent such as tetrahydrofuran, toluene, dichloromethane or acetonitrile in the presence of a base such as triethylamine, diisopropylethylamine or pyridine. The method of Scheme 3 is illustrated in present Example 3, Step B.

Scheme 3



Scheme 4 illustrates a specific example of the general method of Scheme 3 for the preparation of a compound of Formula **1a** (i.e. Formula **1** wherein R^1 is $Cl_3CC(=O)$-, Z^1 is NH and Z^2 is $-OCH_2-$). In this method a compound of Formula **4a** (i.e. Formula **4** wherein Z^2 is $-OCH_2-$) is reacted with 2,2,2-trichloroacetyl isocyanate in a solvent such as dichloromethane. The method of Scheme 4 is illustrated in present Example 4 where a compound of Formula **1a** (wherein J is phenyl) is generated *in situ*.

Scheme 4

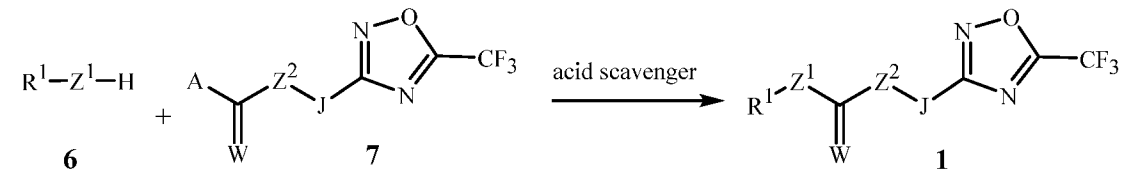


4a 1a

Compounds of Formula **1a** are useful for preparing other compounds of Formula **1**. For example, hydrolysis of a compound of Formula **1a** using aluminum oxide provides a compound of Formula **1** wherein R^1Z^1 is H_2N-. See present Example 4 for reaction conditions.

Alternatively, compounds of Formula **1** wherein Z^1 is N can be prepared by the reaction of an amine of Formula **6** with a carbamoyl or thiocarbamoyl chloride or imidazole of Formula **7** as shown in Scheme 5. The reaction is usually run in a solvent such as acetonitrile, dichloromethane or tetrahydrofuran at a temperature between about 0 and 80 °C. When A is chlorine, the reaction is typically carried out in the presence of an acid scavenger. Typical acid scavengers include amine bases such as triethylamine, diisopropylethylamine and pyridine. Other scavengers include hydroxides such as sodium and potassium hydroxide and carbonates such as sodium carbonate and potassium carbonate. The method of Scheme 5 is illustrated in Example 2.

Scheme 5

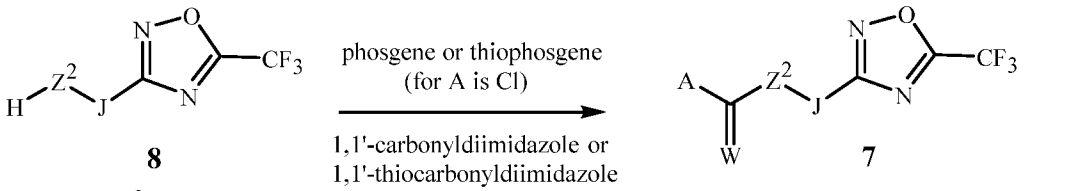


6 **7** **1**

wherein Z^1 is N wherein A is Cl or imidazol-1-yl wherein Z^1 is N

As shown in Scheme 6, the carbamoyl or thiocarbamoyl chloride of Formula **7** (wherein A is Cl) can be prepared from the corresponding hydroxy by treatment with phosgene or thiophosgene, or their equivalents; while the carbamoyl or thiocarbamoyl imidazole of Formula **7** (wherein A is imidazol-1-yl) can be prepared from the corresponding hydroxy by treatment with 1,1'-carbonyldiimidazole or 1,1'-thiocarbonyldiimidazole, according to general methods known in the art. Also, present Example 1, Step B illustrates the method of Scheme 6 for a compound of Formula 7 wherein A is imidazol-1-yl.

Scheme 6



8

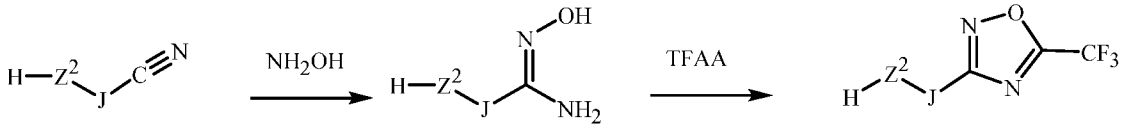
wherein Z^2 is $O(CH_2)_m$ or OCH_2CH_2O

7

wherein A is Cl or imidazol-1-yl

As shown in Scheme 7, the compounds of Formula **8** can be prepared by reaction of nitriles of Formula **9** with hydroxylamine to give the amide oximes of Formula **10** using conditions analogous to those described in Scheme 2. Treatment of compounds of Formula **10** with trifluoroacetic anhydride, analogous to the transformation depicted in Scheme 1, provides compounds of Formula **8**. The nitriles of Formula **5** are known or can be prepared by one skilled in the art. The method of Scheme 7 is illustrated in present Example 1, Step A.

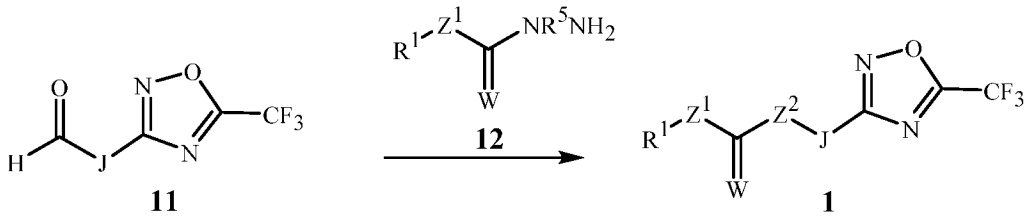
Scheme 7



9 **10** **8**

As shown in Scheme 8, compounds of Formula **1** wherein Z^2 is $-NR^5N=CH-$ can be prepared by reaction of an aldehyde of Formula **11** with a carbohydrazide of Formula **12**. The reaction is typically run in a solvent such as methanol or ethanol at a temperature between 0 to 80 °C.

Scheme 8



11 **12**

1

wherein Z^2 is $-NR^5N=CH-$

Analogous to the method of Scheme 8, compounds of Formula **4** (see Scheme 3) wherein Z^2 is $-NR^5N=CH-$ can be prepared from aldehydes Formula **11** and hydrazines of formula R^5NHNH_2. Aldehydes of Formula **11** are known or can be prepared by methods analogous to those reported for in WO 2017055473 (see preparation of 4-[5-(trifluoromethyl)-1,2,4-oxadiazole-3-yl]benzaldehyde).

It is recognized that some reagents and reaction conditions described above for preparing compounds of Formula **1** may not be compatible with certain functionalities

present in the intermediates. In these instances, the incorporation of protection/deprotection sequences or functional group interconversions into the synthesis will aid in obtaining the desired products. The use and choice of the protecting groups will be apparent to one skilled in chemical synthesis (see, for example, T. W. Greene and P. G. M. Wuts, Protective Groups in Organic Synthesis, 2nd ed.; Wiley: New York, 1991). One skilled in the art will recognize that, in some cases, after the introduction of a given reagent as it is depicted in any individual scheme, it may be necessary to perform additional routine synthetic steps not described in detail to complete the synthesis of compounds of Formula **1**. One skilled in the art will also recognize that it may be necessary to perform a combination of the steps illustrated in the above schemes in an order other than that implied by the particular sequence presented to prepare the compounds of Formula **1**.

One skilled in the art will also recognize that compounds of Formula **1** and the intermediates described herein can be subjected to various electrophilic, nucleophilic, radical, organometallic, oxidation, and reduction reactions to add substituents or modify existing substituents.

Without further elaboration, it is believed that one skilled in the art using the preceding description can utilize the present invention to its fullest extent. The following Examples are, therefore, to be construed as merely illustrative, and not limiting of the disclosure in any way whatsoever. Steps in the following Examples illustrate a procedure for each step in an overall synthetic transformation, and the starting material for each step may not have necessarily been prepared by a particular preparative run whose procedure is described in other Examples or Steps. Percentages are by weight except for chromatographic solvent mixtures or where otherwise indicated. Parts and percentages for chromatographic solvent mixtures are by volume unless otherwise indicated. ^{1}H NMR spectra are reported in ppm downfield from tetramethylsilane; ^{19}F NMR spectra are reported in ppm using trichlorofluoromethane as reference; "s" means singlet, "d" means doublet, "m" means multiplet, "br s" means broad singlet and "br m" means broad multiplet.

EXAMPLE 1

Preparation of 2-[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]ethyl-1*H*-imidazole-1-carboxylate (Compound 40)

Step A: Preparation of 4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]benzeneethanol

A mixture of 4-(2-hydroxyethyl)benzonitrile (10.0 g, 68 mmol) and hydroxylamine (50% aqueous solution, 8.4 mL, 136 mmol) in absolute ethanol (50 mL) was stirred at ambient temperature for 16 h, and then concentrated under reduced pressure. The resulting material was diluted with acetonitrile (100 mL) and concentrated under reduced pressure (2x), and the resulting solid was slurried in diethyl ether and filtered to provide *N*'-hydroxy-4-(2-hydroxyethyl)benzamidine (11.9 g) as a white solid.

To a mixture of *N*'-hydroxy-4-(2-hydroxyethyl)benzamidine (11.7 g, 65.4 mmol) and pyridine (12.1 mL, 150 mmol) in acetonitrile (100 mL) at 0 °C was added trifluoroacetic anhydride (20.8 mL, 140 mmol) dropwise over 30 minutes. The reaction mixture was heated at 70 °C. After 4 h, the reaction mixture was cooled to ambient temperature, and then added to ice water (700 mL) and allowed to stir for 3 days. The mixture was extracted with ethyl acetate (3 x 100 mL) and the combined extracts were washed with aqueous hydrochloric acid solution (1 N), saturated aqueous sodium bicarbonate solution and saturated aqueous sodium chloride solution. The mixture was then dried over magnesium sulfate, filtered and concentrated under reduced pressure to provide an orange solid (17.7 g). The orange solid was stirred in hexane (100 mL) for 2 hr, filtered and air dried to give the title compound as a light yellow solid (10.65 g).

^{1}H NMR ($CDCl_3$): δ 1.35-1.50 (br s, 1H), 2.96 (m, 2H), 3.93 (m, 2H), 7.40 (m, 2H), 8.07 (m, 2H);

^{19}F NMR ($CDCl_3$): δ –65.38.

The following compounds were prepared analogous to the method Step A of Example 1:

4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]benzenemethanol.

^{1}H NMR ($CDCl_3$): δ 1.80 (m, 1H), 4.80-4.81 (d, 2H), 7.54 (d, 2H), 8.13 (d, 2H);

^{19}F NMR ($CDCl_3$): δ –65.37.

4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]benzenepropanol.

^{1}H NMR ($CDCl_3$): δ 1.92-1.95 (m, 2H), 2.79-2.81 (m, 2H), 3.69- 3.72 (m, 2H), 7.35-7.37 (d, 2H), 8.03-8.04 (d, 2H);

^{19}F NMR ($CDCl_3$): δ –65.37.

Step B: Preparation of 2-[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]ethyl-1*H*-imidazole-1-carboxylate

A mixture of 1,1'-carbonyldiimidazole (CDI) (2.0 g, 12.3 mmol) in acetonitrile (25 mL) was cooled to 0 °C in an ice/water bath, and then a solution of 4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]benzeneethanol (i.e. the product of Step A) (2.58 g, 10 mmol) in acetonitrile (20 mL) was added dropwise. The reaction mixture was allowed to warm to ambient temperature, stirred overnight, and then concentrated under reduced pressure. The resulting material was diluted with dichloromethane, washed with water and saturated aqueous sodium chloride solution, dried over magnesium sulfate, filtered and concentrated under reduced pressure to provide the title compound, a compound of the present invention, as a tan solid (3.54 g).

^{1}H NMR ($CDCl_3$): δ 3.20 (m, 2H), 4.67 (m, 2H), 7.06 (s, 1H), 7.37 (s, 1H), 7.42 (m, 2H), 8.09 (m, 3H);

^{19}F NMR ($CDCl_3$): δ –65.38.

The following compound was prepared analogous to the method Step B of Example 1:

2-[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]methyl-1*H*-imidazole-1-carboxylate (Compound 8).

^{1}H NMR ($CDCl_3$): δ 5.50 (s, 2H), 7.09 (s, 1H), 7.46 (s, 1H), 7.60 (m, 2H), 8.18 (m, 3H) (m, 3H);

^{19}F NMR ($CDCl_3$): δ –65.33.

EXAMPLE 2

Preparation of 2-[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]ethyl *N*-ethylcarbamate (Compound 43)

2-[4-[5-(Trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]ethyl-1*H*-imidazole-1-carboxylat3(i.e. the product of Step B) (300 mg, 0.85 mmol) was dissolved in a solution of ethylamine (2 M in tetrahydrofuran, 2 mL) and stirred at ambient temperature for 2 hr. The reaction mixture was concentrated under reduced pressure and the resulting material was diluted with dichloromethane. The dichloromethane mixture was washed with aqueous hydrochloric acid solution (1 N), dried over magnesium sulfate, filtered and concentrated under reduced pressure to provide the title compound, a compound of the present invention, as a white solid (0.27 g).

^{1}H NMR ($CDCl_3$): δ 1.13 (m, 3H), 3.01 (m, 2H), 3.20 (m, 2H), 4.32 (m, 2H), 4.62 (br s, 1H), 7.38 (m, 2H), 8.05 (m, 3H);

^{19}F NMR ($CDCl_3$): δ –65.39.

EXAMPLE 3

Preparation of 1-[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]ethyl *N*-3-pyridinylcarbamate (Compound 23)

Step A: Preparation of α-methyl-4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]benzenemethanol

To a mixture of 4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]benzaldehyde (1.53 g, 6.3 mmol) in tetrahydrofuran (20 ml) at -12 °C was added a solution of methylmagnesium bromide (3 M in diethyl ether, 2.1 mL, 6.3 mmol) dropwise. The reaction mixture was stirred for 2 h at -12 °C, and then quenched with saturated aqueous ammonium chloride solution. The resulting mixture was poured into water and extracted with ethyl acetate. The organic extracts were washed with saturated aqueous sodium chloride solution, dried over sodium sulfate, filtered and concentrated under reduced pressure. The resulting material was purified by silica gel chromatography (eluting with a gradient of 5 to 50% ethyl acetate in hexanes) to provide the title compound as a solid (1.63 g).

^{1}H NMR ($CDCl_3$): δ 1.40-1.61 (m, 3H), 4.84-5.06 (m, 1 H), 7.50 (d, 2H), 8.06 (d, 2H);

^{19}F NMR ($CDCl_3$): δ –65.49.

Step B: Preparation of 1-[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]ethyl *N*-3-pyridinylcarbamate

To a solution of of α-methyl-4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]benzenemethanol (i.e. the product of Step A) (0.287 g, 1.11 mmol) in acetonitrile (10 mL) was added triethylamine (0.25 mL, 1.8 mmol) followed by 3-isocyanatopyridine (0.24 g, 2 mmol). The reaction mixture was heated at reflux for 1 h, cooled to ambient temperature, and then concentrated under reduced pressure. The resulting material was purified by silica gel chromatography (eluting with a gradient of 0 to 100% ethyl acetate in hexanes) to provide the title compound, a compound of the present invention, as a white solid (0.30 g).

^{1}H NMR ($CDCl_3$): δ 1.64 (d, 3H), 5.96 (m, 1H), 7.23-7.26 (m, 1H), 7.45-7.58 (m, 3H), 8.02 (m, 1H), 8.10-8.12 (d, 2H), 8.32-8.34 (m, 1H), 8.52-8.54 (m, 1H);

^{19}F NMR ($CDCl_3$): δ −65.35.

EXAMPLE 4

Preparation of [4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]methyl carbamate (Compound 17)

To a mixture of 4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]benzenemethanol (prepared analogous to the method of Step A in Example 1) (36 g, 147 mmol) in dichloromethane (600 mL) was added 2,2,2-trichloroacetyl isocyanate (33.3 g, 177 mmol) while maintaining the reaction temperature below 30 °C. The reaction mixture was stirred for 2 h at ambient temperature to provide a reaction mixture containing the compound 2,2,2-trichloro-1-((2-(4-(5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl)phenyl)acetyl)-λ^{2}azaneyl)ethan-1-one (a compound of the present invention). Aluminum oxide (720 g) was added to the reaction mixture portionwise and stirring was continued overnight. The reaction mixture was filtered, rinsing with ethyl acetate, and the filtrate was concentrated under reduced pressure to provide a white solid (41 g). The white solid was crystallized from ethanol to provide the title compound, a compound of the present invention, as colorless prisms melting at 142-144 °C.

^{1}H NMR ($CDCl_3$): δ 4.59-4.88 (br s, 2H), 5.19 (s, 2H) 7.51-7.52 (m, 2H), 8.11-8.13 (m, 2H);

^{19}F NMR ($CDCl_3$): δ −65.35.

EXAMPLE 5

Preparation of methyl 2-[[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]methylene]-hydrazinecarboxylate (Compound 105)

To a mixture of 4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]benzaldehyde (0.80 g, 3.30 mmol) in methanol (10 mL) was added methyl hydrazinocarboxylate (0.307 g, 3.30 mmol). The reaction mixture was stirred at ambient temperature, and then concentrated under reduced pressure. The resulting material was purified by MPLC silica gel chromatography (eluting with a gradient of 0 to 100% ethyl acetate in hexanes) to provide a

white solid (0.84 g). The white solid was crystallized from ethanol to provide the title compound, a compound of the present invention, as colorless needles (549 mg) melting at 183-185 °C.

^{1}H NMR ($CDCl_3$): δ 3.89 (br s, 3H), 7.83-7.85 (m, 2H), 7.9-8.0 (br s, 1H), 8.13-8.15 (m, 2H), 8.2-8.5 (br s, 1H);

^{19}F NMR ($CDCl_3$): δ −65.34.

Formulation/Utility

A compound of Formula **1** of this invention (including *N*-oxides, hydrates, and salts thereof) will generally be used as a fungicidal active ingredient in a composition, i.e. formulation, with at least one additional component selected from the group consisting of surfactants, solid diluents and liquid diluents, which serve as a carrier. The formulation or composition ingredients are selected to be consistent with the physical properties of the active ingredient, mode of application and environmental factors such as soil type, moisture and temperature.

Useful formulations include both liquid and solid compositions. Liquid compositions include solutions (including emulsifiable concentrates), suspensions, emulsions (including microemulsions and/or suspoemulsions) and the like, which optionally can be thickened into gels. The general types of aqueous liquid compositions are soluble concentrate, suspension concentrate, capsule suspension, concentrated emulsion, microemulsion and suspo-emulsion. The general types of nonaqueous liquid compositions are emulsifiable concentrate, microemulsifiable concentrate, dispersible concentrate and oil dispersion.

The general types of solid compositions are dusts, powders, granules, pellets, pills, pastilles, tablets, filled films (including seed coatings) and the like, which can be water-dispersible ("wettable") or water-soluble. Films and coatings formed from film-forming solutions or flowable suspensions are particularly useful for seed treatment. Active ingredient can be (micro)encapsulated and further formed into a suspension or solid formulation; alternatively the entire formulation of active ingredient can be encapsulated (or "overcoated"). Encapsulation can control or delay release of the active ingredient. An emulsifiable granule combines the advantages of both an emulsifiable concentrate formulation and a dry granular formulation. High-strength compositions are primarily used as intermediates for further formulation.

Sprayable formulations are typically extended in a suitable medium before spraying. Such liquid and solid formulations are formulated to be readily diluted in the spray medium, usually water, but occasionally another suitable medium like an aromatic or paraffinic hydrocarbon or vegetable oil. Spray volumes can range from about one to several thousand liters per hectare, but more typically are in the range from about ten to several hundred liters per hectare. Sprayable formulations can be tank mixed with water or another suitable medium for foliar treatment by aerial or ground application, or for application to the growing

medium of the plant. Liquid and dry formulations can be metered directly into drip irrigation systems or metered into the furrow during planting. Liquid and solid formulations can be applied onto seeds of crops and other desirable vegetation as seed treatments before planting to protect developing roots and other subterranean plant parts and/or foliage through systemic uptake.

The formulations will typically contain effective amounts of active ingredient, diluent and surfactant within the following approximate ranges which add up to 100 percent by weight.

	Weight Percent		
	Active Ingredient	Diluent	Surfactant
Water-Dispersible and Water-soluble Granules, Tablets and Powders.	0.001-90	0-99.999	0-15
Oil Dispersions, Suspensions, Emulsions, Solutions (including Emulsifiable Concentrates)	1-50	40-99	0-50
Dusts	1-25	70-99	0-5
Granules and Pellets	0.001-95	5-99.999	0-15
High Strength Compositions	90-99	0-10	0-2

Solid diluents include, for example, clays such as bentonite, montmorillonite, attapulgite and kaolin, gypsum, cellulose, titanium dioxide, zinc oxide, starch, dextrin, sugars (e.g., lactose, sucrose), silica, talc, mica, diatomaceous earth, urea, calcium carbonate, sodium carbonate and bicarbonate, and sodium sulfate. Typical solid diluents are described in Watkins et al., *Handbook of Insecticide Dust Diluents and Carriers*, 2nd Ed., Dorland Books, Caldwell, New Jersey.

Liquid diluents include, for example, water, *N*,*N*-dimethylalkanamides (e.g., *N*,*N*-dimethylformamide), limonene, dimethyl sulfoxide, *N*-alkylpyrrolidones (e.g., *N*-methylpyrrolidinone), alkyl phosphates (e.g., triethyl phosphate), ethylene glycol, triethylene glycol, propylene glycol, dipropylene glycol, polypropylene glycol, propylene carbonate, butylene carbonate, paraffins (e.g., white mineral oils, normal paraffins, isoparaffins), alkylbenzenes, alkylnaphthalenes, glycerine, glycerol triacetate, sorbitol, aromatic hydrocarbons, dearomatized aliphatics, alkylbenzenes, alkylnaphthalenes, ketones such as cyclohexanone, 2-heptanone, isophorone and 4-hydroxy-4-methyl-2-pentanone, acetates such as isoamyl acetate, hexyl acetate, heptyl acetate, octyl acetate, nonyl acetate, tridecyl acetate and isobornyl acetate, other esters such as alkylated lactate esters, dibasic esters, alkyl and aryl benzoates and γ-butyrolactone, and alcohols, which can be linear, branched, saturated or unsaturated, such as methanol, ethanol, *n*-propanol, isopropyl alcohol, *n*-butanol, isobutyl alcohol, *n*-hexanol, 2-ethylhexanol, *n*-octanol, decanol, isodecyl alcohol, isooctadecanol, cetyl alcohol, lauryl alcohol, tridecyl alcohol, oleyl alcohol, cyclohexanol,

tetrahydrofurfuryl alcohol, diacetone alcohol, cresol and benzyl alcohol. Liquid diluents also include glycerol esters of saturated and unsaturated fatty acids (typically C_6–C_{22}), such as plant seed and fruit oils (e.g., oils of olive, castor, linseed, sesame, corn (maize), peanut, sunflower, grapeseed, safflower, cottonseed, soybean, rapeseed, coconut and palm kernel), animal-sourced fats (e.g., beef tallow, pork tallow, lard, cod liver oil, fish oil), and mixtures thereof. Liquid diluents also include alkylated fatty acids (e.g., methylated, ethylated, butylated) wherein the fatty acids may be obtained by hydrolysis of glycerol esters from plant and animal sources, and can be purified by distillation. Typical liquid diluents are described in Marsden, *Solvents Guide*, 2nd Ed., Interscience, New York, 1950.

