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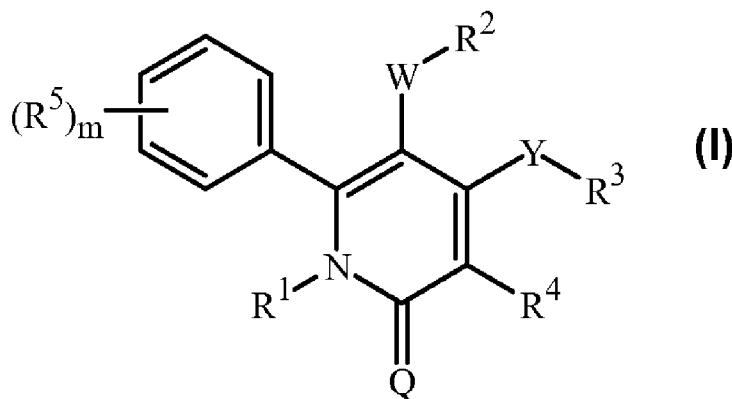
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(54) Title: FUNGICIDAL 2-PYRIDONES



(57) Abstract: Disclosed are compounds of Formula 1, including all stereoisomers, *N* oxides, and salts thereof, wherein R₁, R₂, R₃, R₄, R₅, Q, W, Y and m 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 2-PYRIDONES

FIELD OF THE INVENTION

This invention relates to certain 2-pyridones, their *N*-oxides, salts and compositions,
 5 and methods of their use as fungicides.

BACKGROUND OF THE INVENTION

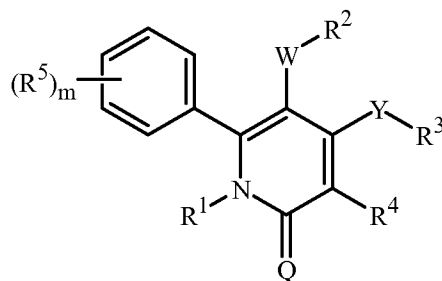
The control of plant diseases caused by fungal plant pathogens is extremely important
 in achieving high crop efficiency. Plant disease damage to ornamental, vegetable, field,
 cereal, and fruit crops can cause significant reduction in productivity and thereby result in
 10 increased costs to the consumer. 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.

Mishrikey et al., *Journal of the Chemical Society Section C: Organic Chemistry* **1969**,
 15, 1950-1954, and *ibid.* **1969**, 15, 974-978 disclose certain 2-pyridone derivatives.

PCT Patent Publication WO 2004/076450 discloses certain 2-pyridone derivatives for
 15 preparing pyrazolopyridine derivatives.

SUMMARY OF THE INVENTION

This invention is directed to compounds of Formula 1 (including all geometric
 isomers, stereoisomers and atropisomers) *N*-oxides, and salts thereof:



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20 wherein

Q is O or S;

R¹ is H, cyano, hydroxy, amino, C₁-C₄ alkyl, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄
 haloalkyl, C₂-C₄ haloalkenyl, C₂-C₄ haloalkynyl, cyclopropyl, halocyclopropyl,
 25 C₂-C₄ alkoxyalkyl, C₂-C₄ alkylthioalkyl, C₂-C₄ alkylsulfinylalkyl, C₂-C₄
 alkylsulfonylalkyl, C₂-C₄ cyanoalkyl, C₁-C₃ hydroxyalkyl, C₁-C₃ alkoxy, C₁-C₃
 haloalkoxy, C₁-C₃ alkylthio, C₁-C₃ haloalkylthio, C₁-C₃ alkylamino or C₂-C₄
 dialkylamino;

W and Y are each independently CH₂, O, C(=O), S(=O)_n, NR⁸ or a direct bond;

R² is a phenyl ring optionally substituted with up to 5 substituents independently selected from R⁶; or a 3-, 4-, 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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)_p(=NR⁹)_q, the heterocyclic ring optionally substituted with up to 5 substituents independently selected from R⁶ on carbon atom ring members and R^{6a} on nitrogen atom ring members;

R³ is a phenyl ring optionally substituted with up to 5 substituents independently selected from R⁷; or a 3-, 4-, 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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)_p(=NR⁹)_q, the heterocyclic ring optionally substituted with up to 5 substituents independently selected from R⁷ on carbon atom ring members and R^{7a} on nitrogen atom ring members; or

when Y is a direct bond, then R³ is also selected from halogen, cyano, hydroxy, amino, nitro, -CHO, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₂-C₆ haloalkenyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₈ alkylcycloalkyl, C₄-C₈ cycloalkylalkyl, C₆-C₁₂ cycloalkylcycloalkyl, C₄-C₈ halocycloalkylalkyl, C₅-C₈ alkylcycloalkylalkyl, C₃-C₆ cycloalkenyl, C₂-C₆ alkoxyalkyl, C₂-C₆ alkylthioalkyl, C₂-C₆ alkylsulfinylalkyl, C₂-C₆ alkylsulfonylalkyl, C₂-C₆ alkylaminoalkyl, C₃-C₆ dialkylaminoalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₄-C₆ cycloalkylcarbonyl, C₂-C₆ alkoxycarbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₈ dialkylaminocarbonyl, C₂-C₆ cyanoalkyl, C₁-C₆ hydroxyalkyl, C₂-C₆ hydroxyhaloalkyl, C₂-C₆ hydroxyalkylcarbonyl, C₂-C₆ hydroxycarbonylalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₂-C₆ alkoxyalkoxy, C₃-C₆ alkoxycarbonylalkyl, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfinyl, C₁-C₆ haloalkylsulfinyl, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl, C₃-C₉ trialkylsilyl, C₁-C₆ alkylamino, C₂-C₆ dialkylamino, C₂-C₆ haloalkylamino, C₂-C₆ halodialkylamino, C₃-C₆ cycloalkylamino, C₂-C₆ alkylcarbonylamino, C₂-C₆ haloalkylcarbonylamino, C₁-C₆ alkylsulfonylamino and C₁-C₆ haloalkylsulfonylamino;

R⁴ is H, halogen, cyano, hydroxy, C₁-C₂ alkyl, C₁-C₂ haloalkyl, C₂ alkenyl, C₂ haloalkenyl or C₂ alkynyl;

each R⁵ is independently halogen, cyano, hydroxy, amino, nitro, -CHO, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₂-C₆ alkoxycarbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₆ dialkylaminocarbonyl, C₂-C₆ alkylaminoalkoxy, C₂-C₆ haloalkenyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₈ alkylcycloalkyl, C₄-C₈ cycloalkylalkyl, C₅-C₈ alkylcycloalkylalkyl, C₂-C₆ alkoxyalkyl, C₂-C₆ cyanoalkyl, C₁-C₆ hydroxyalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₂-C₆ alkylcarbonyloxy, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfinyl, C₁-C₆ haloalkylsulfinyl, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl, C₃-C₉ trialkylsilyl, C₂-C₆ alkylcarbonylthio, C₁-C₆ alkylamino or C₂-C₆ dialkylamino; or

a pair of R⁵ substituents attached to adjacent ring atoms are taken together with the atoms to which they are attached to form a 5-, 6- or 7-membered fused ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 N atoms, and optionally substituted with up to 3 substituents independently selected from the group consisting of C₁-C₂ alkyl, halogen, cyano, nitro and C₁-C₂ alkoxy on carbon ring members and from the group consisting of C₁-C₂ alkyl, cyano and C₁-C₂ alkoxy on nitrogen ring members;

each R⁶ is independently halogen, cyano, hydroxy, amino, nitro, -CHO, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₂-C₆ alkoxycarbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₆ dialkylaminocarbonyl, C₂-C₆ alkylaminoalkoxy, C₂-C₆ haloalkenyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₈ alkylcycloalkyl, C₄-C₈ cycloalkylalkyl, C₅-C₈ alkylcycloalkylalkyl, C₂-C₆ alkoxyalkyl, C₂-C₆ cyanoalkyl, C₁-C₆ hydroxyalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₂-C₆ alkylcarbonyloxy, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfinyl, C₁-C₆ haloalkylsulfinyl, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl, C₃-C₉ trialkylsilyl, C₂-C₆ alkylcarbonylthio, C₁-C₆ alkylamino or C₂-C₆ dialkylamino;

each R^{6a} is independently cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₂-C₆ alkoxycarbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₆ dialkylaminocarbonyl, C₂-C₆ haloalkenyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₈ alkylcycloalkyl, C₄-C₈ cycloalkylalkyl, C₅-C₈ alkylcycloalkylalkyl, C₂-C₆ alkoxyalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl or C₃-C₉ trialkylsilyl; or

a pair of substituents selected from R⁶ and R^{6a} attached to adjacent ring atoms are taken together with the atoms to which they are attached to form a 5-, 6- or 7-membered fused ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 N atoms, and optionally substituted with up to 3 substituents independently selected from the group consisting of C₁-C₂ alkyl, halogen, cyano, nitro and C₁-C₂ alkoxy on carbon atom ring members and from the group consisting of C₁-C₂ alkyl, cyano and C₁-C₂ alkoxy on nitrogen atoms ring members; or

a pair of R⁶ substituents attached to the same ring atom are taken together with the atom to which they are attached to form a 5-, 6- or 7-membered spirocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 N atoms, and optionally substituted with up to 3 substituents independently selected from the group consisting of C₁-C₂ alkyl, halogen, cyano, nitro and C₁-C₂ alkoxy on carbon atom ring members and from the group consisting of C₁-C₂ alkyl, cyano and C₁-C₂ alkoxy on nitrogen atom ring members;

each R⁷ is independently halogen, cyano, hydroxy, amino, nitro, -CHO, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₂-C₆ alkoxy carbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₆ dialkylaminocarbonyl, C₂-C₆ alkylaminoalkoxy, C₂-C₆ haloalkenyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₈ alkylcycloalkyl, C₄-C₈ cycloalkylalkyl, C₅-C₈ alkylcycloalkylalkyl, C₂-C₆ alkoxyalkyl, C₂-C₆ cyanoalkyl, C₁-C₆ hydroxyalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₂-C₆ alkylcarbonyloxy, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfinyl, C₁-C₆ haloalkylsulfinyl, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl, C₃-C₉ trialkylsilyl, C₂-C₆ alkylcarbonylthio, C₁-C₆ alkylamino or C₂-C₆ dialkylamino;

each R^{7a} is independently cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₂-C₆ alkoxy carbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₆ dialkylaminocarbonyl, C₂-C₆ haloalkenyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₈ alkylcycloalkyl, C₄-C₈ cycloalkylalkyl, C₅-C₈ alkylcycloalkylalkyl, C₂-C₆ alkoxyalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl or C₃-C₉ trialkylsilyl; or

a pair of substituents selected from R⁷ and R^{7a} substituents attached to adjacent ring atoms are taken together with the atoms to which they are attached to form a 5-, 6- or 7-membered fused ring containing ring members selected from carbon

atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 N atoms, and optionally substituted with up to 3 substituents independently selected from the group consisting of C₁-C₂ alkyl, halogen, cyano, nitro and C₁-C₂ alkoxy on carbon atom ring members and from the group consisting of C₁-C₂ alkyl, cyano and C₁-C₂ alkoxy on nitrogen atom ring members; or

a pair of R⁷ substituents attached to the same ring atom are taken together with the atom to which they are attached to form a 5-, 6- or 7-membered spirocyclic ring containing ring members selected from carbon and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 N atoms, and optionally substituted with up to 3 substituents independently selected from the group consisting of C₁-C₂ alkyl, halogen, cyano, nitro and C₁-C₂ alkoxy on carbon atom ring members and from the group consisting of C₁-C₂ alkyl, cyano and C₁-C₂ alkoxy on nitrogen atom ring members;

each R⁸ and R⁹ is independently H or C₁-C₃ alkyl;

m is an integer selected from 1, 2, 3, 4 and 5;

each n is independently an integer selected from 0, 1 and 2; and

p and q are independently 0, 1 or 2 in each instance of S(=O)_p(=NR⁹)_q, provided that the sum of p and q is 0, 1 or 2;

provided that the compound is other than

1-methyl-6-(4-methylphenyl)-4,5-diphenyl-2(1*H*)-pyridinone,

6-(4-bromophenyl)-1-methyl-4,5-diphenyl-2(1*H*)-pyridinone,

6-(4-methylphenyl)-4,5-diphenyl-2(1*H*)-pyridinone,

6-(4-bromophenyl)-4,5-diphenyl-2(1*H*)-pyridinone,

6-(4-methoxyphenyl)-4,5-diphenyl-2(1*H*)-pyridinone, or

2-(4-fluorophenyl)-1,6-dihydro-4-methyl-6-oxo-[3,4'-bipyridine]-5-carbonitrile.

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

This invention also relates to a fungicidal composition comprising (a) a compound of Formula 1 (or an *N*-oxide or salt thereof) wherein R¹ is cyano, hydroxy, amino, C₁-C₄ alkyl, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄ haloalkyl, C₂-C₄ haloalkenyl, C₂-C₄ haloalkynyl, cyclopropyl, halocyclopropyl, C₂-C₄ alkoxyalkyl, C₂-C₄ alkylthioalkyl, C₂-C₄ alkylsulfinylalkyl, C₂-C₄ alkylsulfonylalkyl, C₂-C₄ cyanoalkyl, C₁-C₃ hydroxyalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₁-C₃ alkylthio, C₁-C₃ haloalkylthio, C₁-C₃ alkylamino or C₂-C₄ dialkylamino; 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 mixture of a compound of Formula 1 (or an *N*-oxide or salt thereof) wherein R¹ is cyano, hydroxy, amino, C₁-C₄ alkyl, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄ haloalkyl, C₂-C₄ haloalkenyl, C₂-C₄ haloalkynyl, cyclopropyl, halocyclopropyl, C₂-C₄ alkoxyalkyl, C₂-C₄ alkylthioalkyl, C₂-C₄ alkylsulfanylalkyl, C₂-C₄ alkylsulfonylalkyl, C₂-C₄ cyanoalkyl, C₁-C₃ hydroxyalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₁-C₃ alkylthio, C₁-C₃ haloalkylthio, C₁-C₃ alkylamino or C₂-C₄ dialkylamino; 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).

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”

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 used herein, the term “alkylating agent” refers to a chemical compound in which a carbon-containing radical is bound through a carbon atom to 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 R¹, R³ and R⁴.

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” can also include 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, pentoxy and hexyloxy isomers. The term “alkylthio” includes straight-chain and branched alkylthio moieties such as methylthio, ethylthio, and the different propylthio, butylthio, pentylthio and hexylthio isomers. “Alkylsulfinyl” includes

both enantiomers of an alkylsulfinyl group. Examples of "alkylsulfinyl" include $\text{CH}_3\text{S}(=\text{O})$, $\text{CH}_3\text{CH}_2\text{S}(=\text{O})$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{S}(=\text{O})$, $(\text{CH}_3)_2\text{CHS}(=\text{O})$, and the different butylsulfinyl, pentylsulfinyl and hexylsulfinyl isomers. Examples of "alkylsulfonyl" include $\text{CH}_3\text{S}(=\text{O})_2$, $\text{CH}_3\text{CH}_2\text{S}(=\text{O})_2$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{S}(=\text{O})_2$, $(\text{CH}_3)_2\text{CHS}(=\text{O})_2$, and the different butylsulfonyl, pentylsulfonyl and hexylsulfonyl isomers. "Alkylamino" includes an NH radical substituted with a straight-chain or branched alkyl group. Examples of "alkylamino" include $\text{CH}_3\text{CH}_2\text{NH}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}$, and $(\text{CH}_3)_2\text{CHCH}_2\text{NH}$. Examples of "dialkylamino" include $(\text{CH}_3)_2\text{N}$, $(\text{CH}_3\text{CH}_2\text{CH}_2)_2\text{N}$ and $\text{CH}_3\text{CH}_2(\text{CH}_3)\text{N}$.

"Alkylcarbonyl" denotes a straight-chain or branched alkyl group bonded to a $\text{C}(=\text{O})$ moiety. Examples of "alkylcarbonyl" include $\text{CH}_3\text{C}(=\text{O})$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{C}(=\text{O})$ and $(\text{CH}_3)_2\text{CHC}(=\text{O})$. Examples of "alkoxycarbonyl" include $\text{CH}_3\text{OC}(=\text{O})$, $\text{CH}_3\text{CH}_2\text{OC}(=\text{O})$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{OC}(=\text{O})$, $(\text{CH}_3)_2\text{CHOC}(=\text{O})$, and the different butoxy- and pentoxycarbonyl isomers. Examples of "alkylaminocarbonyl" include $\text{CH}_3\text{NHC}(=\text{O})$, $\text{CH}_3\text{CH}_2\text{NHC}(=\text{O})$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{NHC}(=\text{O})$, $(\text{CH}_3)_2\text{CHNHC}(=\text{O})$, and the different butylamino- and pentylaminocarbonyl isomers. Examples of "dialkylaminocarbonyl" include $(\text{CH}_3)_2\text{NC}(=\text{O})$, $(\text{CH}_3\text{CH}_2)_2\text{NC}(=\text{O})$, $\text{CH}_3\text{CH}_2(\text{CH}_3)\text{NC}(=\text{O})$, $(\text{CH}_3)_2\text{CH}(\text{CH}_3)\text{NC}(=\text{O})$ and $\text{CH}_3\text{CH}_2\text{CH}_2(\text{CH}_3)\text{NC}(=\text{O})$.

"Alkoxyalkyl" denotes alkoxy substitution on alkyl. Examples of "alkoxyalkyl" include CH_3OCH_2 , $\text{CH}_3\text{OCH}_2\text{CH}_2$, $\text{CH}_3\text{CH}_2\text{OCH}_2$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OCH}_2$ and $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_2$. "Alkoxyalkoxy" denotes alkoxy substitution on another alkoxy moiety. Examples of "alkoxyalkoxy" include $\text{CH}_3\text{OCH}_2\text{O}$, $\text{CH}_3\text{CH}_2\text{OCH}_2\text{O}$ and $(\text{CH}_3)_2\text{CHOCH}_2\text{O}$.

"Alkylthioalkyl" denotes alkylthio substitution on alkyl. Examples of "alkylthioalkyl" include CH_3SCH_2 , $\text{CH}_3\text{SCH}_2\text{CH}_2$, $\text{CH}_3\text{CH}_2\text{SCH}_2$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{SCH}_2$ and $\text{CH}_3\text{CH}_2\text{SCH}_2\text{CH}_2$; "alkylsulfinylalkyl" and "alkylsulfonylalkyl" include the corresponding sulfoxides and sulfones, respectively.

"Alkylaminoalkyl" denotes alkylamino substitution on alkyl. Examples of "alkylaminoalkyl" include CH_3NHCH_2 , $\text{CH}_3\text{NHCH}_2\text{CH}_2$, $\text{CH}_3\text{CH}_2\text{NHCH}_2$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{NHCH}_2$ and $\text{CH}_3\text{CH}_2\text{NHCH}_2\text{CH}_2$. Examples of "dialkylaminoalkyl" include $((\text{CH}_3)_2\text{CH})_2\text{NCH}_2$, $(\text{CH}_3\text{CH}_2\text{CH}_2)_2\text{NCH}_2$ and $\text{CH}_3\text{CH}_2(\text{CH}_3)\text{NCH}_2\text{CH}_2$.

"Alkylaminoalkoxy" denotes alkylamino substitution on alkoxy. Examples of "alkylaminoalkoxy" include $\text{CH}_3\text{NHCH}_2\text{CH}_2\text{O}$, $\text{CH}_3\text{NHCH}_2\text{CH}_2\text{CH}_2\text{O}$ and $\text{CH}_3\text{CH}(\text{CH}_3)\text{NHCH}_2\text{CH}_2\text{O}$.

"Alkylcarbonylthio" denotes a straight-chain or branched alkylcarbonyl attached to and linked through a sulfur atom. Examples of "alkylcarbonylthio" include $\text{CH}_3\text{C}(=\text{O})\text{S}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{C}(=\text{O})\text{S}$ and $(\text{CH}_3)_2\text{CHC}(=\text{O})\text{S}$. The term "alkylcarbonylamino" denotes alkylcarbonyl attached to and linked through an NH radical. Examples of "alkylcarbonylamino" include $\text{CH}_3\text{CH}_2\text{C}(=\text{O})\text{NH}$ and $\text{CH}_3\text{CH}_2\text{CH}_2\text{C}(=\text{O})\text{NH}$. The term "alkylcarbonyloxy" denotes a straight-chain or branched alkylcarbonyl bonded and linked

through an oxygen atom. Examples of “alkylcarbonyloxy” include $\text{CH}_3\text{CH}_2\text{C}(=\text{O})\text{O}$ and $(\text{CH}_3)_2\text{CHC}(=\text{O})\text{O}$.

“Alkylsulfonylamino” denotes an NH radical substituted with alkylsulfonyl. Examples of “alkylsulfonylamino” include $\text{CH}_3\text{CH}_2\text{S}(=\text{O})_2\text{NH}$ and $(\text{CH}_3)_2\text{CHS}(=\text{O})_2\text{NH}$.

5 “Alkoxy carbonylalkyl” denotes alkoxy carbonyl substitution on straight-chain or branched alkyl. Examples of “alkoxy carbonylalkyl” include $\text{CH}_3\text{OC}(=\text{O})\text{CH}_2\text{CH}(\text{CH}_3)$, $\text{CH}_3\text{CH}_2\text{OC}(=\text{O})\text{CH}_2\text{CH}_2$ and $(\text{CH}_3)_2\text{CHOC}(=\text{O})\text{CH}_2$.

“Cyanoalkyl” denotes an alkyl group substituted with one cyano group. Examples of “cyanoalkyl” include NCCH_2 , NCCH_2CH_2 and $\text{CH}_3\text{CH}(\text{CN})\text{CH}_2$.

10 “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. The term “alkylcycloalkyl” denotes alkyl substitution on a cycloalkyl moiety and includes, for
15 example, ethylcyclopropyl, *i*-propylcyclobutyl, methylcyclopentyl and methylcyclohexyl. “Cycloalkenyl” includes groups such as cyclopentenyl and cyclohexenyl as well as groups with more than one double bond such as 1,3- or 1,4-cyclohexadienyl. The term “cycloalkoxy” denotes cycloalkyl attached to and linked through an oxygen atom such as cyclopentyloxy and cyclohexyloxy.

20 “Alkylcycloalkylalkyl” denotes an alkyl group substituted with alkylcycloalkyl. Examples of “alkylcycloalkylalkyl” include methylcyclohexylmethyl and ethylcyclopropylmethyl. The term “cycloalkylcycloalkyl” denotes cycloalkyl substitution on another cycloalkyl ring, wherein each cycloalkyl ring independently has from 3 to 6 carbon atom ring members. Examples of cycloalkylcycloalkyl include cyclopropylcyclopropyl
25 (such as 1,1'-bicyclopropyl-1-yl, 1,1'-bicyclopropyl-2-yl), cyclohexylcyclopentyl (such as 4-cyclopentylcyclohexyl) and cyclohexylcyclohexyl (such as 1,1'-bicyclohexyl-1-yl), and the different *cis*- and *trans*-cycloalkylcycloalkyl isomers, (such as (1*R*,2*S*)-1,1'-bicyclopropyl-2-yl and (1*R*,2*R*)-1,1'-bicyclopropyl-2-yl).

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

“Cycloalkylcarbonyl” denotes cycloalkyl bonded to and linked through a $\text{C}(=\text{O})$ group including, for example, cyclopropylcarbonyl and cyclopentylcarbonyl.

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,
35 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”, “haloalkylamino”, “haloalkylsulfinyl”, “haloalkylsulfonyl”, “halocycloalkyl”, and the like, are defined analogously to the term “haloalkyl”. Examples of “haloalkenyl” include $\text{Cl}_2\text{C}=\text{CHCH}_2$ and $\text{CF}_3\text{CH}_2\text{CH}=\text{CHCH}_2$. . Examples of “haloalkynyl” include $\text{HC}\equiv\text{CCHCl}$, $\text{CF}_3\text{C}\equiv\text{C}$, $\text{CCl}_3\text{C}\equiv\text{C}$ and $\text{FCH}_2\text{C}\equiv\text{CCH}_2$. Examples of “haloalkoxy” include CF_3O , $\text{CCl}_3\text{CH}_2\text{O}$, $\text{F}_2\text{CHCH}_2\text{CH}_2\text{O}$ and $\text{CF}_3\text{CH}_2\text{O}$. Examples of “haloalkylthio” include CCl_3S , CF_3S , $\text{CCl}_3\text{CH}_2\text{S}$ and $\text{ClCH}_2\text{CH}_2\text{CH}_2\text{S}$. Examples of “haloalkylamino” include $\text{CF}_3(\text{CH}_3)\text{CHNH}$, $(\text{CF}_3)_2\text{CHNH}$ and $\text{CH}_2\text{ClCH}_2\text{NH}$. Examples of “haloalkylsulfinyl” include $\text{CF}_3\text{S}(=\text{O})$, $\text{CCl}_3\text{S}(=\text{O})$, $\text{CF}_3\text{CH}_2\text{S}(=\text{O})$ and $\text{CF}_3\text{CF}_2\text{S}(=\text{O})$. Examples of “haloalkylsulfonyl” include $\text{CF}_3\text{S}(=\text{O})_2$, $\text{CCl}_3\text{S}(=\text{O})_2$, $\text{CF}_3\text{CH}_2\text{S}(=\text{O})_2$ and $\text{CF}_3\text{CF}_2\text{S}(=\text{O})_2$. Examples of “halocycloalkyl” include 2-chlorocyclopropyl, 2-fluorocyclobutyl, 3-bromocyclopentyl and 4-chlorocyclohexyl. The term “halodialkyl”, either alone or in compound words such as “halodialkylamino”, means at least one of the two alkyl groups is substituted with at least one halogen atom, and independently each halogenated alkyl group may be partially or fully substituted with halogen atoms which may be the same or different. Examples of “halodialkylamino” include $(\text{BrCH}_2\text{CH}_2)_2\text{N}$ and $\text{BrCH}_2\text{CH}_2(\text{ClCH}_2\text{CH}_2)\text{N}$.

