

TITLE

FUNGICIDAL PYRIDONES

FIELD OF THE INVENTION

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

BACKGROUND OF THE INVENTION

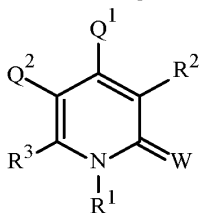
The control of plant diseases caused by fungal plant pathogens is extremely important in achieving high crop efficiency. Plant disease damage to ornamental, vegetable, field, cereal and fruit crops can cause significant reduction in productivity and thereby result in increased costs to
 10 the consumer.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

PCT Patent Publication WO 2018/195155 discloses pyridone derivatives and their use in pharmaceutical compositions.

15 PCT Patent Publications WO 2009158257 and WO 2010/093595 disclose fungicides including 2-pyridones and pyridine derivatives.

SUMMARY OF THE INVENTION

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

**1**

20

wherein

W is O or S;

Q¹ and Q² are each independently a phenyl ring optionally substituted with up to 5
 substituents independently selected from R⁴; or a 5- to 6-membered heteroaromatic
 25 ring, each ring containing ring members selected from carbon atoms and 1 to 4
 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms,
 each ring optionally substituted with up to 5 substituents independently selected from

5 R⁴; or a 3- to 6-membered nonaromatic heterocyclic ring, each ring containing ring members selected from carbon atoms and 1 to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, wherein up to 2 ring members are independently selected from C(=O), C(=S), S(=O) and S(=O)₂, each ring optionally substituted with up to 5 substituents independently selected from R⁴;

10 R¹ is amino, cyano, hydroxy, NH₂C(=O)H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₂-C₆ alkenyl, C₂-C₆ haloalkenyl, C₂-C₆ alkynyl, C₂-C₆ haloalkynyl, C₂-C₆ cyanoalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyloxy, C₂-C₆ haloalkenyloxy, C₂-C₆ alkynyloxy, C₂-C₆ haloalkynyloxy, C₂-C₆ cyanoalkoxy, C₁-C₆ alkylamino, C₁-C₆ haloalkylamino, C₂-C₆ dialkylamino, C₄-C₈ alkylcarbonylamino, C₂-C₆ alkoxyalkylamino, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₂-C₆ alkoxyalkylcarbonyl or C₂-C₆ haloalkoxyalkylcarbonyl; or C₃-C₆ cycloalkyl or C₄-C₆ cycloalkylalkyl, each optionally substituted with up to 3 substituents independently selected from halogen, cyano and C₁-C₃ alkyl;

15 R² is H, halogen, cyano, hydroxy, nitro, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₂-C₆ alkenyl, C₂-C₆ haloalkenyl, C₂-C₆ alkynyl, C₂-C₆ haloalkynyl, C₂-C₆ cyanoalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkoxyalkyl, C₂-C₆ haloalkoxyalkyl, C₂-C₆ alkoxyalkoxy or C₂-C₆ haloalkoxyalkoxy; or C₃-C₆ cycloalkyl or C₄-C₆ cycloalkylalkyl, each optionally substituted with up to 3 substituents independently selected from halogen, cyano and C₁-C₃ alkyl;

20 R³ is H, halogen, amino, cyano, hydroxy, nitro, C(=O)H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₂-C₆ alkenyl, C₂-C₆ haloalkenyl, C₂-C₆ alkynyl, C₂-C₆ haloalkynyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl or C₂-C₆ alkoxyalkylcarbonyl; or a 3- to 6-membered nonaromatic ring containing ring members selected from carbon atoms and optionally up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, wherein up to 2 carbon atom ring members are independently selected from C(=O) and C(=S), each ring optionally substituted with up to 5 substituents independently selected from R⁵;

25 each R⁴ is independently halogen, cyano, nitro, amino, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₂-C₆ alkenyl, C₂-C₆ haloalkenyl, C₂-C₆ alkynyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₆ alkylcycloalkyl, C₄-C₆ cycloalkylalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyloxy, C₂-C₆ haloalkenyloxy, C₂-C₆ alkynyloxy, C₂-C₆ haloalkynyloxy, C₃-C₆ cycloalkoxy, C₂-C₄ alkylcarbonyloxy, C₂-C₄ haloalkylcarbonyloxy, C₁-C₆ alkylsulfonyloxy, C₁-C₆ haloalkylsulfonyloxy, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfinyl, C₁-C₆ haloalkylsulfinyl,

- C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₁-C₆ alkylamino, C₁-C₆ haloalkylamino, C₂-C₆ dialkylamino or -U-V-T;
- 5 each R⁵ is independently halogen, cyano, hydroxy, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₂-C₄ alkylcarbonyl or C₂-C₄ alkylcarbonyloxy;
- each U is independently a direct bond, O, S(=O)_m or NR⁶;
- each V is independently C₁-C₆ alkylene, C₂-C₆ alkenylene, C₃-C₆ alkynylene, C₃-C₆ cycloalkylene or C₃-C₆ cycloalkenylene, wherein up to 2 carbon atoms are C(=O),
 10 each optionally substituted with up to 5 substituents independently selected from halogen, cyano, nitro, hydroxy, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy and C₁-C₆ haloalkoxy;
- each T is independently cyano, NR^{7a}R^{7b}, OR⁸ or S(=O)_mR⁹;
- each R⁶ is independently H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₂-C₆ alkoxycarbonyl, C₂-C₆ (alkylthio)carbonyl or C₂-C₆ alkoxy(thiocarbonyl);
 15 each R^{7a} and R^{7b} is independently H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₂-C₆ alkenyl, C₂-C₆ haloalkenyl, C₂-C₆ alkynyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₂-C₆ alkylcarbonyl or C₂-C₆ alkoxycarbonyl; or
- R^{7a} and R^{7b} are taken together with the nitrogen atom to which they are attached to form a
 20 3- to 6-membered heterocyclic ring, the ring optionally substituted with up to 3 substituents independently selected from R¹⁰;
- each R⁸ and R⁹ is independently H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₂-C₆ alkenyl, C₂-C₆ haloalkenyl, C₂-C₆ alkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl or C₂-C₆ alkoxycarbonyl;
- 25 each R¹⁰ is independently halogen, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy or C₁-C₃ haloalkoxy; and
- each m is independently 0, 1 or 2.
- provided that:
- (a) when Q¹ is an optionally substituted phenyl ring, then Q² is other than an optionally
 30 substituted 1*H*-pyrazol-4-yl ring; and
- (b) the compound of Formula **1** is not:
- 3,6-dichloro-1-methyl-4,5-diphenyl-2(1*H*)-pyridinone;
 1-methyl-4,5-diphenyl-2(1*H*)-pyridinone;
 1-[5-[1-(cyclopropylmethyl)-1*H*-pyrazol-4-yl]-1,2-dihydro-1-methyl-2-oxo-4-pyridinyl]-1*H*-pyrrole-3-carboxylic acid;

1-[1,2-dihydro-1-methyl-5-(1-methyl-1*H*-pyrazol-4-yl)-2-oxo-4-pyridinyl]-1*H*-pyrrole-3-carboxylic acid;
1-methyl-5-(1-methyl-1*H*-pyrazol-4-yl)-4-(1*H*-pyrrol-1-yl)-2(1*H*)-pyridinone,
1-amino-3,6-dimethyl-4,5-diphenyl-2(1*H*)-pyridinone,
methyl (3,6-dimethyl-2-oxo-4,5-diphenyl-1(2*H*)-pyridinyl)carbamate, or
ethyl (3,6-dimethyl-2-oxo-4,5-diphenyl-1(2*H*)-pyridinyl)carbamate.

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

This invention also relates to a fungicidal composition comprising (a) a compound of the invention (i.e. in a fungicidally effective amount); and (b) at least one additional component
5 selected from the group consisting of surfactants, solid diluents and liquid diluents.

This invention also relates to a fungicidal composition comprising (a) a compound of the invention; 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
10 plant pathogens comprising applying to the plant or portion thereof, or to the plant seed, a fungicidally effective amount of a compound of the invention (e.g., as a composition described herein).

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

15 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, method, article, or apparatus that comprises a list of elements is
20 not necessarily limited to only those elements but may include other elements not expressly listed or inherent to such composition, mixture, process, method, article, or apparatus.

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”
25 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, method or apparatus 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.

- 5 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.

The term “agronomic” refers to the production of field crops such as for food and fiber and includes the growth of maize or corn, soybeans and other legumes, rice, cereal (e.g., wheat, oats, barley, rye and rice), leafy vegetables (e.g., lettuce, cabbage, and other cole crops), fruiting vegetables (e.g., tomatoes, pepper, eggplant, crucifers and cucurbits), potatoes, sweet potatoes, grapes, cotton, tree fruits (e.g., pome, stone and citrus), small fruit (e.g., berries and cherries) and other specialty crops (e.g., canola, sunflower and olives).

The term “nonagronomic” refers to other than field crops, such as horticultural crops (e.g., greenhouse, nursery or ornamental plants not grown in a field), residential, agricultural, commercial and industrial structures, turf (e.g., sod farm, pasture, golf course, lawn, sports field, etc.), wood products, stored product, agro-forestry and vegetation management, public health (i.e. human) and animal health (e.g., domesticated animals such as pets, livestock and poultry, undomesticated animals such as wildlife) applications.

The term “crop vigor” refers to rate of growth or biomass accumulation of a crop plant. An “increase in vigor” refers to an increase in growth or biomass accumulation in a crop plant relative to an untreated control crop plant. The term “crop yield” refers to the return on crop material, in

terms of both quantity and quality, obtained after harvesting a crop plant. An “increase in crop yield” refers to an increase in crop yield relative to an untreated control crop plant.

The term “biologically effective amount” refers to the amount of a biologically active compound (e.g., a compound of Formula 1 or a mixture with at least one other fungicidal compound) sufficient to produce the desired biological effect when applied to (i.e. contacted with) a fungus to be controlled or its environment, or to a plant, the seed from which the plant is grown, or the locus of the plant (e.g., growth medium) to protect the plant from injury by the fungal disease or for other desired effect (e.g., increasing plant vigor).

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 referred to in this disclosure, the terms “fungal pathogen” and “fungal plant pathogen” include pathogens in the Ascomycota, Basidiomycota and Zygomycota phyla, and the fungal-like Oomycota class that are the causal agents of a broad spectrum of plant diseases of economic importance, affecting ornamental, turf, vegetable, field, cereal and fruit crops. In the context of this disclosure, “protecting a plant from disease” or “control of a plant disease” includes preventative action (interruption of the fungal cycle of infection, colonization, symptom development and spore production) and/or curative action (inhibition of colonization of plant host tissues).

As used herein, the term “mode of action” (MOA) is as define by the Fungicide Resistance Action Committee (FRAC), and is used to distinguish fungicides according to their biochemical mode of action in the biosynthetic pathways of plant pathogens, and their resistance risk. FRAC-defined modes of actions include (A) nucleic acids metabolism, (B) cytoskeleton and motor protein, (C) respiration, (D) amino acids and protein synthesis, (E) signal transduction, (F) lipid synthesis or transport and membrane integrity or function, (G) sterol biosynthesis in membranes, (H) cell wall biosynthesis, (I) melanin synthesis in cell wall, (P) host plant defense

induction, (U) unknown mode of action, (M) chemicals with multi-site activity and (BM) biologicals with multiple modes of action. Each mode of action (i.e. letters A through BM) contain one or more subgroups (e.g., A includes subgroups A1, A2, A3 and A4) based either on individual validated target sites of action, or in cases where the precise target site is unknown, based on cross resistance profiles within a group or in relation to other groups. Each of these subgroups (e.g., A1, A2, A3 and A4) is assigned a FRAC code which is a number and/or letter. For example, the FRAC code for subgroup A1 is 4. Additional information on target sites and FRAC codes can be obtained from publicly available databases maintained, for example, by FRAC.

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

As used herein, the term “alkylating agent” refers to a chemical compound in which a carbon-containing radical is bound through a carbon atom to a leaving group such as halide or sulfonate, which is displaceable by bonding of a nucleophile to said carbon atom. Unless otherwise indicated, the term “alkylating agent” 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 R².

Generally, when a molecular fragment (i.e. radical) is denoted by a series of atom symbols (e.g., C, H, N, O and S) the implicit point or points of attachment will be easily recognized by those skilled in the art. In some instances herein, particularly when alternative points of attachment are possible, the point or points of attachment may be explicitly indicated by a hyphen (“-”).

In the above recitations, the term “alkyl”, used either alone or in compound words such as “haloalkyl” includes straight-chain and branched alkyl, such as, methyl, ethyl, *n*-propyl and *i*-propyl. “Alkenyl” includes straight-chain and branched alkenes such as ethenyl, 1-propenyl, 2-propenyl, and the different butenyl and pentenyl isomers. “Alkenyl” also includes polyenes such as 1,2-propadienyl and 2,4-pentadienyl. “Alkynyl” includes straight-chain and branched alkynes such as ethynyl, 1-propynyl, 2-propynyl, and the different butynyl and pentynyl isomers. “Alkynyl” can also include moieties comprised of multiple triple bonds such as 2,5-pentadiynyl. “Alkylene” denotes a straight-chain or branched alkanediyl. Examples of “alkylene” include CH₂, CH₂CH₂, CH(CH₃), CH₂CH₂CH₂, CH₂CH(CH₃), and the different butylene, pentylene or hexylene isomers. “Alkenylene” denotes a straight-chain or branched alkenediyl containing one olefinic bond. Examples of “alkenylene” include CH=CH, CH₂CH=CH and CH=C(CH₃).

“Alkynylene” denotes a straight-chain or branched alkynediyl containing one triple bond. Examples of “alkynylene” include $\text{CH}_2\text{C}\equiv\text{C}$, $\text{C}\equiv\text{CCH}_2$, and the different butynylene, pentynylene or hexynylene isomers.

5 “Alkylthio” includes branched or straight-chain alkylthio moieties such as methylthio, ethylthio, and the different propylthio isomers. “Alkylsulfinyl” includes both enantiomers of an alkylsulfinyl group. Examples of “alkylsulfinyl” include $\text{CH}_3\text{S}(=\text{O})$, $\text{CH}_3\text{CH}_2\text{S}(=\text{O})$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{S}(=\text{O})$ and $(\text{CH}_3)_2\text{CHS}(=\text{O})$. Examples of “alkylsulfonyl” include $\text{CH}_3\text{S}(=\text{O})_2$, $\text{CH}_3\text{CH}_2\text{S}(=\text{O})_2$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{S}(=\text{O})_2$ and $(\text{CH}_3)_2\text{CHS}(=\text{O})_2$.

10 “Alkoxy” includes, for example, methoxy, ethoxy, *n*-propyloxy, *i*-propyloxy, and the different butoxy isomers. “Alkenyloxy” includes straight-chain and branched alkenyl attached to and linked through an oxygen atom. Examples of “alkenyloxy” include $\text{H}_2\text{C}=\text{CHCH}_2\text{O}$ and $\text{CH}_3\text{CH}=\text{CHCH}_2\text{O}$. “Alkynyloxy” includes straight-chain and branched alkynyl attached to and linked through an oxygen atom. Examples of “alkynyloxy” include $\text{HC}\equiv\text{CCH}_2\text{O}$ and $\text{CH}_3\text{C}\equiv\text{CCH}_2\text{O}$. The term “alkylsulfonyloxy” denotes alkylsulfonyl attached to and linked through an oxygen atom. Examples of “alkylsulfonyloxy” include $\text{CH}_3\text{S}(=\text{O})_2\text{O}$, $\text{CH}_3\text{CH}_2\text{S}(=\text{O})_2\text{O}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{S}(=\text{O})_2\text{O}$ and $(\text{CH}_3)_2\text{CHS}(=\text{O})_2\text{O}$. “Alkoxyalkyl” denotes alkoxy substitution on alkyl. Examples of “alkoxyalkyl” include CH_3OCH_2 , $\text{CH}_3\text{OCH}_2\text{CH}_2$, $\text{CH}_3\text{CH}_2\text{OCH}_2$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{OCH}_2$ and $\text{CH}_3\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2$. “Alkoxyalkoxy” denotes alkoxy substitution on another alkoxy moiety. Examples of “alkoxyalkoxy” include $\text{CH}_3\text{OCH}_2\text{O}$, $\text{CH}_3\text{OCH}_2\text{CH}_2\text{O}$ and $\text{CH}_3\text{CH}_2\text{OCH}_2\text{O}$.
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“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 pentoxy- or hexoxycarbonyl isomers.
25 The term “alkylcarbonyloxy” denotes straight-chain or branched alkyl bonded to a $\text{C}(=\text{O})\text{O}$ moiety. Examples of “alkylcarbonyloxy” include $\text{CH}_3\text{CH}_2\text{C}(=\text{O})\text{O}$ and $(\text{CH}_3)_2\text{CHC}(=\text{O})\text{O}$. “(Alkylthio)carbonyl” denotes a straight-chain or branched alkylthio group bonded to a $\text{C}(=\text{O})$ moiety. Examples of “(alkylthio)carbonyl” include $\text{CH}_3\text{SC}(=\text{O})$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{SC}(=\text{O})$ and $(\text{CH}_3)_2\text{CHSC}(=\text{O})$. “Alkoxy(thiocarbonyl)” denotes a straight-chain or branched alkoxy group bonded to a $\text{C}(=\text{S})$ moiety. Examples of “alkoxy(thiocarbonyl)” include $\text{CH}_3\text{OC}(=\text{S})$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{OC}(=\text{S})$ and $(\text{CH}_3)_2\text{CHOC}(=\text{S})$.
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“Alkylamino” includes an NH radical substituted with straight-chain or branched alkyl. Examples of “alkylamino” include $\text{CH}_3\text{CH}_2\text{NH}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}$ and $(\text{CH}_3)_2\text{CHNH}$. Examples of “dialkylamino” include $(\text{CH}_3)_2\text{N}$, $(\text{CH}_3\text{CH}_2)_2\text{N}$ and $\text{CH}_3\text{CH}_2(\text{CH}_3)\text{N}$. The term

“alkylcarbonylamino” denotes alkyl bonded to a C(=O)NH moiety. Examples of “alkylcarbonylamino” include $\text{CH}_3\text{C}(=\text{O})\text{NH}$ and $\text{CH}_3\text{CH}_2\text{C}(=\text{O})\text{NH}$.

The term “cycloalkyl” denotes a saturated carbocyclic ring consisting of between 3 to 6 carbon atoms linked to one another by single bonds. Examples of “cycloalkyl” include cyclopropyl, cyclobutyl, cyclopentyl and cyclohexyl. The term “cycloalkylalkyl” denotes cycloalkyl substitution on an alkyl group. Examples of “cycloalkylalkyl” include cyclopropylmethyl, cyclopentylethyl, and other cycloalkyl moieties bonded to straight-chain or branched alkyl groups. “Alkylcycloalkyl” denotes alkyl substitution on a cycloalkyl moiety. Examples include 4-methylcyclohexyl and 3-ethylcyclopentyl. The term “cycloalkoxy” denotes cycloalkyl attached to and linked through an oxygen atom such as cyclopentyloxy and cyclohexyloxy. The term “cycloalkenylene” denotes a cycloalkenediyl ring containing one olefinic bond. Examples of “cycloalkenylene” include cyclopropenylene and cyclopentenylene.

The term “halogen”, either alone or in compound words such as “halomethyl”, “haloalkyl”, includes fluorine, chlorine, bromine or iodine. Further, when used in compound words such as “haloalkyl”, said alkyl may be partially or fully substituted with halogen atoms which may be the same or different. Examples of “haloalkyl” include F_3C , ClCH_2 , CF_3CH_2 and CF_3CCl_2 . The terms “haloalkenyl”, “haloalkoxy”, “haloalkylthio”, “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 $\text{CF}_3\text{CH}_2=\text{CH}$. 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 “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 chlorocyclopropyl, fluorocyclobutyl and chlorocyclohexyl.

“Cyanoalkyl” denotes an alkyl group substituted with one cyano group. Examples of “cyanoalkyl” include NCCH_2 , NCCH_2CH_2 and $\text{CH}_3\text{CH}(\text{CN})\text{CH}_2$. The term “cyanoalkoxy” is defined analogously to the term “cyanoalkyl”.

The total number of carbon atoms in a substituent group is indicated by the “C_i-C_j” prefix where i and j are numbers from 1 to 6. For example, C₁-C₃ alkyl designates methyl through propyl; C₂ alkoxyalkyl designates CH_3OCH_2 ; C₃ alkoxyalkyl designates, for example, $\text{CH}_3\text{CH}(\text{OCH}_3)$, $\text{CH}_3\text{OCH}_2\text{CH}_2$ or $\text{CH}_3\text{CH}_2\text{OCH}_2$; and C₄ 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 means the group does not have any substituents other than its one or more attachments to the remainder of Formula 1.

The term “optionally substituted” means that the number of substituents can be zero. Unless otherwise indicated, optionally substituted groups may be substituted with as many optional substituents as can be accommodated by replacing a hydrogen atom with a non-hydrogen substituent on any available carbon or nitrogen atom. Commonly, the number of optional substituents (when present) ranges from 1 to 3. As used herein, the term “optionally substituted” is used interchangeably with the phrase “substituted or unsubstituted” or with the term “(un)substituted.”

The number of optional substituents may be restricted by an expressed limitation. For example, the phrase “optionally substituted with up to 3 substituents independently selected from R⁴” means that 0, 1, 2 or 3 substituents can be present (if the number of potential connection points allows).

When a range specified for the number of substituents (e.g., n being an integer from 0 to 4 in Exhibit A) exceeds the number of positions available for substituents on a ring (e.g., 2 positions available for (R⁴)_n on A-6 in Exhibit A), the actual higher end of the range is recognized to be the number of available positions.

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

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

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

The terms “heterocyclic ring” or “heterocycle” denotes a ring wherein at least one of the atoms forming the ring backbone is other than carbon. Unless otherwise indicated, a heterocyclic ring can be a saturated, partially unsaturated, or fully unsaturated ring. When a fully unsaturated

heterocyclic ring satisfies Hückel's rule, then said ring is also called a "heteroaromatic ring" or aromatic heterocyclic ring. "Saturated heterocyclic ring" refers to a heterocyclic ring containing only single bonds between ring members.

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

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

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

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

Advances in Heterocyclic Chemistry, vol. 22, pp 390-392, A. R. Katritzky and A. J. Boulton, Eds., Academic Press.

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

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

using selected solvents and temperatures. For a comprehensive discussion of polymorphism see R. Hilfiker, Ed., *Polymorphism in the Pharmaceutical Industry*, Wiley-VCH, Weinheim, 2006.

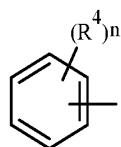
Embodiments of the present invention as described in the Summary of the Invention include those described below. In the following Embodiments, Formula **1** includes stereoisomers, *N*-oxides, and salts thereof, and reference to “a compound of Formula **1**” includes the definitions of substituents specified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

Embodiment 1. A compound of Formula **1** wherein W is O.

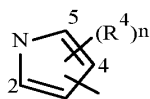
Embodiment 2. A compound of Formula **1** wherein W is S.

Embodiment 3. A compound of Formula **1** or Embodiments 1-2 wherein Q¹ and Q² are each independently selected from A-1 through A-47 as depicted in Exhibit A

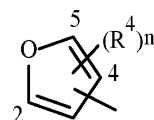
Exhibit A



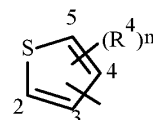
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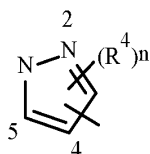
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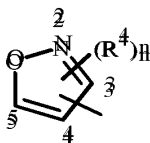
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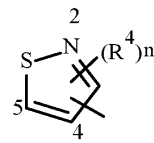
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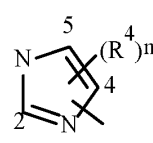
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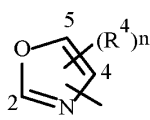
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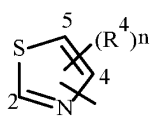
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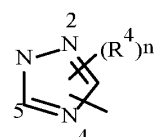
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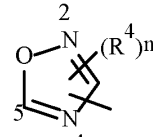
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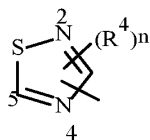
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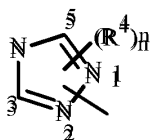
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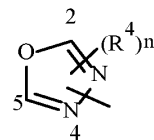
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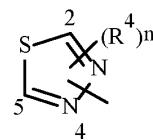
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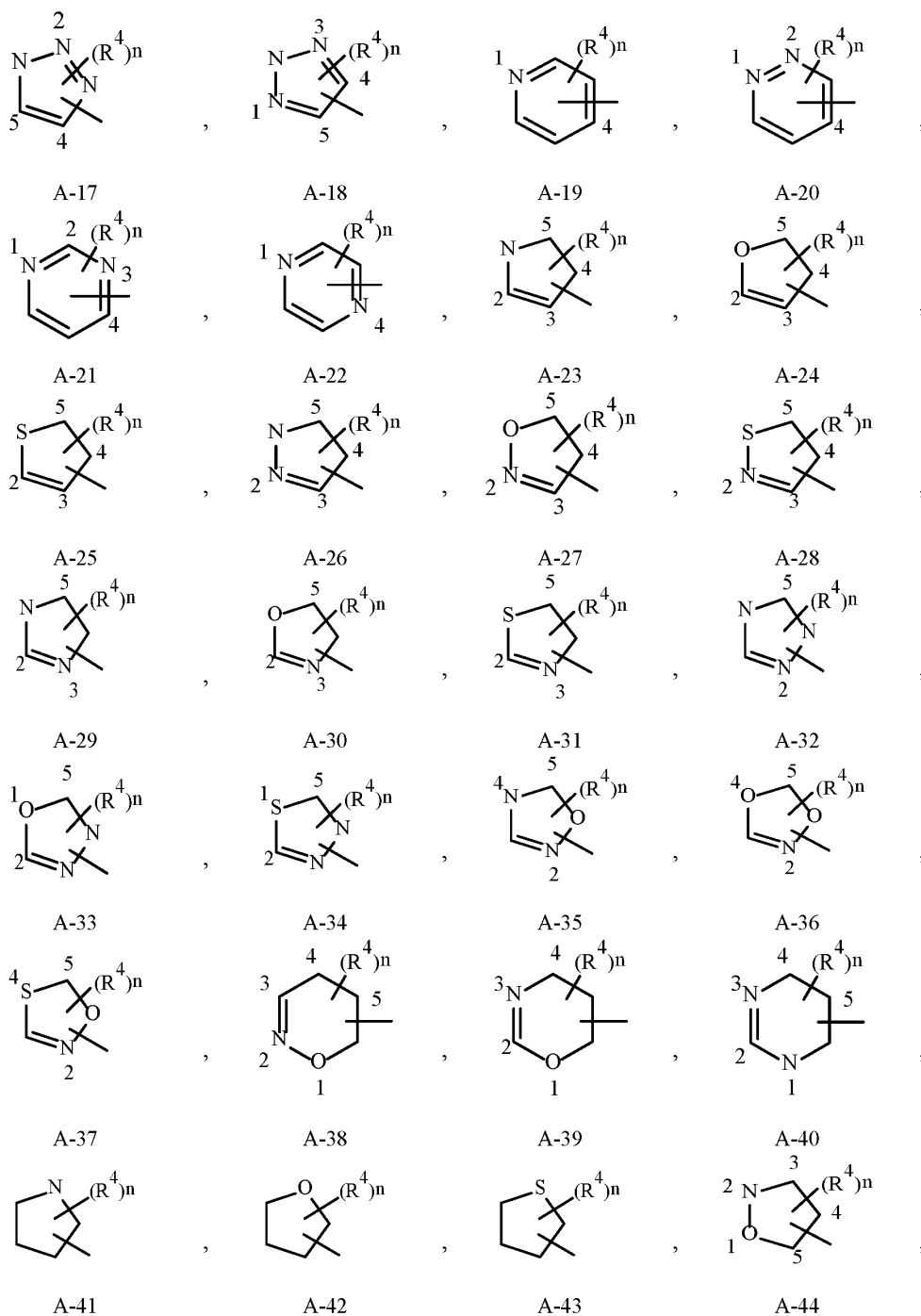
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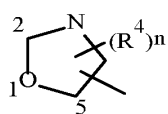


A-15

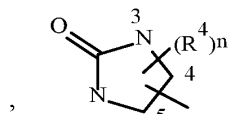


A-16

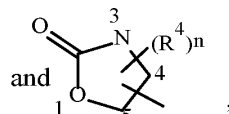




A-45



A-46



A-47

wherein the floating bond is connected to Formula 1 through any available carbon or nitrogen atom of the depicted ring; and each n is independently 0, 1, 2, 3 or 4.