The solid and liquid compositions of the present invention often include one or more surfactants. When added to a liquid, surfactants (also known as "surface-active agents") generally modify, most often reduce, the surface tension of the liquid. Depending on the nature of the hydrophilic and lipophilic groups in a surfactant molecule, surfactants can be useful as wetting agents, dispersants, emulsifiers or defoaming agents.

Surfactants can be classified as nonionic, anionic or cationic. Nonionic surfactants useful for the present compositions include, but are not limited to: alcohol alkoxylates such as alcohol alkoxylates based on natural and synthetic alcohols (which may be branched or linear) and prepared from the alcohols and ethylene oxide, propylene oxide, butylene oxide or mixtures thereof; amine ethoxylates, alkanolamides and ethoxylated alkanolamides; alkoxylated triglycerides such as ethoxylated soybean, castor and rapeseed oils; alkylphenol alkoxylates such as octylphenol ethoxylates, nonylphenol ethoxylates, dinonyl phenol ethoxylates and dodecyl phenol ethoxylates (prepared from the phenols and ethylene oxide, propylene oxide, butylene oxide or mixtures thereof); block polymers prepared from ethylene oxide or propylene oxide and reverse block polymers where the terminal blocks are prepared from propylene oxide; ethoxylated fatty acids; ethoxylated fatty esters and oils; ethoxylated methyl esters; ethoxylated tristyrylphenol (including those prepared from ethylene oxide, propylene oxide, butylene oxide or mixtures thereof); fatty acid esters, glycerol esters, lanolin-based derivatives, polyethoxylate esters such as polyethoxylated sorbitan fatty acid esters, polyethoxylated sorbitol fatty acid esters and polyethoxylated glycerol fatty acid esters; other sorbitan derivatives such as sorbitan esters; polymeric surfactants such as random copolymers, block copolymers, alkyl peg (polyethylene glycol) resins, graft or comb polymers and star polymers; polyethylene glycols (pegs); polyethylene glycol fatty acid esters; silicone-based surfactants; and sugar-derivatives such as sucrose esters, alkyl polyglycosides and alkyl polysaccharides.

Useful anionic surfactants include, but are not limited to: alkylaryl sulfonic acids and their salts; carboxylated alcohol or alkylphenol ethoxylates; diphenyl sulfonate derivatives; lignin and lignin derivatives such as lignosulfonates; maleic or succinic acids or their anhydrides; olefin sulfonates; phosphate esters such as phosphate esters of alcohol

alkoxylates, phosphate esters of alkylphenol alkoxylates and phosphate esters of styryl phenol ethoxylates; protein-based surfactants; sarcosine derivatives; styryl phenol ether sulfate; sulfates and sulfonates of oils and fatty acids; sulfates and sulfonates of ethoxylated alkylphenols; sulfates of alcohols; sulfates of ethoxylated alcohols; sulfonates of amines and amides such as *N,N*-alkyltaurates; sulfonates of benzene, cumene, toluene, xylene, and dodecyl and tridecylbenzenes; sulfonates of condensed naphthalenes; sulfonates of naphthalene and alkyl naphthalene; sulfonates of fractionated petroleum; sulfosuccinamates; and sulfosuccinates and their derivatives such as dialkyl sulfosuccinate salts.

Useful cationic surfactants include, but are not limited to: amides and ethoxylated amides; amines such as *N*-alkyl propanediamines, tripropylenetriamines and dipropylenetetramines, and ethoxylated amines, ethoxylated diamines and propoxylated amines (prepared from the amines and ethylene oxide, propylene oxide, butylene oxide or mixtures thereof); amine salts such as amine acetates and diamine salts; quaternary ammonium salts such as quaternary salts, ethoxylated quaternary salts and diquaternary salts; and amine oxides such as alkyldimethylamine oxides and bis-(2-hydroxyethyl)-alkylamine oxides.

Also useful for the present compositions are mixtures of nonionic and anionic surfactants or mixtures of nonionic and cationic surfactants. Nonionic, anionic and cationic surfactants and their recommended uses are disclosed in a variety of published references including *McCutcheon's Emulsifiers and Detergents*, annual American and International Editions published by McCutcheon's Division, The Manufacturing Confectioner Publishing Co.; Sisely and Wood, *Encyclopedia of Surface Active Agents*, Chemical Publ. Co., Inc., New York, 1964; and A. S. Davidson and B. Milwidsky, *Synthetic Detergents*, Seventh Edition, John Wiley and Sons, New York, 1987.

Compositions of this invention may also contain formulation auxiliaries and additives, known to those skilled in the art as formulation aids. Such formulation auxiliaries and additives may control: pH (buffers), foaming during processing (antifoams such polyorganosiloxanes (e.g., Rhodorsil® 416)), sedimentation of active ingredients (suspending agents), viscosity (thixotropic thickeners), in-container microbial growth (antimicrobials), product freezing (antifreezes), color (dyes/pigment dispersions (e.g., Pro-lzed® Colorant Red)), wash-off (film formers or stickers), evaporation (evaporation retardants), and other formulation attributes. Film formers include, for example, polyvinyl acetates, polyvinyl acetate copolymers, polyvinylpyrrolidone-vinyl acetate copolymer, polyvinyl alcohols, polyvinyl alcohol copolymers and waxes. Examples of formulation auxiliaries and additives include those listed in *McCutcheon's Volume 2: Functional Materials*, annual International and North American editions published by McCutcheon's Division, The Manufacturing Confectioner Publishing Co.; and PCT Publication WO 03/024222.

The compound of Formula **1** and any other active ingredients are typically incorporated into the present compositions by dissolving the active ingredient in a solvent or by grinding in a liquid or dry diluent. Solutions, including emulsifiable concentrates, can be prepared by simply mixing the ingredients. If the solvent of a liquid composition intended for use as an emulsifiable concentrate is water-immiscible, an emulsifier is typically added to emulsify the active-containing solvent upon dilution with water. Active ingredient slurries, with particle diameters of up to 2,000 μm can be wet milled using media mills to obtain particles with average diameters below 3 μm. Aqueous slurries can be made into finished suspension concentrates (see, for example, U.S. 3,060,084) or further processed by spray drying to form water-dispersible granules. Dry formulations usually require dry milling processes, which produce average particle diameters in the 2 to 10 μm range. Dusts and powders can be prepared by blending and usually grinding (such as with a hammer mill or fluid-energy mill). Granules and pellets can be prepared by spraying the active material upon preformed granular carriers or by agglomeration techniques. See Browning, "Agglomeration", *Chemical Engineering*, December 4, 1967, pp 147-48, *Perry's Chemical Engineer's Handbook*, 4th Ed., McGraw-Hill, New York, 1963, pp 8-57 and following, and WO 91/13546. Pellets can be prepared as described in U.S. 4,172,714. Water-dispersible and water-soluble granules can be prepared as taught in U.S. 4,144,050, U.S. 3,920,442 and DE 3,246,493. Tablets can be prepared as taught in U.S. 5,180,587, U.S. 5,232,701 and U.S. 5,208,030. Films can be prepared as taught in GB 2,095,558 and U.S. 3,299,566.

One embodiment of the present invention relates to a method for controlling fungal pathogens, comprising diluting the fungicidal composition of the present invention (a compound of Formula **1** formulated with surfactants, solid diluents and liquid diluents or a formulated mixture of a compound of Formula **1** and at least one other fungicide) with water, and optionally adding an adjuvant to form a diluted composition, and contacting the fungal pathogen or its environment with an effective amount of said diluted composition.

Although a spray composition formed by diluting with water a sufficient concentration of the present fungicidal composition can provide sufficient efficacy for controlling fungal pathogens, separately formulated adjuvant products can also be added to spray tank mixtures. These additional adjuvants are commonly known as "spray adjuvants" or "tank-mix adjuvants", and include any substance mixed in a spray tank to improve the performance of a pesticide or alter the physical properties of the spray mixture. Adjuvants can be anionic or nonionic surfactants, emulsifying agents, petroleum-based crop oils, crop-derived seed oils, acidifiers, buffers, thickeners or defoaming agents. Adjuvants are used to enhancing efficacy (e.g., biological availability, adhesion, penetration, uniformity of coverage and durability of protection), or minimizing or eliminating spray application problems associated with incompatibility, foaming, drift, evaporation, volatilization and degradation. To obtain optimal performance, adjuvants are selected with regard to the properties of the active ingredient, formulation and target (e.g., crops, insect pests).

The amount of adjuvants added to spray mixtures is generally in the range of about 2.5% to 0.1 % by volume. The application rates of adjuvants added to spray mixtures are typically between about 1 to 5 L per hectare. Representative examples of spray adjuvants include: Adigor® (Syngenta) 47% methylated rapeseed oil in liquid hydrocarbons, Silwet® (Helena Chemical Company) polyalkyleneoxide modified heptamethyltrisiloxane and Assist® (BASF) 17% surfactant blend in 83% paraffin based mineral oil.

One method of seed treatment is by spraying or dusting the seed with a compound of the invention (i.e. as a formulated composition) before sowing the seeds. Compositions formulated for seed treatment generally comprise a film former or adhesive agent. Therefore, typically a seed coating composition of the present invention comprises a biologically effective amount of a compound of Formula **1** and a film former or adhesive agent. Seeds can be coated by spraying a flowable suspension concentrate directly into a tumbling bed of seeds and then drying the seeds. Alternatively, other formulation types such as wetted powders, solutions, suspoemulsions, emulsifiable concentrates and emulsions in water can be sprayed on the seed. This process is particularly useful for applying film coatings on seeds. Various coating machines and processes are available to one skilled in the art. Suitable processes include those listed in P. Kosters et al., *Seed Treatment: Progress and Prospects*, 1994 BCPC Mongraph No. 57, and references listed therein.

For further information regarding the art of formulation, see T. S. Woods, "The Formulator's Toolbox - Product Forms for Modern Agriculture" in *Pesticide Chemistry and Bioscience, The Food-Environment Challenge*, T. Brooks and T. R. Roberts, Eds., Proceedings of the 9th International Congress on Pesticide Chemistry, The Royal Society of Chemistry, Cambridge, 1999, pp. 120-133. See also U.S. 3,235,361, Col. 6, line 16 through Col. 7, line 19 and Examples 10-41; U.S. 3,309,192, Col. 5, line 43 through Col. 7, line 62 and Examples 8, 12, 15, 39, 41, 52, 53, 58, 132, 138-140, 162-164, 166, 167 and 169-182; U.S. 2,891,855, Col. 3, line 66 through Col. 5, line 17 and Examples 1-4; Klingman, *Weed Control as a Science*, John Wiley and Sons, Inc., New York, 1961, pp 81-96; Hance et al., *Weed Control Handbook*, 8th Ed., Blackwell Scientific Publications, Oxford, 1989; and *Developments in formulation technology*, PJB Publications, Richmond, UK, 2000.

In the following Examples, all percentages are by weight and all formulations are prepared in conventional ways. Compound numbers refer to compounds in Index Tables A-G. Without further elaboration, it is believed that one skilled in the art using the preceding description can utilize the present invention to its fullest extent. The following Examples are, therefore, to be constructed as merely illustrative, and not limiting of the disclosure in any way whatsoever.

Example A

High Strength Concentrate

Compound 17	98.5%
silica aerogel	0.5%
synthetic amorphous fine silica	1.0%

Example B

Wettable Powder

Compound 67	65.0%
dodecylphenol polyethylene glycol ether	2.0%
sodium ligninsulfonate	4.0%
sodium silicoaluminate	6.0%
montmorillonite (calcined)	23.0%

Example C

Granule

Compound 63	10.0%
attapulgite granules (low volatile matter, 0.71/0.30 mm; U.S.S. No. 25–50 sieves)	90.0%

Example D

Extruded Pellet

Compound 61	25.0%
anhydrous sodium sulfate	10.0%
crude calcium ligninsulfonate	5.0%
sodium alkylnaphthalenesulfonate	1.0%
calcium/magnesium bentonite	59.0%

Example E

Emulsifiable Concentrate

Compound 52	10.0%
polyoxyethylene sorbitol hexoleate	20.0%
C_6–C_{10} fatty acid methyl ester	70.0%

Example F

Microemulsion

Compound 51	5.0%
polyvinylpyrrolidone-vinyl acetate copolymer	30.0%
alkylpolyglycoside	30.0%
glyceryl monooleate	15.0%
water	20.0%

Example G

Seed Treatment

Compound 47	20.00%

polyvinylpyrrolidone-vinyl acetate copolymer	5.00%
montan acid wax	5.00%
calcium ligninsulfonate	1.00%
polyoxyethylene/polyoxypropylene block copolymers	1.00%
stearyl alcohol (POE 20)	2.00%
polyorganosilane	0.20%
colorant red dye	0.05%
water	65.75%

Example H

Fertilizer Stick

Compound 117	2.50%
pyrrolidone-styrene copolymer	4.80%
tristyrylphenyl 16-ethoxylate	2.30%
talc	0.80%
corn starch	5.00%
slow-release fertilizer	36.00%
kaolin	38.00%
water	10.60%

Example I

Suspension Concentrate

Compound 118	35%
butyl polyoxyethylene/polypropylene block copolymer	4.0%
stearic acid/polyethylene glycol copolymer	1.0%
styrene acrylic polymer	1.0%
xanthan gum	0.1%
propylene glycol	5.0%
silicone based defoamer	0.1%
1,2-benzisothiazolin-3-one	0.1%
water	53.7%

Example J

Emulsion in Water

Compound 20	10.0%
butyl polyoxyethylene/polypropylene block copolymer	4.0%
stearic acid/polyethylene glycol copolymer	1.0%
styrene acrylic polymer	1.0%
xanthan gum	0.1%
propylene glycol	5.0%

silicone based defoamer	0.1%
1,2-benzisothiazolin-3-one	0.1%
aromatic petroleum based hydrocarbon	20.0
water	58.7%

Example K

Oil Dispersion

Compound 17	25%
polyoxyethylene sorbitol hexaoleate	15%
organically modified bentonite clay	2.5%
fatty acid methyl ester	57.5%

Example L

Suspoemulsion

Compound 9	10.0%
imidacloprid	5.0%
butyl polyoxyethylene/polypropylene block copolymer	4.0%
stearic acid/polyethylene glycol copolymer	1.0%
styrene acrylic polymer	1.0%
xanthan gum	0.1%
propylene glycol	5.0%
silicone based defoamer	0.1%
1,2-benzisothiazolin-3-one	0.1%
aromatic petroleum based hydrocarbon	20.0%
water	53.7%

Water-soluble and water-dispersible formulations are typically diluted with water to form aqueous compositions before application. Aqueous compositions for direct applications to the plant or portion thereof (e.g., spray tank compositions) typically contain at least about 1 ppm or more (e.g., from 1 ppm to 100 ppm) of the compound(s) of this invention.

Seed is normally treated at a rate of from about 0.001 g (more typically about 0.1 g) to about 10 g per kilogram of seed (i.e. from about 0.0001 to 1% by weight of the seed before treatment). A flowable suspension formulated for seed treatment typically comprises from about 0.5 to about 70% of the active ingredient, from about 0.5 to about 30% of a film-forming adhesive, from about 0.5 to about 20% of a dispersing agent, from 0 to about 5% of a thickener, from 0 to about 5% of a pigment and/or dye, from 0 to about 2% of an antifoaming agent, from 0 to about 1% of a preservative, and from 0 to about 75% of a volatile liquid diluent.

The compounds of this invention are useful as plant disease control agents. The present invention therefore further comprises a method for controlling plant diseases caused by fungal plant pathogens comprising applying to the plant or portion thereof to be protected, or to the plant seed to be protected, an effective amount of a compound of the invention or a fungicidal composition containing said compound. The compounds and/or compositions of this invention provide control of diseases caused by a broad spectrum of fungal plant pathogens in the Ascomycota, Basidiomycota, Zygomycota phyla, and the fungal-like Oomycata class. They are effective in controlling a broad spectrum of plant diseases, particularly foliar pathogens of ornamental, turf, vegetable, field, cereal, and fruit crops. These pathogens include but are not limited to those listed in Table 1-1. For Ascomycetes and Basidiomycetes, names for both the sexual/teleomorph/perfect stage as well as names for the asexual/anamorph/imperfect stage (in parentheses) are listed where known. Synonymous names for pathogens are indicated by an equal sign. For example, the sexual/teleomorph/perfect stage name Phaeosphaeria nodorum is followed by the corresponding asexual/anamorph/imperfect stage name Stagnospora nodorum and the synonymous older name Septoria nodorum.

Table 1-1

Ascomycetes in the order Pleosporales including *Alternaria solani, A. alternata* and *A. brassicae*, *Guignardia bidwellii*, *Venturia inaequalis*, *Pyrenophora tritici-repentis (Dreschlera tritici-repentis = Helminthosporium tritici-repentis)* and *Pyrenophora teres* (*Dreschlera teres = Helminthosporium teres*), *Corynespora cassiicola*, *Phaeosphaeria nodorum (Stagonospora nodorum = Septoria nodorum)*, *Cochliobolus carbonum* and *C. heterostrophus, Leptosphaeria biglobosa and L. maculans*;
Ascomycetes in the order Mycosphaerellales including *Mycosphaerella graminicola (Zymoseptoria tritici = Septoria tritici)*, M. *berkeleyi (Cercosporidium personatum), M. arachidis (Cercospora arachidicola), Passalora sojina* (*Cercospora sojina*), *Cercospora zeae-maydis* and *C. beticola;*
Ascomycetes in the order Erysiphales (the powdery mildews) such as *Blumeria graminis* f.sp. *tritici* and *Blumeria graminis* f.sp. *hordei*, *Erysiphe polygoni, E. necator* (= *Uncinula necator)*, *Podosphaera fuliginea* (= *Sphaerotheca fuliginea)*, and *Podosphaera leucotricha* (= *Sphaerotheca fuliginea*);
Ascomycetes in the order Helotiales such as *Botryotinia fuckeliana (Botrytis cinerea)*, *Oculimacula yallundae* (= *Tapesia yallundae;* anamorph *Helgardia herpotrichoides = Pseudocercosporella herpetrichoides), Monilinia fructicola, Sclerotinia sclerotiorum*, *Sclerotinia minor*, and *Sclerotinia homoeocarpa;*
Ascomycetes in the order Hypocreales such as *Giberella zeae (Fusarium graminearum), G. monoliformis (Fusarium moniliforme), Fusarium solani* and *Verticillium dahliae;*
Ascomycetes in the order Eurotiales such as *Aspergillus flavus* and *A. parasiticus;*
Ascomycetes in the order Diaporthales such as *Cryptosphorella viticola* (= *Phomopsis viticola),*

Phomopsis longicolla, and *Diaporthe phaseolorum;*
Other Ascomycete pathogens including *Magnaporthe grisea*, *Gaeumannomyces graminis, Rhynchosporium secalis*, and anthracnose pathogens such as *Glomerella acutata (Colletotrichum acutatum), G. graminicola (C. graminicola)* and *G. lagenaria (C. orbiculare);*
Basidiomycetes in the order Urediniales (the rusts) including *Puccinia recondita*, *P. striiformis, Puccinia hordei*, *P. graminis* and *P. arachidis), Hemileia vastatrix* and *Phakopsora pachyrhizi;*
Basidiomycetes in the order Ceratobasidiales such as *Thanatophorum cucumeris* (*Rhizoctonia solani)* and *Ceratobasidium oryzae-sativae* (*Rhizoctonia oryzae)*;
Basidiomycetes in the order Polyporales such as *Athelia rolfsii* (*Sclerotium rolfsii)*;
Basidiomycetes in the order Ustilaginales such as *Ustilago maydis;*
Zygomycetes in the order Mucorales such as *Rhizopus stolonifer*;
Oomycetes in the order Pythiales, including *Phytophthora infestans*, *P. megasperma*, *P. parasitica*, *P. sojae*, *P. cinnamomi* and *P. capsici*, and *Pythium* pathogens such as *Pythium aphanidermatum*, *P. graminicola*, *P. irregulare*, *P. ultimum* and *P. dissoticum;*
Oomycetes in the order *Peronosporales* such as *Plasmopara viticola*, *P. halstedii*, *Peronospora hyoscyami (=Peronospora tabacina), P. manshurica, Hyaloperonospora parasitica (=Peronospora parasitica), Pseudoperonospora cubensis* and *Bremia lactucae*;
and other genera and species closely related to all of the above pathogens.

In addition to their fungicidal activity, the compositions or combinations also have activity against bacteria such as *Erwinia amylovora*, *Xanthomonas campestris*, *Pseudomonas syringae*, and other related species. By controlling harmful microorganisms, the compounds of the invention are useful for improving (i.e. increasing) the ratio of beneficial to harmful microorganisms in contact with crop plants or their propagules (e.g., seeds, corms, bulbs, tubers, cuttings) or in the agronomic environment of the crop plants or their propagules.

Compounds of the invention are useful in treating all plants, plant parts and seeds. Plant and seed varieties and cultivars can be obtained by conventional propagation and breeding methods or by genetic engineering methods. Genetically modified plants or seeds (transgenic plants or seeds) are those in which a heterologous gene (transgene) has been stably integrated into the plant's or seed's genome. A transgene that is defined by its particular location in the plant genome is called a transformation or transgenic event.

Genetically modified plant cultivars which can be treated according to the invention include those that are resistant against one or more biotic stresses (pests such as nematodes, insects, mites, fungi, etc.) or abiotic stresses (drought, cold temperature, soil salinity, etc.), or that contain other desirable characteristics. Plants can be genetically modified to exhibit traits of, for example, herbicide tolerance, insect-resistance, modified oil profiles or drought tolerance.

Treatment of genetically modified plants and seeds with compounds of the invention may result in super-additive or synergistic effects. For example, reduction in application

rates, broadening of the activity spectrum, increased tolerance to biotic/abiotic stresses or enhanced storage stability may be greater than expected from just simple additive effects of the application of compounds of the invention on genetically modified plants and seeds.

Compounds of this invention are useful in seed treatments for protecting seeds from plant diseases. In the context of the present disclosure and claims, treating a seed means contacting the seed with a biologically effective amount of a compound of this invention, which is typically formulated as a composition of the invention. This seed treatment protects the seed from soil-borne disease pathogens and generally can also protect roots and other plant parts in contact with the soil of the seedling developing from the germinating seed. The seed treatment may also provide protection of foliage by translocation of the compound of this invention or a second active ingredient within the developing plant. Seed treatments can be applied to all types of seeds, including those from which plants genetically transformed to express specialized traits will germinate. Representative examples include those expressing proteins toxic to invertebrate pests, such as *Bacillus thuringiensis* toxin or those expressing herbicide resistance such as glyphosate acetyltransferase, which provides resistance to glyphosate. Seed treatments with compounds of this invention can also increase vigor of plants growing from the seed.

Compounds of this invention and their compositions, both alone and in combination with other fungicides, nematicides and insecticides, are particularly useful in seed treatment for crops including, but not limited to, maize or corn, soybeans, cotton, cereal (e.g., wheat, oats, barley, rye and rice), potatoes, vegetables and oilseed rape.