“Hydroxyalkyl” denotes an alkyl group substituted with one hydroxy group. Examples of “hydroxyalkyl” include HOCH_2CH_2 , $\text{CH}_3\text{CH}_2(\text{OH})\text{CH}$ and $\text{HOCH}_2\text{CH}_2\text{CH}_2\text{CH}_2$. The term “hydroxyhaloalkyl” denotes a haloalkyl group substituted with one hydroxy group and includes, for example, hexafluorohydroxypropyl. “Hydroxycarbonylalkyl” denotes hydroxycarbonyl substitution on a straight-chain or branched alkyl. Examples of “hydroxycarbonylalkyl” include $\text{HOC}(=\text{O})\text{CH}_2\text{CH}(\text{CH}_3)$, $\text{HOC}(=\text{O})\text{CH}_2\text{CH}_2$ and $\text{HOC}(=\text{O})\text{CH}_2$.

“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.

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.

The total number of carbon atoms in a substituent group is indicated by the “ $\text{C}_i\text{-C}_j$ ” prefix where *i* and *j* are numbers from 1 to 12. For example, $\text{C}_1\text{-C}_4$ alkylsulfonyl designates methylsulfonyl through butylsulfonyl; C_2 alkoxyalkyl designates CH_3OCH_2 ; C_3 alkoxyalkyl designates, for example, $\text{CH}_3\text{OCH}_2\text{CH}_2$ or $\text{CH}_3\text{CH}_2\text{OCH}_2$; 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 $\text{CH}_3\text{CH}_2\text{CH}_2\text{OCH}_2$ and $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_2$.

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) range 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^7 on carbon atom ring members” 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^7 on carbon atom ring members” 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., r being an integer from 0 to 5 in Exhibit 1) exceeds the number of positions available for substituents on a ring (e.g., 2 positions available for $(R^v)_r$ on U-9 in Exhibit 1), 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 exceed 1, said substituents (when they exceed 1) are independently selected from the group of defined substituents (e.g., $(R^5)_m$ wherein m is 1, 2, 3, 4 or 5 or $(R^v)_r$ in Exhibit 1 wherein r is 1, 2, 3, 4 or 5). When a variable group is shown to be optionally attached to a position, for example $(R^v)_r$ wherein r may be 0, then hydrogen may be at the position even if not recited in the variable group definition. When one or more positions on a group are said to be “not substituted” or “unsubstituted”, then hydrogen atoms are attached to take up any free valency.

Unless otherwise indicated, a “ring” or “ring system” as a component of Formula 1 (e.g., substituent R^2 and R^3) is carbocyclic (e.g. phenyl) or heterocyclic (e.g. pyridinyl). The term “ring system” denotes two or more connected rings. The term “bicyclic ring system” denotes a ring system consisting of two rings sharing at least two common atoms. In a “fused bicyclic ring system” the common atoms are adjacent, and therefore the rings share two adjacent atoms and a bond connecting them (e.g., a pair of R^5 substituents taken together to form a naphthalenyl ring system or a pair of R^7 and R^{7a} substituents taken together to form a heterocyclic ring system). The term “spirocyclic ring system” denotes a ring system consisting of two rings connected at a single atom so the rings have a single atom in common. 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 $S(=O)_p(=NR^9)_q$) forming the backbone of a ring or ring system.

The term “aromatic” indicates that each of the ring atoms of a fully unsaturated ring is essentially in the same plane and has a p -orbital perpendicular to the ring plane, and that

$(4n + 2) \pi$ electrons, where n is a positive integer, are associated with the ring to comply with Hückel's rule.

The terms "carbocyclic ring", "carbocycle" or "carbocyclic ring system" denote a ring or ring system 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 carbocyclic ring". The term "saturated carbocyclic ring" 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.

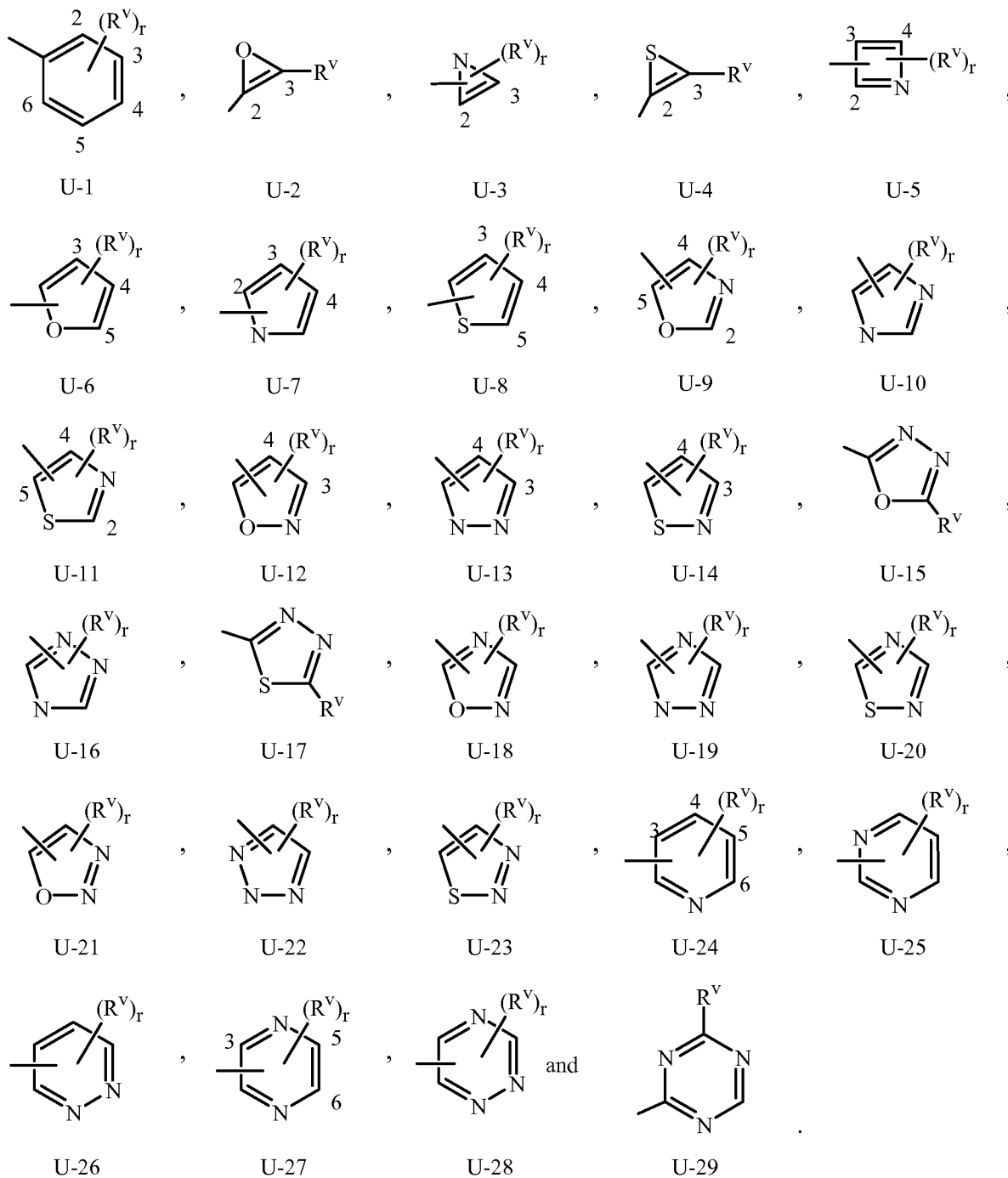
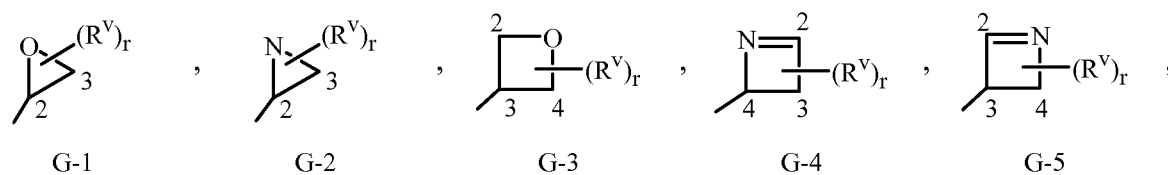
The terms "heterocyclic ring" or "heterocycle" denote rings in which at least one atom forming the ring backbone is not carbon (e.g., N, O or S). Typically a heterocyclic ring contains no more than 3 N atoms, no more than 2 O atoms and no more than 2 S atoms. Unless otherwise indicated, a heterocyclic ring can be a saturated, partially unsaturated or fully unsaturated ring. The term "fully unsaturated heterocyclic ring" includes both aromatic and nonaromatic heterocycles. When a fully unsaturated heterocyclic ring satisfies Hückel's rule, then said ring is also called a "heteroaromatic ring" or "aromatic heterocyclic ring". The terms "heteroaromatic ring system" or "heteroaromatic bicyclic ring system" denote a ring system in which at least one atom forming the ring backbone is not carbon (e.g., N, O or S) and at least one ring is aromatic. Unless otherwise indicated, heterocyclic rings and heteroaromatic ring systems can be attached through any available carbon or nitrogen by replacement of a hydrogen on said carbon or nitrogen.

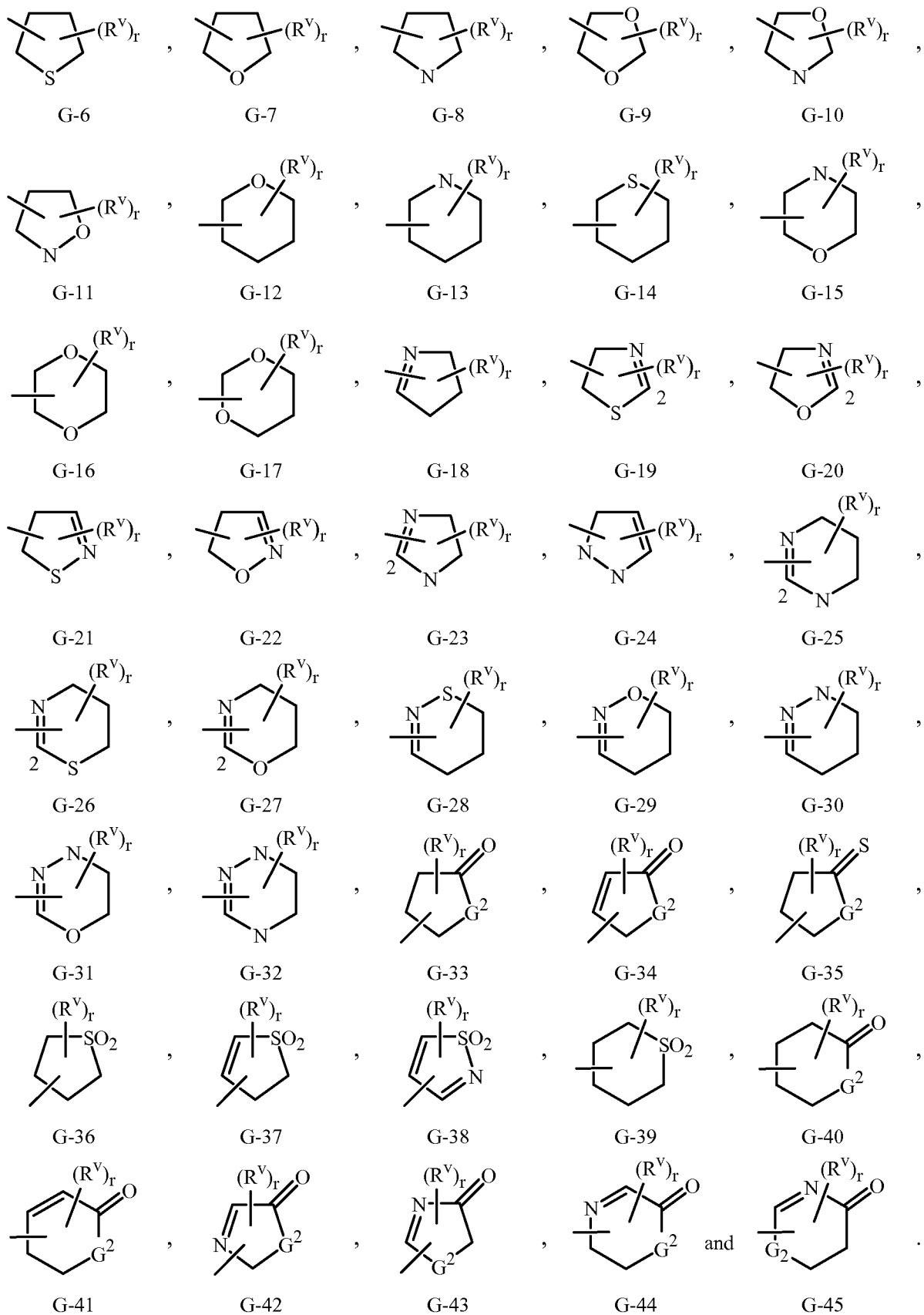
In the context of the present invention when an instance of R^2 and R^3 comprises a phenyl ring or a 6-membered heterocyclic ring, the ortho, meta and para positions of each ring is relative to the connection of the ring to the remainder of Formula 1. Furthermore, when an instance of R^2 and R^3 comprises a phenyl ring or a 6-membered heterocyclic ring attached through a linker (e.g., CH_2 , O, $\text{C}(=\text{O})$, $\text{S}(=\text{O})_n$, NR^8) to the remainder of Formula 1, the ortho, meta and para positions of each ring is relative to the connection of the ring to the linker (e.g., CH_2 , O, $\text{C}(=\text{O})$, $\text{S}(=\text{O})_n$, NR^8).

As noted above, R^2 and R^3 can independently be, *inter alia*, a phenyl ring optionally substituted with up to 5 substituents selected from a group of substituents as defined in the Summary of Invention. An example of phenyl optionally substituted with up to five substituents is the ring illustrated as U-1 in Exhibit 1, wherein R^v is selected from a group of substituents as defined in the Summary of the Invention for R^2 and R^3 (i.e. R^6 on the R^2 ring, and R^7 on the R^3 ring) and r is an integer from 0 to 5. Also as noted above, each R^2 and R^3 is, *inter alia*, a 3-, 4-, 5- or 6-membered heterocyclic ring, each ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 N atoms, wherein up to 3 carbon atom ring members are

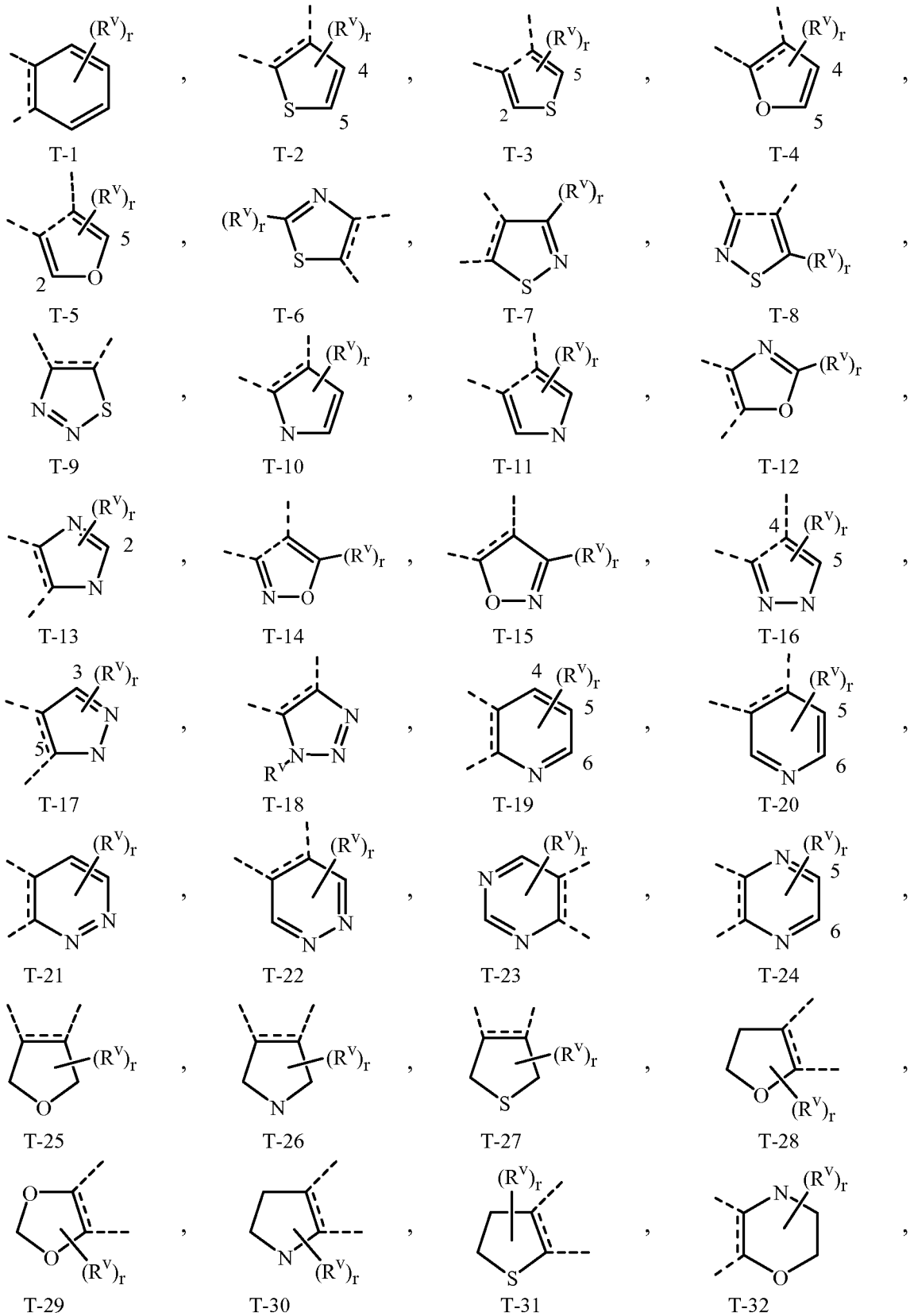
independently selected from C(=O) and C(=S), and the sulfur atom ring members are independently selected from $S(=O)_p(=NR^9)_p$, each ring or ring system optionally substituted with up to 5 substituents independently selected from any substituent as defined in the Summary of the Invention for R^2 and R^3 (i.e. R^2 optional substituents include R^6 on carbon atom ring members and R^{6b} on nitrogen atom ring members; and R^3 optional substituents include R^7 on carbon atom ring members and R^{7a} on nitrogen atom ring members). As the substituents are optional, 0 to 5 substituents may be present, limited only by the number of available points of attachment. In this definition the ring members selected from up to 2 O, up to 2 S and up to 3 N atoms are optional, provided at least one ring member is not carbon (e.g., N, O or S). The definition $S(=O)_p(=NR^9)_p$ allows the up to 2 sulfur ring members to be oxidized sulfur moieties (e.g., S(=O) or S(=O)₂) or unoxidized sulfur atoms (i.e. when p and q are both zero). The nitrogen atom ring members may be oxidized as N-oxides, because compounds relating to Formula 1 also include N-oxide derivatives. The up to 3 carbon atom ring members selected from C(=O) and C(=S) are in addition to the up to 4 heteroatoms selected from up to 2 O, up to 2 S and up to 3 N atoms. Examples of a 3-, 4-, 5- or 6-membered fully unsaturated heterocyclic ring include the rings U-2 through U-29 as illustrated in Exhibit 1; and examples of a 3-, 4-, 5- or 6-membered saturated or partially unsaturated heterocyclic ring include the rings G-1 through G-45 as illustrated in Exhibit 2. In Exhibits 1 and 2 the variable R^v is any substituent as defined in the Summary of the Invention for R^2 and R^3 (i.e. R^2 optional substituents include R^6 on carbon atom ring members and R^{6b} on nitrogen atom ring members; and R^3 optional substituents include R^7 on carbon atom ring members and R^{7a} on nitrogen atom ring members) and r is an integer from 0 to 5, limited by the number of available positions on each depicted ring. Although R^v groups are shown in the structures U-2 through U-29 and G-1 through G-45, it is noted that they do not need to be present since they are optional substituents. The nitrogen atoms that require substitution to fill their valence are substituted with H or R^v . Note that when the attachment point between $(R^v)_r$ and the depicted ring is illustrated as floating, $(R^v)_r$ can be attached to any available carbon or nitrogen atom of the depicted ring. Note that when the attachment point on the depicted ring is illustrated as floating, the depicted ring can be attached to the remainder of Formula 1 through any available carbon or nitrogen of the depicted ring by replacement of a hydrogen atom.

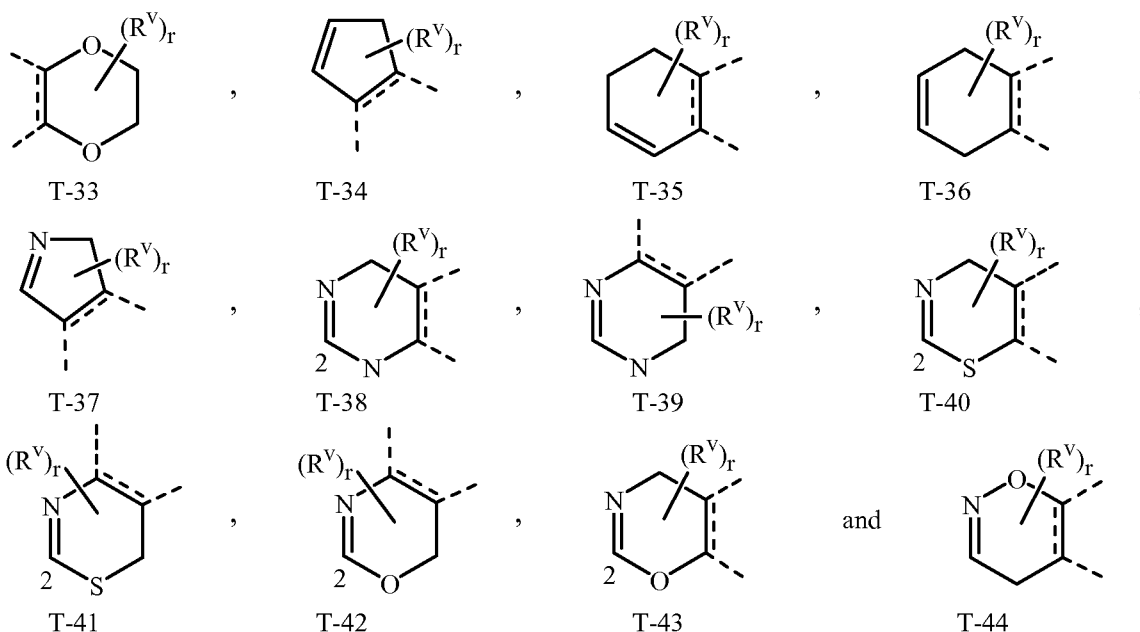
In Exhibit 2, note that when R^2 or R^3 comprises a ring selected from G-33, G-34, G-35 and G-40 through G-45, G^2 is O, S or N. Note that when G^2 is N, the nitrogen atom can complete its valence by substitution with either H or the substituents corresponding to R^v as defined in the Summary of Invention for R^2 or R^3 .