Embodiment 4. A compound of Embodiment 3 wherein each n is independently 0, 1, 2 or 3.

5 Embodiment 5. A compound of Embodiment 4 wherein each n is independently 1, 2 or 3.

Embodiment 6. A compound of Embodiment 5 wherein each n is independently 2 or 3.

Embodiment 7. A compound of Formula 1 or anyone of Embodiments 1 through 6 wherein Q¹ and Q² are each independently selected from A-1 through A-13, A-19, A-20, A-21, A-23, A-24, A-25 and A-26.

10 Embodiment 8. A compound of Embodiment 7 wherein Q¹ and Q² are each independently selected from A-1, A-2, A-3, A-4, A-5, A-6, A-7 and A-19.

Embodiment 9. A compound of Embodiment 9 wherein Q¹ and Q² are each independently selected from A-1, A-4, A-5 and A-19.

15 Embodiment 10. A compound of Embodiment 9 wherein Q¹ and Q² are each independently selected from A-1 and A-4.

Embodiment 11. A compound of Embodiment 10 wherein Q¹ and Q² are each 1-A.

Embodiment 12. A compound of Formula 1 or anyone of Embodiments 1 through 11 wherein Q¹ is A-1 substituted at the 2- and 4-positions (i.e. ortho and para positions) with substituents independently selected from R⁴; or Q¹ is A-1 substituted at the 2- and 6-positions (i.e. ortho positions) with substituents independently selected from R⁴; or Q¹ is A-1 substituted at the 2-, 4- and 6-positions (i.e. para and ortho positions) with substituents independently selected from R⁴.

20 Embodiment 13. A compound of Embodiment 12 wherein Q¹ is A-1 substituted at the 2- and 4-positions (i.e. ortho and para positions) with substituents independently selected from R⁴; or Q¹ is A-1 substituted at the 2- and 6-positions (i.e. ortho positions) with substituents independently selected from R⁴.

Embodiment 14. A compound of Embodiment 13 wherein Q¹ is A-1 substituted at the 2- and 4-positions with substituents independently selected from R⁴.

25 Embodiment 15. A compound of Embodiment 13 wherein Q¹ is A-1 substituted at the 2- and 6-positions (i.e. ortho positions) with substituents independently selected from R⁴.

30

- Embodiment 16. A compound of Formula 1 or anyone of Embodiments 1 through 15 wherein Q² is A-1 substituted at the 3- and 5-positions (i.e. meta positions) with substituents independently selected from R⁴; or Q² is A-1 substituted at the 2- and 4-positions (i.e. ortho and para positions) with substituents independently selected from R⁴; or Q² is A-1 substituted at the 2- and 5-positions (i.e. para and meta positions) with substituents independently selected from R⁴; or Q² is A-1 substituted at the 2-, 3- and 5-positions (i.e. ortho and meta positions) with substituents independently selected from R⁴.
- Embodiment 17. A compound of Embodiment 16 wherein Q² is A-1 substituted at the 3- and 5-positions (i.e. meta positions) with substituents independently selected from R⁴; or Q² is A-1 substituted at the 2- and 5-positions (i.e. ortho and para positions) with substituents independently selected from R⁴; or Q² is A-1 substituted at the 2-, 3- and 5-positions (i.e. ortho and meta positions) with substituents independently selected from R⁴.
- Embodiment 18. A compound of Embodiment 17 wherein Q² is A-1 substituted at the 3- and 5-positions (i.e. meta positions) with substituents independently selected from R⁴; or Q² is A-1 substituted at the 2- and 5-positions (i.e. ortho and para positions) with substituents independently selected from R⁴.
- Embodiment 19. A compound of Formula 1 or anyone of Embodiments 1 through 18 wherein Q¹ is A-1 substituted at the 2- and 4-positions or 2- and 6-positions with substituents independently selected from R⁴, and Q² is A-1 substituted at the 3- and 5-positions, 2- and 5-positions or 2-, 3- and 5-positions with substituents independently selected from R⁴.
- Embodiment 20. A compound of Formula 1 or anyone of Embodiments 1 through 19 wherein R¹ is cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ alkenyl, C₂-C₃ haloalkenyl, C₂-C₃ cyanoalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₂-C₃ alkenyloxy, C₂-C₃ haloalkenyloxy, C₂-C₃ alkynyloxy or C₂-C₃ cyanoalkoxy; or cyclopropyl optionally substituted with up to 3 substituents independently selected from halogen and methyl.
- Embodiment 20a. A compound of Embodiment 20 wherein R¹ is amino, cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ alkenyl, C₂-C₃ haloalkenyl, C₂-C₃ cyanoalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₂-C₃ alkenyloxy, C₂-C₃ haloalkenyloxy, C₂-C₃ alkynyloxy, C₁-C₃ alkylamino, C₂-C₄ dialkylamino, C₄-C₅ alkylcarbonylamino, C₂-C₄ alkoxyalkylamino or C₂-C₃ cyanoalkoxy; or cyclopropyl optionally

substituted with up to 3 substituents independently selected from halogen and methyl.

5 Embodiment 21. A compound of Embodiment 20 wherein R¹ is cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ cyanoalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₂-C₃ alkenyloxy, C₂-C₃ haloalkenyloxy, C₂-C₃ alkynyloxy or C₂-C₃ cyanoalkoxy.

Embodiment 21a. A compound of Embodiment 21 wherein R¹ is amino, cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ cyanoalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₂-C₃ alkenyloxy, C₂-C₃ haloalkenyloxy, C₂-C₃ alkynyloxy, C₁-C₃ alkylamino, C₂-C₄ dialkylamino, C₂-C₄ alkoxyalkylamino or C₂-C₃ cyanoalkoxy.

10 Embodiment 22. A compound of Embodiment 21 wherein R¹ is cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₂-C₃ alkenyloxy, C₂-C₃ alkynyloxy or C₂-C₃ cyanoalkoxy.

Embodiment 22a. A compound of Embodiment 22 wherein R¹ is amino, cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₂-C₃ alkenyloxy, C₂-C₃ alkynyloxy, C₁-C₃ alkylamino, C₂-C₄ dialkylamino or C₂-C₃ cyanoalkoxy.

Embodiment 23. A compound of Embodiment 22 wherein R¹ is C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy or C₁-C₃ haloalkoxy.

Embodiment 23a. A compound of Embodiment 23 wherein R¹ is amino, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy or C₁-C₃ alkylamino.

20 Embodiment 24. A compound of Embodiment 23 wherein R¹ is C₁-C₂ alkyl, C₁-C₂ haloalkyl, C₁-C₂ alkoxy or C₁-C₂ haloalkoxy.

Embodiment 24a. A compound of Embodiment 24 wherein R¹ is amino, C₁-C₂ alkyl, C₁-C₂ haloalkyl, C₁-C₂ alkoxy, C₁-C₂ haloalkoxy or C₁-C₂ alkylamino.

Embodiment 25. A compound of Embodiment 24 wherein R¹ is C₁-C₂ alkyl or C₁-C₂ alkoxy.

Embodiment 25a. A compound of Embodiment 25 wherein R¹ is amino, C₁-C₂ alkyl or C₁-C₂ alkoxy.

Embodiment 26. A compound of Embodiment 25 wherein R¹ is methyl.

30 Embodiment 27. A compound of Formula 1 or anyone of Embodiments 1 through 26 wherein R² is H, halogen, cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ alkenyl, C₂-C₃ haloalkenyl, C₂-C₃ alkynyl, C₂-C₃ haloalkynyl, C₂-C₃ cyanoalkyl, C₁-C₃ alkoxy or C₁-C₃ haloalkoxy; or cyclopropyl optionally substituted with up to 3 substituents independently selected from halogen, cyano and methyl.

Embodiment 28. A compound of Embodiment 27 wherein R² is H, halogen, cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ alkenyl, C₂-C₃ haloalkenyl, C₂-C₃ cyanoalkyl, C₁-C₃ alkoxy or C₁-C₃ haloalkoxy.

5 Embodiment 29. A compound of Embodiment 28 wherein R² is H, halogen, cyano, C₁-C₂ alkyl, C₁-C₂ haloalkyl, C₂-C₃ cyanoalkyl, C₁-C₂ alkoxy or C₁-C₂ haloalkoxy.

Embodiment 30. A compound of Embodiment 29 wherein R² is H, halogen, cyano, C₁-C₂ alkyl or C₁-C₂ haloalkyl.

Embodiment 31. A compound of Embodiment 30 wherein R² is H, halogen, cyano or C₁-C₂ alkyl.

10 Embodiment 32. A compound of Embodiment 31 wherein R² is halogen, cyano, methyl or ethyl.

Embodiment 33. A compound of Embodiment 32 wherein R² is halogen, methyl or ethyl.

Embodiment 33a. A compound of Embodiment 33 wherein R² is halogen or methyl.

Embodiment 33b. A compound of Embodiment 33a wherein R² is halogen.

15 Embodiment 34. A compound of Embodiment 33b where R² is Br or Cl.

Embodiment 35. A compound of Embodiment 34 where R² is Cl.

Embodiment 36. A compound of Formula 1 or anyone of Embodiments 1 through 35 wherein R³ is H, halogen, cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy or C₁-C₃ haloalkoxy; or a 3- to 6-membered nonaromatic ring containing ring members selected from carbon atoms and optionally up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, wherein up to 2 carbon atom ring members are independently selected from C(=O) and C(=S), each ring optionally substituted with up to 3 substituents independently selected from R⁵.

20 Embodiment 37. A compound of Embodiment 36 wherein R³ is H, halogen, cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy or C₁-C₃ haloalkoxy.

Embodiment 38. A compound of Embodiment 37 wherein R³ is H, halogen, C₁-C₂ alkyl or C₁-C₂ haloalkyl.

Embodiment 39. A compound of Embodiment 38 wherein R³ is H, halogen or C₁-C₂ alkyl.

Embodiment 40. A compound of Embodiment 39 wherein R³ is H, Br, Cl or methyl.

30 Embodiment 41. A compound of Embodiment 40 wherein R³ is H.

Embodiment 42. A compound of Formula 1 or anyone of Embodiments 1 through 41 wherein each R⁴ is independently halogen, cyano, C₁-C₄ alkyl, C₁-C₄ haloalkyl, C₂-C₄ alkenyl, C₂-C₄ haloalkenyl, C₂-C₄ alkynyl, C₂-C₄ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₁-C₄ alkoxy, C₁-C₄ haloalkoxy, C₂-C₄ alkenyloxy, C₂-C₄ haloalkenyloxy, C₂-C₄ alkynyloxy, C₂-C₄ haloalkynyloxy,

35

C₂-C₄ alkylcarbonyloxy, C₂-C₄ haloalkylcarbonyloxy, C₁-C₄ alkylthio, C₁-C₄ haloalkylthio, C₂-C₄ alkylcarbonyl, C₂-C₄ haloalkylcarbonyl or -U-V-T.

Embodiment 43. A compound of Embodiment 42 wherein each R⁴ is independently halogen, cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ alkenyl C₂-C₃ haloalkenyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₂-C₄ alkenyloxy, C₂-C₄ haloalkenyloxy, C₂-C₄ alkylcarbonyl, C₂-C₄ haloalkylcarbonyl or -U-V-T.

Embodiment 44. A compound of Embodiment 43 wherein each R⁴ is independently halogen, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ alkenyl C₂-C₃ haloalkenyl, C₁-C₃ alkoxy or C₁-C₃ haloalkoxy.

Embodiment 45. A compound of Embodiment 44 wherein each R⁴ is independently halogen, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy or C₁-C₃ haloalkoxy.

Embodiment 46. A compound of Embodiment 45 wherein each R⁴ is independently halogen, C₁-C₂ alkyl, C₁-C₂ haloalkyl, C₁-C₂ alkoxy or C₁-C₂ haloalkoxy.

Embodiment 47. A compound of Embodiment 46 wherein each R⁴ is independently Br, Cl, F, methyl, C₁-C₂ alkoxy or C₁-C₂ haloalkoxy.

Embodiment 48. A compound of Embodiment 47 wherein each R⁴ is independently Br, Cl, F, methyl, methoxy or ethoxy.

Embodiment 49. A compound of Embodiment 48 wherein each R⁴ is independently Br, Cl, F or methoxy.

Embodiment 50. A compound of Formula 1 or anyone of Embodiments 1 through 49 wherein each R⁵ is independently halogen, cyano, methyl, halomethyl or methoxy.

Embodiment 51. A compound of Formula 1 or any one of Embodiments 1 through 50 wherein each U is independently a direct bond, O or NR⁶.

Embodiment 52. A compound of Embodiment 51 wherein each U is independently a direct bond, O or NH.

Embodiment 53. A compound of Embodiment 52 wherein each U is a direct bond

Embodiment 54. A compound of Formula 1 or any one of Embodiments 1 through 53 wherein each V is independently C₁-C₃ alkylene, wherein up to 2 carbon atoms are C(=O), optionally substituted with up to 3 substituents independently selected from halogen, C₁-C₂ alkyl, C₁-C₂ haloalkyl, C₁-C₂ alkoxy and C₁-C₂ haloalkoxy.

Embodiment 55. A compound of Embodiment 54 wherein each V is independently C₁-C₃ alkylene, wherein up to 1 carbon atom is C(=O), optionally substituted with up to 2 substituents independently selected from halogen, methyl, halomethyl and methoxy.

Embodiment 56. A compound of Embodiment 55 wherein each V is independently CH₂ or CH₂CH₂.

Embodiment 57. A compound of Embodiment 56 wherein each V is CH₂.

Embodiment 58. A compound of Formula 1 or any one of Embodiments 1 through 57 wherein each T is independently NR^{7a}R^{7b} or OR⁸.

5 Embodiment 59. A compound of Formula 1 or any one of Embodiments 1 through 58 wherein each R⁶ is independently H, C₁-C₃ alkyl, C₁-C₃ haloalkyl or C₂-C₄ alkylcarbonyl.

Embodiment 60. A compound of Embodiment 59 wherein each R⁶ is independently H or methyl.

10 Embodiment 61. A compound of Formula 1 or any one of Embodiments 1 through 60 wherein when R^{7a} and R^{7b} are separate (i.e. not taken together to form a ring), then each R^{7a} and R^{7b} is independently H, C₁-C₃ alkyl, C₁-C₃ haloalkyl, cyclopropyl, C₂-C₃ alkylcarbonyl or C₂-C₃ alkoxy carbonyl.

Embodiment 62. A compound of Embodiment 61 wherein each R^{7a} and R^{7b} is independently H, C₁-C₂ alkyl, C₁-C₂ haloalkyl or cyclopropyl.

15 Embodiment 63. A compound of Embodiment 62 wherein each R^{7a} and R^{7b} is independently H, methyl or halomethyl.

Embodiment 64. A compound of Formula 1 or any one of Embodiments 1 through 63 wherein when R^{7a} and R^{7b} are taken together to form a ring (i.e. not separate), then each R^{7a} and R^{7b} are taken together with the nitrogen atom to which they are attached to form a 3- to 6-membered heterocyclic ring, the ring optionally substituted with up to 2 substituents independently selected from R¹⁰.

Embodiment 65. A compound of Embodiment 64 wherein each R^{7a} and R^{7b} are taken together with the nitrogen atom to which they are attached to form a 3- to 6-membered heterocyclic ring.

25 Embodiment 66. A compound of Formula 1 or any one of Embodiments 1 through 65 wherein each R⁸ and R⁹ is independently H, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ alkenyl, C₂-C₃ haloalkenyl or cyclopropyl.

Embodiment 67. A compound of Embodiment 66 wherein each R⁸ and R⁹ is independently H, C₁-C₂ alkyl or C₁-C₂ haloalkyl.

30 Embodiment 68. A compound of Embodiment 67 wherein each R⁸ and R⁹ is independently methyl or ethyl.

Embodiment 69. A compound of Formula 1 or any one of Embodiments 1 through 68 wherein each R¹⁰ is independently halogen, methyl, halomethyl or methoxy.

35 Embodiment 70. A compound of Formula 1 or any one of Embodiments 1 through 69 wherein each m is 0 or 2.

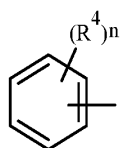
Embodiments of this invention, including Embodiments 1-70 above as well as any other embodiments described herein, can be combined in any manner, and the descriptions of variables in the embodiments pertain not only to the compounds of Formula 1 but also to the starting compounds and intermediate compounds useful for preparing the compounds of Formula 1. In addition, embodiments of this invention, including Embodiments 1-70 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 1-70 are illustrated by:

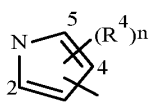
Embodiment A. A compound of Formula 1 wherein

W is O;

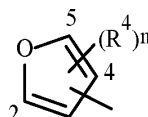
Q¹ and Q² are each independently selected from A-1 through A-47



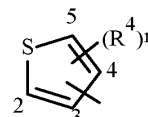
A-1



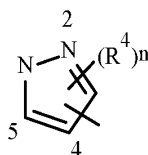
A-2



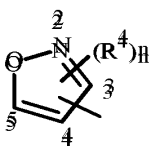
A-3



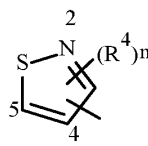
A-4



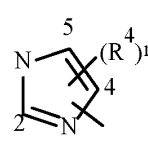
A-5



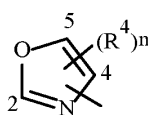
A-6



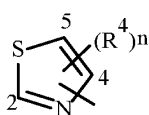
A-7



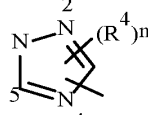
A-8



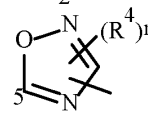
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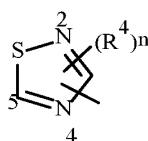
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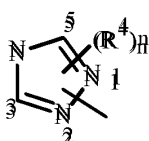
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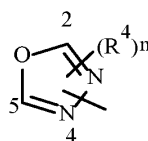
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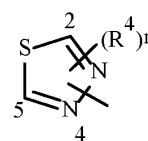
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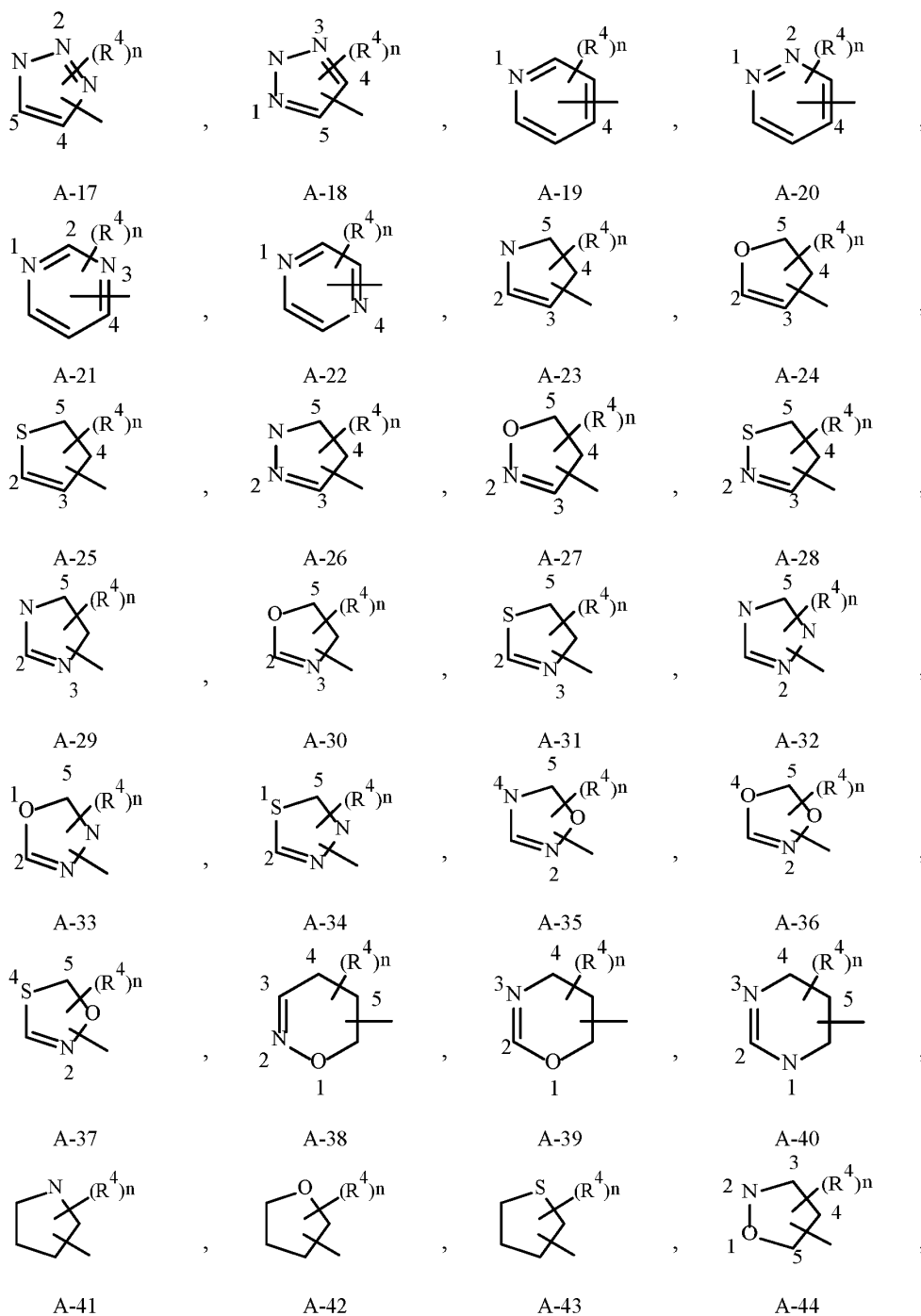
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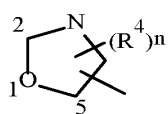


A-15

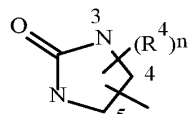


A-16

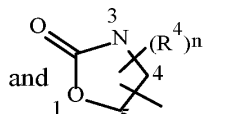




A-45



A-46



A-47

wherein the floating bond is connected to Formula 1 through any available carbon or nitrogen atom of the depicted ring; and each n is independently 0, 1, 2, 3 or 4;

R^1 is cyano, C_1 - C_3 alkyl, C_1 - C_3 haloalkyl, C_2 - C_3 alkenyl, C_2 - C_3 haloalkenyl, C_2 - C_3 cyanoalkyl, C_1 - C_3 alkoxy, C_1 - C_3 haloalkoxy, C_2 - C_3 alkenyloxy, C_2 - C_3 haloalkenyloxy, C_2 - C_3 alkynyloxy or C_2 - C_3 cyanoalkoxy; or cyclopropyl optionally substituted with up to 3 substituents independently selected from halogen and methyl;

R^2 is H, halogen, cyano, C_1 - C_3 alkyl, C_1 - C_3 haloalkyl, C_2 - C_3 alkenyl, C_2 - C_3 haloalkenyl, C_2 - C_3 alkynyl, C_2 - C_3 haloalkynyl, C_2 - C_3 cyanoalkyl, C_1 - C_3 alkoxy or C_1 - C_3 haloalkoxy; or cyclopropyl optionally substituted with up to 3 substituents independently selected from halogen, cyano and methyl;

R^3 is H, halogen, cyano, C_1 - C_3 alkyl, C_1 - C_3 haloalkyl, C_1 - C_3 alkoxy or C_1 - C_3 haloalkoxy; or a 3- to 6-membered nonaromatic ring containing ring members selected from carbon atoms and optionally up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, wherein up to 2 carbon atom ring members are independently selected from $C(=O)$ and $C(=S)$, each ring optionally substituted with up to 3 substituents independently selected from R^5 ;

each R^4 is independently halogen, cyano, C_1 - C_4 alkyl, C_1 - C_4 haloalkyl, C_2 - C_4 alkenyl, C_2 - C_4 haloalkenyl, C_2 - C_4 alkynyl, C_2 - C_4 haloalkynyl, C_3 - C_6 cycloalkyl, C_3 - C_6 halocycloalkyl, C_1 - C_4 alkoxy, C_1 - C_4 haloalkoxy, C_2 - C_4 alkenyloxy, C_2 - C_4 haloalkenyloxy, C_2 - C_4 alkynyloxy, C_2 - C_4 haloalkynyloxy, C_2 - C_4 alkylcarbonyloxy, C_2 - C_4 haloalkylcarbonyloxy, C_1 - C_4 alkylthio, C_1 - C_4 haloalkylthio, C_2 - C_4 alkylcarbonyl, C_2 - C_4 haloalkylcarbonyl or -U-V-T;

each R^5 is independently halogen, cyano, methyl, halomethyl or methoxy;

each U is independently a direct bond, O or NR^6 ;

each V is independently C_1 - C_3 alkylene, wherein up to 1 carbon atom is $C(=O)$, optionally substituted with up to 2 substituents independently selected from halogen, methyl, halomethyl and methoxy;

each T is independently NR^7aR^7b or OR^8 ;

each R^6 is independently H, C_1 - C_3 alkyl, C_1 - C_3 haloalkyl or C_2 - C_4 alkylcarbonyl;

each R^7a and R^7b is independently H, C_1 - C_2 alkyl, C_1 - C_2 haloalkyl or cyclopropyl; and

each R⁸ is independently H, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ alkenyl, C₂-C₃ haloalkenyl or cyclopropyl.

Embodiment B. A compound of Embodiment A wherein

Q¹ and Q² are each independently selected from A-1, A-2, A-3, A-4, A-5, A-6, A-7 and
5 A-19;

R¹ is cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ cyanoalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₂-C₃ alkenyloxy, C₂-C₃ haloalkenyloxy, C₂-C₃ alkynyloxy or C₂-C₃ cyanoalkoxy;

R² is H, halogen, cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ alkenyl, C₂-C₃ haloalkenyl,
10 C₂-C₃ cyanoalkyl, C₁-C₃ alkoxy or C₁-C₃ haloalkoxy;

R³ is H, halogen, cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy or C₁-C₃ haloalkoxy;

each R⁴ is independently halogen, cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ alkenyl
C₂-C₃ haloalkenyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₂-C₄ alkenyloxy, C₂-C₄
15 haloalkenyloxy, C₂-C₄ alkylcarbonyl, C₂-C₄ haloalkylcarbonyl or -U-V-T;

each U is independently a direct bond, O or NH;

each V is independently CH₂ or CH₂CH₂;

each R^{7a} and R^{7b} is independently H, methyl or halomethyl; and

each R⁸ is independently H, C₁-C₂ alkyl or C₁-C₂ haloalkyl.

20 Embodiment C. A compound of Embodiment B wherein

Q¹ and Q² are each independently selected from A-1, A-4, A-5 and A-19;

each n is independently 1, 2 or 3;

R¹ is C₁-C₂ alkyl, C₁-C₂ haloalkyl, C₁-C₂ alkoxy or C₁-C₂ haloalkoxy;

R² is H, halogen, cyano or C₁-C₂ alkyl;

25 R³ is H, halogen or C₁-C₂ alkyl; and

each R⁴ is independently halogen, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy or C₁-C₃ haloalkoxy.

Embodiment D. A compound of Embodiment C wherein

Q¹ and Q² are each 1-A;

30 each n is independently 2 or 3;

R¹ is C₁-C₂ alkyl or C₁-C₂ alkoxy;

R² is halogen, cyano, methyl or ethyl;

R³ is H, Br, Cl or methyl; and

each R⁴ is independently halogen, C₁-C₂ alkyl, C₁-C₂ haloalkyl, C₁-C₂ alkoxy or C₁-C₂
35 haloalkoxy.

Embodiment E. A compound of Embodiment D wherein

Q¹ is A-1 substituted at the 2- and 4-positions with substituents independently selected from R⁴; or Q¹ is A-1 substituted at the 2- and 6-positions with substituents independently selected from R⁴; or Q¹ is A-1 substituted at the 2-, 4- and 6-positions with substituents independently selected from R⁴;

R¹ is methyl; and

each R⁴ is independently Br, Cl, F, methyl, C₁-C₂ alkoxy or C₁-C₂ haloalkoxy.