Furthermore, the compounds of this invention are useful in treating postharvest diseases of fruits and vegetables caused by fungi and bacteria. These infections can occur before, during and after harvest. For example, infections can occur before harvest and then remain dormant until some point during ripening (e.g., host begins tissue changes in such a way that infection can progress); also infections can arise from surface wounds created by mechanical or insect injury. In this respect, the compounds of this invention can reduce losses (i.e. losses resulting from quantity and quality) due to postharvest diseases which may occur at any time from harvest to consumption. Treatment of postharvest diseases with compounds of the invention can increase the period of time during which perishable edible plant parts (e.g., fruits, seeds, foliage, stems, bulbs, tubers) can be stored refrigerated or un-refrigerated after harvest, and remain edible and free from noticeable or harmful degradation or contamination by fungi or other microorganisms. Treatment of edible plant parts before or after harvest with compounds of the invention can also decrease the formation of toxic metabolites of fungi or other microorganisms, for example, mycotoxins such as aflatoxins.

Plant disease control is ordinarily accomplished by applying an effective amount of a compound of this invention either pre- or post-infection, to the portion of the plant to be protected such as the roots, stems, foliage, fruits, seeds, tubers or bulbs, or to the media (soil or sand) in which the plants to be protected are growing. The compounds can also be

applied to seeds to protect the seeds and seedlings developing from the seeds. The compounds can also be applied through irrigation water to treat plants. Control of postharvest pathogens which infect the produce before harvest is typically accomplished by field application of a compound of this invention, and in cases where infection occurs after harvest the compounds can be applied to the harvested crop as dips, sprays, fumigants, treated wraps and box liners.

Rates of application for these compounds (i.e. a fungicidally effective amount) can be influenced by factors such as the plant diseases to be controlled, the plant species to be protected, ambient moisture and temperature and should be determined under actual use conditions. One skilled in the art can easily determine through simple experimentation the fungicidally effective amount necessary for the desired level of plant disease control. Foliage can normally be protected when treated at a rate of from less than about 1 g/ha to about 5,000 g/ha of active ingredient. Seed and seedlings can normally be protected when seed is treated at a rate of from about 0.001 g (more typically about 0.1 g) to about 10 g per kilogram of seed.

Compounds of this invention can also be mixed with one or more other biologically active compounds or agents including fungicides, insecticides, nematocides, bactericides, acaricides, herbicides, herbicide safeners, growth regulators such as insect molting inhibitors and rooting stimulants, chemosterilants, semiochemicals, repellents, attractants, pheromones, feeding stimulants, plant nutrients, other biologically active compounds or entomopathogenic bacteria, virus or fungi to form a multi-component pesticide giving an even broader spectrum of agricultural protection. Thus the present invention also pertains to a composition comprising a compound of Formula **1** (in a fungicidally effective amount) and at least one additional biologically active compound or agent (in a biologically effective amount) and can further comprise at least one of a surfactant, a solid diluent or a liquid diluent. The other biologically active compounds or agents can be formulated in compositions comprising at least one of a surfactant, solid or liquid diluent. For mixtures of the present invention, one or more other biologically active compounds or agents can be formulated together with a compound of Formula **1**, to form a premix, or one or more other biologically active compounds or agents can be formulated separately from the compound of Formula **1**, and the formulations combined together before application (e.g., in a spray tank) or, alternatively, applied in succession.

As mentioned in the Summary of the Invention, one aspect of the present invention is a fungicidal composition comprising (i.e. a mixture or combination of) a compound of Formula **1**, an *N*-oxide, or a salt thereof (i.e. component a), and at least one other fungicide (i.e. component b). Of note is such a combination where the other fungicidal active ingredient has different site of action from the compound of Formula **1**. In certain instances, a combination with at least one other fungicidal active ingredient having a similar spectrum of control but a different site of action will be particularly advantageous for resistance

management. Thus, a composition of the present invention can further comprise a fungicidally effective amount of at least one additional fungicidal active ingredient having a similar spectrum of control but a different site of action.

Of note is a composition which in addition to the Formula **1** compound of component (a), includes as component (b) at least one fungicidal compound selected from the group consisting of the FRAC-defined mode of action (MOA) classes (A) nucleic acid synthesis, (B) mitosis and cell division, (C) respiration, (D) amino acid and protein synthesis, (E) signal transduction, (F) lipid synthesis and membrane integrity, (G) sterol biosynthesis in membranes, (H) cell wall biosynthesis in membranes, (I) melanin synthesis in cell wall, (P) host plant defense induction, multi-site contact activity and unknown mode of action.

FRAC-recognized or proposed target sites of action along with their FRAC target site codes belonging to the above MOA classes are (A1) RNA polymerase I, (A2) adenosine deaminase, (A3) DNA/RNA synthesis (proposed), (A4) DNA topoisomerase, (B1-B3) ß-tubulin assembly in mitosis, (B4) cell division (proposed), (B5) delocalization of spectrin-like proteins, (C1) complex I NADH odxido-reductase, (C2) complex II: succinate dehydrogenase, (C3) complex III: cytochrome *bc*1 (ubiquinol oxidase) at Qo site, (C4) complex III: cytochrome *bc*1 (ubiquinone reductase) at Qi site, (C5) uncouplers of oxidative phosphorylation, (C6) inhibitors of oxidative phosphorylation, ATP synthase, (C7) ATP production (proposed), (C8) complex III: cytochrome *bc*1 (ubiquinone reductase) at Qx (unknown) site, (D1) methionine biosynthesis (proposed), (D2-D5) protein synthesis, (E1) signal transduction (mechanism unknown), (E2-E3) MAP/histidine kinase in osmotic signal transduction, (F2) phospholipid biosynthesis, methyl transferase, (F3) lipid peroxidation (proposed), (F4) cell membrane permeability, fatty acids (proposed), (F6) microbial disrupters of pathogen cell membranes, (F7) cell membrane disruption (proposed), (G1) C14- demethylase in sterol biosynthesis , (G2) Δ14-reductase and Δ8→Δ7- isomerase in sterol biosynthesis, (G3) 3-keto reductase, C4-demethylation, (G4) squalene epoxidase in sterol biosynthesis, (H3) trehalase and inositol biosynthesis, (H4) chitin synthase, (H5) cellulose synthase, (I1) reductase in melanin biosynthesis and (I2) dehydratase in melanin biosynthesis.

Of particular note is a composition which in addition to the Formula **1** compound of component (a), includes as component (b) at least one fungicidal compound selected from the group consisting of the classes (b1) methyl benzimidazole carbamate (MBC) fungicides; (b2) dicarboximide fungicides; (b3) demethylation inhibitor (DMI) fungicides; (b4) phenylamide fungicides; (b5) amine/morpholine fungicides; (b6) phospholipid biosynthesis inhibitor fungicides; (b7) succinate dehydrogenase inhibitor fungicides; (b8) hydroxy(2-amino-)pyrimidine fungicides; (b9) anilinopyrimidine fungicides; (b10) *N*-phenyl carbamate fungicides; (b11) quinone outside inhibitor (QoI) fungicides; (b12) phenylpyrrole fungicides; (b13) azanaphthalene fungicides; (b14) lipid peroxidation inhibitor fungicides; (b15) melanin biosynthesis inhibitor-reductase (MBI-R) fungicides; (b16) melanin biosynthesis

inhibitor-dehydratase (MBI-D) fungicides; (b17) sterol biosynthesis inhibitor (SBI): Class III fungicides; (b18) squalene-epoxidase inhibitor fungicides; (b19) polyoxin fungicides; (b20) phenylurea fungicides; (b21) quinone inside inhibitor (QiI) fungicides; (b22) benzamide and thiazole carboxamide fungicides; (b23) enopyranuronic acid antibiotic fungicides; (b24) hexopyranosyl antibiotic fungicides; (b25) glucopyranosyl antibiotic: protein synthesis fungicides; (b26) glucopyranosyl antibiotic: trehalase and inositol biosynthesis fungicides; (b27) cyanoacetamideoxime fungicides; (b28) carbamate fungicides; (b29) oxidative phosphorylation uncoupling fungicides; (b30) organo tin fungicides; (b31) carboxylic acid fungicides; (b32) heteroaromatic fungicides; (b33) phosphonate fungicides; (b34) phthalamic acid fungicides; (b35) benzotriazine fungicides; (b36) benzene-sulfonamide fungicides; (b37) pyridazinone fungicides; (b38) thiophene-carboxamide fungicides; (b39) complex I NADH oxidoreductase inhibitor fungicides; (b40) carboxylic acid amide (CAA) fungicides; (b41) tetracycline antibiotic fungicides; (b42) thiocarbamate fungicides; (b43) benzamide fungicides; (b44) microbial fungicides; (b45) Q_XI fungicides; (b46) plant extract fungicides; (b47) host plant defense induction fungicides; (b48) multi-site contact activity fungicides; (b49) fungicides other than fungicides of classes (b1) through (b48); and salts of compounds of classes (b1) through (b48).

Further descriptions of these classes of fungicidal compounds are provided below.

(b1) "Methyl benzimidazole carbamate (MBC) fungicides" (FRAC code 1) inhibit mitosis by binding to β-tubulin during microtubule assembly. Inhibition of microtubule assembly can disrupt cell division, transport within the cell and cell structure. Methyl benzimidazole carbamate fungicides include benzimidazole and thiophanate fungicides. The benzimidazoles include benomyl, carbendazim, fuberidazole and thiabendazole. The thiophanates include thiophanate and thiophanate-methyl.

(b2) "Dicarboximide fungicides" (FRAC code 2) inhibit a MAP/histidine kinase in osmotic signal transduction. Examples include chlozolinate, iprodione, procymidone and vinclozolin.

(b3) "Demethylation inhibitor (DMI) fungicides" (FRAC code 3) (Sterol Biosynthesis Inhibitors (SBI): Class I) inhibit C14-demethylase, which plays a role in sterol production. Sterols, such as ergosterol, are needed for membrane structure and function, making them essential for the development of functional cell walls. Therefore, exposure to these fungicides results in abnormal growth and eventually death of sensitive fungi. DMI fungicides are divided between several chemical classes: azoles (including triazoles and imidazoles), pyrimidines, piperazines, pyridines and triazolinthiones. The triazoles include azaconazole, bitertanol, bromuconazole, cyproconazole, difenoconazole, diniconazole (including diniconazole-M), epoxiconazole, etaconazole, fenbuconazole, fluquinconazole, flusilazole, flutriafol, hexaconazole, imibenconazole, ipconazole, metconazole, myclobutanil, penconazole, propiconazole, , quinconazole, simeconazole, tebuconazole, tetraconazole, triadimefon, triadimenol, triticonazole, uniconazole, uniconazole-P, α-(1-

chlorocyclopropyl)-α-[2-(2,2-dichlorocyclopropyl)ethyl]-1*H*-1,2,4-triazole-1-ethanol, *rel*-1-[[(2*R*,3*S*)-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]methyl]-1*H*-1,2,4-triazole, *rel*-2-[[(2*R*,3*S*)-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]methyl]-1,2-dihydro-3*H*-1,2,4-triazole-3-thione, and *rel*-1-[[(2*R*,3*S*)-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]methyl]-5-(2-propen-1-ylthio)-1*H*-1,2,4-triazole. The imidazoles include econazole, imazalil, oxpoconazole, prochloraz, pefurazoate and triflumizole. The pyrimidines include fenarimol, nuarimol and triarimol. The piperazines include triforine. The pyridines include buthiobate, pyrifenox, pyrisoxazole (3-[(3R)-5-(4-chlorophenyl)-2,3-dimethyl3-isoxazolidinyl]pyridine, mixture of 3*R*,5*R*- and 3*R*,5*S*-isomers) and (α*S*)-[3-(4-chloro-2-fluorophenyl)5-(2,4-difluorophenyl)-4-isoxazolyl]-3-pyridinemethanol. The triazolinthiones include prothioconazole and 2-[2-(1-chlorocyclopropyl)-4-(2,2-dichlorocyclopropyl)-2-hydroxybutyl]-1,2-dihydro-3*H*-1,2,4-triazole-3-thione. Biochemical investigations have shown that all of the above mentioned fungicides are DMI fungicides as described by K. H. Kuck et al. in *Modern Selective Fungicides - Properties, Applications and Mechanisms of Action*, H. Lyr (Ed.), Gustav Fischer Verlag: New York, 1995, 205–258.

(b4) "Phenylamide fungicides" (FRAC code 4) are specific inhibitors of RNA polymerase in Oomycete fungi. Sensitive fungi exposed to these fungicides show a reduced capacity to incorporate uridine into rRNA. Growth and development in sensitive fungi is prevented by exposure to this class of fungicide. Phenylamide fungicides include acylalanine, oxazolidinone and butyrolactone fungicides. The acylalanines include benalaxyl, benalaxyl-M (also known as kiralaxyl), furalaxyl, metalaxyl and metalaxyl-M (also known as mefenoxam). The oxazolidinones include oxadixyl. The butyrolactones include ofurace.

(b5) "Amine/morpholine fungicides" (FRAC code 5) (SBI: Class II) inhibit two target sites within the sterol biosynthetic pathway, $\Delta^8 \rightarrow \Delta^7$ isomerase and Δ^{14} reductase. Sterols, such as ergosterol, are needed for membrane structure and function, making them essential for the development of functional cell walls. Therefore, exposure to these fungicides results in abnormal growth and eventually death of sensitive fungi. Amine/morpholine fungicides (also known as non-DMI sterol biosynthesis inhibitors) include morpholine, piperidine and spiroketal-amine fungicides. The morpholines include aldimorph, dodemorph, fenpropimorph, tridemorph and trimorphamide. The piperidines include fenpropidin and piperalin. The spiroketal-amines include spiroxamine.

(b6) "Phospholipid biosynthesis inhibitor fungicides" (FRAC code 6) inhibit growth of fungi by affecting phospholipid biosynthesis. Phospholipid biosynthesis fungicides include phophorothiolate and dithiolane fungicides. The phosphorothiolates include edifenphos, iprobenfos and pyrazophos. The dithiolanes include isoprothiolane.

(b7) "Succinate dehydrogenase inhibitor (SDHI) fungicides" " (FRAC code 7) inhibit Complex II fungal respiration by disrupting a key enzyme in the Krebs Cycle (TCA cycle) named succinate dehydrogenase. Inhibiting respiration prevents the fungus from making

ATP, and thus inhibits growth and reproduction. SDHI fungicides include phenylbenzamide, furan carboxamide, oxathiin carboxamide, thiazole carboxamide, pyrazole-4-carboxamide, pyridine carboxamide, phenyl oxoethyl thiophene amides and pyridinylethyl benzamides. The benzamides include benodanil, flutolanil and mepronil. The furan carboxamides include fenfuram. The oxathiin carboxamides include carboxin and oxycarboxin. The thiazole carboxamides include thifluzamide. The pyrazole-4-carboxamides include benzovindiflupyr (*N*-[9-(dichloromethylene)-1,2,3,4-tetrahydro-1,4-methanonaphthalen-5-yl]-3-(difluoromethyl)-1-methyl-1*H*-pyrazole-4-carboxamide), bixafen, fluxapyroxad (3-(difluoromethyl)-1-methyl-*N*-(3′,4′,5′-trifluoro[1,1′-biphenyl]-2-yl)-1*H*-pyrazole-4-carboxamide), furametpyr, isopyrazam (3-(difluoromethyl)-1-methyl-*N*-[1,2,3,4-tetrahydro9-(1-methylethyl)-1,4-methanonaphthalen-5-yl]-1*H*-pyrazole-4-carboxamide), penflufen (*N*-[2-(1,3-dimethylbutyl)phenyl]-5-fluoro-1,3-dimethyl-1*H*-pyrazole-4-carboxamide), penthiopyrad, sedaxane (*N*-[2-[1,1′-bicyclopropyl]-2-ylphenyl]-3-(difluoromethyl)-1-methyl-1*H*-pyrazole-4-carboxamide), *N*-[2-(1*S*,2*R*)-[1,1'-bicyclopropyl]-2-ylphenyl]-3-(difluoromethyl)-1-methyl-1*H*-pyrazole-4-carboxamide, 3-(difluoromethyl)-*N*-(2,3-dihydro-1,1,3-trimethyl-1*H*-inden-4-yl)-1-methyl-1*H*-pyrazole-4-carboxamide, *N*-[2-(2,4-dichlorophenyl)2-methoxy-1-methylethyl]-3-(difluoromethyl)-1-methyl-1*H*-pyrazole-4-carboxamide and *N*-cyclopropyl-3-(difluoromethyl)-5-fluoro-1-methyl-*N*-[[2-(1-methylethyl)phenyl]methyl]-1*H*-pyrazole-4-carboxamide. The pyridine carboxamides include boscalid. The phenyl oxoethyl thiophene amides include isofetamid (*N*-[1,1-dimethyl-2-[2-methyl-4-(1-methylethoxy)phenyl]-2-oxoethyl]-3-methyl-2-thiophenecarboxamide). The pyridinylethyl benzamides include fluopyram.

(b8) "Hydroxy-(2-amino-)pyrimidine fungicides" (FRAC code 8) inhibit nucleic acid synthesis by interfering with adenosine deaminase. Examples include bupirimate, dimethirimol and ethirimol.

(b9) "Anilinopyrimidine fungicides" (FRAC code 9) are proposed to inhibit biosynthesis of the amino acid methionine and to disrupt the secretion of hydrolytic enzymes that lyse plant cells during infection. Examples include cyprodinil, mepanipyrim and pyrimethanil.

(b10) "*N*-Phenyl carbamate fungicides" (FRAC code 10) inhibit mitosis by binding to β-tubulin and disrupting microtubule assembly. Inhibition of microtubule assembly can disrupt cell division, transport within the cell and cell structure. Examples include diethofencarb.

(b11) "Quinone outside inhibitor (QoI) fungicides" (FRAC code 11) inhibit Complex III mitochondrial respiration in fungi by affecting ubiquinol oxidase. Oxidation of ubiquinol is blocked at the "quinone outside" (Q_o) site of the cytochrome bc_1 complex, which is located in the inner mitochondrial membrane of fungi. Inhibiting mitochondrial respiration prevents normal fungal growth and development. Quinone outside inhibitor fungicides include methoxyacrylate, methoxycarbamate, oximinoacetate, oximinoacetamide and

dihydrodioxazine fungicides (collectively also known as strobilurin fungicides), and oxazolidinedione, imidazolinone and benzylcarbamate fungicides. The methoxyacrylates include azoxystrobin, coumoxystrobin (methyl (α*E*)-2-[[(3-butyl-4-methyl-2-oxo-2*H*-1-benzopyran-7-yl)oxy]methyl]-α-(methoxymethylene)benzeneacetate), enoxastrobin (methyl (α*E*)-2-[[[(*E*)-[(2*E*)-3-(4-chlorophenyl)-1-methyl-2-propen-1-ylidene]amino]oxy]methyl]-α-(methoxymethylene)benzeneaceate) (also known as enestroburin), flufenoxystrobin (methyl (α*E*)-2-[[2-chloro-4-(trifluoromethyl)phenoxy]methyl]-α-(methoxymethylene)benzene-acetate), picoxystrobin, and pyraoxystrobin (methyl (α*E*)-2-[[[3-(4-chlorophenyl)-1-methyl-1*H*-pyrazol-5-yl]oxy]methyl]-α-(methoxymethylene)benzeneacetate). The methoxy-carbamates include pyraclostrobin ,pyrametostrobin (methyl *N*-[2-[[(1,4-dimethyl-3-phenyl-1*H*-pyrazol-5-yl)oxy]methyl]phenyl]-*N*-methoxycarbamate) and triclopyricarb (methyl *N*-methoxy-*N*-[2-[[(3,5,6-trichloro-2-pyridinyl)oxy]methyl]phenyl]carbamate). The oximino-acetates include kresoxim-methyl, and trifloxystrobin. The oximinoacetamides include dimoxystrobin, fenaminstrobin ((α*E*)-2-[[[(*E*)-[(2*E*)-3-(2,6-dichlorophenyl)-1-methyl-2-propen-1-ylidene]amino]oxy]methyl]-α-(methoxyimino)-*N*-methylbenzeneacetamide), metominostrobin, orysastrobin and α-[methoxyimino]-*N*-methyl-2-[[[1-[3-(trifluoro-methyl)phenyl]ethoxy]imino]methyl]benzeneacetamide. The dihydrodioxazines include fluoxastrobin. The oxazolidinediones include famoxadone. The imidazolinones include fenamidone. The benzylcarbamates include pyribencarb. Class (b11) also includes mandestrobin (2-[(2,5-dimethylphenoxy)methyl]-α-methoxy-*N*-benzeneacetamide).

(b12) "Phenylpyrrole fungicides" (FRAC code 12) inhibit a MAP/histidine kinase associated with osmotic signal transduction in fungi. Fenpiclonil and fludioxonil are examples of this fungicide class.

(b13) "Azanaphthalene fungicides" (FRAC code 13) are proposed to inhibit signal transduction by a mechanism which is as yet unknown. They have been shown to interfere with germination and/or appressorium formation in fungi that cause powdery mildew diseases. Azanaphthalene fungicides include aryloxyquinolines and quinazolinones. The aryloxyquinolines include quinoxyfen. The quinazolinones include proquinazid.

(b14) "Lipid peroxidation inhibitor fungicides" (FRAC code 14) are proposed to inhibit lipid peroxidation which affects membrane synthesis in fungi. Members of this class, such as etridiazole, may also affect other biological processes such as respiration and melanin biosynthesis. Lipid peroxidation fungicides include aromatic hydrocarbon and 1,2,4-thiadiazole fungicides. The aromatic hydrocarboncarbon fungicides include biphenyl, chloroneb, dicloran, quintozene, tecnazene and tolclofos-methyl. The 1,2,4-thiadiazoles include etridiazole.

(b15) "Melanin biosynthesis inhibitors-reductase (MBI-R) fungicides" (FRAC code 16.1) inhibit the naphthal reduction step in melanin biosynthesis. Melanin is required for host plant infection by some fungi. Melanin biosynthesis inhibitors-reductase fungicides include isobenzofuranone, pyrroloquinolinone and triazolobenzothiazole fungicides. The

isobenzofuranones include fthalide. The pyrroloquinolinones include pyroquilon. The triazolobenzothiazoles include tricyclazole.

(b16) "Melanin biosynthesis inhibitors-dehydratase (MBI-D) fungicides" (FRAC code 16.2) inhibit scytalone dehydratase in melanin biosynthesis. Melanin in required for host plant infection by some fungi. Melanin biosynthesis inhibitors-dehydratase fungicides include cyclopropanecarboxamide, carboxamide and propionamide fungicides. The cyclopropanecarboxamides include carpropamid. The carboxamides include diclocymet. The propionamides include fenoxanil.

(b17) "Sterol Biosynthesis Inhibitor (SBI): Class III fungicides (FRAC code 17) inhibit 3-ketoreductase during C4-demethylation in sterol production. SBI: Class III inhibitors include hydroxyanilide fungicides and amino-pyrazolinone fungicides. Hydroxyanilides include fenhexamid. Amino-pyrazolinones include fenpyrazamine (*S*-2-propen-1-yl 5-amino-2,3-dihydro-2-(1-methylethyl)-4-(2-methylphenyl)-3-oxo-1*H*-pyrazole-1-carbothioate).

(b18) "Squalene-epoxidase inhibitor fungicides" (FRAC code 18) (SBI: Class IV) inhibit squalene-epoxidase in the sterol biosynthesis pathway. Sterols such as ergosterol are needed for membrane structure and function, making them essential for the development of functional cell walls. Therefore, exposure to these fungicides results in abnormal growth and eventually death of sensitive fungi. Squalene-epoxidase inhibitor fungicides include thiocarbamate and allylamine fungicides. The thiocarbamates include pyributicarb. The allylamines include naftifine and terbinafine.