Exhibit 1Exhibit 2



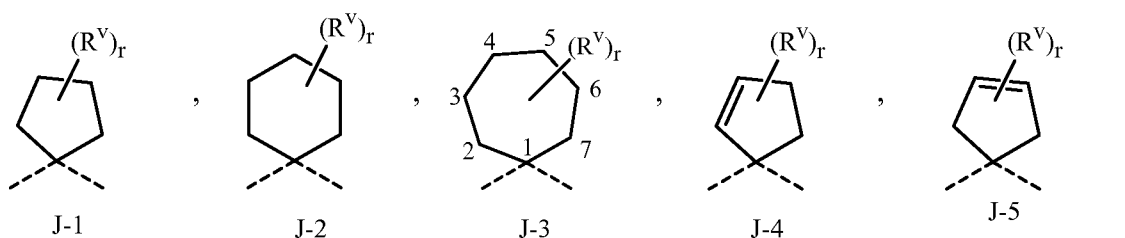
As noted in the Summary of the Invention, when a pair of R^5 substituents are attached to adjacent ring atoms on the phenyl ring of Formula 1, or when a pair of R^6 and/or R^{6a} substituents are attached to adjacent ring atoms on the R^2 ring of Formula 1, or a pair of R^7 and/or R^{7a} substituents are attached to adjacent ring atoms on the R^3 ring of Formula 1, besides the possibility of being separate substituents, they may also be connected to form a ring fused to the respective rings to which they are attached. The fused ring can be a 5-, 6- or 7-membered ring including as ring members the two atoms shared with the ring to which the substituents are attached. The other 3 to 5 ring members of the fused ring are provided by the pair of R^5 substituents, the pair of R^6 and/or R^{6a} substituents or the pair of R^7 and/or R^{7a} substituents taken together. These other ring members can include up to 5 carbon atoms (as allowed by the ring size) and optionally up to 4 heteroatoms selected from up to 2 O, up to 2 S and up to 3 N. The fused ring is optionally substituted with up to 3 substituents as noted in the Summary of the Invention. Exhibit 3 provides, as illustrative examples, rings formed by a pair of adjacent R^5 , R^6 , R^{6a} , R^7 or R^{7a} substituents taken together. As these rings are fused with a ring of Formula 1, a portion of the Formula 1 ring is shown and the dashed lines represent the ring bonds of the Formula 1 ring. In certain cases, as illustrated by T-3, T-5, T-8, T-11, T-14 and T-16, the pattern of single and double bonds between ring members in the fused ring may affect the possible patterns of single and double bonds (according to valence bond theory) in the ring it is fused to in Formula 1, but each of the ring member atoms retains sp^2 hybridized orbitals (i.e. is able to participate in π -bonding). The rings depicted can be fused to any two adjacent atoms of a ring of Formula 1, and furthermore can be fused in either of the two possible orientations. The optional substituents $(R^V)_r$, are independently selected from the group consisting of C_1 - C_2 alkyl, halogen, cyano, nitro and C_1 - C_2 alkoxy on carbon ring members and from the group consisting of C_1 - C_2 alkyl, cyano and C_1 - C_2 alkoxy on nitrogen ring members. For these T-rings, r is an integer from 0 to 3, limited by the number of available positions on each T-ring. When the attachment point between $(R^V)_r$ and the T-ring is illustrated as floating, R^V may be bonded to any available T-ring carbon or nitrogen atom (as applicable). One skilled in the art recognizes that while r is nominally an integer from 0 to 3, some of the rings shown in Exhibit 3 have less than 3 available positions, and for these groups r is limited to the number of available positions. When " r " is 0 this means the ring is unsubstituted and hydrogen atoms are present at all available positions. If r is 0 and $(R^V)_r$ is shown attached to a particular atom, then hydrogen is attached to that atom. The nitrogen atoms that require substitution to fill their valence are substituted with H or R^V . Furthermore, one skilled in the art recognizes that some of the rings shown in Exhibit 3 can form tautomers, and the particular tautomer depicted is representative of all the possible tautomers.

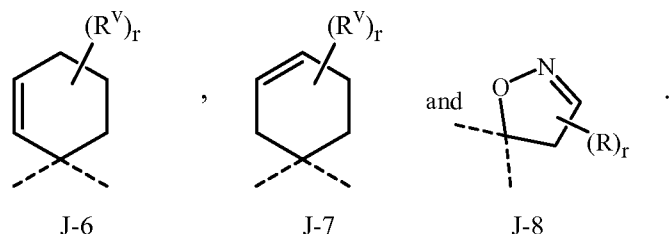
Exhibit 3



As noted in the Summary of the Invention, a pair of R^6 or R^7 substituents, besides the possibility being separate substituents, may also be taken together with the ring atom to which they are attached to form a 5-, 6- or 7-membered spirocyclic ring. The spirocyclic ring includes as a ring member the atom shared with the ring to which the substituents are attached. The other 4 to 6 ring members of the spirocyclic ring are provided by the pair of R^6 substituents or the pair of R^7 substituents taken together. Exhibit 4 provides, as illustrative examples, rings formed by a pair of R^6 or R^7 substituents being taken together. The dashed lines represent bonds in the ring to which the spirocyclic ring is attached. The optional substituents $(R^V)_r$ are independently selected from the group consisting of C_1 - C_2 alkyl, halogen, cyano, nitro and C_1 - C_2 alkoxy on carbon ring members and from the group consisting of C_1 - C_2 alkyl, cyano and C_1 - C_2 alkoxy on nitrogen ring members. For these J-rings, r is an integer from 0 to 3, limited by the number of available positions on each J-ring. When the attachment point between $(R^V)_r$ and the J-ring is illustrated as floating, R^V may be bonded to any available J-ring carbon or nitrogen atom. The optional substituents $(R^V)_r$ are independently selected from the group consisting of C_1 - C_2 alkyl, halogen, cyano, nitro and C_1 - C_2 alkoxy on carbon ring members and from the group consisting of C_1 - C_2 alkyl, cyano and C_1 - C_2 alkoxy on nitrogen ring members. When “ r ” is 0 this means that the ring is unsubstituted and hydrogen atoms are present at all available positions.

Exhibit 4





A wide variety of synthetic methods are known in the art to enable preparation of aromatic heterocyclic rings and ring systems; for extensive reviews see the eight volume set of *Comprehensive Heterocyclic Chemistry*, A. R. Katritzky and C. W. Rees editors-in-chief, Pergamon Press, Oxford, 1984 and the twelve volume set of *Comprehensive Heterocyclic*
 5 *Chemistry II*, A. R. Katritzky, C. W. Rees and E. F. V. Scriven editors-in-chief, Pergamon Press, Oxford, 1996.

Compounds of this invention can exist as one or more stereoisomers. The various stereoisomers include enantiomers, diastereomers, atropisomers and geometric isomers. One skilled in the art will appreciate that one stereoisomer may be more active and/or may
 10 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. The compounds of the invention may be present as a mixture of stereoisomers, individual stereoisomers or as an optically active form.

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
 20 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:
 25 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*,
 30 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 or phenol, 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 (including all geometric isomers, stereoisomers and atropisomers), *N*-oxides and agriculturally suitable salts thereof.

Compounds selected from Formula 1, stereoisomers, *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 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.

Embodiments of the present invention as described in the Summary of the Invention include those described below. In the following Embodiments, Formula 1 includes *N*-oxides 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 R¹ is hydrogen.

Embodiment 2. A compound of Formula 1 wherein R¹ is cyano, hydroxy, amino, C₁-C₄ alkyl, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄ haloalkyl, C₂-C₄ haloalkenyl, C₂-C₄ haloalkynyl, cyclopropyl, halocyclopropyl, C₂-C₄ alkoxyalkyl, C₂-C₄ alkylthioalkyl, C₂-C₄ alkylsulfinylalkyl, C₂-C₄ alkylsulfonylalkyl, C₂-C₄ cyanoalkyl, C₁-C₃ hydroxyalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₁-C₃ alkylthio, C₁-C₃ haloalkylthio, C₁-C₃ alkylamino or C₂-C₄ dialkylamino.

Embodiment 3. A compound of Embodiment 2 wherein R¹ is C₁-C₄ alkyl, C₂-C₄ alkenyl, C₁-C₄ haloalkyl, C₂-C₄ cyanoalkyl or C₁-C₃ alkoxy.

Embodiment 4. A compound of Embodiment 3 wherein R¹ is C₁-C₄ alkyl.

Embodiment 4a. A compound of Embodiment 4 wherein R¹ is methyl, ethyl, or *n*-propyl.

Embodiment 5. A compound of Embodiment 4 wherein R¹ is C₁-C₂ alkyl.

Embodiment 5a. A compound of Embodiment 4a or 5 wherein R¹ is methyl.

Embodiment 6. A compound of Formula 1 or any one of Embodiments 1 through 5 wherein Q is O.

Embodiment 7. A compound of Formula 1 or any one of Embodiments 1 through 6 wherein each W and Y is independently CH₂, O, S, NR⁸ or a direct bond.

Embodiment 7a. A compound of Embodiment 7 wherein each R⁸ is H.

Embodiment 8. A compound of Embodiment 7 wherein each W and Y is independently CH₂, O, S or a direct bond.

Embodiment 9. A compound of Formula 1 or any one of Embodiments 1 through 8 wherein W is a direct bond.

Embodiment 9a. A compound of Formula 1 or any one of Embodiments 1 through 8 wherein Y is a direct bond.

Embodiment 10. A compound of Formula 1 or any one of Embodiments 1 through 9a wherein W and Y are each a direct bond.

Embodiment 11. A compound of Formula 1 or any one of Embodiments 1 through 10a wherein R² is a phenyl ring optionally substituted with up to 5 substituents independently selected from R⁶; or a 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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)_p(=NR⁹)_q, the heterocyclic ring optionally substituted with up to 5

substituents independently selected from R^6 on carbon atom ring members and R^{6a} on nitrogen atom ring members.

Embodiment 12. A compound of Embodiment 11 wherein R^2 is a phenyl ring optionally substituted with up to 3 substituents independently selected from R^6 ; or a 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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 $S(=O)_p(=NR^9)_q$, the heterocyclic ring optionally substituted with up to 3 substituents independently selected from R^6 on carbon atom ring members and R^{6a} on nitrogen atom ring members.

Embodiment 12a. A compound of Embodiment 12 wherein R^2 is a phenyl ring optionally substituted with up to 3 substituents independently selected from R^6 ; or a pyridinyl or oxadiazolyl ring, the heterocyclic ring optionally substituted with up to 3 substituents independently selected from selected from R^6 on carbon atom ring members.

Embodiment 13. A compound of Embodiment 12 wherein R^2 is a phenyl ring optionally substituted with up to 3 substituents independently selected from R^6 .

Embodiment 14. A compound of Embodiment 13 wherein the R^6 substituents are at the 2-, 3- and/or 5-positions.

Embodiment 15. A compound of Embodiment 14 wherein R^2 is a phenyl ring optionally substituted with up to 2 substituents independently selected from R^6 .

Embodiment 16. A compound of Embodiment 15 wherein the R^6 substituents are at the 3- and 5-positions of the phenyl ring.

Embodiment 17. A compound of Embodiment 15 wherein the R^6 substituents are at the 2- and 5-positions of the phenyl ring.

Embodiment 18. A compound of Formula 1 or any one of Embodiments 1 through 17 wherein when R^2 is an optionally substituted phenyl or pyridinyl ring, then R^2 is a phenyl or pyridinyl ring substituted with 2 or 3 substituents independently selected from R^6 .

Embodiment 19. A compound of Formula 1 or any one of Embodiments 1 through 18 wherein when R^2 is an optionally substituted phenyl ring, then R^2 is a phenyl ring substituted with 2 or 3 substituents independently selected from R^6 .

Embodiment 20. A compound of Formula 1 or any one of Embodiments 1 through 19 wherein when R^2 is an optionally substituted phenyl ring, then R^2 is a phenyl ring substituted with 2 substituents independently selected from R^6 attached at the meta positions of the phenyl ring.

Embodiment 21. A compound of Formula 1 or any one of Embodiments 1 through 20 wherein R³ is a phenyl ring optionally substituted with up to 5 substituents independently selected from R⁷; or a 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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)_p(=NR⁹)_q, the heterocyclic ring optionally substituted with up to 5 substituents independently selected from R⁷ on carbon atom ring members and R^{7a} on nitrogen atom ring members; or when Y is a direct bond, then R³ is also selected from halogen, cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₂-C₆ haloalkenyl, C₃-C₆ cycloalkyl, C₃-C₆ cycloalkenyl, C₂-C₆ alkylcarbonyl, C₂-C₆ alkoxycarbonyl and C₁-C₆ hydroxyalkyl.

Embodiment 22. A compound of Embodiment 21 wherein R³ is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁷; or a 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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)_p(=NR⁹)_q, the heterocyclic ring optionally substituted with up to 3 substituents independently selected from R⁷ on carbon atom ring members and R^{7a} on nitrogen atom ring members; or when Y is a direct bond, then R³ is also selected from halogen, cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ alkoxycarbonyl and C₁-C₆ hydroxyalkyl.

Embodiment 22a. A compound of Embodiment 22 wherein R³ is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁷; or a pyridinyl or oxadiazolyl ring, the heterocyclic ring optionally substituted with up to 3 substituents independently selected from selected from R⁷ on carbon atom ring members; or when Y is a direct bond, then R³ is also selected from halogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ alkoxycarbonyl and C₁-C₆ hydroxyalkyl.

Embodiment 23. A compound of Embodiment 22 or 22a wherein R³ is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁷; or when Y is a direct bond, then R³ is also selected from halogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ alkoxycarbonyl and C₁-C₆ hydroxyalkyl.

Embodiment 23a. A compound of Embodiment 23 wherein R^3 is a phenyl ring optionally substituted with up to 3 substituents independently selected from R^7 ; or when Y is a direct bond, then R^3 is also selected from halogen, C_1 - C_4 alkyl, C_2 - C_3 alkenyl, C_1 - C_3 haloalkyl, cyclopropyl, C_2 - C_6 alkylcarbonyl, C_2 - C_3 alkoxy carbonyl or C_1 - C_6 hydroxyalkyl.

Embodiment 24. A compound of Embodiment 23 or 23a wherein R^3 is a phenyl ring optionally substituted with up to 2 substituents independently selected from R^7 ; or when Y is a direct bond, then R^3 is also selected from C_1 - C_4 alkyl, C_2 - C_6 alkoxy carbonyl and C_1 - C_6 hydroxyalkyl.

Embodiment 24a. A compound of Embodiment 24 wherein R^3 is a phenyl ring optionally substituted with up to 1 substituent selected from R^7 ; or when Y is a direct bond, then R^3 is also selected from C_1 - C_4 alkyl, C_2 - C_6 alkoxy carbonyl and C_1 - C_6 hydroxyalkyl.

Embodiment 25. A compound of Embodiment 24 wherein R^3 is a phenyl ring optionally substituted with up to 2 substituents independently selected from R^7 ; or when Y is a direct bond, then R^3 is also selected from C_3 - C_4 alkyl and C_3 - C_4 hydroxyalkyl wherein the carbon atom chain of said alkyl or hydroxyalkyl is branched at the carbon atom connecting R^3 to the remainder of Formula 1.

Embodiment 26. A compound of Formula 1 or any one of Embodiments 1 through 25 wherein R^3 is an optionally substituted phenyl or heterocyclic ring.

Embodiment 27. A compound of Embodiment 26 wherein R^3 is an optionally substituted phenyl ring.

Embodiment 28. A compound of Formula 1 or any one of Embodiments 1 through 27 wherein Y is a direct bond, and R^3 is other than an optionally substituted phenyl ring or heterocyclic ring.

Embodiment 29. A compound of Formula 1 or any one of Embodiments 1 through 28 wherein when R^3 is an optionally substituted phenyl ring, then R^3 is substituted with at least one R^7 substituent attached at an ortho position of the phenyl ring.

Embodiment 30. A compound of Formula 1 or any one of Embodiments 1 through 29 wherein when R^3 is an optionally substituted phenyl ring, then R^3 is a phenyl ring substituted with 1 to 2 substituent independently selected from R^7 .

Embodiment 31. A compound of Formula 1 or any one of Embodiments 1 through 30 wherein when R^3 is an optionally substituted phenyl ring, then R^3 is a phenyl ring substituted with 1 substituent selected from R^7 attached at an ortho or para position of the phenyl ring.

Embodiment 32. A compound of Formula 1 or any one of Embodiments 1 through 31 wherein R^4 is H, halogen, hydroxy or C_1 - C_2 alkyl.

Embodiment 33. A compound of Embodiment 32 wherein R^4 is H, halogen or hydroxy.

Embodiment 34. A compound of Embodiment 33 wherein R⁴ is H.

Embodiment 35. A compound of Formula 1 or any one of Embodiments 1 through 34 wherein each R⁵, R⁶ and R⁷ is independently halogen, cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₁-C₆ alkylthio or C₁-C₆ haloalkylthio.

Embodiment 36. A compound of Embodiments 35 wherein each R⁵, R⁶ and R⁷ is independently halogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl or C₁-C₆ alkoxy.

Embodiment 37. A compound of Embodiment 36 wherein each R⁵, R⁶ and R⁷ is independently halogen, C₁-C₃ alkyl or C₁-C₃ alkoxy.

Embodiment 38. A compound of Embodiment 37 wherein each R⁵, R⁶ and R⁷ is independently halogen, methyl or methoxy.

Embodiment 39. A compound of Embodiment 38 wherein each R⁵ is independently halogen or methoxy.

Embodiment 39a. A compound of Embodiment 39 wherein each R⁵ is methoxy.

Embodiment 40. A compound of Embodiment 38 wherein each R⁶ is independently chloro or methoxy.

Embodiment 40a. A compound of Embodiment 40 wherein each R⁶ is methoxy.

Embodiment 41. A compound of Embodiment 38 wherein each R⁷ is independently halogen.

Embodiment 41a. A compound of Embodiment 41 wherein each R⁷ is fluoro.

Embodiment 42. A compound of Formula 1 or any one of Embodiments 1 through 41a wherein each R^{6a} and R^{7a} is independently cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₁-C₆ alkylthio or C₁-C₆ haloalkylthio.

Embodiment 43. A compound of Embodiment 42 wherein each R^{6a} and R^{7a} is independently C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl or C₁-C₆ alkoxy.

Embodiment 44. A compound of Embodiment 43 wherein each R^{6a} and R^{7a} is independently C₁-C₂ alkyl.

Embodiment 45. A compound of Formula 1 or any one of Embodiments 1 through 44 wherein m is an integer selected from 1, 2 and 3.

Embodiment 46. A compound of Embodiment 45 wherein m is an integer selected from 2 and 3.

Embodiment 47. A compound of Formula 1 or any one of Embodiments 1 through 46 wherein m is 3 and the R⁵ substituents are attached at ortho and para positions of the phenyl ring.

Embodiment 48. A compound of Formula 1 or any one of Embodiments 1 through 47 wherein m is 2 and the R⁵ substituents are attached the ortho positions of the phenyl ring.

Embodiments of this invention, including Embodiments 1-48 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 1-48 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 1-48 are illustrated by:

Embodiment A. A compound of Formula 1 wherein

Q is O;

R¹ is C₁-C₄ alkyl, C₂-C₄ alkenyl, C₁-C₄ haloalkyl, C₂-C₄ cyanoalkyl or C₁-C₃ alkoxy;

R² is a phenyl ring optionally substituted with up to 5 substituents independently selected from R⁶; or a 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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)_p(=NR⁹)_q, the heterocyclic ring optionally substituted with up to 5 substituents independently selected from R⁶ on carbon atom ring members and R^{6a} on nitrogen atom ring members;

R³ is a phenyl ring optionally substituted with up to 5 substituents independently selected from R⁷; or a 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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)_p(=NR⁹)_q, the heterocyclic ring optionally substituted with up to 5 substituents independently selected from R⁷ on carbon atom ring members and R^{7a} on nitrogen atom ring members; or

when Y is a direct bond, then R³ is also selected from halogen, cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₂-C₆ haloalkenyl, C₃-C₆

cycloalkyl, C₃-C₆ cycloalkenyl, C₂-C₆ alkylcarbonyl, C₂-C₆ alkoxycarbonyl and C₁-C₆ hydroxyalkyl;

each R⁵, R⁶ and R⁷ is independently halogen, cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₁-C₆ alkylthio or C₁-C₆ haloalkylthio; and

each R^{6a} and R^{7a} is independently cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₁-C₆ alkylthio or C₁-C₆ haloalkylthio.

Embodiment B. A compound of Embodiment A wherein

R¹ is C₁-C₄ alkyl;

each W and Y is independently CH₂, O, S or a direct bond;

R² is a phenyl ring optionally substituted with up to 3 substituents

independently selected from R⁶; or a 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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)_p(=NR⁹)_q, the heterocyclic ring optionally substituted with up to 3 substituents independently selected from R⁶ on carbon atom ring members and R^{6a} on nitrogen atom ring members;

R³ is a phenyl ring optionally substituted with up to 3 substituents

independently selected from R⁷; or a 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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)_p(=NR⁹)_q, the heterocyclic ring optionally substituted with up to 3 substituents independently selected from R⁷ on carbon atom ring members and R^{7a} on nitrogen atom ring members; or

when Y is a direct bond, then R³ is also selected from halogen, cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ alkoxycarbonyl and C₁-C₆ hydroxyalkyl;

R⁴ is H, halogen, hydroxy or C₁-C₂ alkyl; and

each R^{6a} and R^{7a} is independently C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl or C₁-C₆ alkoxy.

Embodiment C. A compound of Embodiment B wherein

R² is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁶; or a pyridinyl or oxadiazolyl ring, the heterocyclic ring optionally substituted with up to 3 substituents independently selected from selected from R⁶ on carbon atom ring members;

R³ is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁷; or a pyridinyl or oxadiazolyl ring, the heterocyclic ring optionally substituted with up to 3 substituents independently selected from selected from R⁷ on carbon atom ring members; or

when Y is a direct bond, then R³ is also selected from halogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ alkoxy carbonyl and C₁-C₆ hydroxyalkyl; and m is an integer selected from 1, 2 and 3.

Embodiment D. A compound of Embodiment C wherein

R¹ is C₁-C₂ alkyl;

W and Y are each direct bond;

R² is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁶;

R³ is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁷; or

R³ is halogen, C₁-C₄ alkyl, C₂-C₃ alkenyl, C₁-C₃ haloalkyl, cyclopropyl, C₂-C₆ alkylcarbonyl, C₂-C₃ alkoxy carbonyl or C₁-C₆ hydroxyalkyl;

R⁴ is H, halogen or hydroxy; and

each R⁵, R⁶ and R⁷ is independently halogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl or C₁-C₆ alkoxy.

Embodiment E. A compound of Embodiment D wherein

R¹ is methyl;

R² is a phenyl ring optionally substituted with up to 2 substituents independently selected from R⁶;

R³ is a phenyl ring optionally substituted with up to 1 substituent selected from R⁷; or

R³ is C₁-C₄ alkyl, C₂-C₆ alkoxy carbonyl or C₁-C₆ hydroxyalkyl;

R⁴ is H;

each R⁵, R⁶ and R⁷ is independently halogen, C₁-C₃ alkyl or C₁-C₃ alkoxy; and

m is an integer selected from 2 and 3.

Embodiment F. A compound of Embodiment E wherein

R² is a phenyl ring substituted with 2 substituents independently selected from R⁶ attached at the meta positions of the phenyl ring;

R³ is a phenyl ring substituted with 1 substituent selected from R⁷ attached at an ortho or para position of the phenyl ring;

each R⁵ is independently halogen or methoxy;

each R⁶ is independently methoxy or chloro; and

R⁷ is halogen.

Embodiment G. A compound of Embodiment F wherein

each R⁵ is independently halogen; and

each R⁶ is methoxy.

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

6-(2,6-difluorophenyl)-5-(3,5-dimethoxyphenyl)-4-(2-fluorophenyl)-1-methyl-2(1*H*)-pyridinone;

5-(3,5-dimethoxyphenyl)-4-(2-fluorophenyl)-1-methyl-6-(2,4,6-trifluorophenyl)-2(1*H*)-pyridinone;

6-(2,6-difluorophenyl)-5-(3,5-dimethoxyphenyl)-1-ethyl-4-(2-fluorophenyl)-2(1*H*)-pyridinone;

6-(2,6-difluoro-4-methoxyphenyl)-5-(3,5-dimethoxyphenyl)-1-methyl-4-phenyl-2(1*H*)-pyridinone;

6-(2,6-difluoro-4-methoxyphenyl)-5-(3,5-dimethoxyphenyl)-4-(2-fluorophenyl)-1-methyl-2(1*H*)-pyridinone;

5-(3,5-dimethoxyphenyl)-4-(2-fluorophenyl)-1-ethyl-6-(2,4,6-trifluorophenyl)-2(1*H*)-pyridinone; and

5-(2-chloro-3,5-dimethoxyphenyl)-6-(2,6-difluorophenyl)-4-(2-fluorophenyl)-1-methyl-2(1*H*)-pyridinone.

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.

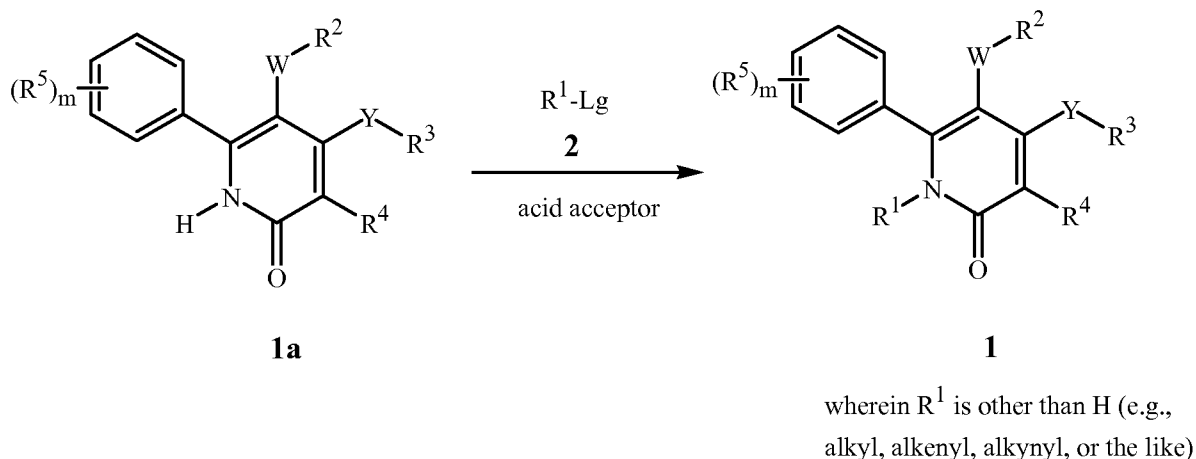
This invention provides a method for controlling plant diseases caused by fungal plant pathogens comprising applying to the plant or portion thereof, or to the plant seed, a

fungicidally effective amount of a compound of Formula **1** (including all stereoisomers, *N*-oxides, and salts thereof). Of note as an embodiment 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 1-5 can be used to prepare the compounds of Formula **1**. The definitions of R^1 , R^2 , R^3 , R^4 , R^5 , m , W and Y in the compounds of Formulae **1-9** below are as defined above in the Summary of the Invention unless otherwise noted. Compounds of Formula **1a** are various subsets of Formula **1**, and all substituents for Formula **1a** are as defined above for Formula **1** unless otherwise noted.