Embodiment F. A compound of Embodiment E wherein

Q¹ is A-1 substituted at the 2- and 4-positions or 2- and 6-positions with substituents independently selected from R⁴,

R² is halogen, methyl or ethyl;

R³ is H; and

each R⁴ is independently Br, Cl, F, methyl, methoxy or ethoxy.

Embodiment G. A compound of Formula 1 wherein

W is O;

Q¹ and Q² are each independently selected from A-1, A-4, A-5 and A-19;

each n is independently 1, 2 or 3;

R¹ is amino, cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ cyanoalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₂-C₃ alkenyloxy, C₂-C₃ haloalkenyloxy, C₂-C₃ alkynyloxy, C₁-C₃ alkylamino, C₂-C₄ dialkylamino, C₂-C₄ alkoxyalkylamino or C₂-C₃ cyanoalkoxy;

R² is H, halogen, cyano or C₁-C₂ alkyl;

R³ is H, halogen or C₁-C₂ alkyl; and

each R⁴ is independently halogen, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy or C₁-C₃ haloalkoxy.

Embodiment H. A compound of Embodiment G wherein

Q¹ and Q² are each 1-A;

each n is independently 2 or 3;

R¹ is amino, C₁-C₂ alkyl, C₁-C₂ alkoxy, C₁-C₂ alkylamino or C₂-C₄ dialkylamino;

R² is halogen, cyano, methyl or ethyl;

R³ is H, Br, Cl or methyl; and

each R⁴ is independently halogen, C₁-C₂ alkyl, C₁-C₂ haloalkyl, C₁-C₂ alkoxy or C₁-C₂ haloalkoxy.

Embodiment I. A compound of Embodiment H wherein

Q¹ is A-1 substituted at the 2- and 4-positions with substituents independently selected from R⁴; or Q¹ is A-1 substituted at the 2- and 6-positions with substituents independently selected from R⁴; or Q¹ is A-1 substituted at the 2-, 4- and 6-positions with substituents independently selected from R⁴;

5 R¹ is amino, methyl or methylamino; and

each R⁴ is independently Br, Cl, F, methyl, C₁-C₂ alkoxy or C₁-C₂ haloalkoxy.

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

3-chloro-5-(2-chloro-3,5-dimethoxyphenyl)-4-(2-chloro-4-fluorophenyl)-1-methyl-2(1*H*)-pyridinone (Compound 4);
5-(2-bromo-3,5-dimethoxyphenyl)-3-chloro-4-(2,4-difluorophenyl)-1-methyl-2(1*H*)-pyridinone (Compound 9);
5-(2-chloro-3,5-dimethoxyphenyl)-4-(2-chloro-4-fluorophenyl)-1,3-dimethyl-2(1*H*)-pyridinone (Compound 13);
5-(2-bromo-5-methoxyphenyl)-3-chloro-4-(2,4-difluorophenyl)-1-methyl-2(1*H*)-pyridinone (Compound 20);
3-chloro-5-(2-chloro-3,5-dimethoxyphenyl)-4-(2,4-difluorophenyl)-1-methyl-2(1*H*)-pyridinone (Compound 29);
3-chloro-5-(2-chloro-5-methoxyphenyl)-4-(2,4-difluorophenyl)-1-methyl-2(1*H*)-pyridinone (Compound 30);
3-chloro-4-(2-chloro-4-fluorophenyl)-5-(2-chloro-5-methoxyphenyl)-1-methyl-2(1*H*)-pyridinone (Compound 32);
3-bromo-4-(2-chloro-4-fluorophenyl)-5-(2-chloro-5-methoxyphenyl)-1-methyl-2(1*H*)-pyridinone (Compound 33);
4-(2-chloro-4-fluorophenyl)-5-(2-chloro-5-methoxyphenyl)-1,3-dimethyl-2(1*H*)-pyridinone (Compound 43);
3-chloro-4-(2,4-difluorophenyl)-5-(2-fluoro-3,5-dimethoxyphenyl)-1-methyl-2(1*H*)-pyridinone (Compound 51);
5-(2-chloro-5-methoxyphenyl)-4-(2,4-difluorophenyl)-1,3-dimethyl-2(1*H*)-pyridinone; and
5-(2-bromo-5-methoxyphenyl)-4-(2,4-difluorophenyl)-1,3-dimethyl-2(1*H*)-pyridinone.

10 In addition to the embodiments described above, this invention also 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 also 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 a plant seed, a fungicidally effective amount of a compound of Formula **1** (including all stereoisomers, *N*-oxides, and salts thereof). Of note as embodiments of such methods are methods comprising applying a fungicidally effective amount of a compound corresponding to any of the compound embodiments described 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 1-12 can be used to prepare the compounds of Formula **1**. The definitions of W, Q¹, Q², R¹, R² and R³ in the compounds of Formulae **1-18** below are as defined above in the Summary of the Invention unless otherwise noted. Compounds of Formulae **1a** are various subsets of the compounds of Formula **1**, and all substituents for Formula **1a** are as defined above for Formula **1** unless otherwise noted.

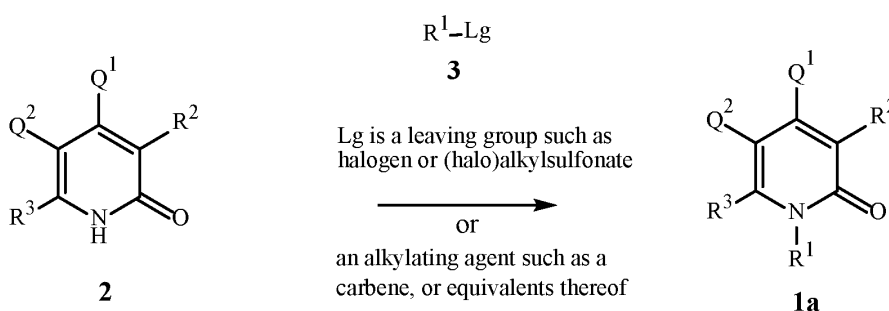
As shown in Scheme 1, compounds of Formula **1a** (i.e. Formula **1** wherein W is O) can be prepared by alkylation of a compound of Formula **2** with a compound of Formula **3** wherein Lg is a leaving group such as halogen, (halo)alkylsulfonate or nonafluorobutanesulfonates (e.g., Cl, Br, I, *p*-toluenesulfonate, methanesulfonate or trifluoromethanesulfonate), and R¹ is alkyl, haloalkyl, alkenyl, haloalkenyl, alkynyl, and the like. As referred to herein, the terms "alkylation" and "alkylating agent" are not limited to R¹ being an alkyl group. Particularly useful alkylating agents include, but are not limited to, alkyl halides, and the like, (e.g., iodoethane, allyl bromide, propargyl chloride, cyanogen bromide) and alkyl sulfates (e.g., dimethyl sulfate). The reaction is often run in the presence of a base such as sodium hydride, potassium *tert*-butoxide, sodium ethoxide or potassium carbonate, and in a solvent compatible with the base, such as dimethyl sulfoxide, *N,N*-dimethylformamide, tetrahydrofuran, acetonitrile or ethanol. The reaction can be carried out at temperatures ranging from about 0 to 100 °C. Alternatively, the alkyl group can be transferred as an alkyl carbocation, a free radical, a carbanion or a carbene. For example, preparation of compounds of Formula **1** wherein R¹ is haloalkyl (e.g., CHF₂ or CHCl₂) can be accomplished under difluorocarbene-mediated conditions using 2-chloro-2,2-difluoroacetic acid or 2,2-difluoro-2-(fluorosulfonyl)acetic acid which is contacted with a compound of Formula **2** in

a solvent such as acetonitrile, and in the presence of a base such as sodium bicarbonate. General procedures for *N*-alkylations of 2-pyridones are well documented in the chemical literature; see, for example, *Journal of Medicinal Chemistry* **1980**, 23(12), 1398-1405; *Organic Biomolecular Chemistry* **2008**, 16, 4151-4158; and *Royal Society of Chemistry* **2020**, 10, 29829-29832. It will be evident to one skilled in the art that regioselective *N*-alkylation versus *O*-alkylation depends on a variety of factors including the structure of the alkylating agent, substituents on the 2-pyridone ring of Formula **2**, solvents, and temperature. Modification of the reaction conditions can improve the conversion and regioselectivity of these alkylations. For references discussing regioselective *N*-alkylation conditions, see, *Organic Letters* **2015**, 17, 3382-3385; and *Tetrahedron Letters* **2013**, 54(30), 3926-3928.

The carbene reagents, such as difluorocarbenes, can be generated by several methods under a variety of reaction conditions, for example, phase-transfer conditions. The most common phase-transfer conditions involve chloroform, aqueous sodium or potassium hydroxide, and a phase-transfer reagent such as benzyltriethylammonium chloride (TEBA), 2-benzylidene-*N,N,N,N,N*-hexaethylpropane-1,2-diammonium dibromide (diqun) and 18-crown-6. For a review of these types of reaction see *Organic Synthesis*, Fourth Edition, **2017**, Pages 917-980.

Compounds of Formula **1** wherein R¹ is amino can be prepared from compounds of Formula **2** by *N*-amination using reagents such as *O*-(diphenylphosphoryl)hydroxylamine, *O*-(2,4-dinitrophenyl)hydroxylamine or *O*-(mesitylsulfonyl)hydroxylamine in the presence of a base such as potassium carbonate, cesium carbonate or sodium hydride, typically in a polar solvent such as *N,N*-dimethylformamide or *N*-methylpyrrolidinone at temperatures ranging from ambient to 100 °C. The *N*-amino group can be further modified by methods well-known by one skilled in the art to afford compounds of Formula **1** wherein R¹ is alkylamino, dialkylamino, and the like.

Scheme 1



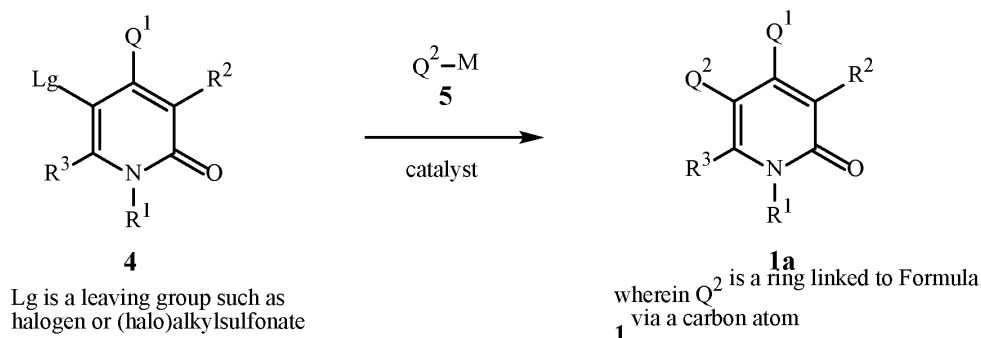
As shown in Scheme 2, compounds of Formula **1a** (i.e. Formula **1** wherein W is O) wherein Q² is a carbon-linked ring can be prepared by reaction of compounds of Formula **4** wherein Lg is

a leaving group such as halogen or (halo)alkylsulfonate (e.g., Cl, Br, I, *p*-toluenesulfonate, methanesulfonate or trifluoromethanesulfonate) with an organometallic compound of Formula 5 under transition-metal-catalyzed cross-coupling reaction conditions, in the presence of a suitable palladium, copper or nickel catalyst. In this method compounds of Formula 5 are organoboronic acids (e.g., M is B(OH)₂), organoboronic esters (e.g., M is B(-OC(CH₂)₃O-), organotrifluoroborates (e.g., M is BF₃K), organotin reagents (e.g., M is Sn(*n*-Bu)₃, Sn(Me)₃), Grignard reagents (e.g., M is MgBr or MgCl) or organozinc reagents (e.g., M is ZnBr or ZnCl). Suitable metal catalysts include, but are not limited to: 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 (e.g., copper(I) iodide, copper(I) bromide, copper(I) chloride, copper(I) cyanide or copper(I) triflate). Optimal conditions will depend on the catalyst used and the counterion attached to the compound of Formula 5 (i.e. M), as is understood by one skilled in the art. In some cases, the addition of a ligand such as a substituted phosphine or a substituted bisphosphinoalkane promotes reactivity. Also, the presence of a base such as an alkali carbonate, tertiary amine or alkali fluoride may be necessary for some reactions involving organoboron reagents of the Formula 5. The reaction is typically carried out at temperatures ranging between about ambient and the boiling point of the solvent. The reaction can also be carried out at temperatures above the solvent boiling point by using a pressurized vessel, such as a microwave reactor or Fisher-Porter tube. For reviews of this type of reaction see: E. Negishi, *Handbook of Organopalladium Chemistry for Organic Synthesis*, John Wiley and Sons, Inc., New York, 2002; N. Miyaura, *Cross-Coupling Reactions: A Practical Guide*, Springer, New York, 2002; H. C. Brown et al., *Organic Synthesis via Boranes*, Vol. 3, Aldrich Chemical Co., Milwaukee, WI, 2002; Suzuki et al., *Chemical Review* **1995**, 95, 2457-2483 and Molander *et al.*, *Accounts of Chemical Research* **2007**, 40, 275-286. Also, present Example 1 (Step C), Example 2 (Step B) and Example 4 (Step E) illustrate the method of Scheme 2 wherein Q² is a substituted phenyl ring.

The presence of certain functional groups on the compounds of Formula 4 may not be compatible with the reaction conditions in the method of Scheme 2, and in those instances the use of a protecting group may be desirable for obtaining the desired products with improved yields and or purity. For example, when R¹ is a hydroxy group, incorporation of a *hydroxy protecting group may be advantageous for obtaining the desired product*. A wide array of protecting groups are suitable for use in the method of Scheme 2 (see, for example, T. W. Greene and P. G. M. Wuts, *Protective Groups in Organic Synthesis*, 2nd ed.; Wiley: New York, **1991**), and the choice of the appropriate protecting group will be apparent to one skilled in chemical synthesis. Present

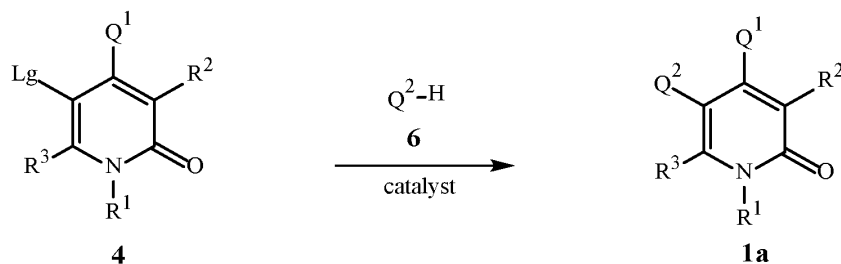
Example 6 (Step C) illustrates the method of Scheme 2 starting with a compound of Formula 4 wherein R¹ is a hydroxy benzyl-protected group.

Scheme 2



- 5 As shown in Scheme 3, compounds of Formula 1a (i.e. Formula 1 wherein W is O) wherein Q² is a nitrogen-linked heterocycle can be prepared by a metal-catalyzed coupling reaction of compounds of Formula 4 with heterocycles of Formula 6 wherein a ring nitrogen is bonded to a hydrogen atom (e.g., 1*H*-pyrazole and 1*H*-imidazole). These reactions are typically conducted in a solvent (e.g., dimethyl sulfoxide, *N,N*-dimethylformamide, toluene, acetonitrile or 1,4-dioxane)
- 10 in the presence of a catalyst such as a copper salt (e.g., copper(I) iodide, copper(I) bromide, copper(I) cyanide, copper(I) oxide or copper(II) acetate) and a base (e.g., NaO-*t*-Bu, K₂CO₃, K₃PO₄ or Cs₂CO₃). Optionally the reaction can be run in the presence of a ligand or solubilizing agent, generally with an amine. For example, a ligand-catalyst system such as CuI with *N,N'*-dimethylethylenediamine, *N,N'*-dimethyl-trans-1,2-cyclohexanediamine, proline or bipyridyl.
- 15 Typical reaction temperatures range from about 50 °C to the boiling point of the solvent. For leading references see, for example, *Nature Protocols* **2007**, 2(10), 2474-2479 and *Journal of Organic Chemistry* **2007**, 72(16), 6190-6199.

Scheme 3

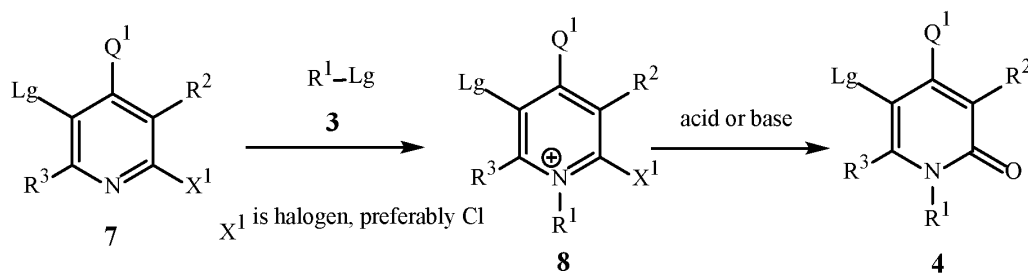


Lg is a leaving group such as halogen or (halo)alkylsulfonate, preferably Br or Cl

wherein Q² is heterocycle linked via a nitrogen atom to Formula 1

As shown in Scheme 4, compounds of Formula 4 can be prepared by reaction of pyridines of Formula 7 (preferably 2-chloropyridines) with alkylating agents of Formula 3 (wherein Lg is a leaving group such as Cl, Br, I or *p*-toluenesulfonate, methanesulfonate or trifluoromethanesulfonates). 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 7. The reaction is often carried out in a solvent such as tetrahydrofuran, acetonitrile, chloroform, dichloromethane, *N,N*-dimethylformamide and alcohols (e.g., methanol, ethanol) at temperatures between about 0 to 100 °C. Preferably the reaction is conducted using a solvent in which the pyridine of Formula 7 is completely or at least substantially soluble and the pyridinium salt of Formula 8 typically has low solubility at ambient temperatures (e.g., about 15-40 °C). Subsequent conversion of the pyridinium salts of Formula 8 to compounds of Formula 4 can be accomplished under either acidic or basic conditions. For example, treatment with an acid such as acetic acid or trifluoroacetic acid, or a base such as triethylamine or sodium hydroxide, or a mixture thereof, often with the addition of a second solvent such as ethanol, methanol, or water, and typically heating the mixture at temperatures up to the boiling point of the solvent or solvent system. For representative procedures see *Biochemical Journal* **1948**, 43, 423-426; and *Canadian Journal of Chemistry* **2011**, 89(6), 617-622. Also, present Example 1 (Step B) illustrates the method of Scheme 4 using dimethyl sulfate as the alkylating agent to provide a compound of Formula 4 wherein R¹ is methyl.

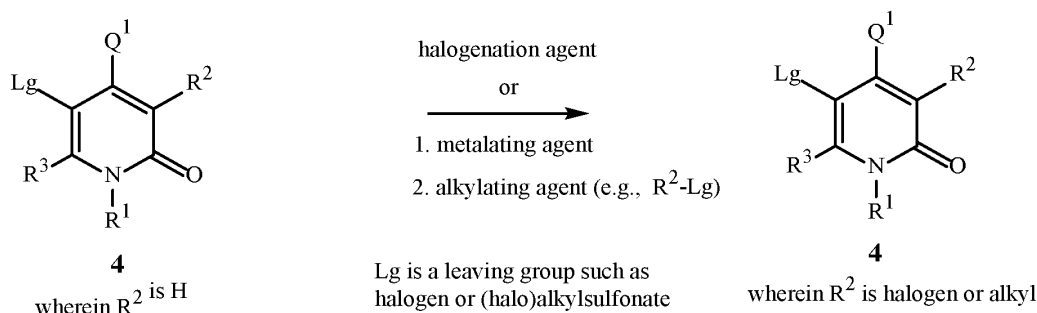
Scheme 4



Compounds of Formula 4 wherein R¹ is haloalkyl, such as difluoromethyl, can be prepared using difluorocarbene-mediated conditions analogous to the method described in Scheme 1.

- 5 Compounds of Formula 4 wherein R² is halogen or alkyl can be prepared from corresponding compounds of Formula 4 wherein R² is H, as shown in Scheme 5. Typically halogenation can be achieved using a variety of halogenating agents known in the art such as elemental halogen (e.g., Cl₂, Br₂, I₂), sulfonyl chloride, iodine monochloride or a *N*-halosuccinimide (e.g., NBS, NCS, NIS) in an appropriate solvent such as
- 10 *N,N*-dimethylformamide, carbon tetrachloride, acetonitrile, dichloromethane or acetic acid. Alkylation is achieved by reacting a compound of Formula 4 wherein R² is H with a metalating agent, followed by an alkylating agent of formula R²-Lg (wherein Lg is a leaving group such as Cl, Br, I or a sulfonate, for example, *p*-toluenesulfonate, methanesulfonate or trifluoromethanesulfonate). Suitable metalating agents include, for example, *n*-butyl lithium (*n*-
- 15 BuLi), lithium diisopropylamide (LDA) or sodium hydride (NaH). As used herein, the terms "alkylation" and "alkylating agent" are not limited to R² being an alkyl group, and in addition to alkyl include such groups as haloalkyl, alkenyl, haloalkenyl, alkynyl, and the like. Present Example 2 (Step A), Example 4 (Step D) and Example 6 (Step B) illustrate the method of Scheme 5 using *N*-chlorosuccinimide as the halogenating agent to provide a compound of Formula 4
- 20 wherein R² is chloro.

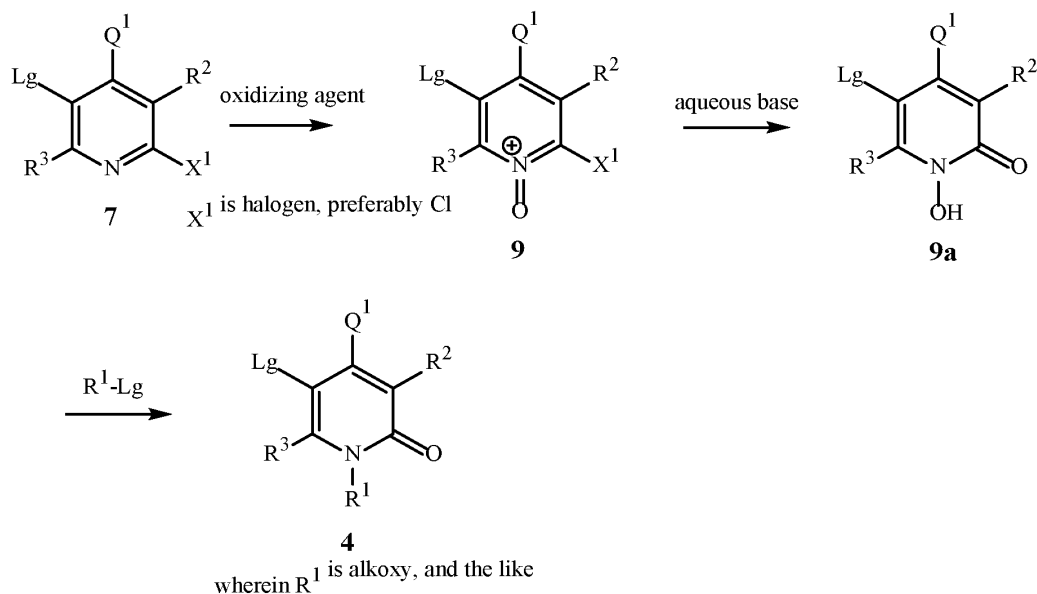
Scheme 5



As shown in Scheme 6, compounds of Formula **4** wherein R¹ is alkoxy, haloalkoxy, and the like, can be prepared by oxidation of pyridines of Formula **7**, followed by hydroxylation and then alkylation. A variety of oxidizing agents can be used in the method of Scheme 6, for example peroxy acids, such as peracetic acid and *m*-chloroperbenzoic acid (MCPBA), hydrogen peroxide, sodium perborate and magnesium monopero-phthalate. The solvent is selected with regard to the oxidizing agent employed, e.g., dichloromethane is generally preferable with MCPBA. The synthetic literature describes a wide-variety of oxidation conditions for the preparation of pyridine *N*-oxides which can be readily adapted to prepare compounds of the present invention; see, for example, *Bioorganic & Medicinal Chemistry* **2009**, 17(16), 6106-6122. For oxidation conditions using trifluoroacetic anhydride and hydrogen peroxide-urea complex, see *Tetrahedron Letters* **2000**, 41, 2299-2302. The resulting pyridine *N*-oxides of Formula **9** can be hydroxylated to the corresponding hydroxypyridines of Formula **9a**. The reaction is typically conducted in an aqueous solution containing an inorganic base, such as hydroxides of lithium, sodium, or potassium, and at temperatures ranging from about 70 to 100 °C. Subsequently, compounds of Formula **9a** can be reacted with an alkylating agent of formula R¹-Lg wherein Lg is a leaving group such as halogen (e.g., Cl, Br or I) to provide compounds of Formula **4** wherein R¹ is alkoxy, haloalkoxy, and the like. The reaction is preferably carried out in the presence of a base such as potassium carbonate, potassium hydroxide or triethylamine, and in a solvent such as *N,N*-dimethylformamide, tetrahydrofuran, toluene or water. General procedures for alkylations of this type are well-known in the art and can be readily adapted to prepare compounds of the present invention. Also, present Example 4, Steps A-C illustrates the method of Scheme 6.

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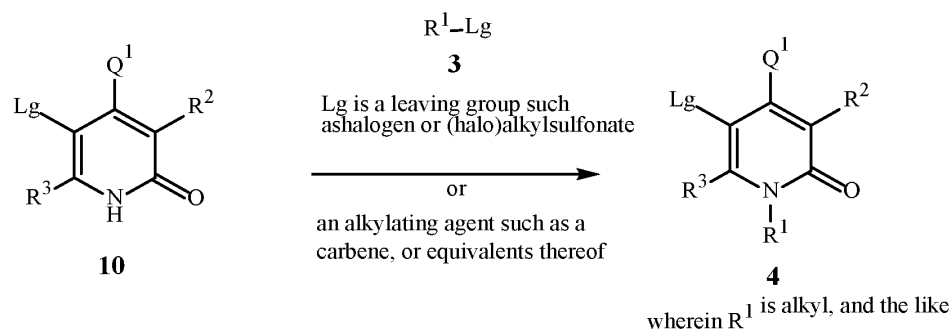
Scheme 6



As shown in Scheme 7, compounds of Formula 4 wherein R^1 is alkyl can also be prepared by alkylation of a compound of Formula 10 analogous to the method of Scheme 1.

5

Scheme 7

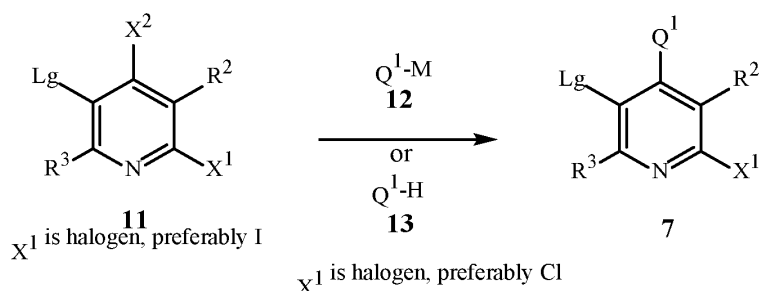


As shown in Scheme 8, compounds of Formula 7 can be prepared analogous to the methods of Schemes 2 and 3. In this method, compounds of Formula 12 are the same as the organometallic compounds as described for Formula 5, and compounds of Formula 13 are the same heterocycles as described for compounds of Formula 6 in Scheme 3. The reactions are carried out in the same manner as illustrated in Schemes 2 and 3. One skilled in the art will appreciate that the group X^1 attached to compounds of Formula 11 should be selected in view of the relative reactivity of other functional groups present on Formula 7 (e.g., the Lg group), so that the group X^1 is displaced first

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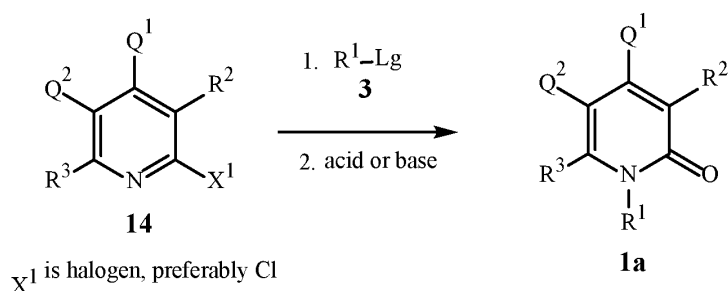
to give the desired compounds of Formula 7. For optimal selectivity (i.e. preferential displacement of X^1), the Lg group should be less reactive than X^1 under cross-coupling conditions, thus allowing for differentiation between the two reactive centers. For example, use of compounds of Formula **11** wherein X^1 is I and Lg is Br or Cl often allows for selective introduction of the Q^1 ring at the 4-position of the pyridine ring. Present Example 1 (Step A) illustrates the method of Scheme 7 starting from a compound of Formula **11** wherein Lg is Br and X^1 is I to provide a compound of Formula 7 wherein Q^1 is a substituted phenyl ring. One skilled in the art will also recognize that the method of Scheme 7 can be performed when the Lg and X^1 functionalities attached to the compound of Formula **11** are reversed, thus allowing for the introduction of a Q^2 ring instead of the Q^1 ring.