(b19) "Polyoxin fungicides" (FRAC code 19) inhibit chitin synthase. Examples include polyoxin.

(b20) "Phenylurea fungicides" (FRAC code 20) are proposed to affect cell division. Examples include pencycuron.

(b21) "Quinone inside inhibitor (QiI) fungicides" (FRAC code 21) inhibit Complex III mitochondrial respiration in fungi by affecting ubiquinone reductase. Reduction of ubiquinone is blocked at the "quinone inside" (Q_i) site of the cytochrome bc_1 complex, which is located in the inner mitochondrial membrane of fungi. Inhibiting mitochondrial respiration prevents normal fungal growth and development. Quinone inside inhibitor fungicides include cyanoimidazole and sulfamoyltriazole fungicides. The cyanoimidazoles include cyazofamid. The sulfamoyltriazoles include amisulbrom.

(b22) "Benzamide and thiazole carboxamide fungicides" (FRAC code 22) inhibit mitosis by binding to β-tubulin and disrupting microtubule assembly. Inhibition of microtubule assembly can disrupt cell division, transport within the cell and cell structure. The benzamides include zoxamide. The thiazole carboxamides include ethaboxam.

(b23) "Enopyranuronic acid antibiotic fungicides" (FRAC code 23) inhibit growth of fungi by affecting protein biosynthesis. Examples include blasticidin-S.

(b24) "Hexopyranosyl antibiotic fungicides" (FRAC code 24) inhibit growth of fungi by affecting protein biosynthesis. Examples include kasugamycin.

(b25) "Glucopyranosyl antibiotic: protein synthesis fungicides" (FRAC code 25) inhibit growth of fungi by affecting protein biosynthesis. Examples include streptomycin.

(b26) "Glucopyranosyl antibiotic: trehalase and inositol biosynthesis fungicides" (FRAC code 26) inhibit trehalase and inositol biosynthesis. Examples include validamycin.

(b27) "Cyanoacetamideoxime fungicides (FRAC code 27) include cymoxanil.

(b28) "Carbamate fungicides" (FRAC code 28) are considered multi-site inhibitors of fungal growth. They are proposed to interfere with the synthesis of fatty acids in cell membranes, which then disrupts cell membrane permeability. Propamacarb, iodocarb, and prothiocarb are examples of this fungicide class.

(b29) "Oxidative phosphorylation uncoupling fungicides" (FRAC code 29) inhibit fungal respiration by uncoupling oxidative phosphorylation. Inhibiting respiration prevents normal fungal growth and development. This class includes 2,6-dinitroanilines such as fluazinam, and dinitrophenyl crotonates such as dinocap, meptyldinocap and binapacryl.

(b30) "Organo tin fungicides" (FRAC code 30) inhibit adenosine triphosphate (ATP) synthase in oxidative phosphorylation pathway. Examples include fentin acetate, fentin chloride and fentin hydroxide.

(b31) "Carboxylic acid fungicides" (FRAC code 31) inhibit growth of fungi by affecting deoxyribonucleic acid (DNA) topoisomerase type II (gyrase). Examples include oxolinic acid.

(b32) "Heteroaromatic fungicides" (Fungicide Resistance Action Committee (FRAC) code 32) are proposed to affect DNA/ribonucleic acid (RNA) synthesis. Heteroaromatic fungicides include isoxazoles and isothiazolones. The isoxazoles include hymexazole and the isothiazolones include octhilinone.

(b33) "Phosphonate fungicides" (FRAC code 33) include phosphorous acid and its various salts, including fosetyl-aluminum.

(b34) "Phthalamic acid fungicides" (FRAC code 34) include teclofthalam.

(b35) "Benzotriazine fungicides" (FRAC code 35) include triazoxide.

(b36) "Benzene-sulfonamide fungicides" (FRAC code 36) include flusulfamide.

(b37) "Pyridazinone fungicides" (FRAC code 37) include diclomezine.

(b38) "Thiophene-carboxamide fungicides" (FRAC code 38) are proposed to affect ATP production. Examples include silthiofam.

(b39) "Complex I NADH oxidoreductase inhibitor fungicides" (FRAC code 39) inhibit electron transport in mitochondria and include pyrimidinamines such as diflumetorim, and pyrazole-5-carboxamides such as tolfenpyrad.

(b40) "Carboxylic acid amide (CAA) fungicides" (FRAC code 40) inhibit cellulose synthase which prevents growth and leads to death of the target fungus. Carboxylic acid amide fungicides include cinnamic acid amide, valinamide and other carbamate, and

mandelic acid amide fungicides. The cinnamic acid amides include dimethomorph, flumorph and pyrimorph (3-(2-chloro-4-pyridinyl)-3-[4-(1,1-dimethylethyl)phenyl]-1-(4-morpholinyl)-2-propene-1-one). The valinamide and other carbamates include benthiavalicarb, benthiavalicarb-isopropyl, iprovalicarb, tolprocarb (2,2,2-trifluoroethyl *N*-[(1*S*)-2-methyl-1-[[(4-methylbenzoyl)amino]methyl]propyl]carbamate) and valifenalate (methyl *N*-[(1-methylethoxy)carbonyl]-L-valyl-3-(4-chlorophenyl)-β-alaninate) (also known as valiphenal). The mandelic acid amides include mandipropamid, *N*-[2-[4-[[3-(4-chlorophenyl)-2-propyn-1-yl]oxy]-3-methoxyphenyl]ethyl]-3-methyl-2-[(methylsulfonyl)amino]-butanamide and *N*-[2-[4-[[3-(4-chlorophenyl)-2-propyn-1-yl]oxy]-3-methoxyphenyl]ethyl]-3-methyl-2-[(ethylsulfonyl)amino]butanamide.

(b41) "Tetracycline antibiotic fungicides" (FRAC code 41) inhibit growth of fungi by affecting protein synthesis. Examples include oxytetracycline.

(b42) "Thiocarbamate fungicides" (FRAC code 42) include methasulfocarb.

(b43) "Benzamide fungicides" (FRAC code 43) inhibit growth of fungi by delocalization of spectrin-like proteins. Examples include pyridinylmethyl benzamide fungicides such as fluopicolide (now FRAC code 7, pyridinylethyl benzamides).

(b44) "Microbial fungicides" (FRAC code 44) disrupt fungal pathogen cell membranes. Microbial fungicides include *Bacillus* species such as *Bacillus amyloliquefaciens* strains QST 713, FZB24, MB1600, D747 and the fungicidal lipopeptides which they produce.

(b45) "Q_XI fungicides" (FRAC code 45) inhibit Complex III mitochondrial respiration in fungi by affecting ubiquinone reductase at an unknown (Q_X) site of the cytochrome bc_1 complex. Inhibiting mitochondrial respiration prevents normal fungal growth and development. Q_XI fungicides include triazolopyrimidylamines such as ametoctradin (5-ethyl-6-octyl[1,2,4]triazolo[1,5-*a*]pyrimidin-7-amine).

(b46) "Plant extract fungicides" are proposed to act by cell membrane disruption. Plant extract fungicides include terpene hydrocarbons and terpene alcohols such as the extract from *Melaleuca alternifolia* (tea tree).

(b47) "Host plant defense induction fungicides" (FRAC code P) induce host plant defense mechanisms. Host plant defense induction fungicides include benzothiadiazoles, benzisothiazole and thiadiazole-carboxamide fungicides. The benzothiadiazoles include acibenzolar-S-methyl. The benzisothiazoles include probenazole. The thiadiazole-carboxamides include tiadinil and isotianil.

(b48) "Multi-site contact fungicides" inhibit fungal growth through multiple sites of action and have contact/preventive activity. This class of fungicides includes: (b48.1) "copper fungicides" (FRAC code M1)", (b48.2) "sulfur fungicides" (FRAC code M2), (b48.3) "dithiocarbamate fungicides" (FRAC code M3), (b48.4) "phthalimide fungicides" (FRAC code M4), (b48.5) "chloronitrile fungicides" (FRAC code M5), (b48.6) "sulfamide fungicides" (FRAC code M6), (b48.7) multi-site contact "guanidine fungicides" (FRAC

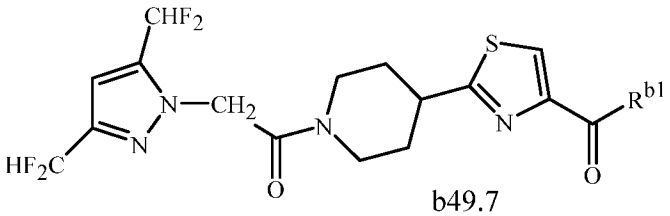
code M7), (b48.8) "triazine fungicides" (FRAC code M8), (b48.9) "quinone fungicides" (FRAC code M9), (b48.10) "quinoxaline fungicides" (FRAC code M10) and (b48.11) "maleimide fungicides" (FRAC code M11). "Copper fungicides" are inorganic compounds containing copper, typically in the copper(II) oxidation state; examples include copper oxychloride, copper sulfate and copper hydroxide, including compositions such as Bordeaux mixture (tribasic copper sulfate). "Sulfur fungicides" are inorganic chemicals containing rings or chains of sulfur atoms; examples include elemental sulfur. "Dithiocarbamate fungicides" contain a dithiocarbamate molecular moiety; examples include mancozeb, metiram, propineb, ferbam, maneb, thiram, zineb and ziram. "Phthalimide fungicides" contain a phthalimide molecular moiety; examples include folpet, captan and captafol. "Chloronitrile fungicides" contain an aromatic ring substituted with chloro and cyano; examples include chlorothalonil. "Sulfamide fungicides" include dichlofluanid and tolyfluanid. Multi-site contact "guanidine fungicides" include, guazatine, iminoctadine albesilate and iminoctadine triacetate. "Triazine fungicides" include anilazine. "Quinone fungicides" include dithianon. "Quinoxaline fungicides" include quinomethionate (also known as chinomethionate). "Maleimide fungicides" include fluoroimide.

(b49) "Fungicides other than fungicides of classes (b1) through (b48)" include certain fungicides whose mode of action may be unknown. These include: (b49.1), "phenyl-acetamide fungicides" (FRAC code U6), , (b49.2) " aryl-phenyl-ketone fungicides" (FRAC code U8), (b49.3) "guanidine fungicides" (FRAC code U12), (b49.4) "thiazolidine fungicides" (FRAC code U13), (b49.5) "pyrimidinone-hydrazone fungicides" (FRAC code U14) and (b49.6) compounds that bind to oxysterol-binding protein as described in PCT Patent Publication WO 2013/009971. The phenyl-acetamides include cyflufenamid and *N*-[[(cyclopropylmethoxy)amino][6-(difluoromethoxy)-2,3-difluorophenyl]-methylene]-benzeneacetamide. The aryl-phenyl ketones include benzophenones such as metrafenone, and benzoylpyridines such as pyriofenone (5-chloro-2-methoxy-4-methyl-3-pyridinyl)(2,3,4-trimethoxy-6-methylphenyl)methanone). The quanidines include dodine. The thiazolidines include flutianil ((2*Z*)-2-[[2-fluoro-5-(trifluoromethyl)phenyl]thio]-2-[3-(2-methoxyphenyl)-2-thiazolidinylidene]acetonitrile). The pyrimidinonehydrazones include ferimzone. The (b49.6) class includes oxathiapiprolin (1-[4-[4-[5-(2,6-difluorophenyl)-4,5-dihydro-3-isoxazolyl]-2-thiazolyl]-1-piperidinyl]-2-[5-methyl-3-(trifluoromethyl)-1*H*-pyrazol-1-yl]ethanone) and its R-enantiomer which is 1-[4-[4-[5*R*-(2,6-difluorophenyl)-4,5-dihydro-3-isoxazolyl]-2-thiazolyl]-1-piperidinyl]-2-[5-methyl-3-(trifluoromethyl)-1*H*-pyrazol-1-yl]-ethanone (Registry Number 1003319-79-6). The (b49) class also includes bethoxazin, flometoquin (2-ethyl-3,7-dimethyl-6-[4-(trifluoromethoxy)phenoxy]-4-quinolinyl methyl carbonate), fluoroimide, neo-asozin (ferric methanearsonate), picarbutrazox (1,1-dimethyl-ethyl *N*-[6-[[[[((Z)1-methyl-1*H*-tetrazol-5-yl)phenylmethylene]amino]oxy]methyl]-2-pyridinyl]carbamate), pyrrolnitrin, quinomethionate, tebufloquin (6-(1,1-dimethylethyl)-8-fluoro-2,3-dimethyl-4-quinolinyl acetate), tolnifanide (N-(4-chloro-2-nitrophenyl)-N-ethyl-

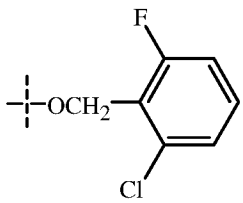
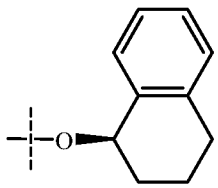
4-methylbenzenesulfonamide), 2-butoxy-6-iodo-3-propyl-4*H*-1-benzopyran-4-one, 3-butyn-1-yl *N*-[6-[[[[(1-methyl-1*H*-tetrazol-5-yl)phenylmethylene]amino]oxy]methyl]-2-pyridinyl]-carbamate, (*N*-(4-chloro-2-nitrophenyl)-*N*-ethyl-4-methylbenzenesulfonamide), *N*'-[4-[4-chloro-3-(trifluoromethyl)phenoxy]-2,5-dimethylphenyl]-*N*-ethyl-*N*-methylmethanimid-amide, *N*-[[(cyclopropylmethoxy)amino][6-(difluoromethoxy)-2,3-difluorophenyl]-methylene]benzeneacetamide, 2,6-dimethyl-1*H*,5*H*-[1,4]dithiino[2,3-*c*:5,6-*c*']dipyrrole-1,3,5,7(2*H*,6*H*)-tetrone, 5-fluoro-2-[(4-methylphenyl)methoxy]-4-pyrimidinamine, 5-fluoro-2-[(4-fluorophenyl)methoxy]-4-pyrimidinamine and 4-fluorophenyl *N*-[1-[[[1-(4-cyano-phenyl)ethyl]sulfonyl]methyl]propyl]carbamate, pentyl *N*-[6-[[[[(1-methyl-1*H*-tetrazol-5-yl)phenylmethylene]amino]oxy]methyl]-2-pyridinyl]carbamate, pentyl *N*-[4-[[[[(1-methyl-1*H*-tetrazol-5-yl)phenylmethylene]amino]oxy]methyl]-2-thiazolyl]carbamate and pentyl *N*-[6-[[[[(Z)-(1-methyl-1*H*-tetrazol-5-yl)phenylmethylene]amino]oxy]methyl]-2-pyridinyl]-carbamate. The (b46) class further includes mitosis- and cell division-inhibiting fungicides besides those of the particular classes described above (e.g., (b1), (b10) and (b22)).

Additional "Fungicides other than fungicides of classes (1) through (46)" whose mode of action may be unknown, or may not yet be classified include a fungicidal compound selected from components (b49.7) through (b49.12), as shown below.

Component (b49.7) relates to a compound of Formula b49.7

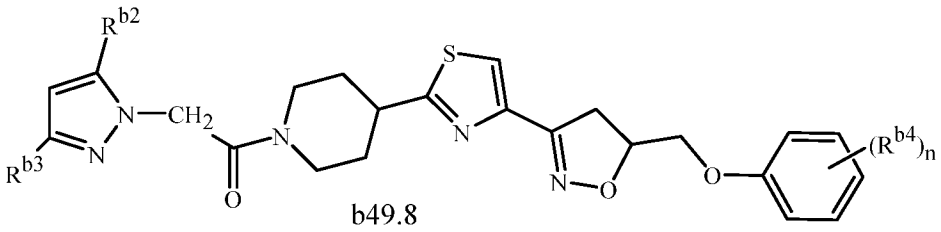


b49.7

wherein R^{b1} is  or  .

Examples of a compound of Formula b49.7 include (b49.7a) (2-chloro-6-fluorophenyl)-methyl 2-[1-[2-[3,5-bis(difluoromethyl)-1*H*-pyrazol-1-yl]acetyl]-4-piperidinyl]-4-thiazole-carboxylate (Registry Number 1299409-40-7) and (b49.7b) (1*R*)-1,2,3,4-tetrahydro-1-naphthalenyl 2-[1-[2-[3,5-bis(difluoromethyl)-1*H*-pyrazol-1-yl]acetyl]-4-piperidinyl]-4-thiazolecarboxylate (Registry Number 1299409-42-9). Methods for preparing compounds of Formula b46.2 are described in PCT Patent Publications WO 2009/132785 and WO 2011/051243.

Component (b49.8) relates to a compound of Formula b49.8

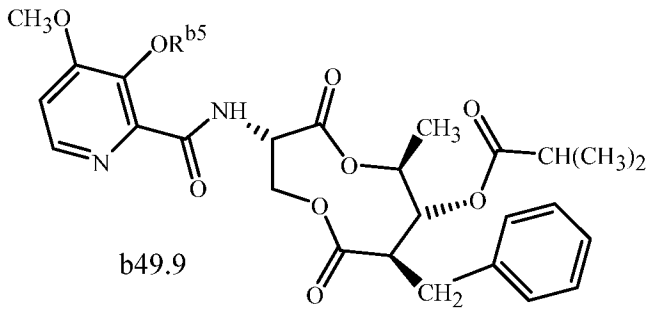


b49.8

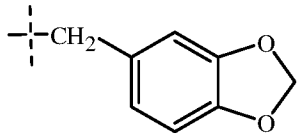
wherein R^{b2} is CH_3, CF_3 or CHF_2; R^{b3} is CH_3, CF_3 or CHF_2; R^{b4} is halogen or cyano; and n is 0, 1, 2 or 3.

Examples of a compound of Formula b49.8 include (b49.8a) 1-[4-[4-[5-[(2,6-difluorophenoxy)methyl]-4,5-dihydro-3-isoxazolyl]-2-thiazolyl]-1-piperdinyl]-2-[5-methyl-3-(trifluoromethyl)-1*H*-pyrazol-1-yl]ethanone. Methods for preparing compounds of Formula b49.8 are described in PCT Patent Application PCT/US11/64324.

Component (b4799) relates to a compound of Formula b49.9



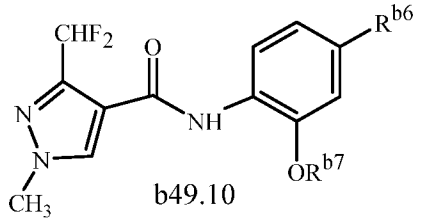
b49.9

wherein R^{b5} is $-CH_2OC(O)CH(CH_3)_2$, $-C(O)CH_3$, $-CH_2OC(O)CH_3$, $-C(O)OCH_2CH(CH_3)_2$ or  .

Examples of a compound of Formula b49.9 include (b49.9a) [[4-methoxy-2-[[[(3*S*,7*R*,8*R*,9*S*)-9-methyl-8-(2-methyl-1-oxopropoxy)-2,6-dioxo-7-(phenylmethyl)-1,5-dioxonan-3-yl]amino]carbonyl]-3-pyridinyl]oxy]methyl 2-methylpropanoate (also known as fenpicoxamid) (Registry Number 517875-34-2), (b49.9b) (3*S*,6*S*,7*R*,8*R*)-3-[[[3-(acetyloxy)-4-methoxy-2-pyridinyl]carbonyl]amino]-6-methyl-4,9-dioxo-8-(phenylmethyl)-1,5-dioxonan-7-yl 2-methylpropanoate (Registry Number 234112-93-7), (b49.9c) (3*S*,6*S*,7*R*,8*R*)-3[[[3[(acetyloxy)methoxy]-4-methoxy-2-pyridinyl]carbonyl]amino]-6-methyl-4,9-dioxo-8-(phenylmethyl)-1,5-dioxonan-7-yl 2-methylpropanoate (Registry Number 517875-31-9), (b49.9d) (3*S*,6*S*,7*R*,8*R*)-3-[[[4-methoxy-3-[[(2-methylpropoxy)carbonyl]oxy]-2-pyridinyl]-carbonyl]amino]6-methyl-4,9-dioxo-8-(phenylmethyl)-1,5-dioxonan-7-yl 2-methyl-propanoate (Registry Number 328256-72-0), and (b49.9e) *N*-[[3-(1,3-benzodioxol-5-ylmethoxy)-4-methoxy-2-pyridinyl]carbonyl]-*O*-[2,5-dideoxy-3-*O*-(2-methyl-1-oxopropyl)-2-(phenylmethyl)L-arabinonoyl]-L-serine, (1→4')-lactone (Registry Number 1285706-70-8).

Methods for preparing compounds of Formula b49.9 are described in PCT Patent Publications WO 99/40081, WO 2001/014339, WO 2003/035617 and WO 2011044213.

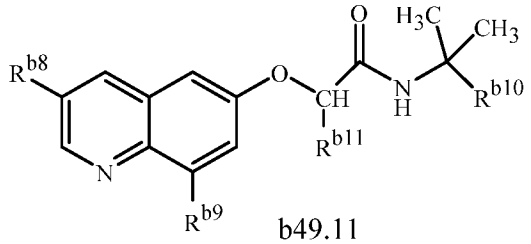
Component (b49.10) relates to a compound of Formula b49.10



b49.10

wherein R^{b6} is H or F, and R^{b7} is $-CF_2CHFCF_3$ or $-CF_2CF_2H$. Examples of a compound of Formula b49.10 are (b49.10a) 3-(difluoromethyl)-*N*-[4-fluoro-2-(1,1,2,3,3,3-hexafluoropropoxy)phenyl]-1-methyl-1*H*-pyrazole-4-carboxamide (Registry Number 1172611-40-3) and (b49.10b) 3-(difluoromethyl)-1-methyl-*N*-[2-(1,1,2,2-tetrafluoroethoxy)phenyl]-1*H*-pyrazole4-carboxamide (Registry Number 923953-98-4). Compounds of Formula 49.10 can be prepared by methods described in PCT Patent Publication WO 2007/017450.

Component b49.11 relates a compound of Formula b49.11



b49.11

wherein

R^{b8} is halogen, C_1-C_4 alkoxy or C_2-C_4 alkynyl;

R^{b9} is H, halogen or C_1-C_4 alkyl;

R^{b10} is C_1-C_{12} alkyl, C_1-C_{12} haloalkyl, C_1—C_{12} alkoxy, C_2-C_{12} alkoxyalkyl, C_2-C_{12} alkenyl, C_2-C_{12} alkynyl, C_4-C_{12} alkoxyalkenyl, C_4-C_{12} alkoxyalkynyl, C_1-C_{12} alkylthio or C_2-C_{12} alkylthioalkyl;

R^{b11} is methyl or $-Y^{b13}$-R^{b12};

R^{b12} is C_1-C_2 alkyl; and

Y^{b13} is CH_2, O or S.