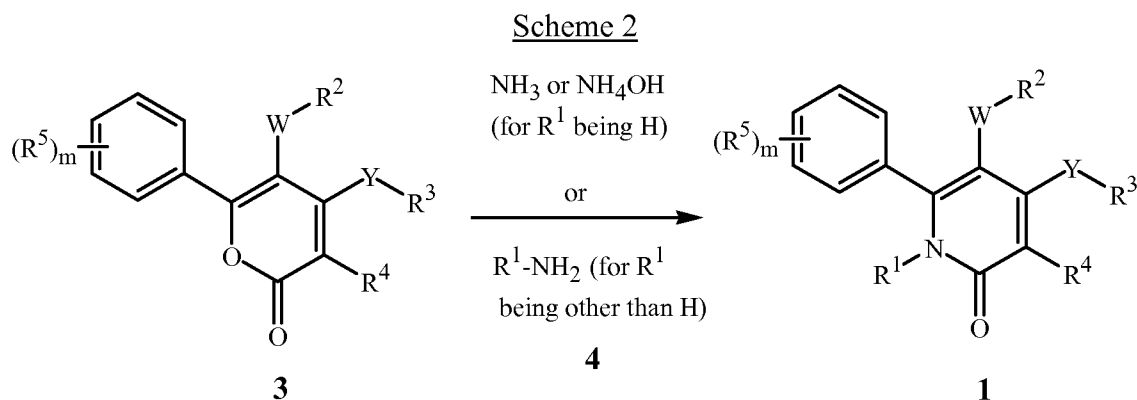
As shown in Scheme 1, compounds of Formula **1** wherein R^1 is other than H (e.g., alkyl, alkenyl, alkynyl, or the like) can be prepared by reacting compounds of Formula **1a** (Formula **1** wherein R^1 is H) with alkylating agents of Formula **2** (wherein Lg is a leaving group such as Cl, Br, I or a sulfonate, for example, *p*-toluenesulfonate, methanesulfonate or trifluoromethanesulfonate) in the presence of an acid acceptor. Suitable acid acceptors for the reaction include inorganic bases such as alkali or alkaline earth metal (e.g., lithium, sodium, potassium and cesium) hydrides, alkoxides, carbonates, phosphates and hydroxides, and organic bases such as triethylamine, *N,N*-diisopropylethylamine and 1,8-diazabicyclo[5.4.0]undec-7-ene. A wide variety of solvents are suitable for the method of Scheme 1 including, for example, tetrahydrofuran, dichloromethane, *N,N*-dimethylformamide, *N,N*-dimethylacetamide, *N*-methylpyrrolidinone, acetonitrile, lower alkanols, and acetone; and mixtures of the foregoing. Typical reaction temperatures range from about -20 to 200 °C, and more typically between about 0 and 50 °C.

Scheme 1



In another method, compounds of Formula **1** are prepared by contacted compounds of Formula **3** with ammonia or ammonium hydroxide (R^1 is H) or primary amines (R^1 is other

than H) of Formula 4 as illustrated in Scheme 2. This method is generally conducted in a liquid phase, usually comprising a solvent, such as lower alkanols, tetrahydrofuran, dichloromethane, *N,N*-dimethylformamide, *N,N*-dimethylacetamide, *N*-methylpyrrolidinone, water, and acetonitrile or a mixture of organic solvent with water, at a temperature between about -20 to 200 °C, and typically between about of 50 to 140 °C. To obtain complete conversion of Formula 3 to Formula 1 at least one molar equivalent of the amine relative to Formula 3 is needed, and the speed of reaction can benefit from a stoichiometric excess, including up to about 50 equivalents, of the amine. This type of method for converting a 2-pyranone to the corresponding 2-pyridones is well known in the literature; see, for example, El-Khohy et al., *Journal of Heterocyclic Chemistry* **1975**, 12(1), 129-133. Also, the method of Scheme 2 is exemplified in Example 1, Step D.



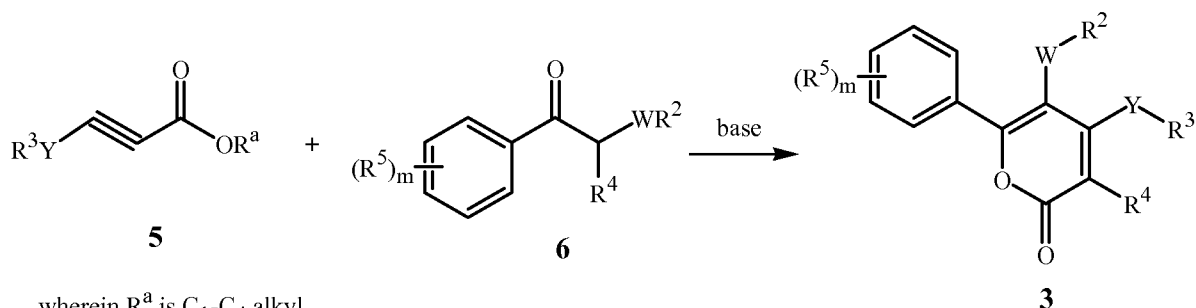
As shown in Scheme 3, the starting 2-pyranones of Formula 3 can be prepared by reaction of acetylenes of Formula 5 with ketones of Formula 6 in the presence of a base. Suitable bases for this method include inorganic bases such as alkali or alkaline earth metal (e.g., lithium, sodium, potassium and cesium) hydrides, hexamethyldisilazides, dialkylamides, alkoxides, carbonates, phosphates and hydroxides, and organic bases such as triethylamine, *N,N*-diisopropylethylamine and 1,8-diazabicyclo[5.4.0]undec-7-ene. Particularly useful as a base is sodium methoxide. Typically the reaction is carried out in a suitable solvent such as diethyl ether, *tert*-butyl methyl ether, tetrahydrofuran, dimethoxyethane, *N,N*-dimethylformamide, *N,N*-dimethylacetamide, *N*-methylpyrrolidinone, and acetonitrile; and mixtures thereof. Preferably the reaction is performed in diethyl ether or *tert*-butyl methyl ether. Typically the method of Scheme 3 is conducted at a temperature between about -20 to 200 °C, and more typically between about 0 to 50 °C. For relevant references see Durani et al., *Journal of Medicinal Chemistry* **1989** 32(8), 1700-1707; El-Kholy et al., *Journal of Heterocyclic Chemistry* **1982** 19, 1329-1334; El-Kholy et al., *Journal of Organic Chemistry* **1966** 31(7), 2167-2170; and references cited therein. Also, the method of Scheme 3 is exemplified in Example 1, Step C.

Acetylenes of Formula 5 are commercially available and can be synthesized by known methods; see, for example, Vasilevsky et al., *Synthetic Communications* **1994** 24(1), 85-88;

Hari et al., *Tetrahedron Letters* **2008** 49(33), 4965-4967; Hari et al., *Heterocycles* **2007** 74, 545-552; Zou et al., *Tetrahedron Letters* **2003** 44(48), 8709-8711; and references cited therein.

Ketones of Formula **6** are commercially available and can be synthesized by known methods; see, for example, Neitzel et al, *Journal of Organic Chemistry* **2000**, 65(20), 6458-6461; PCT Patent Application Publication WO 89/00562; and references cited therein. Example 1, Steps A through B illustrate the synthesis of a compound of Formula **6** wherein W is a direct bond and R² is 2,6-difluorophenyl.

Scheme 3

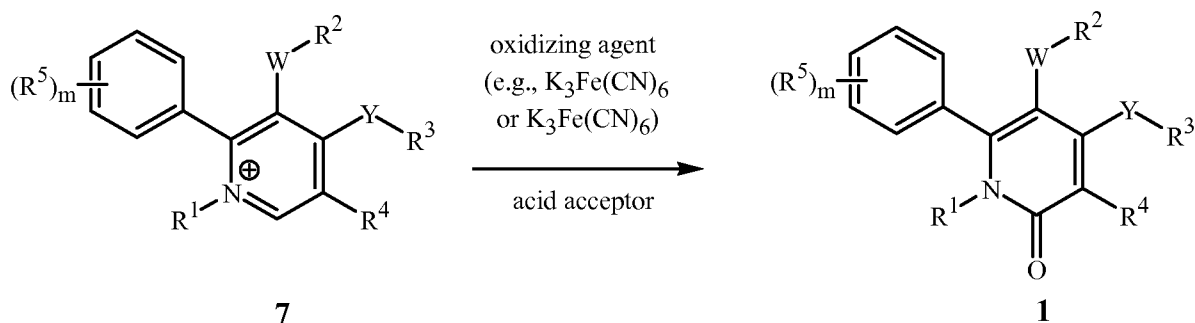


One skilled in the art recognizes that the method of Scheme 3 illustrates just one way of preparing 2-pyranones of Formula **3**, and numerous other methods described in the chemistry literature can also be used for synthesizing Formula **3** compounds. For leading references on synthesis of 2-pyranones see; for example, Larock et al., *Journal of Organic Chemistry* **1999**, 64(24), 8770-8779; Larock et al., *Journal of Organic Chemistry* **2003**, 68(15), 5936-5942; Kuninobu et al., *Chemical Communications* **2008**, 47, 6360-6362; Goel et al., *Tetrahedron* **2009**, 65(38), 7865-7913; Mochida et al., *Journal of Organic Chemistry* **2009**, 74(16), 6295-6298; Kim et al, *Tetrahedron Letters* **2009**, 50(36) 5098-5101; and references cited therein.

In alternate approach, compounds of Formula **1** can be synthesized by oxidation of pyridinium salts of Formula **7** as shown in Scheme 4. The reaction is performed by contacting a compound of Formula **7** with an oxidizing agent such as an alkali metal hexacyanoferrate(II) (e.g., potassium hexacyanoferrate(II) or sodium hexacyanoferrate(II)) in the presence of an acid acceptor and solvent. Suitable acid acceptors for the present method include inorganic bases such as alkali or alkaline earth metal (e.g., lithium, sodium, potassium and cesium) hydrides, alkoxides, carbonates, phosphates and hydroxides, and organic bases such as triethylamine, *N,N*-diisopropylethylamine and 1,8-diazabicyclo [5.4.0]undec-7-ene. An acid acceptor of particular note for the present method is sodium hydroxide. A variety of solvents can be used to form the suitable solvent for this method including lower alkanols, tetrahydrofuran, dichloromethane, *N,N*-dimethylformamide, *N,N*-dimethylacetamide, *N*-methylpyrrolidinone, dimethyl sulfoxide, water, and acetonitrile; and mixtures of the foregoing. Typically, the method is most satisfactorily conducted using

solvents in which the acid acceptor and oxidizing agent (e.g., alkali metal hexacyanoferrate(II)) are substantially soluble. Of particular note is a mixture of an organic solvent and water (e.g., dimethyl sulfoxide/water). When the oxidizing agent used is an alkali metal hexacyanoferrate(II) typically the molar ratio relative to Formula 7 is from about 1.1 to about 20, and more typically from about 4 to about 8. General procedures for oxidation of pyridinium salts are known in the art and can be readily adapted to prepare compounds of Formula 1. Particularly useful are Decker oxidative reaction conditions. For leading references see, for example, Weber et al., *Chemische Berichte* **1985**, 118, 3429-3437; Matsumura et al., *Bulletin of the Chemical Society of Japan* **1970**, 43, 3540-3542; and Hollan et al., *Biochemical Journal* **1948**, 43, 423-426.

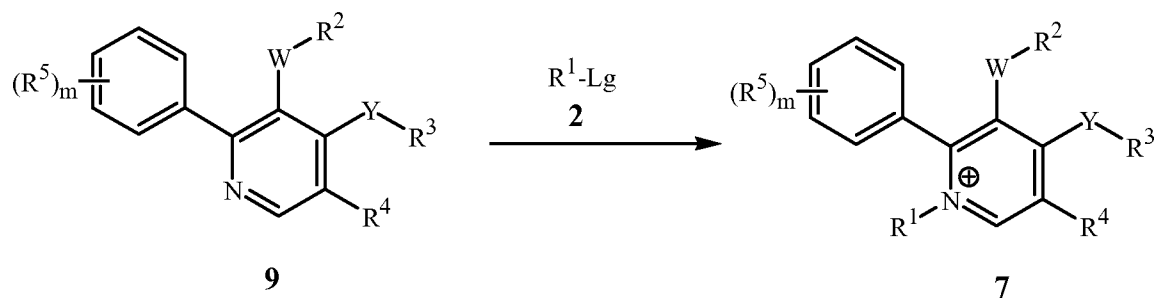
Scheme 4



As shown in Scheme 5 pyridinium salts of Formula 7 can be prepared by the reaction of pyridines of Formula 9 with alkylating agents of Formula 2 (wherein Lg is a leaving group such as Cl, Br, I or a sulfonate, for example, *p*-toluenesulfonate, methanesulfonate or trifluoromethanesulfonate). The alkylating agent is generally present in an excess, typically in the range of about 1.1 to 20 molar equivalents relative to the pyridine of Formula 9. Typically the reaction is carried out in a suitable solvent such as tetrahydrofuran, acetonitrile, acetone, diethyl ether, *N,N*-dimethylformamide, *N,N*-dimethylacetamide, alcohols (e.g., methanol, ethanol), and water. Typically, the method is most satisfactorily conducted using solvents in which the pyridine of Formula 9 is preferably completely or at least substantially soluble and the pyridinium salt of Formula 7 typically has low solubility at ambient temperatures (e.g., about 15-40 °C) in the volume of solvent used such as acetone. The present method is typically conducted at a temperature between about -20 to 200 °C, and more typically between about 0 to 100 °C. Alkylation of pyridines to form pyridinium salts is well known in the chemistry literature. For representative procedures see Matsumura et al., *Bulletin of the Chemical Society of Japan* **1970**, 43, 3540-3542; and Hollan et al., *Biochemical Journal* **1948**, 43, 423-426.

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Scheme 5



Compounds of Formula **9** are commercially available and can also be prepared by known methods. For example, halides of Formula **9** (i.e. when R^5 , R^6 , and/or R^7 is halogen) can be prepared using methods disclosed in U.S. Patent Application Publication US 2005/165015; PCT Patent Application Publication WO 2006/138695; Marzi, et al., *European Journal of Organic Chemistry* **2001**, 1371-1376; Walters et al., *Synthetic Communications* **1992**, 22, 2829-2837; Gibson et al., *Journal of Organic Chemistry* **1985**, 50, 2462-2468; and Rocca *Journal of Organic Chemistry* **1993**, 58, 7832-7638; and references cited within. For example, halides of Formula **9** can be contacted with organoboronic acids, organoboronic esters, organotrifluoroborates, organotin reagents, Grignard reagents or organozinc reagents in the presence of transition metal-catalyzed (e.g., palladium(II) acetate, palladium(II) chloride, tetrakis(triphenylphosphine)palladium(0), bis(triphenylphosphine)palladium(II) dichloride, dichloro[1,1'-bis(diphenylphosphino)ferrocene]palladium(II), bis(triphenylphosphine)dichloronickel(II) and copper(I) salts). For reviews of metal-catalyzed cross-coupling of reactions see: Buchwald et al., *Accounts of Chemical Research*, **1998**, 31(12), 805-818; Suzuki et al., *Chemical Review* **1995**, 95, 2457-2483; Hartwig, *Angew. Chem. Int. Ed.*, **1998**, 37, 2046-2067; and Gribble and Li, *Palladium in Heterocyclic Chemistry*, first edition, Pergamon Press, Amsterdam, 2000 and 2nd edition, Elsevier, Amsterdam, 2007. Regiospecific halogenation of pyridines, and subsequent cross-coupling or nucleophilic substitution reactions are described in PCT Patent Application Publication WO 2008/124582.

One skilled in the art will recognize that for some compounds of Formula **1** the aryl or heteroaryl R^2 ring and/or R^3 ring may be more conveniently incorporated after forming the central 2-pyridone ring. A variety of conditions published in the chemistry literature can be used for introduction of an aryl or heteroaryl ring onto a 2-pyridone ring including contacting halo-substituted 2-pyridones with organoboronic acids using metal-catalyzed cross-coupling reaction conditions (relevant references listed in preceding paragraph). A particularly useful method involving the preparation 3,5-dihalosubstituted 2-pyridones and subsequent selective palladium-catalyzed cross-coupling is described in Conreux et al., *Organic Letters* **2007**, 9, 271-274.

Compounds of Formula **1** prepared by the methods described above wherein Q is O can be converted to the corresponding thioamides wherein Q is S using a variety of standard thiating reagents such as phosphorus pentasulfide or 2,4-bis(4-methoxyphenyl)-1,3-dithia-2,4-diphosphetane-2,4-disulfide (Lawesson's reagent). For typical conditions see Faidallah et al., *Saudi Pharmaceutical Journal* **2008**, 16, 33-42.

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, Greene, T. W.; Wuts, P. G. M. *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**.

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. ¹H NMR spectra are reported in ppm downfield from tetramethylsilane; "s" means singlet, "d" means doublet, "t" means triplet, "m" means multiplet.

EXAMPLE 1

Preparation of 6-(2,6-difluorophenyl)-5-(3,5-dimethoxyphenyl)-4-(2-phenyl)-1-methyl-2(1*H*)-pyridinone (Compound 7)

Step A: Preparation of 2-[(3,5-dimethoxyphenyl)methylene]hydrazide-4-methylbenzenesulfonic acid

To a mixture of 3,5-dimethoxybenzaldehyde (2.00 g, 12.0 mmol) in ethanol (100 mL) was added *p*-toluenesulfonyl hydrazide (2.20 g, 12.0 mmol). The reaction mixture was stirred at room temperature for 2 h, and then concentrated under reduced pressure to about

half its volume. The resulting mixture was filtered to provide the title compound as a white solid (3.61 g).

¹H NMR (CDCl₃): δ 7.86 (d, 2H), 7.81 (s, 1H), 7.66 (s, 1H), 7.30 (d, 2H), 6.71 (s, 2H), 6.46 (t, 1H), 3.79 (s, 6H), 2.40 (s, 3H).

5 Step B: Preparation of 1-(2,6-difluorophenyl)-2-(3,5-dimethoxyphenyl)ethanone

To a mixture of 4-methylbenzenesulfonic acid 2-[(3,5-dimethoxyphenyl)-methylene]hydrazide (i.e. the product of Step A) (3.34 g, 10.0 mmol) and sodium hydroxide (400 mg, 10.0 mmol) in water (50 mL) was added 2,6-difluorobenzaldehyde (710 mg, 5.0 mmol). The reaction mixture was heated at 95 °C for 1 h, cooled to room temperature, and extracted with ethyl acetate (2 x 60 mL). The combined organic extracts were washed with saturated aqueous sodium chloride solution, dried over sodium sulfate, filtered and concentrated under reduced pressure. The resulting oil was purified by silica gel column chromatography (10% ethyl acetate in hexanes as eluant) to provided the title compound as an oil (650 mg).

10 ¹H NMR (CDCl₃): δ 7.37-7.29 (m, 1H), 6.97-6.87 (m, 2H), 6.43-6.33 (m, 3H), 4.09 (s, 2H), 3.75 (s, 6H).

Step C: Preparation of 6-(2,6-difluorophenyl)-5-(3,5-dimethoxyphenyl)-4-phenyl-2H-pyran-2-one

To a mixture of 1-(2,6-difluorophenyl)-2-(3,5-dimethoxyphenyl)ethanone (i.e. the product of Step B) (500 mg, 1.7 mmol) and ethyl 3-phenyl-2-propynoate (643 mg, 1.8 mmol) in ether (20 mL) was added sodium methoxide (100 mg, 2 mmol). The reaction mixture was stirred at room temperature for 48 h, then diluted with water (30 mL) and extracted with ethyl acetate (2 × 60 mL). The combined organic extracts were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting oil was purified by silica gel column chromatography (20% ethyl acetate in hexanes as eluant) to provide the title compound (268 mg).

20 ¹H NMR (CDCl₃): δ 7.33-7.20 (m, 4H), 7.10 (d, 2H), 6.83 (t, 2H), 6.45 (s, 1H), 6.17 (t, 1H), 6.02 (d, 2H), 3.49 (s, 6H).

Step D: Preparation of 6-(2,6-difluorophenyl)-5-(3,5-dimethoxyphenyl)-4-(2-phenyl)-1-methyl-2(1H)-pyridinone

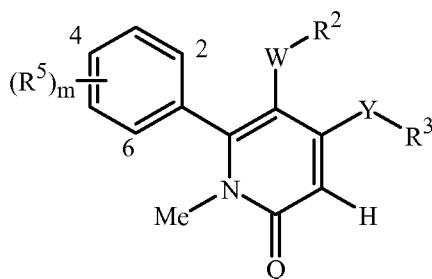
To a mixture of 6-(2,6-difluorophenyl)-5-(3,5-dimethoxyphenyl)-4-phenyl-2H-pyran-2-one (i.e. the product of Step C) (258 mg, 0.61 mmol) in water (3 mL) was added methylamine (33% solution in ethanol, 3 mL). The reaction mixture was heated at 135 °C in a microwave reactor for 10 minutes. After cooling to room temperature, the reaction mixture was diluted with water (20 mL) and extracted with ethyl acetate (2 × 30 mL). The combined organic extracts were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting oil was purified by silica gel column chromatography (30% ethyl

acetate in hexanes as eluant) to provided the title compound, a compound of the present invention, as a solid (150 mg), melting at 157-159 °C.

¹H NMR (CDCl₃): δ 7.31-7.26 (m, 1H), 7.20-7.08 (m, 3H), 6.85 (t, 2H), 6.75 (s, 1H), 6.08 (t, 1H), 6.01 (d, 2H), 3.49 (s, 6H), 3.39 (s, 3H).

5 By the procedures described herein together with methods known in the art, the following compounds of Tables 1 to 4 can be prepared. The following abbreviations are used in the Tables which follow: *s* means secondary, *i* means iso, *c* means cyclo, Me means methyl, Et means ethyl, Pr means propyl, *i*-Pr means isopropyl, Bu means butyl, Ph means phenyl, MeO means methoxy, and CN means cyano. In the following tables a dash (“-”) in
10 the R⁵ column indicates m is 0 and hydrogen is present at all available positions.

Table 1



R² is 3,5-di-MeO-Ph; (R⁵)_m is 2-F; W and Y are each a direct bond; and Q is O.

R ³	R ³	R ³	R ³	R ³	R ³
MeCO ₂	Me	<i>c</i> -pentyl	Ph	4-Cl-Ph	5-MeO-2-pyridinyl
EtCO ₂	Et	<i>c</i> -hexyl	2-F-Ph	4-MeO-Ph	5-Cl-2-pyridinyl
<i>n</i> -Pr-CO ₂	<i>i</i> -Pr	MeC(=CH ₂)	2-Cl-Ph	4-CF ₃ -Ph	6-MeO-3-pyridinyl
MeC(=O)	<i>c</i> -Pr	EtC(=CH ₂)	3-F-Ph	4-CN-Ph	5-Cl, 1,2,4-oxadiazol-3-yl
EtC(=O)	<i>s</i> -Bu	Me ₂ C(OH)	4-F-Ph		

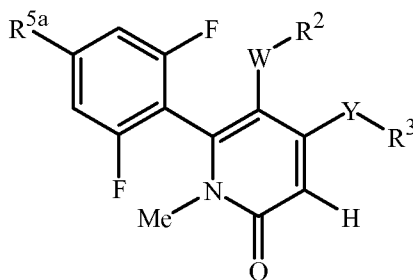
The present disclosure also includes Tables 1A through 64A, each of which is constructed the same as Table 1 above except that the row heading in Table 1 (i.e. “R² is 3,5-di-MeO-Ph; (R⁵)_m is 2-F; W and Y are each a direct bond; and Q is O”) is replaced with the
15 respective row heading shown below. Thus, for example, in Table 1A the row heading is “R² is 2-Cl, 5-MeO-Ph; (R⁵)_m is 2-F; W and Y are each a direct bond; and Q is O”, and R³ is as defined in Table 1 above. Tables 2A through 64A are constructed similarly.

Table	Row Heading
1A	R ² is 2-Cl, 5-MeO-Ph; (R ⁵) _m is 2-F; W and Y are each a direct bond; and Q is O.
2A	R ² is 3,5-di-MeO-Ph; (R ⁵) _m is 4-F; W and Y are each a direct bond; and Q is O.
3A	R ² is 2-Cl, 5-MeO-Ph; (R ⁵) _m is 4-F; W and Y are each a direct bond; and Q is O.
4A	R ² is 3,5-di-MeO-Ph; (R ⁵) _m is 2,4-di-F; W and Y are each a direct bond; and Q is O.
5A	R ² is 2-Cl, 5-MeO-Ph; (R ⁵) _m is 2,4-di-F; W and Y are each a direct bond; and Q is O.
6A	R ² is 3,5-di-MeO-Ph; (R ⁵) _m is 2,6-di-F; W and Y are each a direct bond; and Q is O.