Scheme 8



It will be recognized by one skilled in the art that reactions analogous to those shown in Scheme 4 can also be utilized wherein the Q^2 substituent is attached to the pyridine ring to provide compounds of Formula **1a**, as shown in Scheme 9.

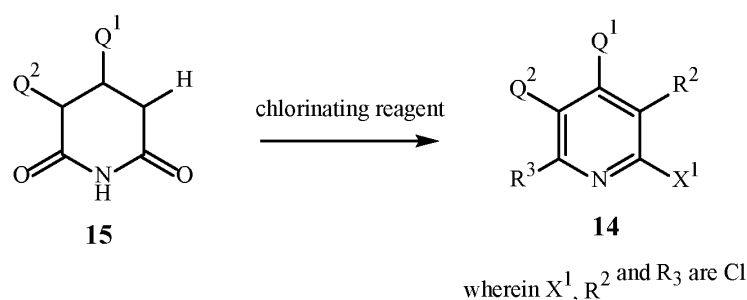
Scheme 9



As shown in Scheme 10, compounds of Formula **14** wherein X^1 , R^2 and R^3 are Cl can be prepared by treating compounds of Formula **15** with a chlorinating reagent such as thionyl chloride, phosphorous oxychloride or phosphorous pentachloride in a solvent such as

dichloromethane. For typical reaction conditions see, for example, *Australian Journal of Chemistry* **1968**, 21(2) 467-76; and *Bioorganic & Medicinal Chemistry Letters* **2011**, 21(10), 2958-2961.

Scheme 10

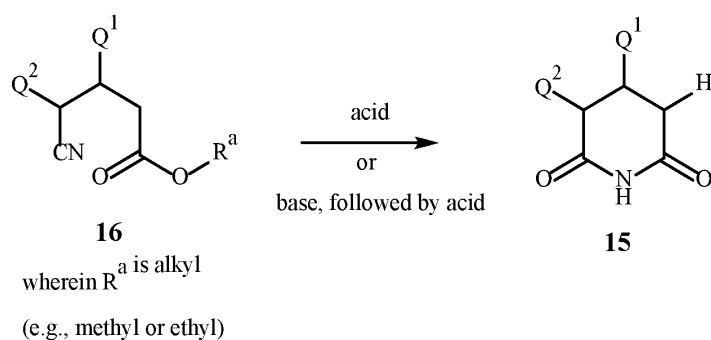


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As shown in Scheme 11, compounds of Formula **15** can be prepared from compounds of formula **16** by treatment with a strong acid, such as sulfuric acid, as described in *Australian Journal of Chemistry* **1968**, 21(2) 467-76; and *Monatshefte fuer Chemie* **1987**, 118(8-9), 987-91. Alternatively, the ester group can first be hydrolyzed, such as by treatment with aqueous sodium hydroxide, optionally in a co-solvent such as methanol or tetrahydrofuran, followed by treatment with acid such as sulfuric acid or hydrochloric acid, generally in a solvent such as water or acetic acid. For a reference, see, *Journal of Organic Chemistry* **2007**, 72(16), 6091-6096.

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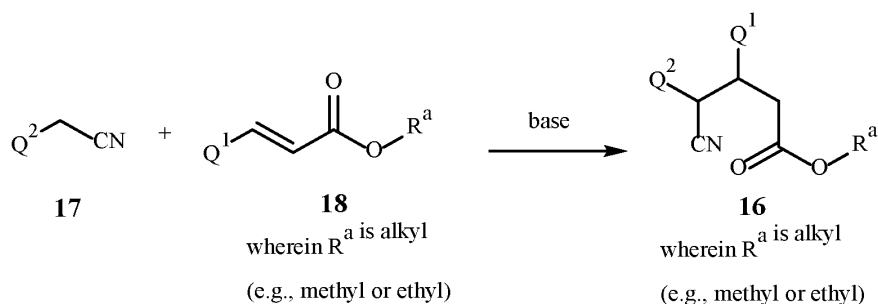
Scheme 11



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As shown in Scheme 12, compounds of Formula **16** can be prepared by reaction of compounds of Formulae **17** and **18** in the presence of a base (e.g., potassium *tert*-butoxide) and in a solvent such as 2-methyl-2-propanol or tetrahydrofuran. For reaction conditions, see *Monatshefte fuer Chemie* **1987**, 118(8-9), 987-91. Compounds of formulae **17** and **18** are commercially available and can be prepared by methods well-known in the art.

Scheme 12



Compounds of Formula 1 and the intermediates described in above methods wherein W is O can be converted to the corresponding thiolates wherein W is S using a variety of standard
 5 thiating reagents such as phosphorus pentasulfide or 2,4-bis(4-methoxyphenyl)-1,3-dithia-2,4-diphosphetane-2,4-disulfide (Lawesson's reagent). Reactions of this type are well-known see, for example, *Heterocycles* **1995**, 40, 271-278; *Journal of Medicinal Chemistry* **2008**, 51, 8124-8134; *Journal of Medicinal Chemistry* **1990**, 33, 2697-706; *Synthesis* **1989**, (5), 396-3977; *J. Chem. Soc., Perkin Trans. 1*, **1988**, 1663-1668; *Tetrahedron* **1988** 44, 3025-3036; and *Journal of*
 10 *Organic Chemistry* **1988** 53(6), 1323-1326.

One skilled in the art will recognize that compounds of Formula 1 can be subjected to numerous other electrophilic, nucleophilic, radical, organometallic, oxidation and reduction reactions to provide other functionalized compounds of Formula 1. Compounds of Formula 1, or intermediates for their preparation, may contain aromatic nitro groups, which can be reduced to
 15 amino groups, and then converted via reactions well-known in the art (e.g., Sandmeyer reaction) to various halides. By similar known reactions, aromatic halides such as bromides or iodides prepared via the Sandmeyer reaction can react with alcohols under copper-catalyzed conditions, such as the Ullmann reaction or known modifications thereof, to provide compounds of Formula 1 that contain alkoxy substituents. Additionally, some halogen groups, such as fluorine or
 20 chlorine, can be displaced with alcohols under basic conditions to provide compounds of Formula 1 containing the corresponding alkoxy substituents. Compounds of Formula 1 or precursors thereof containing a halide, preferably bromide or iodide, are particularly useful intermediates for transition metal-catalyzed cross-coupling reactions to prepare compounds of Formula 1. These types of reactions are well documented in the literature; see, for example, Tsuji in *Transition*
 25 *Metal Reagents and Catalysts: Innovations in Organic Synthesis*, John Wiley and Sons, Chichester, 2002; Tsuji in *Palladium in Organic Synthesis*, Springer, 2005; and Miyaura and Buchwald in *Cross Coupling Reactions: A Practical Guide*, 2002; and references cited therein.

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.

5 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 introduction of the reagents depicted in the individual schemes, additional routine synthetic steps not described in detail may be needed to complete the synthesis of compounds of Formula 1. One
10 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,
15 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. Ambient or room temperature is defined as about 20-25 °C. Percentages are by weight except for
20 chromatographic solvent mixtures or where otherwise indicated. Parts and percentages for chromatographic solvent mixtures are by volume unless otherwise indicated. HPLC refers to high pressure liquid chromatography on silica gel. ¹H NMR spectra are reported in ppm downfield from tetramethylsilane; “s” means singlet, “br s” means broad singlet, “d” means doublet, “dd” means doublet of doublets, “t” means triplet, and “m” means multiplet. Mass spectra are reported
25 as the molecular weight of the highest isotopic abundance parent ion (M+1) formed by addition of H⁺ (molecular weight of 1) to the molecule, or (M-1) formed by the loss of H⁺ (molecular weight of 1) from the molecule, observed by using liquid chromatography coupled to a mass spectrometer (LCMS) using either atmospheric pressure chemical ionization (AP⁺) or electrospray ionization (ESI⁺).

30

EXAMPLE 1

Preparation of 4-(2-chloro-4-fluorophenyl)-5-(3,5-dimethoxyphenyl)-1-methyl-2(1H)-pyridinone (Compound 53)

Step A: Preparation of 5-bromo-2-chloro-4-(2-chloro-4-fluorophenyl)pyridine

A mixture of 5-bromo-2-chloro-4-iodo-pyridine (1.51 g, 4.75 mmol, prepared as in *Tetrahedron* **2004** 60(51), 11869-11874), 2-chloro-4-fluorophenylboronic acid (0.827 g, 5.72 mmol) and potassium carbonate (1.31 g, 9.49 mmol) in 1,4-dioxane (20 mL) and water (2 mL) was purged with nitrogen for 15 minutes, and then [1,1'-bis(diphenylphosphino)-ferrocene]dichloropalladium(II) complex with dichloromethane (0.19 g, 0.24 mmol) was added. The reaction mixture was heated at 100 °C for 16 h, and then cooled to ambient temperature and filtered through a bed of Celite[®], rinsing with ethyl acetate (50 mL). The filtrate was poured into water (50 mL) and extracted with ethyl acetate (2 x 50 mL). The combined organic extracts were washed with saturated aqueous sodium chloride solution, dried over sodium sulfate, filtered, and concentrated under reduced pressure to provide an oil (purple color). The resulting oil was purified by CombiFlash[™] chromatography (eluting with petroleum ether) to provide the title compound as an oil (1.2 g).

¹H NMR (CDCl₃): δ 8.61 (s, 1H), 7.30-7.25 (m, 2H), 7.20 (m, 1H), 7.11 (m, 1H).

LCMS: m/z: 322 [M+H]⁺

15 Step B: Preparation of 5-bromo-4-(2-chloro-4-fluorophenyl)-1-methyl-2(1H)-pyridinone

To a mixture of 5-bromo-2-chloro-4-(2-chloro-4-fluorophenyl)pyridine (i.e. the product of Step A) (1.21 g, 3.77 mmol) in chloroform (30 mL) at 0 °C was added dimethyl sulfate (2.8 g, 22 mmol). The reaction mixture was heated at 80 °C for 20 h, cooled to 0 °C, and then triethylamine (4.8 mL), acetic acid (glacial, 3 mL) and ethanol (3 mL) were added sequentially. The reaction mixture was heated at reflux for 2 h, cooled to ambient temperature, and then water (50 mL) was added. The resulting mixture was extracted with ethyl acetate (2 x 40 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 solid was purified by silica gel column chromatography (eluting with 30% ethyl acetate in petroleum ether) to provide the title compound as an off-white solid (0.60 g).

¹H NMR (CDCl₃): δ 7.57 (s, 1H), 7.28-7.14 (m, 2H), 7.06 (m, 1H), 6.52 (s, 1H), 3.60 (s, 3H).

LCMS m/z: 318 [M+H]⁺

Step C: Preparation of 4-(2-chloro-4-fluorophenyl)-5-(3,5-dimethylphenyl)-1-methyl-2(1H)-pyridinone

30 A mixture of 5-bromo-4-(2-chloro-4-fluorophenyl)-1-methyl-2(1H)-pyridinone (i.e. the product of Step B) (100 mg, 0.317 mmol), 3,5-dimethoxyphenylboronic acid (58 mg, 0.32 mmol) and cesium carbonate (310 mg, 0.95 mmol, 3.0 eq) in 1,4-dioxane (5 mL) and water (0.5 mL), was purged with nitrogen for 15 minutes, and then [1,1'-bis(diphenylphosphino)-ferrocene]dichloropalladium(II) complex with dichloromethane (18 mg, 0.022 mmol) was added.

The reaction mixture was heated at 100 °C for 2 h, and then cooled to ambient temperature and filtered through a bed of Celite[®], rinsing with ethyl acetate (30 mL). The filtrate was poured into ice-cold water (40 mL) and extracted with ethyl acetate (2 x 30 mL). The combined organic extracts were washed with saturated aqueous sodium chloride solution, dried over sodium sulfate, filtered, and concentrated under reduced pressure to provide a solid (purple color). The resulting solid was purified by CombiFlash[™] chromatography (eluting with 30% ethyl acetate in petroleum ether) to provide the title compound, a compound of the present invention, as an off-white solid (20 mg).

¹H NMR (CDCl₃): δ 7.38 (s, 1H), 7.12-7.05 (m, 2H), 6.93 (m, 1H), 6.55 (s, 1H), 6.30 (m, 1H), 6.13 (m, 2H), 3.65 (s, 3H), 3.63 (s, 6H).

LCMS m/z: 374 [M+H]⁺

EXAMPLE 2

Preparation of 3-chloro-4-(2-chloro-4-fluorophenyl)-5-(3,5-dimethoxyphenyl)-1-methyl-2(1*H*)-pyridinone (Compound 3)

15 Step A: Preparation of 5-bromo-3-chloro-4-(2-chloro-4-fluorophenyl)-1-methyl-2(1*H*)-pyridinone

To a solution of 5-bromo-4-(2-chloro-4-fluoro-phenyl)-1-methyl-2(1*H*)-pyridinone (i.e. the product of Step B, Example 1) (1.00 g, 3.17 mmol) in *N,N*-dimethylformamide (10 mL) at 0 °C was added *N*-chlorosuccinimide (508 mg, 3.81 mmol) portionwise. The reaction mixture was heat at 60 °C for 16 h, cooled to ambient temperature, and then poured into ice-cold water (50 mL). The resulting solid precipitate was collected by filtration, washing with water (80 mL) and dried under reduced pressure to provide the title compound as an off-white solid (0.60 g).

¹H NMR (CDCl₃): δ 8.10 (s, 1H), 7.42 (m, 1H), 7.30-7.22 (m, 2H), 3.68 (s, 3H).

LCMS: m/z: 352 [M+H]⁺

25 Step B: Preparation of 3-chloro-4-(2-chloro-4-fluorophenyl)-5-(3,5-dimethoxyphenyl)-1-methyl-2(1*H*)-pyridinone

A mixture of 5-bromo-3-chloro-4-(2-chloro-4-fluorophenyl)-1-methyl-2(1*H*)-pyridinone (i.e. the product of Step A) (0.50 g, 1.43 mmol), 3,5-dimethoxyphenylboronic acid (0.26 g, 1.43 mmol) and cesium carbonate (1.41 g, 4.30 mmol) in 1,4-dioxane (8 mL) and water (1 mL) was purged with nitrogen for 15 minutes and then [1,1'-bis(diphenylphosphino)ferrocene]-dichloropalladium(II) complex with dichloromethane (82 mg, 0.10 mmol) was added. The reaction mixture was heated at 100 °C for 2 h, cooled to ambient temperature, and then filtered through a bed of Celite[®], rinsing with ethyl acetate (30 mL). The filtrate was poured into ice-cold

water (40 mL) and extracted with ethyl acetate (2 x 40 mL). The combined organic extracts were washed with saturated aqueous sodium chloride solution, dried over sodium sulfate, filtered, and concentrated under reduced pressure to provide a solid (purple color). The resulting solid was purified by CombiFlashTM chromatography (eluting with 80% ethyl acetate in petroleum ether) to provide the title compound, a compound of the present invention, as an off-white solid (320 mg).
¹H NMR (DMSO-*d*₆): δ 7.95 (s, 1H), 7.54 (m, 1H), 7.30-7.23 (m, 2H), 6.32 (m, 1H), 6.21 (m, 1H), 3.63 (s, 3H), 3.60 (s, 6H).
LCMS m/z: 408 [M+H]⁺

EXAMPLE 3

- 10 Preparation of 3-chloro-5-(2-chloro-3,5-dimethoxyphenyl)-4-(2-chloro-4-fluorophenyl)-1-methyl-2(1*H*)-pyridinone (Compound 4) and
3-chloro-5-(4-chloro-3,5-dimethoxyphenyl)-4-(2-chloro-4-fluorophenyl)-1-methyl-2(1*H*)-pyridinone (Compound 5)
-

- To a mixture of 3-chloro-4-(2-chloro-4-fluorophenyl)-5-(3,5-dimethoxyphenyl)-1-methyl-2(1*H*)-pyridinone (i.e. the product of Example 2) (0.25 g, 0.61 mmol) in
15 dimethylformamide (5 mL) at 0 °C was added *N*-chlorosuccinimide (82 mg, 0.61 mmol) portionwise. The reaction mixture was heated at 60 °C for 16 h, and then poured into ice-cold water (30 mL) and extracted with ethyl acetate (2 x 30 mL). The combined organic extracts were washed with saturated aqueous sodium chloride solution, dried over sodium sulfate, filtered, and
20 concentrated under reduced pressure. The resulting material was purified by silica gel column chromatography (eluting with 30% ethyl acetate in petroleum ether) to provide 3-chloro-5-(2-chloro-3,5-dimethoxyphenyl)-4-(2-chloro-4-fluorophenyl)-1-methyl-2(1*H*)-pyridinone, a compound of the present invention, as an off-white solid (150 mg).
¹H NMR (DMSO-*d*₆): δ 7.91 (s, 1H), 7.52-7.40 (m, 3H), 6.60-6.35 (m, 2H), 3.77-3.76 (two s, 3H), 3.65 (s, 3H), 3.63 (s, 3H).
25 LCMS: m/z: 444 [M+H]⁺

- Further elution of the chromatography column with 50% ethyl acetate in petroleum ether provided 3-chloro-5-(4-chloro-3,5-dimethoxyphenyl)-4-(2-chloro-4-fluorophenyl)-1-methyl-2(1*H*)-pyridinone, a compound of the present invention, as an off-white solid (20 mg) melting at
30 186-190 °C.

EXAMPLE 4

Preparation of 3-chloro-4-(2-chloro-4-fluorophenyl)-5-(3,5-dimethoxyphenyl)-1-methoxy-2(1*H*)-pyridinone (Compound 19)

Step A: Preparation of 5-bromo-2-chloro-4-(2-chloro-4-fluorophenyl)pyridine 1-oxide

5 To a mixture of 5-bromo-2-chloro-4-(2-chloro-4-fluorophenyl)pyridine (i.e. the product of Example 1, Step A) (6.0 g, 18.8 mmol) in dichloromethane (60 mL) at 0 °C was added 3-chloroperoxybenzoic acid (6.49 g, 37.6 mmol). The reaction mixture was stirred for 48 h and then concentrated under reduced pressure. The resulting material was diluted with water (500 mL) and extracted with ethyl acetate (2 x 200 mL). The combined organic extracts were washed with
10 saturated aqueous sodium chloride solution, dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting material was purified by silica gel column chromatography (eluting with 70% ethyl acetate in petroleum ether) to provide the title compound as a yellow solid (3 g).

¹H NMR (DMSO-*d*₆): δ 9.02 (s, 1H), 7.99 (s, 1H), 7.68-7.65 (m, 1H), 7.53-7.49 (m, 1H), 7.42-
15 7.37 (m, 1H).

LCMS: m/z: 338 [M+H]⁺

Step B: Preparation of 5-bromo-4-(2-chloro-4-fluorophenyl)-1-hydroxy-2(1*H*)-pyridinone

20 To 5-bromo-2-chloro-4-(2-chloro-4-fluorophenyl)pyridine 1-oxide (i.e. the product of Step A) (2.50 g, 7.40 mmol) was added sodium hydroxide (10% aqueous solution, 25 mL). The reaction mixture was heated at 100 °C for 6 h, cooled to room temperature, and then hydrochloric acid (2 N aqueous solution, 10 mL) was added. The resulting precipitate was collected on a frit funnel via vacuum filtration, washed with water (50 mL), and dried under reduced pressure to provide the title compound as a white solid (1 g).

25 ¹H NMR (DMSO-*d*₆): δ 8.46 (s, 1H), 7.62-7.60 (m, 1H), 7.42-7.34 (m, 2H), 6.55 (s, 1H).

LCMS m/z: 318 [M+H]⁺

Step C: Preparation of 5-bromo-4-(2-chloro-4-fluorophenyl)-1-methoxy-2(1*H*)-pyridinone

30 To a mixture of 5-bromo-4-(2-chloro-4-fluorophenyl)-1-hydroxy-2(1*H*)-pyridinone (i.e. the product of Step B) (1.00 g, 3.16 mmol) in *N,N*-dimethylformamide (10 mL) at 0 °C was added potassium carbonate (870 mg, 6.32 mmol), followed by methyl iodide (0.40 mL, 6.32 mmol). The reaction mixture was stirred for 2 h, and then diluted with water (20 mL) and extracted with ethyl acetate (2 x 50 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 material was purified by silica gel column chromatography (eluting with 30% ethyl acetate in petroleum ether) to provide the title compound as a white solid (400 mg).

¹H NMR (CDCl₃): δ 7.81 (s, 1H), 7.24-7.22 (m, 1H), 7.18-7.15 (m, 1H), 7.09-7.05 (m, 1H), 6.62 (s, 1H), 4.15 (s, 3H).

LCMS m/z: 332 [M+H]⁺

Step D: Preparation of 5-bromo-3-chloro-4-(2-chloro-4-fluorophenyl)-1-methoxy-2(1*H*)-pyridinone

To a mixture of 5-bromo-4-(2-chloro-4-fluorophenyl)-1-methoxy-2(1*H*)-pyridinone (i.e. the product of Step C) (400 mg, 1.20 mmol) in *N,N*-dimethylformamide (4 mL) at 0 °C was added *N*-chlorosuccinimide (193 mg, 1.44 mmol). The reaction mixture was heated at 70 °C for 1 h, cooled to room temperature, and then diluted with water (20 mL). The resulting mixture was extracted with ethyl acetate (2 x 50 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 material was purified by silica gel column chromatography (eluting with 10% ethyl acetate in petroleum ether) to provide the title compound as a white solid (300 mg).

¹H NMR (CDCl₃): δ 7.84 (s, 1H), 7.29 (s, 1H), 7.13-7.12 (m, 2H), 4.19 (s, 3H).

LCMS m/z: 367 [M+H]⁺

Step E: Preparation of 3-chloro-4-(2-chloro-4-fluorophenyl)-5-(3,5-dimethoxyphenyl)-1-methoxy-2(1*H*)-pyridinone

To a mixture of 5-bromo-3-chloro-4-(2-chloro-4-fluorophenyl)-1-methoxy-2(1*H*)-pyridinone (i.e. the product of Step D) (600 mg, 1.64 mmol) in 1,4-dioxane (6 mL) and water (1.20 mL) was added 3,5-dimethoxyphenylboronic acid (299 mg, 1.64 mmol), followed by cesium carbonate (1.07 g, 3.28 mmol). The reaction mixture was purged with argon gas for 10 minutes, and then [1,1'-bis(diphenylphosphino)ferrocene]dichloropalladium(II) (120 mg, 0.164 mmol) was added. The reaction mixture was heated at 80 °C for 3 h, cooled to room temperature, and then filtered through a bed of Celite®, rinsing with ethyl acetate (20 mL). The filtrate was diluted with water (50 mL) and extracted with ethyl acetate (2 x 50 mL). The combined organic extracts were washed with saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered and concentrated under reduced pressure. The resulting material was purified by silica gel column chromatography (eluting with 30% ethyl acetate in petroleum ether) to provide the title compound, a compound of the present invention, as a white solid (500 mg).

¹H NMR (DMSO-*d*₆): δ 8.27 (s, 1H), 7.54-7.52 (m, 1H), 7.34-7.31 (m, 1H), 7.26-7.22 (m, 1H), 6.33 (t, 1H), 6.24 (d, 2H), 4.10 (s, 3H), 3.60 (s, 6H).

LCMS m/z: 424 [M+H]⁺

EXAMPLE 5

5 Preparation of 3-chloro-4-(2-chloro-4-fluorophenyl)-5-(2-chloro-3,5-dimethoxyphenyl)-1-methoxy-2(1*H*)-pyridinone (Compound 22)

To a mixture of 3-chloro-4-(2-chloro-4-fluorophenyl)-5-(3,5-dimethoxyphenyl)-1-methoxy-2(1*H*)-pyridinone (i.e. the product of Example 4) (500 mg, 1.18 mmol) in *N,N*-dimethylformamide (10 mL) at 0 °C was added *N*-chlorosuccinimide (189 mg, 1.42 mmol). The reaction mixture was heated at 60 °C for 3 h, diluted with water (20 mL), and then extracted with ethyl acetate (2 x 50 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 material was purified by silica gel column chromatography (eluting with 20% ethyl acetate in petroleum ether) to provide the title compound, a compound of the present invention, as a white solid (300 mg).

¹H NMR (DMSO-*d*₆): δ 8.27 (d, 1H), 7.52-7.50 (m, 1H), 7.21-7.15 (m, 2H), 6.58-6.36 (m, 2H), 4.07 (s, 3H), 3.77 (s, 3H), 3.65 (s, 3H).

LCMS m/z: 458 [M+H]⁺

EXAMPLE 6

20 Preparation of 3-chloro-5-(2-chloro-3,5-dimethoxyphenyl)-4-(2-chloro-4-fluorophenyl)-1-hydroxy-2(1*H*)-pyridinone (Compound 39)

Step A: Preparation of 5-bromo-4-(2-chloro-4-fluorophenyl)-1-(phenylmethoxy)-2(1*H*)-pyridinone

To a mixture of 5-bromo-4-(2-chloro-4-fluorophenyl)-1-hydroxy-2(1*H*)-pyridinone (i.e. the product of Example 4, Step B) (3.60 g, 11.30 mmol) in *N,N*-dimethylformamide (36 mL) at 0 °C was added potassium carbonate (3.13 g, 22.70 mmol). After 10 minute, benzyl bromide (1.61 mL, 13.6 mmol) was added to the reaction mixture. After 2 h, the reaction mixture was diluted with water (50 mL) and extracted with ethyl acetate (2 x 100 mL). The combined organic extracts were washed with water and saturated aqueous sodium chloride solution, and then dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting material was purified by silica gel column chromatography (eluting with 40% ethyl acetate in petroleum ether) to provide the title compound as a white solid (3.5 g).

¹H NMR (DMSO-*d*₆): δ 8.45 (s, 1H), 7.63-7.602 (dd, 8.8 Hz, 1H), 7.55 (m, 2H), 7.44-7.33 (m, 5H), 6.63 (s, 1H), 5.26 (s, 2H).

LCMS: m/z: 408 [M+H]⁺

Step B: Preparation of 5-bromo-3-chloro-4-(2-chloro-4-fluorophenyl)-1-(phenylmethoxy)-2(1*H*)-pyridinone

To 5-bromo-4-(2-chloro-4-fluorophenyl)-1-(phenylmethoxy)-2(1*H*)-pyridinone (i.e. the product of Step A) (3.50 g, 8.56 mmol) in *N,N*-dimethylformamide (35 mL) at 0 °C was added *N*-chlorosuccinimide (1.15 g, 8.61 mmol). The reaction mixture was heated at 70 °C for 1 h, cooled to room temperature, and then diluted with water (50 mL) and extracted with ethyl acetate (2 x 100 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 material was purified by silica gel column chromatography (eluting with 30% ethyl acetate in petroleum ether) to provide the title compound as a white solid (3.1 g).

¹H NMR (CDCl₃): δ 7.45-7.42 (m, 6H), 7.27 (s, 1H), 7.12 (d, 2H), 5.39-5.37 (m, 2H).