Examples of compounds of Formula b49.11 include (b49.11a) 2-[(3-bromo-6-quinolinyl)-oxy]-*N*-(1,1-dimethyl-2-butyn-1-yl)-2-(methylthio)acetamide, (b49.11b) 2[(3-ethynyl-6-quinolinyl)oxy]-*N*-[1-(hydroxymethyl)-1-methyl-2-propyn-1-yl]-2-(methylthio)acetamide, (b49.11c) *N*-(1,1-dimethyl-2-butyn-1-yl)-2-[(3-ethynyl-6-quinolinyl)oxy]-2-(methylthio)-acetamide, (b49.11d) 2-[(3-bromo-8-methyl-6-quinolinyl)oxy]-*N*-(1,1-dimethyl-2-propyn-1-yl)-2-(methylthio)acetamide and (b49.11e) 2-[(3-bromo-6-quinolinyl)oxy]-*N*-(1,1-dimethylethyl)butanamide. Compounds of Formula b49.11, their use as fungicides and methods of preparation are generally known; see, for example, PCT Patent Publications WO

2004/047538, WO 2004/108663, WO 2006/058699, WO 2006/058700, WO 2008/110355, WO 2009/030469, WO 2009/049716 and WO 2009/087098.

Component 49.12 relates to *N*'-[4-[[3-[(4-chlorophenyl)methyl]-1,2,4-thiadiazol-5-yl]oxy]-2,5-dimethylphenyl]-*N*-ethyl-*N*-methylmethanimidamide, which is believed to inhibit C24-methyl transferase involved in the biosynthesis of sterols.

Therefore of note is a mixture (i.e. composition) comprising a compound of Formula **1** and at least one fungicidal compound selected from the group consisting of the aforedescribed classes (1) through (49). Also of note is a composition comprising said mixture (in fungicidally effective amount) and further comprising at least one additional component selected from the group consisting of surfactants, solid diluents and liquid diluents. Of particular note is a mixture (i.e. composition) comprising a compound of Formula **1** and at least one fungicidal compound selected from the group of specific compounds listed above in connection with classes (1) through (49). Also of particular note is a composition comprising said mixture (in fungicidally effective amount) and further comprising at least one additional surfactant selected from the group consisting of surfactants, solid diluents and liquid diluents.

Examples of component (b) fungicides include acibenzolar-S-methyl, aldimorph, ametoctradin, amisulbrom, anilazine, azaconazole, azoxystrobin, benalaxyl (including benalaxyl-M), benodanil, benomyl, benthiavalicarb (including benthiavalicarb-isopropyl), benzovindiflupyr, bethoxazin, binapacryl, biphenyl, bitertanol, bixafen, blasticidin-S, boscalid, bromuconazole, bupirimate, buthiobate, captafol, captan, carbendazim, carboxin, carpropamid, chloroneb, chlorothalonil, chlozolinate, clotrimazole, copper hydroxide, copper oxychloride, copper sulfate, coumoxystrobin, cyazofamid, cyflufenamid, cymoxanil, cyproconazole, cyprodinil, dichlofluanid, diclocymet, diclomezine, dicloran, diethofencarb, difenoconazole, diflumetorim, dimethirimol, dimethomorph, dimoxystrobin, diniconazole (including diniconazole-M), dinocap, dithianon, dithiolanes, dodemorph, dodine, econazole, edifenphos, enoxastrobin (also known as enestroburin), epoxiconazole, etaconazole, ethaboxam, ethirimol, etridiazole, famoxadone, fenamidone, fenarimol, fenaminstrobin, fenbuconazole, fenfuram, fenhexamid, fenoxanil, fenpiclonil, fenpropidin, fenpropimorph, fenpyrazamine, fentin acetate, fentin chloride, fentin hydroxide, ferbam, ferimzone, flometoquin, fluazinam, fludioxonil, flufenoxystrobin, flumorph, fluopicolide, fluopyram, flouroimide, fluoxastrobin, fluquinconazole, flusilazole, flusulfamide, flutianil, flutolanil, flutriafol, fluxapyroxad, folpet, fthalide, fuberidazole, furalaxyl, furametpyr, guazatine, hexaconazole, hymexazole, imazalil, imibenconazole, iminoctadine albesilate, iminoctadine triacetate, iodocarb, ipconazole, iprobenfos, iprodione, iprovalicarb, isoconazole, isofetamid, isoprothiolane, isopyrazam, isotianil, kasugamycin, kresoxim-methyl, mancozeb, mandepropamid, mandestrobin, maneb, mepanipyrim, mepronil, meptyldinocap, metalaxyl (including metalaxyl-M/mefenoxam), metconazole, methasulfocarb, metiram, metominostrobin, metrafenone, miconazole, myclobutanil, naftifine, neo-asozin, nuarimol,

octhilinone, ofurace, orysastrobin, oxadixyl, oxathiapiprolin, oxolinic acid, oxpoconazole, oxycarboxin, oxytetracycline, pefurazoate, penconazole, pencycuron, penflufen, penthiopyrad, phosphorous acid (including salts thereof, e.g., fosetyl-aluminum), picarbutrazox, picoxystrobin, piperalin, polyoxin, probenazole, prochloraz, procymidone, propamacarb, propiconazole, propineb, proquinazid, prothiocarb, prothioconazole, pyraclostrobin, pyrametostrobin, pyraoxystrobin, pyrazophos, pyribencarb, pyributicarb, pyrifenox, pyrimethanil, pyriofenone, pyrisoxazole, pyroquilon, pyrrolnitrin, quinconazole, quinomethionate, quinoxyfen, quintozene, sedaxane, silthiofam, simeconazole, spiroxamine, streptomycin, sulfur, tebuconazole, tebufloquin, teclofthalam, tecnazene, terbinafine, tetraconazole, thiabendazole, thifluzamide, thiophanate, thiophanate-methyl, thiram, tiadinil, tolclofos-methyl, tolnifanide, tolprocarb, tolyfluanid, triadimefon, triadimenol, triarimol, triticonazole, triazoxide, tribasic copper sulfate, tricyclazole, triclopyricarb, tridemorph, trifloxystrobin, triflumizole, triforine, trimorphamide, uniconazole, uniconazole-P, validamycin, valifenalate (also known as valiphenal), vinclozolin, zineb, ziram, zoxamide, (3*S*,6*S*,7*R*,8*R*)-3-[[[3-[(acetyloxy)methoxy]-4-methoxy-2-pyridinyl]carbonyl]amino]-6-methyl-4,9-dioxo-8-(phenylmethyl)-1,5-dioxonan-7-yl 2-methylpropanoate, (3*S*,6*S*,7*R*,8*R*)-3-[[[3-(acetyloxy)-4-methoxy-2-pyridinyl]carbonyl]amino]-6-methyl-4,9-dioxo-8-(phenylmethyl)-1,5-dioxonan-7-yl 2-methylpropanoate, *N*-[[3-(1,3-benzodioxol-5-ylmethoxy)-4-methoxy-2-pyridinyl]carbonyl]-*O*-[2,5-dideoxy-3-*O*-(2-methyl-1-oxopropyl)-2-(phenylmethyl)-L-arabinonoyl]-L-serine, (1→4')-lactone, *N*-[2-(1*S*,2*R*)-[1,1'-bicyclopropyl]-2-ylphenyl]-3-(difluoromethyl)-1-methyl-1*H*-pyrazole-4-carboxamide, 2-[(3-bromo-6-quinolinyl)oxy]-*N*-(1,1-dimethyl-2-butyn-1-yl)-2-(methylthio)acetamide, 2-[(3-bromo-6-quinolinyl)oxy]-*N*-(1,1-dimethylethyl)butanamide, 2-[(3-bromo-8-methyl-6-quinolinyl)oxy]-*N*-(1,1-dimethyl-2-propyn-1-yl)-2-(methylthio)acetamide, 2-butoxy-6-iodo-3-propyl-4*H*-1-benzopyran-4-one, 3-butyn-1-yl *N*-[6-[[[[(1-methyl-1*H*-tetrazol-5-yl)phenylmethylene]-amino]oxy]methyl]-2-pyridinyl]carbamate, α-(1-chlorocyclopropyl)-α-[2-(2,2-dichloro-cyclopropyl)ethyl]-1*H*-1,2,4-triazole-1-ethanol, 2-[2-(1-chlorocyclopropyl)-4-(2,2-dichloro-cyclopropyl)-2-hydroxybutyl]-1,2-dihydro-3*H*-1,2,4-triazole-3-thione, (α*S*)-[3-(4-chloro-2-fluorophenyl)-5-(2,4-difluorophenyl)-4-isoxazolyl]-3-pyridinemethanol, *rel*-1-[[(2*R*,3*S*)-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]methyl]-1*H*-1,2,4-triazole, *rel*-2-[[(2*R*,3*S*)-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]methyl]-1,2-dihydro-3*H*-1,2,4-triazole-3-thione, *rel*-1-[[(2*R*,3*S*)-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]methyl]-5-(2-propen-1-ylthio)-1*H*-1,2,4-triazole, 3-[5-(4-chlorophenyl)-2,3-dimethyl-3-isoxazolidinyl]pyridine, (2-chloro-6-fluorophenyl)methyl 2-[1-[2-[3,5-bis(difluoromethyl)-1*H*-pyrazol-1-yl]acetyl]-4-piperidinyl]-4-thiazolecarboxylate, *N*'-[4-[[3-[(4-chlorophenyl)methyl]-1,2,4-thiadiazol-5-yl]oxy]-2,5-dimethylphenyl]-*N*-ethyl-*N*-methyl-methanimidamide, *N*-[2-[4-[[3-(4-chlorophenyl)-2-propyn-1-yl]oxy]-3-methoxyphenyl]-ethyl]-3-methyl-2-[(methylsulfonyl)amino]butanamide, *N*-[2-[4-[[3-(4-chlorophenyl)-2-propyn-1-yl]oxy]-3-methoxyphenyl]ethyl]-3-methyl-2-[(ethylsulfonyl)amino]butanamide,

N'-[4-[4-chloro-3-(trifluoromethyl)phenoxy]-2,5-dimethylphenyl]-*N*-ethyl-*N*-methyl-methanimidamide, *N*-cyclopropyl-3-(difluoromethyl)-5-fluoro-1-methyl-*N*-[[2-(1-methylethyl)phenyl]methyl]-1*H*-pyrazole-4-carboxamide, *N*-[[(cyclopropylmethoxy)amino][6-(difluoromethoxy)-2,3-difluorophenyl]methylene]benzeneacetamide, *N*-[2-(2,4-dichlorophenyl)-2-methoxy-1-methylethyl]-3-(difluoromethyl)-1-methyl-1*H*-pyrazole-4-carboxamide, *N*-(3',4'-difluoro[1,1'-biphenyl]-2-yl)-3-(trifluoromethyl)-2-pyrazinecarboxamide, 3-(difluoromethyl)-*N*-(2,3-dihydro-1,1,3-trimethyl-1*H*-inden-4-yl)-1-methyl-1*H*-pyrazole-4-carboxamide, 3-(difluoromethyl)-*N*-[4-fluoro-2-(1,1,2,3,3,3-hexafluoropropoxy)-phenyl]-1-methyl-1*H*-pyrazole-4-carboxamide, 5,8-difluoro-*N*-[2-[3-methoxy-4-[[4-(trifluoromethyl)-2-pyridinyl]oxy]phenyl]ethyl]-4-quinazolinamine, 3-(difluoromethyl)-1-methyl-*N*-[2-(1,1,2,2-tetrafluoroethoxy)phenyl]-1*H*-pyrazole-4-carboxamide, 1-[4-[4-[5*R*-[(2,6-difluorophenoxy)methyl]-4,5-dihydro-3-isoxazolyl]-2-thiazolyl]-1-piperdinyl]-2-[5-methyl-3-(trifluoromethyl)-1*H*-pyrazol-1-yl]ethanone, *N*-(1,1-dimethyl-2-butyn-1-yl)-2-[(3-ethynyl-6-quinolinyl)oxy]-2-(methylthio)acetamide, 2,6-dimethyl-1*H*,5*H*-[1,4]dithiino[2,3-*c*:5,6-*c*']dipyrrole-1,3,5,7(2*H*,6*H*)-tetrone, 2-[(3-ethynyl-6-quinolinyl)oxy]-*N*-[1-(hydroxymethyl)-1-methyl-2-propyn-1-yl]-2-(methylthio)acetamide, 4-fluorophenyl *N*-[1-[[[1-(4-cyanophenyl)ethyl]sulfonyl]methyl]propyl]carbamate, 5-fluoro-2-[(4-fluorophenyl)-methoxy]-4-pyrimidinamine, 5-fluoro-2-[(4-methylphenyl)methoxy]-4-pyrimidinamine, (3*S*,6*S*,7*R*,8*R*)-3-[[[4-methoxy-3-[[(2-methylpropoxy)carbonyl]oxy]-2-pyridinyl]-carbonyl]amino]-6-methyl-4,9-dioxo-8-(phenylmethyl)-1,5-dioxonan-7-yl-2-methylpropanoate, α-(methoxyimino)-*N*-methyl-2-[[[1-[3-(trifluoromethyl)phenyl]ethoxy]imino]-methyl]benzeneacetamide, [[4-methoxy-2-[[[(3*S*,7*R*,8*R*,9*S*)-9-methyl-8-(2-methyl-1-oxopropoxy)-2,6-dioxo-7-(phenylmethyl)-1,5-dioxonan-3-yl]amino]carbonyl]-3-pyridinyl]oxy]methyl 2-methylpropanoate, pentyl *N*-[6-[[[[(1-methyl-1*H*-tetrazol-5-yl)-phenylmethylene]amino]oxy]methyl]-2-pyridinyl]carbamate, pentyl *N*-[4-[[[[(1-methyl-1*H*-tetrazol-5-yl)phenylmethylene]amino]oxy]methyl]-2-thiazolyl]carbamate, and pentyl *N*-[6-[[[[(Z)-(1-methyl-1*H*-tetrazol-5-yl)phenylmethylene]amino]oxy]methyl]-2-pyridinyl]-carbamate and (1*R*)-1,2,3,4-tetrahydro-1-naphthalenyl 2-[1-[2-[3,5-bis(difluoromethyl)-1*H*-pyrazol-1-yl]acetyl]-4-piperidinyl]-4-thiazolecarboxylate. Therefore of note is a fungicidal composition comprising as component (a) a compound of Formula **1** (or an *N*-oxide or salt thereof) and as component (b) at least one fungicide selected from the preceding list.

Of particular note are combinations of compounds of Formula 1 (or an N-oxide or salt thereof) (i.e. Component (a) in compositions) with azoxystrobin, benzovindiflupyr, bixafen, captan, carpropamid, chlorothalonil, copper hydroxide, copper oxychloride, copper sulfate, cymoxanil, cyproconazole, cyprodinil, diethofencarb, difenoconazole, dimethomorph, epoxiconazole, ethaboxam, fenarimol, fenhexamid, fluazinam, fludioxonil, fluopyram, flusilazole, flutianil, flutriafol, fluxapyroxad, folpet, iprodione, isofetamid, isopyrazam, kresoxim-methyl, mancozeb, mandestrobin, meptyldinocap, metalaxyl (including metalaxyl-M/mefenoxam), metconazole, metrafenone, myclobutanil, oxathiapiprolin, penflufen,

penthiopyrad, phosphorous acid (including salts thereof, e.g., fosetyl-aluminum), picoxystrobin, propiconazole, proquinazid, prothioconazole, pyraclostrobin, pyrimethanil, sedaxane spiroxamine, sulfur, tebuconazole, thiophanate-methyl, trifloxystrobin, zoxamide, α-(1-chlorocyclopropyl)-α-[2-(2,2-dichlorocyclopropyl)ethyl]-1*H*-1,2,4-triazole-1-ethanol, 2-[2-(1chlorocyclopropyl)-4-(2,2-dichlorocyclopropyl)-2-hydroxybutyl]-1,2-dihydro-3*H*-1,2,4-triazole-3-thione, *N*-[2-(2,4-dichlorophenyl)-2-methoxy-1-methylethyl]-3-(difluoromethyl)-1-methyl-1*H*-pyrazole-4-carboxamide, 3-(difluoromethyl)-*N*-(2,3-dihydro-1,1,3-trimethyl-1*H*-inden-4-yl)-1-methyl-1*H*-pyrazole-4-carboxamide, 1-[4-[4-[5*R*-(2,6-difluorophenyl)-4,5-dihydro-3-isoxazolyl]-2-thiazolyl]-1-piperidinyl]-2-[5-methyl-3-(trifluoromethyl)-1*H*-pyrazol-1-yl]ethanone, 1,1-dimethylethyl *N*-[6-[[[[(1-methyl-1*H*-tetrazol-5-yl)phenylmethylene]amino]oxy]methyl]-2-pyridinyl]carbamate, 2,6-dimethyl-1*H*,5*H*-[1,4]dithiino[2,3-*c*:5,6-*c*']dipyrrole-1,3,5,7(2*H*,6*H*)-tetrone, 5-fluoro-2-[(4-fluorophenyl)methoxy]-4-pyrimidinamine, 5-fluoro-2-[(4-methylphenyl)methoxy]-4-pyrimidinamine, (α*S*)-[3-(4-chloro-2-fluorophenyl)-5-(2,4-difluorophenyl)-4-isoxazolyl]-3-pyridinemethanol, *rel*-1-[[(2*R*,3*S*)-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]methyl]-1*H*-1,2,4-triazole, *rel*-2-[[(2*R*,3*S*)-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]-methyl]-1,2-dihydro-3*H*-1,2,4-triazole-3-thione, and *rel*-1-[[(2*R*,3*S*)-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]methyl]-5-(2-propen-1-ylthio)-1*H*-1,2,4-triazole (i.e. as Component (b) in compositions).

Examples of other biologically active compounds or agents with which compounds of this invention can be formulated are: invertebrate pest control compounds or agents such as abamectin, acephate, acetamiprid, acrinathrin, afidopyropen ([(3*S*,4*R*,4a*R*,6*S*,6a*S*,12*R*,12a*S*,12b*S*)-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)-2*H*,11*H*-naphtho[2,1-*b*]pyrano[3,4-*e*]pyran-4-yl]methyl cyclopropanecarboxylate), amidoflumet (S-1955), avermectin, azadirachtin, azinphos-methyl, bifenthrin, bifenazate, buprofezin, carbofuran, cartap, chlorantraniliprole, chlorfenapyr, chlorfluazuron, chlorpyrifos, chlorpyrifos-methyl, chromafenozide, clothianidin, cyantraniliprole (3-bromo-1-(3-chloro-2-pyridinyl)-*N*-[4-cyano-2-methyl-6-[(methylamino)carbonyl]phenyl]-1*H*-pyrazole-5-carboxamide), cyclaniliprole (3-bromo-*N*-[2-bromo-4-chloro-6-[[(1-cyclopropylethyl)amino]carbonyl]phenyl]-1-(3-chloro-2-pyridinyl)-1*H*-pyrazole-5-carboxamide), cycloxaprid ((5*S*,8*R*)-1-[(6-chloro-3-pyridinyl)methyl]-2,3,5,6,7,8-hexahydro-9-nitro-5,8-epoxy-1*H*-imidazo[1,2-*a*]azepine), cyflumetofen, cyfluthrin, beta-cyfluthrin, cyhalothrin, lambda-cyhalothrin, cypermethrin, cyromazine, deltamethrin, diafenthiuron, diazinon, dieldrin, diflubenzuron, dimefluthrin, dimethoate, dinotefuran, diofenolan, emamectin, endosulfan, esfenvalerate, ethiprole, fenothiocarb, fenoxycarb, fenpropathrin, fenvalerate, fipronil, flonicamid, flubendiamide, flucythrinate, flufenoxystrobin (methyl (α*E*)-2-[[2-chloro-4-(trifluoromethyl)phenoxy]methyl]-α-(methoxymethylene)benzeneacetate), flufensulfone (5-chloro-2-[(3,4,4-trifluoro-3-buten-1-yl)sulfonyl]thiazole), flupiprole (1-

[2,6-dichloro-4-(trifluoromethyl)phenyl]-5-[(2-methyl-2-propen-1-yl)amino]-4-[(trifluoromethyl)sulfinyl]-1*H*-pyrazole-3-carbonitrile), flupyradifurone (4-[[(6-chloro-3-pyridinyl)methyl](2,2-difluoroethyl)amino]-2(5*H*)-furanone), tau-fluvalinate, flufenerim (UR-50701), flufenoxuron, fonophos, halofenozide, heptafluthrin ([2,3,5,6-tetrafluoro-4-(methoxymethyl)phenyl]methyl 2,2-dimethyl-3-[(1*Z*)-3,3,3-trifluoro-1-propen-1-yl]cyclopropanecarboxylate), hexaflumuron, hydramethylnon, imidacloprid, indoxacarb, isofenphos, lufenuron, malathion, meperfluthrin ([2,3,5,6-tetrafluoro-4-(methoxymethyl)phenyl]methyl (1*R*,3*S*)-3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate), metaflumizone, metaldehyde, methamidophos, methidathion, methomyl, methoprene, methoxychlor, methoxyfenozide, metofluthrin, milbemycin oxime, momfluorothrin ([2,3,5,6-tetrafluoro-4-(methoxymethyl)phenyl]methyl-3-(2-cyano-1-propen-1-yl)-2,2-dimethylcyclopropanecarboxylate), monocrotophos, nicotine, nitenpyram, nithiazine, novaluron, noviflumuron (XDE-007), oxamyl, pyflubumide (1,3,5-trimethyl-*N*-(2-methyl-1-oxopropyl)-*N*-[3-(2-methylpropyl)-4-[2,2,2-trifluoro-1-methoxy-1-(trifluoromethyl)ethyl]phenyl]-1*H*-pyrazole-4-carboxamide), parathion, parathion-methyl, permethrin, phorate, phosalone, phosmet, phosphamidon, pirimicarb, profenofos, profluthrin, pymetrozine, pyrafluprole, pyrethrin, pyridalyl, pyrifluquinazon, pyriminostrobin (methyl (α*E*)-2-[[[2-[(2,4-dichlorophenyl)amino]-6-(trifluoromethyl)-4-pyrimidinyl]oxy]methyl]-α-(methoxymethylene)benzeneacetate), pyriprole, pyriproxyfen, rotenone, ryanodine, spinetoram, spinosad, spirodiclofen, spiromesifen (BSN 2060), spirotetramat, sulfoxaflor, sulprofos, tebufenozide, teflubenzuron, tefluthrin, terbufos, tetrachlorvinphos, tetramethylfluthrin, thiacloprid, thiamethoxam, thiodicarb, thiosultap-sodium, tolfenpyrad, tralomethrin, triazamate, trichlorfon and triflumuron; and biological agents including entomopathogenic bacteria, such as *Bacillus thuringiensis* subsp. *aizawai*, *Bacillus thuringiensis* subsp. *kurstaki*, and the encapsulated delta-endotoxins of *Bacillus thuringiensis* (e.g., Cellcap, MPV, MPVII); entomopathogenic fungi, such as green muscardine fungus; and entomopathogenic virus including baculovirus, nucleopolyhedro virus (NPV) such as HzNPV, AfNPV; and granulosis virus (GV) such as CpGV.

Compounds of this invention and compositions thereof can be applied to plants genetically transformed to express proteins toxic to invertebrate pests (such as *Bacillus thuringiensis* delta-endotoxins). The effect of the exogenously applied fungicidal compounds of this invention may be synergistic with the expressed toxin proteins.

General references for agricultural protectants (i.e. insecticides, fungicides, nematocides, acaricides, herbicides and biological agents) include *The Pesticide Manual, 13th Edition*, C. D. S. Tomlin, Ed., British Crop Protection Council, Farnham, Surrey, U.K., 2003 and *The BioPesticide Manual, 2nd Edition*, L. G. Copping, Ed., British Crop Protection Council, Farnham, Surrey, U.K., 2001.