Table	Row Heading
7A	R^2 is 2-Cl, 5-MeO-Ph; $(R^5)_m$ is 2,6-di-F; W and Y are each a direct bond; and Q is O.
8A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 2,4,6-tri-F; W and Y are each a direct bond; and Q is O.
9A	R^2 is 2-Cl, 5-MeO-Ph; $(R^5)_m$ is 2,4,6-tri-F; W and Y are each a direct bond; and Q is O.
10A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 4-Cl; W and Y are each a direct bond; and Q is O.
11A	R^2 is 2-Cl, 5-MeO-Ph; $(R^5)_m$ is 4-Cl; W and Y are both a direct bond; and Q is O.
12A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 4-MeO; W and Y are each a direct bond; and Q is O.
13A	R^2 is 2-Cl, 5-MeO-Ph; $(R^5)_m$ is 4-MeO; W and Y are both a direct bond; and Q is O.
14A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 2,3,6-tri-F; W and Y are each a direct bond; and Q is O.
15A	R^2 is 2-Cl, 5-MeO-Ph; $(R^5)_m$ is 2,3,6-tri-F; W and Y are each a direct bond; and Q is O.
16A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 2,6-di-F, 4-MeO; W and Y are each a direct bond; and Q is O.
17A	R^2 is 2-Cl, 5-MeO-Ph; $(R^5)_m$ is 2,6-di-F, 4-MeO; W and Y are both a direct bond; and Q is O.
18A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 2,6-di-F, 4-MeNH(CH ₂) ₃ O; W and Y are each a direct bond; and Q is O.
19A	R^2 is 2-Cl, 5-Me-Ph; $(R^5)_m$ is 2,6-di-F, 4-MeNH(CH ₂) ₃ O; W and Y are each a direct bond; and Q is O.
20A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 2,6-di-F, 3-MeO; W and Y are each a direct bond; and Q is O.
21A	R^2 is 2-Cl, 5-Me-Ph; $(R^5)_m$ is 2,6-di-F, 3-MeO; W and Y are each a direct bond; and Q is O.
22A	R^2 is 2-Cl, 3,5-di-MeO-Ph; $(R^5)_m$ is 2-F; W and Y are each a direct bond; and Q is O.
23A	R^2 is 2-Cl, 3,5-MeO-Ph; $(R^5)_m$ is 4-F; W and Y are each a direct bond; and Q is O.
24A	R^2 is 2-Cl, 3,5-MeO-Ph; $(R^5)_m$ is 2,4-di-F; W and Y are each a direct bond; and Q is O.
25A	R^2 is 2-Cl, 3,5-di-MeO-Ph; $(R^5)_m$ is 2,6-di-F; W and Y are each a direct bond; and Q is O.
26A	R^2 is 2-Cl, 3,5-di-MeO-Ph; $(R^5)_m$ is 2,4,6-tri-F; W and Y are each a direct bond; and Q is O.
27A	R^2 is 2-Cl, 3,5-di-MeO-Ph; $(R^5)_m$ is 4-Cl; W and Y are both a direct bond; and Q is O.
28A	R^2 is 2-Cl, 3,5-di-MeO-Ph; $(R^5)_m$ is 4-MeO; W and Y are both a direct bond; and Q is O.
29A	R^2 is 2-Cl, 3,5-di-MeO-Ph; $(R^5)_m$ is 2,3,6-tri-F; W and Y are each a direct bond; and Q is O.
30A	R^2 is 2-Cl, 3,5-di-MeO-Ph; $(R^5)_m$ is 2,6-di-F, 4-MeO; W and Y are both a direct bond; and Q is O.
31A	R^2 is 2-Cl, 3,5-di-MeO-Ph; $(R^5)_m$ is 2,6-di-F, 4-MeNH(CH ₂) ₃ O; W and Y are each a direct bond; and Q is O.
32A	R^2 is 2-Cl, 3,5-di-MeO-Ph; $(R^5)_m$ is 2,6-di-F, 3-MeO; W and Y are each a direct bond; and Q is O.
33A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 2-F; W and Y are each a direct bond; and Q is S
34A	R^2 is 2-Cl, 5-MeO-Ph; $(R^5)_m$ is 2-F; W and Y are each a direct bond; and Q is S.
35A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 4-F; W and Y are each a direct bond; and Q is S.
36A	R^2 is 2-Cl, 5-MeO-Ph; $(R^5)_m$ is 4-F; W and Y are each a direct bond; and Q is S.
37A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 2,4-di-F; W and Y are each a direct bond; and Q is S.
38A	R^2 is 2-Cl, 5-MeO-Ph; $(R^5)_m$ is 2,4-di-F; W and Y are each a direct bond; and Q is S.
39A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 2,6-di-F; W and Y are each a direct bond; and Q is S.
40A	R^2 is 2-Cl, 5-MeO-Ph; $(R^5)_m$ is 2,6-di-F; W and Y are each a direct bond; and Q is S.
41A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 2,4,6-tri-F; W and Y are each a direct bond; and Q is S.
42A	R^2 is 2-Cl, 5-MeO-Ph; $(R^5)_m$ is 2,4,6-tri-F; W and Y are each a direct bond; and Q is S.

Table	Row Heading
43A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 4-Cl; W and Y are each a direct bond; and Q is S.
44A	R^2 is 2-Cl, 5-MeO-Ph; $(R^5)_m$ is 4-Cl; W and Y are both a direct bond; and Q is S.
45A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 4-MeO; W and Y are each a direct bond; and Q is S.
46A	R^2 is 2-Cl, 5-MeO-Ph; $(R^5)_m$ is 4-MeO; W and Y are both a direct bond; and Q is S.
47A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 2,3,6-tri-F; W and Y are each a direct bond; and Q is S.
48A	R^2 is 2-Cl, 5-MeO-Ph; $(R^5)_m$ is 2,3,6-tri-F; W and Y are each a direct bond; and Q is S.
49A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 2,6-di-F, 4-MeO; W and Y are each a direct bond; and Q is S.
50A	R^2 is 2-Cl, 5-MeO-Ph; $(R^5)_m$ is 2,6-di-F, 4-MeO; W and Y are both a direct bond; and Q is S.
51A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 2,6-di-F, 4-MeNH(CH ₂) ₃ O; W and Y are each a direct bond; and Q is S.
52A	R^2 is 2-Cl, 5-Me-Ph; $(R^5)_m$ is 2,6-di-F, 4-MeNH(CH ₂) ₃ O; W and Y are each a direct bond; and Q is S.
53A	R^2 is 3,5-di-MeO-Ph; $(R^5)_m$ is 2,6-di-F, 3-MeO; W and Y are each a direct bond; and Q is S.
54A	R^2 is 2-Cl, 5-Me-Ph; $(R^5)_m$ is 2,6-di-F, 3-MeO; W and Y are each a direct bond; and Q is S.
55A	R^2 is 2-Cl, 3,5-di-MeO-Ph; $(R^5)_m$ is 2-F; W and Y are each a direct bond; and Q is S.
56A	R^2 is 2-Cl, 3,5-MeO-Ph; $(R^5)_m$ is 4-F; W and Y are each a direct bond; and Q is S.
57A	R^2 is 2-Cl, 3,5-MeO-Ph; $(R^5)_m$ is 2,4-di-F; W and Y are each a direct bond; and Q is S.
58A	R^2 is 2-Cl, 3,5-di-MeO-Ph; $(R^5)_m$ is 2,6-di-F; W and Y are each a direct bond; and Q is S.
59A	R^2 is 2-Cl, 3,5-di-MeO-Ph; $(R^5)_m$ is 2,4,6-tri-F; W and Y are each a direct bond; and Q is S.
60A	R^2 is 2-Cl, 3,5-di-MeO-Ph; $(R^5)_m$ is 4-Cl; W and Y are both a direct bond; and Q is S.
61A	R^2 is 2-Cl, 3,5-di-MeO-Ph; $(R^5)_m$ is 4-MeO; W and Y are both a direct bond; and Q is S.
62A	R^2 is 2-Cl, 3,5-di-MeO-Ph; $(R^5)_m$ is 2,3,6-tri-F; W and Y are each a direct bond; and Q is S.
63A	R^2 is 2-Cl, 3,5-di-MeO-Ph; $(R^5)_m$ is 2,6-di-F, 4-MeO; W and Y are both a direct bond; and Q is S.
64A	R^2 is 2-Cl, 3,5-di-MeO-Ph; $(R^5)_m$ is 2,6-di-F, 4-MeNH(CH ₂) ₃ O; W and Y are each a direct bond; and Q is S.

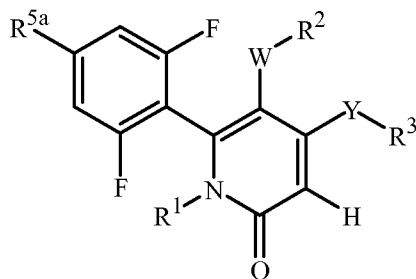
Table 2



W is O; and Y is a direct bond.			W is S; and Y is a direct bond.		
R^2	R^3	R^{5a}	R^2	R^3	R^{5a}
3,5-di-MeO-Ph	Ph	H	3,5-di-MeO-Ph	Ph	H
2-Cl, 5-MeO-Ph	Ph	H	2-Cl, 5-MeO-Ph	Ph	H
3,5-di-MeO-Ph	2-F-Ph	H	3,5-di-MeO-Ph	2-F-Ph	H
2-Cl, 5-MeO-Ph	2-F-Ph	H	2-Cl, 5-MeO-Ph	2-F-Ph	H

W is O; and Y is a direct bond.			W is S; and Y is a direct bond.		
R ²	R ³	R ^{5a}	R ²	R ³	R ^{5a}
2-Cl, 3,5-di-MeO-Ph	2-F-Ph	H	2-Cl, 3,5-di-MeO-Ph	2-F-Ph	H
3,5-di-MeO-Ph	4-F-Ph	H	3,5-di-MeO-Ph	4-F-Ph	H
2-Cl, 5-MeO-Ph	4-F-Ph	H	2-Cl, 5-MeO-Ph	4-F-Ph	H
2-Cl, 3,5-di-MeO-Ph	4-F-Ph	H	2-Cl, 3,5-di-MeO-Ph	4-F-Ph	H
3,5-di-MeO-Ph	4-Cl-Ph	H	3,5-di-MeO-Ph	4-Cl-Ph	H
2-Cl, 5-MeO-Ph	4-Cl-Ph	H	2-Cl, 5-MeO-Ph	4-Cl-Ph	H
2-Cl, 3,5-di-MeO-Ph	4-Cl-Ph	H	2-Cl, 3,5-di-MeO-Ph	4-Cl-Ph	H
3,5-di-MeO-Ph	<i>i</i> -Pr	H	3,5-di-MeO-Ph	<i>i</i> -Pr	H
2-Cl, 5-MeO-Ph	<i>i</i> -Pr	H	2-Cl, 5-MeO-Ph	<i>i</i> -Pr	H
2-Cl, 3,5-di-MeO-Ph	<i>i</i> -Pr	H	2-Cl, 3,5-di-MeO-Ph	<i>i</i> -Pr	H
3,5-di-MeO-Ph	MeC(=CH ₂)	H	3,5-di-MeO-Ph	MeC(=CH ₂)	H
2-Cl, 5-MeO-Ph	MeC(=CH ₂)	H	2-Cl, 5-MeO-Ph	MeC(=CH ₂)	H
3,5-di-MeO-Ph	Et	H	3,5-di-MeO-Ph	Et	H
2-Cl, 5-MeO-Ph	Et	H	2-Cl, 5-MeO-Ph	Et	H
2-Cl, 3,5-di-MeO-Ph	Et	H	2-Cl, 3,5-di-MeO-Ph	Et	H
3,5-di-MeO-Ph	Ph	F	3,5-di-MeO-Ph	Ph	F
2-Cl, 5-MeO-Ph	Ph	F	2-Cl, 5-MeO-Ph	Ph	F
2-Cl, 3,5-di-MeO-Ph	Ph	F	2-Cl, 3,5-di-MeO-Ph	Ph	F
3,5-di-MeO-Ph	2-F-Ph	F	3,5-di-MeO-Ph	2-F-Ph	F
2-Cl, 5-MeO-Ph	2-F-Ph	F	2-Cl, 5-MeO-Ph	2-F-Ph	F
2-Cl, 3,5-di-MeO-Ph	2-F-Ph	F	2-Cl, 3,5-di-MeO-Ph	2-F-Ph	F
3,5-di-MeO-Ph	4-F-Ph	F	3,5-di-MeO-Ph	4-F-Ph	F
2-Cl, 5-MeO-Ph	4-F-Ph	F	2-Cl, 5-Me-Ph	4-F-Ph	F
2-Cl, 3,5-di-MeO-Ph	4-F-Ph	F	2-Cl, 3,5-di-MeO-Ph	4-F-Ph	F
3,5-di-MeO-Ph	<i>i</i> -Pr	F	3,5-di-MeO-Ph	<i>i</i> -Pr	F
2-Cl, 5-MeO-Ph	<i>i</i> -Pr	F	2-Cl, 5-MeO-Ph	<i>i</i> -Pr	F
2-Cl, 3,5-di-MeO-Ph	<i>i</i> -Pr	F	2-Cl, 3,5-diMeO-Ph	<i>i</i> -Pr	F
3,5-di-MeO-Ph	MeC(=CH ₂)	F	3,5-di-MeO-Ph	MeC(=CH ₂)	F
2-Cl, 5-MeO-Ph	MeC(=CH ₂)	F	2-Cl, 5-MeO-Ph	Me C(=CH ₂)	F

Table 3



R^1 is MeO; R^2 is 3,5-di-MeO-Ph; R^{5a} is H; and W and Y are each a direct bond.

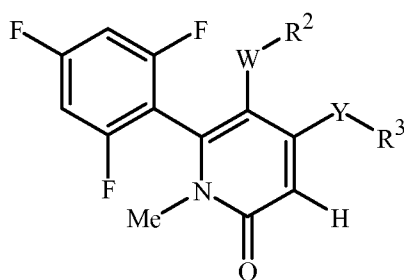
R^3	R^3	R^3	R^3	R^3	R^3
MeCO ₂	Me	<i>c</i> -pentyl	Ph	4-Cl-Ph	5-MeO-2-pyridinyl
EtCO ₂	Et	<i>c</i> -hexyl	2-F-Ph	4-MeO-Ph	5-Cl-2-pyridinyl
<i>n</i> -Pr-CO ₂	<i>i</i> -Pr	MeC(=CH ₂)	2-Cl-Ph	4-CF ₃ -Ph	6-MeO-3-pyridinyl
MeC(=O)	<i>c</i> -Pr	EtC(=CH ₂)	3-F-Ph	4-CN-Ph	5-Cl, 1,2,4-oxadiazol-3-yl
EtC(=O)	<i>s</i> -Bu	Me ₂ C(OH)	4-F-Ph		

The present disclosure also includes Tables 3B through 19B, each of which is constructed the same as Table 3 above except that the row heading in Table 3 (i.e. “ R^1 is MeO; R^2 is 3,5-di-MeO-Ph; R^{5a} is H; and W and Y are each a direct bond”) is replaced with the respective row heading shown below. Thus, for example, in Table 3B the row heading is “ R^1 is MeO; R^2 is 2-Cl, 5-MeO-Ph; R^{5a} is H; and W and Y are each a direct bond”, and R^3 is as defined in Table 3 above. Tables 3B through 19B are constructed similarly.

Table	Row Heading
3B	R^1 is MeO; R^2 is 2-Cl, 5-MeO-Ph; R^{5a} is H; W and Y are each a direct bond.
4B	R^1 is MeO; R^2 is 3,5-di-MeO-Ph; R^{5a} is F; W and Y are each a direct bond.
5B	R^1 is MeO; R^2 is 2-Cl, 5-MeO-Ph; R^{5a} is F; W and Y are each a direct bond.
6B	R^1 is CN; R^2 is 3,5-di-MeO-Ph; R^{5a} is H; W and Y are each a direct bond.
7B	R^1 is CN; R^2 is 2-Cl, 5-MeO-Ph; R^{5a} is H; W and Y are each a direct bond.
8B	R^1 is CN; R^2 is 3,5-di-MeO-Ph; R^{5a} is F; W and Y are both a direct bond.
9B	R^1 is CN; R^2 is 2-Cl, 5-MeO-Ph; R^{5a} is F; W and Y are both a direct bond.
10B	R^1 is Et; R^2 is 3,5-di-MeO-Ph; R^{5a} is H; W and Y are both a direct bond.
11B	R^1 is Et; R^2 is 2-Cl, 5-MeO-Ph; R^{5a} is H; W and Y are both a direct bond.
12B	R^1 is Et; R^2 is 3,5-di-MeO-Ph; R^{5a} is F; W and Y are both a direct bond.
13B	R^1 is Et; R^2 is 2-Cl, 5-MeO-Ph; R^{5a} is F; W and Y are both a direct bond.
14B	R^1 is MeO; R^2 is 2-Cl, 3,5-di-MeO-Ph; R^{5a} is H; W and Y are each a direct bond.
15B	R^1 is MeO; R^2 is 2-Cl, 3,5-di-MeO-Ph; R^{5a} is F; W and Y are each a direct bond.
16B	R^1 is CN; R^2 is 2-Cl, 3,5-di-MeO-Ph; R^{5a} is H; W and Y are each a direct bond.
17B	R^1 is CN; R^2 is 2-Cl, 3,5-di-MeO-Ph; R^{5a} is F; W and Y are both a direct bond.
18B	R^1 is Et; R^2 is 2-Cl, 3,5-di-MeO-Ph; R^{5a} is H; W and Y are both a direct bond.

Table	Row Heading
19B	R ¹ is Et; R ² is 2-Cl, 3,5-di-MeO-Ph; R ^{5a} is F; W and Y are both a direct bond.

Table 4



W and Y are each a direct bond.

R ²	R ³
3-MeO-Ph	Ph
2-F, 5-MeO-Ph	Ph
2-Br, 5-MeO-Ph	Ph
2-F, 3,5-di-MeO-Ph	Ph
2-Cl, 3,5-di-MeO-Ph	Ph
2-Br, 3,5-di-MeO-Ph	Ph
3-MeO-Ph	4-F-Ph
2-F, 5-MeO-Ph	4-F-Ph
2-Br, 5-MeO-Ph	4-F-Ph
2-F, 3,5-di-MeO-Ph	4-F-Ph
2-Cl, 3,5-di-MeO-Ph	4-F-Ph
2-Br, 3,5-di-MeO-Ph	4-F-Ph
3-MeO-Ph	2-F-Ph
2-F, 5-MeO-Ph	2-F-Ph
2-Br, 5-MeO-Ph	2-F-Ph
2-F, 3,5-di-MeO-Ph	2-F-Ph
2-Cl, 3,5-di-MeO-Ph	2-F-Ph
2-Br, 3,5-di-MeO-Ph	2-F-Ph

W and Y are each a direct bond.

R ²	R ³
3-MeO-Ph	<i>i</i> -Pr
2-F, 5-MeO-Ph	<i>i</i> -Pr
2-Br, 5-MeO-Ph	<i>i</i> -Pr
2-F, 3,5-di-MeO-Ph	<i>i</i> -Pr
2-Cl, 3,5-di-MeO-Ph	<i>i</i> Pr
2-Br, 3,5-di-MeO-Ph	<i>i</i> -Pr
3-MeO-Ph	MeC(=CH ₂)
2-F, 5-MeO-Ph	MeC(=CH ₂)
2-Br, 5-MeO-Ph	MeC(=CH ₂)
2-F, 3,5-di-MeO-Ph	MeC(=CH ₂)
2-Cl, 3,5-di-MeO-Ph	MeC(=CH ₂)
2-Br, 3,5-di-MeO-Ph	MeC(=CH ₂)
3-MeO-Ph	<i>c</i> -pentyl
2-F, 5-MeO-Ph	<i>c</i> -pentyl
2-Br, 5-MeO-Ph	<i>c</i> -pentyl
2-F, 3,5-di-MeO-Ph	<i>c</i> -pentyl
2-Cl, 3,5-di-MeO-Ph	<i>c</i> -pentyl
2-Br, 3,5-di-MeO-Ph	<i>c</i> -pentyl

Formulation/Utility

5 A compound of Formula 1 of this invention (including *N*-oxides 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
5 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, prills, pastilles, tablets, filled films (including seed coatings) and the like, which can be
10 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
15 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,
20 usually water. 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
25 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
30 and surfactant within the following approximate ranges which add up to 100 percent by weight.

	Weight Percent		
	<u>Active Ingredient</u>	<u>Diluent</u>	<u>Surfactant</u>
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), ethylene glycol, triethylene glycol, propylene glycol, dipropylene glycol, polypropylene glycol, propylene carbonate, butylene carbonate, paraffins (e.g., white mineral oils, normal paraffins, isoparaffins), alkylbenzenes, alkyl naphthalenes, glycerine, glycerol triacetate, sorbitol, aromatic hydrocarbons, dearomatized aliphatics, alkylbenzenes, alkyl naphthalenes, 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 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 and benzyl alcohol. Liquid diluents also include glycerol esters of saturated and unsaturated fatty acids (typically C₆-C₂₂), 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, alkyd 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 (some of which may be considered to also function as solid diluents, liquid diluents or surfactants). Such formulation auxiliaries and additives may control: pH (buffers), foaming during processing (antifoams such polyorganosiloxanes), sedimentation of active ingredients (suspending agents), viscosity (thixotropic thickeners), in-container microbial growth (antimicrobials), product freezing (antifreezes), color (dyes/pigment dispersions), 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, pages 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.

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 Table A. 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. Percentages are by weight except where otherwise indicated.

Example A

High Strength Concentrate

Compound 7	98.5%
silica aerogel	0.5%
synthetic amorphous fine silica	1.0%

Example BWettable Powder

Compound 9	65.0%
dodecylphenol polyethylene glycol ether	2.0%
sodium ligninsulfonate	4.0%
sodium silicoaluminate	6.0%
montmorillonite (calcined)	23.0%

Example CGranule

Compound 13	10.0%
attapulgite granules (low volatile matter, 0.71/0.30 mm; U.S.S. No. 25–50 sieves)	90.0%

Example DExtruded Pellet

Compound 17	25.0%
anhydrous sodium sulfate	10.0%
crude calcium ligninsulfonate	5.0%
sodium alkyl naphthalenesulfonate	1.0%
calcium/magnesium bentonite	59.0%

Example EEmulsifiable Concentrate

Compound 17	10.0%
polyoxyethylene sorbitol hexoleate	20.0%
C ₆ –C ₁₀ fatty acid methyl ester	70.0%

Example FMicroemulsion

Compound 19	5.0%
polyvinylpyrrolidone-vinyl acetate copolymer	30.0%
alkylpolyglycoside	30.0%
glyceryl monooleate	15.0%
water	20.0%

Example GSeed Treatment

Compound 22	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%

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 at least about 1 ppm or more (e.g., from 1 ppm to 100 ppm) of the compound(s) of this invention.

5 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

10 compositions of this invention provide control of diseases caused by a broad spectrum of fungal plant pathogens in the Basidiomycete, Ascomycete, Oomycete and Deuteromycete classes. 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: Oomycetes, including *Phytophthora* diseases such as *Phytophthora*

15 *infestans*, *Phytophthora megasperma*, *Phytophthora parasitica*, *Phytophthora cinnamomi* and *Phytophthora capsici*, *Pythium* diseases such as *Pythium aphanidermatum*, and diseases in the Peronosporaceae family such as *Plasmopara viticola*, *Peronospora* spp. (including *Peronospora tabacina* and *Peronospora parasitica*), *Pseudoperonospora* spp. (including *Pseudoperonospora cubensis*) and *Bremia lactucae*; Ascomycetes, including *Alternaria*

20 diseases such as *Alternaria solani* and *Alternaria brassicae*, *Guignardia* diseases such as *Guignardia bidwell*, *Venturia* diseases such as *Venturia inaequalis*, *Septoria* diseases such as *Septoria nodorum* and *Septoria tritici*, powdery mildew diseases such as *Erysiphe* spp. (including *Erysiphe graminis* and *Erysiphe polygoni*), *Uncinula necator*, *Sphaerotheca fuliginea* and *Podosphaera leucotricha*, *Pseudocercospora herpotrichoides*, *Botrytis*

25 diseases such as *Botrytis cinerea*, *Monilinia fructicola*, *Sclerotinia* diseases such as *Sclerotinia sclerotiorum*, *Magnaporthe grisea*, *Phomopsis viticola*, *Helminthosporium* diseases such as *Helminthosporium tritici repentis*, *Pyrenophora teres*, anthracnose diseases such as *Glomerella* or *Colletotrichum* spp. (such as *Colletotrichum graminicola* and *Colletotrichum orbiculare*), and *Gaeumannomyces graminis*; Basidiomycetes, including rust

30 diseases caused by *Puccinia* spp. (such as *Puccinia recondita*, *Puccinia striiformis*, *Puccinia hordei*, *Puccinia graminis* and *Puccinia arachidis*), *Hemileia vastatrix* and *Phakopsora pachyrhizi*; other pathogens including *Rutstroemia floccosum* (also known as *Sclerotinia homoeocarpa*); *Rhizoctonia* spp. (such as *Rhizoctonia solani*); *Fusarium* diseases such as

Fusarium roseum, *Fusarium graminearum* and *Fusarium oxysporum*; *Verticillium dahliae*; *Sclerotium rolfii*; *Rhynchosporium secalis*; *Cercosporidium personatum*, *Cercospora arachidicola* and *Cercospora beticola*; and other genera and species closely related to these 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.