LCMS m/z: 442 [M+H]⁺

Step C: Preparation of 3-chloro-4-(2-chloro-4-fluorophenyl)-5-(3,5-dimethoxyphenyl)-1-(phenylmethoxy)-2(1*H*)-pyridinone

To a mixture of 5-bromo-3-chloro-4-(2-chloro-4-fluorophenyl)-1-(phenylmethoxy)-2(1*H*)-pyridinone (i.e. the product of Step B) (3.10 g, 7.03 mmol) in 1,4-dioxane (31 mL) and water (6.2 mL) was added (3,5-dimethoxyphenyl)boronic acid (1.53 g, 8.43 mmol), followed by cesium carbonate (6.87 g, 21.1 mmol). The reaction mixture was purged with argon gas for 20 minutes and then [1,1'-bis(diphenylphosphino)ferrocene]dichloropalladium(II) (514 mg, 0.702 mmol) was added. The reaction mixture was heated at 80 °C for 3 h, cooled to room temperature, and then diluted with water (30 mL) and extracted with ethyl acetate (2 x 100 mL). The combined organic extracts were washed with saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The resulting material was purified by silica gel column chromatography (eluting with 40% ethyl acetate in petroleum ether) to provide the title compound as a white solid (2.56 g).

¹H NMR (DMSO-*d*₆): δ 8.00 (s, 1H), 7.56-7.51 (m, 3H), 7.45-7.44 (m, 3H), 7.34-7.31 (m, 1H), 7.24-7.21 (m, 1H), 6.30 (t, 1H), 6.09 (d, 2H), 5.35 (d, 2H), 3.58 (s, 6H).

LCMS m/z: 500 [M+H]⁺

Step D: Preparation of 3-chloro-5-(2-chloro-3,5-dimethoxyphenyl)-4-(2-chloro-4-fluorophenyl)-1-(phenylmethoxy)-2(1*H*)-pyridinone

To a mixture of 3-chloro-4-(2-chloro-4-fluorophenyl)-5-(3,5-dimethoxyphenyl)-1-(phenylmethoxy)-2(1*H*)-pyridinone (i.e. the product of Step C) (2.50 g, 5.12 mmol) in *N,N*-dimethylformamide (25 mL) at 0 °C was added *N*-chlorosuccinimide (684 mg, 5.12 mmol). The reaction mixture was heated at 70 °C for 1 h, cooled to room temperature, and then diluted with

5 water (50 mL) and extracted with ethyl acetate (2 x 100 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 material was purified by silica gel column chromatography (eluting with 40% ethyl acetate in petroleum ether) to provide the title compound as a white solid (2.1 g).

10 ¹H NMR (CDCl₃): δ 7.43-7.40 (m, 5H), 7.07-7.00 (m, 3H), 6.85 (s, 1H), 6.31 (br s, 1H), 6.10 (s, 1H), 5.43 (s, 2H), 3.77 (s, 3H), 3.62 (s, 3H).

LCMS m/z: 534 [M+H]⁺

Step E: Preparation of 3-chloro-5-(2-chloro-3,5-dimethoxyphenyl)-4-(2-chloro-4-fluorophenyl)-1-hydroxy-2(1*H*)-pyridinone

15 To a mixture of 3-chloro-5-(2-chloro-3,5-dimethoxyphenyl)-4-(2-chloro-4-fluorophenyl)-1-(phenylmethoxy)-2(1*H*)-pyridinone (i.e. the product of Step D) (2.1 g, 3.9 mmol) in ethanol (11 mL) was added palladium (10% on carbon, 1.0 g, 10 mol). The reaction mixture was stirred under a hydrogen balloon for 1 h, and then filtered through a pad of Celite®, rinsing with ethyl acetate (50 mL). The filtrate was concentrated and dried under reduced pressure to provide the

20 title compound, a compound of the present invention, as an off-white solid (1.3 g).

LCMS m/z: 444 [M+H]⁺

EXAMPLE 7

Preparation of 3-chloro-5-(2-chloro-3,5-dimethoxyphenyl)-4-(2-chloro-4-fluorophenyl)-1-(difluoromethoxy)-2(1*H*)-pyridinone (Compound 38)

25 To a mixture of 3-chloro-5-(2-chloro-3,5-dimethoxyphenyl)-4-(2-chloro-4-fluorophenyl)-1-hydroxy-2(1*H*)-pyridinone (i.e. the product of Example 6) (200 mg, 0.449 mmol) in acetonitrile (1 mL) and water (1 mL) acetonitrile at -78 °C was added potassium hydroxide (302 mg, 5.38 mmol), followed by diethyl (bromodifluoromethyl)phosphonate (468 mg, 1.75 mmol). The reaction mixture was allowed to warm to room temperature and stirred for 16 h, and then diluted

30 with water (20 mL), followed by hydrochloric acid (1 N aqueous solution, 1 mL). The resulting mixture was extracted with ethyl acetate (2 x 50 mL). The combined organic extracts were washed with ice-cold water (50 mL) and saturated aqueous sodium chloride solution, and then dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting

material was purified by preparative HPLC to provide the title compound, a compound of the present invention, as a white solid (40 mg).

^1H NMR (CDCl_3): δ 7.51 (s, 1H), 7.13-6.77 (m, 4H), 6.37 (d, 1H), 6.31 (d, 1H), 3.81 (s, 3H), 3.66 (s, 3H).

5 LCMS m/z: 494 $[\text{M}+\text{H}]^+$

EXAMPLE 8

Preparation of 3-chloro-5-(2-chloro-3,5-dimethoxyphenyl)-4-(2-chloro-4-fluorophenyl)-1-(2-propynyloxy)-2(1H)-pyridinone (Compound 36)

To a mixture of 3-chloro-5-(2-chloro-3,5-dimethoxyphenyl)-4-(2-chloro-4-fluorophenyl)-1-hydroxy-2(1H)-pyridinone (i.e. the product of Example 6) (300 mg, 0.677 mmol) in *N,N*-dimethylformamide (3 mL) at 0 °C was added potassium carbonate (187 mg, 1.33 mmol) followed by 3-bromo-1-propyne (96.0 mg, 0.79 mmol). After 6 h, the reaction mixture was diluted with water (50 mL) and extracted with ethyl acetate (2 x 50 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 material was purified by preparative HPLC to provide the title compound, a compound of the present invention, as a white solid (82 mg).

^1H NMR (CDCl_3): δ 7.60 (s, 1H), 7.08-7.05 (m, 2H), 6.89-6.87 (m, 1H), 6.37-6.31 (m, 2H), 5.22 (d, 1H), 5.01 (d, 1H), 3.82 (s, 3H), 3.66 (s, 3H), 2.66 (t, 1H).

20 LCMS m/z: 482 $[\text{M}+\text{H}]^+$

Formulation/Utility

A compound of Formula 1 of this invention (including *N*-oxides and salts thereof), or a mixture (i.e. composition) comprising the compound with at least one additional fungicidal compound as described in the Summary of the Invention, 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.

30 A compound of Formula 1, or mixture thereof, can be formulated in a number of ways, including:

- (i) the compound of Formula 1 and optionally one or more other biologically active compounds or agents can be formulated separately and applied separately or applied simultaneously in an appropriate weight ratio, e.g., as a tank mix; or

- (ii) the compound of Formula 1 and optionally one or more other biologically active compounds or agents can be formulated together in the proper weight ratio.

Useful formulations include both liquid and solid compositions. Liquid compositions include solutions (including emulsifiable concentrates), suspensions, emulsions (including microemulsions, oil-in-water emulsions, flowable concentrates and/or suspoemulsions) and the like, which optionally can be thickened into gels. The general types of aqueous liquid compositions are soluble concentrate, suspension concentrate, capsule suspension, concentrated emulsion, microemulsion, oil-in-water emulsion, flowable concentrate 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 water-dispersible (“wettable”) or water-soluble. Films and coatings formed from film-forming solutions or flowable suspensions are particularly useful for seed treatment. Active ingredient can be (micro)encapsulated and further formed into a suspension or solid formulation; alternatively the entire formulation of active ingredient can be encapsulated (or “overcoated”). Encapsulation can control or delay release of the active ingredient. An emulsifiable granule combines the advantages of both an emulsifiable concentrate formulation and a dry granular formulation. High-strength compositions are primarily used as intermediates for further formulation.

Sprayable formulations are typically extended in a suitable medium before spraying. Such liquid and solid formulations are formulated to be readily diluted in the spray medium, usually water, but occasionally another suitable medium like an aromatic or paraffinic hydrocarbon or vegetable oil. Spray volumes can range from about one to several thousand liters per hectare, but more typically are in the range from about ten to several hundred liters per hectare. Sprayable formulations can be tank mixed with water or another suitable medium for foliar treatment by aerial or ground application, or for application to the growing medium of the plant. Liquid and dry formulations can be metered directly into drip irrigation systems or metered into the furrow during planting. Liquid and solid formulations can be applied onto seeds of crops and other desirable vegetation as seed treatments before planting to protect developing roots and other subterranean plant parts and/or foliage through systemic uptake.

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

Weight Percent

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

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

Liquid diluents include, for example, water, *N,N*-dimethylalkanamides (e.g., *N,N*-dimethylformamide), limonene, dimethyl sulfoxide, *N*-alkylpyrrolidones (e.g., *N*-methylpyrrolidinone), alkyl phosphates (e.g., triethyl phosphate), ethylene glycol, triethylene glycol, propylene glycol, dipropylene glycol, polypropylene glycol, propylene carbonate, butylene carbonate, paraffins (e.g., white mineral oils, normal paraffins, isoparaffins), alkylbenzenes, alkylnaphthalenes, glycerine, glycerol triacetate, sorbitol, aromatic hydrocarbons, dearomatized aliphatics, alkylbenzenes, alkylnaphthalenes, ketones such as cyclohexanone, 2-heptanone, isophorone and 4-hydroxy-4-methyl-2-pentanone, acetates such as isoamyl acetate, hexyl acetate, heptyl acetate, octyl acetate, nonyl acetate, tridecyl acetate and isobornyl acetate, other esters such as alkylated lactate esters, dibasic esters, alkyl and aryl benzoates and γ -butyrolactone, and alcohols, which can be linear, branched, saturated or unsaturated, such as methanol, ethanol, *n*-propanol, isopropyl alcohol, *n*-butanol, isobutyl alcohol, *n*-hexanol, 2-ethylhexanol, *n*-octanol, decanol, isodecyl alcohol, isooctadecanol, cetyl alcohol, lauryl alcohol, tridecyl alcohol, oleyl alcohol, cyclohexanol, tetrahydrofurfuryl alcohol, diacetone alcohol, cresol and benzyl alcohol. Liquid diluents also include glycerol esters of saturated and unsaturated fatty acids (typically 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 tristyrilphenol (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 as 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, pp 8-57 and following, and WO 91/13546. Pellets can be prepared as described in U.S. 4,172,714. Water-dispersible and water-soluble granules can be prepared as taught in U.S. 4,144,050, U.S. 3,920,442 and DE 3,246,493. Tablets can be prepared as taught in U.S. 5,180,587, U.S. 5,232,701 and U.S. 5,208,030. Films can be prepared as taught in GB 2,095,558 and U.S. 3,299,566.

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

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

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

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

For further information regarding the art of formulation, see T. S. Woods, "The Formulator's Toolbox – Product Forms for Modern Agriculture" in *Pesticide Chemistry and Bioscience, The Food–Environment Challenge*, T. Brooks and T. R. Roberts, Eds., Proceedings of the 9th International Congress on Pesticide Chemistry, The Royal Society of Chemistry, Cambridge, 1999, pp. 120-133. Also see 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. Active ingredient refers to the compounds in Index Table A disclosed herein. Without further elaboration, it is believed that one skilled in the art using the preceding description can utilize the present invention to its fullest extent. The following Examples are, therefore, to be constructed as merely illustrative, and not limiting of the disclosure in any way whatsoever.

Example AHigh Strength Concentrate

Compound 1	98.5%
silica aerogel	0.5%
synthetic amorphous fine silica	1.0%

Example BWettable Powder

Compound 2	65.0%
dodecylphenol polyethylene glycol ether	2.0%
sodium ligninsulfonate	4.0%
sodium silicoaluminate	6.0%
montmorillonite (calcined)	23.0%

Example CGranule

Compound 3	10.0%
attapulgit granules (low volatile matter, 0.71/0.30 mm; U.S.S. No. 25–50 sieves)	90.0%

Example DExtruded Pellet

Compound 4	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 5	10.0%
polyoxyethylene sorbitol hexoleate	20.0%
C ₆ -C ₁₀ fatty acid methyl ester	70.0%

Example FMicroemulsion

Compound 13	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%

Example HFertilizer Stick

Compound 25	2.50%
pyrrolidone-styrene copolymer	4.80%
tristyrylphenyl 16-ethoxylate	2.30%
talc	0.80%
corn starch	5.00%
slow-release fertilizer	36.00%
kaolin	38.00%
water	10.60%

Example ISuspension Concentrate

Compound 30	35%
butyl polyoxyethylene/polypropylene block copolymer	4.0%
stearic acid/polyethylene glycol copolymer	1.0%
styrene acrylic polymer	1.0%
xanthan gum	0.1%
propylene glycol	5.0%
silicone based defoamer	0.1%
1,2-benzisothiazolin-3-one	0.1%
water	53.7%

Example JEmulsion in Water

Compound 32	10.0%
butyl polyoxyethylene/polypropylene block copolymer	4.0%
stearic acid/polyethylene glycol copolymer	1.0%
styrene acrylic polymer	1.0%
xanthan gum	0.1%
propylene glycol	5.0%
silicone based defoamer	0.1%
1,2-benzisothiazolin-3-one	0.1%
aromatic petroleum based hydrocarbon	20.0
water	58.7%

Example KOil Dispersion

Compound 33	25%
polyoxyethylene sorbitol hexaoleate	15%
organically modified bentonite clay	2.5%
fatty acid methyl ester	57.5%

Example LSuspoemulsion

Compound 51	10.0%
imidacloprid	5.0%
butyl polyoxyethylene/polypropylene block copolymer	4.0%
stearic acid/polyethylene glycol copolymer	1.0%
styrene acrylic polymer	1.0%
xanthan gum	0.1%
propylene glycol	5.0%
silicone based defoamer	0.1%
1,2-benzisothiazolin-3-one	0.1%
aromatic petroleum based hydrocarbon	20.0%
water	53.7%

Water-soluble and water-dispersible formulations are typically diluted with water to form
5 aqueous compositions before application. Aqueous compositions for direct applications to the

plant or portion thereof (e.g., spray tank compositions) typically contain at least about 1 ppm or more (e.g., from 1 ppm to 100 ppm) of the compound(s) of this invention.

Seed is normally treated at a rate of from about 0.001 g (more typically about 0.1 g) to about 10 g per kilogram of seed (i.e. from about 0.0001 to 1% by weight of the seed before treatment).

- 5 A flowable suspension formulated for seed treatment typically comprises from about 0.5 to about 70% of the active ingredient, from about 0.5 to about 30% of a film-forming adhesive, from about 0.5 to about 20% of a dispersing agent, from 0 to about 5% of a thickener, from 0 to about 5% of a pigment and/or dye, from 0 to about 2% of an antifoaming agent, from 0 to about 1% of a preservative, and from 0 to about 75% of a volatile liquid diluent.

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

- 25 Table 1-1

Ascomycetes in the order Pleosporales including <i>Alternaria solani</i>, <i>A. alternata</i> and <i>A. brassicae</i>, <i>Guignardia bidwellii</i>, <i>Venturia inaequalis</i>, <i>Pyrenophora tritici-repentis</i> (<i>Dreschlera tritici-repentis</i> = <i>Helminthosporium tritici-repentis</i>) and <i>Pyrenophora teres</i> (<i>Dreschlera teres</i> = <i>Helminthosporium teres</i>), <i>Corynespora cassiicola</i>, <i>Phaeosphaeria nodorum</i> (<i>Stagonospora nodorum</i> = <i>Septoria nodorum</i>), <i>Cochliobolus carbonum</i> and <i>C. heterostrophus</i>, <i>Leptosphaeria biglobosa</i> and <i>L. maculans</i>;

Ascomycetes in the order Mycosphaerellales including <i>Mycosphaerella graminicola</i> (<i>Zymoseptoria tritici</i> = <i>Septoria tritici</i>), <i>M. berkeleyi</i> (<i>Cercosporidium personatum</i>), <i>M. arachidis</i> (<i>Cercospora arachidicola</i>), <i>Passalora sojae</i> (<i>Cercospora sojae</i>), <i>Cercospora zae-maydis</i> and <i>C. beticola</i>;

Ascomycetes in the order Erysiphales (the powdery mildews) such as <i>Blumeria graminis</i> f.sp. <i>tritici</i> and <i>Blumeria graminis</i> f.sp. <i>hordei</i> , <i>Erysiphe polygoni</i> , <i>E. necator</i> (= <i>Uncinula necator</i>), <i>Podosphaera fuliginea</i> (= <i>Sphaerotheca fuliginea</i>), and <i>Podosphaera leucotricha</i> (= <i>Sphaerotheca fuliginea</i>);
Ascomycetes in the order Helotiales such as <i>Botryotinia fuckeliana</i> (<i>Botrytis cinerea</i>), <i>Oculimacula yallundae</i> (= <i>Tapesia yallundae</i> ; anamorph <i>Helgardia herpotrichoides</i> = <i>Pseudocercospora herpotrichoides</i>), <i>Monilinia fructicola</i> , <i>Sclerotinia sclerotiorum</i> , <i>Sclerotinia minor</i> , and <i>Sclerotinia homoeocarpa</i> ;
Ascomycetes in the order Hypocreales such as <i>Giberella zeae</i> (<i>Fusarium graminearum</i>), <i>G. moniliformis</i> (<i>Fusarium moniliforme</i>), <i>Fusarium solani</i> (= <i>Neocosmopora solani</i>) and <i>Verticillium dahliae</i> ;
Ascomycetes in the order Eurotiales such as <i>Aspergillus flavus</i> and <i>A. parasiticus</i> ;
Ascomycetes in the order Diaporthales such as <i>Cryptosphaera viticola</i> (= <i>Phomopsis viticola</i>), <i>Phomopsis longicolla</i> , and <i>Diaporthe phaseolorum</i> ;
Other Ascomycete pathogens including <i>Magnaporthe grisea</i> , <i>Gaeumannomyces graminis</i> , <i>Rhynchosporium secalis</i> , and anthracnose pathogens such as <i>Glomerella acutata</i> (<i>Colletotrichum acutatum</i>), <i>G. graminicola</i> (<i>C. graminicola</i>) and <i>G. lagenaria</i> (<i>C. orbiculare</i>);
Basidiomycetes in the order Uredinales (the rusts) including <i>Puccinia recondita</i> , <i>P. striiformis</i> , <i>Puccinia hordei</i> , <i>P. graminis</i> and <i>P. arachidis</i>), <i>Hemileia vastatrix</i> and <i>Phakopsora pachyrhizi</i> ;
Basidiomycetes in the order Ceratobasidiales such as <i>Thanatophorum cucumeris</i> (<i>Rhizoctonia solani</i>) and <i>Ceratobasidium oryzae-sativae</i> (<i>Rhizoctonia oryzae</i>);
Basidiomycetes in the order Polyporales such as <i>Athelia rolfsii</i> (<i>Sclerotium rolfsii</i>);
Basidiomycetes in the order Ustilaginales such as <i>Ustilago maydis</i> ;
Zygomycetes in the order Mucorales such as <i>Rhizopus stolonifer</i> ;
Oomycetes in the order Pythiales, including <i>Phytophthora infestans</i> , <i>P. megasperma</i> , <i>P. parasitica</i> , <i>P. sojae</i> , <i>P. cinnamomi</i> and <i>P. capsici</i> , and <i>Pythium</i> pathogens such as <i>Pythium aphanidermatum</i> , <i>P. graminicola</i> , <i>P. irregulare</i> , <i>P. ultimum</i> and <i>P. dissoticum</i> ;
Oomycetes in the order Peronosporales such as <i>Plasmopara viticola</i> , <i>P. halstedii</i> , <i>Peronospora hyoscyami</i> (= <i>Peronospora tabacina</i>), <i>P. manshurica</i> , <i>Hyaloperonospora parasitica</i> (= <i>Peronospora parasitica</i>), <i>Pseudoperonospora cubensis</i> and <i>Bremia lactucae</i> ;
and other genera and species closely related to all of the above pathogens.

In addition to their fungicidal activity, the compositions or combinations also have activity against bacteria such as *Erwinia amylovora*, *Xanthomonas campestris*, *Pseudomonas syringae*, and other related species. By controlling harmful microorganisms, the compounds of the

invention are useful for improving (i.e. increasing) the ratio of beneficial to harmful microorganisms in contact with crop plants or their propagules (e.g., seeds, corms, bulbs, tubers, cuttings) or in the agronomic environment of the crop plants or their propagules.

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

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

15 Treatment of genetically modified plants and seeds with compounds of the invention may result in super-additive or enhanced effects. For example, reduction in application rates, broadening of the activity spectrum, increased tolerance to biotic/abiotic stresses or enhanced storage stability may be greater than expected from just simple additive effects of the application of compounds of the invention on genetically modified plants and seeds.

20 Compounds of this invention are useful in seed treatments for protecting seeds from plant diseases. In the context of the present disclosure and claims, treating a seed means contacting the seed with a biologically effective amount of a compound of this invention, which is typically formulated as a composition of the invention. This seed treatment protects the seed from soil-borne disease pathogens and generally can also protect roots and other plant parts in contact with the soil of the seedling developing from the germinating seed. The seed treatment may also provide protection of foliage by translocation of the compound of this invention or a second active ingredient within the developing plant. Seed treatments can be applied to all types of seeds, including those from which plants genetically transformed to express specialized traits will germinate. Representative examples include those expressing proteins toxic to invertebrate pests, 25 such as *Bacillus thuringiensis* toxin or those expressing herbicide resistance such as glyphosate acetyltransferase, which provides resistance to glyphosate. Seed treatments with compounds of this invention can also increase vigor of plants growing from the seed.

30 Compounds of this invention and their compositions, both alone and in combination with other fungicides, nematicides and insecticides, are particularly useful in seed treatment for crops

including, but not limited to, maize or corn, soybeans, cotton, cereal (e.g., wheat, oats, barley, rye and rice), potatoes, vegetables and oilseed rape.

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

Plant disease control is ordinarily accomplished by applying an effective amount of a compound of this invention either pre- or post-infection, to the portion of the plant to be protected such as the roots, stems, foliage, fruits, seeds, tubers or bulbs, or to the media (soil or sand) in which the plants to be protected are growing. The compounds can also be applied to seeds to protect the seeds and seedlings developing from the seeds. The compounds can also be applied through irrigation water to treat plants. Control of postharvest pathogens which infect the produce before harvest is typically accomplished by field application of a compound of this invention, and in cases where infection occurs after harvest the compounds can be applied to the harvested crop as dips, sprays, fumigants, treated wraps and box liners.

The compounds can also be applied using an unmanned aerial vehicle (UAV) for the dispensation of the compositions disclosed herein over a planted area. In some embodiments the planted area is a crop-containing area. In some embodiments, the crop is selected from a monocot or dicot. In some embodiments, the crop is selected from rice, corn, barley, soybean, wheat, vegetable, tobacco, tea tree, fruit tree and sugar cane. In some embodiments, the compositions disclosed herein are formulated for spraying at an ultra-low volume. Products applied by drones may use water or oil as the spray carrier. Typical spray volume (including product) used for drone applications globally is 5.0 liters/ha – 100 liters/ha (approximately 0.5-10 gpa). This includes the range of ultra low spray volume (ULV) to low spray volume (LV). Although not common there may be situations where even lower spray volumes could be used as low as 1.0 liter/ha (0.1 gpa).

Suitable rates of application for the compounds of this invention (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, the population structure of the pathogen to be controlled, ambient moisture and temperature and should be determined under actual use conditions. One skilled in the art can easily determine through simple experimentation the fungicidally effective amount necessary for the desired level of plant disease control. Foliage can normally be protected when treated at a rate of from less than about 1 g/ha to about 5,000 g/ha of active ingredient. Seed and seedlings can normally be protected when seed is treated at a rate of from about 0.001 g (more typically about 0.1 g) to about 10 g per kilogram of seed. One skilled in the art can easily determine through simple experimentation the application rates for the compounds of this invention, and compositions thereof, needed to provide the desired spectrum of plant protection and control of plant diseases and optionally other plant pests.

Compounds of the present invention may also be useful for increasing vigor of a crop plant. This method comprises contacting the crop plant (e.g., foliage, flowers, fruit or roots) or the seed from which the crop plant is grown with a compound of Formula 1 in amount sufficient to achieve the desired plant vigor effect (i.e. biologically effective amount). Typically the compound of Formula 1 is applied in a formulated composition. Although the compound of Formula 1 is often applied directly to the crop plant or its seed, it can also be applied to the locus of the crop plant, i.e. the environment of the crop plant, particularly the portion of the environment in close enough proximity to allow the compound of Formula 1 to migrate to the crop plant. The locus relevant to this method most commonly comprises the growth medium (i.e. medium providing nutrients to the plant), typically soil in which the plant is grown. Treatment of a crop plant to increase vigor of the crop plant thus comprises contacting the crop plant, the seed from which the crop plant is grown or the locus of the crop plant with a biologically effective amount of a compound of Formula 1.

Increased crop vigor can result in one or more of the following observed effects: (a) optimal crop establishment as demonstrated by excellent seed germination, crop emergence and crop stand; (b) enhanced crop growth as demonstrated by rapid and robust leaf growth (e.g., measured by leaf area index), plant height, number of tillers (e.g., for rice), root mass and overall dry weight of vegetative mass of the crop; (c) improved crop yields, as demonstrated by time to flowering, duration of flowering, number of flowers, total biomass accumulation (i.e. yield quantity) and/or fruit or grain grade marketability of produce (i.e. yield quality); (d) enhanced ability of the crop to withstand or prevent plant disease infections and arthropod, nematode or mollusk pest infestations; and (e) increased ability of the crop to withstand environmental stresses such as exposure to thermal extremes, suboptimal moisture or phytotoxic chemicals.

The compounds of the present invention may increase the vigor of treated plants compared to untreated plants by preventing and/or curing plant diseases caused by fungal plant pathogens in the environment of the plants. In the absence of such control of plant diseases, the diseases reduce plant vigor by consuming plant tissues or sap, or transmitting plant pathogens such as viruses. Even in the absence of fungal plant pathogens, the compounds of the invention may increase plant vigor by modifying metabolism of plants. Generally, the vigor of a crop plant will be most significantly increased by treating the plant with a compound of the invention if the plant is grown in a nonideal environment, i.e. an environment comprising one or more aspects adverse to the plant achieving the full genetic potential it would exhibit in an ideal environment.

Of note is a method for increasing vigor of a crop plant wherein the crop plant is grown in an environment comprising plant diseases caused by fungal plant pathogens. Also of note is a method for increasing vigor of a crop plant wherein the crop plant is grown in an environment not comprising plant diseases caused by fungal plant pathogens. Also of note is a method for increasing vigor of a crop plant wherein the crop plant is grown in an environment comprising an amount of moisture less than ideal for supporting growth of the crop plant.

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

As mentioned in the Summary of the Invention, one aspect of the present invention is a fungicidal composition comprising (i.e. a mixture or combination of) a compound of Formula 1, an *N*-oxide, or a salt thereof (i.e. component a), and at least one other fungicide (i.e. component b). Of note is such a combination where the other fungicidal active ingredient has different site

of action from the compound of Formula 1. In certain instances, a combination with at least one other fungicidal active ingredient having a similar spectrum of control but a different site of action will be particularly advantageous for resistance management. Thus, a composition of the present invention can further comprise a fungicidally effective amount of at least one additional fungicidal active ingredient having a similar spectrum of control but a different site of action.

Of note is a composition which in addition to the Formula 1 compound of component (a), includes as component (b) at least one fungicidal compound selected from the group consisting of the FRAC-defined mode of action (MOA) classes, including (A) nucleic acids metabolism, (B) cytoskeleton and motor protein, (C) respiration, (D) amino acids and protein synthesis, (E) signal transduction, (F) lipid synthesis or transport and membrane integrity or function, (G) sterol biosynthesis in membranes, (H) cell wall biosynthesis, (I) melanin synthesis in cell wall, (P) host plant defense induction, (U) unknown mode of action, (M) chemicals with multi-site activity and (BM) biologicals with multiple modes of action.