For embodiments where one or more of these various mixing partners are used, the weight ratio of these various mixing partners (in total) to the compound of Formula **1** is

typically between about 1:3000 and about 3000:1. Of note are weight ratios between about 1:300 and about 300:1 (for example ratios between about 1:30 and about 30:1). One skilled in the art can easily determine through simple experimentation the biologically effective amounts of active ingredients necessary for the desired spectrum of biological activity. It will be evident that including these additional components may expand the spectrum of diseases controlled beyond the spectrum controlled by the compound of Formula **1** alone.

In certain instances, combinations of a compound of this invention with other biologically active (particularly fungicidal) compounds or agents (i.e. active ingredients) can result in a greater-than-additive (i.e. synergistic) effect. Reducing the quantity of active ingredients released in the environment while ensuring effective pest control is always desirable. When synergism of fungicidal active ingredients occurs at application rates giving agronomically satisfactory levels of fungal control, such combinations can be advantageous for reducing crop production cost and decreasing environmental load.

Also in certain instances, combinations of a compound of the invention with other biologically active compounds or agents can result in a less-than-additive (i.e. safening) effect on organisms beneficial to the agronomic environment. For example, a compound of the invention may safen a herbicide on crop plants or protect a beneficial insect species (e.g., insect predators, pollinators such as bees) from an insecticide.

Fungicides of note for formulation with compounds of Formula **1** to provide mixtures useful in seed treatment include but are not limited to amisulbrom, azoxystrobin, boscalid, carbendazim, carboxin, cymoxanil, cyproconazole, difenoconazole, dimethomorph, fluazinam, fludioxonil, flufenoxystrobin, fluquinconazole, fluopicolide, fluoxastrobin, flutriafol, fluxapyroxad, ipconazole, iprodione, metalaxyl, mefenoxam, metconazole, myclobutanil, paclobutrazole, penflufen, picoxystrobin, prothioconazole, pyraclostrobin, sedaxane, silthiofam, tebuconazole, thiabendazole, thiophanate-methyl, thiram, trifloxystrobin and triticonazole.

Invertebrate pest control compounds or agents with which compounds of Formula **1** can be formulated to provide mixtures useful in seed treatment include but are not limited to abamectin, acetamiprid, acrinathrin, afidopyropen, amitraz, avermectin, azadirachtin, bensultap, bifenthrin, buprofezin, cadusafos, carbaryl, carbofuran, cartap, chlorantraniliprole, chlorfenapyr, chlorpyrifos, clothianidin, cyantraniliprole, cyclaniliprole, cyfluthrin, beta-cyfluthrin, cyhalothrin, gamma-cyhalothrin, lambda-cyhalothrin, cypermethrin, alpha-cypermethrin, zeta-cypermethrin, cyromazine, deltamethrin, dieldrin, dinotefuran, diofenolan, emamectin, endosulfan, esfenvalerate, ethiprole, etofenprox, etoxazole, fenothiocarb, fenoxycarb, fenvalerate, fipronil, flonicamid, flubendiamide, fluensulfone, flufenoxuron, flufiprole, flupyradifurone, fluvalinate, formetanate, fosthiazate, heptafluthrin, hexaflumuron, hydramethylnon, imidacloprid, indoxacarb, lufenuron, meperfluthrin, metaflumizone, methiocarb, methomyl, methoprene, methoxyfenozide, momfluorothrin, nitenpyram, nithiazine, novaluron, oxamyl, pyflubumide, pymetrozine, pyrethrin, pyridaben,

pyriminostrobin, pyridalyl, pyriproxyfen, ryanodine, spinetoram, spinosad, spirodiclofen, spiromesifen, spirotetramat, sulfoxaflor, tebufenozide, tetramethrin, tetramethylfluthrin, thiacloprid, thiamethoxam, thiodicarb, thiosultap-sodium, tralomethrin, triazamate, triflumuron, *Bacillus thuringiensis* delta-endotoxins, strains of *Bacillus thuringiensis* and strains of *Nucleo polyhydrosis* viruses.

Compositions comprising compounds of Formula **1** useful for seed treatment can further comprise bacteria and fungi that have the ability to provide protection from the harmful effects of plant pathogenic fungi or bacteria and/or soil born animals such as nematodes. Bacteria exhibiting nematicidal properties may include but are not limited to *Bacillus firmus*, *Bacillus cereus*, *Bacillius subtiliis* and *Pasteuria penetrans*. A suitable *Bacillus firmus* strain is strain CNCM I-1582 (GB-126) which is commercially available as BioNem™. A suitable *Bacillus cereus* strain is strain NCMM I-1592. Both *Bacillus* strains are disclosed in US 6,406,690. Other suitable bacteria exhibiting nematicidal activity are *B. amyloliquefaciens* IN937a and *B. subtilis* strain GB03. Bacteria exhibiting fungicidal properties may include but are not limited to *B. pumilus* strain GB34. Fungal species exhibiting nematicidal properties may include but are not limited to *Myrothecium verrucaria*, *Paecilomyces lilacinus* and *Purpureocillium lilacinum*.

Seed treatments can also include one or more nematicidal agents of natural origin such as the elicitor protein called harpin which is isolated from certain bacterial plant pathogens such as *Erwinia amylovora*. An example is the Harpin-N-Tek seed treatment technology available as N-Hibit™ Gold CST.

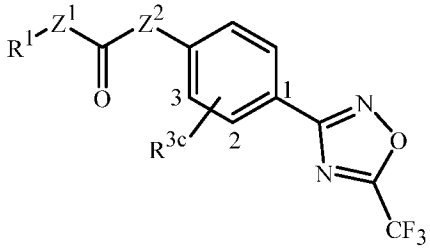
Seed treatments can also include one or more species of legume-root nodulating bacteria such as the microsymbiotic nitrogen-fixing bacteria *Bradyrhizobium japonicum*. These inocculants can optionally include one or more lipo-chitooligosaccharides (LCOs), which are nodulation (Nod) factors produced by rhizobia bacteria during the initiation of nodule formation on the roots of legumes. For example, the Optimize® brand seed treatment technology incorporates LCO Promoter Technology™ in combination with an inocculant.

Seed treatments can also include one or more isoflavones which can increase the level of root colonization by mycorrhizal fungi. Mycorrhizal fungi improve plant growth by enhancing the root uptake of nutrients such as water, sulfates, nitrates, phosphates and metals. Examples of isoflavones include, but are not limited to, genistein, biochanin A, formononetin, daidzein, glycitein, hesperetin, naringenin and pratensein. Formononetin is available as an active ingredient in mycorrhizal inocculant products such as PHC Colonize® AG.

Seed treatments can also include one or more plant activators that induce systemic acquired resistance in plants following contact by a pathogen. An example of a plant activator which induces such protective mechanisms is acibenzolar-*S*-methyl.

The following TESTS demonstrate the control efficacy of compounds of this invention on specific pathogens. The pathogen control protection afforded by the compounds is not limited, however, to these species. See Index Tables A-G below for compound descriptions. The following abbreviations are used in the Index Tables: Me means methyl, Et means ethyl, *n*-Pr means *n*-propyl, *i*-Pr means *iso*-propyl, *c*-Pr means cyclopropyl, *t*-Bu means *tert*-butyl, Ph means phenyl, MeO means methoxy and EtO means ethoxy. The abbreviation "Cmpd. No." stands for "Compound Number", and the abbreviation "Ex." stands for "Example" and is followed by a number indicating in which example the compound is prepared. ^{19}F NMR spectra are reported in ppm relative to trichlorofluoromethane in $CDCl_3$ solution unless indicated otherwise. The numerical value reported in the column "MS" is the molecular weight of the highest isotopic abundance positively charged parent ion (M+1) formed by addition of H^+ (molecular weight of 1) to the molecule having the highest isotopic abundance, or the highest isotopic abundance negatively charged ion (M–1) formed by loss of H^+ (molecular weight of 1). The presence of molecular ions containing one or more higher atomic weight isotopes of lower abundance (e.g., ^{37}Cl, ^{81}Br) is not reported. The reported MS peaks were observed by mass spectrometry using electrospray ionization (ESI) or atmospheric pressure chemical ionization (APCI).

INDEX TABLE A



A dash "–" in the R^{3c} column means that no R^{3c} substituent is present and the remaining carbon valences are occupied by hydrogen atoms. In the Z^2 column, the bond projecting to the left is attached to C=O, and the bond projecting to the right is attached to the phenyl ring.

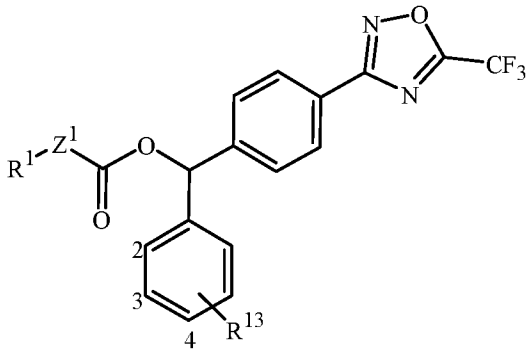
Cmpd.	R^1	Z^1	Z^2	R^{3c}	^{19}F NMR	MP °C	MS
1	Ph	NH	-OCH_2-	–	–65.42		
2	CH_3CH_2	NH	-OCH_2-	–	–65.37	99-101	
3	*i*-Pr	NH	-OCH_2-	–	-65.36		
4	$EtOC(=O)CH_2$	NH	-OCH_2-	–	-65.36		
5	CH_3CH_2	NH	-$OCH_2CH(OMe)$-	–	-65.35		
6	CH_3	N(Me)	-OCH_2-	–	-65.35		
7	$ClCH_2CH_2$	NH	-OCH_2-	–	-65.35		
9	CH_3	NH	-OCH_2-	–	-65.36		
10	$CH_3CH_2CH_2$	NH	-OCH_2-	–	-65.36		

Cmpd.	R^1	Z^1	Z^2	R^{3c}	^{19}F NMR	MP °C	MS
11	$MeOCH_2CH_2$	NH	$-OCH_2-$	–	-65.36		
12	$CH{\equiv}CCH_2$	NH	$-OCH_2-$	–	-65.35	94-96	
13	$PhCH_2$	NH	$-OCH_2-$	–	-65.35		
14	$CH_3CH_2CH(Me)$	NH	$-OCH_2-$	–	-65.36		
15	*n*-Bu	NH	$-OCH_2-$	–	-65.36		
16	*t*-Bu	NH	$-OCH_2-$	–	-65.37		
17 (Ex. 4)	H	NH	$-OCH_2-$	–	-65.35	142-144	
19	CH_3CH_2	NH	-OCH(Me)-	–	-65.44		
20	CH_3CH_2	NH	$-OCH_2CH_2CH_2-$	–	-65.36		344 (M+1)
22	3-pyridinyl	NH	$-OCH_2-$	–	-65.33		365 (M+1)
23 (Ex. 3)	3-pyridinyl	NH	-OCH(Me)-	–	-65.35		379 (M+1)
24	4-(MeOC(=O))$PhCH_2$	NH	$-OCH_2-$	–	-65.35		436 (M+1)
25	4-(MeOC(=O))$PhCH_2$	NH	-OCH(Me)-	–	-65.35		450 (M+1)
26	4-(EtOC(=O))$PhCH_2$	NH	$-OCH_2-$	–	-65.39		450 (M+1)
27	4-(EtOC(=O))$PhCH_2$	NH	-OCH(Me)-	–	-65.35		464 (M+1)
28	CH_3	N(Me)	$-OCH_2CH_2CH_2-$	–	-65.38		344 (M+1)
29	$CH_2{=}CHCH_2$	NH	$-OCH_2CH_2CH_2-$	–	-65.39		356 (M+1)
30	$CH{\equiv}CCH_2$	NH	$-OCH_2CH_2CH_2-$	–	-65.39		354 (M+1)
31	CH_3	NH	$-OCH_2CH_2CH_2-$	–	-65.44		330 (M+1)
32	$CH{\equiv}CCH_2$	N(Me)	$-OCH_2-$	–	-65.36		340 (M+1)
33	$CH{\equiv}CCH_2CH_2$	NH	$-OCH_2-$	–	-65.40		340 (M+1)
34	3-pyridinyl	NH	$-OCH_2CH_2-$	–	-65.36		379 (M+1)
35	3-pyridinyl	NH	$-OCH_2CH_2CH_2-$	–	-65.40		393 (M+1)
36	$CH_3C{\equiv}CCH_2$	NH	$-OCH_2-$	–	-65.42		340 (M+1)
41	H	NH	$-OCH_2CH_2-$	–	-64.72[a]		
42	CH_3	NH	$-OCH_2CH_2-$	–	-65.37		
43 (Ex. 2)	CH_3CH_2	NH	$-OCH_2CH_2-$	–	-65.39		
44	CH_3	N(Me)	$-OCH_2CH_2-$	–	-65.39		
45	$CH{\equiv}CCH_2$	NH	$-OCH_2CH_2-$	–	-65.37		
47	4-(MeOC(=O))Ph	NH	$-OCH_2-$	–	-65.34		422 (M-1)
48	4-(MeOC(=O))Ph	NH	-OCH(Me)-	–	-65.34		436 (M+1)
49	4-(MeOC(=O))Ph	NH	$-OCH_2CH_2-$	–	-65.36		436 (M+1)
50	4-(MeOC(=O))Ph	NH	$-OCH_2CH_2CH_2-$	–	-65.38		450 (M+1)
51	$CH_2{=}CHCH_2$	NH	$-OCH_2-$	–	-65.36		
52	CH_3CH_2	N(Me)	$-OCH_2-$	–	-65.36		
53	CH_3CH_2	N(Et)	$-OCH_2-$	–	-65.36		

Cmpd.	R^1	Z^1	Z^2	R^{3c}	^{19}F NMR	MP °C	MS
54	*c*-Pr	NH	-OCH_2-	–	-65.36		
55	N≡CCH_2	NH	-OCH_2-	–	-65.35		
57	4-(EtOC(=O))Ph	NH	-OCH_2-	–	-65.35		434 (M-1)
58	4-(EtOC(=O))Ph	NH	-OCH(Me)-	–	-65.36		448 (M-1)
59	4-(EtOC(=O))Ph	NH	-OCH_2CH_2-	–	-65.37		448 (M-1)
60	4-(EtOC(=O))Ph	NH	-$OCH_2CH_2CH_2$-	–	-65.38		462 (M-1)
62	CH_3C≡CCH_2	NH	-OCH(Me)-	–	-65.35		
63	CH_3C≡CCH_2	NH	-OCH_2CH_2-	–	-65.41		
64	CH_3C≡CCH_2	NH	-$OCH_2CH_2CH_2$-	–	-65.44		
65	CH≡CCH_2CH_2	NH	-$OCH_2CH_2CH_2$-	–	-65.48		368 (M+1)
66	CH≡CCH_2CH_2	NH	-OCH_2CH_2-	–	-65.42		354 (M+1)
67	CH≡CCH_2CH_2	NH	-OCH(Me)-	–	-65.39		
68	4-(EtOC(=O))PhCH_2	NH	-OCH_2CH_2-	–	-65.37		464 (M+1)
69	4-(EtOC(=O))PhCH_2	NH	-$OCH_2CH_2CH_2$-	–	-65.38		478 (M+1)
71	CH_3	NH	-OCH(Me)-	–	-65.35		
72	CH_3	N(Me)	-OCH(Me)-	–	-65.61		
73	$CH_3CH_2CH_2$	NH	-OCH(Me)-	–	-65.33	65-67	
75	CH_3CH_2	NH	OCH(CH_2OMe)CH_2	–	-65.39		
76	CH≡CCH_2	NH	-OCH(Me)-	–	-65.43		
77	*c*-Pr	NH	-OCH(Me)-	–	-65.37	90-92	342 (M+1)
78	CH_3CH_2OC(=O)	NH	-OCH_2CH_2-	–	-65.35		
79	CH_3CH_2OC(=O)	NH	-OCH_2-	–	-65.35		
84	H	NH	-OCH(Me)-	–	-65.35		
85	H	NH	-OCH_2-	3-F	-65.33, -115.99		
86	H	NH	-OCH_2-	3-Cl	-65.33		
87	H	NH	-$OC(Me)_2$-	–	-65.34		
89	H	NH	-OCH_2-	2-F	-65.21, -106.66	149-150	
90	H	NH	-OCH_2-	3-Me	-65.35	108-109	
105 (Ex. 5)	CH_3	O	-NHN=CH-	–	-65.34	183-185	315 (M+1)
106	*t*-Bu	O	-NHN=CH-	–	-65.35		356 (M-1)
107	CH_3CH_2	O	-NHN=CH-	–	-65.34		329 (M+1)
108	CH_3	O	-NHN=C(Me)-	–	-65.35		329 (M+1)
109	*t*-Bu	O	-N(Me)N=CH-	–	-65.36		
136	H	N(OMe)	-OCH_2-	–	-65.34		316(M-1)

a. ^{19}F NMR in DMSO-d_6 solution.

INDEX TABLE B

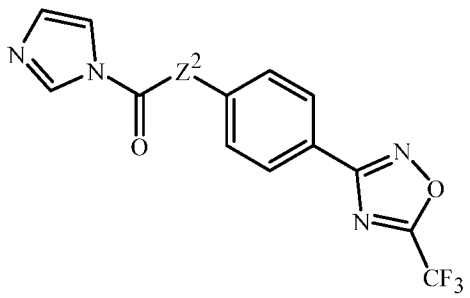


A dash "–" in the R^{13} column means that no R^{13} substituent is present and the remaining carbon valences are occupied by hydrogen atoms.

Cmpd.	R^1	Z^1	R^{13}	^{19}F NMR	MS
101	H	NH	3-Cl	-65.33	
102	CH_3	NH	3-Cl	-65.34	
103	CH_3CH_2	NH	3-Cl	-65.35	
104	$CH{\equiv}CCH_2$	NH	3-Cl	-65.34	
110	CH_3CH_2	NH	–	-65.35	
112	H	NH	4-F	-65.34, -113.6	381 (M-1)
113	CH_3	NH	4-F	-65.34, -113.64	395 (M-1)
114	CH_3CH_2	NH	4-F	-65.35, -113.69	409 (M-1)
115	$CH{\equiv}CCH_2$	NH	4-F	-65.34, -113.38	381 (M-1)
116	$CH_3CH_2CH_2$	NH	4-F	-65.35, -113.69	321 (M+1)
117	H	NH	–	-65.35	362 (M-1)
118	$CH{\equiv}CCH_2$	NH	–	-65.35	400 (M-1)
119	4-(MeOC(=O))$PhCH_2$	NH	–	-65.35	511 (M-1)
120	$CH{\equiv}CCH_2CH_2$	NH	–	-65.35	414 (M-1)
121	CH_3	N(Me)	–	-65.35	
122	$CH_3OCH_2CH_2$	NH	–	-65.35	
128	H	NH	2-CH_3	-65.35	
129	CH_3	NH	2-CH_3	-65.35	
130	CH_3CH_2	NH	2-CH_3	-65.35	317 (M-1)
131	H	NH	3-F	-65.34, -112.10	380 (M-1)
132	CH_3	NH	3-F	-65.34, -112.21	
133	CH_3CH_2	NH	3-F	-65.35, -112.22	
134	CH_3	N(Me)	3-F	-65.35, -112.22	
135	$CH{\equiv}CCH_2$	NH	3-F	-65.34, -112.05	418 (M-1)
137	CH_3	NH	–	-65.35	
138	$CH_2{=}CHCH_2$	NH	–	-65.35	

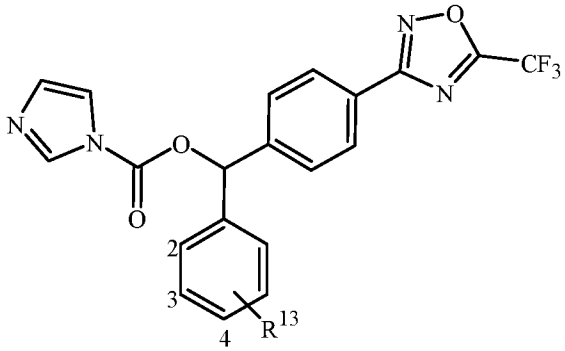
Cmpd.	R^1	Z^1	R^{13}	^{19}F NMR	MS
139	$CH_3CH_2CH_2$	NH	–	-65.35	
140	$(CH_3)_2CHCH_2$	NH	–	-65.35	
143	H	NH	4-CH_3	-65.35	
144	CH_3	NH	4-CH_3	-65.35	
145	CH_3CH_2	NH	4-CH_3	-65.35	
146	CH_2=C(Me)CH_2	NH	4-CH_3	-65.35	

INDEX TABLE C



Cmpd.	Z^2	^{19}F NMR	MS
8	-OCH_2-	-65.33	
21	-$OCH_2CH_2CH_2$-	-65.34	365 (M-1)
40 (Ex. 1)	-OCH_2CH_2-	-65.38	
70	-OCH(Me)-	-65.32	351 (M-1)

INDEX TABLE D

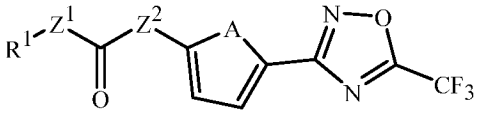


A dash "–" in the R^{13} column means that no R^{13} substituent is present and the remaining carbon valences are occupied by hydrogen atoms.