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, fruit, 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.

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 0.1 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.

Of note is a composition which in addition to the compound of Formula 1 include at least one fungicidal compound selected from the group consisting of the classes (1) methyl benzimidazole carbamate (MBC) fungicides; (2) dicarboximide fungicides; (3) demethylation inhibitor (DMI) fungicides; (4) phenylamide fungicides; (5) amine/morpholine fungicides; (6) phospholipid biosynthesis inhibitor fungicides; (7) carboxamide fungicides; (8) hydroxy(2-amino-)pyrimidine fungicides; (9) anilinopyrimidine fungicides; (10) *N*-phenyl carbamate fungicides; (11) quinone outside inhibitor (QoI) fungicides; (12) phenylpyrrole fungicides; (13) quinoline fungicides; (14) lipid peroxidation inhibitor fungicides; (15) melanin biosynthesis inhibitors-reductase (MBI-R) fungicides; (16) melanin biosynthesis inhibitors-dehydratase (MBI-D) fungicides; (17) hydroxyanilide fungicides; (18) squalene-epoxidase inhibitor fungicides; (19) polyoxin fungicides; (20) phenylurea fungicides; (21) quinone inside inhibitor (QiI) fungicides; (22) benzamide fungicides; (23) enopyranuronic acid antibiotic fungicides; (24) hexopyranosyl antibiotic fungicides; (25) glucopyranosyl antibiotic: protein synthesis fungicides; (26) glucopyranosyl antibiotic: trehalase and inositol biosynthesis fungicides; (27) cyanoacetamideoxime fungicides; (28) carbamate fungicides; (29) oxidative phosphorylation uncoupling fungicides; (30) organo tin fungicides; (31) carboxylic acid fungicides; (32) heteroaromatic fungicides; (33) phosphonate fungicides; (34) phthalamic acid fungicides; (35) benzotriazine fungicides; (36) benzene-sulfonamide fungicides; (37) pyridazinone fungicides; (38) thiophene-carboxamide fungicides; (39) pyrimidinamide fungicides; (40) carboxylic acid amide (CAA) fungicides; (41) tetracycline antibiotic fungicides; (42) thiocarbamate fungicides; (43) benzamide fungicides; (44) host plant defense induction fungicides; (45) multi-site contact activity fungicides; (46) fungicides other than classes (1) through (45); and salts of compounds of classes (1) through (46).

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

(1) "Methyl benzimidazole carbamate (MBC) fungicides" (Fungicide Resistance Action Committee (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.

(2) "Dicarboximide fungicides" (Fungicide Resistance Action Committee (FRAC) code 2) are proposed to inhibit a lipid peroxidation in fungi through interference with NADH cytochrome c reductase. Examples include chlozolate, iprodione, procymidone and vinclozolin.

(3) "Demethylation inhibitor (DMI) fungicides" (Fungicide Resistance Action Committee (FRAC) code 3) 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 and pyridines. The triazoles include azaconazole, bitertanol, bromuconazole, cyproconazole, difenoconazole, diniconazole (including diniconazole-M), epoxiconazole, fenbuconazole, fluquinconazole, flusilazole, flutriafol, hexaconazole, imibenconazole, ipconazole, metconazole, myclobutanil, penconazole, propiconazole, prothioconazole, simeconazole, tebuconazole, tetraconazole, triadimefon, triadimenol, triticonazole and uniconazole. The imidazoles include clotrimazole, imazalil, oxpoconazole, prochloraz, pefurazoate and triflumizole. The pyrimidines include fenarimol and nuarimol. The piperazines include triforine. The pyridines include pyrifenoxy. 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.

(4) "Phenylamide fungicides" (Fungicide Resistance Action Committee (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, furalaxyl, metalaxyl and metalaxyl-M/mefenoxam. The oxazolidinones include oxadixyl. The butyrolactones include ofurace.

(5) "Amine/morpholine fungicides" (Fungicide Resistance Action Committee (FRAC) code 5) 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.

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

(7) “Carboxamide fungicides” (Fungicide Resistance Action Committee (FRAC) code 7) inhibit Complex II (succinate dehydrogenase) 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. Carboxamide fungicides include benzamides, furan carboxamides, oxathiin carboxamides, thiazole carboxamides, pyrazole carboxamides and pyridine carboxamides. 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 carboxamides include furametpyr, penthiopyrad, bixafen, isopyrazam, *N*-[2-(1*S*,2*R*)-[1,1'-bicyclopropyl]-2-ylphenyl]-3-(difluoromethyl)-1-methyl-1*H*-pyrazole-4-carboxamide and penflufen (*N*-[2-(1,3-dimethylbutyl)phenyl]-5-fluoro-1,3-dimethyl-1*H*-pyrazole-4-carboxamide). The pyridine carboxamides include boscalid.

(8) “Hydroxy(2-amino-)pyrimidine fungicides” (Fungicide Resistance Action Committee (FRAC) code 8) inhibit nucleic acid synthesis by interfering with adenosine deaminase. Examples include bupirimate, dimethirimol and ethirimol.

(9) “Anilinopyrimidine fungicides” (Fungicide Resistance Action Committee (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.

(10) “*N*-Phenyl carbamate fungicides” (Fungicide Resistance Action Committee (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.

(11) “Quinone outside inhibitor (QoI) fungicides” (Fungicide Resistance Action Committee (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 (also known as strobilurin fungicides) include methoxyacrylate, methoxycarbamate, oximinoacetate, oximinoacetamide, oxazolidinedione, dihydrodioxazine, imidazolinone and benzylcarbamate fungicides. The methoxyacrylates include azoxystrobin, enestroburin (SYP-Z071), picoxystrobin and pyraoxystrobin (SYP-3343). The methoxycarbamates include pyraclostrobin and pyrametostrobin (SYP-4155). The oximinoacetates include kresoxim-methyl and trifloxystrobin. The oximinoacetamides include dimoxystrobin, metominostrobin, orysastrobin, α -[methoxyimino]-*N*-methyl-2-[[[1-[3-(trifluoromethyl)phenyl]ethoxy]imino]-methyl]benzeneacetamide and 2-[[[3-(2,6-dichlorophenyl)-1-methyl-2-propen-1-ylidene]-

amino]oxy]methyl]- α -(methoxyimino)-*N*-methylbenzeneacetamide. The oxazolidinediones include famoxadone. The dihydrodioxazines include fluoxastrobin. The imidazolinones include fenamidone. The benzylcarbamates include pyribencarb.

(12) "Phenylpyrrole fungicides" (Fungicide Resistance Action Committee (FRAC) code 12) inhibit a MAP protein kinase associated with osmotic signal transduction in fungi. Fenpiclonil and fludioxonil are examples of this fungicide class.

(13) "Quinoline fungicides" (Fungicide Resistance Action Committee (FRAC) code 13) are proposed to inhibit signal transduction by affecting G-proteins in early cell signaling. They have been shown to interfere with germination and/or appressorium formation in fungi that cause powder mildew diseases. Quinoxifen and tebufloquin are examples of this class of fungicide.

(14) "Lipid peroxidation inhibitor fungicides" (Fungicide Resistance Action Committee (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 carbon and 1,2,4-thiadiazole fungicides. The aromatic carbon fungicides include biphenyl, chloroneb, dicloran, quintozone, tecnazene and tolclofos-methyl. The 1,2,4-thiadiazole fungicides include etridiazole.

(15) "Melanin biosynthesis inhibitors-reductase (MBI-R) fungicides" (Fungicide Resistance Action Committee (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.

(16) "Melanin biosynthesis inhibitors-dehydratase (MBI-D) fungicides" (Fungicide Resistance Action Committee (FRAC) code 16.2) inhibit scytalone dehydratase in melanin biosynthesis. Melanin is 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.

(17) "Hydroxyanilide fungicides (Fungicide Resistance Action Committee (FRAC) code 17) inhibit C4-demethylase which plays a role in sterol production. Examples include fenhexamid.

(18) "Squalene-epoxidase inhibitor fungicides" (Fungicide Resistance Action Committee (FRAC) code 18) inhibit squalene-epoxidase in ergosterol 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.

(19) "Polyoxin fungicides" (Fungicide Resistance Action Committee (FRAC) code 19) inhibit chitin synthase. Examples include polyoxin.

5 (20) "Phenylurea fungicides" (Fungicide Resistance Action Committee (FRAC) code 20) are proposed to affect cell division. Examples include penicureon.

(21) "Quinone inside inhibitor (QiI) fungicides" (Fungicide Resistance Action Committee (FRAC) code 21) inhibit Complex III mitochondrial respiration in fungi by affecting ubiquinol reductase. Reduction of ubiquinol 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.

15 (22) "Benzamide fungicides" (Fungicide Resistance Action Committee (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. Examples include zoxamide.

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

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

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

30 (26) "Glucopyranosyl antibiotic: trehalase and inositol biosynthesis fungicides" (Fungicide Resistance Action Committee (FRAC) code 26) inhibit trehalase in inositol biosynthesis pathway. Examples include validamycin.

(27) "Cyanoacetamideoxime fungicides (Fungicide Resistance Action Committee (FRAC) code 27) include cymoxanil.

35 (28) "Carbamate fungicides" (Fungicide Resistance Action Committee (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, propamacarb-hydrochloride, iodocarb, and prothiocarb are examples of this fungicide class.

(29) "Oxidative phosphorylation uncoupling fungicides" (Fungicide Resistance Action Committee (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, pyrimidonehydrazones such as ferimzone and dinitrophenyl crotonates such as dinocap, meptyldinocap and binapacryl.

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

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

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

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

(34) "Phthalamic acid fungicides" (Fungicide Resistance Action Committee (FRAC) code 34) include teclofthalam.

(35) "Benzotriazine fungicides" (Fungicide Resistance Action Committee (FRAC) code 35) include triazoxide.

(36) "Benzene-sulfonamide fungicides" (Fungicide Resistance Action Committee (FRAC) code 36) include flusulfamide.

(37) "Pyridazinone fungicides" (Fungicide Resistance Action Committee (FRAC) code 37) include diclomezine.

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

(39) "Pyrimidinamide fungicides" (Fungicide Resistance Action Committee (FRAC) code 39) inhibit growth of fungi by affecting phospholipid biosynthesis and include diflumetorim.

(40) "Carboxylic acid amide (CAA) fungicides" (Fungicide Resistance Action Committee (FRAC) code 40) are proposed to inhibit phospholipid biosynthesis and cell wall deposition. Inhibition of these processes prevents growth and leads to death of the target fungus. Carboxylic acid amide fungicides include cinnamic acid amide, valinamide carbamate and mandelic acid amide fungicides. The cinnamic acid amides include dimethomorph and flumorph. The valinamide carbamates include benthiavalicarb, benthiavalicarb-isopropyl, iprovalicarb, valifenalate and 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.

(41) "Tetracycline antibiotic fungicides" (Fungicide Resistance Action Committee (FRAC) code 41) inhibit growth of fungi by affecting complex 1 nicotinamide adenine dinucleotide (NADH) oxidoreductase. Examples include oxytetracycline.

(42) "Thiocarbamate fungicides (b42)" (Fungicide Resistance Action Committee (FRAC) code 42) include methasulfocarb.

(43) "Benzamide fungicides" (Fungicide Resistance Action Committee (FRAC) code 43) inhibit growth of fungi by delocalization of spectrin-like proteins. Examples include acylpicolide fungicides such as fluopicolide and fluopyram.

(44) "Host plant defense induction fungicides" (Fungicide Resistance Action Committee (FRAC) code P) induce host plant defense mechanisms. Host plant defense induction fungicides include benzo-thiadiazole, benzisothiazole and thiadiazole-carboxamide fungicides. The benzo-thiadiazoles include acibenzolar-S-methyl. The benzisothiazoles include probenazole. The thiadiazole-carboxamides include tiadinil and isotianil.

(45) "Multi-site contact fungicides" inhibit fungal growth through multiple sites of action and have contact/preventive activity. This class of fungicides includes: (45.1) "copper fungicides" (Fungicide Resistance Action Committee (FRAC) code M1)", (45.2) "sulfur fungicides" (Fungicide Resistance Action Committee (FRAC) code M2), (45.3) "dithiocarbamate fungicides" (Fungicide Resistance Action Committee (FRAC) code M3), (45.4) "phthalimide fungicides" (Fungicide Resistance Action Committee (FRAC) code M4), (45.5) "chloronitrile fungicides" (Fungicide Resistance Action Committee (FRAC) code M5), (45.6) "sulfamide fungicides" (Fungicide Resistance Action Committee (FRAC) code M6), (45.7) "guanidine fungicides" (Fungicide Resistance Action Committee (FRAC) code M7), (45.8) "triazine fungicides" (Fungicide Resistance Action Committee (FRAC) code M8) and (45.9) "quinone fungicides" (Fungicide Resistance Action Committee (FRAC) code M9). "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. "Guanidine fungicides" include dodine,

guazatine, iminoctadine albesilate and iminoctadine triacetate. "Triazine fungicides" include anilazine. "Quinone fungicides" include dithianon.

(46) "Fungicides other than fungicides of classes (1) through (45)" include certain fungicides whose mode of action may be unknown. These include: (46.1) "thiazole carboxamide fungicides" (Fungicide Resistance Action Committee (FRAC) code U5), (46.2) "phenyl-acetamide fungicides" (Fungicide Resistance Action Committee (FRAC) code U6), (46.3) "quinazolinone fungicides" (Fungicide Resistance Action Committee (FRAC) code U7), (46.4) "benzophenone fungicides" (Fungicide Resistance Action Committee (FRAC) code U8) and (46.5) "triazolopyrimidine fungicides". The thiazole carboxamides include ethaboxam. The phenyl-acetamides include cyflufenamid and *N*-[[cyclopropylmethoxy]-amino][6-(difluoromethoxy)-2,3-difluorophenyl]-methylene]benzeneacetamide. The quinazolinones include proquinazid. The benzophenones include metrafenone. The triazolopyrimidines include ametoctradin. The (b46) class also includes bethoxazin, neoasozin (ferric methanearsonate), pyrrolnitrin, quinomethionate, *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, 2-[[2-fluoro-5-(trifluoromethyl)phenyl]thio]-2-[3-(2-methoxyphenyl)-2-thiazolidinylidene]acetonitrile, 3-[5-(4-chlorophenyl)-2,3-dimethyl-3-isoxazolidinyl]pyridine, 4-fluorophenyl *N*-[1-[[[1-(4-cyanophenyl)ethyl]sulfonyl]methyl]-propyl]carbamate, 5-chloro-6-(2,4,6-trifluorophenyl)-7-(4-methylpiperidin-1-yl)[1,2,4]-triazolo[1,5-*a*]pyrimidine, *N*-(4-chloro-2-nitrophenyl)-*N*-ethyl-4-methylbenzenesulfonamide, *N*-[[cyclopropylmethoxy]amino][6-(difluoromethoxy)-2,3-difluorophenyl]methylene]-benzeneacetamide, *N*'-[4-[4-chloro-3-(trifluoromethyl)phenoxy]-2,5-dimethylphenyl]-*N*-ethyl-*N*-methylmethanimidamide, 1-[(2-propenylthio)carbonyl]-2-(1-methylethyl)-4-(2-methylphenyl)-5-amino-1*H*-pyrazol-3-one, *N*-[9-(dichloromethylene)-1,2,3,4-tetrahydro-1,4-methanonaphthalen-5-yl]-3-(difluoromethyl)-1-methyl-1*H*-pyrazole-4-carboxamide, 3-(difluoromethyl)-*N*-[9-(difluoromethylene)-1,2,3,4-tetrahydro-1,4-methanonaphthalen-5-yl]-1-methyl-1*H*-pyrazole-4-carboxamide, *N*-[9-(dibromomethylene)-1,2,3,4-tetrahydro-1,4-methanonaphthalen-5-yl]-3-(difluoromethyl)-1-methyl-1*H*-pyrazole-4-carboxamide, *N*-[9-(dibromomethylene)-1,2,3,4-tetrahydro-1,4-methanonaphthalen-5-yl]-1-methyl-3-(trifluoromethyl)-1*H*-pyrazole-4-carboxamide, *N*-[9-(difluoromethylene)-1,2,3,4-tetrahydro-1,4-methanonaphthalen-5-yl]-1-methyl-3-(trifluoromethyl)-1*H*-pyrazole-4-carboxamide and *N*-[9-(dichloromethylene)-1,2,3,4-tetrahydro-1,4-methanonaphthalen-5-yl]-1-methyl-3-(trifluoromethyl)-1*H*-pyrazole-4-carboxamide.

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 aforescribed classes (1) through (46). 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 (46). 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 other biologically active compounds or agents with which compounds of this invention can be formulated are: insecticides such as abamectin, acephate, acetamiprid, acrinathrin, 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), 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, tau-fluvalinate, flufenerim (UR-50701), flufenoxuron, fonophos, halofenozide, hexaflumuron, hydramethylnon, imidacloprid, indoxacarb, isofenphos, lufenuron, malathion, metaflumizone, metaldehyde, methamidophos, methidathion, methomyl, methoprene, methoxychlor, metofluthrin, milbemycin oxime, monocrotophos, methoxyfenozide, nicotine, nitenpyram, nithiazine, novaluron, noviflumuron (XDE-007), oxamyl, parathion, parathion-methyl, permethrin, phorate, phosalone, phosmet, phosphamidon, pirimicarb, profenofos, profluthrin, pymetrozine, pyrafluprole, pyrethrin, pyridalyl, pyrifluquinazon, pyriprole, pyriproxifen, rotenone, ryanodine, spinetoram, spinosad, spirotetramat, spiromesifen (BSN 2060), spirotetramat, sulprofos, tebufenozide, teflubenzuron, tefluthrin, terbufos, tetrachlorvinphos, 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.

Of note is a combination of a compound of Formula 1 with at least one other fungicidal active ingredient. Of particular 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 biologically effective amount of at least one additional fungicidal active ingredient having a similar spectrum of control but a different site of action.

Of particular note are compositions which in addition to compound of Formula 1 include at least one compound selected from the group consisting of (1) alkylenebis(dithiocarbamate) fungicides; (2) cymoxanil; (3) phenylamide fungicides; (4) proquinazid (6-iodo-3-propyl-2-propyloxy-4(3*H*)-quinazolinone); (5) chlorothalonil; (6) carboxamides acting at complex II of the fungal mitochondrial respiratory electron transfer site; (7) quinoxifen; (8) metrafenone; (9) cyflufenamid; (10) cyprodinil; (11) copper compounds; (12) phthalimide fungicides; (13) fosetyl-aluminum; (14) benzimidazole fungicides; (15) cyazofamid; (16) fluazinam; (17) iprovalicarb; (18) propamocarb; (19) validomycin; (20) dichlorophenyl dicarboximide fungicides; (21) zoxamide; (22) fluopicolide; (23) mandipropamid; (24) carboxylic acid amides acting on phospholipid

biosynthesis and cell wall deposition; (25) dimethomorph; (26) non-DMI sterol biosynthesis inhibitors; (27) inhibitors of demethylase in sterol biosynthesis; (28) *bc*₁ complex fungicides; and salts of compounds of (1) through (28).

Further descriptions of classes of fungicidal compounds are provided below.

5 Sterol biosynthesis inhibitors (group (27)) control fungi by inhibiting enzymes in the sterol biosynthesis pathway. Demethylase-inhibiting fungicides have a common site of action within the fungal sterol biosynthesis pathway, involving inhibition of demethylation at position 14 of lanosterol or 24-methylene dihydrolanosterol, which are precursors to sterols in fungi. Compounds acting at this site are often referred to as demethylase inhibitors, DMI
10 fungicides, or DMIs. The demethylase enzyme is sometimes referred to by other names in the biochemical literature, including cytochrome P-450 (14DM). The demethylase enzyme is described in, for example, *J. Biol. Chem.* **1992**, 267, 13175-79 and references cited therein. DMI fungicides are divided between several chemical classes: azoles (including triazoles and imidazoles), pyrimidines, piperazines and pyridines. The triazoles include
15 azaconazole, bromuconazole, cyproconazole, difenoconazole, diniconazole (including diniconazole-M), epoxiconazole, etaconazole, fenbuconazole, fluquinconazole, flusilazole, flutriafol, hexaconazole, imibenconazole, ipconazole, metconazole, myclobutanil, penconazole, propiconazole, prothioconazole, quinconazole, simeconazole, tebuconazole, tetraconazole, triadimefon, triadimenol, triticonazole and uniconazole. The imidazoles
20 include clotrimazole, econazole, imazalil, isoconazole, miconazole, oxpoconazole, prochloraz and triflumizole. The pyrimidines include fenarimol, nuarimol and triarimol. The piperazines include triforine. The pyridines include buthiobate and pyrifenoxy. 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,*
25 *Applications and Mechanisms of Action*, H. Lyr (Ed.), Gustav Fischer Verlag: New York, 1995, 205-258.

*bc*₁ Complex Fungicides (group 28) have a fungicidal mode of action which inhibits the *bc*₁ complex in the mitochondrial respiration chain. The *bc*₁ complex is sometimes referred to by other names in the biochemical literature, including complex III of the electron
30 transfer chain, and ubiquinol:cytochrome *c* oxidoreductase. This complex is uniquely identified by Enzyme Commission number EC1.10.2.2. The *bc*₁ complex is described in, for example, *J. Biol. Chem.* **1989**, 264, 14543-48; *Methods Enzymol.* **1986**, 126, 253-71; and references cited therein. Strobilurin fungicides such as azoxystrobin, dimoxystrobin, enestroburin (SYP-Z071), fluoxastrobin, kresoxim-methyl, metominostrobin,
35 oryastrobin, picoxystrobin, pyraclostrobin, pyrametostrobin, pyraoxystrobin and trifloxystrobin are known to have this mode of action (H. Sauter et al., *Angew. Chem. Int. Ed.* **1999**, 38, 1328-1349). Other fungicidal compounds that inhibit the *bc*₁ complex in the mitochondrial respiration chain include famoxadone and fenamidone.

Alkylenebis(dithiocarbamate)s (group (1)) include compounds such as mancozeb, maneb, propineb and zineb. Phenylamides (group (3)) include compounds such as metalaxyl, benalaxyl, furalaxyl and oxadixyl. Carboxamides (group (6)) include compounds such as boscalid, carboxin, fenfuram, flutolanil, furametpyr, mepronil, oxycarboxin, thifluzamide, penthiopyrad and *N*-[2-(1,3-dimethylbutyl)phenyl]-5-fluoro-1,3-dimethyl-1*H*-pyrazole-4-carboxamide (PCT Patent Publication WO 2003/010149), and are known to inhibit mitochondrial function by disrupting complex II (succinate dehydrogenase) in the respiratory electron transport chain. Copper compounds (group (11)) include compounds such as copper oxychloride, copper sulfate and copper hydroxide, including compositions such as Bordeaux mixture (tribasic copper sulfate). Phthalimides (group (12)) include compounds such as folpet and captan. Benzimidazole fungicides (group (14)) include benomyl and carbendazim. Dichlorophenyl dicarboximide fungicides (group (20)) include chlozolate, dichlozoline, iprodione, isovaledione, myclozolin, procymidone and vinclozolin.

Non-DMI sterol biosynthesis inhibitors (group (26)) include morpholine and piperidine fungicides. The morpholines and piperidines are sterol biosynthesis inhibitors that have been shown to inhibit steps in the sterol biosynthesis pathway at a point later than the inhibitions achieved by the DMI sterol biosynthesis (group (27)). The morpholines include aldimorph, dodemorph, fenpropimorph, tridemorph and trimorphamide. The piperidines include fenpropidin.

Of further note are combinations of compounds of Formula 1 with azoxystrobin, kresoxim-methyl, trifloxystrobin, pyraclostrobin, picoxystrobin, dimoxystrobin, metominostrobin/fenominostrobin, carbendazim, chlorothalonil, quinoxifen, metrafenone, cyflufenamid, fenpropidine, fenpropimorph, bromuconazole, cyproconazole, difenoconazole, epoxiconazole, fenbuconazole, flusilazole, hexaconazole, ipconazole, metconazole, penconazole, propiconazole, proquinazid, prothioconazole, tebuconazole, triticonazole, famoxadone, prochloraz, penthiopyrad and boscalid (nicobifen).

Preferred for better control of plant diseases caused by fungal plant pathogens (e.g., lower use rate or broader spectrum of plant pathogens controlled) or resistance management are mixtures of a compound of this invention with a fungicide selected from the group: azoxystrobin, kresoxim-methyl, trifloxystrobin, pyraclostrobin, picoxystrobin, dimoxystrobin, metominostrobin/fenominostrobin, quinoxifen, metrafenone, cyflufenamid, fenpropidine, fenpropimorph, cyproconazole, epoxiconazole, flusilazole, metconazole, propiconazole, proquinazid, prothioconazole, tebuconazole, triticonazole, famoxadone and penthiopyrad.