FRAC-recognized or proposed target sites of action along with their FRAC target site codes belonging to the above MOA classes are (A1) RNA polymerase I, (A2) adenosine deaminase, (A3) DNA/RNA synthesis (proposed), (A4) DNA topoisomerase type II (gyrase), (B1)-(B3) β -tubulin assembly in mitosis, (B4) cell division (unknown site), (B5) delocalization of spectrin-like proteins, (B6) actin/myosin/fimbrin function, (C1) complex I NADH oxidoreductase, (C2) complex II: succinate dehydrogenase, (C3) complex III: cytochrome *bc*1 (ubiquinol oxidase) at Qo site, (C4) complex III: cytochrome *bc*1 (ubiquinone reductase) at Qi site, (C5) uncouplers of oxidative phosphorylation, (C6) inhibitors of oxidative phosphorylation, ATP synthase, (C7) ATP production (proposed), (C8) complex III: cytochrome *bc*1 (ubiquinone reductase) at Qo site, stigmatellin binding sub-site (D1) methionine biosynthesis (proposed), (D2) protein synthesis (ribosome, termination step), (D3) protein synthesis (ribosome, initiation step), (D4) protein synthesis (ribosome, initiation step), (D5) protein synthesis (ribosome, elongation step), (E1) signal transduction (mechanism unknown), (E2)-(E3) MAP/histidine kinase in osmotic signal transduction, (F2) phospholipid biosynthesis, methyl transferase, (F3) cell peroxidation (proposed), (F4) cell membrane permeability, fatty acids (proposed), (F6) microbial disrupters of pathogen cell membranes, (F7) cell membrane disruption, (F8) ergosterol binding, (F9) lipid homeostasis and transfer/storage, (G1) C14-demethylase in sterol biosynthesis, (G2) Δ 14-reductase and Δ 8 $\rightarrow$ Δ 7-isomerase in sterol biosynthesis, (G3) 3-keto reductase, C4-demethylation, (G4) squalene epoxidase in sterol biosynthesis, (H4) chitin synthase, (H5) cellulose synthase, (I1) reductase in melanin biosynthesis, (I2) dehydratase in melanin biosynthesis, (I3) polyketide synthase in melanin biosynthesis, (P1)-(P3) salicylate-related, (P4) polysaccharide elicitors, (P5)

anthraquinone elicitors, (P6) microbial elicitors, (P7) phosphonates, (BM01) plant extract, and (BM02) microbial, living microbes or extract, metabolites.

Of note is a composition which in addition to the Formula 1 compound of component (a), includes as component (b) at least one fungicidal compound selected from the group consisting of the classes (b1) methyl benzimidazole carbamate (MBC) fungicides; (b2) dicarboximide fungicides; (b3) demethylation inhibitor (DMI) fungicides; (b4) phenylamide (PA) fungicides; (b5) amine/morpholine fungicides; (b6) phospholipid biosynthesis inhibitor fungicides; (b7) succinate dehydrogenase inhibitor (SDHI) fungicides; (b8) hydroxy(2-amino-)pyrimidine fungicides; (b9) anilinopyrimidine (AP) fungicides; (b10) *N*-phenyl carbamate fungicides; (b11) quinone outside inhibitor (QoI) fungicides; (b12) phenylpyrrole (PP) fungicides; (b13) azanaphthalene fungicides; (b14) cell peroxidation inhibitor fungicides; (b15) melanin biosynthesis inhibitor-reductase (MBI-R) fungicides; (b16a) melanin biosynthesis inhibitor-dehydratase (MBI-D) fungicides; (b16b) melanin biosynthesis inhibitor-polyketide synthase (MBI-P) fungicides; (b17) keto reductase inhibitor (KRI) fungicides; (b18) squalene-epoxidase inhibitor fungicides; (b19) polyoxin fungicides; (b20) phenylurea fungicides; (b21) quinone inside inhibitor (QiI) fungicides; (b22) benzamide and thiazole carboxamide fungicides; (b23) enopyranuronic acid antibiotic fungicides; (b24) hexopyranosyl antibiotic fungicides; (b25) glucopyranosyl antibiotic: protein synthesis fungicides; (b26) glucopyranosyl antibiotic fungicides; (b27) cyanoacetamideoxime fungicides; (b28) carbamate fungicides; (b29) oxidative phosphorylation uncoupling fungicides; (b30) organo tin fungicides; (b31) carboxylic acid fungicides; (b32) heteroaromatic fungicides; (b33) phosphonate fungicides; (b34) phthalamic acid fungicides; (b35) benzotriazine fungicides; (b36) benzene-sulfonamide fungicides; (b37) pyridazinone fungicides; (b38) thiophene-carboxamide fungicides; (b39) complex I NADH oxido-reductase inhibitor fungicides; (b40) carboxylic acid amide (CAA) fungicides; (b41) tetracycline antibiotic fungicides; (b42) thiocarbamate fungicides; (b43) benzamide fungicides; (b44) microbial fungicides; (b45) quinone outside inhibitor, stigmatellin binding (QoSI) fungicides; (b46) plant extract fungicides; (b47) cyanoacrylate fungicides; (b48) polyene fungicides; (b49) oxysterol binding protein inhibitor (OSBPI) fungicides; (b50) aryl-phenyl-ketone fungicides; (b51) host plant defense induction fungicides; (b52) multi-site activity fungicides; (b53) biologicals with multiple modes of action; (b54) fungicides other than fungicides of component (a) and components (b1) through (b53); and salts of compounds of (b1) through (b54).

Also of note are embodiments wherein component (b) comprises at least one fungicidal compound from each of two different groups selected from (b1) through (b54).

Further descriptions of groups (b1) through (b54) are as follows.

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

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

(b3) "Demethylation inhibitor (DMI) fungicides" (FRAC code 3) (Sterol Biosynthesis Inhibitors (SBI): Class I) inhibit C14-demethylase, which plays a role in sterol production. Sterols, such as ergosterol, are needed for membrane structure and function, making them essential for the development of functional cell walls. Therefore, exposure to these fungicides results in abnormal growth and eventually death of sensitive fungi. DMI fungicides are divided between several chemical classes: piperazines, pyridines, pyrimidines, imidazoles, triazoles and triazolinthiones. The piperazines include triforine. The pyridines include buthiobate, pyrifeno, pyrisoxazole and (α S)-[3-(4-chloro-2-fluorophenyl)-5-(2,4-difluorophenyl)-4-isoxazolyl]-3-pyridinemethanol. The pyrimidines include fenarimol, nuarimol and triarimol. The imidazoles include econazole, imazalil, oxpoconazole, pefurazoate, prochloraz and triflumizole. The triazoles include azaconazole, bitertanol, bromuconazole, cyproconazole, difenoconazole, diniconazole (including diniconazole-M), epoxiconazole, etaconazole, fenbuconazole, fluquinconazole, flusilazole, flutriafol, hexaconazole, imibenconazole, ipconazole, ipfentrifluconazole, mefentrifluconazole, metconazole, myclobutanil, penconazole, propiconazole, quinconazole, simeconazole, tebuconazole, tetraconazole, triadimefon, triadimenol, triticonazole, uniconazole, uniconazole-P, α -(1-chlorocyclopropyl)- α -[2-(2,2-dichlorocyclopropyl)ethyl]-1*H*-1,2,4-triazole-1-ethanol, *rel*-1-[[*(2R,3S)*-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]methyl]-1*H*-1,2,4-triazole, *rel*-2-[[*(2R,3S)*-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]methyl]-1,2-dihydro-3*H*-1,2,4-triazole-3-thione and *rel*-1-[[*(2R,3S)*-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]methyl]-5-(2-propen-1-ylthio)-1*H*-1,2,4-triazole. The triazolinthiones include prothioconazole. Biochemical investigations have shown that all of the above mentioned fungicides are DMI fungicides as described by K. H. Kuck et al. in *Modern Selective Fungicides - Properties, Applications and Mechanisms of Action*, H. Lyr (Ed.), Gustav Fischer Verlag: New York, 1995, 205-258.

(b4) "Phenylamide fungicides" (FRAC code 4) are specific inhibitors of RNA polymerase in Oomycete fungi. Sensitive fungi exposed to these fungicides show a reduced capacity to

incorporate uridine into rRNA. Growth and development in sensitive fungi is prevented by exposure to this class of fungicide. Phenylamide fungicides include acylalanine, oxazolidinone and butyrolactone fungicides. The acylalanines include benalaxyl, benalaxyl-M (also known as kiralaxyl), furalaxyl, metalaxyl and metalaxyl-M (also known as mefenoxam). The oxazolidinones include oxadixyl. The butyrolactones include ofurace.

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

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

(b7) "Succinate dehydrogenase inhibitor (SDHI) fungicides" (FRAC code 7) inhibit complex II fungal respiration by disrupting a key enzyme in the Krebs Cycle (TCA cycle) named succinate dehydrogenase. Inhibiting respiration prevents the fungus from making ATP, and thus inhibits growth and reproduction. SDHI fungicides include phenylbenzamide, phenyloxoethylthiophene amide, pyridinylethylbenzamide, furan carboxamide, oxathiin carboxamide, thiazole carboxamide, pyrazole-4-carboxamide, *N*-cyclopropyl-*N*-benzyl-pyrazole carboxamide, *N*-methoxy-(phenyl-ethyl)-pyrazole carboxamide, pyridine carboxamide and pyrazine carboxamide fungicides. The phenylbenzamides include benodanil, flutolanil and mepronil. The phenyloxoethylthiophene amides include isofetamid. The pyridinylethylbenzamides include fluopyram. The furan carboxamides include fenfuram. The oxathiin carboxamides include carboxin and oxycarboxin. The thiazole carboxamides include thifluzamide. The pyrazole-4-carboxamides include benzovindiflupyr, bixafen, flubeneteram (provisional common name, Registry Number 1676101-39-5), fluindapyr, fluxapyroxad, furametpyr, inpyrfluxam, isopyrazam, penflufen, penthiopyrad, pyrapropoyne (provisional common name, Registry Number 1803108-03-3), sedaxane and *N*-[2-(2,4-dichlorophenyl)-2-methoxy-1-methylethyl]-3-(difluoromethyl)-1-methyl-1*H*-pyrazole-4-carboxamide. The *N*-cyclopropyl-*N*-benzyl-pyrazole carboxamides include isoflucypram. The *N*-methoxy-(phenyl-

ethyl)-pyrazole carboxamides include pydiflumetofen. The pyridine carboxamides include boscalid. The pyrazine carboxamides include pyraziflumid.

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

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

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

(b11) “Quinone outside inhibitor (QoI) fungicides” (FRAC code 11) inhibit complex III mitochondrial respiration in fungi by affecting ubiquinol oxidase. Oxidation of ubiquinol is blocked at the “quinone outside” (Qo) site of the cytochrome *bc*₁ complex, which is located in the inner mitochondrial membrane of fungi. Inhibiting mitochondrial respiration prevents normal fungal growth and development. Quinone outside inhibitor fungicides include methoxyacrylate, methoxyacetamide, methoxycarbamate, oximinoacetate, oximinoacetamide and dihydrodioxazine fungicides (collectively also known as strobilurin fungicides), and oxazolidinedione, imidazolinone and benzylcarbamate fungicides. The methoxyacrylates include 15 azoxystrobin, coumoxystrobin, enoxastrobin (also known as enestroburin), flufenoxystrobin, picoxystrobin and pyraoxystrobin. The methoxyacetamides include mandestrobin. The methoxycarbamates include pyraclostrobin, pyrametostrobin and triclopyricarb. The oximinoacetates include kresoxim-methyl and trifloxystrobin. The oximinoacetamides include dimoxystrobin, fenaminstrobin, metominostrobin and orysastrobin. The dihydrodioxazines include fluoxastrobin. 20 The oxazolidinediones include famoxadone. The imidazolinones include fenamidone. The benzylcarbamates include pyribencarb.

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

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

(b14) “Lipid peroxidation inhibitor fungicides” (FRAC code 14) are proposed to inhibit lipid peroxidation which affects membrane synthesis in fungi. Members of this class, such as etridiazole, may also affect other biological processes such as respiration and melanin biosynthesis. Cell peroxidation fungicides include aromatic hydrocarbon and 1,2,4-thiadiazole fungicides. The aromatic hydrocarbon fungicides include biphenyl, chloroneb, dicloran, 5 quinotozene, tecnazene and tolclofos-methyl. The 1,2,4-thiadiazoles include etridiazole.

(b15) “Melanin biosynthesis inhibitors-reductase (MBI-R) fungicides” (FRAC code 16.1) inhibit the naphthal reduction step in melanin biosynthesis. Melanin is required for host plant infection by some fungi. Melanin biosynthesis inhibitor-reductase fungicides include 10 isobenzofuranone, pyrroloquinolinone and triazolobenzothiazole fungicides. The isobenzofuranones include fthalide. The pyrroloquinolinones include pyroquilon. The triazolobenzothiazoles include tricyclazole.

(b16a) “Melanin biosynthesis inhibitors-dehydratase (MBI-D) fungicides” (FRAC code 16.2) inhibit scytalone dehydratase in melanin biosynthesis. Melanin is required for host plant 15 infection by some fungi. Melanin biosynthesis inhibitor-dehydratase fungicides include cyclopropanecarboxamide, carboxamide and propionamide fungicides. The cyclopropanecarboxamides include carpropamid. The carboxamides include diclocymet. The propionamides include fenoxanil.

(b16b) “Melanin biosynthesis inhibitor-polyketide synthase (MBI-P) fungicides” (FRAC 20 code 16.3) inhibit polyketide synthase in melanin biosynthesis. Melanin is required for host plant infection by some fungi. Melanin biosynthesis inhibitor-polyketide synthase fungicides include trifluoroethylcarbamate fungicides. The trifluoroethylcarbamates include tolprocarb.

(b17) “Sterol Biosynthesis Inhibitor (SBI): Class III fungicides (FRAC code 17) inhibit 3-keto reductase during C4-demethylation in sterol production. Keto reductase inhibitor fungicides 25 (also known as Sterol Biosynthesis Inhibitors (SBI): Class III) include hydroxyanilides and amino-pyrazolinones. Hydroxyanilides include fenhexamid. Amino-pyrazolinones include fenpyrazamine. Quinofumelin (provisional common name, Registry Number 861647-84-9) and ipflufenquin (provisional common name, Registry Number 1314008-27-9) are also believed to be keto reductase inhibitor fungicides.

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

fungicides. The thiocarbamates include pyributicarb. The allylamines include naftifine and terbinafine.

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

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

(b21) "Quinone inside inhibitor (QiI) fungicides" (FRAC code 21) inhibit complex III mitochondrial respiration in fungi by affecting ubiquinone reductase. Reduction of ubiquinone is blocked at the "quinone inside" (Qi) site of the cytochrome *bc*₁ complex, which is located in the
10 inner mitochondrial membrane of fungi. Inhibiting mitochondrial respiration prevents normal fungal growth and development. Quinone inside inhibitor fungicides include cyanoimidazole, sulfamoyltriazole and picolinamide fungicides. The cyanoimidazoles include cyazofamid. The sulfamoyltriazoles include amisulbrom. The picolinamides include fenpicoxamid (Registry Number 517875-34-2).

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

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

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

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

(b26) "Glucopyranosyl antibiotic fungicides" (FRAC code U18, previously FRAC code 26 reclassified to U18) are proposed to inhibit trehalase and inositol biosynthesis. Examples include validamycin.

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

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

(b29) "Oxidative phosphorylation uncoupling fungicides" (FRAC code 29) inhibit fungal
35 respiration by uncoupling oxidative phosphorylation. Inhibiting respiration prevents normal

fungal growth and development. This class includes 2,6-dinitroanilines such as fluazinam, and dinitrophenyl crotonates such as dinocap, meptyldinocap and binapacryl.

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

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

(b32) “Heteroaromatic fungicides” (FRAC code 32) are proposed to affect DNA/ribonucleic acid (RNA) synthesis. Heteroaromatic fungicides include isoxazoles and isothiazolones. The isoxazoles include hymexazole and the isothiazolones include oethilnolone.

(b33) “Phosphonate fungicides” (FRAC code P07, previously FRAC code 33 reclassified to P07) include phosphorous acid and its various salts, including fosetyl-aluminum.

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

(b35) “Benzotriazine fungicides” (FRAC code 35) include triazoxide.

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

(b37) “Pyridazinone fungicides” (FRAC code 37) include diclomezine.

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

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

(b40) “Carboxylic acid amide (CAA) fungicides” (FRAC code 40) inhibit cellulose synthase which prevents growth and leads to death of the target fungus. Carboxylic acid amide fungicides include cinnamic acid amide, valinamide carbamate and mandelic acid amide fungicides. The cinnamic acid amides include dimethomorph, flumorph and pyrimorph. The valinamide carbamates include bentiavalicarb, bentiavalicarb-isopropyl, iprovalicarb, tolprocarb and valifenalate (also known as valiphenal). The mandelic acid amides include mandipropamid, *N*-[2-[4-[[3-(4-chlorophenyl)-2-propyn-1-yl]oxy]-3-methoxyphenyl]ethyl]-3-methyl-2-[(methylsulfonyl)amino]butanamide and *N*-[2-[4-[[3-(4-chlorophenyl)-2-propyn-1-yl]oxy]-3-methoxyphenyl]ethyl]-3-methyl-2-[(ethylsulfonyl)amino]butanamide.

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

(b42) “Thiocarbamate fungicides” (FRAC code M12, previously FRAC code 42 reclassified to M12) include methasulfocarb.

(b43) “Benzamide fungicides” (FRAC code 43) inhibit growth of fungi by delocalization of spectrin-like proteins. Examples include pyridinylmethyl benzamides such as fluopicolide and fluopimomide.

5 (b44) “Microbial fungicides” (FRAC code BM02, previously FRAC code 44 reclassified to BM02) disrupt fungal pathogen cell membranes. Microbial fungicides include *Bacillus* species such as *Bacillus amyloliquefaciens* strains AP-136, AP-188, AP-218, AP-219, AP-295, QST713, FZB24, F727, MB1600, D747, TJ100 (also called strain 1 BE; known from EP2962568), and the fungicidal lipopeptides which they produce.

10 (b45) “Quinone outside inhibitor, stigmatellin binding (QoSI) fungicides” (FRAC code 45) inhibit complex III mitochondrial respiration in fungi by affecting ubiquinone reductase at the “quinone outside” (Qo) site, stigmatellin binding sub-site, of the cytochrome *bc*₁ complex. Inhibiting mitochondrial respiration prevents normal fungal growth and development. QoSI fungicides include triazolopyrimidylamines such as ametocradin.

15 (b46) “Plant extract fungicides” (FRAC code 46) cause cell membrane disruption. Plant extract fungicides include terpene hydrocarbons, terpene alcohols and terpen phenols such as the extract from *Melaleuca alternifolia* (tea tree) and plant oils (mixtures) such as eugenol, geraniol and thymol.

(b47) “Cyanoacrylate fungicides” (FRAC code 47) bind to the myosin motor domain and effect motor activity and actin assembly. Cyanoacrylates include fungicides such as phenamacril.

20 (b48) “Polyene fungicides” (FRAC code 48) cause disruption of the fungal cell membrane by binding to ergosterol, the main sterol in the membrane. Examples include natamycin (pimaricin).

25 (b49) “Oxysterol binding protein inhibitor (OSBPI) Fungicides” (FRAC code 49) bind to the oxysterol-binding protein in oomycetes causing inhibition of zoospore release, zoospore motility and sporangia germination. Oxysterol binding fungicides include piperdinythiazoleisoxazolines such as oxathiapiprolin and fluoxapiprolin.

(b50) “Aryl-phenyl-ketone fungicides” (FRAC code 50, previously FRAC code U8 reclassified to 50) inhibit the growth of mycelium in fungi. Aryl-phenyl ketone fungicides include benzophenones such as metrafenone, and benzoylpyridines such as pyriofenone.

30 (b51) “Host plant defense induction fungicides” induce host plant defense mechanisms. Host plant defense induction fungicides include benzothiadiazole (FRAC code P01), benzisothiazole (FRAC code P02), thiadiazole carboxamide (FRAC code P03), polysaccharide (FRAC code P04), plant extract (FRAC code P05), microbial (FRAC code P06) and phosphonate fungicides (FRAC code P07, see (b33) above). The benzothiadiazoles include acibenzolar-S-methyl. The benzisothiazoles include probenazole. The thiadiazole carboxamides include tiadinil

35

and isotianil. The polysaccharides include laminarin. The plant extracts include extract from *Reynoutria sachalinensis* (giant knotweed). The microbials include *Bacillus mycoides* isolate J and cell walls of *Saccharomyces cerevisiae* strain LAS117.

(b52) “Multi-site activity fungicides” inhibit fungal growth through multiple sites of action and have contact/preventive activity. Multi-site activity fungicides include copper fungicides (FRAC code M01), sulfur fungicides (FRAC code M02), dithiocarbamate fungicides (FRAC code M03), phthalimide fungicides (FRAC code M04), chloronitrile fungicides (FRAC code M05), sulfamide fungicides (FRAC code M06), multi-site contact guanidine fungicides (FRAC code M07), triazine fungicides (FRAC code M08), quinone fungicides (FRAC code M09), quinoxaline fungicides (FRAC code M10), maleimide fungicides (FRAC code M11) and thiocarbamate (FRAC code M12, see (b42) above) fungicides. 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 ferbam, mancozeb, maneb, metiram, propineb, thiram, zinc thiazole, zineb and ziram. Phthalimide fungicides contain a phthalimide molecular moiety; examples include folpet, captan and captafol. Chloronitrile fungicides contain an aromatic ring substituted with chloro and cyano; examples include chlorothalonil. Sulfamide fungicides include dichlofluanid and tolyfluanid. Multi-site contact guanidine fungicides include, guazatine, iminoctadine albesilate and iminoctadine triacetate. Triazine fungicides include anilazine. Quinone fungicides include dithianon. Quinoxaline fungicides include quinomethionate (also known as chinomethionate). Maleimide fungicides include fluoroimide.

(b53) “Biologicals with multiple modes of action” include agents from biological origins showing multiple mechanisms of action without evidence of a dominating mode of action. This class of fungicides includes polypeptide (lectin), phenol, sesquiterpene, triterpenoid and coumarin fungicides (FRAC code BM01) such as extract from the cotyledons of lupine plantlets. This class also includes momicrobial fungicides (FRAC code BM02, see (b44) above).

(b54) “Fungicides other than fungicides of component (a) and components (b1) through (b53)”; include certain fungicides whose mode of action may be unknown. These include: (b54.1) “phenyl-acetamide fungicides” (FRAC code U06), (b54.2) “guanidine fungicides” (FRAC code U12), (b54.3) “thiazolidine fungicides” (FRAC code U13), (b54.4) “pyrimidinone-hydrazone fungicides” (FRAC code U14), (b54.5) “4-quinolylacetate fungicides” (FRAC code U16), (54.6) “tetrazolyloxime fungicides” (FRAC code U17) and “glucopyranosyl antibiotic fungicides” (FRAC code U18, see (b26) above). The phenyl-acetamides include cyflufenamid. The

guanidines include dodine. The thiazolidines include flutianil. The pyrimidinonehydrazones include ferimzone. The 4-quinolylacetates include tebufloquin. The tetrazolyloximes include picarbutrazox.

5 The (b54) class also includes bethoxazin, dichlobentiazox (provisional common name, Registry Number 957144-77-3), dipymetitrone (provisional common name, Registry Number 16114-35-5), flometoquin, neo-asozin (ferric methanearsonate), pyrrolnitrin, tolnifanide (Registry Number 304911-98-6), *N*-[4-[4-chloro-3-(trifluoromethyl)phenoxy]-2,5-dimethylphenyl]-*N*-ethyl-*N*-methylmethanimidamide, 5-fluoro-2-[(4-fluorophenyl)methoxy]-4-pyrimidinamine and 4-fluorophenyl *N*-[1-[[[1-(4-cyanophenyl)ethyl]sulfonyl]methyl]propyl]carbamate.

10 Additional “Fungicides other than fungicides of classes (b1) through (b54)” whose mode of action may be unknown, or may not yet be classified include a fungicidal compound selected from components (b54.7) through (b54.12), as shown below.

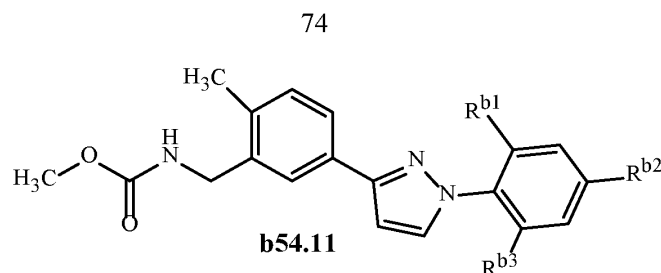
Component (54.7) relates to (1*S*)-2,2-bis(4-fluorophenyl)-1-methylethyl *N*-[[3-(acetyloxy)-4-methoxy-2-pyridinyl]carbonyl]-L-alaninate (provisional common name florylpicoxamid, 15 Registry Number 1961312-55-9) which is believed to be a Quinone inside inhibitor (QiI) fungicide (FRAC code 21) inhibiting the Complex III mitochondrial respiration in fungi.

Component (54.8) relates to 1-[2-[[[1-(4-chlorophenyl)-1*H*-pyrazol-3-yl]oxy]methyl]-3-methylphenyl]-1,4-dihydro-4-methyl-5*H*-tetrazol-5-one (provisional common name metyltetraprole, Registry Number 1472649-01-6), which is believed to be a quinone outside 20 inhibitor (QoI) fungicide (FRAC code 45) inhibiting the Complex III mitochondrial respiration in fungi, and is effective against QoI resistant strains.

Component (54.9) relates to 3-chloro-4-(2,6-difluorophenyl)-6-methyl-5-phenylpyridazine (provisional common name pyridachlometyl, Registry Number 1358061-55-8), which is believed to be promoter tubulin polymerization, resulting antifungal activity against fungal species 25 belonging to the phyla Ascomycota and Basidiomycota.

Component (54.10) relates to (4-phenoxyphenyl)methyl 2-amino-6-methyl-pyridine-3-carboxylate (provisional common name aminopyrifen, Registry Number 1531626-08-0) which is believed to inhibit GWT-1 protein in glycosylphosphatidylinositol-anchor biosynthesis in *Neurospora crassa*.

30 Component (b54.11) relates a compound of Formula **b54.11**



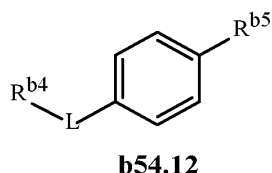
wherein

R^{b1} and R^{b3} are each independently halogen; and

R^{b2} is H, halogen, C_1 - C_3 alkyl, C_1 - C_3 haloalkyl or C_3 - C_6 cycloalkyl.

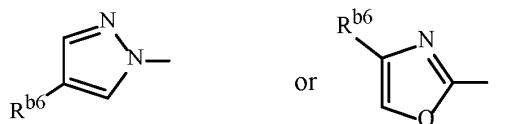
- 5 Examples of compounds of Formula **b54.11** include (b54.11a) methyl *N*-[[5-[1-(2,6-difluoro-4-formylphenyl)-1*H*-pyrazol-3-yl]-2-methylphenyl] methyl]carbamate, (b54.11b) methyl *N*-[[5-[1-(4-cyclopropyl-2,6-dichlorophenyl)-1*H*-pyrazol-3-yl]-2-methylphenyl]methyl]carbamate, (b54.11c) methyl *N*-[[5-[1-(4-chloro-2,6-difluorophenyl)-1*H*-pyrazol-3-yl]-2-methylphenyl]-methyl]carbamate, (b54.11d) methyl *N*-[[5-[1-(4-cyclopropyl-2,6-difluorophenyl)-1*H*-pyrazol-3-yl]-2-methylphenyl]methyl]carbamate, (b54.11e) methyl *N*-[[5-[1-[2,6-difluoro-4-(1-methylethyl)phenyl]-1*H*-pyrazol-3-yl]-2-methylphenyl]methyl]carbamate and (b54.11f) methyl *N*-[[5-[1-[2,6-difluoro-4-(trifluoromethyl)phenyl]-1*H*-pyrazol-3-yl]-2-methylphenyl]methyl]carbamate. Compounds of Formula **b54.11**, their use as fungicides and methods of preparation are generally known; see, for example, PCT Patent Publications
- 15 WO 2008/124092, WO 2014/066120 and WO 2020/097012.