Cmpd.	R^{13}	^{19}F NMR	MS
83	4-CH_3O	-65.41	
100	4-CH_3	-65.37	
111	–	-65.33	414 (M-1)
127	4-F	-65.31, -111.68	431 (M-1)
142	2-CH_3	-65.33	427 (M-1)

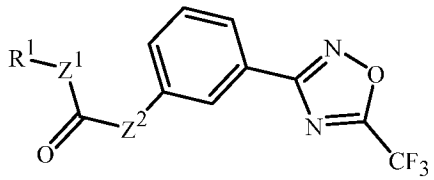
Cmpd.	R^{13}	^{19}F NMR	MS
125	3-F	-65.32, -111.12	431 (M-1)
126	3-Cl	-65.31	447 (M-1)

INDEX TABLE E



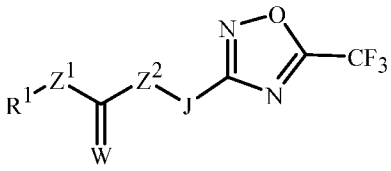
Cmpd.	R^1	Z^1	Z^2	A	^{19}F NMR
37	$CH{\equiv}CCH_2$	NH	$-OCH_2-$	S	-65.42
38	CH_3	NH	$-OCH_2-$	S	-65.41
39	CH_3CH_2	NH	$-OCH_2-$	S	-65.40
46	$CH_3CH_2CH_2$	NH	$-OCH_2-$	S	-65.39
61	$CH{\equiv}CCH_2$	NH	-OCH(Me)-	S	-65.43
74	$CH_3CH_2CH_2$	NH	-OCH(Me)-	S	-65.41
80	H	NH	$-OCH_2-$	O	-65.30
81	$CH{\equiv}CCH_2$	NH	$-OCH_2-$	O	-65.31
124	CH_3CH_2	O	-NHN=CH-	S	-65.39
141	CH_3	O	-NHN=CH-	S	-65.39

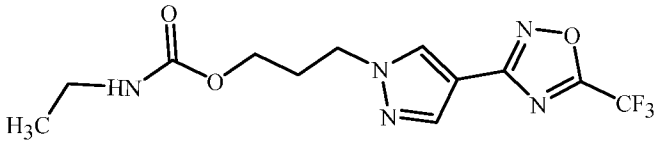
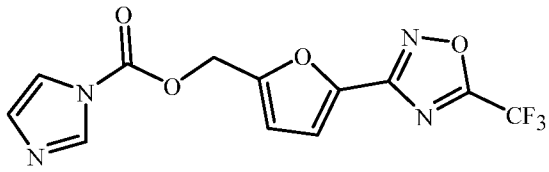
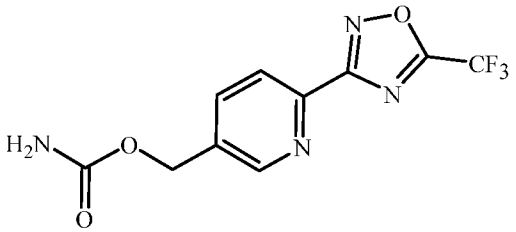
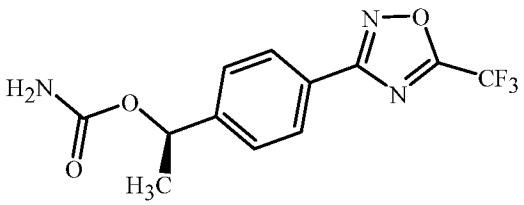
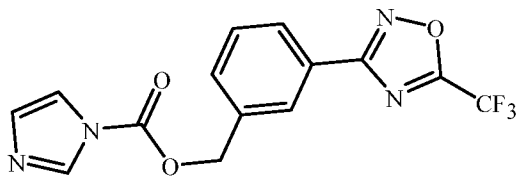
INDEX TABLE F



Cmpd.	R^1	Z^1	Z^2	^{19}F NMR
93	H	NH	$-OCH_2-$	-65.37
94	CH_3	NH	$-OCH_2-$	-65.35
95	CH_3CH_2	NH	$-OCH_2-$	-65.37
96	$CH{\equiv}CCH_2$	NH	$-OCH_2-$	-65.36
97	$CH_2{=}CHCH_2$	NH	$-OCH_2-$	-65.36
98	$CH_2{=}C(Me)CH_2$	NH	$-OCH_2-$	-65.34
99	CH_3	N(Me)	$-OCH_2-$	-65.37

INDEX TABLE G



Cmpd.	R^1-Z^1-C(=W)-Z^2-J-	^{19}F NMR	M.P.
18		-65.44	
82		-65.27	
88		-65.18	159-160
91		-65.35	107-108
123		-65.32	

BIOLOGICAL EXAMPLES OF THE INVENTION

General protocol for preparing test suspensions for Tests A-C: the test compounds were first dissolved in acetone in an amount equal to 3% of the final volume and then suspended at the desired concentration (in ppm) in acetone and purified water (50/50 mix by volume) containing 250 ppm of the surfactant PEG400 (polyhydric alcohol esters). The resulting test suspensions were then used in Tests A-C.

TEST A

The test solution was sprayed to the point of run-off on soybean seedlings. The following day the seedlings were inoculated with a spore suspension of *Phakopsora pachyrhizi* (the causal agent of Asian soybean rust) and incubated in a saturated atmosphere at 22 °C for 24 h, and then moved to a growth chamber at 22 °C for 8 days, after which time visual disease ratings were made.

TEST B

The test solution was sprayed to the point of run-off on wheat seedlings. The following day the seedlings were inoculated with a spore suspension of *Zymoseptoria tritici* (the causal agent of wheat leaf blotch) and incubated in a saturated atmosphere at 24 °C for 48 h, and then moved to a growth chamber at 20 °C for 17 days, after which time disease ratings were made.

TEST C

The test solution was sprayed to the point of run-off on wheat seedlings. The following day the seedlings were inoculated with a spore suspension of *Puccinia recondita* f. sp. *tritici* (the causal agent of wheat leaf rust) and incubated in a saturated atmosphere at 20 °C for 24 h, and then moved to a growth chamber at 20 °C for 6 days, after which time disease ratings were made.

Results for Tests A-C are given in Table A. In the Table, a rating of 100 indicates 100% disease control and a rating of 0 indicates no disease control (relative to the controls). A dash (–) indicates the compound was not tested.

TABLE A

Cmpd No.	Rate in ppm	Test A	Test B	Test C
1	270	100	79	100
2	260	100	99	100
3	250	100	73	100
4	260	100	46	100
5	260	100	81	100
6	260	100	76	100
7	260	100	98	100
8	255	100	13	100
9	260	100	94	100
10	250	100	97	100
11	250	100	96	100
12	265	100	100	100
13	260	100	36	100
14	250	100	84	100

Cmpd No.	Rate in ppm	Test A	Test B	Test C
15	265	100	92	100
16	255	100	19	100
17	260	100	92	100
18	50	38	50*	0
19	10	100	–	74
20	10	100	–	99
21	50	100	–	99
22	10	99	–	97
23	10	100	–	97
24	10	13	–	68
25	10	100	–	26
26	10	95	–	26
27	10	100	–	0
28	10	100	–	40
29	10	100	–	74
30	10	100	–	99
31	10	100	–	99
32	10	100	0*	68
33	10	100	0*	100
34	50	100	–	98
35	50	100	–	100
36	10	100	–	100
37	50	100	–	100
38	10	94	80*	96
39	10	96	93*	95
40	10	0	–	18
41	10	100	–	99
42	10	100	0	99
43	10	100	0*	97
44	10	100	–	41
45	10	100	–	93
46	10	99	97*	97
47	50	100	–	41
48	50	100	–	97
49	50	96	–	0
50	50	0	–	0
51	10	100	–	99

Cmpd No.	Rate in ppm	Test A	Test B	Test C
52	10	100	–	68
53	10	100	–	68
54	10	100	–	92
55	10	100	–	86
57	10	100	–	0
58	50	100	–	79
59	50	96	–	0
60	50	0	–	0
61	10	100	–	100
62	50	100	–	100
63	50	100	–	100
64	50	100	–	100
65	50	100	–	100
66	50	100	–	100
67	50	100	–	100
68	50	99	–	0
69	50	100	–	0
70	10	99	–	68
71	10	100	–	83
72	10	100	0*	55
73	10	100	–	68
74	10	100	–	98
75	10	100	97*	91
76	10	100	0*	99
77	10	100	0	92
78	10	100	95	91
79	10	100	98	97
80	10	0	–	0
81	10	0	–	45
82	50	89	–	0
83	50	100	–	100
84	10	100	–	100
85	250	100	98	100
86	250	100	94	100
87	250	100	99	100
88	–	–	–	–
89	–	–	–	–

Cmpd No.	Rate in ppm	Test A	Test B	Test C
90	–	–	–	–
91	–	–	–	–
93	250	100	97	100
94	250	69	1	100
95	250	99	3	100
96	250	100	64	100
97	250	100	52	100
98	250	100	3	100
99	250	0	0	55
100	250	100	98	97
101	250	100	90	99
102	250	100	96	90
103	250	100	20	86
104	250	100	84	80
105	250	100	99	100
106	10	97	–	68
107	10	100	–	99
108	10	92	–	89
109	50	100	–	95
110	250	100	–	100
111	250	100	–	100
112	250	100	85	100
113	250	100	82	100
114	250	100	9	100
115	250	100	66	100
116	250	100	0	88
117	250	100	–	100
118	250	100	–	100
119	250	100	–	74
120	250	100	–	100
121	250	100	–	99
122	10	100	–	89
123	250	100	0	96
124	50	100	73*	100
125	250	100	97	100
126	10	99	88*	0
127	250	100	99	100

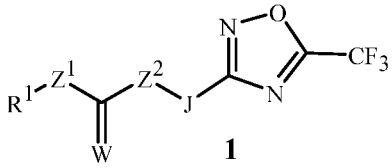
Cmpd No.	Rate in ppm	Test A	Test B	Test C
128	250	100	88	100
129	250	100	74	100
130	250	100	3	98
131	250	100	96	100
132	250	100	95	100
133	250	100	99	100
134	250	100	50	89
135	250	100	88	100
136	10	79	–	0
137	250	100	70	100
138	250	100	99	100
139	250	100	56	100
140	250	100	34	86
141	50	100	93*	100
142	10	98	–	0
143	250	100	69	100
144	250	100	0	100
145	250	100	28	98
146	250	100	21	97

* Indicates compound was tested at 250 ppm.

CLAIMS

What is claimed is:

1. A compound selected from Formula **1**, *N*-oxides, and salts thereof,



1

R^1 is H; or C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_2-C_6 alkylcarbonyl or C_2-C_6 alkoxycarbonyl, each optionally substituted with up to 3 substituents independently selected from R^2; or phenyl optionally substituted with up to 3 substituents independently selected from R^{3a}; or a 3- to 7-membered nonaromatic carbocyclic ring, wherein up to 3 carbon atom ring members are independently selected from C(=O) and C(=S), each ring optionally substituted with up to 3 substituents independently selected from R^{3a}; or a 5- to 6-membered heterocyclic ring, each ring containing ring members selected from carbon atoms and 1 to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, wherein up to 3 carbon atom ring members are independently selected from C(=O) and C(=S), and the sulfur atom ring members are independently selected from $S(=O)_u(=NR^{12})_v$, each ring optionally substituted with up to 5 substituents independently selected from R^{3a} on carbon atom ring members and R^{3b} on nitrogen atom ring members;

Z^1 is O, $-(CH_2)_nNR^{4a}-$, $-(CH_2)_nNR^{4a}NR^{4b}-$ or $-CH=NNR^{4b}-$, wherein the bond projecting to the left is attached to R^1, and the bond projecting to the right is attached to C=W;

W is O or S;

Z^2 is $-O(CH_2)_m-$, $-OCH_2CH_2O-$ or $-NR^5N=CH-$, wherein the bond projecting to the left is attached to C=W, and the bond projecting to the right is attached to J, each carbon atom optionally substituted with up to 2 substituents independently selected from R^6;

J is phenyl optionally substituted with up to 2 substituents independently selected from R^7; or a 5- to 6-membered heteroaromatic ring, each ring containing ring members selected from carbon atoms and 1 to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, wherein up to 2 ring members are independently selected from C(=O), C(=S), S(=O) and $S(=O)_2$, each ring optionally substituted with up to 2 substituents independently selected from R^7 on carbon atom ring members and R^8 on nitrogen atom ring members;

each R^2 is independently halogen, hydroxy, cyano, -S-C≡N, -SH, amino, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_3-C_6 cycloalkyl, C_3-C_6 halocycloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_1-C_4 alkylthio, C_1-C_4 alkylsulfinyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_1-C_4 alkylamino, C_2-C_4 dialkylamino, C_2-C_4 alkylcarbonyl, C_2-C_4 haloalkylcarbonyl, C_2-C_5 alkoxycarbonyl, C_2-C_5 haloalkoxycarbonyl, C_2-C_5 alkylaminocarbonyl or C_3-C_5 dialkylaminocarbonyl; or phenyl, pyridinyl, pyrazolyl, imidazolyl, triazolyl, thiazolyl, oxazolyl, isoxazolyl, oxetanyl, 1,3-dioxolanyl, tetrahydropyranyl, thienyl, furanyl, pyrrolidinyl, isoxazolinyl, tetrahydrofuranyl, piperidinyl, morpholinyl or piperazinyl, each optionally substituted with up to 3 substituents independently selected from R^{3c} on carbon atom ring members and R^{3d} on nitrogen atom ring members;

each R^{3a} and R^{3c} is independently halogen, hydroxy, cyano, amino, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_1-C_4 hydroxyalkyl, C_3-C_6 cycloalkyl, C_4-C_7 cycloalkylalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkenyloxy, C_2-C_4 alkynyloxy, C_2-C_4 alkoxyalkyl, C_2-C_6 alkylcarbonyloxy, C_1-C_4 alkylthio, C_1-C_4 haloalkylthio, C_2-C_6 alkylcarbonylthio, C_1-C_4 alkylsulfinyl, C_1-C_4 haloalkylsulfinyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_1-C_4 alkylsulfonyloxy, C_1-C_4 alkylamino, C_2-C_8 dialkylamino, C_3-C_6 cycloalkylamino, C_2-C_4 alkylcarbonyl, C_2-C_6 alkoxycarbonyl, C_2-C_6 alkylaminocarbonyl, C_3-C_8 dialkylaminocarbonyl or C_3-C_6 trialkylsilyl;

each R^{3b} and R^{3d} is independently C_1-C_3 alkyl, C_1-C_3 alkoxy, C_2-C_3 alkylcarbonyl or C_2-C_3 alkoxycarbonyl;

R^{4a} and R^{4b} are each independently H, hydroxy, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 haloalkenyl, C_2-C_4 alkynyl, C_2-C_4 haloalkynyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_2-C_4 alkylthioalkyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_2-C_4 alkylsulfinylalkyl, C_2-C_4 alkylsulfonylalkyl, C_2-C_4 alkylcarbonyl, C_2-C_4 haloalkylcarbonyl, C_2-C_5 alkoxycarbonyl, C_3-C_5 alkoxycarbonylalkyl, C_2-C_5 alkylaminocarbonyl, C_3-C_5 dialkylaminocarbonyl, C_3-C_7 alkylaminocarbonylalkyl or C_4-C_7 dialkylaminocarbonylalkyl; or

one pair of R^1 and R^{4a} substituents or one pair of R^1 and R^{4b} substituents are taken together with the atoms to which they are attached to form a 5- to 7-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, wherein up to 3 ring members are independently selected from C(=O), C(=S), S(=O) and $S(=O)_2$, each ring optionally substituted with up to 4 substituents independently selected from R^9; or

one pair of R^{3a} and R^{4a} substituents or one pair of R^{3a} and R^{4b} substituents are taken together with the atoms to which they are attached to form a 5- to 7-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, wherein up to 3 ring members are independently selected from C(=O), C(=S), S(=O) and $S(=O)_2$, each ring optionally substituted with up to 4 substituents independently selected from R^{10}; or

one pair of R^{3b} and R^{4a} substituents or one pair of R^{3b} and R^{4b} substituents are taken together with the nitrogen atoms to which they are attached to form a 5- to 7-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, wherein up to 3 ring members are independently selected from C(=O), C(=S), S(=O) and $S(=O)_2$, each ring optionally substituted with up to 4 substituents independently selected from R^{11};

R^5 is H, hydroxy, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 haloalkenyl, C_2-C_4 alkynyl, C_2-C_4 haloalkynyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_2-C_4 alkylthioalkyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_2-C_4 alkylsulfinylalkyl, C_2-C_4 alkylsulfonylalkyl, C_2-C_4 alkylcarbonyl, C_2-C_4 haloalkylcarbonyl, C_2-C_5 alkoxycarbonyl, C_3-C_5 alkoxycarbonylalkyl, C_2-C_5 alkylaminocarbonyl or C_3-C_5 dialkylaminocarbonyl;

each R^6 is independently halogen, hydroxy, cyano, nitro, C_1-C_2 alkyl, C_1-C_2 haloalkyl, C_1-C_2 alkoxy, C_1-C_2 haloalkoxy or C_2-C_4 alkoxyalkyl; or phenyl optionally substituted with up to 3 substituents independently selected from R^{13};

each R^7 is independently halogen, hydroxy, cyano, amino, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_1-C_4 hydroxyalkyl, C_3-C_6 cycloalkyl, C_4-C_7 cycloalkylalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkenyloxy, C_2-C_4 alkynyloxy, C_2-C_4 alkoxyalkyl, C_2-C_4 alkylcarbonyloxy, C_1-C_4 alkylthio, C_1-C_4 haloalkylthio, C_2-C_4 alkylcarbonylthio, C_1-C_4 alkylsulfinyl, C_1-C_4 haloalkylsulfinyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_1-C_4 alkylsulfonyloxy, C_1-C_4 alkylamino, C_2-C_6 dialkylamino, C_3-C_6 cycloalkylamino, C_2-C_4 alkylcarbonyl, C_2-C_6 alkoxycarbonyl, C_2-C_6 alkylaminocarbonyl, C_3-C_6 dialkylaminocarbonyl or C_3-C_6 trialkylsilyl;

each R^8 is independently C_1-C_3 alkyl;

each R^9, R^{10} and R^{11} is independently halogen, hydroxy, cyano, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 haloalkenyl, C_2-C_4 alkynyl, C_2-C_4 haloalkynyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_2-C_4 alkylthioalkyl, C_1-C_4 alkylsulfonyl, C_1-C_4 haloalkylsulfonyl, C_2-C_4 alkylsulfinylalkyl, C_2-C_4 alkylsulfonylalkyl, C_2-C_4 alkylcarbonyl, C_2-C_4

haloalkylcarbonyl, C_2-C_5 alkoxycarbonyl, C_3-C_5 alkoxycarbonylalkyl, C_2-C_5 alkylaminocarbonyl or C_3-C_5 dialkylaminocarbonyl;

each R^{12} is independently H, cyano, C_1-C_3 alkyl or C_1-C_3 haloalkyl;

each R^{13} is independently halogen, cyano, amino, nitro, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_1-C_4 hydroxyalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkenyloxy, C_2-C_4 alkynyloxy or C_2-C_4 alkoxyalkyl;

n is 0;

m is 1, 2 or 3; and

each u and v are independently 0, 1 or 2 in each instance of $S(=O)_u(=NR^{12})_v$, provided that the sum of u and v is 0, 1 or 2;

provided that:

(a) when J is phenyl or a 6-membered heteroaromatic ring, then J is attached to Z^2 and the oxadiazole ring in Formula **1** in a meta- or para-arrangement; and

(b) the compound of Formula **1** is not:

[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl](2-chlorophenyl)]methyl *N*-(phenylmethyl)carbamate;

[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl](4-chlorophenyl)]methyl *N*-(phenylmethyl)carbamate;

[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl] methyl ester 4-morpholinecarboxylic acid;

[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]benzyl acetyl(methyl)carbamate;

[4-[5-(trifluoromethyl)-1,2-3-oxadiazol-3-yl]phenyl]methyl *N*-methylcarbamate;

[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]methyl *N*-2-pyridinylcarbamate;

1-[4-[5-(trifluoromethyl)-1,2,3-oxadiazol-3-yl]phenyl]ethyl *N*,*N*-dimethylcarbamate;

[4-[5-(trifluoromethyl)-1,2-3-oxadiazol-3-yl]phenyl]methyl *N*-methoxy-*N*-methylcarbamate;

[4-[5-(trifluoromethyl)-1,2-3-oxadiazol-3-yl]phenyl]methyl *N*-(2,2,2-trifluoroethyl)carbamate;

[4-[5-(trifluoromethyl)-1,2-3-oxadiazol-3-yl]phenyl]methyl *N*-cyclopropylcarbamate; or

[4-[5-(trifluoromethyl)-1,2-3-oxadiazol-3-yl]phenyl]methyl *N*,*N*-dimethylcarbamate.

2. A compound of Claim 1 wherein:

R^1 is H; or C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_2-C_6 alkylcarbonyl or C_2-C_6 alkoxycarbonyl, each optionally substituted with up to 2

substituents independently selected from R^2; or phenyl optionally substituted with up to 3 substituents independently selected from R^{3a}; or a 3- to 7-membered nonaromatic carbocyclic ring, wherein up to 2 carbon atom ring members are independently selected from C(=O) and C(=S), each ring optionally substituted with up to 3 substituents independently selected from R^{3a}; or a 5- to 6-membered heterocyclic ring, each ring containing ring members selected from carbon atoms and 1 to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, wherein up to 2 carbon atom ring members are independently selected from C(=O) and C(=S), each ring optionally substituted with up to 3 substituents independently selected from R^{3a} on carbon atom ring members and R^{3b} on nitrogen atom ring members;

Z^1 is O, $-NR^{4a}-$ or $-NR^{4a}NR^{4b}-$;

W is O;

Z^2 is $-O(CH_2)_m-$ or $-NR^5N=CH-$, each carbon atom optionally substituted with up to 2 substituents independently selected from R^6;

J is phenyl optionally substituted with up to 2 substituents independently selected from R^7; or a 5- to 6-membered heteroaromatic ring, each ring containing ring members selected from carbon atoms and 1 to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, each ring optionally substituted with up to 2 substituents independently selected from R^7 on carbon atom ring members and R^8 on nitrogen atom ring members;

each R^2 is independently halogen, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_3-C_6 cycloalkyl, C_3-C_6 halocycloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkylcarbonyl, C_2-C_4 haloalkylcarbonyl or C_2-C_5 alkoxycarbonyl; or phenyl, pyridinyl, pyrazolyl, imidazolyl, triazolyl, pyrrolidinyl, isoxazolinyl, tetrahydrofuranyl, piperidinyl, morpholinyl or piperazinyl, each optionally substituted with up to 2 substituents independently selected from R^{3c} on carbon atom ring members and R^{3d} on nitrogen atom ring members;

each R^{3a} and R^{3c} is independently halogen, cyano, C_1-C_2 alkyl, C_1-C_2 haloalkyl, C_2-C_3 alkenyl, C_2-C_3 alkynyl, C_1-C_2 alkoxy, C_2-C_3 alkenyloxy, C_2-C_3 alkynyloxy, C_2-C_4 alkylcarbonyl, C_2-C_5 alkoxycarbonyl, C_2-C_5 alkylaminocarbonyl or C_3-C_7 dialkylaminocarbonyl;

each R^{3b} and R^{3d} is independently C_1-C_2 alkyl, C_1-C_2 alkoxy, C_2-C_3 alkylcarbonyl or C_2-C_3 alkoxycarbonyl;

R^{4a} and R^{4b} are each independently H, methyl, C_1-C_2 haloalkyl, methoxymethyl, methylsulfonyl, methylcarbonyl or methoxycarbonyl; or

one pair of R^1 and R^{4a} substituents or one pair of R^1 and R^{4b} substituents are taken together with the atoms to which they are attached to form a 5- to 6-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, each ring optionally substituted with up to 2 substituents independently selected from R^9; or

one pair of R^{3a} and R^{4a} substituents or one pair of R^{3a} and R^{4b} substituents are taken together with the atoms to which they are attached to form a 5- to 6-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, each ring optionally substituted with up to 2 substituents independently selected from R^{10}; or

one pair of R^{3b} and R^{4a} substituents or one pair of R^{3b} and R^{4b} substituents are taken together with the nitrogen atoms to which they are attached to form a 5- to 6-membered ring containing ring members selected from carbon atoms and optionally up to 3 heteroatoms independently selected from up to 1 O, up to 1 S and up to 2 N atoms, each ring optionally substituted with up to 2 substituents independently selected from R^{11};

R^5 is H or methyl;

each R^6 is independently halogen, C_1-C_2 alkyl, C_1-C_2 haloalkyl, C_1-C_2 alkoxy or C_2-C_4 alkoxyalkyl; or phenyl optionally substituted with up to 2 substituents independently selected from R^{13};

each R^7 is independently halogen, methyl, trifluoromethyl or methoxy;

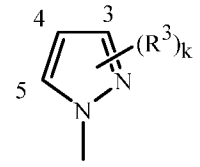
each R^8 is independently methyl or ethyl;

each R^9, R^{10} and R^{11} is independently halogen, hydroxy, cyano, nitro, C_1-C_3 alkyl, C_1-C_3 haloalkyl, C_1-C_3 alkoxy or C_1-C_3 haloalkoxy; and

each R^{13} is independently halogen, C_1-C_2 alkyl, C_1-C_2 haloalkyl or C_1-C_2 alkoxy.