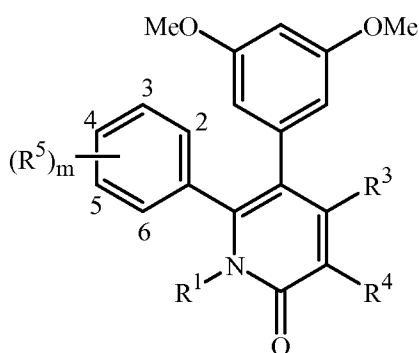
Specifically preferred mixtures (compound numbers refer to compounds in Tables A-B) are selected from the group: combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound

27 with azoxystrobin, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with kresoxim-methyl, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with trifloxystrobin, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with pyraclostrobin, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with picoxystrobin, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with dimoxystrobin, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with metominostrobin/fenominostrobin, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with quinoxifen, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with metrafenone, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with cyflufenamid, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with fenpropidine, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with fenpropimorph, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with cyproconazole, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with epoxiconazole, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with flusilazole, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with metconazole, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with propiconazole, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with proquinazid, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with prothioconazole, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with

tebuconazole, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with triticonazole, combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with famoxadone, and combinations of Compound 6, Compound 9, Compound 13, Compound 17, Compound 19, Compound 20, Compound 22, Compound 23, and Compound 27 with penthiopyrad.

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-B for compound descriptions. See Index Table C for ^1H NMR data. In the column heading of Index Tables A-B the abbreviation "Cmpd." stands for "Compound", and the abbreviation "m.p." stands for melting point. The following abbreviations are used in the Index Tables: *n* is normal, *i* is iso, Me is methyl, Et is ethyl, Pr is propyl, MeO is methoxy and Ph is phenyl. In Index Table A the abbreviation "Ex." stands for "Example" and is followed by a number indicating in which example the compound is prepared.

INDEX TABLE A

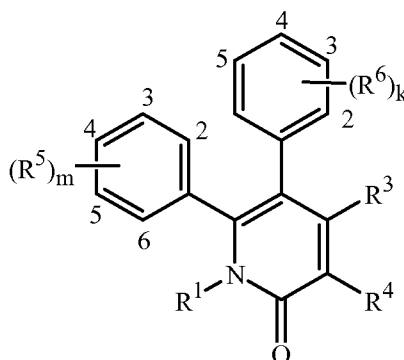


Cmpd.	R ¹	R ³	R ⁴	(R ⁵) _m	m.p. (°C)
1	Me	2-F-Ph	H	4-F	178-181
2	Me	Ph	H	4-F	137-140
3	Me	4-F-Ph	H	2-F	158-161
4	Me	2-F-Ph	H	2-F	160-162
5	Me	Ph	H	2,4-di-F	122-124
6	Me	2-F-Ph	H	2,4-di-F	141-143
7 (Ex. 1)	Me	Ph	H	2,6-di-F	157-159
8	Me	2-Cl-Ph	H	2,6-di-F	187-189
9	Me	2-F-Ph	H	2,6-di-F	90-92
10	Me	2-F-Ph	H	2-Cl	115-117
11	Me	2-Cl-Ph	H	2,4-di-F	149-151
12	Me	4-F-Ph	H	2,4-di-F	136-138

Cmpd.	R ¹	R ³	R ⁴	(R ⁵) _m	m.p. (°C)
13	Me	2-F-Ph	H	2,4,6-tri-F	124-126
14	CH ₂ =CHCH ₂	2-F-Ph	H	2,6-di-F	136-138
15	CH≡CCH ₂	2-F-Ph	H	2,6-di-F	213-215
16	<i>n</i> -Pr	2-F-Ph	H	2,6-di-F	124-126
17	Et	2-F-Ph	H	2,6-di-F	186-188
18	N≡CCH ₂	2-F-Ph	H	2,6-di-F	143-145
19	MeOCH ₂ CH ₂	2-F-Ph	H	2,6-di-F	147-149
20	Me	Ph	H	2,6-di-F, 4-MeO	150-151
21	MeO	2-F-Ph	H	2,6-di-F	171-173
22	Me	2-F-Ph	H	2,6-di-F, 4-MeO	129-130
23	Et	2-F-Ph	H	2,4,6-tri-F	122-124
24	Me	Et	H	2,6-di-F	168-170
25	Me	<i>i</i> -Pr	H	2,6-di-F	193-195
26	Me	Me	H	2,6-di-F	*

* See Index Table C for ¹H NMR data.

INDEX TABLE B



Cmpd.	R ¹	R ³	R ⁴	(R ⁵) _m	(R ⁶) _k	m.p. (°C)
27	Me	2-F-Ph	H	2,6-di-F	2-Cl, 3,5-di-MeO	*
28	Me	2-F-Ph	H	2,6-di-F	4-Cl, 3,5-di-MeO	*

** See Index Table C for ¹H NMR data.

INDEX TABLE C

Cmpd No.	¹ H NMR Data (CDCl ₃ solution unless indicated otherwise) ^a
26	δ 1.98 (s, 3H), 3.30 (s, 3H), 3.70 (s, 6H), 6.20 (s, 1H), 6.23 (s, 1H), 6.60 (s, 1H), 6.81 (t, 2H), 7.26 (m, 1H).
27	δ 3.41 (s, 3H), 3.62 (s, 3H), 3.64 (s, 3H), 6.15 (s, 1H), 6.35 (s, 1H), 6.75 (s, 1H), 6.85 (m, 2H), 6.92 (m, 1H), 7.16 (m, 2H), 7.25 (m, 1H).
28	δ 3.41 (s, 3H), 3.57 (s, 6H), 6.11 (s, 1H), 6.75 (s, 1H), 6.90 (m, 3H), 7.05 (m, 1H), 7.13 (m, 1H), 7.25 (m, 1H), 7.35 (m, 1H).

^a ¹H NMR data are in ppm downfield from tetramethylsilane. Couplings are designated by (s)-singlet, (t)-triplet, (m)-multiplet.

BIOLOGICAL EXAMPLES OF THE INVENTION

General protocol for preparing test suspensions for Tests A-F: The test compounds
5 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)
containing 250 ppm of the surfactant Trem[®] 014 (polyhydric alcohol esters). The resulting
test suspensions were then used in Tests A-F. Spraying a 200 ppm test suspension to the
point of run-off on the test plants was the equivalent of a rate of 500 g/ha. (An asterisk “*”
10 next to the rating value indicates a 40 ppm test suspension.)

TEST A

The test suspension was sprayed to the point of run-off on wheat seedlings. The
following day the seedlings were inoculated with a spore dust of *Erysiphe graminis*
f. sp. *tritici* (the causal agent of wheat powdery mildew) and incubated in a growth chamber
15 at 20 °C for 8 days, after which time visual disease ratings were made.

TEST B

The test suspension 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 20 °C for 24 h, and then moved to a growth chamber at 20 °C for 7 days, after which time
visual disease ratings were made.

TEST C

The test suspension was sprayed to the point of run-off on wheat seedlings. The
following day the seedlings were inoculated with a spore suspension of *Septoria tritici* (the
25 causal agent of wheat leaf blotch) and incubated in saturated atmosphere at 20 °C for 48 h,
and then moved to a growth chamber at 20 °C for 19 days, after which time visual disease
ratings were made.

TEST D

The test suspension was sprayed to the point of run-off on wheat seedlings. The following day the seedlings were inoculated with a spore suspension of *Septoria nodorum* (the causal agent of wheat glume blotch) and incubated in a saturated atmosphere at 20 °C for 48 h, and then moved to a growth chamber at 20 °C for 7 days, after which time visual disease ratings were made.

TEST E

The test suspension was sprayed to the point of run-off on tomato seedlings. The following day the seedlings were inoculated with a spore suspension of *Alternaria solani* (the causal agent of tomato early blight) and incubated in a saturated atmosphere at 27 °C for 48 h, and then moved to a growth chamber at 20 °C for 5 days, after which time visual disease ratings were made.

TEST F

The test suspension was sprayed to the point of run-off on tomato seedlings. The following day the seedlings were inoculated with a spore suspension of *Botrytis cinerea* (the causal agent of tomato Botrytis) and incubated in saturated atmosphere at 20 °C for 48 h, and then moved to a growth chamber at 24 °C for 3 days, after which time visual disease ratings were made.

Results for Tests A-F 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). All results are for 200 ppm except where followed by “*”, which indicates 40 ppm.

Table A

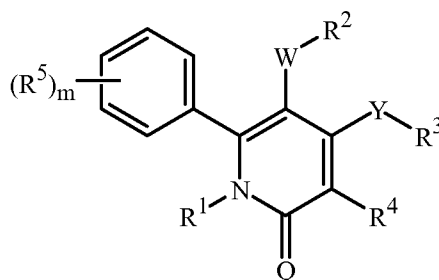
Compound No.	Test A	Test B	Test C	Test D	Test E	Test F
1	97	100	99	95	100	100
2	95	100	100	78	97	100
3	59	80	98	0	57	100
4	96	100	99	80	100	100
5	89	99	95	100	99	93
6	99	100	97	100	97	99
7	98	100	98	100	99	96
8	96	100	96	100	99	98
9	92	100	98	99	99	99
10	91	100	96	99	100	99
11	55	100	95	98	99	98
12	21	91	95	0	0	98
13	100	100	96	100	100	100
14	64	95	98	0	88	100

Compound No.	Test A	Test B	Test C	Test D	Test E	Test F
15	0	0	10	0	0	0
16	78	88	99	0	0	100
17	100	100	96	100	100	99
18	92	89	96	100	96	81
19	75	67	94	0	16	96
20	100	100	93	100	99	99
21	43	100	96	99	97	100
22	99	100	96	100	100	100
23	94*	100*	99*	99*	99*	100*
24	56*	99*	79*	0*	91*	99*
25	84*	98*	98*	0*	88*	99*
26	43*	98*	98*	0*	0*	99*
27	100	100	99	100	100	99
28	0*	91*	0*	0*	0*	64*

CLAIMS

What is claimed is:

1. A compound selected from Formula 1, (including all geometric isomers, stereoisomers and atropisomers), *N*-oxides, and salts thereof,



1

wherein

Q is O or S;

R¹ is H, cyano, hydroxy, amino, C₁-C₄ alkyl, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄ haloalkyl, C₂-C₄ haloalkenyl, C₂-C₄ haloalkynyl, cyclopropyl, halocyclopropyl, C₂-C₄ alkoxyalkyl, C₂-C₄ alkylthioalkyl, C₂-C₄ alkylsulfinylalkyl, C₂-C₄ alkylsulfonylalkyl, C₂-C₄ cyanoalkyl, C₁-C₃ hydroxyalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₁-C₃ alkylthio, C₁-C₃ haloalkylthio, C₁-C₃ alkylamino or C₂-C₄ dialkylamino;

W and Y are each independently CH₂, O, C(=O), S(=O)_n, NR⁸ or a direct bond;

R² is a phenyl ring optionally substituted with up to 5 substituents independently selected from R⁶; or a 3-, 4-, 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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)_p(=NR⁹)_q, the heterocyclic ring optionally substituted with up to 5 substituents independently selected from R⁶ on carbon atom ring members and R^{6a} on nitrogen atom ring members;

R³ is a phenyl ring optionally substituted with up to 5 substituents independently selected from R⁷; or a 3-, 4-, 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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)_p(=NR⁹)_q, the heterocyclic ring optionally substituted with up to 5 substituents independently

selected from R⁷ on carbon atom ring members and R^{7a} on nitrogen atom ring members; or

when Y is a direct bond, then R³ is also selected from halogen, cyano, hydroxy, amino, nitro, -CHO, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₂-C₆ haloalkenyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₈ alkylcycloalkyl, C₄-C₈ cycloalkylalkyl, C₆-C₁₂ cycloalkylcycloalkyl, C₄-C₈ halocycloalkylalkyl, C₅-C₈ alkylcycloalkylalkyl, C₃-C₆ cycloalkenyl, C₂-C₆ alkoxyalkyl, C₂-C₆ alkylthioalkyl, C₂-C₆ alkylsulfinylalkyl, C₂-C₆ alkylsulfonylalkyl, C₂-C₆ alkylaminoalkyl, C₃-C₆ dialkylaminoalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₄-C₆ cycloalkylcarbonyl, C₂-C₆ alkoxycarbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₈ dialkylaminocarbonyl, C₂-C₆ cyanoalkyl, C₁-C₆ hydroxyalkyl, C₂-C₆ hydroxyhaloalkyl, C₂-C₆ hydroxyalkylcarbonyl, C₂-C₆ hydroxycarbonylalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₂-C₆ alkoxyalkoxy, C₃-C₆ alkoxycarbonylalkyl, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfinyl, C₁-C₆ haloalkylsulfinyl, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl, C₃-C₉ trialkylsilyl, C₁-C₆ alkylamino, C₂-C₆ dialkylamino, C₂-C₆ haloalkylamino, C₂-C₆ halodialkylamino, C₃-C₆ cycloalkylamino, C₂-C₆ alkylcarbonylamino, C₂-C₆ haloalkylcarbonylamino, C₁-C₆ alkylsulfonylamino and C₁-C₆ haloalkylsulfonylamino;

R⁴ is H, halogen, cyano, hydroxy, C₁-C₂ alkyl, C₁-C₂ haloalkyl, C₂ alkenyl, C₂ haloalkenyl or C₂ alkynyl;

each R⁵ is independently halogen, cyano, hydroxy, amino, nitro, -CHO, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₂-C₆ alkoxycarbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₆ dialkylaminocarbonyl, C₂-C₆ alkylaminoalkoxy, C₂-C₆ haloalkenyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₈ alkylcycloalkyl, C₄-C₈ cycloalkylalkyl, C₅-C₈ alkylcycloalkylalkyl, C₂-C₆ alkoxyalkyl, C₂-C₆ cyanoalkyl, C₁-C₆ hydroxyalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₂-C₆ alkylcarbonyloxy, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfinyl, C₁-C₆ haloalkylsulfinyl, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl, C₃-C₉ trialkylsilyl, C₂-C₆ alkylcarbonylthio, C₁-C₆ alkylamino or C₂-C₆ dialkylamino; or

a pair of R⁵ substituents attached to adjacent ring atoms are taken together with the atoms to which they are attached to form a 5-, 6- or 7-membered fused ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 N atoms, and optionally substituted with up to 3 substituents independently selected from the

group consisting of C₁-C₂ alkyl, halogen, cyano, nitro and C₁-C₂ alkoxy on carbon ring members and from the group consisting of C₁-C₂ alkyl, cyano and C₁-C₂ alkoxy on nitrogen ring members;

each R⁶ is independently halogen, cyano, hydroxy, amino, nitro, -CHO, C₁-C₆ alkyl,

5 C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₂-C₆ alkoxycarbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₆ dialkylaminocarbonyl, C₂-C₆ alkylaminoalkoxy, C₂-C₆ haloalkenyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₈ alkylcycloalkyl, C₄-C₈ cycloalkylalkyl, C₅-C₈ alkylcycloalkylalkyl, C₂-C₆ alkoxyalkyl, C₂-C₆ cyanoalkyl, C₁-C₆ hydroxyalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₂-C₆ alkylcarbonyloxy, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfinyl, C₁-C₆ haloalkylsulfinyl, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl, C₃-C₉ trialkylsilyl, C₂-C₆ alkylcarbonylthio, C₁-C₆ alkylamino or C₂-C₆ dialkylamino;

15 each R^{6a} is independently cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₂-C₆ alkoxycarbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₆ dialkylaminocarbonyl, C₂-C₆ haloalkenyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₈ alkylcycloalkyl, C₄-C₈ cycloalkylalkyl, C₅-C₈ alkylcycloalkylalkyl, C₂-C₆ alkoxyalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl or C₃-C₉ trialkylsilyl; or

a pair of substituents selected from R⁶ and R^{6a} attached to adjacent ring atoms are taken together with the atoms to which they are attached to form a 5-, 6- or 7-membered fused ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 N atoms, and optionally substituted with up to 3 substituents independently selected from the group consisting of C₁-C₂ alkyl, halogen, cyano, nitro and C₁-C₂ alkoxy on carbon atom ring members and from the group consisting of C₁-C₂ alkyl, cyano and C₁-C₂ alkoxy on nitrogen atoms ring members; or

a pair of R⁶ substituents attached to the same ring atom are taken together with the atom to which they are attached to form a 5-, 6- or 7-membered spirocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 N atoms, and optionally substituted with up to 3 substituents independently selected from the group consisting of C₁-C₂ alkyl, halogen, cyano, nitro and C₁-C₂ alkoxy on carbon atom ring members and from the group consisting of C₁-C₂ alkyl, cyano and C₁-C₂ alkoxy on nitrogen atom ring members;

each R⁷ is independently halogen, cyano, hydroxy, amino, nitro, -CHO, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₂-C₆ alkoxy carbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₆ dialkylaminocarbonyl, C₂-C₆ alkylaminoalkoxy, C₂-C₆ haloalkenyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₈ alkylcycloalkyl, C₄-C₈ cycloalkylalkyl, C₅-C₈ alkylcycloalkylalkyl, C₂-C₆ alkoxyalkyl, C₂-C₆ cyanoalkyl, C₁-C₆ hydroxyalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₂-C₆ alkylcarbonyloxy, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfinyl, C₁-C₆ haloalkylsulfinyl, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl, C₃-C₉ trialkylsilyl, C₂-C₆ alkylcarbonylthio, C₁-C₆ alkylamino or C₂-C₆ dialkylamino;

each R^{7a} is independently cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₂-C₆ alkoxy carbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₆ dialkylaminocarbonyl, C₂-C₆ haloalkenyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₈ alkylcycloalkyl, C₄-C₈ cycloalkylalkyl, C₅-C₈ alkylcycloalkylalkyl, C₂-C₆ alkoxyalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl or C₃-C₉ trialkylsilyl; or

a pair of substituents selected from R⁷ and R^{7a} substituents attached to adjacent ring atoms are taken together with the atoms to which they are attached to form a 5-, 6- or 7-membered fused ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 N atoms, and optionally substituted with up to 3 substituents independently selected from the group consisting of C₁-C₂ alkyl, halogen, cyano, nitro and C₁-C₂ alkoxy on carbon atom ring members and from the group consisting of C₁-C₂ alkyl, cyano and C₁-C₂ alkoxy on nitrogen atom ring members; or

a pair of R⁷ substituents attached to the same ring atom are taken together with the atom to which they are attached to form a 5-, 6- or 7-membered spirocyclic ring containing ring members selected from carbon and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 N atoms, and optionally substituted with up to 3 substituents independently selected from the group consisting of C₁-C₂ alkyl, halogen, cyano, nitro and C₁-C₂ alkoxy on carbon atom ring members and from the group consisting of C₁-C₂ alkyl, cyano and C₁-C₂ alkoxy on nitrogen atom ring members;

each R⁸ and R⁹ is independently H or C₁-C₃ alkyl;

m is an integer selected from 1, 2, 3, 4 and 5;

each n is independently an integer selected from 0, 1 and 2; and
 p and q are independently 0, 1 or 2 in each instance of $S(=O)_p(=NR^9)_q$, provided that
the sum of p and q is 0, 1 or 2;

provided that the compound is other than

1-methyl-6-(4-methylphenyl)-4,5-diphenyl-2(1*H*)-pyridinone,

6-(4-bromophenyl)-1-methyl-4,5-diphenyl-2(1*H*)-pyridinone,

6-(4-methylphenyl)-4,5-diphenyl-2(1*H*)-pyridinone,

6-(4-bromophenyl)-4,5-diphenyl-2(1*H*)-pyridinone,

6-(4-methoxyphenyl)-4,5-diphenyl-2(1*H*)-pyridinone, or

2-(4-fluorophenyl)-1,6-dihydro-4-methyl-6-oxo-[3,4'-bipyridine]-5-carbonitrile.

5 2. A compound of Claim 1 wherein:

Q is O;

R^1 is C_1 - C_4 alkyl, C_2 - C_4 alkenyl, C_1 - C_4 haloalkyl, C_2 - C_4 cyanoalkyl or
 C_1 - C_3 alkoxy;

R^2 is a phenyl ring optionally substituted with up to 5 substituents

10 independently selected from R^6 ; or a 5- or 6-membered heterocyclic
ring containing ring members selected from carbon atoms and up to 4
heteroatoms independently selected from up to 2 O, up to 2 S and up to
3 N atoms, wherein up to 3 carbon atom ring members are
independently selected from C(=O) and C(=S), and the sulfur atom ring
15 members are independently selected from $S(=O)_p(=NR^9)_q$, the
heterocyclic ring optionally substituted with up to 5 substituents
independently selected from R^6 on carbon atom ring members and R^{6a}
on nitrogen atom ring members;

R^3 is a phenyl ring optionally substituted with up to 5 substituents

20 independently selected from R^7 ; or a 5- or 6-membered heterocyclic
ring containing ring members selected from carbon atoms and up to 4
heteroatoms independently selected from up to 2 O, up to 2 S and up to
3 N atoms, wherein up to 3 carbon atom ring members are
independently selected from C(=O) and C(=S), and the sulfur atom ring
25 members are independently selected from $S(=O)_p(=NR^9)_q$, the
heterocyclic ring optionally substituted with up to 5 substituents
independently selected from R^7 on carbon atom ring members and R^{7a}
on nitrogen atom ring members; or

when Y is a direct bond, then R^3 is also selected from halogen, cyano, C_1 - C_6
30 alkyl, C_2 - C_6 alkenyl, C_1 - C_6 haloalkyl, C_2 - C_6 haloalkenyl, C_3 - C_6
cycloalkyl, C_3 - C_6 cycloalkenyl, C_2 - C_6 alkylcarbonyl, C_2 - C_6
alkoxycarbonyl and C_1 - C_6 hydroxyalkyl;

each R⁵, R⁶ and R⁷ is independently halogen, cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₁-C₆ alkylthio or C₁-C₆ haloalkylthio; and

each R^{6a} and R^{7a} is independently cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₁-C₆ alkylthio or C₁-C₆ haloalkylthio.

3. A compound of Claim 2 wherein:

R¹ is C₁-C₄ alkyl;

each W and Y is independently CH₂, O, S or a direct bond;

R² is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁶; or a 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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)_p(=NR⁹)_q, the heterocyclic ring optionally substituted with up to 3 substituents independently selected from R⁶ on carbon atom ring members and R^{6a} on nitrogen atom ring members;

R³ is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁷; or a 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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)_p(=NR⁹)_q, the heterocyclic ring optionally substituted with up to 3 substituents independently selected from R⁷ on carbon atom ring members and R^{7a} on nitrogen atom ring members; or

when Y is a direct bond, then R³ is also selected from halogen, cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ alkoxycarbonyl and C₁-C₆ hydroxyalkyl;

R⁴ is H, halogen, hydroxy or C₁-C₂ alkyl; and

each R^{6a} and R^{7a} is independently C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl or C₁-C₆ alkoxy.

4. A compound of Claim 3 wherein:

R² is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁶; or a pyridinyl or oxadiazolyl ring, the heterocyclic ring optionally substituted with up to 3 substituents independently selected from selected from R⁶ on carbon atom ring members;

R³ is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁷; or a pyridinyl or oxadiazolyl ring, the heterocyclic ring optionally substituted with up to 3 substituents independently selected from selected from R⁷ on carbon atom ring members; or

when Y is a direct bond, then R³ is also selected from halogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ alkoxy carbonyl and C₁-C₆ hydroxyalkyl; and m is an integer selected from 1, 2 and 3.

5. A compound of Claim 4 wherein:

R¹ is C₁-C₂ alkyl;

W and Y are each direct bond;

R² is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁶;

R³ is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁷; or

R³ is halogen, C₁-C₄ alkyl, C₂-C₃ alkenyl, C₁-C₃ haloalkyl, cyclopropyl, C₂-C₆ alkylcarbonyl, C₂-C₃ alkoxy carbonyl or C₁-C₆ hydroxyalkyl;

R⁴ is H, halogen or hydroxy; and

each R⁵, R⁶ and R⁷ is independently halogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl or C₁-C₆ alkoxy.

6. A compound of Claim 5 wherein:

R¹ is methyl;

R² is a phenyl ring optionally substituted with up to 2 substituents independently selected from R⁶;

R³ is a phenyl ring optionally substituted with up to 1 substituent selected from R⁷; or

R³ is C₁-C₄ alkyl, C₂-C₆ alkoxy carbonyl or C₁-C₆ hydroxyalkyl;

R⁴ is H;

each R⁵, R⁶ and R⁷ is independently halogen, C₁-C₃ alkyl or C₁-C₃ alkoxy; and

m is an integer selected from 2 and 3.

7. A compound of Claim 6 wherein:

R^2 is a phenyl ring substituted with 2 substituents independently selected from R^6 attached at the meta positions of the phenyl ring;

R^3 is a phenyl ring substituted with 1 substituent selected from R^7 attached at an ortho or para position of the phenyl ring;

each R^5 is independently halogen or methoxy;

each R^6 is independently methoxy or chloro; and

R^7 is halogen.

8. A compound of Claim 7 wherein:

each R^5 is independently halogen; and

each R^6 is methoxy.

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

6-(2,6-difluorophenyl)-5-(3,5-dimethoxyphenyl)-4-(2-fluorophenyl)-1-methyl-2(1*H*)-pyridinone;

5-(3,5-dimethoxyphenyl)-4-(2-fluorophenyl)-1-methyl-6-(2,4,6-trifluorophenyl)-2(1*H*)-pyridinone;

6-(2,6-difluorophenyl)-5-(3,5-dimethoxyphenyl)-1-ethyl-4-(2-fluorophenyl)-2(1*H*)-pyridinone;

6-(2,6-difluoro-4-methoxyphenyl)-5-(3,5-dimethoxyphenyl)-1-methyl-4-phenyl-2(1*H*)-pyridinone;

6-(2,6-difluoro-4-methoxyphenyl)-5-(3,5-dimethoxyphenyl)-4-(2-fluorophenyl)-1-methyl-2(1*H*)-pyridinone;

5-(3,5-dimethoxyphenyl)-4-(2-fluorophenyl)-1-ethyl-6-(2,4,6-trifluorophenyl)-2(1*H*)-pyridinone; and

5-(2-chloro-3,5-dimethoxyphenyl)-6-(2,6-difluorophenyl)-4-(2-fluorophenyl)-1-methyl-2(1*H*)-pyridinone.