Component (b54.12) relates to a compound of Formula **b54.12**

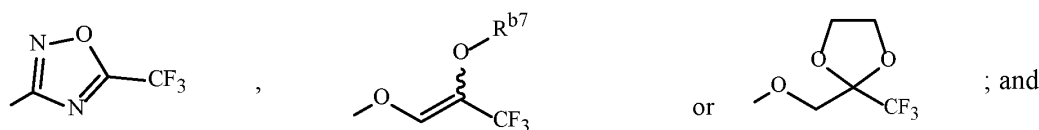


wherein

R^{b4} is



- 20 R^{b6} is C_2 - C_4 alkoxycarbonyl or C_2 - C_4 haloalkylaminocarbonyl;
 L is CH_2 or CH_2O , wherein the atom to the right is connected to the phenyl ring in Formula **b54.12**;
 R^{b5} is



R^{b7} is C_1-C_3 alkyl, wherein the wavy bond indicates the adjacent double bond is either (*Z*)- or (*E*)-configuration, or a mixture thereof.

Examples of compounds of Formula **b54.12** include (b54.12a) *N*-(2,2,2-trifluoroethyl)-2-[[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenyl]methyl]-4-oxazolecarboxamide, (b54.12b) ethyl 1-[[4-[5-(trifluoromethyl)-1,2,4-oxadiazol-3-yl]phenoxy]methyl]-1*H*-pyrazole-4-carboxylate, (b54.12c) ethyl 1-[[4-[(1*Z*)-2-ethoxy-3,3,3-trifluoro-1-propen-1-yl]oxy]phenyl]methyl]-1*H*-pyrazole-4-carboxylate and (b54.12d) ethyl 1-[[4-[[2-(trifluoromethyl)-1,3-dioxolan-2-yl]methoxy]phenyl]methyl]-1*H*-pyrazole-4-carboxylate. Compounds of Formula **b54.12**, their use as fungicides and methods of preparation are generally known; see, for example, PCT Patent Publications WO 2008/187553 and WO 2020/056090.

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 (b1) through (b54), including (b54.7) through (b54.12). 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 (b1) through (b54). Also of particular note is a composition comprising said mixture (in fungicidally effective amount) and further comprising at least one additional surfactant selected from the group consisting of surfactants, solid diluents and liquid diluents.

Examples of component (b) fungicides include acibenzolar-S-methyl, aldimorph, ametocradin, amisulbrom, anilazine, azaconazole, azoxystrobin, benalaxyl (including benalaxyl-M), benodanil, benomyl, benthiavalicarb (including benthiavalicarb-isopropyl), benzoindiflupyr, bethoxazin, binapacryl, biphenyl, bitertanol, bixafen, blasticidin-S, boscalid, bromuconazole, bupirimate, buthiobate, captafol, captan, carbendazim, carboxin, carpropamid, chloroneb, chlorothalonil, chlozolinate, clotrimazole, copper hydroxide, copper oxychloride, copper sulfate, coumoxystrobin, cyazofamid, cyflufenamid, cymoxanil, cyproconazole, cyprodinil, dichlofluanid, diclocymet, diclomezine, dicloran, diethofencarb, difenoconazole, diflumetorim, dimethirimol, dimethomorph, dimoxystrobin, diniconazole (including diniconazole-M), dinocap, dithianon, dithiolanes, dodemorph, dodine, dipymetitrone, econazole, edifenphos, enoxastrobin (also known as enestroburin), epoxiconazole, etaconazole, ethaboxam,

ethirimol, etridiazole, famoxadone, fenamidone, fenarimol, fenaminstrobin, fenbuconazole, fenfuram, fenhexamid, fenoxanil, fencpiclonil, fenpropidin, fenpropimorph, fenpyrazamine, fentin acetate, fentin chloride, fentin hydroxide, ferbam, ferimzone, flometoquin, florylpicoxamid, fluazinam, fludioxonil, flufenoxystrobin, fluindapyr, flumorph, fluopicolide, fluopimomide, fluopyram, flouroimide, fluoxastrobin, fluquinconazole, flusilazole, flusulfamide, flutianil, flutolanil, flutriafol, fluxapyroxad, folpet, fthalide, fuberidazole, furalaxyl, furametpyr, guazatine, hexaconazole, hymexazole, imazalil, imibenconazole, iminoctadine albesilate, iminoctadine triacetate, iodocarb, ipconazole, ipfentrifluconazole, iprobenfos, iprodione, iprovalicarb, isoconazole, isofetamid, isoprothiolane, isoflucypram, isopyrazam, isotianil, kasugamycin, kresoxim-methyl, mancozeb, mandepropamid, mandestrobin, maneb, mepanipyrim, mepronil, meptyldinocap, metalaxyl (including metalaxyl-M/mefenoxam), mefentrifluconazole, metconazole, methasulfocarb, metiram, metominostrobin, metrafenone, miconazole, myclobutanil, naftifine, neo-asozin, nuarimol, octhilineone, ofurace, orysastrobin, oxadixyl, oxathiapiiprolin, oxolinic acid, oxpoconazole, oxycarboxin, oxytetracycline, pefurazoate, penconazole, pencycuron, penflufen, penthiopyrad, phosphorous acid (including salts thereof, e.g., fosetyl-aluminum), picarbutrazox, picoxystrobin, piperalin, polyoxin, probenazole, prochloraz, procymidone, propamacarb, propiconazole, propineb, proquinazid, prothiocarb, prothioconazole, pyraclostrobin, pyrametostrobin, pyraoxystrobin, pyrazophos, pyribencarb, pyributicarb, pyrifenoxy, pyrimethanil, pyriofenone, pyrisoxazole, pyroquilon, pyrrolnitrin, quinconazole, quinofumelin (Registry Number 861647-84-9) quinomethionate, quinoxifen, quintozone, sedaxane, silthiofam, simeconazole, spiroxamine, streptomycin, sulfur, tebuconazole, tebufloquin, teclofthalam, tecnazene, terbinafine, tetraconazole, thiabendazole, thifluzamide, thiophanate, thiophanate-methyl, thiram, tiadinil, tolclofos-methyl, tolnifanide, tolprocarb, tolyfluanid, triadimefon, triadimenol, triarimol, triticonazole, triazoxide, tribasic copper sulfate, tricyclazole, triclopyricarb, tridemorph, trifloxystrobin, triflumizole, triforine, trimorphamide, uniconazole, uniconazole-P, validamycin, valifenalate (also known as valiphenal), vinclozolin, zineb, ziram, zoxamide, *N*-[2-(1*S*,2*R*)-[1,1'-bicyclopropyl]-2-ylphenyl]-3-(difluoromethyl)-1-methyl-1*H*-pyrazole-4-carboxamide, α -(1-chlorocyclopropyl)- α -[2-(2,2-dichlorocyclopropyl)-ethyl]-1*H*-1,2,4-triazole-1-ethanol, (α *S*)-[3-(4-chloro-2-fluorophenyl)-5-(2,4-difluorophenyl)-4-isoxazolyl]-3-pyridinemethanol, *rel*-1-[(2*R*,3*S*)-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]methyl]-1*H*-1,2,4-triazole, *rel*-2-[(2*R*,3*S*)-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]methyl]-1,2-dihydro-3*H*-1,2,4-triazole-3-thione, *rel*-1-[(2*R*,3*S*)-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]methyl]-5-(2-propen-1-ylthio)-1*H*-1,2,4-triazole, *N*-[2-[4-[[3-(4-chlorophenyl)-2-propyn-1-yl]oxy]-3-methoxyphenyl]ethyl]-3-methyl-2-[(methylsulfonyl)-amino]butanamide, *N*-[2-[4-[[3-(4-chlorophenyl)-2-propyn-1-yl]oxy]-3-methoxyphenyl]ethyl]-

3-methyl-2-[(ethylsulfonyl)amino]butanamide, *N*'-[4-[4-chloro-3-(trifluoromethyl)phenoxy]-2,5-dimethylphenyl]-*N*-ethyl-*N*-methylmethanimidamide, *N*-[[cyclopropylmethoxyamino][6-(difluoromethoxy)-2,3-difluorophenyl]methylene]benzeneacetamide, *N*-[2-(2,4-dichlorophenyl)-2-methoxy-1-methylethyl]-3-(difluoromethyl)-1-methyl-1*H*-pyrazole-4-carboxamide, *N*-(3',4'-difluoro[1,1'-biphenyl]-2-yl)-3-(trifluoromethyl)-2-pyrazinecarboxamide, 3-(difluoromethyl)-*N*-(2,3-dihydro-1,1,3-trimethyl-1*H*-inden-4-yl)-1-methyl-1*H*-pyrazole-4-carboxamide, 5,8-difluoro-*N*-[2-[3-methoxy-4-[[4-(trifluoromethyl)-2-pyridinyl]oxy]phenyl]ethyl]-4-quinazolinamine, 1-[4-[4-[5*R*-(2,6-difluorophenoxy)methyl]-4,5-dihydro-3-isoxazolyl]-2-thiazolyl]-1-piperidinyl]-2-[5-methyl-3-(trifluoromethyl)-1*H*-pyrazol-1-yl]ethanone, 4-fluorophenyl *N*-[1-[[[1-(4-cyanophenyl)ethyl]sulfonyl]methyl]propyl]carbamate, 5-fluoro-2-[(4-fluorophenyl)-methoxy]-4-pyrimidinamine, α -(methoxyimino)-*N*-methyl-2-[[[1-[3-(trifluoromethyl)phenyl]-ethoxy]imino]methyl]benzeneacetamide, and [[4-methoxy-2-[[[(3*S*,7*R*,8*R*,9*S*)-9-methyl-8-(2-methyl-1-oxopropoxy)-2,6-dioxo-7-(phenylmethyl)-1,5-dioxonan-3-yl]amino]carbonyl]-3-pyridinyl]oxy]methyl 2-methylpropanoate. Therefore of note is a fungicidal composition comprising as component (a) a compound of Formula 1 (or an *N*-oxide or salt thereof) and as component (b) at least one fungicide selected from the preceding list.

Of particular note are combinations of compounds of Formula 1 (or an *N*-oxide or salt thereof) (i.e. Component (a) in compositions) with aminopyrifin (Registry Number 1531626-08-0), azoxystrobin, benzovindiflupyr, bixafen, captan, carpropamid, chlorothalonil, copper hydroxide, copper oxychloride, copper sulfate, cymoxanil, cyproconazole, cyprodinil, dichlobentiazox (Registry Number 957144-77-3), diethofencarb, difenoconazole, dimethomorph, dipymetritrone, epoxiconazole, ethaboxam, fenarimol, fenhexamid, fluazinam, fludioxonil, fluindapyr, fluopyram, flusilazole, flutianil, flutriafol, fluxapyroxad, folpet, ipflufenquin (Registry Number 1314008-27-9), iprodione, isofetamid, isoflucypram, isopyrazam, kresoxim-methyl, mancozeb, mandestrobin, meptyldinocap, metalaxyl (including metalaxyl-M/mefenoxam), mefentrifluconazole, metconazole, metrafenone, metyltetraprole (Registry Number 1472649-01-6), myclobutanil, oxathiapiprolin, penflufen, penthiopyrad, phosphorous acid (including salts thereof, e.g., fosetyl-aluminum), picoxystrobin, propiconazole, proquinazid, prothioconazole, pyridachlometyl (Registry Number 1358061-55-8), pyraclostrobin, pyrapropoyne (Registry Number 1803108-03-3), pyrimethanil, sedaxane spiroxamine, sulfur, tebuconazole, thiophanate-methyl, trifloxystrobin, zoxamide, α -(1-chlorocyclopropyl)- α -[2-(2,2-dichlorocyclopropyl)ethyl]-1*H*-1,2,4-triazole-1-ethanol, *N*-[2-(2,4-dichlorophenyl)-2-methoxy-1-methylethyl]-3-(difluoromethyl)-1-methyl-1*H*-pyrazole-4-carboxamide, 3-(difluoromethyl)-*N*-(2,3-dihydro-1,1,3-trimethyl-1*H*-inden-4-yl)-1-methyl-1*H*-pyrazole-4-carboxamide, 1-[4-[4-[5*R*-(2,6-difluorophenyl)-4,5-dihydro-3-isoxazolyl]-2-thiazolyl]-1-piperidinyl]-2-[5-methyl-3-

(trifluoromethyl)-1*H*-pyrazol-1-yl]ethanone, 1,1-dimethylethyl *N*-[6-[[[(1-methyl-1*H*-tetrazol-5-yl)phenylmethylene]amino]oxy]methyl]-2-pyridinyl]carbamate, 5-fluoro-2-[(4-fluorophenyl)-methoxy]-4-pyrimidinamine, (*αS*)-[3-(4-chloro-2-fluorophenyl)-5-(2,4-difluorophenyl)-4-isoxazolyl]-3-pyridinemethanol, *rel*-1-[[*(2R,3S)*-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]methyl]-1*H*-1,2,4-triazole, *rel*-2-[[*(2R,3S)*-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]methyl]-1,2-dihydro-3*H*-1,2,4-triazole-3-thione, and *rel*-1-[[*(2R,3S)*-3-(2-chlorophenyl)-2-(2,4-difluorophenyl)-2-oxiranyl]methyl]-5-(2-propen-1-ylthio)-1*H*-1,2,4-triazole (i.e. as Component (b) in compositions).

Generally 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 Formula 1, an *N*-oxide, or salt thereof, with a fungicidal compound selected from the group: amisulbrom, azoxystrobin, boscalid, carbendazim, carboxin, cymoxanil, cyproconazole, difenoconazole, dimethomorph, dimoxystrobin, fenpropimorph, florylpicoxamid, fluazinam, fludioxonil, flufenoxystrobin, fluindapyr, fluquinconazole, fluopicolide, fluoxastrobin, flutriafol, fluxapyroxad, ipconazole, ipfentrifluconazole, iprodione, kresoxim-methyl, metalaxyl, mefenoxam, mefentrifluconazole, metconazole, metominostrobin, myclobutanil, paclobutrazole, penflufen, picoxystrobin, prothioconazole, pyraclostrobin, pyrametostrobin, pyraoxystrobin, pyriofenone, sedaxane, silthiofam, tebuconazole, thiabendazole, thiophanate-methyl, thiram, trifloxystrobin and triticonazole.

Examples of other biologically active compounds or agents with which compounds of this invention can be formulated are: invertebrate pest control compounds or agents such as abamectin, acephate, acetamiprid, acrinathrin, afdopyropen ([*(3S,4R,4aR,6S,6aS,12R,12aS,12bS)*-3-[(cyclopropylcarbonyl)oxy]-1,3,4,4a,5,6,6a,12,12a,12b-decahydro-6,12-dihydroxy-4,6a,12b-trimethyl-11-oxo-9-(3-pyridinyl)-2*H*,11*H*-naphtho[2,1-*b*]pyrano[3,4-*e*]pyran-4-yl]methyl cyclopropanecarboxylate), amidoflume (S-1955), avermectin, azadirachtin, azinphos-methyl, bifenthrin, bifenazate, buprofezin, carbofuran, cartap, chlorantraniliprole, chlorfenapyr, chlorfluazuron, chlorpyrifos, chlorpyrifos-methyl, chromafenozide, clothianidin, cyantraniliprole (3-bromo-1-(3-chloro-2-pyridinyl)-*N*-[4-cyano-2-methyl-6-[(methylamino)carbonyl]phenyl]-1*H*-pyrazole-5-carboxamide), cyclaniliprole (3-bromo-*N*-[2-bromo-4-chloro-6-[(1-cyclopropylethyl)amino]carbonyl]phenyl]-1-(3-chloro-2-pyridinyl)-1*H*-pyrazole-5-carboxamide), cycloxaprid ((*5S,8R*)-1-[(6-chloro-3-pyridinyl)methyl]-2,3,5,6,7,8-hexahydro-9-nitro-5,8-epoxy-1*H*-imidazo[1,2-*a*]azepine), cyflumetofen, cyfluthrin, beta-cyfluthrin, cyhalothrin, lambda-cyhalothrin, cypermethrin, cyromazine, deltamethrin, diafenthiuron, diazinon, dieldrin, diflubenzuron, dimefluthrin, dimethoate, dinotefuran, diofenolan, emamectin, endosulfan, esfenvalerate, ethiprole, fenothiocarb, fenoxycarb,

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

One embodiment of biological agents for mixing with compounds of this disclosure include entomopathogenic bacteria such as *Bacillus thuringiensis*, and the encapsulated delta-endotoxins of *Bacillus thuringiensis* such as MVP® and MVPII® bioinsecticides prepared by the CellCap® process (CellCap®, MVP® and MVPII® are trademarks of Mycogen Corporation, Indianapolis, Indiana, USA); entomopathogenic fungi such as green muscardine fungus; and entomopathogenic (both naturally occurring and genetically modified) viruses including baculovirus,

nucleopolyhedro virus (NPV) such as *Helicoverpa zea* nucleopolyhedrovirus (HzNPV), *Anagrapha falcifera* nucleopolyhedrovirus (AfNPV); and granulosis virus (GV) such as *Cydia pomonella* granulosis virus (CpGV).

5 General references for these 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.

10 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 to about 3000: 1, and more typically between about 1:500 and about 500:1. Of note are compositions where in the weight ratio of component (a) to component (b) is from about 125:1 to about 1:125. With many fungicidal compounds of component (b), these compositions are particularly effective for controlling plant diseases caused by fungal plant pathogens. Of
15 particular note are compositions wherein the weight ratio of component (a) to component (b) is from about 25:1 to about 1:25, or from about 5:1 to about 1:5. One skilled in the art can easily determine through simple experimentation the weight ratios and application rates of fungicidal compounds necessary for the desired spectrum of fungicidal protection and control. It will be evident that including additional fungicidal compounds in component (b) may expand the
20 spectrum of plant diseases controlled beyond the spectrum controlled by component (a) 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
25 fungicidal active ingredients occurs at application rates giving agronomically satisfactory levels of fungal control, such combinations can be advantageous for reducing crop production cost and decreasing environmental load.

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

Fungicides of note for formulation with compounds of Formula 1 to provide mixtures useful in seed treatment include but are not limited to amisulbrom, azoxystrobin, boscalid, carbendazim,
35 carboxin, cymoxanil, cyproconazole, difenoconazole, dimethomorph, florylpicoxamid,

fluazinam, fludioxonil, flufenoxystrobin, fluquinconazole, fluopicolide, fluoxastrobin, flutriafol, fluxapyroxad, ipconazole, iprodione, metalaxyl, mefenoxam, mefentrifluconazole, metconazole, myclobutanil, paclobutrazole, penflufen, picoxystrobin, prothioconazole, pyraclostrobin, sedaxane, silthiofam, tebuconazole, thiabendazole, thiophanate-methyl, thiram, trifloxystrobin and triticonazole.

Invertebrate pest control compounds or agents with which compounds of Formula 1 can be formulated to provide mixtures useful in seed treatment include but are not limited to abamectin, acetamiprid, acrinathrin, afidopyropen, amitraz, avermectin, azadirachtin, bensultap, bifenthrin, buprofezin, cadusafos, carbaryl, carbofuran, cartap, chlorantraniliprole, chlorfenapyr, chlorpyrifos, clothianidin, cyantraniliprole, cyclaniliprole, cyfluthrin, beta-cyfluthrin, cyhalothrin, gamma-cyhalothrin, lambda-cyhalothrin, cypermethrin, alpha-cypermethrin, zeta-cypermethrin, cyromazine, deltamethrin, dieldrin, dinotefuran, diofenolan, emamectin, endosulfan, esfenvalerate, ethiprole, etofenprox, etoxazole, fenothiocarb, fenoxycarb, fenvalerate, fipronil, flonicamid, flubendiamide, fluensulfone, flufenoxuron, flufiprole, flupyradifurone, fluvalinate, formetanate, fosthiazate, heptafluthrin, hexaflumuron, hydramethylnon, imidacloprid, indoxacarb, lufenuron, meperfluthrin, metaflumizone, methiocarb, methomyl, methoprene, methoxyfenozide, momfluorothrin, nitenpyram, nithiazine, novaluron, oxamyl, pyflubumide, pymetrozine, pyrethrin, pyridaben, pyriminostrobin, pyridalyl, pyriproxyfen, ryanodine, spinetoram, spinosad, spirotetramat, sulfoxaflor, tebufenozide, tetramethrin, tetramethylfluthrin, thiacloprid, thiamethoxam, thiodicarb, thiosultap-sodium, tralomethrin, triazamate, triflumuron, *Bacillus thuringiensis* delta-endotoxins, strains of *Bacillus thuringiensis* and strains of *Nucleo polyhydrosis* viruses.

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

Seed treatments can also include one or more nematicidal agents of natural origin such as the elicitor protein called harpin which is isolated from certain bacterial plant pathogens such as

Erwinia amylovora. An example is the Harpin-N-Tek seed treatment technology available as N-Hibit™ Gold CST.

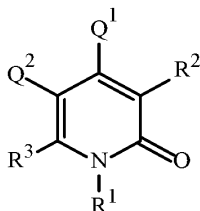
Seed treatments can also include one or more species of legume-root nodulating bacteria such as the microsymbiotic nitrogen-fixing bacteria *Bradyrhizobium japonicum*. These
5 inoculants can optionally include one or more lipo-chitooligosaccharides (LCOs), which are nodulation (Nod) factors produced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

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

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

The following TESTS demonstrate the control efficacy of compounds of this invention on specific pathogens. The pathogen control protection afforded by the compounds is not limited,
20 however, to these species. See Index Table A below for compound descriptions. The abbreviation “Cmpd.” stands for “Compound”, and the abbreviation “Ex.” stands for “Example” and is followed by a number indicating in which example the compound is prepared. The numerical value reported in the column “MS” is the molecular weight of the highest isotopic abundance positively charged parent ion (M+1) formed by addition of H⁺ (molecular weight of 1) to the
25 molecule having the highest isotopic abundance, or the highest isotopic abundance negatively charged ion (M–1) formed by loss of H⁺ (molecular weight of 1). The presence of molecular ions containing one or more higher atomic weight isotopes of lower abundance (e.g., ³⁷Cl, ⁸¹Br) is not reported. The reported MS peaks were observed by mass spectrometry using electrospray ionization (ESI) or atmospheric pressure chemical ionization (APCI).

INDEX TABLE A



Cmpd. No.	R ¹	R ²	Q ¹	Q ²	R ³	m.p. (°C)	MS (M+1)
1	Me	Cl	2-Cl, 4-F-Ph	2-Cl, 5-F-Ph	H		400
2	Me	I	2-Cl, 4-F-Ph	2-Cl, 5-F-Ph	H		492
3 (Ex. 2)	Me	Cl	2-Cl, 4-F-Ph	3,5-di-MeO-Ph	H	172-175	
4 (Ex. 3)	Me	Cl	2-Cl, 4-F-Ph	2-Cl, 3,5-di-MeO-Ph	H	170-173	
5 (Ex. 3)	Me	Cl	2-Cl, 4-F-Ph	4-Cl, 3,5-di-MeO-Ph	H	186-190	
6	Me	C≡N	2-Cl, 4-F-Ph	3-MeO-Ph	Me		383
7	Me	C≡N	2-Cl, 4-F-Ph	2-Br, 4-F-Ph	Me		
8	Me	Cl	2,4-di-F-Ph	3-MeO-Ph	H	159-161	
9	Me	Cl	2,4-di-F-Ph	2-Br, 3,5-di-MeO-Ph	H	211-214	
10	Me	Cl	2,4-di-F-Ph	2-Cl, 5-PrO-Ph	H	123-126	
11	Me	Cl	2,6-di-F-Ph	Ph	H	189-192	
12	Me	Me	2-Cl, 4-F-Ph	3,5-di-MeO-Ph	H	169-172	
13	Me	Me	2-Cl, 4-F-Ph	2-Cl, 3,5-di-MeO-Ph	H	140-143	
14	Me	C≡N	2-Cl, 4-F-Ph	2-Cl, 5-F-Ph	H		391
15	Me	Cl	2-Cl, 4-F-Ph	2-Cl-Ph	H		384
16	Me	Cl	2,6-di-F-Ph	2-Cl, 4-F-Ph	H	206-209	
17	Me	Cl	2,6-di-F-Ph	4-F-Ph	H	201-204	
18	Me	Me	2-Cl, 4-F-Ph	2-Cl, 5-F-Ph	H		380
19 (Ex. 4)	MeO	Cl	2-Cl, 4-F-Ph	3,5-di-MeO-Ph	H	144-147	
20	Me	Cl	2,4-di-F-Ph	2-Br, 5-MeO-Ph	H	227-230	
21	Me	Cl	2,4-di-F-Ph	3-MeO, 4-Br-Ph	H	185-188	
22 (Ex. 5)	MeO	Cl	2-Cl, 4-F-Ph	2-Cl, 3,5-di-MeO-Ph	H	157-160	
23	Me	Et	2-Cl, 4-F-Ph	2-Cl, 5-F-Ph	H		394
24	Me	Cl	2-Cl, 4-F-Ph	2,5-di-F-Ph	H		384
25	Me	Cl	2,4-di-F-Ph	3,5-di-MeO-Ph	H	148-151	
26	Me	Cl	2-Cl, 4-F-Ph	2,4,5-tri-F-Ph	H		402

Cmpd. No.	R ¹	R ²	Q ¹	Q ²	R ³	m.p. (°C)	MS (M+1)
27	Me	Cl	2-Cl, 4-F-Ph	2-CF ₃ -Ph	H		416
28	Me	Cl	2-Cl, 4-F-Ph	2-F, 5-MeO-Ph	H		396
29	Me	Cl	2,4-di-F-Ph	2-Cl, 3,5-di-MeO-Ph	H	189-192	
30	Me	Cl	2,4-di-F-Ph	2-Cl, 5-MeO-Ph	H	192-195	
31	Me	H	2-Cl, 4-F-Ph	2-Cl, 5-MeO-Ph	H		378
32	Me	Cl	2-Cl, 4-F-Ph	2-Cl, 5-MeO-Ph	H		414
33	Me	Br	2-Cl, 4-F-Ph	2-Cl, 5-MeO-Ph	H		458
34	Me	H	2-Cl, 4-F-Ph	2-Cl, 5-F-Ph	H		366
35	N≡CCH ₂ O	Cl	2-Cl, 4-F-Ph	2-Cl, 3,5-di-MeO-Ph	H	139-142	
36 (Ex. 8)	CH≡CCH ₂ O	Cl	2-Cl, 4-F-Ph	2-Cl, 3,5-di-MeO-Ph	H	140-143	
37	F ₂ CHCH ₂ O	Cl	2-Cl, 4-F-Ph	2-Cl, 3,5-MeO-Ph	H	83-86	
38 (Ex. 7)	F ₂ CHO	Cl	2-Cl, 4-F-Ph	2-Cl, 3,5-di-MeO-Ph	H		
39 (Ex. 6)	OH	Cl	2-Cl, 4-F-Ph	2-Cl, 3,5-di-MeO-Ph	H	144-147	
40	Me	Cl	2,4-di-F-Ph	2-Cl, 5-F	H	161-165	
41	Me	Cl	2,4-di-F-Ph	2,4-di-F-Ph	H	141-144	
42	Me	Cl	2,4-di-F-Ph	2-Cl, 4-F-Ph	H	156-159	
43	Me	Me	2-Cl, 4-F-Ph	2-Cl, 5-MeO-Ph	H		392
44	Me	Cl	2,6-di-F-Ph	2-Cl, 4-F-Ph	Cl	162-165	
45	EtO	Cl	2-Cl, 4-F-Ph	3,5-di-MeO-Ph	H	163-167	
46	EtO	Cl	2-Cl, 4-F-Ph	2-Cl, 3,5-di-MeO-Ph	H	147-150	
47	Me	Et	2-Cl, 4-F-Ph	2-Cl, 5-MeO-Ph	H		406
48	Me	Cl	2,4-di-F-Ph	2-Cl-Ph	H	173-176	
49	Me	Cl	2,4-di-F-Ph	2-F, 5-MeO-Ph	H	159-162	
50	Me	Cl	2,4-di-F-Ph	2,6-di-F, 3,5-di-MeO-Ph	H	165-168	
51	Me	Cl	2,4-di-F-Ph	2-F, 3,5-di-MeO-Ph	H	155-158	
52	Me	Cl	2,4-di-F-Ph	2-Cl, 5-EtO-Ph	H	123-126	
53 (Ex. 1)	Me	H	2-Cl, 4-F-Ph	3,5-di-MeO-Ph	H		374
54	Me	Cl	2-Cl, 4-F-Ph	2-Me, 3-NO ₂ -Ph	H		407
55	Me	Cl	2-Cl, 4-F-Ph	3-Cl, 2-thienyl	H		388
56	Me	Cl	2-Cl, 4-C≡N-Ph	2-Cl, 5-MeO-Ph	H	236-239	
57	Me	Cl	2-CF ₃ -Ph	2-Cl, 5-MeO-Ph	H	148-152	
58	Me	H	2-Cl, 4-Br-Ph	2-Cl, 5-MeO-Ph	H	110-114	
59	Me	H	2-Cl, 4-C≡N-Ph	2-Cl, 5-MeO-Ph	H		385

Cmpd. No.	R ¹	R ²	Q ¹	Q ²	R ³	m.p. (°C)	MS (M+1)
60	Me	Cl	2-Cl, 4-F-Ph	4-Me, 6-F, 3-pyridinyl	H		381
61	Me	Cl	2-F-Ph	2-Cl, 5-MeO-Ph	H	173-175	
62	Me	H	2-Br-Ph	2-Cl, 5-MeO-Ph	H		404
63	Me	Cl	2-Cl, 4-F-Ph	3-Me, 2-thienyl	H		368
64	Me	Cl	2,3-di-F-Ph	2-Cl, 5-MeO-Ph	H	160-163	
65	Me	H	2,3-di-F-Ph	2-Cl, 5-MeO-Ph	H		362
66	Me	Cl	2-Cl, 4-F-Ph	3-NO ₂ -Ph	H		393
67	Me	Cl	2-Br-Ph	2-Cl, 5-MeO-Ph	H	133-136	
68	Me	H	2-Cl, 4-MeO-Ph	2-Cl, 5-MeO-Ph	H		390
69	Me	Cl	2-Cl, 4-MeO-Ph	2-Cl, 5-MeO-Ph	H		424
70	Me	H	2-CF ₃ -Ph	2-Cl, 5-MeO-Ph	H		394
71	Me	Cl	2-Br, 4-F-Ph	2-Cl, 5-MeO-Ph	H		456
72	N≡C	Cl	2-Cl, 4-F-Ph	2-Cl, 5-MeO-Ph	H	68-71	
73	N≡CCH ₂	Cl	2-Cl, 4-F-Ph	2-Cl, 5-MeO-Ph	H	153-156	
74	HC≡CCH ₂	Cl	2-Cl, 4-F-Ph	2-Cl, 5-MeO-Ph	H		436
75	CH ₃ CH ₂	Cl	2-Cl, 4-F-Ph	2-Cl, 5-MeO-Ph	H		426
76	CH ₃ CH ₂ CH ₂	Cl	2-Cl, 4-F-Ph	2-Cl, 5-MeO-Ph	H		440
77	CH ₂ =CHCH ₂	Cl	2-Cl, 4-F-Ph	2-Cl, 5-MeO-Ph	H		438
78	NH ₂	Cl	2-Cl, 4-F-Ph	2-Cl, 5-MeO-Ph	H		445

BIOLOGICAL EXAMPLES OF THE INVENTION

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

TEST A

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

TEST B

The test solution was sprayed to the point of run-off on wheat seedlings. The following day the seedlings were inoculated with a spore suspension of *Puccinia recondita* f. sp. *tritici* (the causal agent of wheat leaf rust) and incubated in a saturated atmosphere at 20 °C for 24 h, and then moved to a growth chamber at 20 °C for 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 dust of *Blumeria graminis* f. sp. *tritici*, (also known as *Erysiphe graminis* f. sp. *tritici*, the causal agent of wheat powdery mildew) and incubated in a growth chamber at 20 °C for 8 days, after which time visual disease ratings were made.