3. A compound of Claim 2 wherein:

R^1 is H; or C_1-C_6 alkyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_2-C_6 alkylcarbonyl or C_2-C_6 alkoxycarbonyl, each optionally substituted with up to 2 substituents independently selected from R^2; or R^1 is selected from U-1 through U-79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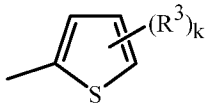
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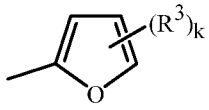
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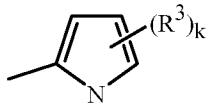
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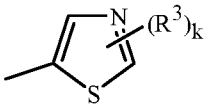
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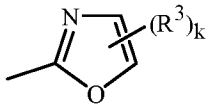
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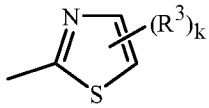
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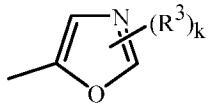
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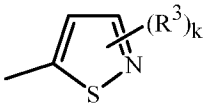
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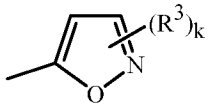
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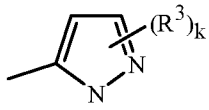
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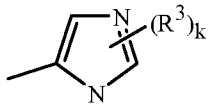
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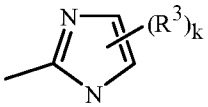
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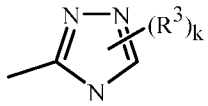
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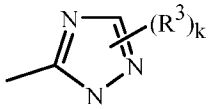
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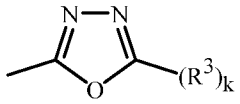
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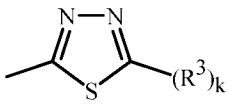
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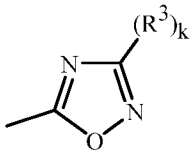
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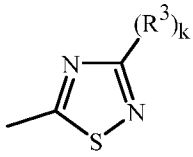
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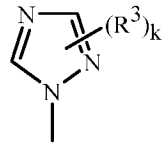
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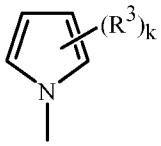
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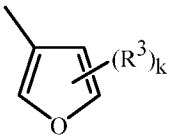
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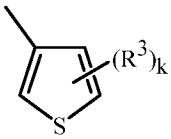
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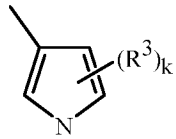
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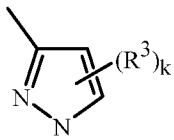
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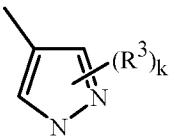
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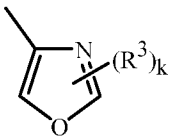
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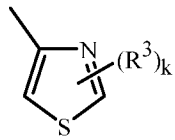
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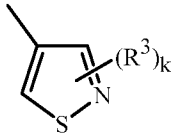
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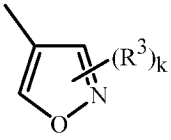
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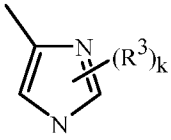
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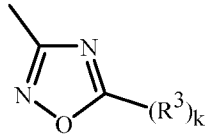
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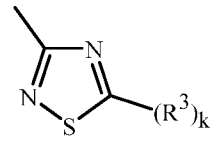
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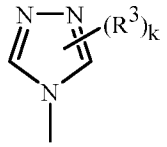
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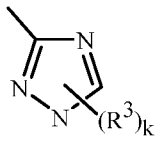
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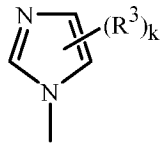
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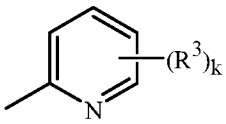
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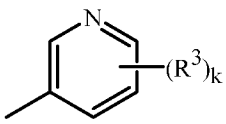
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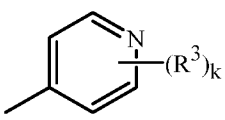
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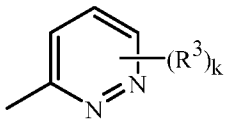
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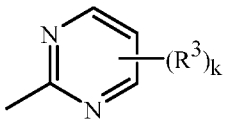
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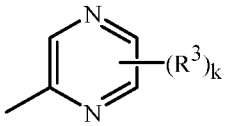
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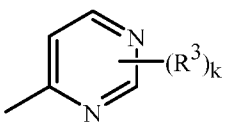
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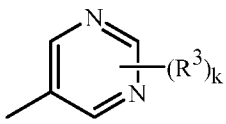
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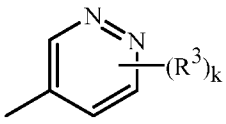
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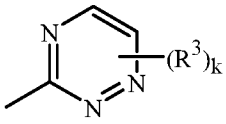
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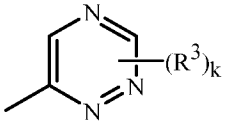
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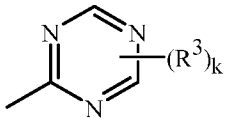
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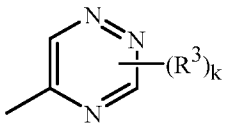
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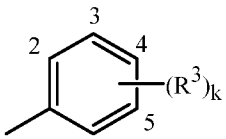

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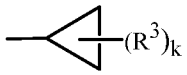
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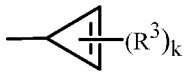
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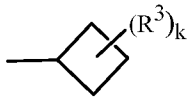
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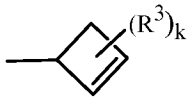
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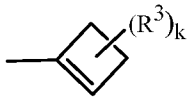
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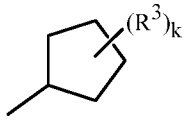
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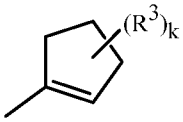
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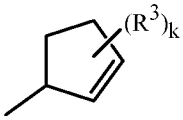
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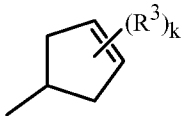
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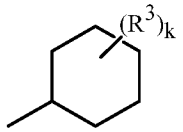
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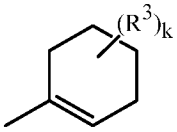
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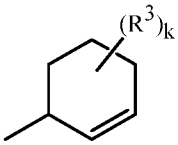
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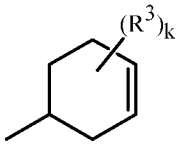
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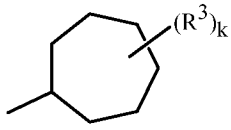
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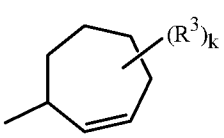
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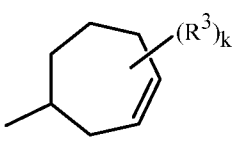
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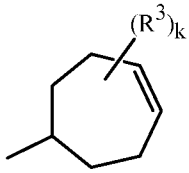
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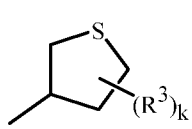
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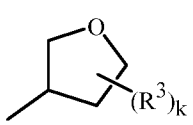
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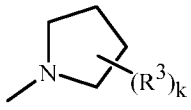
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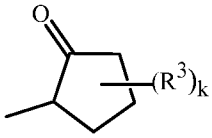
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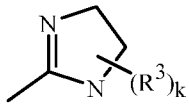
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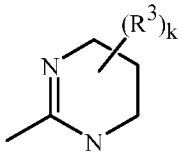
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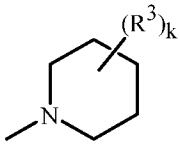
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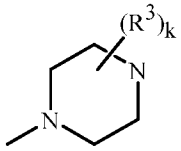
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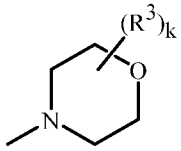
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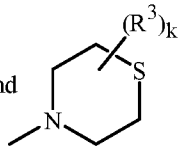
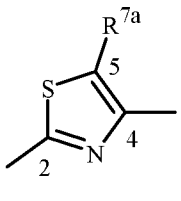

U-79 ;

wherein when R^3 is attached to a carbon ring member, said R^3 is selected from R^{3a}, and when R^3 is attached to a nitrogen ring member said R^3 is selected from R^{3b}; and k is 0, 1 or 2;

J is selected from J-1 through J-71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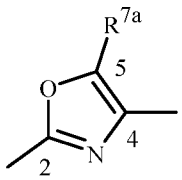
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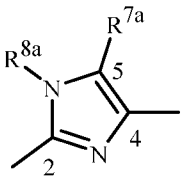
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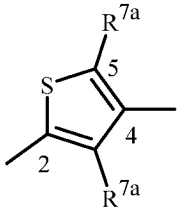
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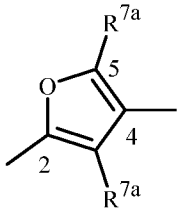
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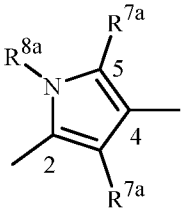
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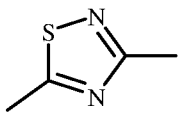
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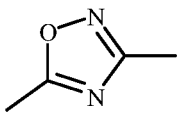
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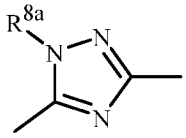
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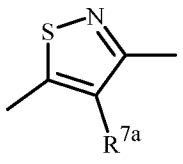
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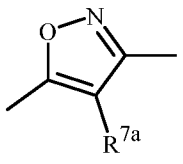
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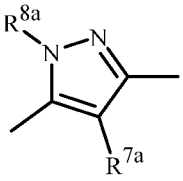
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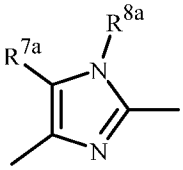

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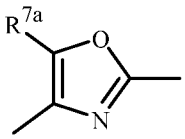

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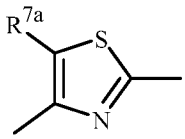

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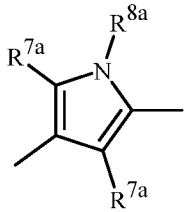

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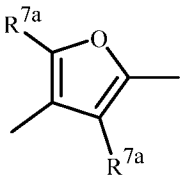

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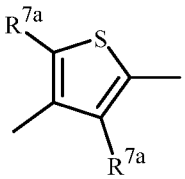

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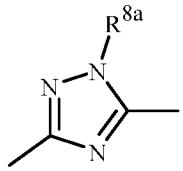

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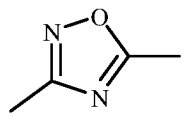

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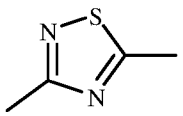

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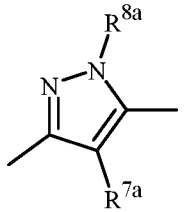

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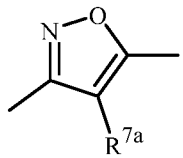

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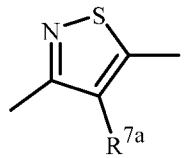

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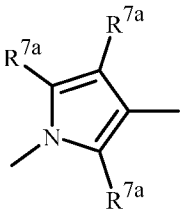

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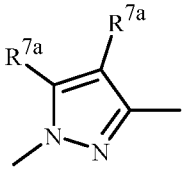

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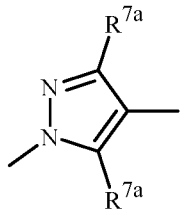

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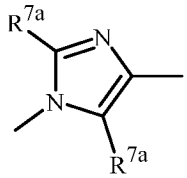

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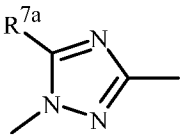

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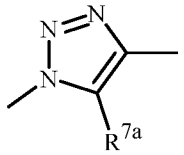

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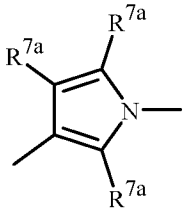

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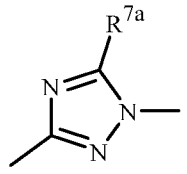

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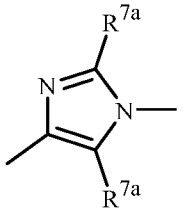

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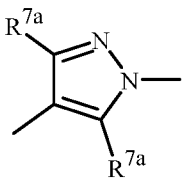

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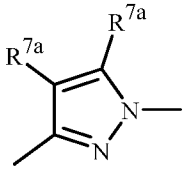

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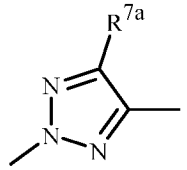

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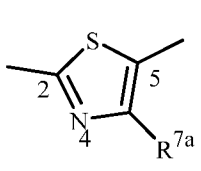

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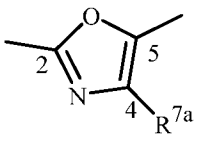

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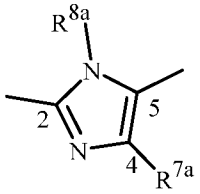

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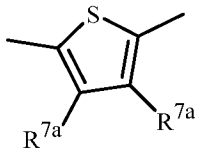

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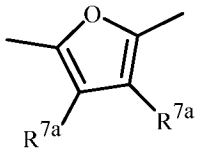

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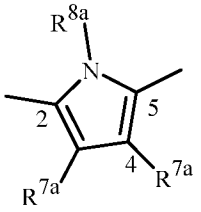

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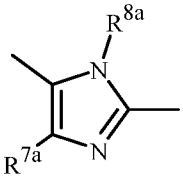

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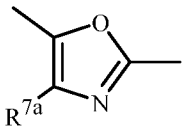

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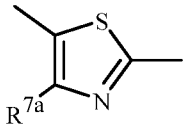

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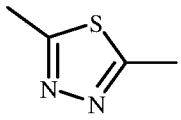

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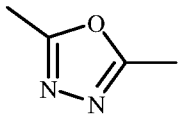

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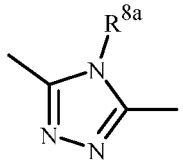

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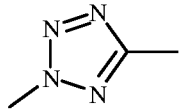

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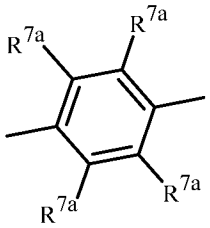

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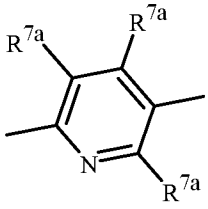

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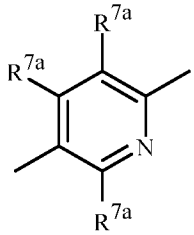

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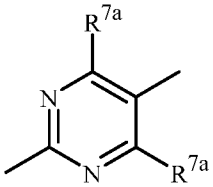

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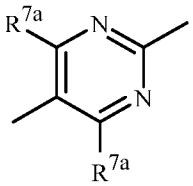

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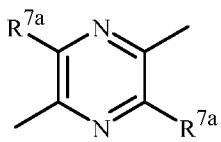

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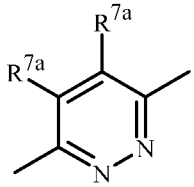

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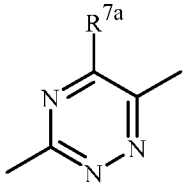

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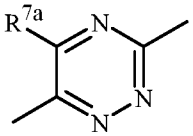

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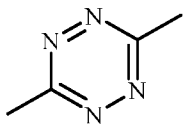

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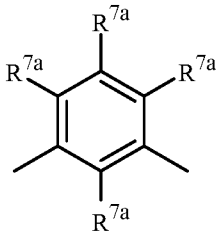

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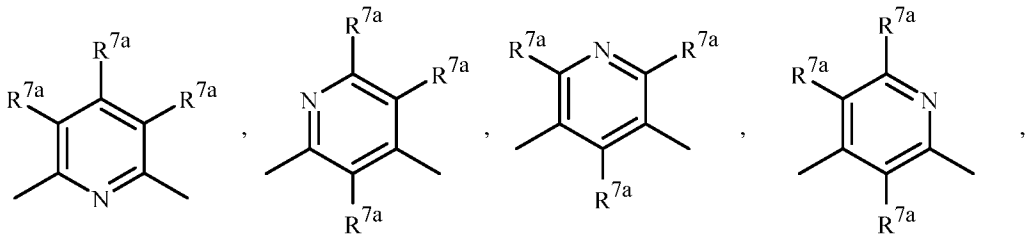

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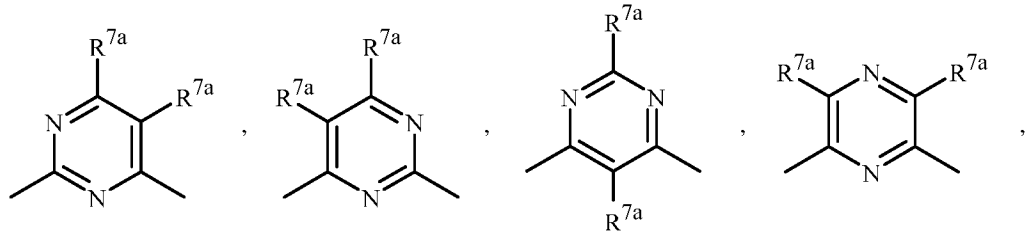

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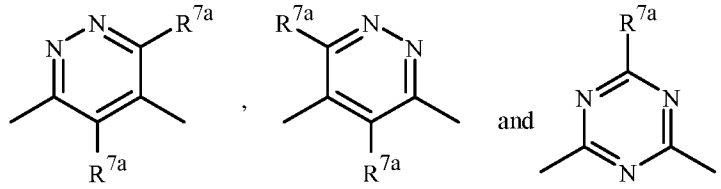

J-69 J-70 and J-71 ;

wherein the bond projecting to the left is bonded to Z^2, and the bond projecting to the right is bonded to the oxadiazole ring in Formula **1**;

each R^{7a} is independently H or R^7; and R^{8b} is H; provided that at most only two of R^{7a} are other than H;

each R^2 is independently halogen, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_3-C_6 cycloalkyl, C_3-C_6 halocycloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkylcarbonyl, C_2-C_4 haloalkylcarbonyl or C_2-C_5 alkoxycarbonyl;

each R^{3a} is independently halogen, C_1-C_2 alkyl, C_2-C_3 alkenyl, C_2-C_3 alkynyl, C_2-C_3 alkenyloxy, C_2-C_3 alkynyloxy, C_2-C_4 alkylcarbonyl or C_2-C_5 alkoxycarbonyl;

each R^{3b} is methyl;

R^{4a} and R^{4b} are each independently H or methyl; or

one pair of R^1 and R^{4a} substituents are taken together with the atoms to which they are attached to form a pyrazolyl or imidazolyl ring, each ring optionally substituted with up to 2 substituents independently selected from R^9;

R^5 is H;

each R^6 is independently methyl, methoxy or C_2-C_4 alkoxyalkyl; or phenyl optionally substituted with up to 2 substituents independently selected from R^{13};

each R^7 is independently halogen or methyl;
each R^9 is independently halogen, hydroxy, C_1-C_2 alkyl, C_1-C_2 haloalkyl or C_1-C_2 alkoxy; and
R^{13} is halogen or methyl.

4. A compound of Claim 3 wherein:
R^1 is H; or C_1-C_4 alkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_2-C_4 alkylcarbonyl or C_2-C_4 alkoxycarbonyl, each optionally substituted with up to 1 substituent selected from R^2; or U-36, U-37, U-38, U-39, U-41, U-50, U-53, U-55 or U-58;
Z^1 is -NR^{4a}-;
J is J-40, J-50, J-51 or J-52;
R^2 is halogen, cyano, C_1-C_3 alkyl, C_1-C_3 haloalkyl, C_3-C_6 cycloalkyl, C_3-C_6 halocycloalkyl, C_1-C_3 alkoxy or C_1-C_3 haloalkoxy;
each R^{3a} is independently halogen, C_1-C_2 alkyl, C_2-C_4 alkylcarbonyl or C_2-C_5 alkoxycarbonyl;
R^{4a} is H; or
one pair of R^1 and R^{4a} substituents are taken together with the atoms to which they are attached to form an imidazolyl ring, the ring optionally substituted with up to 2 substituents independently selected from R^9;
each R^6 is independently methyl or CH_3OCH_2; or phenyl optionally substituted with up to 1 substituent selected from R^{13};
each R^7 is independently Cl, F or methyl; and
each R^9 is independently F, Cl, methyl or methoxy.

5. A compound of Claim 4 wherein:
R^1 is H; or C_1-C_4 alkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_2-C_4 alkylcarbonyl or C_2-C_4 alkoxycarbonyl, each optionally substituted with up to 1 substituent selected from R^2; or U-50;
Z^2 is -$O(CH_2)_m$-;
J is J-50;
R^2 is halogen, cyano, C_1-C_3 alkyl or C_1-C_3 alkoxy;
each R^{3a} is independently Br, Cl, F, methyl, C_2-C_4 alkylcarbonyl or C_2-C_4 alkoxycarbonyl;
R^{4a} is H;
each R^{7a} is H; and
m is 1 or 2.

6. A compound of Claim 1 which is selected from the group:

[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]methyl carbamate (Compound 17);

[6-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]-3-pyridinyl]methyl] carbamate;
[5-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]-2-pyridinyl]methyl] carbamate;
[5-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]-2-thienyl]methyl] carbamate;
1-[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]ethyl *N*-3-pyridinyl-carbamate (Compound 23);
2-[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]ethyl *N*-ethylcarbamate (Compound 43); and
methyl 2-[[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]methylene]-hydrazinecarboxylate (Compound 105).

7. A fungicidal composition comprising (a) a compound of Claim 1; and (b) at least one other fungicide.

8. A fungicidal composition comprising (a) a compound of Claim 1; and (b) at least one additional component selected from the group consisting of surfactants, solid diluents and liquid diluents.

9. A method for controlling plant diseases caused by fungal plant pathogens comprising applying to the plant or portion thereof, or to the plant seed, a fungicidally effective amount of a compound of Claim 1.

10. A method for controlling plant diseases caused by Basidiomycetes fungal plant pathogens comprising applying to the plant or portion thereof, or to the plant seed, a fungicidally effective amount of a compound of Claim 1.

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2018/040740

A. CLASSIFICATION OF SUBJECT MATTER
INV. C07D413/14 A01N43/48 C07D413/12 C07D271/06
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C07D A01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A,P	WO 2017/178549 A1 (SYNGENTA PARTICIPATIONS AG [CH]) 19 October 2017 (2017-10-19) cited in the application Claim 1	1-10
X,P	WO 2018/117034 A1 (SUMITOMO CHEMICAL CO [JP]) 28 June 2018 (2018-06-28) claims and examples	1-10
X,P	WO 2017/222951 A1 (MERCK SHARP & DOHME [US]; WALJI ABBAS [US]; BERGER RICHARD [US]; STUMP) 28 December 2017 (2017-12-28) claims, examples 192 and 194	1-5
A	WO 2013/066835 A2 (GLAXOSMITHKLINE LLC [US]; TEMPERO PHARMACEUTICALS INC [US]; GHOSH SHOM) 10 May 2013 (2013-05-10) claim 1	1-10

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
4 October 2018	10/10/2018

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2018/040740

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2017/055473 A1 (SYNGENTA PARTICIPATIONS AG [CH]) 6 April 2017 (2017-04-06) cited in the application claims, examples -----	1-10

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2018/040740

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2017178549 A1	19-10-2017	NONE	
WO 2018117034 A1	28-06-2018	NONE	
WO 2017222951 A1	28-12-2017	NONE	
WO 2013066835 A2	10-05-2013	NONE	
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		EP 3356358 A1	08-08-2018
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