10. A fungicidal composition comprising (a) a compound of Claim 1 wherein R^1 is cyano, hydroxy, amino, C_1 - C_4 alkyl, C_2 - C_4 alkenyl, C_2 - C_4 alkynyl, C_1 - C_4 haloalkyl, C_2 - C_4 haloalkenyl, C_2 - C_4 haloalkynyl, cyclopropyl, halocyclopropyl, C_2 - C_4 alkoxyalkyl, C_2 - C_4 alkylthioalkyl, C_2 - C_4 alkylsulfinylalkyl, C_2 - C_4 alkylsulfonylalkyl, C_2 - C_4 cyanoalkyl, C_1 - C_3 hydroxyalkyl, C_1 - C_3 alkoxy, C_1 - C_3 haloalkoxy, C_1 - C_3 alkylthio, C_1 - C_3 haloalkylthio, C_1 - C_3 alkylamino or C_2 - C_4 dialkylamino; and (b) at least one other fungicide.

11. A fungicidal composition comprising (a) a compound of Claim 1 wherein R^1 is cyano, hydroxy, amino, C_1 - C_4 alkyl, C_2 - C_4 alkenyl, C_2 - C_4 alkynyl, C_1 - C_4 haloalkyl, C_2 - C_4 haloalkenyl, C_2 - C_4 haloalkynyl, cyclopropyl, halocyclopropyl, C_2 - C_4 alkoxyalkyl, C_2 - C_4 alkylthioalkyl, C_2 - C_4 alkylsulfinylalkyl, C_2 - C_4 alkylsulfonylalkyl, C_2 - C_4 cyanoalkyl, C_1 - C_3 hydroxyalkyl, C_1 - C_3 alkoxy, C_1 - C_3 haloalkoxy, C_1 - C_3 alkylthio, C_1 - C_3 haloalkylthio,

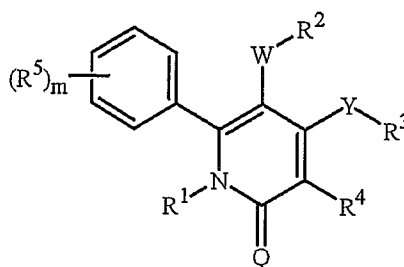
C₁-C₃ alkylamino or C₂-C₄ dialkylamino; and (b) at least one additional component selected from the group consisting of surfactants, solid diluents and liquid diluents.

12. 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 wherein R¹ is cyano, hydroxy, amino, C₁-C₄ alkyl, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄ haloalkyl, C₂-C₄ haloalkenyl, C₂-C₄ haloalkynyl, cyclopropyl, halocyclopropyl, C₂-C₄ alkoxyalkyl, C₂-C₄ alkylthioalkyl, C₂-C₄ alkylsulfinylalkyl, C₂-C₄ alkylsulfonylalkyl, C₂-C₄ cyanoalkyl, C₁-C₃ hydroxyalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₁-C₃ alkylthio, C₁-C₃ haloalkylthio, C₁-C₃ alkylamino or C₂-C₄ dialkylamino.

CLAIMS

What is claimed is:

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



1

5 wherein

Q is O or S;

R^1 is H, cyano, hydroxy, amino, C_1 - C_4 alkyl, C_2 - C_4 alkenyl, C_2 - C_4 alkynyl, C_1 - C_4 haloalkyl, C_2 - C_4 haloalkenyl, C_2 - C_4 haloalkynyl, cyclopropyl, halocyclopropyl, C_2 - C_4 alkoxyalkyl, C_2 - C_4 alkylthioalkyl, C_2 - C_4 alkylsulfinylalkyl, C_2 - C_4 alkylsulfonylalkyl, C_2 - C_4 cyanoalkyl, C_1 - C_3 hydroxyalkyl, C_1 - C_3 alkoxy, C_1 - C_3 haloalkoxy, C_1 - C_3 alkylthio, C_1 - C_3 haloalkylthio, C_1 - C_3 alkylamino or C_2 - C_4 dialkylamino;

W and Y are each independently CH_2 , O, $C(=O)$, $S(=O)_n$, NR^8 or a direct bond;

R^2 is a phenyl ring optionally substituted with up to 5 substituents independently selected from R^6 ; or a 3-, 4-, 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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 $S(=O)_p(=NR^9)_q$, the heterocyclic ring optionally substituted with up to 5 substituents independently selected from R^6 on carbon atom ring members and R^{6a} on nitrogen atom ring members;

R^3 is a phenyl ring optionally substituted with up to 5 substituents independently selected from R^7 ; or a 3-, 4-, 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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 $S(=O)_p(=NR^9)_q$, the heterocyclic ring optionally substituted with up to 5 substituents independently

selected from R⁷ on carbon atom ring members and R^{7a} on nitrogen atom ring members; or

when Y is a direct bond, then R³ is also selected from halogen, cyano, hydroxy, amino, nitro, -CHO, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₂-C₆ haloalkenyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₈ alkylcycloalkyl, C₄-C₈ cycloalkylalkyl, C₆-C₁₂ cycloalkylcycloalkyl, C₄-C₈ halocycloalkylalkyl, C₅-C₈ alkylcycloalkylalkyl, C₃-C₆ cycloalkenyl, C₂-C₆ alkoxyalkyl, C₂-C₆ alkylthioalkyl, C₂-C₆ alkylsulfinylalkyl, C₂-C₆ alkylsulfonylalkyl, C₂-C₆ alkylaminoalkyl, C₃-C₆ dialkylaminoalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₄-C₆ cycloalkylcarbonyl, C₂-C₆ alkoxycarbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₈ dialkylaminocarbonyl, C₂-C₆ cyanoalkyl, C₁-C₆ hydroxyalkyl, C₂-C₆ hydroxyhaloalkyl, C₂-C₆ hydroxyalkylcarbonyl, C₂-C₆ hydroxycarbonylalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₂-C₆ alkoxyalkoxy, C₃-C₆ alkoxycarbonylalkyl, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfinyl, C₁-C₆ haloalkylsulfinyl, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl, C₃-C₉ trialkylsilyl, C₁-C₆ alkylamino, C₂-C₆ dialkylamino, C₂-C₆ haloalkylamino, C₂-C₆ halodialkylamino, C₃-C₆ cycloalkylamino, C₂-C₆ alkylcarbonylamino, C₂-C₆ haloalkylcarbonylamino, C₁-C₆ alkylsulfonylamino and C₁-C₆ haloalkylsulfonylamino;

R⁴ is H, halogen, cyano, hydroxy, C₁-C₂ alkyl, C₁-C₂ haloalkyl, C₂ alkenyl, C₂ haloalkenyl or C₂ alkynyl;

each R⁵ is independently halogen, cyano, hydroxy, amino, nitro, -CHO, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₂-C₆ alkoxycarbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₆ dialkylaminocarbonyl, C₂-C₆ alkylaminoalkoxy, C₂-C₆ haloalkenyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₈ alkylcycloalkyl, C₄-C₈ cycloalkylalkyl, C₅-C₈ alkylcycloalkylalkyl, C₂-C₆ alkoxyalkyl, C₂-C₆ cyanoalkyl, C₁-C₆ hydroxyalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₂-C₆ alkylcarbonyloxy, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfinyl, C₁-C₆ haloalkylsulfinyl, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl, C₃-C₉ trialkylsilyl, C₂-C₆ alkylcarbonylthio, C₁-C₆ alkylamino or C₂-C₆ dialkylamino; or

a pair of R⁵ substituents attached to adjacent ring atoms are taken together with the atoms to which they are attached to form a 5-, 6- or 7-membered fused ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 N atoms, and optionally substituted with up to 3 substituents independently selected from the

group consisting of C₁-C₂ alkyl, halogen, cyano, nitro and C₁-C₂ alkoxy on carbon ring members and from the group consisting of C₁-C₂ alkyl, cyano and C₁-C₂ alkoxy on nitrogen ring members;

each R⁶ is independently halogen, cyano, hydroxy, amino, nitro, -CHO, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₂-C₆ alkoxy carbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₆ dialkylaminocarbonyl, C₂-C₆ alkylaminoalkoxy, C₂-C₆ haloalkenyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₈ alkylcycloalkyl, C₄-C₈ cycloalkylalkyl, C₅-C₈ alkylcycloalkylalkyl, C₂-C₆ alkoxyalkyl, C₂-C₆ cyanoalkyl, C₁-C₆ hydroxyalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₂-C₆ alkylcarbonyloxy, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfinyl, C₁-C₆ haloalkylsulfinyl, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl, C₃-C₉ trialkylsilyl, C₂-C₆ alkylcarbonylthio, C₁-C₆ alkylamino or C₂-C₆ dialkylamino;

each R^{6a} is independently cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ haloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₂-C₆ alkoxy carbonyl, C₂-C₆ alkylaminocarbonyl, C₃-C₆ dialkylaminocarbonyl, C₂-C₆ haloalkenyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₈ alkylcycloalkyl, C₄-C₈ cycloalkylalkyl, C₅-C₈ alkylcycloalkylalkyl, C₂-C₆ alkoxyalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₃-C₆ cycloalkoxy, C₃-C₆ halocycloalkoxy, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl or C₃-C₉ trialkylsilyl; or

a pair of substituents selected from R⁶ and R^{6a} attached to adjacent ring atoms are taken together with the atoms to which they are attached to form a 5-, 6- or 7-membered fused ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 N atoms, and optionally substituted with up to 3 substituents independently selected from the group consisting of C₁-C₂ alkyl, halogen, cyano, nitro and C₁-C₂ alkoxy on carbon atom ring members and from the group consisting of C₁-C₂ alkyl, cyano and C₁-C₂ alkoxy on nitrogen atoms ring members; or

a pair of R⁶ substituents attached to the same ring atom are taken together with the atom to which they are attached to form a 5-, 6- or 7-membered spirocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 N atoms, and optionally substituted with up to 3 substituents independently selected from the group consisting of C₁-C₂ alkyl, halogen, cyano, nitro and C₁-C₂ alkoxy on carbon atom ring members and from the group consisting of C₁-C₂ alkyl, cyano and C₁-C₂ alkoxy on nitrogen atom ring members;

each R^7 is independently halogen, cyano, hydroxy, amino, nitro, -CHO, C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, C_1 - C_6 haloalkyl, C_2 - C_6 alkylcarbonyl, C_2 - C_6 haloalkylcarbonyl, C_2 - C_6 alkoxycarbonyl, C_2 - C_6 alkylaminocarbonyl, C_3 - C_6 dialkylaminocarbonyl, C_2 - C_6 alkylaminoalkoxy, C_2 - C_6 haloalkenyl, C_2 - C_6 haloalkynyl, C_3 - C_6 cycloalkyl, C_3 - C_6 halocycloalkyl, C_4 - C_8 alkylcycloalkyl, C_4 - C_8 cycloalkylalkyl, C_5 - C_8 alkylcycloalkylalkyl, C_2 - C_6 alkoxyalkyl, C_2 - C_6 cyanoalkyl, C_1 - C_6 hydroxyalkyl, C_1 - C_6 alkoxy, C_1 - C_6 haloalkoxy, C_3 - C_6 cycloalkoxy, C_3 - C_6 halocycloalkoxy, C_2 - C_6 alkylcarbonyloxy, C_1 - C_6 alkylthio, C_1 - C_6 haloalkylthio, C_1 - C_6 alkylsulfinyl, C_1 - C_6 haloalkylsulfinyl, C_1 - C_6 alkylsulfonyl, C_1 - C_6 haloalkylsulfonyl, C_3 - C_9 trialkylsilyl, C_2 - C_6 alkylcarbonylthio, C_1 - C_6 alkylamino or C_2 - C_6 dialkylamino;

each R^{7a} is independently cyano, C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, C_1 - C_6 haloalkyl, C_2 - C_6 alkylcarbonyl, C_2 - C_6 haloalkylcarbonyl, C_2 - C_6 alkoxycarbonyl, C_2 - C_6 alkylaminocarbonyl, C_3 - C_6 dialkylaminocarbonyl, C_2 - C_6 haloalkenyl, C_2 - C_6 haloalkynyl, C_3 - C_6 cycloalkyl, C_3 - C_6 halocycloalkyl, C_4 - C_8 alkylcycloalkyl, C_4 - C_8 cycloalkylalkyl, C_5 - C_8 alkylcycloalkylalkyl, C_2 - C_6 alkoxyalkyl, C_1 - C_6 alkoxy, C_1 - C_6 haloalkoxy, C_3 - C_6 cycloalkoxy, C_3 - C_6 halocycloalkoxy, C_1 - C_6 alkylthio, C_1 - C_6 haloalkylthio, C_1 - C_6 alkylsulfonyl, C_1 - C_6 haloalkylsulfonyl or C_3 - C_9 trialkylsilyl; or

a pair of substituents selected from R^7 and R^{7a} substituents attached to adjacent ring atoms are taken together with the atoms to which they are attached to form a 5-, 6- or 7-membered fused ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 N atoms, and optionally substituted with up to 3 substituents independently selected from the group consisting of C_1 - C_2 alkyl, halogen, cyano, nitro and C_1 - C_2 alkoxy on carbon atom ring members and from the group consisting of C_1 - C_2 alkyl, cyano and C_1 - C_2 alkoxy on nitrogen atom ring members; or

a pair of R^7 substituents attached to the same ring atom are taken together with the atom to which they are attached to form a 5-, 6- or 7-membered spirocyclic ring containing ring members selected from carbon and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 N atoms, and optionally substituted with up to 3 substituents independently selected from the group consisting of C_1 - C_2 alkyl, halogen, cyano, nitro and C_1 - C_2 alkoxy on carbon atom ring members and from the group consisting of C_1 - C_2 alkyl, cyano and C_1 - C_2 alkoxy on nitrogen atom ring members;

each R^8 and R^9 is independently H or C_1 - C_3 alkyl;

m is an integer selected from 1, 2, 3, 4 and 5;

each n is independently an integer selected from 0, 1 and 2; and
 p and q are independently 0, 1 or 2 in each instance of $S(=O)_p(=NR^9)_q$, provided that
 the sum of p and q is 0, 1 or 2;

provided that the compound is other than

1-methyl-6-(4-methylphenyl)-4,5-diphenyl-2(1*H*)-pyridinone,

6-(4-bromophenyl)-1-methyl-4,5-diphenyl-2(1*H*)-pyridinone,

6-(4-methylphenyl)-4,5-diphenyl-2(1*H*)-pyridinone,

6-(4-bromophenyl)-4,5-diphenyl-2(1*H*)-pyridinone,

6-(4-methoxyphenyl)-4,5-diphenyl-2(1*H*)-pyridinone, or

2-(4-fluorophenyl)-1,6-dihydro-4-methyl-6-oxo-[3,4'-bipyridine]-5-carbonitrile.

5 2. A compound of Claim 1 wherein:

Q is O;

R^1 is C_1 - C_4 alkyl, C_2 - C_4 alkenyl, C_1 - C_4 haloalkyl, C_2 - C_4 cyanoalkyl or
 C_1 - C_3 alkoxy;

10 R^2 is a phenyl ring optionally substituted with up to 5 substituents
 independently selected from R^6 ; or a 5- or 6-membered heterocyclic
 ring containing ring members selected from carbon atoms and up to 4
 heteroatoms independently selected from up to 2 O, up to 2 S and up to
 3 N atoms, wherein up to 3 carbon atom ring members are
 independently selected from C(=O) and C(=S), and the sulfur atom ring
 15 members are independently selected from $S(=O)_p(=NR^9)_q$, the
 heterocyclic ring optionally substituted with up to 5 substituents
 independently selected from R^6 on carbon atom ring members and R^{6a}
 on nitrogen atom ring members;

20 R^3 is a phenyl ring optionally substituted with up to 5 substituents
 independently selected from R^7 ; or a 5- or 6-membered heterocyclic
 ring containing ring members selected from carbon atoms and up to 4
 heteroatoms independently selected from up to 2 O, up to 2 S and up to
 3 N atoms, wherein up to 3 carbon atom ring members are
 independently selected from C(=O) and C(=S), and the sulfur atom ring
 25 members are independently selected from $S(=O)_p(=NR^9)_q$, the
 heterocyclic ring optionally substituted with up to 5 substituents
 independently selected from R^7 on carbon atom ring members and R^{7a}
 on nitrogen atom ring members; or

30 when Y is a direct bond, then R^3 is also selected from halogen, cyano, C_1 - C_6
 alkyl, C_2 - C_6 alkenyl, C_1 - C_6 haloalkyl, C_2 - C_6 haloalkenyl, C_3 - C_6

cycloalkyl, C₃-C₆ cycloalkenyl, C₂-C₆ alkylcarbonyl, C₂-C₆ alkoxy carbonyl and C₁-C₆ hydroxyalkyl;

each R⁵, R⁶ and R⁷ is independently halogen, cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₁-C₆ alkylthio or C₁-C₆ haloalkylthio; and

each R^{6a} and R^{7a} is independently cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₁-C₆ alkylthio or C₁-C₆ haloalkylthio.

3. A compound of Claim 2 wherein:

R¹ is C₁-C₄ alkyl;

each W and Y is independently CH₂, O, S or a direct bond;

R² is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁶; or a 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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)_p(=NR⁹)_q, the heterocyclic ring optionally substituted with up to 3 substituents independently selected from R⁶ on carbon atom ring members and R^{6a} on nitrogen atom ring members;

R³ is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁷; or a 5- or 6-membered heterocyclic ring containing ring members selected from carbon atoms and up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 3 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)_p(=NR⁹)_q, the heterocyclic ring optionally substituted with up to 3 substituents independently selected from R⁷ on carbon atom ring members and R^{7a} on nitrogen atom ring members; or

when Y is a direct bond, then R³ is also selected from halogen, cyano, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ alkoxy carbonyl and C₁-C₆ hydroxyalkyl;

R⁴ is H, halogen, hydroxy or C₁-C₂ alkyl; and

each R^{6a} and R^{7a} is independently C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl or C₁-C₆ alkoxy.

4. A compound of Claim 3 wherein:

R² is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁶; or a pyridinyl or oxadiazolyl ring, the heterocyclic ring optionally substituted with up to 3 substituents independently selected from selected from R⁶ on carbon atom ring members;

R³ is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁷; or a pyridinyl or oxadiazolyl ring, the heterocyclic ring optionally substituted with up to 3 substituents independently selected from selected from R⁷ on carbon atom ring members; or

when Y is a direct bond, then R³ is also selected from halogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl, C₃-C₆ cycloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ alkoxy carbonyl and C₁-C₆ hydroxyalkyl; and m is an integer selected from 1, 2 and 3.

5. A compound of Claim 4 wherein:

R¹ is C₁-C₂ alkyl;

W and Y are each direct bond;

R² is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁶;

R³ is a phenyl ring optionally substituted with up to 3 substituents independently selected from R⁷; or

R³ is halogen, C₁-C₄ alkyl, C₂-C₃ alkenyl, C₁-C₃ haloalkyl, cyclopropyl, C₂-C₆ alkylcarbonyl, C₂-C₃ alkoxy carbonyl or C₁-C₆ hydroxyalkyl;

R⁴ is H, halogen or hydroxy; and

each R⁵, R⁶ and R⁷ is independently halogen, C₁-C₆ alkyl, C₂-C₆ alkenyl, C₁-C₆ haloalkyl or C₁-C₆ alkoxy.

6. A compound of Claim 5 wherein:

R¹ is methyl;

R² is a phenyl ring optionally substituted with up to 2 substituents independently selected from R⁶;

R³ is a phenyl ring optionally substituted with up to 1 substituent selected from R⁷; or

R³ is C₁-C₄ alkyl, C₂-C₆ alkoxy carbonyl or C₁-C₆ hydroxyalkyl;

R⁴ is H;

each R⁵, R⁶ and R⁷ is independently halogen, C₁-C₃ alkyl or C₁-C₃ alkoxy; and

m is an integer selected from 2 and 3.

7. A compound of Claim 6 wherein:

R² is a phenyl ring substituted with 2 substituents independently selected from R⁶ attached at the meta positions of the phenyl ring;

- 5 R³ is a phenyl ring substituted with 1 substituent selected from R⁷ attached at an ortho or para position of the phenyl ring;

each R⁵ is independently halogen or methoxy;

each R⁶ is independently methoxy or chloro; and

R⁷ is halogen.

- 10 8. A compound of Claim 7 wherein:

each R⁵ is independently halogen; and

each R⁶ is methoxy.

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

6-(2,6-difluorophenyl)-5-(3,5-dimethoxyphenyl)-4-(2-fluorophenyl)-1-methyl-2(1H)-pyridinone;

5-(3,5-dimethoxyphenyl)-4-(2-fluorophenyl)-1-methyl-6-(2,4,6-trifluorophenyl)-2(1H)-pyridinone;

6-(2,6-difluorophenyl)-5-(3,5-dimethoxyphenyl)-1-ethyl-4-(2-fluorophenyl)-2(1H)-pyridinone;

6-(2,6-difluoro-4-methoxyphenyl)-5-(3,5-dimethoxyphenyl)-1-methyl-4-phenyl-2(1H)-pyridinone;

6-(2,6-difluoro-4-methoxyphenyl)-5-(3,5-dimethoxyphenyl)-4-(2-fluorophenyl)-1-methyl-2(1H)-pyridinone;

5-(3,5-dimethoxyphenyl)-4-(2-fluorophenyl)-1-ethyl-6-(2,4,6-trifluorophenyl)-2(1H)-pyridinone; and

5-(2-chloro-3,5-dimethoxyphenyl)-6-(2,6-difluorophenyl)-4-(2-fluorophenyl)-1-methyl-2(1H)-pyridinone.

10. A fungicidal composition comprising (a) a compound of Claim 1 wherein R¹ is
15 cyano, hydroxy, amino, C₁-C₄ alkyl, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄ haloalkyl, C₂-C₄ haloalkenyl, C₂-C₄ haloalkynyl, cyclopropyl, halocyclopropyl, C₂-C₄ alkoxyalkyl, C₂-C₄ alkylthioalkyl, C₂-C₄ alkylsulfanylalkyl, C₂-C₄ alkylsulfonylalkyl, C₂-C₄ cyanoalkyl, C₁-C₃ hydroxyalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₁-C₃ alkylthio, C₁-C₃ haloalkylthio, C₁-C₃ alkylamino or C₂-C₄ dialkylamino; and (b) at least one other fungicide.

- 20 11. A fungicidal composition comprising (a) a compound of Claim 1 wherein R¹ is cyano, hydroxy, amino, C₁-C₄ alkyl, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄ haloalkyl, C₂-C₄ haloalkenyl, C₂-C₄ haloalkynyl, cyclopropyl, halocyclopropyl, C₂-C₄ alkoxyalkyl, C₂-C₄

alkylthioalkyl, C₂-C₄ alkylsulfinylalkyl, C₂-C₄ alkylsulfonylalkyl, C₂-C₄ cyanoalkyl, C₁-C₃ hydroxyalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₁-C₃ alkylthio, C₁-C₃ haloalkylthio, C₁-C₃ alkylamino or C₂-C₄ dialkylamino; and (b) at least one additional component selected from the group consisting of surfactants, solid diluents and liquid diluents.

- 5 12. 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 wherein R¹ is cyano, hydroxy, amino, C₁-C₄ alkyl, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄ haloalkyl, C₂-C₄ haloalkenyl, C₂-C₄ haloalkynyl, cyclopropyl, halocyclopropyl, C₂-C₄ alkoxyalkyl, C₂-C₄ alkylthioalkyl, C₂-C₄ alkylsulfinylalkyl, C₂-C₄ alkylsulfonylalkyl, C₂-C₄ cyanoalkyl, C₁-C₃ hydroxyalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₁-C₃ alkylthio, C₁-C₃ haloalkylthio, C₁-C₃ alkylamino or C₂-C₄ dialkylamino.
- 10

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2010/023548

A. CLASSIFICATION OF SUBJECT MATTER

INV. C07D213/64 C07D401/04 C07D413/04 A01N43/56
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 practical, search terms used)

EPO-Internal, CHEM ABS Data, 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	WO 2004/076450 A1 (URIACH Y COMPANIA S A J [ES]; ROSALES CARMEN ALMANSA [ES]; BERNADO MAR) 10 September 2004 (2004-09-10) Caplus-RN: 755756-89-9 as intermediate; page 1, line 3 - page 1, line 5; examples -----	1-12
A	I. EL-SAYED EL KHOLY ET AL: "Pyrene Series. Part IX. Some Reactions of 1-Amino-4,5,6-triaryl-2-pyridones" J. CHEM. SOC. (C), vol. 15, 1969, pages 974-978, XP009131446 page 976, right column, 2nd paragraph ----- -/--	1-12

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

13 April 2010

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19/04/2010

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INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	DE 10 2005 001990 A1 (CLARIANT GMBH [DE]) 20 July 2006 (2006-07-20) page 2/8, paragraph [0001]claims 1-10 -----	1-12
A	EP 0 535 980 A1 (SUMITOMO CHEMICAL CO [JP]) 7 April 1993 (1993-04-07) page 2, line 1 - page 2; claims; examples -----	1-12

INTERNATIONAL SEARCH REPORT

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International application No

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