TEST D

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

TEST 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 *Botrytis cinerea* (the causal agent of tomato Botrytis) and incubated in a 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.

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 *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 3 days, after which time visual disease ratings were made.

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

TABLE A

Cmpd. No.	Rate in ppm	Test A	Test B	Test C	Test D	Test E	Test F
1	50	100	100	0	0	98	46
2	50	100	98	0	0	91	33

Cmpd. No.	Rate in ppm	Test A	Test B	Test C	Test D	Test E	Test F
3	50	99	100	0	65	100	100
4	50	100	100	98	99	100	100
5	250	100	100	0	78	98	99
6	250	0	0	89	0	0	0
7	50	0	19	99	0	0	0
8	250	100	100	98	81	99	99
9	50	100	100	99	100	98	100
10	50	99	99	79	0	94	0
11	50	99	80	0	0	97	94
12	50	100	99	40	83	92	99
13	50	100	100	100	100	94	100
14	50	100	100	0	0	96	0
15	50	100	100	69	0	88	0
16	50	100	97	0	68	96	31
17	50	100	99	0	75	98	100
18	50	100	100	94	96	98	99
19	50	58	99	0	11	98	0
20	50	100	100	98	97	98	99
21	50	70	96	0	0	94	91
22 (Ex. 5)	50	99	100	76	97	98	99
23	50	100	100	99	0	69	83
24	50	96	96	0	0	85	0
25	50	100	100	0	84	82	99
26	50	99	86	0	0	83	0
27	50	98	100	0	25	58	0
28	50	100	100	97	87	98	99
29	50	100	100	99	100	94	99
30	50	100	100	100	100	94	99
31	50	96	96	0	0	99	0
32	50	100	100	99	99	100	100
33	50	100	100	99	89	100	100
34	50	100	68	48	59	98	0
35	50	84	100	73	92	94	0
36	50	98	99	0	96	96	0

88

Cmpd. No.	Rate in ppm	Test A	Test B	Test C	Test D	Test E	Test F
37	50	68	99	0	87	88	0
38 (Ex. 6)	50	96	100	73	75	96	0
39	50	69	86	0	77	56	0
40	50	100	100	98	92	94	99
41	50	100	96	96	69	91	91
42	50	100	99	93	73	94	93
43	50	100	100	100	97	98	100
44	50	98	93	79	96	40	0
45	250	100	91	72	0	97	0
46	250	99	100	92	99	88	47
47	50	81	100	99	51	91	99
48	50	99	99	72	77	96	96
49	50	100	100	0	73	96	100
50		—	—	—	—	—	—
51	50	100	100	98	99	98	100
52	50	100	100	91	81	99	99
53	250	100	97	56	59	99	0
54	50	100	99	0	75	92	26
55	50	96	90	0	0	97	0
56	50	100	100	98	97	96	99
57	50	98	99	64	44	90	0
58	50	98	55	0	0	90	0
59	50	99	92	0	0	95	0
60	50	99	95	73	65	97	40
61	50	100	100	89	94	98	100
62	50	37	74	0	0	98	0
63	50	84	80	0	0	88	0
64	50	98	100	87	87	96	100
65	50	8	95	0	0	96	0
66	50	42	80	0	0	79	0
67	50	99		56	73	91	33
68	50	61	98	0	0	88	73
69	50	100	100	99	79	98	100
70	50	50	68	83	0	93	0

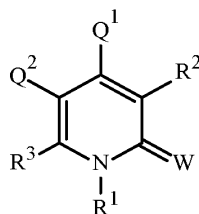
89

Cmpd. No.	Rate in ppm	Test A	Test B	Test C	Test D	Test E	Test F
71	50	100	100	100	73	96	99
72	50	82	99	0	75	99	0
73		—	—	—	—	—	—
74		—	—	—	—	—	—
75	50	97	97	0	0	98	0
76	50	63	55	0	0	96	0
77	50	40	74	0	0	91	0
78	50	—	99	—	92	98	—

CLAIMS

What is claimed is:

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

**1**

5 wherein

W is O or S;

Q¹ and Q² are each independently a phenyl ring optionally substituted with up to 5
substituents independently selected from R⁴; or a 5- to 6-membered
heteroaromatic ring, each ring containing ring members selected from carbon
atoms and 1 to 4 heteroatoms independently selected from up to 2 O, up to 2 S
and up to 4 N atoms, each ring optionally substituted with up to 5 substituents
independently selected from R⁴; or a 3- to 6-membered nonaromatic heterocyclic
ring, each ring containing ring members selected from carbon atoms and 1 to 4
heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N
atoms, wherein up to 2 ring members are independently selected from C(=O),
C(=S), S(=O) and S(=O)₂, each ring optionally substituted with up to 5
substituents independently selected from R⁴;

R¹ is amino, cyano, hydroxy, NH₂C(=O)H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₂-C₆
alkenyl, C₂-C₆ haloalkenyl, C₂-C₆ alkynyl, C₂-C₆ haloalkynyl, C₂-C₆
cyanoalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyloxy, C₂-C₆
haloalkenyloxy, C₂-C₆ alkynyloxy, C₂-C₆ haloalkynyloxy, C₂-C₆ cyanoalkoxy,
C₁-C₆ alkylamino, C₁-C₆ haloalkylamino, C₂-C₆ dialkylamino, C₄-C₈
alkylcarbonylamino, C₂-C₆ alkoxyalkylamino, C₂-C₆ alkylcarbonyl, C₂-C₆
haloalkylcarbonyl, C₂-C₆ alkoxy carbonyl or C₂-C₆ haloalkoxy carbonyl; or C₃-
C₆ cycloalkyl or C₄-C₆ cycloalkylalkyl, each optionally substituted with up to 3
substituents independently selected from halogen, cyano and C₁-C₃ alkyl;

R² is H, halogen, cyano, hydroxy, nitro, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₂-C₆ alkenyl,
C₂-C₆ haloalkenyl, C₂-C₆ alkynyl, C₂-C₆ haloalkynyl, C₂-C₆ cyanoalkyl, C₁-C₆
alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkoxyalkyl, C₂-C₆ haloalkoxyalkyl, C₂-C₆
alkoxyalkoxy or C₂-C₆ haloalkoxyalkoxy; or C₃-C₆ cycloalkyl or C₄-C₆

- cycloalkylalkyl, each optionally substituted with up to 3 substituents independently selected from halogen, cyano and C₁-C₃ alkyl;
- R³ is H, halogen, amino, cyano, hydroxy, nitro, C(=O)H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₂-C₆ alkenyl, C₂-C₆ haloalkenyl, C₂-C₆ alkynyl, C₂-C₆ haloalkynyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl or C₂-C₆ alkoxycarbonyl; or a 3- to 6-membered nonaromatic ring containing ring members selected from carbon atoms and optionally up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, wherein up to 2 carbon atom ring members are independently selected from C(=O) and C(=S), each ring optionally substituted with up to 5 substituents independently selected from R⁵;
- each R⁴ is independently halogen, cyano, nitro, amino, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₂-C₆ alkenyl, C₂-C₆ haloalkenyl, C₂-C₆ alkynyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₄-C₆ alkylcycloalkyl, C₄-C₆ cycloalkylalkyl, C₁-C₆ alkoxy, C₁-C₆ haloalkoxy, C₂-C₆ alkenyloxy, C₂-C₆ haloalkenyloxy, C₂-C₆ alkynyloxy, C₂-C₆ haloalkynyloxy, C₃-C₆ cycloalkoxy, C₂-C₄ alkylcarbonyloxy, C₂-C₄ haloalkylcarbonyloxy, C₁-C₆ alkylsulfonyloxy, C₁-C₆ haloalkylsulfonyloxy, C₁-C₆ alkylthio, C₁-C₆ haloalkylthio, C₁-C₆ alkylsulfinyl, C₁-C₆ haloalkylsulfinyl, C₁-C₆ alkylsulfonyl, C₁-C₆ haloalkylsulfonyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₁-C₆ alkylamino, C₁-C₆ haloalkylamino, C₂-C₆ dialkylamino or -U-V-T;
- each R⁵ is independently halogen, cyano, hydroxy, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₂-C₄ alkylcarbonyl or C₂-C₄ alkylcarbonyloxy;
- each U is independently a direct bond, O, S(=O)_m or NR⁶;
- each V is independently C₁-C₆ alkylene, C₂-C₆ alkenylene, C₃-C₆ alkynylene, C₃-C₆ cycloalkylene or C₃-C₆ cycloalkenylenylene, wherein up to 2 carbon atoms are C(=O), each optionally substituted with up to 5 substituents independently selected from halogen, cyano, nitro, hydroxy, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₁-C₆ alkoxy and C₁-C₆ haloalkoxy;
- each T is independently cyano, NR^{7a}R^{7b}, OR⁸ or S(=O)_mR⁹;
- each R⁶ is independently H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₂-C₆ alkylcarbonyl, C₂-C₆ haloalkylcarbonyl, C₂-C₆ alkoxycarbonyl, C₂-C₆ (alkylthio)carbonyl or C₂-C₆ alkoxy(thiocarbonyl);
- each R^{7a} and R^{7b} is independently H, C₁-C₆ alkyl, C₁-C₆ haloalkyl, C₂-C₆ alkenyl, C₂-C₆ haloalkenyl, C₂-C₆ alkynyl, C₂-C₆ haloalkynyl, C₃-C₆ cycloalkyl, C₃-C₆ halocycloalkyl, C₂-C₆ alkylcarbonyl or C₂-C₆ alkoxycarbonyl; or

R^{7a} and R^{7b} are taken together with the nitrogen atom to which they are attached to form a 3- to 6-membered heterocyclic ring, the ring optionally substituted with up to 3 substituents independently selected from R^{10} ;

each R^8 and R^9 is independently H, C_1 - C_6 alkyl, C_1 - C_6 haloalkyl, C_2 - C_6 alkenyl, C_2 - C_6 haloalkenyl, C_2 - C_6 alkynyl, C_3 - C_6 cycloalkyl, C_3 - C_6 halocycloalkyl, C_2 - C_6 alkylcarbonyl, C_2 - C_6 haloalkylcarbonyl or C_2 - C_6 alkoxy carbonyl;

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

each m is independently 0, 1 or 2.

provided that:

(a) when Q^1 is an optionally substituted phenyl ring, then Q^2 is other than an optionally substituted 1*H*-pyrazol-4-yl ring; and

(b) the compound of Formula 1 is not:

3,6-dichloro-1-methyl-4,5-diphenyl-2(1*H*)-pyridinone;

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

1-[5-[1-(cyclopropylmethyl)-1*H*-pyrazol-4-yl]-1,2-dihydro-1-methyl-2-oxo-4-pyridinyl]-1*H*-pyrrole-3-carboxylic acid;

1-[1,2-dihydro-1-methyl-5-(1-methyl-1*H*-pyrazol-4-yl)-2-oxo-4-pyridinyl]-1*H*-pyrrole-3-carboxylic acid;

1-methyl-5-(1-methyl-1*H*-pyrazol-4-yl)-4-(1*H*-pyrrol-1-yl)-2(1*H*)-pyridinone,

1-amino-3,6-dimethyl-4,5-diphenyl-2(1*H*)-pyridinone,

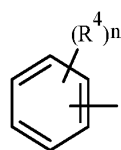
methyl (3,6-dimethyl-2-oxo-4,5-diphenyl-1(2*H*)-pyridinyl)carbamate, or

ethyl (3,6-dimethyl-2-oxo-4,5-diphenyl-1(2*H*)-pyridinyl)carbamate.

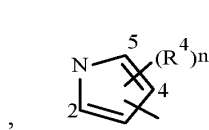
2. A compound Claim 1 wherein

W is O;

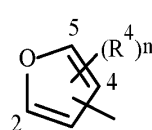
Q^1 and Q^2 are each independently selected from A-1 through A-47



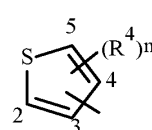
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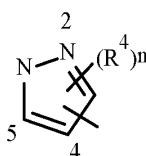
A-2



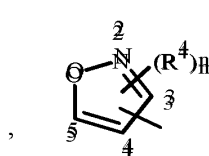
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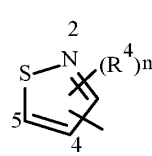
A-4



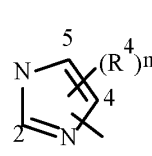
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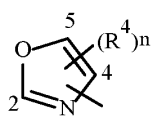
A-6



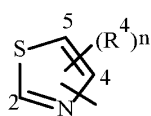
A-7



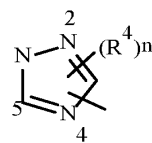
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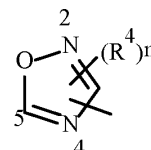
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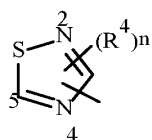
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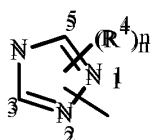
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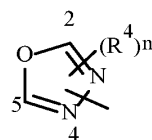
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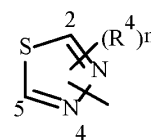
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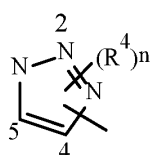
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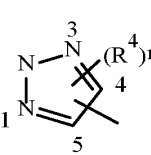
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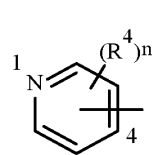
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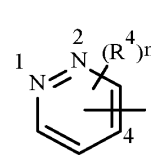
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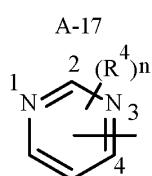
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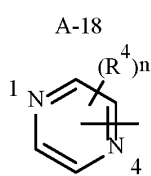
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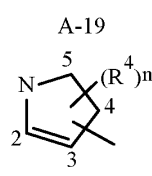
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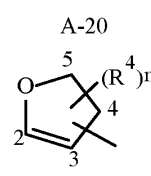
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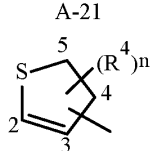
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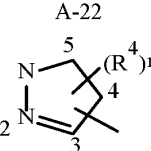
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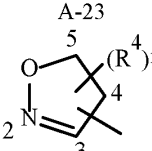
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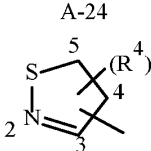
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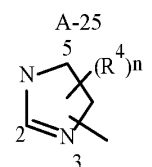
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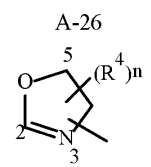
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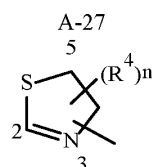
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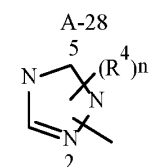
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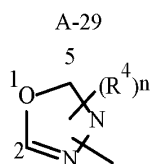
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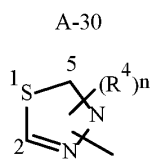
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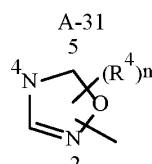
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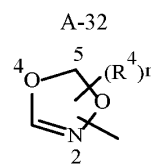
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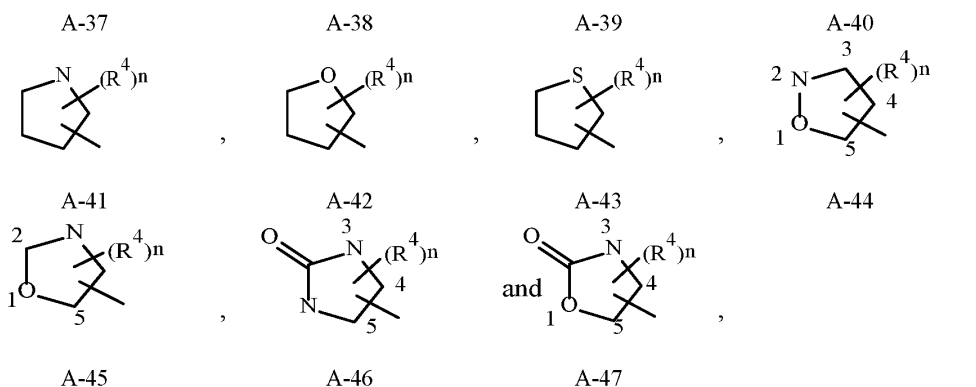
A-34



A-35



A-36



wherein the floating bond is connected to Formula 1 through any available carbon or nitrogen atom of the depicted ring; and

each n is independently 0, 1, 2, 3 or 4;

R^1 is cyano, C_1 - C_3 alkyl, C_1 - C_3 haloalkyl, C_2 - C_3 alkenyl, C_2 - C_3 haloalkenyl, C_2 - C_3 cyanoalkyl, C_1 - C_3 alkoxy, C_1 - C_3 haloalkoxy, C_2 - C_3 alkenyloxy, C_2 - C_3 haloalkenyloxy, C_2 - C_3 alkynyloxy or C_2 - C_3 cyanoalkoxy; or cyclopropyl optionally substituted with up to 3 substituents independently selected from halogen and methyl;

R^2 is H, halogen, cyano, C_1 - C_3 alkyl, C_1 - C_3 haloalkyl, C_2 - C_3 alkenyl, C_2 - C_3 haloalkenyl, C_2 - C_3 alkynyl, C_2 - C_3 haloalkynyl, C_2 - C_3 cyanoalkyl, C_1 - C_3 alkoxy or C_1 - C_3 haloalkoxy; or cyclopropyl optionally substituted with up to 3 substituents independently selected from halogen, cyano and methyl;

R^3 is H, halogen, cyano, C_1 - C_3 alkyl, C_1 - C_3 haloalkyl, C_1 - C_3 alkoxy or C_1 - C_3 haloalkoxy; or a 3- to 6-membered nonaromatic ring containing ring members selected from carbon atoms and optionally up to 4 heteroatoms independently selected from up to 2 O, up to 2 S and up to 4 N atoms, wherein up to 2 carbon atom ring members are independently selected from $C(=O)$ and $C(=S)$, each ring optionally substituted with up to 3 substituents independently selected from R^5 ;

each R^4 is independently halogen, cyano, C_1 - C_4 alkyl, C_1 - C_4 haloalkyl, C_2 - C_4 alkenyl, C_2 - C_4 haloalkenyl, C_2 - C_4 alkynyl, C_2 - C_4 haloalkynyl, C_3 - C_6 cycloalkyl, C_3 - C_6 halocycloalkyl, C_1 - C_4 alkoxy, C_1 - C_4 haloalkoxy, C_2 - C_4 alkenyloxy, C_2 - C_4 haloalkenyloxy, C_2 - C_4 alkynyloxy, C_2 - C_4 haloalkynyloxy, C_2 - C_4 alkylcarbonyloxy, C_2 - C_4 haloalkylcarbonyloxy, C_1 - C_4 alkylthio, C_1 - C_4 haloalkylthio, C_2 - C_4 alkylcarbonyl, C_2 - C_4 haloalkylcarbonyl or -U-V-T;

each R^5 is independently halogen, cyano, methyl, halomethyl or methoxy;

each U is independently a direct bond, O or NR^6 ;

each V is independently C_1 - C_3 alkylene, wherein up to 1 carbon atom is $C(=O)$, optionally substituted with up to 2 substituents independently selected from halogen, methyl, halomethyl and methoxy;

each T is independently NR^{7a}R^{7b} or OR⁸;
each R⁶ is independently H, C₁-C₃ alkyl, C₁-C₃ haloalkyl or C₂-C₄ alkylcarbonyl;
each R^{7a} and R^{7b} is independently H, C₁-C₂ alkyl, C₁-C₂ haloalkyl or cyclopropyl;
and
5 each R⁸ is independently H, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ alkenyl, C₂-C₃
haloalkenyl or cyclopropyl.

3. A compound of Claim 2 wherein

Q¹ and Q² are each independently selected from A-1, A-2, A-3, A-4, A-5, A-6, A-7
and A-19;

10 R¹ is cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ cyanoalkyl, C₁-C₃ alkoxy, C₁-C₃
haloalkoxy, C₂-C₃ alkenyloxy, C₂-C₃ haloalkenyloxy, C₂-C₃ alkynyloxy or
C₂-C₃ cyanoalkoxy;

R² is H, halogen, cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ alkenyl, C₂-C₃
haloalkenyl, C₂-C₃ cyanoalkyl, C₁-C₃ alkoxy or C₁-C₃ haloalkoxy;

15 R³ is H, halogen, cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy or C₁-C₃
haloalkoxy;

each R⁴ is independently halogen, cyano, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₂-C₃ alkenyl
C₂-C₃ haloalkenyl, C₁-C₃ alkoxy, C₁-C₃ haloalkoxy, C₂-C₄ alkenyloxy, C₂-C₄
haloalkenyloxy, C₂-C₄ alkylcarbonyl, C₂-C₄ haloalkylcarbonyl or -U-V-T;

20 each U is independently a direct bond, O or NH;

each V is independently CH₂ or CH₂CH₂;

each R^{7a} and R^{7b} is independently H, methyl or halomethyl; and

each R⁸ is independently H, C₁-C₂ alkyl or C₁-C₂ haloalkyl.

4. A compound of Claim 3 wherein

25 Q¹ and Q² are each independently selected from A-1, A-4, A-5 and A-19;

each n is independently 1, 2 or 3;

R¹ is C₁-C₂ alkyl, C₁-C₂ haloalkyl, C₁-C₂ alkoxy or C₁-C₂ haloalkoxy;

R² is H, halogen, cyano or C₁-C₂ alkyl;

R³ is H, halogen or C₁-C₂ alkyl; and

30 each R⁴ is independently halogen, C₁-C₃ alkyl, C₁-C₃ haloalkyl, C₁-C₃ alkoxy or
C₁-C₃ haloalkoxy.

5. A compound of Claim 4 wherein

Q¹ and Q² are each 1-A;

each n is independently 2 or 3;

35 R¹ is C₁-C₂ alkyl or C₁-C₂ alkoxy;

R² is halogen, cyano, methyl or ethyl;

R³ is H, Br, Cl or methyl; and

each R⁴ is independently halogen, C₁-C₂ alkyl, C₁-C₂ haloalkyl, C₁-C₂ alkoxy or C₁-C₂ haloalkoxy.

6. A compound of Claim 5 wherein

5 Q¹ is A-1 substituted at the 2- and 4-positions with substituents independently selected from R⁴; or Q¹ is A-1 substituted at the 2- and 6-positions with substituents independently selected from R⁴; or Q¹ is A-1 substituted at the 2-, 4- and 6-positions with substituents independently selected from R⁴;

R¹ is methyl; and

each R⁴ is independently Br, Cl, F, methyl, C₁-C₂ alkoxy or C₁-C₂ haloalkoxy.

10 7. A compound of Claim 6 wherein

Q¹ is A-1 substituted at the 2- and 4-positions or 2- and 6-positions with substituents independently selected from R⁴,

R² is halogen, methyl or ethyl;

R³ is H; and

15 each R⁴ is independently Br, Cl, F, methyl, methoxy or ethoxy.

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

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

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

5-(2-chloro-3,5-dimethoxyphenyl)-4-(2-chloro-4-fluorophenyl)-1,3-dimethyl-2(1*H*)-pyridinone;

5-(2-bromo-5-methoxyphenyl)-3-chloro-4-(2,4-difluorophenyl)-1-methyl-2(1*H*)-pyridinone;

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

3-chloro-5-(2-chloro-5-methoxyphenyl)-4-(2,4-difluorophenyl)-1-methyl-2(1*H*)-pyridinone;

3-chloro-4-(2-chloro-4-fluorophenyl)-5-(2-chloro-5-methoxyphenyl)-1-methyl-2(1*H*)-pyridinone;

3-bromo-4-(2-chloro-4-fluorophenyl)-5-(2-chloro-5-methoxyphenyl)-1-methyl-2(1*H*)-pyridinone;

4-(2-chloro-4-fluorophenyl)-5-(2-chloro-5-methoxyphenyl)-1,3-dimethyl-2(1*H*)-pyridinone;

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

5-(2-chloro-5-methoxyphenyl)-4-(2,4-difluorophenyl)-1,3-dimethyl-2(1*H*)-pyridinone; and

5-(2-bromo-5-methoxyphenyl)-4-(2,4-difluorophenyl)-1,3-dimethyl-2(1*H*)-pyridinone.

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

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